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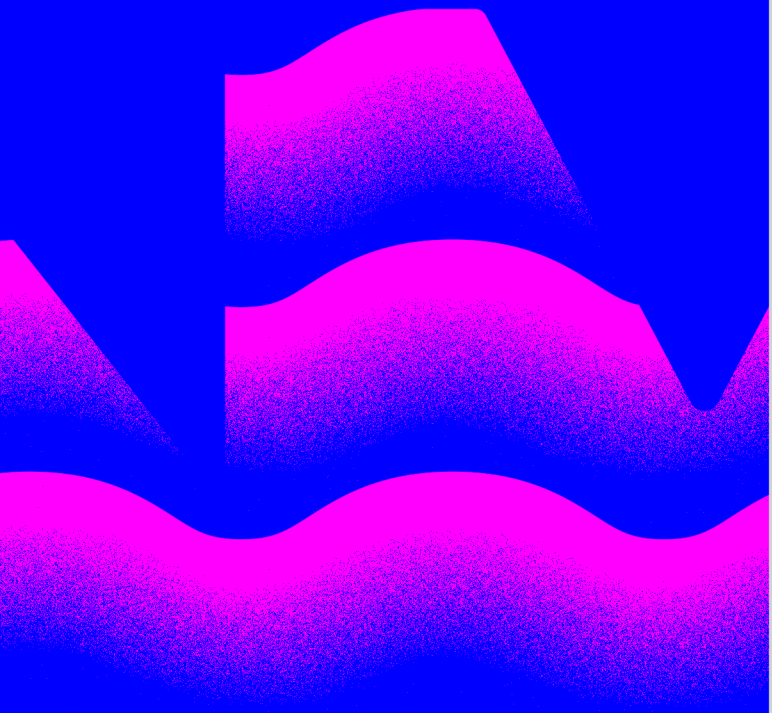

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藝術儀貳

INTERNATIONAL SYMPOSIUM ON MACHINE LEARNING AND ART 2021

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Art Machines 2: International Symposium on Machine Learning and Art 2021 Proceedings

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Preface and Acknowledgements

These are the official proceeding of *Art Machines 2: International Conference on Machine Learning and Art 2021* (*AM2*), which was conducted as a hybrid conference in Hong Kong from 10th-14th June, 2021, and organized and hosted by the School of Creative Media, City University of Hong Kong. *Art Machines 2* followed the success of *Art Machines* (2019) in establishing a community of scholars and artists focused upon Machine Learning Art. The conference consisted of three plenary sessions on machine learning and art featuring artists, a plenary session featuring scientists, three keynote addresses, open call panels, an open-call art exhibition and a student-run salon. Thanks to all who responded to our call and participated in this year's conference and thanks also to the various session chairs and moderators.

Plenary panels and keynotes were solicited by invitation; the breakout panels by open call. The overall acceptance rate for the open call was 42% and contributions were invited under four categories. Full papers were subject to double-blind peer review. Conference abstracts were solicited under two categories: artistic project abstracts and scholarly abstracts, and were reviewed by the organizing committee. Entries for the art exhibition were also subject to committee review. This volume contains the accepted full papers (8), together with the accepted scholarly abstracts (30), artistic project abstracts (32) and the description of artworks shown in the conference exhibition (27).

The conference organizing committee, who were mostly drawn from faculty and students of the School of Creative Media, divided responsibilities between them. Dr. Tobias Klein and Dr. Harald Kraemer led the review of artistic abstracts, Dr. Damien Charrieras, the scholarly abstracts, and Dr. Hector Rodriguez, the machine learning proposals, while Professor Richard Allen organized the full paper review process. Dr. Tobias Klein and Rodrigo Guzman Serrano curated the open call exhibition. Dr. Bryan Chung (Hong Kong Baptist University), Dr. Linda Lai, Dr. Tomas Laurenzo (University of Colorado, Boulder), Dr. RAY LC, Dr. Can Liu, and Dr. Elena Sherstoboeva participated in the review process. Anton Dragan Maslić, Rodrigo Guzman Serrano and Park Ji Yun organized the student salon. I want to thank them all for their hard work in making this conference possible.

Art Machines 2 was enabled by generous financial contributions from the U.S. Consulate General of Hong Kong & Macau and The Croucher Foundation. I want to thank CityU's former Provost Alex Jen and current Provost Christian Wagner for their support. Above all, I wish to thank Malina Siu for her brilliant administrative leadership, together with our production team of Danny Cheng, Antony Chan, Alan Tse, who smoothly implemented the online platforms, and Fion Ng, who expertly coordinated the staging of the art exhibition and student salon. Thanks also to Tobias Tang, Candy Tso and Sureshika Piyasena for their assistance and to Dr. Olli Tapio Leino for his help in publishing the proceedings.

Richard William Allen
Conference Director, Art Machines 2
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Part I

Full Papers

Control and Communication: A System Study of Platform Economics and Digital Archives in Architectural Design

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Abstract

A platform economy is a peer-to-peer model of circulating resources, facilitated by community-based digital platforms that are rapidly reconfiguring the notion of archives by democratizing the production, aggregation, and dissemination of information. This helps to facilitate a multi-access system for Creative Commons in architectural design, especially with the rise of generative algorithms that feed on large amounts of data. For instance, Pinterest has created one of the largest digital archives of architectural images, and gained immense popularity for its convenience in information exchange, providing a single access point that translates fragments of information between various mediums. Conversely, it can contribute to the generalization and depreciation of heterogeneity in architectural design and the progressive privatization of the platform economy. This gives urgency to the study of the benefits and limitations of digital platforms and technologies to facilitate a multi-access system, for which archival functions are crucial in serving democratization in three ways.

First, control and communication, for which the standardization of protocols facilitates multi-access platforms and crowd contribution to a worldwide architectural archive consortium. Second, information and value exchange within a platform economy, which may help to democratize the institutional model of appraisal by utilizing consensus mechanisms for self-organization, and direct valuable architectural information to users. Third, artificial creative common intelligence – data archives feed into distributive production pipelines comprising various open-source generative algorithms. This paper illustrates its arguments with a speculative research design, called *Current.cam*.

Introduction

For architects, archives are informative and intellectual agencies that feed and inspire our creative neurons, or nowadays, artificial neuronal networks. Within the larger socio-economic system, the role of archives is even more profound. First, archives provide an important legal function in identifying, managing, and preserving the integrity of properties and provide essential protection for the legal rights of constituents (CLIR 2017). This means that archives are our best proof system for authenticating tangible and intangible property rights. Second, value security. It is important to distinguish archives from storage; the latter is largely temporary, whereas the former is for the long-term preservation of singular objects. Storage has to ensure responsivity to logistics, while it is difficult to retrieve something from an archive, partly because of operations, and the cost of archiving acts as a guarantee of the value of an object, whereas storage does not necessarily do the same. The digital transformation of archival functions may help to democratize and integrate the qualities of archive and storage, where authenticity is built into the network structure to enable responsive and secure information transactions. Third, archives exist to accumulate and grow.

From a historiographical perspective, if there are insufficient records of our happenings, it will be difficult for historians to reconstruct events and truth, and this may affect our construction of shared memories. From a governing perspective, insufficient data creates a void of insecurity if the capacity to retain evidence is reduced (Jenkinson 1948). Apart from centralized surveys, which are often difficult to undertake in rural areas, the challenge in crowdsourcing of data is security and validity. For instance, institutions like the World Bank invest effort in designing incentive provisions to motivate individuals to contribute information, such as deed and title mining for land properties (WorldBank 2020). From an architectural perspective, the accumulation and growth of intellectual property (IP) is equivalent to accumulating and growing the wealth of designers. This problematizes the relationship between design as a shared construction, crowd participation, and intellectual wealth in the archives and its digital transformation.

While architecture has always been an economy that relies on information exchange, platform economics is different, in that it emphasizes the peer-to-peer (P2P) collection and distribution of relevant information at an appropriate time (Castells 2000). Platform economies as complex systems can be studied through control and communication (C&C) to examine their capacity for self-organization (Wiener, 1948). The relationship between C&C is embodied in a networking model that enables the description of all types of communication and their control in each layer. The control problem of information exchanges in a network concerns communication functions and protocols, "the latter being a tool for implementing the relevant communication functions" (Puman and Poízek 1979, 1). In architecture, C&C are practiced every day through platforms and technologies that are devoted to the design and development of IP, industrial processes, resources circulation, and value networks. This facilitates a platform economy, in which actors interact, exchange, and make decisions based on feedback from information, and productivity, which depends on the design of C&C within a multi-access information system, in which nodes collectively agree on the value of information assets, quantify the importance of connections in a network, distribute data storage and computing power, and create value through P2P information feedback.

Architectural design is a system that depends on the import and export of information, such as drawings and 3D-models. Digital platforms provide an interface network for users and machines, and archives function as the backend, which supports not only generative algorithms, but also system evaluation. Presently, our indexical measures of development, such as GDP, are designed to quantify the mass of information that is consumed, but not the amount of valued work that is circulating. In other words, architectural industries account for the monetary value generated without taking into consideration relative utility, in which energy and resources may be easily dissipated within the system during participatory processes, like logistics and communication. Economies that assess development solely by its linear consumption become a fundamental obstacle to multi-access systems.

Fig. 1. A platform economy with a network of computers transacting information from P2P on an E_8 topology.

The question of how to take advantage of the network structure through the design of C&C in a system is at the heart of the problem; it helps to think about how our socio-econometric system can be transformed, which depends upon and affects our means of archiving. As architectural production progresses into the digital age, the architectural economy and the means of producing, gathering, trading, and archiving information has to advance beyond the industrial age. This gives urgency to the study of the modern history of C&C. Systematic organization can be traced back to cybernetics, where information feedback on human-machine interactions was investigated under various

disciplinary contexts, from the natural sciences to the social sciences.

This study asks the question: What are the roles of archives and platforms in a multi-access system design? More specifically, how may such a system aggregate human and machine intelligence into collectively processing data in architectural design, creating artificial creative common intelligence?

Historiography

This historiography maps a series of events around cybernetics and its related domains, including information and game theory. It focuses on cybernetics as the main field of study because of its interdisciplinary nature, which enables us to approach all kinds of sciences, from social to natural, using a set of vocabularies that is understandable across disciplines, and facilitates communication using both natural and mathematical language to infer models of systems and begin to work with them. Cybernetics is also one of the founding fields of Artificial Intelligence (AI) in its formulation of feedback systems, black boxes, and human-machine interactions.

As cybernetics emphasizes C&C between actors, humans, and machines, it is inevitable that the processes of information circularity be brought into the light of speculation. These processes range from the garnering, structuring, and archiving information from our sensory devices to the control of our environment, according to predictions generated from archived data in a feedback loop. Thus, a historiography of cybernetics provides a prospective starting point that delivers an interdisciplinary vocabulary base to discuss the workings of archives and platforms.

Architecture has always had an intriguing relationship with cybernetics, from Cedric Price's (1964) Fun Palace to Gordon Pask's (1968) Colloquy of Mobiles. These architectural works embody the spirit of cybernetics, with their interactivity between the occupant and the physical building, while capturing a future where computer-aided design, as a cybernetic method, facilitates the feedback processes between humans and the machines in all walks of life. Pask (1969) stated that such forms of embodiment are merely the veneer of what will lead to extensive disciplinary and philosophical avenues of system design and operational research in architecture.

Today, the legacy of cybernetics and its theories are being deployed in all aspects of architectural production, to such an extent that we barely notice it anymore, including our personalization feedback systems on social media, enabled by AI; smart technologies that facilitate a "man-environment dialogue;" the design of agent-based and goal-oriented generative algorithms; and our interdisciplinary approach, which unifies the concepts of architecture with others "to yield an adequately broad view of such entities as 'civilisation' 'city' and 'educational system'" (Pask 1969, 74).

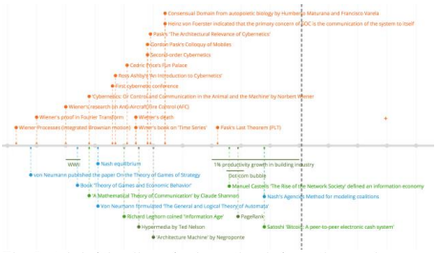


Fig. 2. A brief timeline of cybernetics, information, and game theory from pre-WWII to late 2000s.

Cybernetics and Information

The year 1948 saw the birth of two publications that changed the way we think about information: "A Mathematical Theory of Communication," by Claude Shannon, and "Cybernetics: Or Control and Communication in the Animal and the Machine," by Norbert Wiener. The former dealt with the nature of information and its relationship with the tools that operate it; while the latter dealt with how information can become a tool. While both consisted of discovery processes that considered how information becomes value at the point of interaction, Shannon saw value as bandwidth – how much information can be expressed within a transmission; and Weiner saw value as the ability to pre-empt within a statistical structure (Kaiser 2020).

Shannon's work was born in a time when the democratization of telephone communication was at the forefront. It was in his landmark publication that Shannon (1948) expressed the potential he saw in the digitization of information, which helps prevent messages from being corrupted by noise when transmitted from one end to a distant other end. He used "bits" as a unit of information transmission. "Bits," short for binary digits, revolutionized the traditional view of communication theory in which the transmission of information could only be analogue, and involved continuous wave forms and modulations. Although the use of "bits" as units predated Shannon (it was coined by his colleague John Tukey from Bell Lab to denote a simple contraction of signals to either 1 or 0 as a unit of data storage), Shannon's "bits" caused significant savings in the length of transmission by incorporating methods of probability distribution.

Most forms of communication that we use, such as speech, have a statistical structure, a mixture of predictability and surprises characterizes what we can say using a language. Shannon (1948) defined information not simply as a measure of what we say, but as a measure of the predictability of what we can say – entropy. This helps encode the original message into an optimal form for transmission relative to the machine that is generating the message (e.g., compression). In other words, Shannon put forward the idea that the amount of information in a message must be bounded in the design of the system, and also defined a quantitative measure of information from storage to communication – the Shannon-Wiener Index – a value ranking of random variables as the average level of uncertainty based on diversity (Spellerberg and Fedor 2003).

Shannon (1948, 34) noted that he was "heavily indebted to Wiener for … [defining] the first clear-cut formulation of communication theory as a statistical problem, the study of operations on time series ... we may also refer here to Wiener's Cybernetics, dealing with the general problems of communication and control." Although Shannon and Wiener were dealing with a similar set of problems with corresponding logic, the subtle distinctions in their understanding of utility in prediction sparked separate discourses of information theory and cybernetics (Kaiser 2020).

Shannon (1948, 32) devoted the entire third section of his paper to a statistical analysis of natural languages, but gave no concern to "meaning," arguing that "these semantic aspects of communication are irrelevant to the engineering problem." Wiener (1950, 113), on the other hand, saw the use of information as a tool in C&C within systems that concern humans and machines alike: "questions of information will be evaluated according to a standard American criterion: a thing is valuable as a commodity for what it will bring in the open market." This thrust cybernetics into becoming a general science that can be used to model and operate complex systems, both social and mechanical.

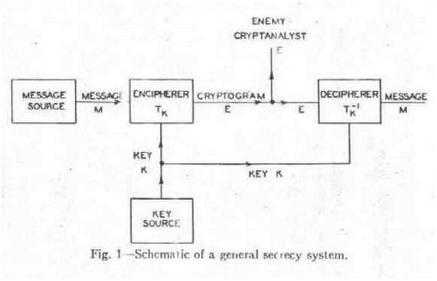


Fig. 1—Schematic of a general secrecy system.

Fig. 3. (a) Schematic of a general secrecy system of communication (Vasiloudis 2018). (b) Wiener's cybernetic diagram on radar guidance systems for AFC (Johannson 1993).

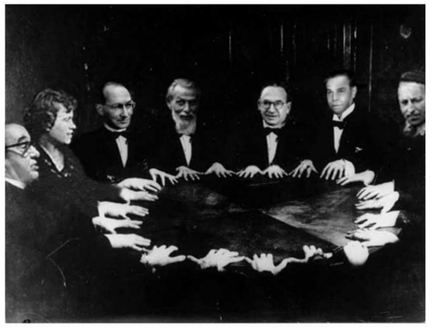
Before WWII, Wiener made great mathematical contributions to Brownian motion and Fourier Transform (FT) (Mindell et al. 2002). For the former, he "constructed and analyzed a rigorous mathematical model of probabilistic laws" (Doob 1966, 69). For the latter, Wiener (1942) aimed to make predictions based on probabilistic structures of serial events. This was why he was drafted to conduct Anti-aircraft Fire Control (AFC) research during WWII (Galison 1994). Wiener realized the field

of concern was pressing the limits of engineering knowledge at the time in both technical and disciplinary terms, falling between the tools of the established fields of expertise (Beer 1999).

AFC is an interdisciplinary problem that encompasses system study of dynamic performance, mathematical precision, corrupted data, information feedback, and the most unpredictable parameter, human operators (Mindell et al. 2002). Wiener began to think from an engineering perspective about ways to simulate a gun pointer situation. He came to the conclusion that the scenario must be reduced to a single structure: either a mechanical interpretation of humans or a human interpretation of machines (Beer 1999). Thus, Wiener's research relied heavily on two key elements of system control: data smoothing and data prediction (Mindell et al. 2002). In other words, Wiener had to consider how a system makes predictions on the movement of German aircraft operators and how this information can be communicated between humans and machines to pre-empt the opponent's decisions.

When the war ended, Wiener began to elaborate his work beyond military demands, partly because the funding he had received from the National Defense Research Committee (NDRC) had been terminated, and partly because of his long-time interest in physiology (Mindell et al. 2002). Wiener shared a common fascination with the relationship of the computer to the brain with scientists from various disciplines, one of whom was John von Neumann; the two organized meetings together (Beer 1999). Von Neumann (1951) formulated "The General and Logical Theory of Automata," for which his previous works on game theory provided him with insights into the nature of rationality and complexity (Mahoney 1998). Wiener, (1950), on the other hand, developed his notion of feedback from mechanical to biological processes, to which output is compared with the original goal at each iteration to determine deviations from the predictive model. The probabilistic techniques of information theory were used to study the interactive nature of organisms relative to the larger environment, and expanded the use of pre-emption beyond AFC to real-time responsive feedback towards any behavior of intelligence. (Mirowski 1992).

Wiener's work on predictive analytics was a fundamental building block in stochastic models and stochastic control, and contributed to the evolution of modern-day information processing that is widely used in many C&C systems, from the military to the everyday consumer world. For instance, it is used in the characterization of the random quantum behavior of particles, fluctuations in the stock market, pre-emptive scheduling in IoT systems, and personalization algorithms on all our mobile devices – pre-emptive marketing (Hardesty 2011).



Cybernetic Séance – New York City, 1947
From Left to Right : Rafael Lorente De Nó (Neurophysiologist), Margaret Mead (Anthropologist), Kurt Lewin (Psychologist), Warren S. McCulloch (Neuropsychiatrist), Paul F. Lazarsfeld (Sociologist), Arturo Rosenblueth (Physiologist) and Gregory Bateson (Anthropologist). Front (missing from view): Molly Harrower (Psychologist), Heinrich Klüver (Psychologist), Norbert Wiener (Mathematician), Lawrence K. Frank (Social Scientist), Heinz von Foerster (Electrical Engineer), John von Neumann (Mathematician) and Ralph W. Gerard (Neurophysiologist). Observers (missing from view): Frank Fremont-Smith (Medical Director of the Macy Foundation), Julian Bigelow (Computer Engineer), Walter Pitts (Mathematician), George Evelyn Hutchinson (Ecologist), Leonard J. Savage (Mathematician), Henry Brosin (Psychiatrist), Theodore Schneirla (Comparative Psychologist), Hans Lukas Teuber (Psychologist), Gerhardt von Bonin (Neuroanatomist), Lawrence S. Kubie (Psychiatrist), Filmer S. C. Northrop (Philosopher), Alex Bavelas (Social Psychologist) and Donald Marquis (Psychologist).

Fig. 4. The 1947 Macy Conference, aka the third cybernetics conference (HEXEN 2011).

These and many other interdisciplinary collaborations gave form to what would later become the foundation of Wiener's (1948) book on cybernetics. Its title indicated that the C&C of information is necessary to propel any system with self-regulatory functions, which is crucial to a network of P2P interactions, where variety and circularity are the pillars of cybernetic processes. Variety emphasizes option dynamics, multiplicity, and derivatives within self-organizational networks; it paraphrases "surprise" and "entropy" in information theories (Heylighen and Joslyn 2001). Circularity concerns causation and feedback, which enables cybernetics to observe and describe systems

from within, such as iteration theories, self-referencing cognitive organization, and autonomous emergent systems (e.g. autopoiesis and financial markets) (Krippendorff 1984).

Second-order Cybernetics

Shortly after Wiener's death in 1964, cybernetics saw a new wave of understanding, which sought to expand and reform the discipline – second-order cybernetics (SOC). Wiener's cybernetics is being reinterpreted as first-order, which is "the study of observed systems;" whereas second-order is "the study of observing systems" – taking into account the observer as part of the system (Scott 2004, 1; von Foerster 1992, 11). The implication of this is both epistemological and social, further democratizing cybernetics from an art of high sciences to an art of civicness.

Von Foerster (1974, 281) indicated that the primary concern of SOC is communication of the system to itself – "explaining the observer to himself" – and that "the environment contains no information; it is as it is." Paraphrasing this in Shannon's (1948) language, any message of the description of an environment can be quantified with the predictability of what an observer will say. In order words, information is a construction by the observer of a system; it is created when the observer makes an effort to reason about the environment. This has design implications in that one cannot reason without constructing and learning from maps and models, where a "map is not the territory," but a blueprint that helps you "act towards the future you desire" (Korzybski 1958, 58; von Foerster 1992, 38).

In an indeterminate world, von Foerster (1984, 282) added that we should "act so as to maximize the alternatives." The context of this dictum is that he was concerned with scientific problems that are undecidable in principle, so it is a scientist's responsibility to provide pluralist perspectives to facilitate decisions. Put differently, if information is a construct of the observer and its creation creates value, then information should help maximize choices in the system. This behooves us to design to facilitate option processes and shed light on the dynamics under which a self-organizing system sustains itself, powered by an archival aggregation of models and options.

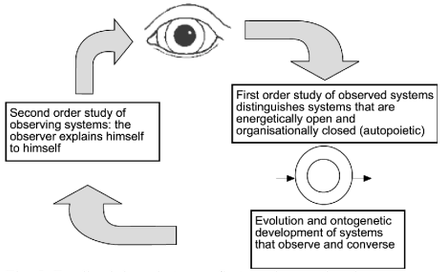


Fig. 5. Feedback loop between first- and second-order cybernetics. (Scott 2004).

The secondary concern of SOC is "to proceed to construct a consensual domain as a system of beliefs" – an idea translated from autopoietic biology to describe self-organizational ontogenetic structural coupling – where individuals amalgamate into communities by reaching consensus facilitated by the circularity of information (Scott 2001, 345; Maturana et al. 1980; Abou-Zeid 2009). If we can model consensual domains using hard sciences, we will be able to apply mathematics as a language to describe these processes and potentially be able to compute them. For instance, if the process of two individuals reaching an agreement through iterative exchanges can be described using FT, we can write down a differential equation and map the variables. Therefore, not only can we understand the anatomy of these processes, they can now be captured computationally to pre-empt the outcome (e.g., automated negotiation). Also, we may start generating sets of questions or testable rafts of hypotheses using alternative process theories that conform with the same principles (Friston et al. 2006). This describes how constructed models and archived options might inform one another to facilitate generative processes.

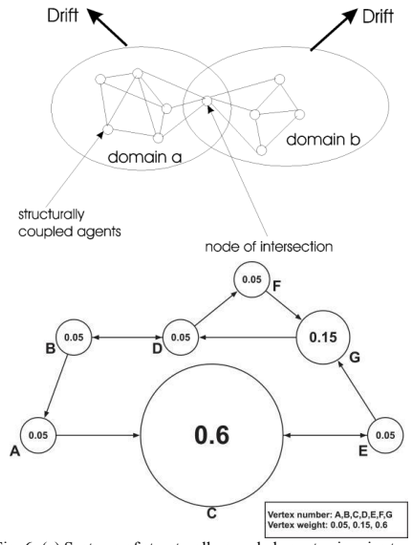


Fig. 6. (a) Systems of structurally coupled agents give rise to nodes of intersection through interactions - a form of consensus domain (Goldspink, 2000). (b) Example of a weighted directed network using a PageRank algorithm (Zhao, et al., 2018).

Gordon Pask studied social dynamics using physical theories as models to map to precision the working of agreements and epistemological dependence. In Pask's (1992) Last Theorem (PLT), he proposed that concepts exchanged during a consensual process are comparable to quantums that spin in a single direction, with like spins repelling and unlike spins attracting. That is, distinctions in concepts attract dialogues across perspectives and propel information transactions that fluctuate, where FT and sampling techniques may be operated to predict deviations. Equally, the creation of knowledge or learning are convergence processes of building connections between concepts (Dubberly and Pangaro 2019).

In Pask's contributions to Negroponte's (1970) book *Architecture Machine*, he tried to capture these processes using machines with analogue interfaces that generate different signals when plugged into one another. Pask's works were influential in the development of hypermedia, coined by Ted Nelson (1974), in which contents can be linked to build network connections, foreshadowing multi-access communal information systems of all kinds. This enabled indexical measures on digital platforms and information archives, like Page's (1999) Rank, to quantify value by their linkage and collaborative filtering through user interactions and feedback.

Games and Agencies

In Ross Ashby's *An Introduction to Cybernetics* (1957), he addressed a wide range of adjacent disciplines, one of which was game theory – "the study of mathematical models of strategic interactions among rational decision-makers" (Myerson 1991). Certain branches of game theory are concerned with perfect, complete, and incomplete information within a set of interactions (Mycielski 1992). This became the underlying doctrine of platform economics, where consensus is studied with objective probabilities. Objectives can be understood as short-term plans towards a purpose, or in economic terms, incentives (Merrick and Shafi 2013). Thus, reaching consensus can be understood as achieving an equilibrium within a game, to which actors have no incentive to deviate from their chosen strategy after predicting their opponent's choices via information feedback; simply put, one has nothing to gain by changing only one's own strategy (Osborne and Rubinstein 1994).

Von Neumann (1928) established the discipline in a paper published on mathematical means to describe game dynamics. He began with two-person, zero-sum games, where the goals of individuals are diametrically opposed, and then expanded his interest to self-organizations in both cooperative and non-cooperative fashion through actions of C&C amongst human agents. The paper was followed by a book, co-authored with economist Oskar Morgenstern (1944), which included complex interactions of groups – n-person games – which actors might presumably join to form coalitions of optimizing agents.

More often than not, actors in a coalition do not bring the same amount of value. Presumably, this is reflected in the division of payoffs among its members (Leyton-Brown and Shoham 2010). Thus, coalitional analysis is generally concerned with two questions: which coalition it makes sense to form and the

possibility for any coalition to redistribute the value it has achieved amongst its members – transferable utility (Ross 2019). These questions, when answered, define the nature and stability of the consensual domain. By cooperative, it does not mean that the actors' interests are aligned, but that the coalition formed may achieve larger benefits or complete tasks the members otherwise could not done on their own. Equally, non-cooperative games can produce harmonious situations, where the overall system increases in value (Nash 2002). Von Neumann broke the ground for scalable modelling in socioeconomic analytics, for which the study of P2P exchanges can help reason about the larger system that emerges.

John Nash's work on the agencies method advanced the modelling of coalitional dynamics, taking into consideration the use of autonomous agents and contemporary economics. Nash "was stimulated to think of the possibility of modelling cooperation in games through actions of acceptance, in which one player could simply accept the 'agency' of another player . . . the action of acceptance would have the form of being entirely cooperative, as if 'altruistic'. . . ." (2018, 539). Nash's study "computationally discovered the evolutionarily stable behavior of a triad of bargaining or negotiation players." Put simply, rather than human subjects, he worked with what is equivalent to a set of three robots, 'so whether or not the experiment can be carried out successfully becomes simply a matter of the mathematics'.

The control variable to the probabilities of acceptance is "demand," which can presumably be assigned a single value. This has design implications in platform economics, which match-make P2P supply and demand, in that we may mathematically pre-empt situations or criteria that would or wouldn't motivate individuals in the market to form and maintain coalitions to achieve a collective payoff (e.g. climate change mitigation). Although Nash's work was modelled only on three-person games, for it was already computationally heavy at the time, he envisioned the feasibility of "much more complicated models for [. . .] more players, with many more distinct strategy parameters being involved" (2008, 540) for the future, forming a true multi-access consensual system.

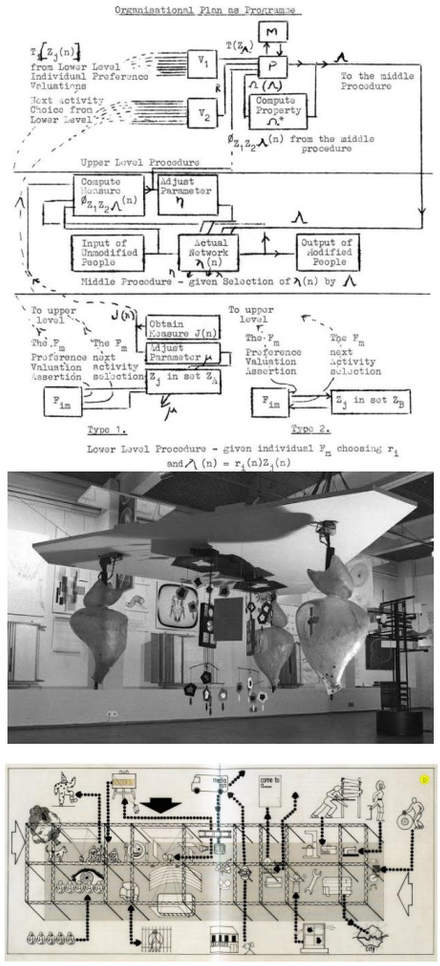


Fig. 7. (a) Cybernetic diagram of the Fun Palace program by Pask (Mathews 2006). (b) The Colloquy of Mobiles by Pask (1968). (c) Price (1964) Fun Palace, architecture marketing.

Multi-access System: Digital Archive and Platform Economy

From the historiography of C&C, this research summarizes the core principles for facilitating a multi-access system, where the platform economy and digital archives serve essential functions in democratization and P2P exchanges.

Digital Archiving

- ***Discovery Processes***:
  Motivating crowd contribution of information
- ***Value Ranking***:
  Decentralized search system in archives
- ***Pay-Per-Compute***
  P2P information exchange with instant value realisation to enable transparency between archives

Platform Economics

- ***Option Dynamics***
  Capability to describe system behavior from interacting components.
- ***Consensus Mechanism***
  Achieving equilibrium within sets of P2P interactions.
- ***Agencies Method***
  Collaboration and harmonic system outcome enabled by both cooperative and non-cooperative action.
- ***Pre-emption***
  Self-organisation through predictive action.

Table 1. Multi-access system core C&C principles: democratisation and P2P exchanges

Discovery Processes	Price discovery is a dynamic process by which pricing incorporates new information; it is one of the most important functions of a market (Yan & Zivot, 2010). Discovery processes expand this logic to the mining, analysing, and modeling of price, management, ownership, and other data within natural property markets for new asset classes, such as digital assets. In price discovery, individuals with better information participate to take advantage of information asymmetry, and feed information to cause changes in derivatives. For instance, futures and options preempt markets' statistical structures to create value for an individual. Whereas discovery processes motivates actors to anchor information on the network to secure value in information, where value comes from work input and consensus from the rest of the network. For instance, title mining helps to crowdsource sufficient data for archives to assist authentication and secure trading, where the system as a collective gains value and payoffs are distributed to individuals who did work (EDER, 2019) (Shang & Price, 2019). This turns discovery from an act of speculation to cooperative competition, and helps to reach consensus on the value of an asset through interactions of actors in a network. Transaction costs for exchanges should be kept low to ensure responsivity, so 'these markets indicate what is likely to happen' and assist in better discovery (Harris, 2002) (Svartdal, et al., 2016).
Value Ranking	Ranking in information retrieval (IR) concerns assigning some values on information to produce a permutation of items so the best results appear early in a list (Piccoli & Pigni, 2018). The notion of ranking dates back to the 1940s, from IR problems in fields of socio-economics and academic referencing (e.g. importance of a journal is determined based on citation from other important journals). Most ranking models exploit the structure of links, probabilistic, and iterative approaches (Franceschet, 2010). For instance, Page's (1999) Rank deals with relevance expressed in terms of probability by hyperlinks and collaborative filtering, instead of average score for each item of interest, which would be much too imprecise for natural languages (i.e. keywords) and may require complete information match (Ricci, et al., 2011) (Chu, 2003) (Repplinger, 2011). Value ranking helps nodes in a platform network vote on the importance of information to decentralise search engines in an archive, where individuals have some influence over the permutation. Ranking methods can be combinatory according to specific use. For instance, within IP networks where nodes are strongly connected, an entropy method can be introduced - probabilities on links with highest entropy rate are chosen, for the closer an event gets to zero entropy, it is more unsurprising and yields no information for users (Shannon, 1948) (Delvenne, 2005).
Pay-per-compute	Presently, platform economies generally realise value on the application layer, where computation services are offered to users for free in exchange for data licensing - *pay-per-impression*. Centralisation of such processes prevents information systems from dividing payoffs to individual users who contributed their information and computational power. Considering alternative economic logics along other layers of network protocol can help to expand econometrics and diversify option processes. For instance, the link layer is responsible for 'data transfer between adjacent nodes', which can enable *pay-per-compute* mechanisms to allow users to directly pay for information services (e.g. bandwidth, GPU, storage, etc.) (Whitehouse & Scott, 2011). This helps to distribute values and work according to each's abilities and needs where any device can broadcast based on their amount of free power (e.g. battery, distance, etc.). For instance, router cost can be added based on bandwidth and what the node wants for latency. This revises the meaning of information as value with Shannon's (1948) entropy, nodes can trade their rendering/modelling/designing/etc. power in a p2p manner for a participatory production pipeline, where each node is its own specialist and gains reputation for its work, all accounted for and visible to users. As value can be realised at the point of information exchange, digital archives can be transparent to facilitate better information flow within the network.
Option Dynamics	Option dynamics assist actors to identify the optimal in decision-making given the constraints and assumptions of a system. In a platform economy where actors are in cooperative competition to create value for users by maximising choices within a system, option dynamics is the ability to describe observed behaviors of individuals or networks with available information. In financial markets, options are derivatives that insure a commodity with preemptive rights, to which the value of a piece of information is realised when a risk takes place. Whereas in digital platforms, the value of a piece of information is being realised from the point of creation via collaborative ranking, and such values should be immediately directed back to the content creator at each interaction. This facilitates a unique form of option as insurance by providing a pool of knowledge-based assets and a natural selection of information to preempt uncertainty in the system. Take the investment of IP as an example, option dynamics can help to evaluate options for expand/contract, sequencing, flexibility, etc., as opposed to simply trading financial values as securities (Chang, et al., 2005). The extension of options can be customised with decision-support-systems (DSS) (Zhang & Babovic, 2011). There can be cooperative options, where IPs can be designed as compatible units to other information assets on the network with an option term (time during which management may decide to act). This helps the network to aggregate more information components in their archives to feed a broader range of design demand (e.g. BIM).
Consensus Mechanism	An economy as a complex system has dynamic and self-organisational behaviours with random fluctuations that is amplified by positive feedback (Beer, 1995). Interacting individuals change their actions and strategies in response to the outcome they mutually create (Arthur, 2013). Each interaction facilitates network consensus on the expected value and utility of an asset. Within a platform economy, such game theoretic principles are assisted by ranking, valuation, and discovery components, where mechanisms of consensus are of core concern. On a technical level, consensus mechanisms assist nodes to share information to establish a trust system of exchange, thus, facilitates circularity and transparency for information flow and archiving. For instance, a decentralised ledger is a record of consensus maintained and validated by a network of interacting nodes; like blockchain, consensus can be achieved with various techniques - Proof-of-Work (PoW), Proof-of-Stake (PoS), Proof-of-Authority (PoA), Proof-of-Importance (PoI), etc. - each distributes trust distinctly (Rutland, n.d.) (Wang, et al., 2019). Such proof techniques can be applied to platform strategies to assist structural coupling. For instance, in PoA, validator nodes earn their rights with verified reputation by the network. This gives incentives for the node to input valued work so as to maintain its position. In principle, this is not so different from the ideal of a democratic jurisdiction, except it would allow the simultaneous production, broadcasting, and anchoring of such information to accelerate self-organisational processes and relieve bureaucratic symptoms, and these processes can be captured computationally to ensure interoperability and inclusivity. As such, consensus is an iterative process through cooperative competition, its dynamicity implies that it is not in logical rivalry with conflicts in information systems (Horowitz, 1962).
Agencies Method	The realization of collaboration for individual actors is enabled through the election of agencies. This makes collaboration a process that is achieved by means of actions that are not necessarily cooperative, but would accumulate to a harmonic and directional force. Developing a broader range of agencies methods may assist the division of payoffs, provide visibility, and diversify coalitional models (e.g. crowdfunding). Moreover, such forms of cooperations can then be modelled mathematically to design protocols for incentive provisions. One of the biggest obstacles in achieving a decentralised multi-accessibility is proprietary incompatibility, which leads to silo-functioning in information systems. Standardising network protocol can support the stacking of multiple modular and single-purpose apps and application programming interface (API) units, where each is freely integratable with another to form universal compatible software packages on demand - an *integratable app stack*. By accepting the agency of another player, coalitions can achieve larger or distinct forms of payoffs and utility (e.g. design functions, manufacturing techniques, etc.). Vendors can consider option dynamics (e.g. flexibility, cooperative, etc.) for sustainable collaboration, where value can be realised with *pay-per-compute*. Agencies method creates value for users by increasing integratable options in a system. Such diversification may help to build up socio-economic capacity within architectural software R&D to prevent the dominance of a particular brand, which often limits flexibility and cultural sensitivity in design production.
Preemption	Preemption is the first right to act, and is enabled by the amount and quality of information that an individual or a network possesses. For instance, insurance is a form of everyday preemption that allows an individual to act before a risk is realised. In a platform economy, preemption helps to create value for users and ensures their rights to act through applying knowledge-based information. For instance, automated process discovery analyses unstructured data in event commits and application logs to predict multi-party collaboration outcomes and find solutions for preemptive transformation (Reeves, et al., 2020) (Maggi, et al., 2018). On a technical level, preemptive computing uses some criteria to decide how much time to allocate to any one task before giving another to preempt the resources constraints of a system. However, almost complete context information is needed for the scheduler to task switch (Rouse, 2005). Imagine a network of computer nodes each with intensive computational tasks, they may share time and resources with cooperative scheduling, so that each CPU relinquishes control at its own accord, and only relevant information needs to be synchronised to relieve data traffic, and the system as a collective preempts larger tasks faster. This helps to establish a platform economy where computational capabilities can be traded to achieve complex tasks. Moreover, such preemptive models can be applied from digital to physical manufacturing, where tasks are preemptively allocated within a network of IoTs (Internet-of-Things) according to probability distribution of supply and demand. Another example is IP mining, which helps to understand the dynamic relationship between a digital asset with the rest of the market; such information helps to deliver probability structure mapping, to which the first right of acting with an IP minimises opportunity costs.

Digital Platforms, Data Archives, and Intellectual Property

Platform economies consist of information technologies and the economy of things – the hard and soft infrastructure that help as many people as possible efficiently create, realize, accumulate, and circulate knowledge-based information. In economics, "technologies" are defined as useful arts that help to organize tasks efficiently to increase productivity (Steenhuis et al. 2012). The annual productivity growth of the architectural industry has increased only 1% over the past 20 years, but accounts for 13% of the world's GDP (McKinsey 2017). This implies that we are increasing input with almost no growth in output, rendering the industry low in sustainability. When information and value flows within a supply chain are dry, value is not effectively distributed in the socio-economic structure, leading to poor conservation and greater consumption of resources.

The aim of platform economies should be to aggregate and circulate ideas and value across geographical and disciplinary boundaries. To aggregate is to grow; "growth" refers not only to monetary value, but also utility value. The approach of this research is the following: if buildings are physical property, then architecture is intellectual property; physical property puts liquid capital into concrete form to provide stability, while intellectual property provides fluidity to rigid matter (Harvey 2019). If physical property has the space for growth, which we generally call the real-estate market, how can intellectual property have the same space for growth? If one considers how physical property grows, fundamentally, it gains value through exchanges and interactions - the more time something is traded often, that implies that there is aggregate demand, and its value increases. So what about intellectual property—IP?

In the problematization of IP, it is essential to think about information flow within design production in architecture, as well as the organization of data through archival functions within digital platforms, which constitute around themselves socio-economies.

Data Organization: a Socio-economic Spectrum

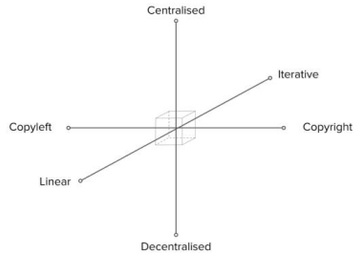


Fig. 8. A socio-economic spectrum for data organization.

The aim of the socio-economic spectrum in Fig. 8 is to model data organization. On the economic axis, there is copyright at one end and copyleft at the other. Within the current system of copyright, design disciplines rely on transacting IP; in the absence of a secure but transparent way to circulate IP, copyright is established on information asymmetry. A corresponding phenomena is proprietary incompatibility. Information and its relative technologies are designed to work in silos, causing output components (from data format to material types) to be incompatible and take extra energy to recycle. This impedes the channels to which information circulates, and thus interferes with the forming of coalitions.

Copyleft – the Creative Commons – is where most small actors are accumulating. For instance, within the habitat of Wikipedia and Google, communal information environments have been set up, where information is offered to users free of monetary value. Copyleft is essentially accumulating the effort of "invisible hands" (Smith 1761). The outcome is that the system has gained a lot of value, which cannot be realized unless it populates the information environment with advertising units or asks users to donate a dollar, but that is not a realization of aggregate value; it's charity. This causes excessive noise and useless information to accumulate in the system, and offsets system functionality and productivity, causing fallback and bottlenecks in growth. And individuals who have contributed valued information do not get appropriate returns. This inevitably results in a form of digital communism, which does not

redistribute value effectively between the observer and the observed in a coalition, rendering the system unsustainable in the long run.

On the network axis, there are centralized, decentralized, and, in between, distributed organizations. Centralization benefits responsivity with a focused vision and lowers regulatory and transaction costs through economies of scale (bulk pricing, volume discounts, etc.). In a centralized platform, all nodes share the same set of resources and top-down C&C to divide work and responsibilities for productivity. More often than not with architecture, centralization is translated only in financial terms. In order to acquire or trade architectural IP, one needs a significant amount of upfront capital, and complex contracts are generally trusted to large international actors with substantial financial resources. The impeded flow of information, work, and cash marginalizes many local independent and small-scale actors, such as small and medium enterprises (SMEs), designer collectives, and self-employed architects. Thus, instead of having a circular economy, we have a small clique economy.

Decentralization is a trustless organizational model, where “every node makes a decision for its own behavior and the resulting system behavior is the aggregate response” (BetaNet 2019, 1). Decentralization has no central management or storage, which minimizes the attack surface and prevents a single point of failure. For instance, a decentralized database is installed on systems that have different geographical locations and are not linked through a data communication network (OECD 2019). In participatory archiving, decentralization enables economics to be designed into the network structure, where crowdsourcing and crowdfunding are integrated to build open development platforms. However, performance may be inconsistent if it is not properly optimized and there are no logical connections between nodes, which lowers the data transfer rate and increases difficulty in coordination (Pattamsetti 2017).

A distributed network, in terms of information transaction and storage, is different from decentralization in that there is centrality for its graph connections, and it uses complete system knowledge, where the processing is shared across multiple nodes (Lawyer 2015). Centrality is different from centralization in that centrality is a control-based measure of the importance of a node relative to its network, and all nodes contain information for P2P verification and authentication instead of relying on a central authority (Hossain and Wu 2009). For instance, a distributed database is a single logical database, which is installed on a set of computers that have different geographical locations and are linked through a data communication network (Özsu and Valduriez 2020). Thus, distribution facilitates interoperability, while maintaining independence between database instances. Also, there's more alignment in network ownership, where nodes have an equal incentive to contribute valued work. Nonetheless, there are issues of scalability and high maintenance costs, where synchronizing consensus between all nodes in a network is a time- and resources-consuming process. Inability to solve such issues may lead to the forking of networks and create voids of insecurity.

On the time axis, there is linear and iterative processing at each end. Linear processing uses a simple averaging mechanism, which increases computational capacity. This may help to accelerate the speed of exchanges and run fast statistical fits on simple operations (O'reilly 2020). For instance, linear encoding of information may help to focus on how a message may be altered or influenced in the communication process. The downside is fragmentation (e.g. exchange processes function in isolated and linear units, resulting in high operational costs) and accumulation of risks, especially in immutable operations.

Iterative processing, in contrast, promotes circularity, whereby the output of a process is feedback as input until the operation converges to a desired state. In a platform economy, this may help to minimize discovery cycles and is essential for learning and development processes with high precision C&C. For instance, it may help design iterations to be executed the same way for a range of different

data structures to save time and effort in later attempts (e.g. object-oriented programming) (Gatcomb 2005).

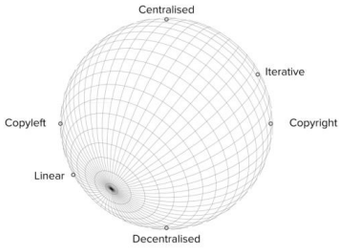


Fig. 9. The spectrum is embedded in a spherical projection so that every point is topologically equal to maximise choices in a multi-access system.

Each point on the spectrum has its own distinct benefits and weaknesses. A multi-access information system emphasizes agencies and option dynamics, which means that this socio-economic spectrum can be embedded in a spherical projection so that every point is topologically equal in probability and opportunity to maximize choices in the system. Data organization strategies may be oriented to any point on the spectrum, according to the system’s goals, values, and interests for some criteria to be achieved. Take a blockchain system as an example. Technically, it is distributed (many nodes hold copies of a ledger), but it is not inherently decentralized (which refers to the rights of nodes operating on a ledger); decentralization is a question of design (Rutland n.d.).

Ledger operation design forms part of the essential functions to which an institutional model of appraisal may be democratized within digital archives, where the value of an object may be evaluated based on the record of P2P interactions. Recent initiatives on Non-Fungible Tokens (NFT) exemplify this approach, where platforms and archives are built on top of the data organization, which give blockchain the plasticity to adapt to specific uses and provides an interesting subject for investigation.

Case Studies

Through two case studies, the aim of this research is to develop a better understanding of the implications of the proposed socioeconomic spectrum in three areas: network modelling, C&C protocols, and economic logic.

Pinterest as an Archive

Pinterest is a communal information environment that has created one of the largest digital archives of architectural drawings, which enables the saving and retrieval of information on the World Wide Web (www) using a single access point. Pinterest is successful because of its capability to provide uniform access points, enabling crowd contribution, and translating fragments of information between various mediums to streamline information exchange: for instance, bridging Google and Baidu incompatibility by functioning as a platform that takes advantage of the link structure of hypermedia.

One of Pinterest’s biggest challenges in data organization is information ranking (IR). In terms of archives, ranking concerns means assigning value to information to produce a permutation, so that during a search or a query, the best results appear early in the list. Pinterest uses a SmartFeed algorithm to help nodes in the network vote on the importance of information; images are labelled with keywords by collaborative filtering. The algorithm deals with search relevance expressed in terms of probability.

Nonetheless, Pinterest’s network tendency has little control over centrality, except for promotion or paid advertising; it is highly susceptible to spam and repetitive information, where IR utility becomes problematic, especially in the discipline of architectural design. For instance, in the first 10 results recommended by Pinterest for ‘modernist art’, three were from North America; three were contemporary pieces; one was a Bauhaus poster for an advertisement selling a replica for £3.45, and the remaining three were recommendations, notably, all of which were paintings.

This illustrates a few potential limitations of the platform model of Pinterest in data organization of its online archive: 1) the format of data input restricts the definition of art to the format of paintings; 2) the dominance of certain

user groups diminishes plurality (the absence of modernism art from Russia, South America, etc.); and 3) the commercial pricing of information influences the ways in which we perceive and define history. Based on its benefits (multi-accessibility) and limitations (low IR utility), Pinterest exemplifies tendencies in decentralized copyleft information systems, where data organization is a linear process.

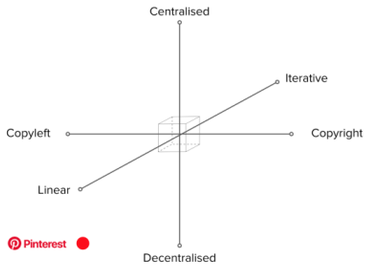


Fig. 10. The Pinterest platform exemplifies tendencies of decentralized copyleft linear data organization.

Blockchain Platforms

Satoshi Nakamoto (2008) proposed a P2P transaction system secured with timestamp functions, called bitcoin, with the aim of improving the autonomy of information transactions within a decentralized network to eliminate the time and resources needed for institutional authentication. The back-end mechanism of this is blockchain.

Blockchain operates information archiving functions that are built into the network structure itself. It anchors information in an immutable manner, and archives not only IP, but all transaction and exchange data that comes with it. In this way, an architecture archive that builds upon blockchain guarantees authenticity, much like the way in which museum specialists authenticate a painting by the transaction labels and signatures that are attached to the back.

Blockchain's quality as a distributed ledger has the potential to be coupled with platform strategies to specify architectural design functions, for instance, with Building Information Modelling (BIM) systems to act as a real-time archive and tackle fragmentation in the architectural supply chain, at both a technical and socio-economic level. Blockchain's universal C&C protocols standardize data organization along the chain, from data input to encryption vehicles, and enable a means for BIM systems to freely integrate with crowdsourced efforts for democratization. This describes the agencies method, coined by the famous mathematician Nash (2008), where multiple parties can simply accept the agencies of another to accomplish larger, more complex tasks that each party otherwise could not have achieved on its own, facilitating (non-)cooperative games and self-organization.

Blockchain is technically distributed, but not inherently decentralized, where decentralization is a question of data organization design. DAO and Twetch are two great examples.

DAO, or decentralized autonomous organization, is a crowdfunded venture capital fund, allowing any user to pitch their IP to the community and potentially receive funding, according to network consensus (Santos and Kostakis 2018). DAO built the role of an archive into its economic logic, a form of "Fully Automated Luxury Communism" (Bastani 2020). Automated refers to running on smart contracts to streamline information transactions and immutability. Luxury refers to eliminating human labor in dealing with repetitive contractual work. And communism refers to complete transparency, total shareholder control, unprecedented flexibility, and autonomous governance (Puyang 2018). This leftist tendency is made clear by the actions it has taken to resolve difficult situations, such as the DAO hack, and its introduction of a proof-of-stake consensus mechanism (Castillo 2016).

Twetch (2019) is a start-up that explores the minimal tradable unit of information – a micro-information economy. Twetch modelled its interface after Twitter, but its economic logic is the polar opposite of Twitter's. Twitter shares information for free, realizing value on the application layer within the protocol stack. Nonetheless, the system gains a lot of value, which is difficult to realize unless it populates the information environment with an infinite scroll of advertising units. This causes excessive noise to accumulate in the system and offsets system functionality.

Nowadays, such platforms utilize personalization algorithms and collaborative filtering to assist in data retrieval and tackle the information overload problem in the every-mounting terabytes of data. Instead of maintaining the quality of information in the archive, Twitter invests in creating better recommendations and search methods. This creates problems such as data licensing. Also, individuals who have contributed their data do not get appropriate returns, resulting in digital communism, which does not redistribute value effectively.

Twetch, in contrast, assigns every piece of information with a micro-value from a tenth of a cent. Every time a user posts, likes, comments, or forwards a tweet on Twetch, it costs the user, and the micro-value is instantly directed back to the content creator. In this way, Twetch enables its users to own the financial rights to their digital content, and directly profit from social media's attention economy.

Although DAO and Twetch are both built upon the data organizational models of blockchain, DAO exemplifies the opportunities and limitations of decentralized copyleft systems, Twetch illustrates that of decentralized copyright, and Twitter depicts that of distributed copyleft.

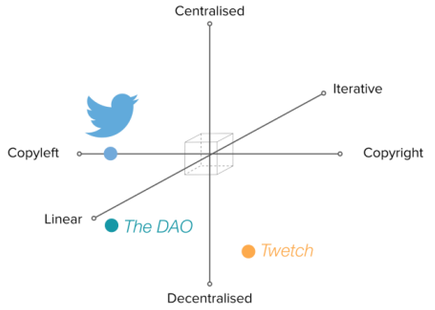


Fig. 11. Platforms on blockchain illustrating different qualities of the spectrum: DAO, Twetch, and Twitter.

Design Research—Current.cam: A Platform of Urban Archiving for Artificial Creative Common Intelligence

Any changes in the technologies we use to perceive space changes the way in which we intervene with space (Bottazzi 2020). The archiving of architectural and urban data helps us evaluate, analyze, predict, and navigate both physical and mediated space.

Current (2019) is a speculative urbanism project that examines the future of broadcasting cinema, facilitated by collaborative urban archives, and its impact on our cities, including current questions about the democratization of institutional appraisal, the existing models of data organization from digital platforms, which form economies that extract value from crowd contribution of IPs, and the future role of archives in a design world increasingly governed by Creative Commons and open-source generative algorithms.

Fig. 12. *Current*, 2019, Volumetric Cinema, www.current.cam.

In the process of training our machines to see and comprehend, Current anchors its data feeds from livestream, because of its real time and crowdsourcing qualities. Streaming data channels from multiple sources and perspectives provides Current with a means to outsource imagination. Current seeks to facilitate an "artificial creative common intelligence." This

points to a new form of creativity, where authorship is participatory and the relationship between AI and creativity is contextualized within the Creative Commons.

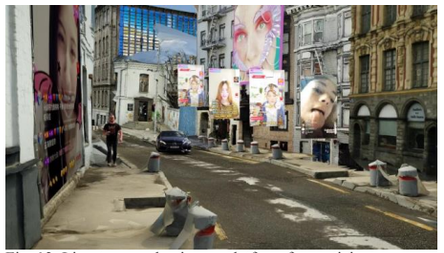


Fig. 13. Livestream urbanism: a platform for participatory archiving: https://youtu.be/4ngiZ5X0-kY.

The word "creativity" has its root in Latin, with the Christian implication of 'creation from nothing' – genesis from a higher being. It was not until the 19th century that the term embedded itself in poetry, science, and art. It was no longer a mere form of repetition and propagation, but creativity that reconciles with rules, from constructing and deconstructing – a creation from something.

Today, creativity has encountered a third archetypal turn in the face of AI, which can take the form of "rule-based" and "machine learning" systems. The former involves the design of models with a set of rules. The latter achieves intelligence through machines that define their own rules based on available data, transcending creativity from causation to correlation, and from small data to big data.

This probabilistic approach implies a measure of the amount of possible arrangements within the state of a system – the measure of entropy. If we are to contextualize the use of entropy within the art of design that is bounded by our socioeconomic system, it implies cognition of their possible arrangements in the future. Thus, measuring entropy not only gives us information about the present state of a system; it seems to capture the critical information that we need to speculate on the future evolution of a system. Within any large-scale information system, such a measure is made available only through a crowdsourcing model, which aggregates data and has the computational power to process the ever-increasing terabytes of data.

Fig. 14. Shots from *Current*, illustrating the personalized future of infinite livestreams.

Current, which investigates livestream culture, has experimented first-hand with a range of rule-based machine-learning systems that are readily available to any individual, and developed a production pipeline that provides a means for individuals to collectively reconstruct, navigate, and understand event landscapes that are often hidden from us, from the handling of trash to changes in nordic animal behavior. In the process of iterative feedback, filling in voids between sensory data in an endless stream of history, where designer intuition and algorithmic generation come together as a larger whole, this is the current definition of "artificial creative common intelligence."

What is the role of urban archiving? The quality of our built environment is often assessed through records of data and history. But traditional architectural archives include mainly drawings and models of buildings since it is operational costs that guarantee the value of an object. But this does not give a comprehensive overview of the qualities and impact of a design. Advances in digital technologies expand the possibilities of archiving and democratizing it into a real-time multi-accessed system. One of the challenges of urban archiving is the abundance of data with no simple or economic way to structure and extract useful information. For instance, livestream data from media platforms often consists of information about our built environment and its events, but this infinite scrolling of image and video data at 30 frames per second presents immense challenges

for processing and analysis. Along these lines, emerging tools such as volumetric navigation, AI image processing, and algorithmic personalization may assist us in collective information operations, such as indexing, analyzing, filtering, ranking, and synthesizing.

In its research, Current references various initiatives in its approach to urban archives and event reconstruction using AI, including Intel® True View, which renders 3D video captured from a football field of cameras in near real-time to reconstruct sporting events; Forensic Architecture, which investigates violence and terrorism using a composed archive of social media data; and Tzina, which virtually preserved a demolished historical site and its occupants in Tel Aviv (Intel 2020; FA 2020; Tzina 2016.

Inspired by these works, Current focuses on democratizing these techniques to facilitate a collective contribution to urban archives and AI – an artificial creative commons intelligence. Instead of using high-end technology and software, which are available mainly to institutions and corporates, Current tested a range of open-source neural networks, photogrammetry frameworks, and low-end sensors (mobile phones, Kinect, motion sensing, drones, etc.). The proposed production pipeline enables individual users to simultaneously produce, broadcast, and acquire information through livestream.

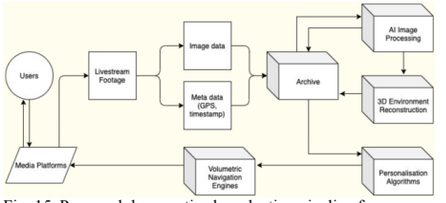


Fig. 15. Proposed democratized production pipeline for Current.

Livestream includes images and metadata that can be extracted for environmental reconstruction. Machine learning allows an estimation of what is behind a foreground object, and thus it can be paired with photogrammetry frameworks that calculate based on vantage points. We experimented with AI image processing using Autoencoder, which helps fill in missing information on texture maps based on archived data, and object detection, which helps estimate scene descriptions. The output volumetric data is then plugged into personalization algorithms, which label, rank, and deliver recommended content through collaborative filtering. Finally, the output is pulled into displays on demand, which are volumetric navigation engines, like WebVR, which can be multi-accessed by a network of users. This helps reconstruct 3D environments based on multiple vantage points from sequences of 2D images. Using this pipeline, the team produced a cinema in the most economic way possible for democratization and participatory purposes.

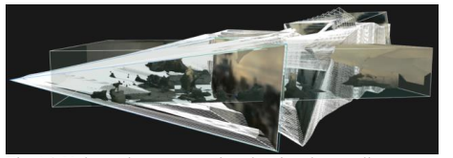


Fig. 16. Volumetric reconstruction showing the peculiar aesthetic of shadows around the scene; generative algorithms negotiate to fill in data voids.

This may facilitate an attention economy via platform technologies, where the reconstruction of certain events and environments may direct value back to the entity through harnessing network effects. For instance, Current reconstructed polar bear tracks using livestream data from bear cams to give a sense of immediacy in a simulated virtual environment. This can potentially generate financial and social credit for the protection of species via virtual signaling, with blockchain helping automate P2P transactions, facilitate value routes, where each reconstructed data point may be minted as an NFT, and enable endangered environments to own themselves by raising public awareness and crowd contributions. These are the next steps of Current's design research.

The resulting speculative cinema illustrates what such a multi-access system may look and feel like, based on the convergence of democratized urban archiving and artificial creative commons intelligence. Current remains

a form of artistic expression for now, but it foresees a near future as computational power advances in which such pipelines calculate to precision reconstructions, facilitating live volumetric streams and data flows that update simulated environments in real time.

Fig. 17. Comparison between reconstruction output of Current, which aggregates open-source efforts and enterprise grade AI technologies from Intel and Nvidia.

Conclusion

The paper discusses how platform economies and types of digital archiving may act as socio-economic drivers of change in architectural design production. Through theoretical, historical, and technical means, this paper hopes to stimulate discussion about the design of systems in a social realism that is increasingly molded by data organization.

It looks to the 20th century to search for the rise in modern system study (including cybernetics, information, and game theory in the 1940s, second-order cybernetics in the 1970s, and agency methods in the 2000s), and proposes a set of control and communication principles to allow us to begin to discuss the integration of network dynamics and economic logic: specifically, the use of Discovery Processes, Value Ranking, Pay-per-Compute, Option Dynamics, Consensus Mechanisms, the Agencies Method, and Pre-emption to build multi-access platforms that form economies around data organization in digital archiving. On this basis, we propose a socio-economic spectrum and its qualities, illustrated with existing platform examples, including Pinterest and those built with blockchain. This research discusses the potential and limitations of the strategies of democratizing technological systems and knowledge-based information.

Finally, this research illustrates its arguments with a design called *Current.cam*, which aims to build a relationship between AI and creativity that is contextualized in the creative commons, and proposes ways in which urban archives and "artificial creative common intelligence" may converge, which provide a means for us to collectively speculate on our future.

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Biography

Provides Ng (@provides.ism) is an architect and researcher, who studies the emergence of digital tools, and their application and impact on urbanism. Her theoretical work maps a timeline of events around Cybernetics, Information, and Game Theory in her search for system design tools that fall between the established fields of expertise. In her applied research, she explores how readily available distributive technologies – BIM, blockchain, and Artificial Intelligence – can be amalgamated to form multi-access systems that promote peer-to-peer (P2P) network exchanges of data and computational power in a computational data market.

Provides currently teaches at the Bartlett School of Architecture (UCL), where she received a distinction in her Master of Research on Digital Theory and Architecture. She actively engages in speculative design in interdisciplinary collaboration with talent around the world. She has also established a creative practice, @current.cam, and a researcher collective, @R.E.Ar_, to experiment with technologies first-hand and expand the audiovisual spectrum of design production and architectural representation.

Hatred Apparatus: A Sculpture for the First Half of the 21st Century

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Abstract

This paper presents a sculptural object, titled "Hatred Apparatus" (2014–), an artwork that regularly scrapes user comments from news websites and Twitter accounts and classifies them using a neural network according to the intensity of hatred they display. Comments classified with a confidence index higher than 0.6 in the hate speech or offensive language category are entered into a database and randomly displayed every minute on a small black-and-white canvas centred on top of the sculpture. This article describes the creative process, the events that inspired the creation of the device, and the technical issues involved in its creation. It concludes with a reflection on the Hatred Apparatus placement in relation to other works of art.

Keywords

Hate speech, offensive language, sculpture, natural language processing, machine learning.

Introduction

One of the major revolutions introduced with the advent of Internet Technologies (IE) is the possibility for users around the globe to freely communicate at nearly no cost. Information and Communication Technology (ICT) provides inexpensive ways for anyone to instantaneously reach millions of other users. But despite some early optimism, this has led to a substantial increase in hate speech, a term that can be understood as "any kind of communication in speech, writing or behavior that attacks or uses pejorative or discriminatory language with reference to a person or a group on the basis of who they are, in other words, based on their religion, ethnicity, nationality, race, color, descent, gender or other identity factor." (United Nations 2019, 2)

Cohen-Almajor defines hate speech as "bias-motivated, hostile, malicious speech aimed at a person or a group of people because of some of their actual or perceived innate characteristics. Hate speech expresses discriminatory, intimidating, disapproving, antagonistic and/or prejudicial attitudes towards those characteristics, which include sex, race, religion, ethnicity, color, national origin, disability or sexual orientation. Hate speech is intended to injure, dehumanize, harass, intimidate, debase, degrade, and victimize the targeted groups, and to foment insensitivity and brutality against them" (2011, 1).

One of the main attributes of online hate speech is that it takes advantage of the way many internet websites and virtual communities operate. Anonymity is supposedly an advantage of the Internet as a medium for communication, since individuals are not compelled to reveal aspects of their offline identity unless they wish to (Brown 2018), but ironically it is this very anonymity that allows the proliferation of such hate. Hence, although online anonymity allows opportunities for freer speech, giving voice to people who otherwise would not have it, it also disinhibits users to write things that they would not otherwise state face to face (Suler 2004).

Anonymity and invisibility are key properties that lead to the omnipresent tension between freedom of speech and hate speech. According to Titley, this tension between "understandings

of the fundamental importance and scope of 'freedom of speech', and the injustice and implications of hate speech, can never be satisfactorily resolved" (2014, 14).

Although this is a global problem, the ways in which different countries deal with this question are quite diverse. In the United States, for example, hate speech is protected under the free speech provisions of the First Amendment, although its limits have been extensively debated in the legal sphere (Davidson et al. 2017). However, "many liberals in the US tend to object to general hate speech regulations. They believe that legal restrictions on racist or hate speech are not warranted because they violate the speaker's autonomy." (Cohen-Almajor 2018, 39).

In many other countries, however, including the United Kingdom, Canada, Germany, and France, there are laws prohibiting and targeting hate speech. Often people convicted of using hate speech face large fines and even imprisonment. These laws extend to the internet and social media, leading many websites to create their own provisions against hate speech (Davidson et al. 2017). Despite such legislation, many websites still use slow manual moderation to tackle hate speech and offensive language, so abusive comments and posts are usually left online for long periods of time (Gambäck and Sikdar 2017, 85). During the Spring of 2017, parliamentary committees in Germany and the UK strongly criticized leading social media sites such as Facebook, Twitter and YouTube for failing to take sufficient and swift action against hate speech, and the German government threatened to fine these social networks up to €50 million per year if they continue to fail to act (Thomasson 2017).

Origins of the inspiration to build an apparatus that displays only hate speech

The topic of hate speech started to draw our attention in 2013, when massive protests emerged in our home country, Brazil. Various individuals and social groups from across the ideological spectrum took part in the demonstrations. What started as a movement demanding free public transportation soon became an entanglement of multiple demands that exposed cracks in the Brazilian social fabric. These protests, in other words, uncovered tension that Brazilians had tried to hide since at least since the end of military rule in the 1980s.

As Saad-Filho argued, these protests "expressed a wide range of demands about public service provisions and governance, and concerns about corruption. Their social base was broad, starting with students and left-wing activists, and later including many middle-class protesters and specific categories of workers. The deep and contradictory frustrations expressed by the protests were symptomatic of a social malaise associated with neoliberalism, the power of the right-wind media, the limitations of the federal administration, led by the Worker's Party (PT), the rapid growth of expectations in a dynamic country, and the atrophy of traditional forms of social representation." (2013, 657).

In the end, the protests weakened president Dilma Rousseff's position, and paved the way for her impeachment some two years after the beginning of Brazil's social unrest. A short time later, she was replaced by her former ally and vice-president, Michael Temer, a traditional politician, whose deeply unpopular government slashed public services, flouting the wishes of the majority of Brazilians. In sum, this was the background that allowed for the rise of Jair Bolsonaro, an ultra-conservative figure, who was elected president in 2018.

A former army captain turned politician, Bolsonaro branded himself a political outsider, an anti-politician (Arantes 2020), despite having been involved in politics for almost 30 years. His notoriety, as Faley reminds us, "comes from making a series of bizarrely offensive statements during his career" (2019, 4). His long list of offenses includes: telling a fellow legislator that she was too ugly for him to rape her; saying that he would rather have a dead son than accept him as gay; and taunting Afro-Brazilians, indigenous communities and those from the poorer states of the Brazilian northeast. He also stated that the Brazilian dictatorship's only mistake was that it did not kill enough of its political opponents. In his inauguration speech Bolsonaro vowed to "liberate" Brazil from "socialism", "gender ideology", "political correctness" and "ideologies that defend criminals." (Faley

2019). We believe it is this same aggressive and supposedly "carefree" attitude, shared by other extreme right-wing populists around the world, that has fostered an explosion of online hate speech in Brazil's social media.

Hatred Apparatus

When the 2013 protests began, the division between left-wing and right-wing supporters in Brazil came into view both in traditional media and online. One of its most visible signs was seen in the huge influx of hate speech in Brazilian social media and the comment sections of news websites. This fact led us to research hate speech internationally and compare that to what was happening nationally in Brazil. This research was the starting point for "Hatred Apparatus", an artwork we have been developing since 2014 as part of a series of creative AI apparatus, such as "LoveApparatus" and "Prophecy Apparatus".

The basic aim of Hatred Apparatus is simple: to display internet comments identified as not only hateful but also containing extremely offensive language by a machine learning system. The first version was exhibited in the 2017 edition of the renowned artistic festival Ars Electronica, in Linz, Austria.

The apparatus (figure 1) comprises a wood box, featuring a small black-and-white display, which houses a NVIDIA® Jetson Nano™[1], a small, powerful computer designed to run neural network applications. The initial versions of the Hatred Apparatus ran on Raspberry Pi computers. The software consists of a series of custom Python programs, developed mostly by us, that constantly scrape the comments of users and readers from a number of websites and Twitter accounts in English, covering the entire political spectrum, from the extreme left to the extreme right, including Young Communists, News and Letters Committees, Communist Party USA, AlterNet, Common Dreams, Consortium News, The Intercept, Daily Kos, Mint Press News, OpEdNews, Raw Story, World Socialist Web Site, The American Conservative, The American Spectator, the American Thinker, Breitbart, City Journal, Daily Caller, The Daily Wire, Fox News, the Foundation for Economic Education, Free Republic, Hot Air, the National Review, The New American, NewsMax, One America News Network, PowerLine, Quillette, Reason, RebelNews, RedState, and Ricochet.

Web scraping is a technique to automatically access and extract large amounts of information from a website. Our scraping script, coded using the Python libraries *Beautiful Soup*[2] (to scrape websites) and *snscrape*[3] (to scrape Twitter), makes no distinction regarding the collected content. Working alongside the scraping process, another Python program, using machine learning, analyses the comments, and stores those identified as containing either hate speech or offensive language with a confidence higher than 0.6 in a MongoDB database. This process runs twice a day, and it is controlled by a Linux cron job.

Fig. 1. *Hatred Apparatus*, 2014–2021, +zero, Wood box, LCD screen, NVIDIA® Jetson Nano™.

The data stored in MongoDB is then randomly displayed on the apparatus' screen, and its messages are rotated every minute. Although much more information about every comment is stored in the database, including its source, article title, URL, author, date it was scraped, and type of comment (hate speech or offensive language), only the text of the selected comment is displayed, with no other information or context. Figure 2 depicts the entire Hatred Apparatus workflow.

[1] https://developer.nvidia.com/embedded/jetson-nano-developer-kit

[2] https://www.crummy.com/software/BeautifulSoup/

[3] https://github.com/JustAnotherArchivist/snscrape

As a work of art, Hatred Apparatus acts as a repository and living memory of one of the most harmful aspects of our digitally interconnected global society. The fact that online hate speech is so frequently and easily found means that it is deeply embedded in various sectors and layers of today's societies. The internet just gave these people an anonymous platform to spread their hate and intolerance towards those considered different or somehow, the enemy.

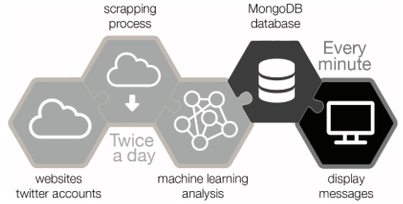

Fig. 2. *Hatred Apparatus' workflow.*

It is important to highlight the fact this artwork is not a celebration of hate speech. It is the very opposite. As artists, it was our deliberate decision to collect and show one of the ugliest facets of human nature.

Automatic detection of hate speech, and abusive and offensive language

The task of identifying online hate speech, and abusive and offensive language has been a central topic in many research communities for more than 20 years (Gambäck and Sidkar 2017). Even with recent advances in the field of machine learning, it is still a great challenge to classify texts and filter out hate speech using machine learning alone.

Machine learning has been shown to solve several language-processing tasks, such as part-of-speech tagging, sentiment analysis, and entity recognition (Gambäck and Sidkar 2017). Therefore, despite the fact that "the majority of the solutions for automated detection of offensive text rely on Natural Language Processing (NLP) [. . .], there is lately a tendency towards employing pure machine learning techniques, like neural networks for that task." (Pitsilis et al. 2018, 2)

Nonetheless, the complexity of the natural language (Badjatiya et al. 2017) and the fact that "what is considered a hate speech message might be influenced by aspects such as the domain of an utterance, its discourse context, as well as context consisting of co-occurring media objects (e.g., images, videos, audios), the exact time of posting and world events at this moment, identity of author and targeted recipient" (Schmidt and Wiegand 2017) further complicates matters. As "a key challenge for automatic hate speech detection […] is the separation of hate speech from other instances of offensive language" (Davidson et al. 2017, 1), we decided to extend the scope of the artwork to also include abusive and offensive language, and not to rely only on strictly defined hate speech. Therefore, our artwork does not require a high precision algorithm, and the inclusion of abusive and offensive language in general made the database and its contents even richer, reflecting the polarities and emotions at play.

Bespoke vs. off-the-shelf solutions

Although there are many datasets annotated for hate speech, online abuse, and offensive language (Vidgen and Derczynski 2020; The Alan Turing Institute 2020; Gilbert et al. 2018), the process of designing, training, and optimizing neural network models is time consuming, and it was not our main focus. Creating a new dataset was also out of the question, as the annotation process is costly in terms of time and resources. To name a few examples that illustrate the complexity of creating a dataset, we can cite Sood et al. (2012), who collected 1.6 million comments from the Yahoo! social news website, 6,500 of which were randomly selected for annotation by 221 people on Amazon Mechanical Turk (AMT); Xiang et al. (2012) created offensive language topic clusters using logistic regression over a set of 860,071 tweets automatically annotated using a boot-strapping technique and supplemented with a dictionary of 339 offensive words; Wasseem (2016) discusses a similar issue while providing a set of 6,909 English hate speech tweets annotated using Appe[4] (former

[4] https://appen.com/

CrowdFlower) users; and Risch et al. (2020) reports that its *toxic comments* dataset contains about 220,000 comments, each labelled with regard to six non-exclusive classes (toxic, severe toxic, insult, thread, obscene, and identity hate).

Over the years, various techniques have been employed by the Hatred Apparatus to classify its scrapped messages. First, we tried our own implementations using word filters. This method, as expected, produced mediocre results, which led us to the implementation of more sophisticated NLP techniques, such as Simple Surface Features using character n-grams, Word Generalization and Sentiment Analysis. These also produced mixed results, resulting in many false positives.

Recently, along with the replacement of the Raspberry Pi by the NVIDIA® Jetson Nano™, message classification has been achieved by Python's *HateSonar*[5] library, which allowed us to easily detect hate speech and offensive language without the need for further training. It also provides a confidence percentage alongside the hate speech and offensive language classifications, which we use to decide which messages should be included in our database, using the 0.6% threshold.

Technically, the adoption of an off-the-shelf solution for the classification of messages has proved correct, since *HateSonar* is a specialized library for this task, and its development was based on one of the most influential research studies on the subject, namely, the pre-trained model based on the work of Davidson et al. (2017).

Conclusion

Our apparatus, in its essence, shows only what is already visible on the surface of social networks and news websites. These are public messages seen by millions on a daily basis. What interests us, however, is the aesthetic exploration of the crude and the deplorable, and how absurd these messages are, especially when observed in isolation, without any context, in a sculptural object that remits nothing to the universe of hate from which these messages emanate. In this regard, our artwork approaches photographs or paintings of war and misfortune, which serve as an artistic and social repository of challenging times, without glorifying the content in any way, and its display of decontextualized utterances points to the absurdity and even stupidity of its content. Since the messages are usually written in a crude and immature manner, the collection produced by the apparatus also highlights the interchangeable nature of these distilled pieces of anger, which could be used in basically any heated debate in social media. These are spectral messages that haunt us daily, collected and exhibited to heighten the effect of reality without any attempt to intervene in their capacity to reflect current events. Here we propose a time machine for future generations, an eyewitness to our incapacity to deal with our current situation. Hence, the act of collecting and displaying these images, we believe, is one that is especially relevant to our current age, where the rise of political extremism and hate speech is undeniable (Bleich 2011; Hunter and Power 2019; Butt and Khalid 2018; Lazaridis *et al.* 2016).

[5] https://github.com/Hironsan/HateSonar

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Biographies

Fabrizio Augusto Poltronieri (São Paulo, 1976) is an award-winning computer artist, researcher and curator with a special interest in the relationships between Art, Design, Digital Media, and Technology. His expertise lies in the development of creative coding and its exchanges with philosophical questions. Two of his artworks from the "Visual Theogonies" series (Dionysus and Calliope, 2014) are in the V&A's – Victoria and Albert Museum – collection, in London, UK. Poltronieri is a member of the IOCT (Institute of Creative Technologies) and Associate Professor in Creative Technologies at De Montfort University, Leicester, UK. He is currently researching Creativity & Artificial Intelligence, applying machine and deep learning techniques to the production and design of narratives, moving images and objects.

German Alfonso Nunez is currently a FAPESP postdoctoral fellow at the University of São Paulo, Brazil. Previously he was a Visiting Postdoctoral Scholar at Stanford University. Co-editor of the recent Handbook of Popular Culture and Biomedicine: Knowledge in the Life Sciences as Cultural Artefact (Springer, 2018), he is interested in the intersections between specialist technoscientific knowledge, politics and cultural products. His latest research attempts to explain the reach and impact of Cold War American policy into the development of technological/digital art in Brazil during its military period. Alongside his academic work, he is also a member of the computational artist trio known as [+zero], nominated for the Brazilian Contemporary Art PIPA awards of 2011.

Nicolau Centola was born in 1967 in Ribeirão Preto, Brazil. PhD at the Institute of Arts at UNESP, with a thesis on chance in sound art. Master in Education, Art and History of Culture at Universidade Presbiteriana Mackenzie, studying the installation Poème Électronique. Lecturer since 2005 in several colleges in São Paulo, Brazil, Centola develops works in the areas of sound art, computer art, digital art, performances and installations.

Playing with Soma: Speculating on the Physical Body and Somatic Practice of AI

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Abstract

Current trends in new media art and dance technology have given rise to artworks driven by motion capture (mocap) data and machine-learning algorithms that take the form of immersive media, live performance and projection-based installations. In these works, the human form is still emphasized even when heavily abstracted, and the data remains in a digital and/or virtual realm. In response to these trends, the authors explore the application of laser projections of motion trails to bring data into physical reality, thus metaphorically giving a "body" to generated movement. Somatic movement improvisations (i.e. Contact Improvisation and the Skinner Releasing Technique) will be used for training to teach the attributes of human movement rather than the vocabulary of a set dance technique.

Introduction

The field of artificial intelligence (AI) emerged from the application of techniques and methods from biological systems (e.g. evolution, neural networks and bacterial growth) to solve computational problems. Over time, multiple categories and subsets of AI have emerged with crossover applications into other disciplines. Within the new media art and dance technology realms, "AI" has come to be associated with practice and research typically making use of machine learning (ML) techniques, such as deep learning (DL). Training models require datasets of existing content, whether it be paintings, musical compositions or movement.

A common way to create a movement dataset is to record a moving human with some form of motion capture (mocap) technology. Early datasets, such as the Carnegie Mellon University Graphics Lab Motion Capture Database (2002), provide a large range of movements performed in daily life. Other types of datasets include those making use of trained dancers performing a vocabulary of movements from a set technique or improvisation (Crnkovic-Friis and Crnkovic-Friis 2016; Girschig 2019; Google 2019). While these datasets can teach the poses associated with human movement, whether intangible attributes of human movement, such as breath and energy transfer, can be passed on remain in question. This challenge is tied to the difficulty of capturing the individual nature of human movement as opposed to simple locomotor movements and pathways (Shao and Terzopoulos 2005, 20).

Human movement is inextricably tied to the "soma," or body. When a machine generates a movement dataset, it does so without an actual body experiencing it. This places a machine in an interesting position to essentially have a reverse somatic practice or the use of movement to define a body for itself, which can be then brought into physical space. By accomplishing something that humans cannot yet do by natural means, another layer of complexity is added to the human–machine relationship.

To illustrate this concept, the authors present

an artwork-in-progress, which makes use of a custom laser projector prototype to visualize mocap data generated through ML and DL models. Using the concept of "soma" as the core inspiration, improvisations using somatic movement practices (SMP) are recorded for use as training datasets. The final dataset uploaded to the prototype is generated from a two-step ML process: the first step provides a machine-generated dataset, and the second step defines the visual expression of the data, aka the machine's body. By developing a process for visualizing movement data with lasers, the authors lay the foundation for developing an interdisciplinary performance installation that challenges where human movement ends and machine movement begins.

Mocap, Human Movement and AI/ML

The origin of this project is Cassinelli's observation that to truly explore the potential of dance mocap data, ML is needed to classify movement, identify relations and extend the range of applications for the data. This observation led to speculation on what would happen if a machine were trained to produce movement data reflecting internal rather than pose-based motivation (i.e., Feldenkrais vs. ballet) and include data glitch, as used in new media art. The purpose of this approach is to provide the machine with a wider range of movement possibilities from which to generate new movement choices instead of focusing on the accurate identification and replication of human movement vocabularies. Additionally, a machine might need the option of defining its own "body" through its movement rather than an assigned avatar.

The importance of the body in human movement comes from the fact that the body dictates the movement that is generated. SMP, one of three branches of somatic practices, focuses on "help[ing] a person discover the natural movement or flow of life activity within the body (Eddy 2009, 8)." This may be accomplished through actions such as breathing, touch or contact, personal exploration, or responsiveness. Specific elements include Novel Learning Context, where the emphasis is on responding to the moment rather than "correctness" and Sensory Attunement, where the "how" is prioritized over the "what" of movement (IADMS 2009, 3–5). Historically, SMP have had a close relationship with modern dance forms (Mangione 1993, 27–28). Specific examples include Asian practices such as yoga, qigong, and various martial arts (Eddy 2009, 7), and the Eurocentric practices of Alexander, Feldenkrais, Bartenieff Fundamentals, Contact Improvisation, and Skinner/releasing techniques (IADMS 2009, 3, 7–8). New methods continue to be developed with dance artists such as Ruth Gibson (Whatley 2012, 265) and Stephanie Hutchison (Hutchison and Vincs 2013, 1), which incorporate SMP into their practice-based research involving ML.

The initial intersections of AI, mocap data and dance, however, tended to focus on recognising poses and generating new choreography. Open source projects such as OpenPose (Hidalgo *et al*. 2021) can then be used to extract key points that define shapes made by the body, which are then used to synthesize new dances using a generative adversarial network (GAN) (Lee *et al*. 2019). This kind of research has been used to create choreographic tools such as *Pathfinder* (Loclair 2017) and *Scuddle* (Carlson, Schiphorst, and Pasquier 2011, 123, 125); and for interdisciplinary media artwork *CyberBallet* (Ars Electronica 2020; CyberRäuber 2020), *Blackberry Winter* (Loclair 2019), *Future You* (Universal Everything 2019), *Kung Fu Visualization* (Shaw and Kenderdine 2016); and has led to several collaborations between dance artists and technologists. Of these collaborations, the Google projects with Bill T. Jones (Google 2019; Jones and Google Creative Lab 2019) and Wayne McGregor (Girschig 2019; Leprince-Ringuet 2018) provide public access to both mocap data and interactive tools for synthesizing new movement sequences. Both Jones and McGregor are known for their use of SMP in their movement style.

Based on the way elements such as Novel Learning Context and Sensory Attunement require a human to focus on elements such as quality of movement and motion pathways, SMP is considered preferable for training datasets for more structured dance techniques.

The use of the SMP-approach by Gibson, Hutchison, Jones and McGregor also provided evidence that SMP mocap data could be used with an ML model. For this project, the authors plan to generate the mocap dataset by recording multiple contrasting improvisations performed by a single individual. This dataset will be processed through an existing ML model that will further abstract the data into motion trail combinations determined by the machine.

The use of a human body, along with the application of ML, inevitably raises some ethical questions. Initiatives such as JUST AI (Joining Up Society and Technology in AI) uses the humanities as a lens for mapping AI and data ethics using existing literature and facilitating discussion through working groups (Ada Lovelace Institute 2020). Specific discussions centring on the impact of bodies and embodied knowledge of AI ethics are also starting to emerge (C-DaRE 2020). Although there are no clear guidelines for ethically creating an artwork of this nature, it seems that these issues should still be taken into consideration.

Defining a body is also contentious in that this is an attribute usually associated with living organisms. Susan Kozel noted in the earlier era of AI that the difference between extending the body with technology and using AI is that "an AI approach substitutes the body with a digitalized one, or sees it as a hindrance and tries to lose it entirely" (Kozel 1994, 85). She later described the experience of performing in a camera-based sensing system that blurs these boundaries because it was "sufficiently responsive and had enough 'fuzziness' in its system for me to feel as if I were engaging with a quasi- autonomous, and at times aggressive, being" (Kozel 2011, 213). The creation of digital agents using artificial neural networks to not only perform with dancers, but engage in a rehearsal process where both entities learn from each other (McCormick, Vincs and Vincent 2015, 2-3), gives rise to the question of whether more attention ought to be given to the physicality of movement generated from ML even if it is simply responding based on how it was trained using human data.

Lasers, Lines, and Artistic Expression

As the primary goal is to visualize ML-generated movement and subsequent body movements rather than develop a new algorithm or model, the authors decided to start by creating a prototype laser sculpture, making use of existing ML models where possible. The prototype could then be developed into a full interdisciplinary installation that serves as a commentary on human-machine relationships. To do this, a laser device prototype engineered by the authors will take in ML-generated mocap data and display the motion trails in 3D space. This device builds upon research on a custom laser graphics processing unit (LGPU) developed by (Haebich, Sandor and Cassinelli 2020, 1), which was, in turn, based on the "Laser Sensing Display" developed by Cassinelli and previous collaborators (Cassinelli *et al.* 2010, 3; Cassinelli *et al.* 2012, 324–25).

Fig. 1. *Smart Laser Projector/Laser Sensing Display*, 2010, Alvaro Cassinelli, Yusaku Kuribara, Alexis Zerroug and Daito Manabe. Lasers/video capture, Copyright belongs to Alvaro Cassinelli, Yusaku Kuribara, Alexis Zerroug and Daito Manabe.

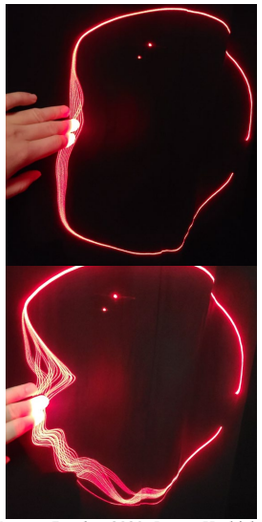

Fig. 2. *Laser Sensing Display*, 2020, Jayson Haebich, Christian Sandor, and Alvaro Cassinelli, Laser/video capture, Copyright belongs to Jayson Haebich, Christian Sandor, and Alvaro Cassinelli.

The rationale for showing motion trails rather than shapes is based on how lasers appear to the human eye as lines of light. This illusion is achieved by a persistence-of-vision effect, whereby a single point moves so quickly that the eye perceives it as a line. To achieve this effect, the laser makes use of the human visual system to display the image. By taking advantage of persistence of vision as a display method, a single laser can be assigned a unique point of data at one point in time, or a system of lasers can display all the data across a longer period. This creates a more dynamic experience compared to viewing a static image where all the visual data is displayed simultaneously. To create this projection, the hardware prototype mentioned earlier will be coupled with a custom programmed software platform to load and output a mocap dataset.

The process for transforming the initial SMP involves two steps. The first involves training a machine to generate movement. This process can be accomplished using either an RNN or the autoencoder method (Pettee *et al*. 2019, 197–98). One example of movement-specific architecture is *chor-rnn* (not to be confused with the char-rnn architectural model), which is a deep RNN that can be trained with a mocap data set to produce generative choreography (Crnkovic-Friis and Crnkovic-Friis 2016, 272) and then transforming that output with a GAN. *Chor-rnn* was used by Kyle McDonald for Rhizome and Elevenplay's *discrete figures* live performance work to create an animated AI dancer (McDonald 2018; Rhizomatiks 2020). Pettee *et al*. (2019, 197) further modified *chor-rnn* to take in three-dimensional data and make use of a mixture density network (MDN) to help process the data. The RNN model is publicly available for use and will serve as our starting point. After producing the machine-generated dataset, we will process it through a GAN to determine factors such as number of data points represented, the color, size, and shape of each data point, and the delay of the motion trail. Loclair's RayGan system used for *Blackberry Winter* is an example of a GAN that does both steps with one model (2019).

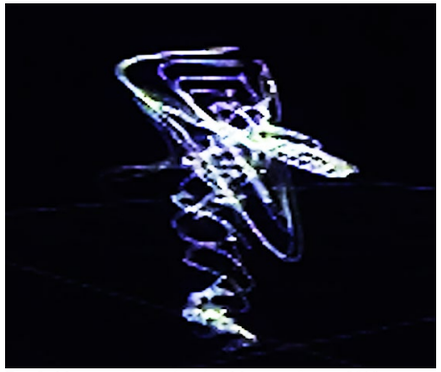

Fig. 3. *Motion trails rendered in Motive software*, 2019, Eugenia S. Kim and the Centre for Transformative Media Technologies, Video capture, Copyright belongs to Eugenia S. Kim.

To help envision what the final output might look like, mocap data recorded by Kim was visualized using the Optitrack Motive software motion trail setting, which revealed abstract lines and shapes that deviate from a human shape. This same data was then mapped to a set of particle streams in Unity, with modified elements, including colors, timing, trail decay, and number of data points. By selectively

choosing which data points were rendered, it was possible to further obscure the presence of a human body. The end result was abstract animations of light that were reminiscent of the Laser Sensing Display output and therefore feasible for laser projection.

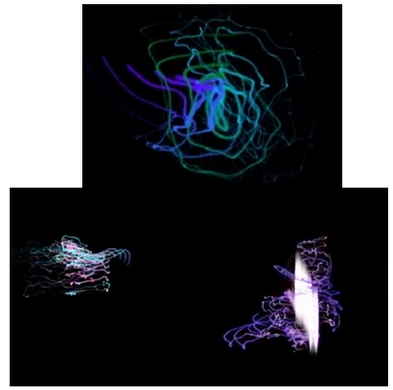

Fig. 4. *Motion trails rendered in Unity software*, 2020, Eugenia S. Kim and Andrew Crowley, Video capture, Copyright belongs to Eugenia S. Kim.

Future Directions and Conclusion

At the time of writing, the hardware prototype was completed and preparations were being made to record the datasets. After cleaning the datasets, emphasis will shift to using the modified *chor-rnn* to generate a new dataset and then identifying a GAN model to further process the data. This data will then be converted into a format usable by the prototype. For the future installation project, further possibilities may lie in interactive ML tools, such as those being produced by the 4i project group (2020). These tools are generally intended for use with movement data in immersive environments (Gillies 2019; Plant et al 2020) and maintain the interactivity and collaboration elements explored earlier by McCormick, Vinca, and Vincent through the use of an artificial neural network (2015). It is also possible to incorporate interactivity at the laser projection level, as evidenced by the previous work of the authors.

Fig. 5. *Photon*, 2015, Jayson Haebich, Laser/video capture, Copyright belongs to Jayson Haebich.

The overall intention of the authors differs fundamentally from the majority of new media and dance technology projects in that the endpoint lies in defining a body rather than selecting movement. In some ways, the project can be seen as a response to the statement "without a real body or any human spirit to complete it (McDonald 2018)." Focusing on alternative visualisation methods rather than creating custom algorithms may help the general public more easily understand the possibilities of gaining new insight into movement through a generated "body."

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Biographies

Eugenia S. Kim is an interdisciplinary creator and researcher. She is an artist for Leonardo21 and Lecturer (Performing Arts Research) at the Hong Kong Academy for Performing Arts. Kim received a PhD from the School of Creative Media of City University of Hong Kong in 2020 and holds degrees from the State University of New York at Albany and Rensselaer Polytechnic Institute.

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Christian Sandor is an Associate Professor in City University of Hong Kong's School of Creative Media, where he directs the Extended Reality Lab. In October 2020, he was appointed Augmented Reality Evangelist at the Guangzhou Greater Bay Area Virtual Reality Research Institute. Since 2000, his foremost research interest has been Augmented Reality. In 2005, he obtained a doctorate in Computer Science from Technische Universität München, Germany. Since then he has worked in leading research institutions including Nara Institute of Science and Technology (Japan), Columbia University (New York, USA), Canon's Leading-Edge Technology Research Headquarters (Tokyo, Japan), Graz University of Technology (Austria), the University of Stuttgart (Germany), and Tohoku University (Japan).

Alvaro Cassinelli was born in Uruguay and earned both a French and Uruguayan bachelor of science before pursuing his studies in France. In 1996, he received a Graduate Engineering diploma from the Ecole Nationale Supérieure des Télécom (Télécom ParisTech) and a Doctoral Qualifying Degree in Physics from the University of Paris-XI, Telecom and Ecole Polytechnique. In 2000, he received a PhD from the University of Paris-XI Orsay. From 2001 to 2015, he worked in the Ishikawa-Watanabe Laboratory at the University of Tokyo, where he co-founded and led the Meta-Perception group. He is also co-founder and organizer of the "Devices that Alter Perception" international workshop and was the first "Taller de Arte y Computación Física" in Uruguay. He is currently director of the Augmented Materiality Lab and Associate Professor in the School of Creative Media, City University of Hong Kong.

Exploiting Swarm Aesthetics in Sound Art

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Abstract

As robots move from our imagination into our lives and with modern advances in electronics, more new applications have become possible. Over the past 40 years, many artists, musicians, and researchers have used robotics and mechatronics to create novel sound art. We review current robotic interventions in sound art and discuss the characteristics of similar works. Then we introduce Liminal Tones (A / Autumn Swarm) – a series of experimental sound compositions made by multiple mechanical objects that sync and swarm together, and generate noise music. Our goal is to investigate swarm aesthetics, and collective and emergent behaviors to create chaotic and patterned sounds.

Keywords

Swarm Aesthetic, Noise Music, Sound Compositions, Swarm Intelligence, Collective Behavior, Emergence, Particle Swarm Optimization, PID Controller

Introduction

Sound as a conceptual medium is influencing our art culture. Many contemporary artists have begun to explore sound in its pure state, simultaneously bridging and blurring the notion of sound, noise, and music. In the past few decades there have been several approaches, using robotics, mechatronics and artificial intelligence (AI) to develop musical improvisations, sonification, orchestras, and sound art. The goal in most cases is to push the boundaries of conventional music and explore the infinite possibilities of randomness, chance, noise-sounds, and glitches. Robotic and electromechanical machines with embedded automation and performative capabilities have extended the musical creation process.

We discuss the related art about mechatronic sound objects and musical robots in Section 2, using a number of examples, followed by the emerging interest in noise in Section 3. In Section 4, we discuss the aesthetic value of chaos and swarming techniques in sound art. In Section 5 we present Liminal Tones (A / Autumn Swarm), its sound mechanism, technical features, swarm dynamics, and architecture. Finally, in Section 6, we discuss our initial results and future work.

Background

A key pioneer in the renewed interest in musical robots is Gottfried-Willem Raes, the founder of the Logos Foundation (1968). Logos was influenced by anti-authoritarianism, opposition and radical denial of serialism and post-serialism in music. As Raes argues, this refusal was rooted in the musical trends in the late 1960s and the "desire to conquer the hierarchy of power involving music and its producers" (1992, 29). Another music roboticist and key figure is Trimpin, who used mainly physical objects, actuated mechatronic systems, and obsolete machines to create sonic environments and drumming apparatuses (Murphy, Kapur and Carnegie 2012).

Both Raes and Trimpin's artistic practices laid a rich foundation for contemporary sound art and inspired a few of the current musical

trends. Murphy, Kapur and Carnegie categorized these practices into three separate streams: "works making use of found objects, works consisting of purpose-built instruments, and sculptures using automatophonic instruments" (2012, 43).

Sound sculptor Gordon Monahan (2011) creates sound sculpture, installations, and sonic environments exemplifying the subfield of found-object musical robotics. For example, in his installation *Trembling Antennae for Henning Christiansen* (2013), Monahan used electric motors as sound diaphragms to amplify audio signals in the exhibition space. Similarly, Jon Pigott (2011) explored sound, technology, and material systems in sonic art and noise music.

Other works in this group are the solenoid-based instruments of Chris Kaczmarek and the noise-making assemblages of Peter William Holden. Prominent in this category is Nicolas Bernier, the winner of Prix Ars Electronica Golden Nica in Digital Music & Sound Art (2013) for his artwork *Frequencies (A)* (fig. 1). Bernier's sound performances and practices over the years evolved from a chaotic noise-based approach to a more minimal and pure focus on sounds and exploration about the relation between music, conventional mediums, and new technology. His works echo the interplay between digital sounds and light to create an elegant balance between the logical and the sensual. Similarly, Moritz Simon Geist makes electronic musical robots (fig. 2) and vibraphones to push and extend the boundaries of music, and explores the unknown and futuristic world of techno robotics. Geist questions our perception of technology and AI in a playful and entertaining style.

In a different approach, a group of artists have created purpose-built noise systems. Examples of using mechatronic sound-objects can be found in works of Zimoun (fig. 3), who combines visual, sonic, and spatial elements to create sound sculptures, sound architectures, and installations.

Zimoun and Pe Lang usually use a large number (generally hundreds) of mechanical elements, such as DC motors, and other actuators, as sound-producing objects. They refer to these elements as "prepared DC motors or actuators", which often resemble biological systems and evoke an eerie or uncanny feeling (Stoddart, 2015).

Fig. 1. *"Frequencies (A)"*, Sound performance of mechanically triggered tuning forks with pure digital soundwaves. Nicolas Bernier, 2013.

Fig. 2. A shot from "Robotic Electronic Music (R.E.M)", using music robots, mechanics and sound devices. Moritz Simon Geist 2019.

In a third approach, sound artists create automatophonic sound sculptures made of altered instruments, such as the *Mechanical Orchestra of França Xica*, an interconnected web of altered instruments by Roger Aixut, and *Felix's Machines*, by Felix Thorn.

Although these artists seem to have different tastes in form and approach, all of them seem motivated by a desire to explore sounds and sonic characteristics of space that are not otherwise accessible through traditional music (Murphy, Kapur and Carnegie 2012). For example, both Monahan and Zimoun focus on exploring acoustic sounds in space (Muecke and Zach 2007).

Noise as Music

Since the late 20th century, there has been an emergent aesthetic and musical phenomenon known as "Noise Music." More recently, various artists have used noise to create audiovisual performances (e.g. Frank Bretschneider, Michael Kummer and Ryoichi Kurokawa), compositions (e.g. Aoki Takamasa and Mika Vainio), and installations and sound sculptures (e.g. Ryoji Ikeda, Nicolas Bernier and Mo Zareei, fig. 4).

These works share some common features, such as dodging harmonic material and embracing sounds, otherwise known as "extra-musical," including concrete sounds, noise, and sonic glitches. Also, they have a minimal approach and often use multiple sound-objects, pulse-based rhythms, complex noisy timbres, repeated patterns, recurring images, or stroboscopic visuals (Zareei 2016).

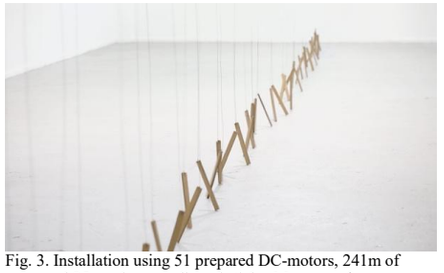

Fig. 3. Installation using 51 prepared DC-motors, 241m of rope, and 25-cm-long cardboard sticks, Museum of Contemporary Art MAC, Santiago de Chile. Zimoun, 2019.

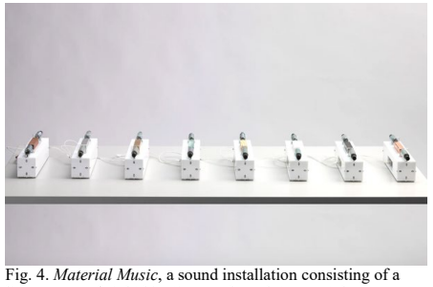

Fig. 4. *Material Music*, a sound installation consisting of a linear array of eight kinetic sound- sculptures, at the International Symposium on Electronic Art (ISEA). Mo H. Zareei 2020.

Order, Chaos and Sonic Swarms

Throughout the history of Western music, many composers and musicians have used natural sound as a source of inspiration in their work, particularly the sound of wind, water, and birds. This interest in mimicking natural sounds is also manifested in the works of a few contemporary sound artists, such as Nelo Akamatsu, Pe Lang, and Zimoun.

Nelo Akamatsu takes a minimal approach to sound art, which is rooted in Japanese culture and their delicate perception of nature. He often uses a few elements, such as water, tumblers, and wires to create sounds. These gentle sounds, multiplied by several hundred, create an organic symphony and a minimal expression of perceived nature (reminiscent of natural swarms) in a mythical, magical, and repetitive pattern.

Pe Lang and Zimoun create sound sculptures and installations with rhythms and flow using a large number of basic mechanical components as sound objects. In their practice, both together and individually, they create analogue rhythms and flow, and study the creation and degeneration of patterns. Inspired by generative systems and swarm behaviors, their works display both simplicity and complexity. The emergent and intricate behaviors of these sound objects (in sound and motion) appear to be organic and alive, and sound like "the acoustic hum of natural phenomena" (Schlatter 2013).

Liminal Tones

Concept

Liminal Tones (A / Autumn Swarm) is a series of sound compositions generated by eight vibration motors, wires, and actuators. We used a swarming technique and a specific control loop mechanism to regulate the DC motors and make the wire move, twist, and turn. The moving wires make tiny sounds, which are accompanied by the noise of the DC motors and form rhythmic sounds that are both organized and chaotic.

System Overview

We used a laptop, an Arduino Uno board, and a multi-channel driver board (8 channel DC 5V relay module). The output signals are generated by the Arduino in response to the incoming MIDI velocities, which in turn, drive the DC motors and attached wires (figs. 7 and 8). To control the frequency and speed of the DC

motors, we used a swarm control loop, known as a PSO-based PID controller.

PSO-based PID Controller

It is inherently difficult to tune proportional-integral derivative (PID) loops and their parameters. Normally, the tuning process is done through trial and error. To automatically control multiple DC motors, we adapted a heuristic algorithm known as particle swarm optimization (PSO) from Hashim and Mustafa (2020). A PSO-based PID controller is a robust, nonlinear parameter-tuning process for synchronising and stabilizing E.

PID controllers have been widely used to control the speed fluctuation and frequency of DC motors in different control systems, such as process control, motor drives, and magnetic and optical memory. In the most simplistic terms, the PID controller calculates the P, I, and D parameters and multiplies each by an error (e) and then calculates the sum as a control variable (CV) (fig. 5). The proportional term (Gain or K_P) is a ratio that controls how fast the DC motors responds. The integral term (I Constant or K_I) determines how fast the error is removed. Finally, the derivative term (D Constant or K_D) predicts the rate of change in the process variable (PV). The PID controller is described as:

$$u(t) = K_P e(t) + K_I \int e(t)dt + K_D \frac{de(t)}{dt}$$

where $e(t) = r(t) - y(t)$ represents the tracking error and the difference between the desired input value and the actual output. The main advantage of the PSO algorithm is that it is an auto-tuning method, and it does not require a detailed mathematical process to find the K_P, K_I and K_D and tune the PID process control parameters (fig. 6).

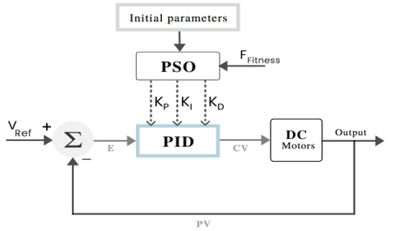

Fig. 5. Block diagram of our PID controller with PSO algorithm. Adapted from Hashim & Mustafa (2020).

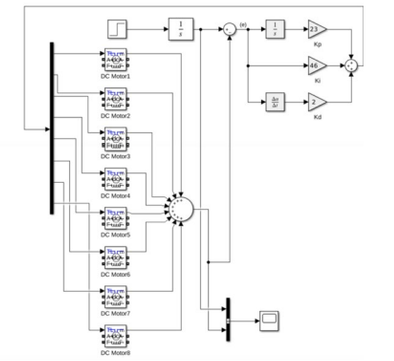

Fig. 6. Simulink block diagram of our PID controller and 8 DC motors.

Particle Swarm Optimization

Particle swarm optimization (PSO) is a heuristic optimization technique, which was developed by Kennedy and Eberhart in 1995, inspired by the social behavior of animals such as birds in flocks and fish in schools.

PSO begins by creating a number of artificial particles and assigning them initial velocities. Then it explores the space of the objective function and adjusts the trail of each agent (or particle). The position of each particle is updated, based on the agent's history (current and best previous locations), other members of the swarm (the global optimizer value), and some random perturbations (Brownlee 2012). The new position of each particle is computed as the sum of its previous position with a quantity that is estimated using several factors, depending on the PSO variant and eventually the swarm flock around the desired area. The particle position in PSO can be modeled as:

$$x^i = [K_P, K_I, K_D, K_{PS}, K_{DS}]$$

where x is the particle position, and K_P, K_I, K_D are the proportional, integral, and derivative values of the PID controller to control speed, torque, and voltage of the DC motors, respectively, and K_{PS} and K_{DS} are the proportional and derivative values of the PID controller to control the oscillation. The particle initialization is computed using:

$$x^i = x_{min} + rad(x_{max} - x_{min})$$

where x_{min} and x_{max} are the minimum and maximum values in the search space. Each particle is assessed by fitness function and particles, with a minimum fitness value compared to the best local and global values and updated. Each particle represents a candidate solution for PID parameters. A good set of PID controller parameters can yield flocking behavior and optimal control of DC motors (Allaoua et al. 2009).

Compositional Strategy

Our approach can be used both for both an interactive music performance accompanying a performer, or to generating sound compositions. Repetitive, and complex patterns of *Liminal Tones (A / Autumn Swarm)* are reminiscent of works by Pe Lang, and Zimoun, regardless of the choice of material or the architecture that drives the outputs (figs 7 and 8).

These common and key features are: the minimalistic approach and the use of multiple mechanical elements, following simple principles and resemblance to natural systems (in sound and motion). However, instead of an analogue, and un-controlled approach, which is common in Pe Lang and Zimoun works, we used an auto-tuning controller as a feedback loop to digitally mediate the movement of the wires and the patterns of sounds.

Discussion and Future Works

Swarm Aesthetic

Swarm intelligence (SI) is one of the most beautiful and unusual phenomena in nature, which emerges from the interaction between a group of decentralized simple agents and their environment. Widely recognized examples of swarms include flocks of birds, bacterial growth, schools of fish, and the societal superorganisms of ant colonies (i.e. foraging). Natural swarms are often perceived as a single entity or "super-organism," which exhibits cognitive behavior and emergent intelligence (Passino et al. 2011).

Swarm systems inspired by swarm intelligence and natural ecosystems present unique frontiers for art. Many artists have used artificial swarm systems in their practice and utilized swarming principles such as self-organization and emergence (Barrass 2006; Beyls 2007) to create novel aesthetics.

Self-organization is a spatio-temporal process resulting from multiple interactions, positive or negative feedback, amplification of fluctuations, or randomness (Bonabeau et al. 1999). Another unique capacity of swarms is emergence, a complex collective phenomenon that arises from relatively simple lower-level interactions.

In addition, the aesthetic richness of swarms and their compositional properties are often the result of two core qualities: (1) swarm agents are autonomous and therefore useful for creating generative art systems (e.g. Shiffman 2004; Blackwell & Jefferies 2005; Bisig & Unemi 2005 and 2009); and (2) artificial swarms or "complex symbolic systems" act like organic or living entities, which makes them particularly attractive in ALife Art (e.g. Correll et al. 2013; Greenfield and Machado 2015).

A Complex Multibody

As AI and robotics have advanced, their influence in the cultural imagination and art have become inevitable. This poses ontological questions: Can machines be creative? What is creativity? What new aesthetics can or will emerge?

To respond to these questions and challenge the music traditions of using fixed instruments, we present *Liminal Tones (A / Autumn Swarm)*, a series of sound compositions with a multibody architecture, consisting of identical mechanical elements (figs. 7 and 8) that sync and swarm together, inspired by the colony behaviors of social insects (e.g. foraging ants).

Our goal is to explore a performative ontology and the potential aesthetics of swarm agents in sound art. To achieve this objective, we followed two criteria: (1) exploring chaotic and emergent behaviors, and (2) embracing imperfections and errors. *Liminal Tones (A / Autumn Swarm)* is an attempt and critical reflection of a still-emergent field of work.

6.3 Synchronous Speed Control and Spectrogram Analysis

For quantitative assessment and influence of the PSO-based PID controller, we evaluated the PID performance of the overall group behavior of multiple DC motors (speed and fluctuation). We chose the PID parameters using random values for K_P, K_I and K_D followed by the step response calculation, which resulted in unstable control.

Then we tuned the initial values using a PSO algorithm to reduce the peak overshoot and synchronize the DC motors, as shown in Table 1. Our primary results illustrated that to eliminate high fluctuations and synchronize DC motors, the PID values should be in range of $K_P \in [20, 75]$, $K_I \in [18{,}50]$ and $K_D \in [1, 40]$.

Parameters	Motor 1&2	Motor 3&4	Motor 5&6	Motor 7&8
K_P	23	35	51	67
K_I	46	18	20	23
K_D	2	14	27	39

Table 1: PID values for multiple identical DC motors and synchronous speed control

For qualitative assessment and the role of materiality in *Liminal Tones (A / Autumn Swarm)*, we analyzed six samples (fig. 9), which presents the spectrum of acoustic sound objects, and their pitch and timbral qualities on different surfaces (wood, ceramic and granite). Vertical lines reveal the rhythmic structures, and horizontal lines the harmonic structures across frequencies. For some sound categories, the audio samples are very noisy, meaning that all the frequencies are pretty much present, while others have fewer frequencies and show step intervals and rhythmic cycles, which resulted from vibrating patterns, and turning and twisting of the motors or errors (on-off). The speeding patterns can be identified too, in which the sound amplitudes vary with distance and result from fluctuations in the batteries.

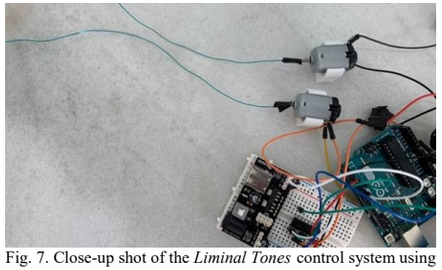

Fig. 7. Close-up shot of the *Liminal Tones* control system using an Arduino board.

Fig. 8. *Liminal Tones* in action, 8 DC Motors swarming together.

Moreover, each material shows different timbral signatures. For example, wood resonates in all frequencies, while ceramic absorbs sounds in a dry fashion and absorbs low and mid frequencies.

In general, *Liminal Tones (A / Autumn Swarm)* generated rhythmic patterns with high jumps between different frequencies and exhibited similarity to the combination of constant and rhythmic patterns of heavy hail and the noisy profile and calming pattern of sleet. Combining the qualities of different materials helps broaden the resulting timbre and frequency domains and enrich the audio expressivity. Considering the inherent autonomy of swarms, it will be feasible to simultaneously engage multiple groups in the format of an ensemble with relatively wide timbral and frequency ranges, such as a mechatronic noise-ensemble.

Therefore, with respect to future works, our plan is to investigate multi swarms and a large number of DC motors as sound objects (100 or more) and further explore the collective behavior and swarm aesthetic with relatively wide timbral and frequency range and mechanical tones.

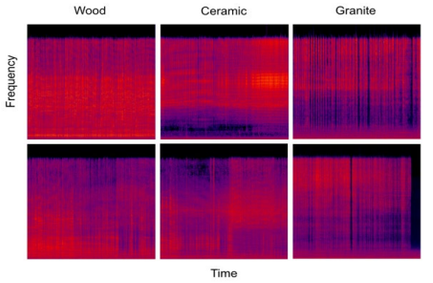

Fig. 9. Spectrograms of six sound compositions (each ranging from 15 to 30 seconds). Note the constant noisy profile of wood, and the mid-level frequencies and orders of ceramic or resonance of granite. Some samples have different characteristics, such as rhythmic patterns and high-low pass, while others are noisy.

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As If They Were Thinking: New Aesthetics of "Thought" in Machine Intelligence

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Abstract

The present century has seen a boom in both artificial intelligence (AI) and biotechnology research, but it is mainly in the past decade that machine learning (ML) has been explored as a form of artistic expression. These art practices run in parallel with an emerging paradigm shift that problematizes default models of intelligence (the human brain, neuron structures, and abstract and representational thinking). How do artists manifest these shifts in computational media art, and how does art as a cultural institution reflect these transformations in technology and culture? We examine (1) the shifting cultural discourse concerning the nature of "intelligence"; (2) the diversity of computational models that challenge processes and values associated with the human brain; (3) scientific examples of sophisticated self-organization, from the molecular level to the super organismal; and (4) the aesthetic tendencies of eco-hybrid computational artworks engaging with new concepts of "thinking" and AI. To conclude, we propose an aesthetic and conceptual framework for artists working at the intersection of ecology, biotechnology, and AI, and call for an open ecology of machine intelligence that incorporates reciprocal aesthetics and planetary thinking into AI and ML.

Keywords

Aesthetics, Contemporary Art, Artificial Intelligence, Self-Organization, Biosemiotics, Unconventional Computing

Introduction

Artist and critic Jack Burnham declared in *Systems Esthetics* (1968) that the culture of his time was transitioning from object-oriented to system-oriented, arguing for art as an adaptive mechanism and cybernetic system that produces new information, rather than objects. Like cybernetics in the 1960s, research in artificial intelligence (AI) has inspired artistic exploration since the 1990s (Stephen Wilson 2002). The late 20th century witnessed biological research and computational living systems expanding from hardware and software into the realm of wetware, as the convergence of art and technology "has imagined, represented and mimicked, then simulated and manipulated living beings and systems" (Jens Hauser 2017, 264). In *Edge Life: Technoetic Structures and Moist Media* (2000), Roy Ascott stated that moist media, where bits, atoms, neurons and genes converge, will be the substrate for art of the 21st century. Ascott argued that this radical restructuring requires new intelligent architectures that function at the "planetary level of self-organising, self-aware systems," in which the artist's role is "to plant, grow and cultivate new forms, new structures, and new meanings."

The 21st century has seen an unprecedented boom in AI and biotechnology research, especially machine learning (ML), a sub-field of AI that has attracted growing interest from the technological and cultural industries, but it is predominantly in the past decade that ML has been explored as a form of artistic expression. Echoing Ascott's statement, we ask: What new thinking models and architectures can be built by today's artists in relation to the convergence of biotechnology and ML? As we examine the underlying politics and assumptions around intelligence, what can be gained from expanding our human-centric, neuro-centric notions and better understanding diverse natural phenomena *as if they were thinking*? Beyond expanding artistic expression, we believe these investigations are philosophically and scientifically imperative, as they open more inclusive and ecological ways of thinking about the world and interacting in it.

It is largely in the past decade that ML has been explored through generative algorithms and opened new territory for AI applications in the creative industries. Artistic interest in ML took off after the development of generative adversarial networks (GANs) by computer scientist Ian Goodfellow in 2014. Shortly after his research was published, raw, untrained GANs and general ML toolboxes were made open source by different companies, including TensorFlow by Google, Torch by Facebook, and pix2pix by the Dutch NPO radio broadcaster (Artnet News 2018). The invention of new tools like Artbreeder and Runway ML have continually lowered the technical barriers, making GANs and other machine learning models accessible for artistic exploration (Fritz AI 2019).

We identified two major types of artworks that use ML: (1) Generative ML works: These works synthesize general classes of objects, images and textures (Refik Anadol, Robbie Barrat, Mario Klingemann, Trevor Paglen, Jason Salavon, Helena Sarin, Mike Tyka); musical composition (Hao-Wen Dong, et. al. 2017); literature with the advanced NLP techniques and language models such as GPT2 by OpenAI (Fritz AI 2018); and machine poems (Bei Liu et.al 2018) with NLP-aided network generation of poems from images. (2) Agent-based works with other ML models: These works create autonomous systems with artificial agents that manifest AI-based behavioral evolution. Ruairi Glynn's *Performative Ecologies* (2006–2010), Stephen Kelly's *Open Ended Ensemble* (2016), Sofian Audry's *For the sleepers in that quiet earth* (2019), and Ian Cheng's *Emissaries* (2015–17) and *Bag Of Beliefs* (2018–19). Artist and media theorist Simon Penny calls these works "embodied cultural agents" or "agents as artworks" and frames them as a "new aesthetic field opened up by the possibility of cultural interaction with machine systems" (Penny 1997).

The aesthetics of GANs, in particular, are best-acknowledged for their "visual indeterminacy" (Hertzmann 2020) and famous GAN-generated artworks, which have been auctioned by Christie's and Sotheby's. However, the aesthetics of GANs are often criticised as homogeneous and without artistic intention. Some artists, such as Sougwen Chung, Anna Ridler, and Helena Sarin, have reintroduced elements of analog art production by training GANs with their own drawings and paintings, but they are still limited by the arbitrariness of their training and execution. Agent-based, adaptive computational artworks represent an "aesthetics of adaptive behaviours" (Sofian 2019). However, by simulating or mimicking living systems, these artworks are based on algorithmic generative processes. In both types of artworks mentioned above, we recognize the lack of biological or organic living elements involved in ML processes.

Among the most prominent ML approaches, artificial neural networks are inspired by the structure and functional aspects of biological neural networks, and reinforcement learning is influenced by behaviorist psychology (Aguilar et al. 2014). However, are there interesting approaches to understanding information processing that does not emerge only in neurons? Can we broaden our artistic and aesthetic experience by introducing new strata of complex behavior that might not result from the process of "learning" as it is conventionally defined? In "An Outside View of Ourselves as a Toy Model AGI" (2020), philosopher Reza Negarestani

questions whether the "human" is a sufficient model for conceptualizing intelligence. In order to surpass the transcendental structure of human experience that artificial general intelligence (AGI) is modelling on, there needs to be an outside view of humans that resets our collective notion of intelligence.

In the following sections, we examine the problems concerning the current definitions and models of AI and ML, and offer alternative information architectures for "thinking" and "learning". We note an increasing number of artistic practices from artists such as Evelina Domnitch and Dmitry Gelfand, Jenna Sutela, Saša Spačal, Michael Sedbon and Tega Brain that combine AI and ML with biological systems, not as a simulation or representation, but by engaging organic living entities, from microscopic organisms to whole ecosystems. We believe artists can and should participate in a cultural dialogue that recognizes the diverse information processing unfolding at every level of the material world. Reframing diverse natural phenomena "as if they were thinking" can help us acknowledge the full complexity and sophistication of these processes.

Shifting Cultural Discourse

P. W. Anderson famously claimed, "more is different" (1972). Although we are not particle physicists, we believe this principle can be applied to the question we are engaged with in this essay. In *Resisting Reduction: A Manifesto* (2017), Ito Joichi urges us to "embrace the unknowability—the irreducibility—of the real world that artists, biologists and those who work in the messy world of liberal arts and the humanities are familiar with." He acutely points out that we are all participants in multiple, complex adaptive systems, in which individuals are composed of interwoven systems of different scale. Therefore, instead of thinking of machine intelligence in the framework of humans vs. machines, it is the system that *integrates* humans and machines that needs to be studied, from the perspective of "Extended Intelligence (EI), understanding intelligence as a fundamentally distributed phenomenon."

We argue that focusing only on the brain, neurons and the traditional concept of "thinking," centred around abstract symbolic thought excludes many sophisticated behaviors and self-organizational capacities that may be characterized as "intelligent." In her talk, *Questioning the Cranial Paradigm*, art historian Caroline A. Jones and her colleagues playfully refer to these brain-centric tendencies as "neuron supremacy" and "representation fetishism." Jones provokes her colleagues to rethink the traditional neuro-cognitive concept of intelligence, pushing towards a notion of distribution, or "homeostatic surfing" along worldly engagements. Jones cites the incredible intricacy of the mammalian gut and the immune system and their engagement with non-representational processes analogous to memory (creation of antibodies) and recognition (immune cells' ability to distinguish between self and nonself).

Anthropologist Eduardo Kohn proposes that non-human living entities participate in sign-making, a type of 'living logic' that can be seen in natural phenomena, from tropical forests to the logistical dances of bees. Kohn relates his work to the field of *biosemiotics* and believes symbolic thought is emergent from other kinds of semiotic thinking, which always remains "open." Kohn aims to "break down the Cartesian divide that still relegates all of mind and thought to the human," but warns that we should not "see these other kinds of minds as human minds." While we agree that it is important to distinguish between diverse modes of "thinking," Kohn's framework risks the reinforcement of restrictive binaries. Kohn argues that "thinking" is present only in biological life, and is not apparent in geological or mineral life, and warns us not to reduce human and nonhuman thought to "effect and vibration" (2014). To drive his point home, he bluntly states that "life thinks; stones don't" (Kohn 2013, 100).

To go beyond the Western analytical mode of binary thinking, animism may provide a useful lens as a "relational epistemology. . . a way of understanding relatedness from a related point of view within the shifting horizons of the related viewer" (Nurit Bird-David 1999). Robin Wall Kimmerer, botanist and member of the

Citizen Potawatomi Nation, outlines the question of animacy as a problem of grammar, noting the "arrogance" of the English language, with its preponderance of nouns and severe lack of verbs (only 30%), compared to that of her indigenous language (70%). Describing the liveliness of water, Kimmerer writes that "a bay is a noun only if water is dead. When bay is a noun, it is defined by humans, trapped between its shores and contained by the word. But the verb *wiikwegamaa*—to *be* a bay—releases the water from bondage and lets it live" (116).

Pursuing Robin Wall Kimmer's consideration of the liveliness of water, what might be gained from viewing the interactions between these water molecules as a type of "thought?" Is thought a phenomenon that can be extended into the most minute of scales—the microscopic and molecular? Within contemporary Western academic discourse, materials and entities once neglected or dismissed as "inert, inanimate, without moral or political will or relations" (Astor-Aguilera 2018, 4) are now becoming subjects of multidisciplinary interest, for example, agential particles (Barad 2007), living water (Kimmerer 2017), molecular assemblages (Parisi and Terranova 2000), "vibrant matter" such as metal, toxins and stem cells (Bennett 2010), and microbes as Shamanic beings (Herrera 2018). When we consider the "training" and "learning" of machines, what lessons might be gathered from these lively materials and their diverse modes of information processing?

We note that Ito's proposal for "extended intelligence" is still narrowly anthropocentric by emphasizing *human* participants. Indigenous communities worldwide open new lines of non-anthropocentric discussion, proposing an "extended circle of relationship", which includes AI and machines as non-human kin (Lewis et al. 2018). In *Making Kin with Machines*, the authors highlight three core concepts in Indigenous Epistemologies from Hawaiian, Cree, and Lakota cultural knowledge: *Hāloa*, the long breath that nourishes people and their surroundings, guiding them to privilege balance (*pono*) as an ethical stance to achieve "good growth;" *wahkohtawin*, the state of being related to others; and *wakȟáŋ*—that which cannot be understood. These ontologies illuminate possible paths of recognizing non-human beings, and privileging reciprocal and respectful relationships, instead of the default Western "epistemology of control," in cultural philosopher Jim Cheney's term. As alternative world views, they offer resistance to the capitalist model of extraction and exploitation, as well as the singularitarian's belief in the world being fully "knowable" and computable.

In contrast to the universal mono-technology and unified global system of the modern age, philosopher Yuk Hui suggests the notion of *cosmotechnics*. Hui's concept describes "the unification of the cosmos and the moral through technical activities, whether craft-making or art-making." Hui emphasizes the urgency of envisioning alternative possibilities, bifurcations and fragmentations by conceiving different cosmotechnics (Hui 2017). His book *The Question Concerning Technology in China: An Essay in Cosmotechnics* interrogates Chinese cosmotechnics through the inseparable unity, yet dynamic relationship between *Dao* (the ethereal life force that circulates among all things, commonly referred to as "the way", the soul) and *Qi* (tool or utensil; the machine), and relational sensibility (*ganying*) as "correlative thinking" that resonates between the subject and the cosmos based on morality (*de*, virtue) (2019, 27).

Emerging Technical Developments

In tandem with this shifting cultural discourse, in the past few years we have noted a renewed interest in computational models that challenge processes and values associated with the human brain. Drawing further from the work of Yuk Hui, we examine these models from the standpoint of *technodiversity*, the idea that technologies are not anthropologically universal, but expressive of specific ontologies and epistemologies. In other words, technologies are *shaped by* and *expressive of* specific world views. Hui identifies a narrow anthropocentrism in the Western history of technology, a reductionist stance that resonates with Caroline Jones's critique of "neuron supremacy" and "representation fetishism." Hui describes a

dangerous convergence of Western modernist technologies into a universal and totalizing mode, an "anthropological machine, the victory of a humanism that aspires to reinvent *homo sapiens* as *homo deus* through technological acceleration" (Hui 2019).

The focus on the processes of the brain, specifically the cognitive abilities of the human brain, permeates AI discourse. In the beginning of his 1950 paper *Computing Machinery and Intelligence*, Alan Turing famously posed the question, "Can machines think?" Turing didn't originally offer a definition of "thinking." Rather, the Turing Test was proposed simply as an operational definition of intelligence. However, the question regarding "thinking machines" continued to fascinate his successors in the following 70 years. Most of these discussions centred around the "brain." From the functional machine consciousness model, which sees the brain as a central information exchange or "global workspace" within a distributed system, to phenomenal consciousness models, which identify all thoughts and experience as statuses in the brain, to the emphasis on intentionality, which would necessarily require neuroprotein for intelligence (Boden 2018).

ML suffers from a similar reductivist problem, as many of its modern network architectures are structured to mimic those aspects of the brain that are considered virtuous in Western culture: speed, efficiency, abstraction, and autonomy. This approach assumes that for everything the brain does well, we can and *should* build a model (although we do not even have a very clear idea of how the brain itself functions). Additionally, there is a common assumption that the conclusions drawn from limited datasets are objective and converge on truth. Yet just because the data used to drive ML originates in the physical world, it does necessarily mean that the results are communicated back to the origin. Similarly, the psychology theories related to learning and reinforcement that initially inspired the ML field are quite far from the mathematical techniques that drive ML today. Gary Marcus, professor of cognitive psychology at NYU, has identified the fragility and limitations of ML, summarizing that they are "greedy, brittle, opaque, and shallow" (2018). This is not to criticize ML on the whole as a field of study, but to clarify that it is in no way representative of different modes of "learning" and is in actuality only loosely connected to traditional ideas of "thought."

Artificial Life (ALife) and Swarm Intelligence are two historically related fields that emphasize decentralized organization and a relational mode of "intelligence." Eric Bonabeau and Guy Theraulaz, early members of both the ALife and swarm intelligence communities, define ALife as a method for "generating at a macroscopic level, from microscopic, generally simple, interacting components, behaviors that are *interpretable as lifelike*" (1994, 303, emphasis in original). Similarly, Swarm Intelligence describes the collective behavior that emerges from decentralized systems, both natural and artificial (Beni et al. 1993). These systems are composed of many, usually very simple agents, which interact locally with one another and with the environment, leading to emergent "intelligent" global behaviors. Models of swarm intelligence include numerous distributed phenomena, such as flocks of birds, the social behavior of insect colonies, bacterial growth, and schools of fish.

Unconventional computing is an emerging field, which explores alternative models of both computation and thinking at the practical level. British computer scientist Andrew Adamatzky has been a consistent champion of this field, strongly urging practitioners to move beyond theorizing "natural computing" and into the production of artworks and laboratory prototypes. Adamatzky has made significant strides in developing real applications for liquid computing (2019), fungal computing (2018), and slime-mold based "physarum machines" (2010). Unconventional computing expresses alternative modes of intelligence and demonstrates that a nervous system is not necessary to fuse sensorial inputs, process information, and make decisions. This field creates alternative models of learning by slime mould, and morphogenetic and spatial computing, distributed information processing in plant organs, and neuron-like activity of bacterial biofilms (Adamatzky 2019).

Adamatzky admits that fungal computers will never be as fast as silicone-based computers, but argues that they offer new ecological insights—forest-sized networks of mycelium can collect and analyze information about the environment, including the health and well-being of other forest inhabitants.

Challenging the human brain from another angle, Katherine Hayles argues that humans have awarded ourselves too much credit, often imagining that we are the "sole possessors of agency, value, and cognition," and that our technologies are not capable of participating in human activities such as meaning-making. According to Hayles, the human brain is biologically limited by the speed and memory capacity of its neuronal system and expands this capacity by engaging in "cognitive assemblages." Hayles states that there is a continuity between biological and computational cognition, progressing through levels of dynamic organization from the subatomic scale to atoms, and onwards. She names this evolving spectrum *biotechnoevolution*, a "hybrid process in which information, interpretations, and meanings circulate through flexible interactive human-computational collectivities" or "cognitive assemblages" (2019, 32–55). Expanding the notion of biosemiotics, Hayles identifies her perspective as one of *cyber/bio/semiotics*.

In her consideration of the "smart forest," media theorist Jennifer Gabrys introduces what we might characterize as an ecosystem-level cognitive assemblage (2020). If, as posited by Eduardo Kohn, forests can think, how does a "smart forest" think through all of its many cognitive connections, both with humans and our technologies, and other organisms? Gabrys suggests that these hybrid forests, with sensor networks attached to tree trunks and embedded in soil, are transforming into technologies for managing environmental change. She identifies the contested nature of the term "smart" in these environmental contexts, as it is often used as a marketing ploy, rather than given serious consideration. What are the implications of fully embracing this term and imagining smart forests as something possessing a technologically assembled "intelligence" beyond simple augmentation through a collection of sensors? Extending this line of questioning to the planetary level, Gabrys outlines the varying scales of environmental sensing and effects in the "becoming environmental of computation" (2016).

Material Insights - Self-organization from molecular to super organismal

Many of our computational models still fall under the "cranial paradigm" and justify or demonstrate their sophistication by appealing to many of the qualities of brains as virtues. But perplexingly, many descriptions of biological systems, particularly within the synthetic biology community, are rife with terms originating in computer science: genes are turned "on" and "off" in digital fashion, these genes operate in "circuits," which organisms use to "compute" information about their environment, and they can be "programmed" to the will of bioengineers. We believe that broadening the language and thinking around "thinking" might make the tension between these two frameworks productive: what happens if we think about bodies and bacteria, or even "simpler" forms of matter, *as if they were thinking* in a similar way?

We can ground this line of reasoning by examining and extending Kohn's arguments about symbol-making, first, by showing that even very simple living things without a brain or even a nervous system at all perform symbolic "thought," then showing how symbol use is also not actually required for complex behaviours in organisms that *do* have brains, and finally by arguing that this complexity, and perhaps even the complexity and sophistication of "higher level" thought may be grounded in, or at least intimately related to, physical principles involving self-assembly and reductions in local entropy.

Symbol use and abstraction in nature

There are numerous examples of what might be called "abstract, symbolic" thought that occur in nature. Although often methodologically problematic, there exist several known cases of primates using hand symbols or touchpads to communicate, and at least one case in which a primate may have deliberately lied to its trainers about making a mess (Patterson 1981, 181–182). Beyond the admittedly convoluted cases of trained primate behaviors, both primates and birds may use similarly sophisticated behavior as part of feeding strategies. Capuchin monkeys, for instance, may use fake warning calls to frighten other individuals away from food, and some birds may do the same even to non-bird animals, sounding fake warning calls near other animals feeding on a tasty morsel, inducing those competitors to flee (Wheeler 2009; Flower 2010). These behaviors seem to be symbolic: using hand or image symbols to represent something other than themselves, and also abstract: they rest on the understanding that the symbol is subject to interpretation, and is therefore more complex than a raw, uninterpretable statement of reality.

Pure symbolic "thought," as Kohn has suggested, also appears to be widespread. Those same warning calls, when used as an actual warning, for instance, are the encapsulation of a concept into a communication channel in a way that does not rely on similarities between the information ("Predator!"), the channel medium (sound), or any direct representational model, as warning calls do not typically mimic, for example, the sounds the predator makes. Such thinking behavior extends to those organisms that we do not conventionally think capable of symbolic thought. Bees, for instance, perform a "dance" after returning to the hive, which communicates the direction (encoded representationally in that the bee may dance along a line oriented relative to the sun and the nectar source in real space, and the length of that danced line is proportional to the distance to the nectar source), and communicates symbolically (modulating a "waggle" behavior and sound production to indicate how rich the nectar source is) (von Frisch 1967). Our lack of recognition reflects the over-emphasis we place on brains like ours, while we underestimate the power of brains much smaller than ours, as bees seem to be able to count, and can potentially understand the concept of zero or nothingness (Howard et al. 2018).

Brainless symbolic thought

In fact, brains are not a prerequisite for this type of "thinking." Plants, for instance, use representational communication, in the form of volatile organic compounds that act both as defense compounds to repel insects and signals to neighboring trees of insect attack (which insects, in turn, have successfully learned to interpret and use as guides to vulnerable plants). They also use what appears to be pure symbolic messaging, communicating with neighbors about stressful conditions like drought, sometimes even with the help of other species, like the dense fungal networks present in soil (Engelberth et al. 2004; Halitschke et al. 2008; Falik et al. 2011; Gorzelak et al. 2015). Bacteria also utilize small molecules ubiquitously to organize density dependent functions like biofilm formation using a system called quorum sensing (Abisado *et al.* 2018). In a prototypical quorum sensing system, bacteria produce small molecules, called acyl homoserine lactones, that signal their presence to nearby individuals. When enough individuals are present together, the build-up of this signal can induce changes in morphology and behaviour that help stabilize and/or defend the bacterial community.

Sophisticated non-symbolic behaviors and emergence

However, symbolic thought is not a prerequisite for behavioral complexity, even among organisms with brains. In fact, in some cases it is precisely the absence of the typical virtues of brains and symbolic thought that allow sophisticated behavior to occur. For instance, ant larval sorting appears to *require* short term memory loss (Parunak 1997). Models of ant behavior using simple rule sets can recapitulate the ability of ants to move larvae from chamber to chamber within nests, but only if the ants are sufficiently (but not overly) forgetful: too short and the ants will not be able to move around enough to successfully separate larvae from eggs before dropping larvae, and too long and the ants will see egg and larvae storage areas as part of the same "location" and will not differentiate where to place the larvae. Nowhere in this process are the ants performing symbolic representation; the sophistication appears

somehow displaced from the cognitive process as we might think of it, even with the broad definition of thought that Kohn espouses, and is an emergent function *of* behavior, rather than *a behavior*.

Slime molds, the best-studied of which are *Physarum polycephalum* and *Dictyostelium discoideum*, can exhibit similarly sophisticated behaviors despite not having a nervous system, much less a brain (Reid and Latty 2016). The true slime mold *P. polycephalum*, for instance, can solve mazes and allocate resources spatially, as demonstrated by its ability to recapitulate the shape of human-made transportation networks like the Tokyo subway when food sources are positioned on a growing plate of *P. polycephalum*, as if they were real locations on an actual map (Nakagaki et al. 2000; Tero et al. 2010). *P. polycephalum* also appears to have a kind of memory and is able to anticipate coming stresses, like changes in temperature if it has been conditioned by repeated experience with the same stressor (Saigusa et al. 2008). *D. discoideum*, on the other hand, spends a significant part of its life cycle in a single-cell state, but when reproducing, it coalesces into a single "slug" with differentiated multicellular organ-like structures and moves as a unit until it finds a suitable place to develop into its final reproductive form, producing a single-celled amoebae as its solitary offspring. As with *P. polycephalum*, the organizing signal that brings these organisms together into the "slug" is both symbolic and emergent, taking the form of self-organizing pulses of the signalling molecule cyclic adenosine monophosphate, which eventually coalesce into spiral waves of signals that draw the individual *D. discoideum* amoeba together to a single point, forming the slug (Tyson et al. 1989).

Thinking close to the metal

These spiral waves of signals are strikingly similar to those observed in some non-linear thin-layer chemical reactions, most familiarly the Belousov-Zhabotinskii reaction, and may be driven by the same underlying chemical processes (Tyson et al. 1989). With tongue in cheek, this raises the question: why not extend the principle of *as if it were thinking* to similarly complex, but non-living systems? After all, the "complexity" of all these systems is, ultimately, a product of their underlying physics, differing more by degree than quality. Does the tool of "symbolic" thought, broad as it can be, go far enough to extend our thinking, or just recapitulate the same old mind-body dualisms, arbitrary hierarchies, and appeals to the supposed virtue of brains, conveniently exemplified by our own? At the risk of just playing a semantic game, let us consider what might be included if we broadened the definition of "thought" to something closer to "complexity", or simply the organized properties of a system that result from interactions between the system's parts. The bacterial quorum communication described above, for instance, already falls well within this definition, even as it remains symbolic, with most of the biochemical mechanisms underlying the quorum-sensing molecular function being relatively well understood. One order of magnitude in scaled-down, bare biochemical systems have also already been coaxed to "think." Microtubules, part of the superstructural system that gives mammalian cells, including our own, their physical shape, can be used to run mazes that physically encode difficult computational problems (Nicolau et al. 2016). Similarly, the folding behavior of DNA has been used to solve difficult problems, and even to construct the famous fractal Sierpiński triangle structures that appear in some Alife models, like Conway's Life (Adleman 1994; Rothemund et al. 2004). While convoluted, these examples may hint at deep connections between self-assembly, complexity, and "thought."

In the early 20th century, the physicist Alfred Lotka proposed a kind of informal fifth law of thermodynamics, which he believed might help explain how locally complex systems, more specifically life, have come to exist in the face of the ever-increasing global entropy described by the second law (Chen 2006). The "maximum power principle", as it is now known, roughly states that in open systems (like living ones), configurations that maximize efficient intake and transformation will prevail over time. Recent more rigorous work has lent support to this idea, showing that in certain cases, systems

of interconnected chemical reactions will stabilize those reactions that most effectively dissipate energy, effectively selecting more complex reactions in the process, and offering a tantalizing glimpse of a coherent, physically grounded story of the origin of life (Horowitz and England 2017). Similarly, admittedly probably unfalsifiable arguments have been proposed, controversially, as explanatory models for cognition itself in the form of the "free energy principle", which formally relates cognition to a process by which agents minimize differences between their beliefs about the world and their observations of it—a discrepancy which can be calculated using the same principles of entropy that govern thermodynamics and information theory (Friston 2010). Another way of articulating the proposed connection between "thinking" and the basic principles of order-generation exhibited by such systems might be to articulate *thinking of self-organization as thinking*.

Self-organization can itself be broadly divided into two classes: dissipative structures, which must pass energy through them to maintain their organization, and structures existing at thermodynamic equilibrium (Whitesides and Grzybowski 2002). Both classes are subject to ongoing study, often adjacent to studies in unconventional computing. As well as probably being central to every example presented above, self-organization extends to much simpler structures like a sink drain whirlpool, which is a particularly ordered form of water (compared to the same sink at rest), which emerges from the properties of the sink, the water, and the drain, and is stabilized by the dissipation of energy in the form of water flow. More provocatively, something as simple as crystallization, probably known most familiarly through the freezing of water into ice, is an example of a self-organizing system operating at equilibrium. As water freezes, molecules spontaneously organize themselves into the ordered crystalline form we know as ice, each finding a properly oriented set of partners and settling into a locally ordered structure.

So what if we thought of something as calm as our draining sinks (as wild as Charybdis?) or familiar as ice *as if it were thinking*? The fundamental processes of dissipative and equilibrium self-assembly are clearly important to nearly every biological process, and the statistical physics that underlie them may even lie at the heart of thought and life themselves. But a draining sink is also clearly not "thinking" in the way we typically think about thinking. Given that the fundamental differences and lines between these systems seem to get slippery as one looks closer, perhaps such a framework holds a productive tension for questioning existing paradigms, zeitgeists and epistemologies.

New Aesthetics

In parallel with the shifting cultural paradigm regarding the nature of intelligence, as well as the computational developments and scientific insights that challenge neuro-cognitive defaults, we identify emerging artistic practices that engage with the diverse information processing unfolding at every level of the material world. The next section introduces some of these artworks that we believe contribute to reframing diverse natural phenomena *as if they were thinkin*g and acknowledge the full complexity and sophistication of these processes. By emphasizing these works, we hope to create an alternative artistic genealogy of artificial intelligent systems.

Artist duo Dmitry Gelfand and Evelina Domnitch are known for creating multisensory environments and pursuing philosophical inquiries in their installations, which function as "phenomenological investigations" (2014). Resonating with our speculations above on the organizing principles of whirlpools and sink drains, Gelfand and Domnitch explore the energetics, memory, and cognitive capacities of turbulent matter at the particle level, forgoing the use of "solid, fixative and recording media in favour of liquids, gases and plasmas permeated by acoustic vibrations and light emissions" (Domnitch and Gelfand 2019). *Memory Vapor* (2011) transforms a thread of condensation droplets into a dynamic prism with a particle accelerator and a scanning white laser sheet. *Luminiferous Drift* (2016) speculates on the ambiguous planetary transition from lifeless

to living matter by tracing bioluminescent protocells (fig. 1). As the artists state, their works describe an "emergent cognisphere" and explore "the non-rigid, morphing structures of consciousness itself."

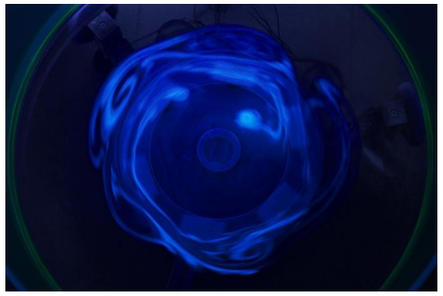

Fig. 1. *Luminiferous Drift*, 2016. Dmitry Gelfand and Evelina Domnitch. Installation.© Domnitch Gelfand.

Berlin-based artist Jenna Sutela performs an experimental survey of slime mold *Physarum polycephalum* in her project *Orgs* (2016), which consists of layered organizational and spiritual charts, networking diagrams, architectural mazes, and installation. The "many-headed, no brain" *Physarum* becomes not only a collection of "abstract machines generating alternate realities" (Sutela 2017, 26), but also a soft machine that encodes its own instructions through spatial, non-human intelligence. In an experimental performance of the publication, Sutela ingested *Physarum polycephalum* and imagined that the organism might be able to program the artist (fig. 2). *nimiia cétiï* (2018) deals with another kind of intelligence—*Bacillus subtilis,* a bacterium gathered from fermented soybeans, which according to recent spaceflight experiments, can survive on Mars (Cortesão et al. 2019). Sutela uses ML to generate a new written and spoken language, based on the computer's interpretation of a Martian tongue. Using the generated alien language, the computer observes and details the movements of a *Bacillus subtilis nattō* culture under a microscope, generating a script to be recited in the machine language. Sutela's work de-emphasizes neuro-centric human intelligence, highlighting how humans are convenient earthly vessels for "brainless" microbial collectives, which may manipulate human behaviour in order to spread them to other planets.

Fig. 2. *Many-Headed Reading, 2016.* Jenna Sutela. Decentralized performance featuring a Physarum polycephalum (slime mold) trip report. Photo by Mikko Gaestrel. © Jenna Sutela.

Saša Spačal is a postmedia artist with a similar interest in decentralized, networked intelligence, who often juxtaposes both biological and technological living systems in her immersive installations. Her *MycoMythologies* (2020) is a speculative artistic investigation of ontogenetic mythological stories, video essays and machines that taps into the underground flow of the mycelium network (fig. 3). She points out that the "wood wide web" metaphor used to describe mycorrhizal networks (connections between plants and fungi) treats fungi as merely wires, rather than organisms with their own agency. To highlight the thought processes of fungi, Spačal developed her own language and protocol, the *Fungal Network Traits Protocol*, in collaboration with fungal agents. Using her protocol, Spačal channelled fungal messages through machines and performed their decision-making processes. In the installation, the microscopic node in the *World Networks Entanglement* programmed

with the *Fungal Network Traits Protocol* is experiencing an overflow of sonic data. One single sentence with numerous languages is computed by the *Entanglement* and repeatedly uttered by the machine, creating an intense, distant and glitched machinic murmuring, "We can't return to normal because the normal that we had was precisely the problem." The machine failed to compute the immense breaching across the feedback looping of the planetary networks, rendering a rupture of the entanglement of the world.

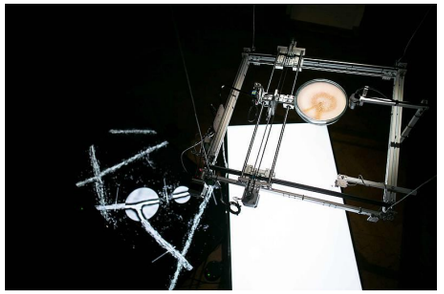

Fig. 3. *MycoMythologies: Rupture, 2020.* Saša Spačal. Installation. © *Saša Spačal.*

Michael Sedbon, a French artist and interaction designer, explores digital networked technologies and systems through their convergence with non-human intelligence. *CMD* (2019) is a juxtaposition of an artificial intelligence and two artificial ecosystems of Cyanobacteria that are competing for the same light source (fig. 4). Each colony of photosynthetic bacteria can claim access to light as its reward earned from its oxygen production. The distribution of the light source is managed by a market, whose rules are constantly optimized by a genetic algorithm. The computer and the photosynthetic cells experiment with various political and economic systems granting access to the resource, which can also be tested at the macroscopic scale. As Sedbon noted, a new status quo granting non-human entities agency over political economic and ecological systems at an unprecedented speed marks a cultural paradigm shift regarding the notion of living and nonliving, and reconsidering "intelligence" and agency provides a good prism to assess these transitions (Cao 2020).

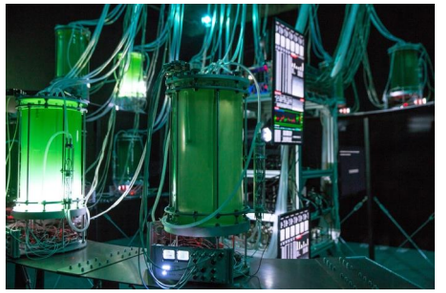

Fig. 4. *CMD*, 2019. Michael Sedbon. Mixed media installation (installation view). © Michael Sedbon.

However, some of these initiatives remain human-centered. *terra0* is a blockchain-based project, whose aim is to turn a forest into a technologically augmented self-owning ecosystem by providing technical infrastructure such as remote sensing, machine learning, and smart contract. Instead of extending our economic and political structures into the non-human realm, which seems to be rather an attempt to reinforce the existing hierarchy, we should be more open to the possible emergent properties of such technological or algorithmic systems regarding decision-making processes by incorporating our systems into the complex ecology.

The problematics underlying the application of engineering metaphors to complex environments is also addressed by Australian artist and environmental engineer Tega Brain, who argues that the term "ecosystem" enmeshes ecology with systems theory, framing interspecies relations as functional and controllable. With her installations and extended writing, she brings up concerns regarding ecosystem optimization and manipulation in the context of increasing human impacts on climate change, mass extinction, and paradoxically, the unprecedented surplus of computing used to manage ecological processes (Brain 2018). *Deep Swamp* (2018) is a triptych of semi-inundated environments, where wetland life forms and artificially intelligent software agents converge (fig. 5). The swamp territories are

under the management, engineering and strategic intervention of three AI agents, whose responsibilities are modifying the wetland conditions—floods, melting, dehydration and erosion—to achieve optimal conservation. Each agent possesses different engineering goals and gains increasing understanding of its tasks through a deep-learning approach with data collected online, which guide them to experiment with new combinations of settings in order to achieve their programmatic goals. This piece raises the question of the goal and means of optimization concerning environmental engineering, whether by machine or human intelligence.

Fig. 5. *Deep Swamp,* 2018. Tega Brain. Glass tanks, wetland plant species, gravel, sand, acrylic pipes, shade balls, electronics, misters, lighting, pumps, custom software, 3 channel sound (installation and detail view). © Tega Brain.

With the examples above we have identified an emerging tendency towards ecohybridized computational artworks. These works often involve "biologized" machine (Yi, 2020) and nonhuman intelligence, and interrogate the limitations and possibilities of computational models involving complex living systems and planetary ecology. By engaging with organic living entities, the artists expand the conversations around critical issues in AI-related artworks and offer new understandings for notions such as "intelligence," and "living vs. nonliving."

Conclusion

Within the context of AI-related computational media arts, this paper outlines the cultural paradigm shift around the notion of "intelligence" and "thinking," and examines some technical developments and scientific insights associated with such transitions. By presenting the emerging artistic practices involving eco-hybrid computation, we propose a new aesthetic and conceptual framework for contemporary artmaking to be engaged with the increasing convergence of biotechnology and machine learning. Artists have an important role to play in expanding our cultural notions of intelligence and our corresponding appreciation for the diversity and sophistication of non-human lifeforms and phenomena.

We want to emphasize the importance of not confusing blindness with absence. We advocate an extended practice of "noticing" (Tsing, Bubandt, Gan, and Heather 2017) when it comes to computational models that challenge processes and values associated with the human brain. The limiting focus on traditional concepts of "thinking" excludes many types of sophisticated behaviors and self-organizational capacities that may be characterized as "intelligent." What new models of AI and ML might be developed that privilege slow, gradual, collective, embodied, emergent intelligence? What can we and our machines learn from cognitive complexity, diverse informational processing, an emergent cognisphere, cognitive assemblages, vibrant matter, living water, and living logics?

We call for artists to engage with an open ecology of machine intelligence that incorporates non-human cognition, reciprocal aesthetics, and entangled planetary thinking into AI and ML. We also urge an increased awareness of the gravity of utilization—think twice before instrumentalizing something that may also be thinking.

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The Art of Data Portraiture: Enabling a Public Debate on Self-surveillance

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Abstract

This research is a practice-based speculative design inquiry into the emerging field of data portraiture. Humans' use of the networked digital environments that are now so much part of life leaves a massive data trail stemming from individuals' everyday interactions with these environments. An increasing amount of this data trail remains invisible. Although we spend a significant amount of time participating in digital network activities, we have just begun to discover the potential of visualizing personal data as a graphical representation. This research into the emerging field of data portraiture seeks to understand the role of the "artist" as a creative practitioner in interpreting qualitative data into image experiences, and to offer insights into the behaviour and interests of individuals engaging with such work. Through a number design iterations, this research investigates and reveals the importance of participant contribution to the "datafication" of social life and the emergence of "self-surveillance" that can shape data portraits.

The transformation of photographs into Big Data

This practice-based project was named *Selfie Factory* to reflect the phenomenon of the "selfie" photograph as an act of self-surveillance, as well as Andy Warhol's art studio, known as "the Factory." Many of Warhol's artworks were created in the Factory. The name implies changes in artistic practice, influenced by industrialisation, and the resulting mass production of consumer goods, which has influenced Western societies' understanding of art and creativity in a broader sense. Warhol's portraits explored different mediums and often showcased celebrities and other artists. They challenged the conventional understanding of the portrait as a single, still image.

He understood that the portrait at its time of creation is fundamentally connected to the medium that carries the image, which influences the interpretation of the portrait. Warhol envisioned that the medium and the lifecycle of a portrait as an image would take on new forms, when he said his famous words that in the future, everybody would have 15 minutes of fame. It seems as though he almost predicted a future in which everybody has access to sophisticated technology, such as computers and smartphones. Through contemporary network technology and smartphones, today's social media platforms enable individuals to broadcast their opinions, photographs, and videos immediately to the world. The internet provides access to a large volume of image data, such as selfies, from smartphone users. The Instagram application programming interface (API) enabled us to access publicly available selfies, which added a reader-driven element to our prototype. The phenomenon of selfies has occurred in part because of the Instagram online

platform. Today #selfie is the most popular hashtag used to describe a self-portrait taken with a smartphone and posted on Instagram.

Network technology offers access to sophisticated infrastructure that enables individuals to take self-portraits and immediately share them with millions of users on their smartphone screen. This phenomenon enables users of these devices to briefly experience mediated fame, similar to what Warhol envisioned—except perhaps that users gain only 15 seconds rather than 15 minutes of fame, considering the volume of selfies and the frequency at which they are posted every few seconds. *Selfie Factory* does not reveal many of its computational features as an installation. Rather, it hides the intelligent parts that operate its mechanical and technological features. The intention behind the installation is that the observer can explore the images and their automated process, and experience a telematic performance with as little distraction as possible. To achieve this, we provided a "reader-driven" element to it, enabling exploration (Segal and Heer 2010), which according to Cairo (2016, 31), allows us to "conceive a data-driven representation as a tool that lets people extract their own conclusions from the data." To facilitate such an approach and at the same time prevent distraction, we decided to hide the Raspberry computers and any tactile features that indicated technological equipment and to enable engagement only via a smartphone. Some individuals post on Instagram to increase their popularity, while others use Instagram to stay in contact with friends or follow their idols. Selfies are often an expression of the moment—a way of sharing that the individual is experiencing something worth photographing:

> unlike traditional portraiture, selfies don't make pretentious claims. They go in the other direction—or no direction at all. Although theorists like Susan Sontag and Roland Barthes saw melancholy and signs of death in every photograph, selfies aren't for the ages (Saltz 2014).

As author Jerry Saltz (2014) points out, selfies are important right now; they are not made to be preserved; they are a temporary statement in a telematic society. However, selfies endure because their data are stored online and cannot be erased. Sharing and at the same time recording social activities online—by posting selfies, for example, is a contribution to the datafication of social life. The datafication surrounding social activities in the online environment is perceived critically: even "for media scholars . . . the shift to a data-rich environment poses challenges for a robust understanding of how agency and expression might still work within that environment" (Couldry and Powell 2014). In particular, one may ask what agency individuals have over their personal data use, captured online; and whether there is a way to express one's concern about the use or abuse of personal data other than within the temporary cycle of sharing personal data on the platform from which it may be gathered.

Some critics have questioned whether selfies are more than simple fun and a method of expression. From a psychological perspective, Sunitha (2016, 151) considers that "the present generation is technology-addicted and selfie-obsessed. Efforts need to be made to educate everyone about how social networking is leading to a culture of 'popularity' based on materialism and giving way to unreal standards of physical appearance." Although we agree with the concerns raised by Sunitha regarding the use of selfies and the addictive nature of technology, we are fascinated by the immediate experience and the need to share one's data, given that millions of people take self-portraits with their smartphones. Our research is less concerned with the selfie as a visual artefact; rather it views the selfie as a reference frame of datafication resulting from "the ubiquitous quantification of social life" (Mayer-Schönberger and Cukier 2013, 78). The selfie is a vehicle that carries personal data freely shared online through platforms such as Instagram, with little resistance. We question what might happen to image data once an image's temporary message of personal expression expires. The selfie is a great example and an appropriate reference for the increase in the volume of personal data shared online. However, this increasing trend of sharing personal data on

free platforms such as Instagram is a transactional exchange between individuals taking advantage of a convenient way to upload selfies and a company obtaining valuable data on users. This disconnect in the transactional relationship taking place, which operates within a sophisticated system, can be difficult for users to comprehend. Moreover, the issue is not unique to image data from selfies: "Big Data technologies and the growing relevance of algorithms may disconnect system and experience . . . because the traces of data people leave behind are often unconscious and not meaningful to them, and the insights generated by companies or governments are not, or only partially" (Couldry and Powell 2014, 5), "folded back into the experience of everyday life" (Baack 2015, 2).

Regardless of the factors that motivate individuals to post and share images, an individual with a large follower group (known as an "influencer") is more likely to be displayed on Instagram's 'most recent' page, than are others. Rubinstein (2015a, 165) states that "classifications of 'good' and 'bad' or 'original' and 'copy' are less important online than such questions as how many 'likes' does a selfie get." It is interesting that Instagram enables its users to view each other's images, which I believe changes the digital Instagram platform into a digital curated public space, where people observe themselves and each other through photographs.

We are intrigued by the fact that millions of selfies are shared online everyday (Glum 2015) and people are willing to provide their data—even via a digital portrait to correlate with their personal identity—with little concern. Thus, we began to conceptualise the direction of the *Selfie Factory* prototype. However, it is not just visual data that are contained in a selfie; the literature suggests that a selfie carries a rich set of data, both qualitative and quantitative. Rubinstein (2015a, 173) suggests that "the defining quality of the selfie is its instant shareability: Its logic does not distinguish between the act of 'taking,' 'making' or 'snapping' and the act of uploading and sharing." The simple act of creating a selfie relies on sophisticated network technology and the individual's willingness to freely share personal data online.

The massive increase in the volume of data available for our prototype seemed to present both a challenge and an opportunity to explore the dynamic dimensions of Big Data. It allowed us to explore a new medium and investigate the indexical properties of portraiture in an automated context using selfies. According to Rubinstein (2015a), "the self is not permanent and solid; rather it is dependent on continuous reinvention and adaption." Considering this argument, it occurred to us that selfie data on Instagram were appropriate for the prototype. They would enable us to utilise the undistinguishable qualities of selfie data and the adaptive nature of the self in a data portrait capable of demonstrating our divided self; that is, a self that is a split representation involving the online self and our actual self, emerging as a result of today's telematic world in which we live. As selfies are shared constantly, we were confident they would provide a flow of data as part of the automated process. As Rubinstein (2015a, 175) indicates, "The selfie opens up a possibility of a discourse about self and about photography that is not bound to indexicality, representation or memory but instead suggests a meditation on the forces of network expressed through the plurality of fragments." While Donath's (2014) work reminded us that portraits are situated within a community, or even emerge from a community, Rubinstein's (2015a) view reassured us about our decision to use selfies and their dialectic meaning as a vehicle to iterate and learn through prototyping. We decided to display the data because they were creating the image and displaying the time and date of selfies as shared on Instagram. The literature identifies two forces at play in a selfie: it points to someone in space and time, and yet it is instantly distributed among different spaces, appearing on the screens of multiple Instagram users.

Our intention was to highlight the high frequency of selfies taken and shared online, as well as how accessible the data is to the public. By printing a selfie, observers can experience the data in the physical form of paper. However, a printed selfie is only a by-product of the data that we aimed to highlight; that is, the time and

date of the shared selfie entering the Instagram database and its relationship with the qualitative data. As Rubinstein (2015a, 171) states, "the selfie . . . encapsulates the present moment as 'ecstatic' temporality." The printed image to which we applied "direct visualisation" to maintain context was like a signature confirming that the event of the selfie had occurred. In Rubinstein's (2015a, 175) words, "what the selfie shares is the possibility of detaching the image from its foundation in platonic metaphysical unity and the chance of overcoming the representational force of photography." We partly agree with Rubinstein's view and suggest that the selfie's photographic indexicality is tied to a representation of a social phenomenon, rather than abolishing its indexicality completely. While Rubinstein describes the loss of the indexicality of the photograph through the mediation of network technology and the plurality of fragments of the selfie, we argue that it acts as a facilitator pointing to a social phenomenon, rather than functioning as causal indexicality of a single individual. With this in mind, we began to explore the scale and data traffic of selfies shared on Instagram, which eventually became the source of personal data for a third (and final) prototype. *Selfie Factory* underwent three major iterations, described in the following section. Each iteration reached a point of exhaustion in terms of ideas, designs, software, or hardware capabilities until the final stage was reached as a functioning media installation.

Designing a data portraiture machine

Before we explain in further detail the conceptual approach linked to our theory and the installation's iterative process, we provide a brief overview of the installation's function that determined its final physical format. The final installation consisted of five small computational units, each of which contained a Raspberry Pi computer connected to the internet via WiFi, and a 30 cm diameter roll of thermal paper, which fed into a thermal printer (Figure 1). The five units were mounted parallel to each other traversing along the wall with a 20 cm space between them. As the custom-made and designed software began to connect to Instagram via WiFi, the five units began sequentially printing in a 10-minute cycle (to prevent overheating), which continued for about 24 hours. The thermal printer began to print the rasterized greyscale selfies as they were shared publicly online, and the thermal paper slowly made a long trail of selfies flowing from the units, elevated two metres above the floor. As the five paper trails dangled down, people were able to explore the selfies until the paper trails eventually curled up in a pile on the floor. People could also use their smartphones to share a selfie via Instagram and experience the installation from a participant's point of view. The installation was exhibited in four galleries: Watt Space Gallery, Testing Grounds, Campbelltown Arts Centre, and the National Portrait Gallery.

Fig. 1. *Selfie Factory*, Ralph Kenke and Elmar Trefz, 2016, Sydney (Campbelltown Arts Centre), Australia. Mixed media. Copyright Ralph Kenke, 2016, all rights reserved.

The first attempt to design *Selfie Factory* soon revealed (fig. 2) that the format or medium to represent the dynamic nature of the accumulation process would require a different approach than simply displaying images on a screen. In a way, *Selfie Factory* acts as an artefact—an image experience, pointing to a possible future speculative design. It presents an alternative present and suggests replacing the act of taking and looking at photographs made with

smartphones with the act of recording and sharing data. It aims to shift our perspective away from the behavior we associate with photography and perceive it as self-surveillance. It presents a speculative future in which we all participate in self-surveillance through data. Rubinstein (2015b, 17) expressed a similar viewpoint:

> As photography becomes encoded in a networked object, the emphasis shifts from considering it in visual terms . . . this in turn establishes photography as a kind of unstable surface that produces meanings not through indexicality or representation, but through the aggregation and the embodiments of data.

Fig. 2. *Selfie Factory*, Ralph Kenke and Elmar Trefz (Prototype) 2016, Sydney, Australia. Mixed media. Copyright Ralph Kenke, 2016, all rights reserved.

Selfie Factory suggests a shift away from the tradition of photography, indicating that data portraits facilitate the sharing of personal data on a more comprehensive level than photographs can through social network platforms. The successes and failures of our first attempt made us realise that we had emphasised problem solving during the process and forgotten our initial intention to create a project that facilitated debate about the possible future of data portraits, rather than proposing a ready-made solution. We wanted to build a prototype that demonstrated in real time the scale of data being shared, which we believed was essential in the debate about future data portraits and self-surveillance.

An iteration of an interactive art installation to free the artist from reliance on vision

The first iteration involved a prototype that used an automated accumulated procedure for data, scrapping the Instagram API. This was important to gain a sense of the data volume available online. With each iteration, the prototype and its conceptual manifestation refined the installation's execution. Influenced by decision making along the way, the final result was a mixed media installation that operated at intervals. People using their smartphones to capture selfies often refer to the act of taking a photograph when they point the device at themselves. However, we learnt from Rubinstein (2015a, 173) that the selfie "does not distinguish 'taking,' 'making' and the act of 'uploading and sharing;' rather it encapsulates the present moment as 'ecstatic' temporality, while it is in fact the aggregation of data and the embodiment of data shared online" (Rubinstein 2015a). Since the selfie's characteristics are distinct from the idea of taking a photograph, our intention was to provide a form of tangible evidence of personal data being shared on Instagram, thereby demonstrating that the aggregated data are automatically accessible to the public, and providing a form of receipt that the data have been noticed by the public after performing a selfie.

In some instances, challenges arising at the time influenced the prototype, and later provided the effect we were seeking. For example, the nature of automation and printing in a real-time process (which was vital for us to emphasise the telematic experience in the gallery space) forced us to use the cost- and time-efficient medium of thermal paper. The nature of the high volume of data shared meant that we had to experiment with the paper supply and elevate the thermal printer (fig. 3) to enable the printed trails to display enough images for

observers to notice the printer's real-time response as the paper slowly made its way to the floor, while also allowing enough room for an audience in a gallery to explore the installation and its printed images.

The transition of the telematic experience from the mobile screen (which is commonly used to interact on Instagram) to the temporary medium of thermal paper (fig. 2) was a statement about the images and their use; they fade from sight shortly after being posted on social media. Although they are stored on Cloud servers, images such as the selfie disappear from most smartphone screens shortly after they are posted, and become just another image in a massive stream of data.

Fig. 3. *Selfie Factory*, Ralph Kenke and Elmar Trefz (exhibition at Testing Ground) 2017, Melbourne. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

The installation created awareness of this topic in two ways. First, it constantly printed images posted on Instagram from all around the world, moving slowly down a thermal paper trail. The installation displayed the images in an orderly manner on five paper trails next to each other, thereby enabling easy comparison of the images. The *Selfie Factory* revealed little about the mechanics of the installation and focused simply on the ever-changing content on display. In a debate at the Campbelltown Arts Centre, participant Majidah told her mother Malika, "I love that it uploads itself as things get posted. Because that's what it is; everything is so instantaneous in our culture." Malika agreed, stating, "After a minute is gone, it is interesting and then it ends up in a pile; it's from fifteen minutes of fame to one minute of fame" (quoted in Ayres 2018). However, the fragile paper trails with images on display eventually create a pile of paper that is messy and chaotic. This short lifecycle of the data in the form of an image is manifest in the kinetic nature of the installation's chosen medium. Second, thermal paper is a non-permanent medium, meaning that printed images fade over time (within three to seven years, depending on the temperature at which the paper is kept). This non-permanence is a statement on the uncertainty around what happens to the data we leave online. We know we can view the data online, yet so can others, and wondering what others do with these data can cause discomfort. We have only a vague understanding of the degree to which Cloud storage keeps track of our data and how the accumulated data may be used in the future.

When viewed from a distance (fog. 3), the media installation appeared the same at each venue, yet its displayed content was never the same when viewed in detail. The selfies hanging from the wall at the Campbelltown Arts Centre were not the same as the selfies shown at the National Portrait Gallery, which means that an observer would never see the same image in both galleries, although the media installation remained the same. The artist was not in control of the continuously changing content appearing in the gallery because the content was entirely the responsibility of the individual subjects exercising self-surveillance by taking and sharing selfies online. The subjects viewed their selfies on a smartphone and approved their visual appearance without me—the artist—being present.

I argue that in this instance the artist is, in a sense, free from a core reliance on vision. We essentially provided a framework for an existing cultural activity—the selfie—to be documented and displayed in an altered format through a different medium than anticipated by the participant and observer. This transformation in medium and content situates the selfie as a portrait in a new context. In Donath's (2014) words, "the photographer's eye and intention remained actively involved, but creating the image itself become the job of the machine. The installation invited individuals to post their own data by sharing their images on Instagram (fig. 4) using the hashtag #selfiefactory while in the

gallery to experience their own image being printed by *Selfie Factory*.

Fig. 4. *Selfie Factory*, Ralph Kenke and Elmar Trefz (interacting participant) 2016, Watt Space Gallery. Mixed media. Copyright Ralph Kenke, 2016, all rights reserved.

The images appeared on Instagram's online platform, while simultaneously being documented on thermal paper dangling on the gallery wall. As intended at the beginning of my research, *Selfie Factory* functioned as a perceptual bridge (Auger 2013) across the gap between the online and physical image experience. According to Nathaniel Stern's reading of Brian Massumi's writing, *Parables for the Virtual*, on the subject of the body: "It moves as it feels, and it feels itself moving" (2008, 22). In this way, *Selfie Factory* provided observers with a different perspective of a familiar activity on a larger scale and displayed in an altered medium.

More importantly than documenting and transforming data in the form of an image (fig. 5) via a screen-based setting into a tactile media installation, *Selfie Factory* places the experience in a new context by making it available online and changing it into a tangible group portrait of Instagram users performing selfies in a gallery setting (fig, 4). It amplifies the usual palm-sized image of a selfie (fig. 6) into a sculpture-like media installation.

The transformation of data from an intimately sized experience on a smartphone screen held in an individual's hand suddenly enabled groups of people to view the posted images in a new context—a representation where everything was seen. Participants interacting with *Selfie Factory* online via Instagram while at Watt Space Gallery considered the two different layers of interactivity that invited visitors to participate by either posting their own image or simply viewing the images of others. This playful exploration of their own embodiment within a group of other bodies or portraits through interaction with an artwork is what media artist Lonzan-Hemmer described as (quoted in Stern 2011) "tele-absence" in his participatory media installation *Body Movies* (Stern 2008). The experience with *Selfie Factory* amplified the often-isolated experience of sharing and viewing a selfie on the small screen of a smartphone.

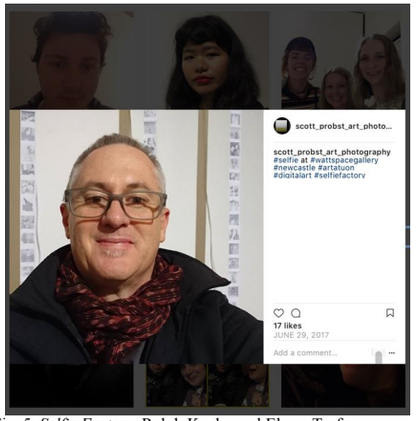

Fig. 5. *Selfie Factory*, Ralph Kenke and Elmar Trefz (participant posting his selfie on Instagram) 2017, Watt Space Gallery. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

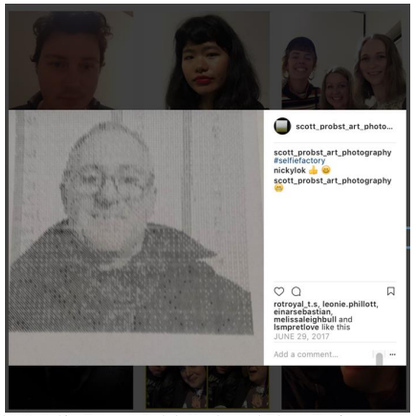

Fig. 6. *Selfie Factory*, Ralph Kenke and Elmar Trefz (participant re-posting his selfie on Instagram after the print

appeared) 2017, Watt Space Gallery. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

The difference between the framework of *Selfie Factory* (which made the observer a participant) and the framework of Instagram on which the work was built, is that *Selfie Factory* automatically employed the motion of scrolling. On a smartphone, an Instagram user participates by taking and observing their selfies by using their finger to scroll through them on the screen. In the case of *Selfie Factory*, this act of scrolling was automated through the kinetic experience of images slowly moving down a paper trail.

The combination of selfies being printed instantly as people posted them on Instagram and the movement of the printed selfie amplified the automation (fig. 7) to the point where it removed the scrolling gesture from this cultural activity. With its simulation of smartphone participants scrolling on Instagram, the work commented on a gesture in the telematic culture that has emerged in our society.

Fig. 7. *Selfie Factory*, Ralph Kenke and Elmar Trefz, National Portrait Gallery, Canberra. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

This aligned with our research method of speculative design, where the creative work is in fact speculative design—a future artefact that speculates on an alternative future (Dunne and Raby 2013) with the potential to comment on self-observation through data. More importantly, it explains what Flusser referred to as "the magical nature of images," which is that they replace events by states of things and translate them into "scenes." The scenes not only emerge, but can also be re-enacted by the participant, which in *Selfie Factory* was demonstrated by people pointing their smartphones towards themselves to take and share a selfie (fig. 8). This combination caused friction between the embodied experience and the temporary image, thereby creating what Deleuze referred to as a "time-image" (1988).

Fig. 8. *Selfie Factory*, Ralph Kenke and Elmar Trefz (participants: mother and daughter performing a selfie at the exhibition, Campbelltown Arts Centre, Sydney). Mixed Media, Copyright Ralph Kenke, 2017, all rights reserved.

When participation in self-surveillance also contributes to an artwork

The installation captured the evolutionary development of social engagement and communication in the increasingly digitally dominant environment (fig. 9) that shapes our current state of online behaviour. It is no longer a matter of identifying the act of self-surveillance, but more a question of negotiating between the act of photography and self-surveillance. The level of connectivity created by digital network technology has forced individuals to operate and perform in everyday life, and today has reached an irreversible height: "Statistics confirm the assertion that the datafication of almost everything is growing relentlessly" (Kennedy 2018).

"More than 200 million people obtained their first mobile device in 2017, and two-thirds of the world's 7.6 billion inhabitants now have a mobile phone" (Kemp 2018).Well over half of the world's population is now connected online, with the latest data showing that almost a quarter of a billion new users came online for the first time in 2017.

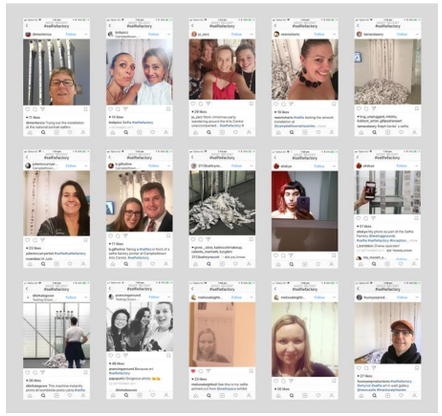

Fig. 9. *Selfie Factory*, Ralph Kenke and Elmar Trefz (collage of 15 participants posting their selfies to engage with *Selfie Factory* in 2016–18; screenshots from Instagram searching the hashtag #selfiefactory). Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

In addition, the web is expanding: "the Internet of Things, connected 'smart' devices that interact with each other and us while collecting all kinds of data, is exploding from 2 billion devices in 2006 to a projected 200 billion by 2020 and is one of the primary drivers for our data vaults exploding" (Marr 2018). As a consequence, the world and its people who operate within this connected network have already abolished the critique that our world has become a large panopticon. Baudrillard pointed out that the observer in front of a television (an earlier visual format of a telematic experience) has become a participator without noticing it: "a switch from the panoptic mechanism of surveillance (Discipline and Punish [Surveiller et punir]) to a system of deterrence, in which the distinction between the passive and the active is abolished" (1994, 11). Instagram abolishes this "distinction between the passive and the active," and *Selfie Factory* aimed to highlight this state to participants through the re-enactment of taking and sharing a selfie. Therefore, the installation *Selfie Factory* demonstrated our collective acceptance of self-surveillance, while questioning the rules we, as a society, establish around network technology.

Baudrillard (1994, 12) continued:

> You are information, you are the social, you are the event, you are involved, you have the word . . . no more violence or surveillance: only "information," secret virulence, chain reaction, slow implosion, and simulacra of spaces in which the effect of the real gain comes into play.

In the instance of *Selfie Factory*, observers who volunteer as participants view their own simulacrum—a simulation of existence in a telematic society that is fluidly crossing from the physical experience to the online environment, back and forth—without any great effort, providing context to an otherwise abstract experience.

Artwork as a facilitator of public debate on self-surveillance and data portraiture

Selfie Factory is aligned with the idea of "the practices and imaginaries of open data activists which are centred around the distribution and use of data and thus linked to datafication, the ubiquitous quantification of social life" (Mayer-Schönberger and Cukier 2013). The aim of the installation was to expose the transformation of the value of the individual —from consumption to commodification—and the realization that our digital identity is reduced to a product.

By highlighting the tactile features of the medium, the thermal paper's temporary nature, fading over time, carried a message that is relevant for the age of information in which we live today. Receipt paper is designed to carry information about sales transactions and is offered as proof to tax institutions of the exchange of goods and services for money. It is an item in a consumer system that has been fundamentally important to the growth of capitalism in the Western world. In a sense, it is a representation of capitalism: receipts are not

required for barter—where one person swaps an egg for an apple, for example. Receipts are crucial for tracing transactions and monitoring exchanges. Capital systems rely on these little pieces of paper as much as they rely on the dollar bills that are used to communicate the exchange of money for goods and services. Unlike ink-based print techniques, thermal paper does not absorb ink, but instead turns darker on the surface when exposed to high temperature. As a consequence, the printed information on thermal-paper receipts fades after some years, and the information is eventually lost. The receipt is a mechanical product, which in the context of *Selfie Factory*, references the passing of the industrialisation that dominated social and cultural behaviour during the twentieth century.

Selfie Factory (figs. 10, 11 and 12) is a manifestation of the transitional stage that society is currently experiencing while romanticising industrialisation and struggling to reach a digitalised age of information. During industrialisation, machines were praised for freeing individuals from exhausting labour and elevating them to engage in more enlightened work, thereby reducing physical stress on the human body and enabling companies to manufacture cost-effective products in larger quantities. Applying this thinking to the age of information, questions arise in relation to personal data—for example, are our selfies somehow enslaved to the gig economy of Big Data and its markets, thereby causing us existential stress? Lehtiniemi points out that individuals may be unaware that they are targeted by companies that capitalise on their selfie data: "Surveillance capitalism monetises data acquired through surveillance. It operates on data extracted from users, turns extracted data into behavioural predictions, and often monetises them through markets that users cannot participate in" (2017, 2). In hindsight, industrialization had both benefits and drawbacks; however, it was not the intention of *Selfie Factory* to comment on this argument, as such an undertaking would be too ambitious. The installation was a "perceptual bridge" towards the potential of data portraits and their future meaning and appearance, rather than a statement on our history.

While industrialisation had to rely on the synchronisation of working hours, in the age of information, this centralised approach is no longer needed. The physical dimension in a telematic society connected through computers leaves behind the old structure of punch clocks.

Fig. 10. *Selfie Factory*, Ralph Kenke and Elmar Trefz (Campbelltown Art Centre exhibition, shortlisted for the Fisher's Ghost Award) 2017. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

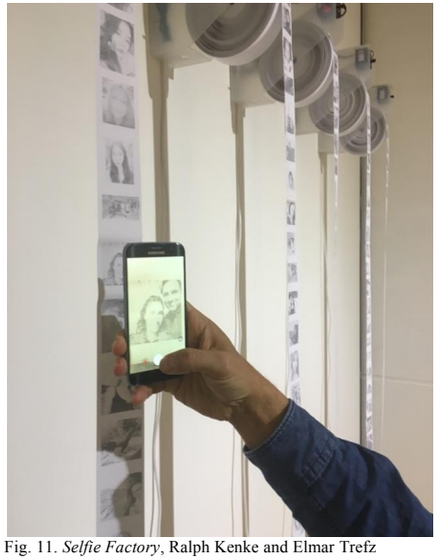

Fig. 11. *Selfie Factory*, Ralph Kenke and Elmar Trefz (participant exploring *Selfie Factory* at the exhibition at Watt Space Gallery) 2017. Mixed media, Copyright Ralph Kenke, 2017, all rights reserved.

Fig. 12. *Selfie Factory*, Ralph Kenke and Elmar Trefz (participant capturing a re-posted selfie in *Selfie Factory*) 2017, Watt Space Gallery. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

In the online space, we experience the expansion of the public space; hence, *Selfie Factory* brought the online space into the public space to facilitate interaction within the public space of the gallery (fig. 13). Kennedy discussed the relevance of engaging the public on a personal level in her 2018 publication *Living with Data*, in which she explained:

> We need to listen to the voices of ordinary people speaking about the conditions that they say would enable them to live better with data, and in so doing, arm ourselves with knowledge which advances data studies and serves the interests of data activism.

The installation *Selfie Factory* aimed to facilitate public debate using art (fig. 13) as a manifestation of the future of our online identities and the commodification of our data. Posting and sharing selfies online can be an innocent act with no intention other than to display a self-portrait online. As we saw with *Selfie Factory*, only a smartphone and a few button clicks are required to enable the entire world to view a photograph. The simplicity and popularity of posting a selfie online renders this act of self-surveillance with a selfie a telematic gesture that can be the start of a broader debate via *Selfie Factory*.

Fig. 13. *Selfie Factory*, Ralph Kenke and Elmar Trefz (with a gallery visitor at the National Portrait Gallery, Canberra) 2017. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

However, this transactional relationship between the installation and the participant raises an important question: who or what was programmed—the media installation or the participants directing their smartphone cameras towards themselves? One can think of this scenario in a different way—it was not only *Selfie Factory* that was programmed, but also the participants. Flusser (1983, 64) argues that "we are manipulated by photographs and programmed to act in a ritual fashion in the service of a feedback mechanism for the benefit of the camera."If this is the case for the camera, it may also be the case for computational power and its network technology, in which case we are engaging in a ritual of data contribution on a global scale without much discussion of the possible outcomes or disadvantages that such a development may have for our society. Our creative practice resonates with contemporary philosophy regarding automation and datafication through computation. It implements elements of data activism as a driver to inform the public on complex cultural matters such as surveillance capitalism, datafication, and self-surveillance.

As Baack (2015) suggests, "we can turn to research on its broader cultural significance and influence beyond software development." It was the intention of my research to use publicly available data and open-source tools to develop an artistic project to include citizens in a discourse on the subject of data. *Selfie Factory* was an instrument of "data activism"—an artefact that functioned as a mediator (fig. 14) of

quantified social life (open data) to capture an image experience while facilitating self-surveillance through a small-scale simulation of the way Big Data in action may appear. The artistic installation invited participation in the experience, as well as in a public debate. This was achieved partly by including a level of reader-driven elements, which is a common feature in the field of data-journalism and is used to demonstrate how the participation of an audience can result in different interpretation in a design. The artist's or author's role is to create such a reader-driven framework so that participants become their own protagonist, steering away from a visualisation of "prioritized expert knowledge or institutional knowledge over what Jeremijenko called 'layerperson knowledge'" (quoted in Abrams and Hall 2003, 225). Because of its observer-driven design, *Selfie Factory* is capable of acting as a "perceptual bridge," enabling participants to experience the transitional nature of selfie data from the perspective of protagonists who can extract facts, connect events, and shape their own conclusions. The installation thereby relied on "layperson knowledge" gained from their prior experience with selfies and their ability to act within a technology network environment, which is an essential part of our lives in a telematic society.

Fig. 14. *Selfie Factory*, Ralph Kenke and Elmar Trefz, (at the exhibition opening on the left, and approximately 24 hours later with a pile of paper on the floor on the right) 2017, Watt Space Gallery. Mixed media. Copyright Ralph Kenke, 2017, all rights reserved.

Conclusion

In conclusion, this paper describes the iterative design process for the interactive installation *Selfie Factory*, and a shift in artistic practice away from the reliance on vision and towards the use of automation, which can facilitate or trigger a debate on our relationship with technology today. More importantly, the process and the engagement with *Selfie Factory* in public showcased the complex nature of shaping data portraits and the nuances of enacting self-surveillance with technological means.

Selfie Factory has influenced and provided a new perspective on our increasingly important dual identity in two ways. First, the project gained success and recognition by engaging with public galleries and festivals, and earned several awards, which indicates its relevance in the field. Second, the project attracted media coverage shortly before evidence emerged of mass data surveillance conducted by the company Cambridge Analytica via some of the most popular social media platforms, such as Facebook. The company successfully recorded approximately 50 million user accounts and their personal data, which are used to deliver targeted messaging (also known as "psychographic targeting") to influence political elections and referenda through social media. In this final section, I provide a brief overview of these two levels of influence and how my research may offer knowledge to the community and the broader public.

Selfie Factory was shortlisted for a Fisher's Ghost Award at the Campbelltown Arts Centre before receiving its most prestigious recognition—the Digital Portraiture Award at the National Portrait Gallery in Canberra. This award culminated in *Selfie Factory* being exhibited at the National Portrait Gallery, alongside the works of other Australian artists.

Selfie Factory's impact reached an unexpected magnitude, spreading the idea and message to the public for further debate. This message is relevant at a time when personal data are accessible to everyone—including companies such as Cambridge Analytica—and can be used to influence our decisions and future identities. Considering the facts mentioned above, *Selfie Factory* influenced media art because of its reader-driven and participatory elements concerning the genre of portraiture, encouraging gallery audiences to engage with art in the context of data portraits. Therefore, the participants and observers could experience the digital divide our telematic society currently inhabits through a "perceptual bridge" (Auger

2013), titled *Selfie Factory*. As a result of its timely relevance, the installation enabled members of the public to draw their own conclusions around the notion of self-surveillance and data portraiture, and actively shape their own future, potentially with more consideration of personal data accessibility.

In light of Flusser's (1983) critique of photography as part of a feedback mechanism that programs humans to perform rituals, we can see how in some cases, we are not aware when we perform self-surveillance or when we capture a photograph. It becomes clear with this research that distinguishing self-surveillance is not an easy task in a world intertwined with network technology. By agreeing with Flusser (1983) that photographs are, in essence, the transformation of scenes, we can confidently propose that *Selfie Factory* is an installation where photographs turned into scenes, and scenes were part of a re-enactment that revealed the presence of self-surveillance both inside and outside the art gallery.

As demonstrated here, the negotiation between photography and self-surveillance is in its infancy because the technology of the medium continues to shift and evolve. Further investigation into the practice of data portraiture and the design process of art installations utilising automation will provide more rigorous findings on the subject and help us understand the use of technology in an artistic context.

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Biographies

Ralph Kenke is a visual communication designer and media artist. He studied Visual Communication as an undergraduate at Swinburne University and later graduated with a Masters in Design at the University of New South Wales. He received his PhD at the University of Newcastle on his study of prototyping data portraits, where he is teaching as a Design Lecturer and researcher at FASTlab. Ralph has held multiple positions as a Design Consultant and Senior Designer working alongside companies such as Deloitte, M&C Saatchi and Imagination, delivering conceptual design applications that bridge art technology and design. His installations and designs were exhibited at Galleries such as the Campbelltown Art Centre, The Copper Union and the National Portrait Gallery(Australia). Ralph's work was recognised with awards such as the Digital Portraiture Award (Australia), Museums Australian Multimedia & Publication Award (MAPDA), several Australian Graphic Design Association Awards and distinctions from the New York Type Directors Club (USA).

An expert on the interactions between humans, computers, urbanism and art, **Elmar Trefz** began his multimedia fascination by programming Commodors in the '80s. In 2016, he was awarded a PhD for his research into urban user experiences in the digital age.

Along the way, he has blended data and media art for projects with Futurefarmers in San Francisco, Spinifex in LA and Sydney, Art-for-Innovation initiative Disonancias in San Sebastian, Spain, and Germany's ZKM in Karlsruhe. He taught Big Data Visualisation at the University of Sydney and directed the Electrofringe festival in Newcastle, Australia.

Having co-created AMP's 360Goals project, he is currently exploring how decentralised finance is reshaping our interactions with money and financial products. When not solving thorny problems, Elmar is up a mountain, on a skateboard, or enjoying the ocean with his friends and family.

Mark Roxburgh, Ph.D., is an associate professor of design, a management stooge, and a fading would be indie rock star (google Joeys Coop) in the School of Creative Industries at the University of Newcastle, (Newcastle, New South Wales) Australia. He received his undergraduate degree in Visual Arts from the College of Fine Arts, Australia; his Masters in Communication and Cultural Studies from the University of Western Sydney, Australia; and his PhD in Design from the University of Canberra, Australia. He has been a design educator and researcher for over thirty years. His scholarship in those fields has been focused on design research methods; design theory; photo-observation in design research; research-based inquiry and learning; work integrated learning; the relationship between tacit and explicit knowledge and the role of visual communication in mediating those domains.

Mario Minichiello, Ph.D. studied at the University of Leicester, Saint Martins, and Loughborough in England. He has over thirty years of experience in industry and academia including leading roles in the academy at Leicester DMU University, Birmingham City University, Loughborough University in the UK, and the University of Newcastle in NSW. As a researcher, he has investigated and prototyped new ideas, experiences and products using tacit and explicit knowledge with creative practices. He is Professor of Design and Director of the Future Arts Science and Technologies Laboratory (FASTlab) at the University of Newcastle. Minichiello has the rare distinction of working closely with Birmingham Children's Hospital (UK), a world-leading teaching hospital, and with the Hunter Medical Research Institute, one of the foremost medical research centres in the world. He is the author and co-author of a number of books, journal articles as well as developing creative outputs and intellectual property.

Meta-Evolver: Evolutionary Strategy for Architectural Intelligence

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Abstract

Meta-Evolver is a tool that provides a visual representation of the various dynamic environment models that correlate in multi-layered systems. *Meta-Evolver* provides an environment for testing dynamic spatial adaptation, where the environment is composed of algorithms and parametric definitions.

This research uses advanced artificial intelligence (AI) methods (meta-learning) and cutting-edge technologies, including immersive environments and virtual reality (VR), to offer innovative methods of architectural creation. The ability to continuously learn and adapt from limited experience in a dynamic environment is an important milestone on the path towards building interactive spaces in modern architecture. We developed the tool *Meta-Evolver* to test spatial adaptation in dynamic environments and integrated the capability for interaction with a human user.

Introduction

This project proposes a new strategy for creating evolving architectural structures, based on the idea of adaptation to a dynamically changing environment through the use of advanced machine learning and AI methods. The evolving architecture uses physical and virtual processes that are transformed and assembled into structures based on environmental properties and capabilities. The computational models are used to process dynamic multidimensional forces, but are they suitable to be integrated into environmental intelligent models for architectural spatial adaptation? And to what extent are they capable of grasping composed spatial dynamical forces and defining the edge and trajectory of the self-evolved architectural environment? The project investigates a living dynamic system as a complex set of natural and cultural sub-processes, in which each of the interacting entities and systems creates complex aggregates. It deals with natural processes, communication flows, information networks, resource distribution, dense noise masses, and a large group of agents and their spatial interaction in the environment. By significantly expanding existing research, the project creates a meta-learning model useful for testing aspects of adaptation to a complex dynamic environment. This refers to the difficulty of designing artificial agents that can intelligently respond to evolving complex processes.

Architectural Intelligence

The future is under perpetual construction. It emerges from the interaction of billions of current activities, both natural and artificial (Rzevski 2014). Future architecture will be capable of perceptual interaction with its environment and will stimulate construction and growth with regard to the needs of natural and artificial aspects of a specific environment.

Architectural Intelligence is a set of evolutionary mechanisms that has the capability to adapt an architectural organism to a new environmental situation or behavioural patterns of its symbionts, in a short- or long-term interaction. Architectural Intelligence adapts, changes and accommodates the environmental dynamics and behavioral conventions. Architectural intelligence is taught by its architect.

The intelligence is encoded in the script of a neural networks model that is capable of rewriting existing code protocols, and therefore actively addressing acute issues of architecture for effective and dynamic adaptability. Our architectural approach proposes a theory of architectural adaptive systems. Intelligence can be seen as a form of adaptation, in which

knowledge is constructed by each individual through two complementary processes of assimilation and adaptation (Jean Piaget 1963). Adaptation is an evolutionary process as a result of which the body better adapts to a dynamically changing environment. If an organism cannot move or change enough to maintain its long-term viability, it will obviously go extinct. From this perspective, Architectural Intelligence is a set of methods that adapt architecture to environmental and social changes and instability. Architectural intelligence is a method of solving architectural problems. We propose the use of computer science techniques, in particular deep learning and meta-learning, to represent and analyse complex architectural and urban phenomena and to find and generate optimal spatial forms. Modelling complex natural processes requires computer science, and it is no coincidence that the development of computer science has been largely shaped by the construction of computer models that simulate natural processes. Using developed models, we generate intelligent architectural structures that provide sustainable environmental conditions for individuals and communities, based on their spatial experience and behaviour. Predictions generated from models with the use of neural networks actively solve difficult problems of architecture to allow it to effectively adapt to dynamic changes in the environment (Kotnour & Lisek 2020).

Evolving Architecture

Evolving Architecture is a large field with a few subfields such as Prescribed, Responsive, Interactive and Evolutionary or Living Systems. Each of these areas requires different expertise and often focuses on certain interaction strategies and techniques, as practiced by people like Michael Fox, Rachel Armstrong, Philip Beesley, and Heatherwick and UN Studio. Evolving Architecture uses the features of natural design processes and relies on dynamic adaptation to environmental changes. The analogies of evolving architecture can be

Fig. 1. *Evolving Architectures*, 2020, Karolína Kotnour.

Fig. 2. *Evolving Architecture*, 2020, Karolína Kotnour.

understood not only in terms of the applied natural processes of development of forms through natural selection, but also in the restless tendencies towards optimization and self-organisation, which significantly improve the efficiency and power of diverse prototyping. Architecture involves designing for survival, designing for life, and emphasizes the need for a responsible approach to the transformation and formation of energy and materials. The solution to dynamic environmental problems is to link architecture with a contextual understanding of the structure of nature. Traditional documentation of architectural production and construction design is replaced by code as a set of instructions and calculation formulas that reflect and adapt to a specific dynamic environmental and spatial context. The proposed approach to understanding and designing architecture introduces a set of instructions and general principles of interaction with the environment, which John Frazer calls "the genetic code of architecture" (Frazer 1995). It is also necessary to create large groups of researchers, architects and urban planners that change and adapt the architecture of our cities and suburban areas to the new needs of their inhabitants.

At the same time, in computer science, methods inspired by the process of natural selection, such as genetic algorithms, have been widely developed: design, games, image processing and robotics, for example. Genetic algorithms are commonly used to generate high-quality solutions to optimization and search problems by relying on biologically inspired operators, such as mutation, crossover, and selection. A particular example is Hyper-NEAT, which we use to transform 3D objects. The principle of the algorithm is the simple weight evolution in a topologically static neural network (CNE) or the evolutionary adaptation of the covariance matrix (CMA-ES) strategy, to weight and topology evolution (NEAT) and intermediate weight coding (HyperNEAT). All algorithms encode artificial neural networks (ANNs), which are represented by weights and connectivity (also called topology). The first two algorithms search only the ANS weights, while the last two can also modify the topology.

The Genetic Code of Architecture

The Genetic Code of Architecture performs adaptation through changes in genetic configurations, which is primarily a search for co-adapted sets of various forms of genes, which together significantly augment the performance of the corresponding composite observable characteristics of an architectural style, or architectural organism. The technical word “phenotype” is used for the bodily manifestation of a gene, and the effect that a gene, in comparison with its alleles, has on the body, via development. The phenotypic effect of a particular gene might be, say, green eyes. In practice, most genes have more than one phenotypic effect, say green eyes and curly hair. Natural selection favours some genes rather than others not because of the nature of the genes themselves, but because of their consequences – their phenotypic effects. Genes, therefore, reach outside their “own” body to influence phenotypes in other bodies (Dawkins 1976, 2006). The phenotype is the product of the balanced and harmonious interaction of all genes. Natural selection tends to bring together those genes that constitute a balanced system.

The process by which genes are accumulated in the gene pool that collaborate harmoniously is called “integration” or “coadaptation.” The result of this selection has been referred to as "internal balance” (Mayr 1963). The genes act in many ways, affecting various physiological and morphological characteristics that are relevant to survival. All of these come together into the sufficient parameter “fitness” or

selective value. Similarly, environmental fluctuation, patchiness, and productivity can be combinations of environmental uncertainty (Levins 1968). The genetic adaptive plan develops in terms of an ever-changing population of chromosomes, which, interacting with the environment, provides a concurrent sequence of phenotype populations. For many purposes, it is convenient to represent a_i population as a probability distribution over the set of genotypes ai, where the probability assigned to genotype A E: a_i is a fraction of the total population consisting of that genotype (Holland 1992, Crow 1970).

Evolutionary Algorithms

Evolutionary algorithms is a term used to describe computer-based problem solving systems that use computational models of some of the known mechanisms of evolution as key elements in their design and implementation. They all start from a common conceptual base of simulating the evolution of individual structures by the processes of selection, mutation, and reproduction. The processes depend on the perceived performance of the individual structures as defined by an environment.

More precisely, EAs maintain a population of structures that evolve according to rules of selection and other operators, which are referred to as “search operators,” (or genetic operators), such as recombination and mutation. Each individual in the population receives a measure of its fitness in the environment. Reproduction focuses on highly fit individuals, thus exploiting (exploitation) the available fitness information. Recombination and mutation perturb those individuals, providing general heuristics for exploration. EAs use stochastic processes, but the result is distinctly non-random.

Genetic algorithms (GAs) can be seen as a software tool used to find structure in data that might seem random, or to make a seemingly unsolvable problem more or less solvable. GAs can be applied to domains about which there is insufficient knowledge, or for which the size and complexity is too high for analytic solution. Examples are finding a best-fit solution, *not necessarily the perfect solution*, for crew and team planning, delivery itineraries, finding the most beneficial locations for stores or warehouses, building statistical models, and game-playing behavior (Beasley 1993). The genetic algorithm is a model of machine learning, a stochastic optimisation strategy that derives its behavior from a metaphor of some of the mechanisms of evolution in nature. Genetic algorithms are used for a number of different application areas; one example is multidimensional optimisation problems, in which the character string of the chromosome (machine of a population of individuals, arrays of bits or characters) can be used to encode the values for the different parameters being optimized.

Evolutionary Strategies in Architecture Meta-learning

Deep artificial neural networks (DNNs) are multilayer networks of nodes and connections between nodes (weights), typically trained via gradient-based learning algorithms, namely backpropagation. The next step is to research and implement Evolutionary Strategies, which means transformation of architectural objects in time. This can be done by modifying selected layers in the neural network or by using the population-based genetic algorithm (GA). We evolve the weights of a Deep Neural Network by applying additive Gaussian noise in such a way that the general features of the training class of 3D objects are kept, but their evolution is possible. We created a mechanism for controlling the hyper-parameters of the neural network and ipso facto for controlling generated output numbers that represent new 3D objects. In this way it is possible to create a fully universal object generator and propose a new method of designing complex original architectures. The evolution strategy described above is a step toward research focused on the self-organization of complex structures from random elements. This method is general enough to become the starting point for meta-learning research and creating a universal toolkit that supports architects and designers.

Working with large data sets obtained from a changing environment requires advanced machine-learning methods. We tested different AI methods and approaches for modelling and generating new architectural forms. In particular, we used Transformers, which work by using convolutional neural networks, together with attention models, making them much more efficient than previous models. We previously tested recurrent neural networks (RNNs), long short-term memory networks (LSTMs) and variational autoencoders (VAEs). The transformer model is a seq2seq model, which uses attention in the encoder as well as the decoder. Transformers have been used for many (conditional) sequence-generation tasks, such as machine translation, constituency parsing, and protein sequence generation, and can be used for architecture design. Transformer models consist of an Encoder and a Decoder. The Encoder takes the input sequence and maps it into a higher dimensional space (n-dimensional vector). This abstract vector is fed into the Decoder, which turns it into an output sequence, which can be in any sequence of numbers, symbols, etc. The attention mechanism looks at an input sequence and decides at each step which other parts of the sequence are important. Self-attention is an attention mechanism relating different positions of a single sequence to compute a representation of the sequence. Self-attention can be intuitively explained using a text example. When reading this text, you temporarily focus on the words, but at the same time your mind retains the important keywords in the text to provide context.

In our research, we worked with sequences of numbers that represent 3D objects as positions of its particles or elements and velocity. Our approach for analyzing and creating evolving architecture is based on meta-learning, which is the next generation of AI systems. Meta-learning goes by many different names: learning to learn, multi-task learning, transfer learning, zero shot learning, etc. People easily transfer knowledge acquired from solving one task to another more general task. This means that we naturally recognize and apply previously acquired knowledge to new tasks. The closer the new task is related to our previous experience, the easier it is to master. In contrast, popular machine-learning algorithms deal with individual tasks and problems. Transfer learning attempts to change this by developing methods to transfer knowledge acquired in one or more source tasks and using it to improve learning in a related target task. The goal of transfer learning is to improve learning in the target task using knowledge from the source task.

Techniques enabling knowledge transfer will constitute significant progress in AI and architecture. We have developed a learning strategy for a set of neural network modules that can be combined as needed regarding environmental qualities. We train different modular structures on a set of related tasks and generalize it to new tasks, composing the learned architectural modules in a new way. For composing, we use concatenation, addition, and product operators. We quickly learn something about a new task based on previous tasks without training our model from scratch. Our system finds two or more suitable modules that can be combined as an optimal solution for a new task.

Meta-Evolver

We defined the framework for the adaptive agent-based model for dynamic environments, based on data from generated random numbers and soundscapes. We outlined and established the architectural strategy of the multi-platform system for generative modelling based on input datasets. The framework for a visual representation of the dynamic models was generated, resulting in correlated layers.

The main task was adapting an agent to new environments and creating a new multi-agent environment and architecture for testing aspects of continuous adaptation. The whole model was parameterized, and the communication protocols were integrated into the digital environment. The aim of the method was to present dynamics as a sequence of tasks and train agents to use the dependencies between successive tasks. We created a meta-learning model for the problem of the continuous adaptation of an artificial agent in a complex dynamic environment. We conducted observation-based research on these generated correlations and defined the possible dispositions of forming patterns and structures.

The model can be applied to various dynamic environments and after pre-training of agents can effectively adapt and generate architectural dispositions, structures, and environments.

The three different and complementary 3D environments and experiments are 1) adaptation in a dynamic environment created by changes in the structure of the parametrized environment; 2) adaptation in a multi-agent environment created by the presence of multiple learning actors (interdepended datasets and transformation matrices), and 3) adaptation in a dynamic environment created by the interaction of a human user with an adaptive artificial agent. The immersive dynamic environment is created using virtual reality (VR) and sound synthesis. The model keeps the transformation of 3D objects and sound synthesis as synchronous processes.

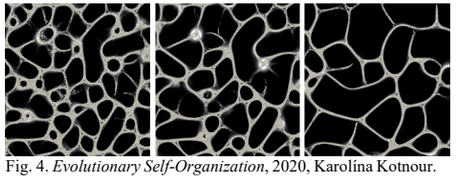

Fig. 4. *Evolutionary Self-Organization*, 2020, Karolína Kotnour.

Dynamic environments

In our view, urban and architectural structures are complex multi-dimensional structures in which natural processes and interactions of large groups of agents, communication flows, information networks, and others are intertwined and undergo continuous transformation. A dynamic environment is any space that surrounds us whose structure changes over time or is modified by groups of agents. There are closed spaces with relatively well-defined boundaries and others that do not have well-defined boundaries, which we can call open spaces. These environments are usually rich, complex, and unpredictable, and can generate significant “noisy” data, and unstructured and sometimes very dynamic changes.

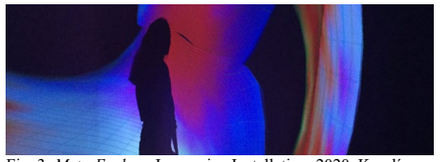

Fig. 3. *Meta-Evolver*, Immersive Installation, 2020, Karolína Kotnour and Robert B. Lisek, VR.

Tests in immersive spaces

An interesting direction of research on modern architecture is related to the problem of immersion, and creating virtual environments and sound spatialisation. Virtual environments also provide an excellent space for testing machine-learning methods. Restrictions introduced during the pandemic motivated us to study the potential of AI and virtual architecture for the evolution of society. Our research focused on the role of presence, flow, immersion, and interactivity. We were particularly interested in the problem of presence and flow in VE. Presence is defined as the subjective experience of being in one place or environment, when physically situated in another. Presence is a normal awareness phenomenon that requires directed attention and is based in the interaction between sensory stimulation and environmental factors that encourage and enable immersion. Flow is a state of experience in which a person is completely absorbed and immersed in an activity. We researched relations between presence, adaptation and interactivity, such as how interactivity and adaptation improve the experience of presence. We tested our meta-learning approach in a virtual environment. The project proposed a new method of operation in virtual architecture and a strong concept that will influence future social structures.

Conclusion and Future Research

The proposed AI model of Transformers provides variability and flexibility in dynamic environments. The meta-learning approach provides the sustainable possibility of implementing already tested and trained models

from other domains and areas of machine learning to the field of architecture.

In terms of evolutionary strategy for architecture, the new support tools in the form of software for researching and developing evolutionary architectures should be developed. The above research is fundamental to an architecture of the future that will be well adapted, in particular, to a flexible safe architecture that accommodates mass migration and crisis situations such as pandemics.

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Biographies

Robert Lisek, PhD, is an artist, mathematician and composer, who focuses on exploring complex dynamic environments (biological, computational and social) and creating agents that learn to learn through "feedback" with an evolving environment and transform the methods and algorithms they use. He is involved in the number of projects focusing on media art, immersive art and storytelling. Drawing on post-conceptual art, software art and meta-media, his work intentionally defies categorization. Lisek is a pioneer of art based on machine learning and artificial intelligence (AI). Lisek is also a composer of contemporary music, and author of many projects on the intersection of spectral, stochastic, AI music and noise. His scientific research interests are category theory and high-order algebra. He has exhibited at 300 exhibitions and concerts, including Ircam Center Pompidou, ZKM Center for Art and Media Karlsruhe, MAXXI Rome, STEIM Amsterdam, PRADO Museum, WORM Rotterdam, ARCO Madrid, Venice Biennale, LMCC NYC, Ars Electronic, and Siggraph. More at: http://fundamental.art.pl.

Karolína Kotnour is an architect and artist dedicated to architectural spatial and audio-visual production. She focuses on creating future-evolving architecture by transforming methods from neuroscience, machine learning, and immersive and sound spatialization research. In her projects and installations, she connects and synchronizes architectural and sound structures. She claims "the reciprocal confrontation of sound waves is a liberated contour of space." She is interested in "space as evolving over time, in parallel, and with mutual confrontations and reflections." with a significant role played by human acoustic presence and performance. She observes extreme space phenomena, such as "acoustic black holes" and the transformation of sound vibrations in their surroundings. She is PhD research fellow at the FLOW Studio in the Faculty of Architecture CTU, Prague.

On Content Aware and Other Case-Studies: Historical Investigations at Blazing Ultra Resolution

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Abstract

The use of machine-learning in historical analysis and reproduction as a scientific tool brings to the forefront ethical questions of bias contamination in data and the automation of its analysis. Through examples of various confusing para-scientific interventions, including AI-based Voynich Manuscript decryptions and artistic investigations, such as the speculative series *Content Aware Studies*, this paper examines the various sides of this inquiry and its consequences. It also looks into the material repercussions of objects as synthetic documents of emerging machine-rendered history. This text attempts to instrumentalise recent theoretical developments, such as agential realism in the analysis of computation in its advanced forms and their derivatives, including AI, its output, and their ontologies. The focus of this text is the ethical, philosophical, and historical challenges we face when using such automated means of knowledge production and investigation, and what epistemics such methodologies hold by uncovering deeper and sharply unexpected new knowledge instead of masking unacknowledged biases. The series *Content Aware Studies* is one of the key case studies, as it vividly illustrates the results of machine-learning technologies as a means of automation and augmentation of historical and cultural documents, museology, and historiography, taking speculative forms of restoration not only within historical and archaeological contexts, but also in contemporary applications across machine vision and sensing technics, such as LiDAR scanning. These outputs also provide a case study for critical examination through the lens of cultural sciences of potential misleading trajectories in knowledge production and epistemic focal biases that occur at the level of the applications and processes described above. Given the preoccupation with warnings and ontologies related to biases, authenticities, and materialities, we seek to vividly illustrate them. As data in this text is seen as the crude material and building blocks of inherent bias, the new materialist framework helps address these notions in a non-anthropocentric way, while seeking to locate the subjects of investigations as encounters between non-organic bodies. In the optics of a non-human agency of the AI-investigator, what parts of our historical knowledge and interpretation encoded in the datasets will survive this digital digestion? How are historical narratives and documents, and their meanings and functions perverted when their analysis is outsourced to machine vision and cognition? In other words, what happens to historical knowledge and documentation in the age of information-production epidemics and computational reality-engineering?

He fell in love with a GAN generated face from www.thispersondoesnotexist.com. He has tried to find her in the latent space ever since.

Synthetic Histories

Let us start with a few key thoughts to open up speculation and thought experiments related to history, matter, agency, and computation. History in this text is seen as data; while data is seen as crude material and a critical resource for content-form-knowledge production, through which questions of origin and genuineness can be posed. How are historical objects viewed, and how is their authenticity determined or undermined when observed through the lens of machine vision? These questions are asked in relation to synthetic forms of knowledge production as a result of output of machine-learning technologies operating on historical archives. They inquire about the capacities and consequences of such machine-learning technologies as a means of automated historical investigation and question whether these findings are still historical. One of the main questions concerning technology and culture posed here is what the ethical, philosophical, and historical challenges we're facing when using such automated means of production and investigation are. Can AI-led investigations allow us to uncover deeper and sharply unexpected new knowledge, or do they mask unacknowledged biases?

As part of this investigation, we look into the collaborative artistic intervention, *Content Aware Studies* (CAS)[1], as a case study, which through artistic practice seeks to establish investigative methods of these machine-learning capacities. This research examines how various advanced AI, or more specifically, General Adversarial Networks (GAN's), which are particularly known for their recent advances in computer vision and hyper-realistic image rendering, operate when trained on datasets consisting of thousands of 3D scans from renowned international museum collections. Specifically, trained neural network models are directed to replenish lost fragments of friezes and sculptures and thus generate previously never-existing objects of classical antiquity. The algorithm generates results convertible into 3D models, which are then 3D-printed on synthetic materials and used to fill the voids of the original sculptures or turned into entirely new machine-fabricated marble objects, faithfully restoring original forms, while also producing bizarre errors and algorithmic interpretations of Hellenistic and Roman art previously familiar to us, which are then embodied in machine-carved thousand-year-old stone blocks. Through this, we also question methods of preservation and reconstruction, along with new challenges in these fields posed by automated synthetic cognition and sensing. CAS is used as a case study for critical examination through the lens of cultural sciences (including media studies) of potentially misleading trajectories in knowledge production and epistemic focal biases that occur at the level of these hybrid experiments. Similar AI techniques are being ubiquitously instrumentalized, as seen in the investigation of historical documents, including the Voynich Manuscript (Artnet 2018), collaboration between the British Library and the Turing Institute, and others, for example, reported by Nvidia (Nvidia 2019), and also used as a predictive instrument for modelling and designing the future. However, before celebrating such advances, we might as well first critically examine the role of such forms of knowledge production; how does one distinguish between accelerated forms of empirical investigation and algorithmic bias? Will the question hold up if this is the new normal of historiography?

How far should we consider AI as a tool vs. AI as an agent? This question is not new for media theory and perhaps neither is it for anthropology. Research at Emory University, led by anthropologist Dietrich Stout, suggests that the process of making tools changed human neurology. Stout claims that neural circuits of the brain underwent changes to adapt to Palaeolithic toolmaking, thus playing a key role in primitive forms of communication (Stout 2016, 28–35). Projecting these dynamics onto various forms of machine-learning techniques,

[1] Video documentation of *Content Aware Studies* https://youtu.be/pnbHCEMkAf8

we may observe a peculiar relationship, which we would like to describe as an epistemic feedback loop, suggesting that these tools, as forms of knowledge production, may unpack new latent languages and possibilities contained within our minds. So one might begin to view AI as yet another tool in this chain of synthetic evolution leading to a more precise question: to what degree can machine-learning-based approaches help us augment our methods of analysis as opposed to introducing non-human bias, a product of machinic agency? We think that we know how we think, but machines might see this differently.

Perhaps to further understand the nature of algorithmic and other biases, it may be helpful to view them through the lens of recently developed theoretical developments, often referred to as new materialism or the ontological turn. To do so, let us acknowledge the ever-present entanglement of forces and complex dynamics as a fundamental condition occurring between a multitude of agencies via their material-discursive apparatuses (as described by Karen Barad in *Agential Realism: On the Importance of Material-Discursive Practices*) (Barad 2007). This theoretical model is particularly useful to us if we acknowledge that the phenomenon of computation itself is essentially possible through the entanglement of matter and meaning, so it is not only a project of applied sciences, but also a vividly onto-epistemological notion. In simple words, computers are materially programmable knowledge logistics and knowledge production systems; made from rare and common earth materials, they are incredibly efficient in these logistics and exceptionally programmable. The very principle of computation is more a discovery than an invention, and one can argue that it is a radical development redesigning the relationship between matter and meaning on a ubiquitous scale. We all know how pop culture misleadingly depicted AI in endowing it with extremely anthropomorphised agency – the ghost in the machine – both matter and knowledge; which then of course was juxtaposed with fears, well encompassed by the AI computer HAL, in Kubrick's well-known motion picture, which in response to the human command to "Open the pod bay doors" answers: "I'm afraid I can't do that, Dave."

Hylomorphism and Materiality

Materiality has reappeared as a highly contested topic, not only in recent philosophy and media studies, but also in recent art. Modernist criticism tended to privilege form over matter, considering the material as the essentialized basis of medium specificity, and technically based approaches in art history reinforced connoisseurship through the science of artistic materials. But in order to engage critically with materiality in the post-digital era, the time of big data and automation, we may require a more advanced set of methodological tools. Let us address digital infrastructure as entirely physical and thus re-examine how they are commonly described as "immaterial." If we acknowledge that data itself is not immaterial, but a generative product of complex infrastructures, including magnetic materials and associated physical responses of electron magnetic dipole moments, hosting it, data centres, wi-fi, low-frequency radio signals, transatlantic cables, and satellites amongst other elements, we may view a global network of computational apparatuses, its software and hardware as a planetary conveyor belt producing and handling data. To develop this argument further, we turn to the aforementioned instruments of new materialist critique. We may approach this by addressing materialist critiques of artistic production, surveying the relationships between matter and bodies, exploring the "vitality" (Bennett 2010) of substances, and looking closely at the concepts of inter-materiality and trans-materiality emerging in the hybrid zones of digital experimentation. Building on Bennett's notion of *vital* and *vibrant* matters, an understanding of expanding universes between objects comes into play, which leads us to ask the question: What are the understandings of agency between matters, the dynamics between inhuman objects undefined by human intervention? We used to think of artistic work as a process of turning formless materials into intelligible forms, i.e., paint into a painting, clay into a sculpture, and data into a model. These ways of thinking about forms and being refer back to Aristotle's term *–hylomorphism.*

However, does this assumption of matter and capacity still hold after developments in digital infrastructure, media theory, and *Quantum Physics, and the Entanglement of Matter and Meaning*, as Karen Barad put it in her book title (Barad 2007)? The aforementioned social theory developments of agential realism, affect theory, and new materialism provide us with new deterministic methods. In the words of Bruce Miranda, "New materialism tries not to have a set of maxims, but as a whole, it does emphasise a non-anthropocentric approach. This means it doesn't just pay attention to other organic lifeforms – but also non-organic ontology and agency. It focuses on how all kinds of matter are an organising and agential part of existence" (Bruce 2014). From the New Materialist point of view, the meeting of clay and sculptor is actually an encounter between non-inert material bodies, each with their own agency and capacities. Perhaps *Content Aware Studies* provides a good case study for the overwhelming complexities of new materialist dynamics, as opposed to holomorphic relationships, where the authorship of sculptures equally (or not) distributed between the StyleGAN algorithm, the contents of the datasets, classical sculptors, CNC router machines, 3d printers and finally the artist, Egor Kraft. The agency of the author has somewhat dissolved within the thingness of the things, as follows:

A motor-driven spinning end mill of a five-axis CNC machine under a water coolant jet stream encounters a marble block composed of recrystallized carbonate minerals to shape it into a form defined through the process of an encounter of a dataset consisting of 3d-scanned historical documents; encoded as collections of 3-dimensional model files; converted into binary files to be processed by computational algorithms, based on mathematical equations describing multidimensional vector space, enabled via a multi-layered software stack, which triggers electric signals across semiconductor-microchips of a GPU-accelerated server within computer-clusters, which processes and routes millions of electric signals and request-response operations across its RAM, CPU, GPU, VRAM solid-state drives, hard disks and other hardware components. Once physical, the marble output is met with various nitric acid solutions with each layer adding centuries of age. Hardware, software and data here are active authors and creators of objects, no longer merely tools.

One can look at any *CAS* sculpture as the embodiment of new materiality, illustrating how materials and meanings confront, violate, or interfere with common standards as mediators within entanglements of processes, but any other object would also pass. Approaching *CAS_05 Julia Mamea*, we see the marble bust of a woman, but when seen from all sides, the portrait turns out to be an uncanny distorted amalgamation of glitches in the gap between the acid-aged marble. In place of where human gut feeling would tell us to expect an ear or a cheekbone, the polyamide inlay depicts multiple eyes rippling along the side of her face. Is then an archive of such objects now a museum of synthetic history, filled with documents of algorithmic prejudice?

Fig. 1. *CAS_05_Julia Mamea,* 2019, Egor Kraft, marble, / polyamide, Copyright by Egor Kraft.

Predispositions by Design

Preoccupied with these warnings and ontologies of biases, *CAS* examines what visual and aesthetic qualities for such guises are conveyed when rendered by a synthetic agency and perceived through our anthropocentric lens. What of our historical knowledge and

interpretation encoded in the datasets will survive this digital digestion? Having previously established the notion of machine-generated history, let us now unpack its problematics. The current research by the British Library and the Turing Institute is directed to using AI to analyze large, digitized collections "to provide new insights into the human impact of the industrial revolution." Such intervention poses the question of to what degree we may and should accept machine-analysis of archival data-based deliverables as a ground for truth when aiming for historical reconstructions. In *CAS,* the voids that the project aims to resolve are also the information least represented in the dataset, particularly noses, fingers, chins, and extremities, is lost because of their fragile nature, causing further misrepresentations. Is this not also true for the above? We must acknowledge blind spots in the data: history, pre-saturated with one-sided narratives, misinterpretations, and accounts written by the victors of conflicts. For the sake of precision in arguments, it needs be mentioned that it is not only data introducing bias, but also algorithms, their architecture, and the parameters of operations, including the number of training epochs and floating-point precision format. The latter is a binary floating-point computer number format that describes training accuracy: FP16 stands for half-precision, while FP32 provides a wider dynamic range in handling data and thus delivering output.

Another example of AI-led historical investigations surrounds the Voynich manuscript, a 240-page illustrated ancient book purchased in 1912 by a Polish book dealer, containing botanical drawings, celestial diagrams, and naked female figures, all described in an unknown script and an unknown language, which no one has been able to interpret so far. In early 2018, computer scientists at the University of Alberta claimed to have deciphered the inscrutable handwritten 15th-century codex, which had baffled cryptologists, historians, and linguists for decades (Pascoe 2018), stymied by the seemingly unbreakable code. It became a subject of conspiracy theories, claiming it had extraterrestrial origins or that it was a medieval prank without hidden meaning. But using natural language processing machine-learning techniques, over 80 percent of the words have been found in a Hebrew dictionary. However, these assumptions have met harsh skepticism outside of the computer-scientist community. AI might approach problems as puzzles, which it tries to solve by brute force, even if the sum of the pieces is incomplete, and even more so, gleaned from other puzzles. In other words, it is unlikely that AI will see beyond the subject it was trained to see. Instead, it will make sure to find that very subject regardless of whether it's there or not: from the plate of spaghetti and meatballs hallucinating a hellscape of dog faces on a *Deep Dream* trip[2] to how a residual neural network reveals an alarming resemblance shared between chihuahuas and muffins[3], and finally, how AI deciphered the *Voynich Manuscript*.

Fig. 2. Deep Dream Chiuahua, unknown artist: https://www.topbots.com/chihuahua-muffin-searching-best-computer-vision-api/

Let's look at the AI-revisited Lumière brothers 1895 film *Arrival of a Train at La Ciotat*, which has been upscaled to blazing 4K resolution and streamlined at 60 frames per second, with colour added. It messes with our understanding of the age of the material by actively triggering and confusing our code-reading of aesthetic references. This recently re-rendered tape comes across as a confusingly

[2] https://i.imgur.com/iRy0vC4.jpg

[3] https://www.topbots.com/chihuahua-muffin-searching-best-computer-vision-api/

uncanny, yet still somewhat archival footage; The high definition aspect places it in the post-digital realm, perverting the age of original recording. Second, the high frame rate of 60 frames per second leans further towards this perversion, rendering it to be read as if it were from the second decade of the 21st century, as 60fps had become a common standard. The final augmentation occurs through introduction of color to the originally black and white footage, which because of its desaturated hues, confusingly imitates 1960s aged materials. So the augmentations performed by the machine-learning algorithms rip the footage out of time, leaving us with frankenstein-monster archival document. We are confronted with augmented pixels, synthetic color, and a confusing timestamp bias, which leaves us wondering in what way this footage remains archive material.

Historical Investigations at Blazing Ultra-Resolution

Perhaps to speculate on potential design changes in policies related to AI-led investigations; and in response to questions about the changing nature of historical objects through their interaction with computational interventions, it may be helpful to analyse the responses that took place within Archeoinformatics, as it became "firmly and irreversibly digitized" (Fischer 2020) throughout the '90s and early 2000s. There we can observe changes in policy regarding research methods as a reaction to their computational evolution. We witnessed the rise of international and domestic laws, answering calls to protect cultural heritage, data ethics, and personal information in historical archives (Richardson 2018). Recording archaeological data became less about creating exact digital copies, and more about preserving an exact record of how excavators interacted with the observed object (Roosevelt et al. 2015). Looking at this evolution within Archaeoinformatics, we might ponder the possibilities of record-keeping as a method of addressing ethical concerns and questions of biases in historical knowledge production. But LiDAR scans of excavation sites are acts of machine observation, with humans in this equation still holding the reigns of *moral responsibility*. This method of additional documentation may be somewhat similar to classification of supervised and unsupervised machine-learning. In the former, humans still play a supervisory role, as they do in the case of these archaeology examples. But what of unsupervised machine learning? Earlier in the text, we touched upon one of the pillars for true AI emergence, which is that it needs pre-programmed means for self-awareness in order to account for its own bias, but might it also have to learn self-responsibility. Is it a question of designing a system that documents its own process of documentation, in a perpetual loop of record-keeping and self-observation, a panopticon of computational algorithms supervising computational algorithms with *super-vision?*

In our concluding thoughts, we can speculate that until machine cognition systems are trained to recognize themselves, AI as the lead investigator is doomed to fail to account for its agency, which according to our case study, has lasting repercussions. The thoughts expanded in this paper do not provide solutions; rather they point towards alarming outcomes if the outlined complexities are disregarded. They acknowledge that the nature of these complexities lies within the notion of the computational phenomenon itself, or more specifically, its onto-epistemological capacity, materiality, and programmability. We may address growing concerns about some possible scenarios in the future in which its past will be largely augmented by automated versions of AI-investigators to which it was ingenuously outsourced. Hence, whilst the evolution of scientific tools is, in fact, "a good thing," it is alarmingly crucial to continuously highlight that this progress not only fails to eliminate existing biases, but likely amplifies them. Thus, awareness of these biases has to be kept at the forefront of conversations and the design of tools, so that we do not succumb to a naive fantasy that historical-detective-virtual-assistant-led research may be the way towards historical investigations at blazing ultra-resolution.

Fig. 3. Snapshot from GAN-generated latent space walk video from the CAS series, 2019, Egor Kraft, Copyright Egor Kraft.

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Biographies

Egor Kraft, an nterdisciplinary artist and researcher (b. 1986, St. Petersburg), lives and works in Moscow and Berlin. Egor studied at Rodchenko Art School, The Academy of Arts Vienna, Central St. Martins College, and 'The New Normal' program at the Strelka Institute. His preferred artistic method involves looking for ways to produce works on the boundary between reality and their virtual misrepresentation. He has participated in the 5th Moscow Young Art Biennial, the Industrial Biennial, Ars Electronica, the WRO Biennial, the Impakt Festival, Open Codes at ZKM, and other international art shows. Egor was nominated various times for the Lumen, Kandinsky, Pulsar, Innovation and Kuryokhin prizes. In 2017, he was included in New East 100, a list of people and projects shaping today's world, by the *Calvert Journal*. In 2019, he became a STARTS residency research fellow at

the University of Southampton and a Garage Museum Grant recipient.

Ekaterina Kormilitsyna (b. 1994, Vienna) is a writer, researcher and interdisciplinary filmmaker, based in Vienna and London. After finishing her film studies at Queen Mary, she completed her MA in research in Art & Design at Cardiff Metropolitan University in 2020, and continues to be a visiting researcher in the TransTechnology Research Group at Plymouth University. In her work she pursues the aesthetics of language and culture within digital frames – looking at 'how things are looked at'. Since 2015, she has contributed to the *Film Matters Journal* and has worked as an artist and filmmaker in Beijing, London and Vienna.

Part II

Scholarly Abstracts

Inquiring the Backends of Machine Learning Artworks: Making Meaning by Calculation

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Abstract

How is machine learning (ML) in its materiality entangled in the making of meaning in contemporary art? And could the making of meaning based on calculations of machine learning be read as a new cultural technique? This scholarly presentation will explore these questions by looking at three artistic approaches—Jenna Sutela, Rafik Anadol and the chatbot *HUO9000*—and how they make use of the role of back-end *interfaces*, the control centres that manipulate the calculations of machine learning to make meaning.

Contemporary Art and ML

When artists turn to machine learning (ML) as a medium—i.e. labeling datasets and building and optimizing ML models—backend or technical processes become central to the conceptual framework of the artwork and the artist's (and their teams') practice. The interfaces that act as control centers for these projects have therefore become critical sites for artistic work: they are where artistic meaning making is happening when using ML as a medium, tool or—depending on the artist's positioning—collaborator.

To show this, our scholarly presentation will analyze the production and use of interfaces created for three artworks that we can access through our work with the Creative AI Lab situated at Serpentine Galleries: 1) Jenna Sutela's *I Magma,* in which the artist worked with Allison Parrish and Memo Akten to create an RNN language generation model. This model was trained on the Sacred Texts Archive and open source LSD "trip" reports and used Google Quickdraw to associate the movement of custom lava lamps with predictions from the model; 2) Refik Anadol's *Machine Hallucinations* series which uses generative adversarial networks (GANs) to transform huge image archives into data sculptures; 3) An experimental chatbot prototype by the Creative AI Lab called *HUO9000*, trained on thousands of interviews by Hans Ulrich Obrist, the Serpentine's Artistic Director.

Creative AI Lab

The research into these three artworks and their backends is part of the *Creative AI Lab*, co-founded and led by PI Dr Mercedes Bunz (DDH, KCL) and Co-I Eva Jäger (Serpentine Galleries). The Lab, founded in 2019, is a research collaboration between the Serpentine Galleries and the Digital Humanities Department at King's College London. Through the lens of art-making, the Lab engages with ML as creative media. In 2020, the Creative AI Lab launched a database of ML/AI tools and resources and a series of events including a panel discussion series on the Aesthetics of New AI. The next phase of the Creative AI Lab's research is devoted to the study of artistic interfaces and their role in meaning making through ML, which will be initiated with this scholarly presentation.

By studying the backend interface of each project, this presentation aims to understand what the art production paradigm can help us understand about building and interfacing with ML models, and to ask how ML is transforming the making of meaning (Bunz 2019) in those art works.

Fig. 1. I Magma, 2019, Jenna Sutela, Mixed Media, Commissioned by Moderna Museet and Serpentine Galleries.

Cultural institutions and the artistic usages of ML play a pivotal role in offering a space for much needed experimentation and understanding of ML technology beyond its corporate application as an effective instrument (Penny, 2017). This presentation will analyze the artistic workings of (and with) ML interfaces and inquire into the ways ML could be understood as a new procedure for encoding and decoding symbolic information and cultural signs (images, language). We will ask: to what extent can the making of meaning through *calculation* (i.e. algorithmic processes) be read as a new "cultural technique?" (Siegert 2020); And, in what way would this new cultural technique transform past prevailing understandings of the making of meaning in culture? (Hall 1980).

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Biographies

Dr. Mercedes Bunz is the Creative AI Principal Investigator and Senior Lecturer in Digital Society in the Department of Digital Humanities, King's College London, where she is also Deputy Head of the Department. Her research explores how digital technology transforms knowledge and power.

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Platform AI Art and the Naturalization of Facial Recognition

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Abstract

This presentation outlines my current research on the relationship between AI art practices promoted by social media platforms and the naturalization of facial recognition technologies. While recognising the top-down implications of these technologies in terms of social reduction and surveillance, I also wish to assess their potential for a tactical reclamation by their users.

While it has been demonstrated that the deployment of facial recognition technologies by authorities has dangerous implications in terms of surveillance and bias (Buolamwini & Gebru 2018), the naturalization of the same technologies is happening through banal applications on social media. In this respect, I wish to focus on Facebook as the centre of a platform ecology that is playing a crucial role in the definition of AR art for the mainstream public. The company owns in fact both Instagram and Spark AR: the former allows users to deploy facial recognition-driven "filters" in its popular Stories feature, the latter is a free software for the creation of customized AR applications (mostly filters). They have also been investing in technologies to create lifelike avatars (Tech@Facebook 2019).

Rather than focusing on biometric data as a privacy issue, I wish to center my research on how the socio-technical environment delineated by the convergence of Facebook's infrastructure, Instagram-driven identity models, and Spark AR as a creative technology shapes the development of facial recognition as a mass cultural phenomenon. In particular, I want to emphasize how this negotiation happens through practices that are explicitly framed as creative and even artistic.

Facebook has in fact very explicitly been promoting Spark AR as an art-orientated technology: they have presented a Spark AR-powered augmented reality exhibition at Tate Britain (Tech@Facebook 2019), while the Spark AR blog regularly showcases artists or designers who use their software.

Per se, the embeddedness of face filters within the Facebook-Instagram-Spark AR ecology does not contradict the status of much of what has been termed "AI art" in recent years. In fact, highlighting how much of machine learning-driven artworks are funded and developed alongside big players in the tech industry, Zylinska (2020 75) argues much of it is effectively already "platform art." My focus, then, will be on assessing how much critical freedom is afforded to filter artists, what type of original cultural forms might emerge from AR- and facial recognition-powered platform art, and what socio-cultural tensions these new formats engage with. The most evident tension is the coexistence of a corporate infrastructure imbued with a neoliberal ethos—which encourages active posting (Docherty 2020) and commodifies user identities (Lim 2020)—and the potential for critical self-reflection that is inherent to media art practice (Stark & Crawford 2019). Other interesting angles are framing face filters in the context of animation and racial stereotyping (Stark 2018) or the use of protest-themed filters as "memetic signifiers" (Gerbaudo, 2015)—among the categories that creators can use to classify their filters is in fact popular "causes," which suggests the possibility of political commitment.

By discussing relevant literature, as well as specific examples of AR-filter-based art and critical media art addressing facial recognition in other technical environments, my presentation will thus address the following questions: can the face filters and virtual avatars emerging from the triangulation of Facebook, Instagram, and Spark AR become forms of "tactical media" (Garcia & Lovink 1997) that leverage the technical environment they are embedded within to generate critical responses to it? Can they evolve into forms of critical computing, "phantasmal media" (Harrell, 2013) that work towards the transformation of dangerous stereotypes into more multi-faceted, emancipatory identity templates?

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Biography

Nicola Bozzi is a researcher and freelance writer contributing to international publications like Frieze, Domus, and Wired Italia. His main research interests are globalized identities and the role of art in society. He also has a newsletter about comedy, media, and culture titled Letdown Comedy. You can follow him on Twitter as @schizocities.

Extralegal Portraiture and Surveillance

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Abstract

While issues surrounding privacy and surveillance are nothing new, many recent creative projects have situated extralegality as a crucial component within aesthetic pursuits. Indeed, in the past decade, artworks have both activated digital surveillance tools and showcased the deeply personal information that such new technologies have collected (without legal consequences)—thus spotlighting a severe lack of legal frameworks and privacy protections.

Scholarship considering the intersection of art and surveillance has largely focused on issues of privacy (and attribution), methods of control, and creative approaches to meta- and counter-surveillance tending toward transparency (Bertrand and Bridle 2016; Phillips 2010). These discussions assume that the mechanisms and the subjects of surveillance operate within a closed system—cultivating a mise-en-abyme of watchers and watched, controllers and controlled, and hosts and parasites.

But, what about the systems of law which facilitate the surveillance apparatus itself—systems which are frequently activated and contoured as a material component within so-called surveillance art? Here, I consider projects such as Paolo Cirio's *Street Ghosts* (2012) and *Obscurity* (2016), Arne Svenson's *The Neighbours* (2012-2013), and Heather Dewey-Hagborg's *Stranger Visions* (2012-2014). These works are indicative of a larger, strategic form of artistic practice; they are realized by artists for whom digital surveillance is the norm and they deploy the mechanisms of surveillance to generate the work. These artworks capture portraits of strangers through digital, visual, bio, and data surveillance while simultaneously contouring the space of the extralegal—a space outside of the law (neither explicitly legal nor illegal). With a focus on the United States, but with an eye toward a global perspective and a wider artistic practice, this paper considers how a group of artists perform ethically problematic yet not technically illegal actions. Adopting a strategy of uncivil obedience—acting in accordance with the law but outside of common practice—the artists delineate the boundaries of legally unregulated spaces and thus protest the very actions they perform. Their work thus encompasses a kind of extralegal portraiture, a map of both a private individual and the legal space which allows the details of that individual to be accessed and shared.

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Biography

Monica Steinberg is an Art Historian and an Assistant Professor in American Studies at The University of Hong Kong. Steinberg's research considers the intersection of art, fictional attribution, and law. Her work has appeared in journals such as *Archives of American Art Journal*, *American Art Journal*, and *Oxford Art Journal*.

Re Sound Art Machines and Aesthetics

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Modelling an aesthetic experience through computational processes can be problematic for artistic expressions foregrounding the conceptual over the perceptual. Nevertheless, being able to judge aesthetic value and to generate accordingly, is evidently non-negotiable for the notion of an "art machine." Despite neuroscientific evidence (Berridge and Kringelbach 2015; Reybrouck et al 2018) that aesthetic appreciation is not a specific neural process concerned with aesthetic properties of a perceptual input, it is still customary to endorse the contrary and its natural corollaries: that there must be some objective mapping (a rule, a universal law) between perception and judgment, and that aesthetic judgment can be reduced to normative assessments of an art object's perceptual qualities. This fallacy, surprisingly widespread in creative AI endeavors, can often lead to single-factor explanations.

In the realm of "experimental aesthetics," instead, Leder and Nadal's (2014) posit that aesthetic judgement and aesthetic emotion are outputs of a recursive and complex network of connected stages in a continuous evaluation of an artwork. This model of information processing integrates perceptual, cognitive and affective accounts of the aesthetic experience, and it is modular, lending itself to countless variations. In it, one can distinguish two connected and inter-dependent circuits: an inner loop of continuous affective evaluation, comprising automatic and deliberate evaluation, and an outer loop which includes social interaction discourse, context and pre-classification.

Computational aesthetics in the sound realm has so far explored exclusively the automatic evaluation subnetwork, with particular focus on perceptual analyses. The music phenomenon per se, is based on different levels: a general domain level of the auditory system, a syntactical or prosodic level, and a culture-specific level. At a domain-general level, sound complexity (*e.g.*, spectral, temporal, etc.) is directly linked to information theory-based accounts of the music experience, an approach rooted in Birkhoff's (1933) "aesthetic measure," Bense's (1965) and Mole's (1973) "Information Aesthetics," Stiny and Gips' (1978) "Algorithmic Aesthetics," and Gell-Mann and Lloyds' (1996) "effective complexity." Complexity and entropy, however, are fundamentally different in music, where redundancy and repetition can be deliberately used as aesthetic features. For abstract art or music, conceptual complexity (Minissale 2012) might be more relevant than perceptual complexities. Similarly, dissonance is thought to be linked to unpleasant sensations, but there are many examples of music willingly employing it as an aesthetic signature. The same applies to design-based measures, such as contrast, unity in variety or symmetry.

The syntactical or prosodic level is normally informed by Gestalt theory, often combined with probability theory. According to Meyer (1956), for example, musical enjoyment is proportional to the level of agreement or violation of perceptual musical expectation (acquired, allegedly, through statistical learning). Narmour (1990) extended these concepts in his "Implication-Realization" (I-R) model of melodic expectation, which has been applied in music to generative (Brown et al 2015) and analytical (Potter et al 2007) tasks. However, in types of organized sound other than tonal, some of which have been described as "boring, formless and nonsense" (Priest 2013), the balance between expectation and novelty is often intentionally subverted for artistic reasons. "Prototypicality" (Martindale and Moore 1988) was proposed as a counter theory to Berlyne's

(1960) "arousal potential" but, to the author's knowledge, it has not been employed in a generative music context. Similarly, the "processing fluency" theory of aesthetic pleasure (Reber et al 2004), which maintains the notion of expectation insofar as familiarity is concerned, is still largely unexplored in the sound domain, except for "self-similarity" (Manaris et al 2005), one of the fluency variables.

Beyond the merits and issues that the above approaches might have when used in isolation, the most urgent agenda if one is to hope for truly engaging sound art machines is to address the lack of networked modularity between different automatic evaluation methods and to overcome single-factor explanations in the modelling of the aesthetic experience of music. Moreover, it is paramount to consider the role of context and social interaction discourse. For example, communities of sound art machines could exchange information and "experiences" about artworks, dynamically updating their beliefs about the context and the social value of the artifacts, which would in turn contribute to deriving online expectations. Affective computing could be leveraged to model the emotional state component of an aesthetic experience, while meta learning (Lemke 2015) and Bayesian program learning (Lake 2015) could be instead employed for tasks involving familiarity and the treatment of unseen classes of artworks. While the aim is not necessarily to reproduce, simulate or surrogate what is thought to be the human aesthetic experience, it is imperative to move beyond perceptual analyses of the aesthetic object, and towards the full potential of sound art machines.

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Biography

Stefano Kalonaris is a researcher interested in generative music systems, human–machine musical improvisation, and computational aesthetics. He is currently a member of the Music Information Intelligence Team, RIKEN AIP (JP) and the AI Music Creativity research forum. Previous affiliations include Sensilab, Monash University (AU), the Sonic Arts Research Centre, Queen's University Belfast (UK), and the Guildhall School of Music & Drama (UK).

An Information Theory Application to Bio-design in Architecture: *UnSESUS*

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This research translates info-biological principles into the design of architecture; more specifically, it reviews the use of the Gestalt approach (GA) and Free Energy Principle (FEP) in bio-design, and asks: "how can Artificial Intelligence (AI) learn from bio-intelligence to facilitate designs that are sustainable and aesthetically interesting?" This research illustrates its argument with a design experiment: Unattended Solar Energy Smart Urban System — *UnSESUS*.

Architecture stands at the convergence of art and tectonics—the art of creating built environments that immerse and guide our everyday lives. In our information age, media platforms often interface between architecture, its users, and their exchanges, and have the potential, beyond entertainment, to satisfy both sustainability and aesthetic desiderata by taking into consideration users demand and comfort through the collection of data. AI may help to accelerate and automate exchange processes as the content that users create deep learns from itself. For instance, digital platforms often perform content personalisation with AI—using system information to distribute information—a self-organisational strategy.

With millions of years of evolution, nature is a master in self-organisation. It is a system that is adaptive and efficient, and it is sustained through the rapid exchanges of all sorts of information, from DNA to languages. Even though the word "information" is a noun, it is in fact a process—a construct that arises in the context of trying to understand our complex environment. How should we create information? Is information a form of energy or a pattern extracted from stochasticity? In raising these questions, this research rethinks the relationship between information, biology and architecture, in order for us to better understand our AI tools for design—from generative algorithms to predictive analysis.

There is an increasing amount of biological research that tries to understand bio-intelligence using information theory, which helps us in applying mathematics as a language for describing complex systems—from organisms to organisations—and potentially enables us to capture them computationally (Friston 2019). More specifically, GA and FEP study how entropic information is fed back from the interior to exterior of a system in an iterative manner. The former argues that "individuals are aggregates that preserve a measure of temporal integrity, i.e., 'propagate' information from their past into their futures," where we may begin to describe the performance and qualities of an individual by the variation in their "degree of environmental dependence and inherited information," which is a measure of entropy (Krakauer 2020). The latter argues that individuals have access to information through their individuation. The "consideration of how an individual maintains the boundary that delimits itself"— the *Markov blanket*—is the key to studying self-organisations (Ramstead 2018). Thus, biological systems tend to minimise entropy—the average level of disorder or surprises in some information—through active inference.

Active inference is what intersects between info-biology and AI, it is how an individual "uses an internal generative model to predict incoming sensory data" (Friston 2019). This research extrapolated three main points of how an individual—be it a set of building components or an energy system—can perform active inference using AI: negentropic, preemptive, and network design. It exemplifies this approach with a design experiment—*UnSESUS*—based on self- sufficient (i.e. perpetual) networks.

UnSESUS aims at tackling three issues: 1) distribute infrastructural power (not every building has the same solar capacity); 2) minimise energy dispersal (i.e. entropy) through active inference and preemptive designs; 3) leverage between aesthetic, microclimatic, and structural concerns. *UnSESUS* couples form-finding for Carbon NanoTube (CNT) backed solar cells (CNT can be produced as flexible and conductive thin films to be placed over building facades as light harvesting materials) with a personalisation feedback system using sudoku gameplay (a combinatorial game as a distribution strategy to resolve the hierarchical structure in time and demand factors for solar energy).

In *UnSESUS*, negentropy is the minimization of energy dispersal, where a "solar swarm" installation is proposed based on the Hadley cell, which transports energy polewards for more equal distributions. Negentropy is equally important for the information that represents energy exchanges to minimise uncertainty and maximise efficiency using active inference (i.e. AI with Markov models), and facilitate a smart energy system that is not reactive but preemptive—it acts before demands/climatic conditions are realised. The immediate advantage is a reduction in energy absorption by the power grid, which is usually obtained from carbon fossil. Thus, the system becomes environmentally friendly (Miozzo, et al., 2013). The design of media platforms facilitates information exchanges between users. The network design based on sudoku brings the users and the solar installation together.

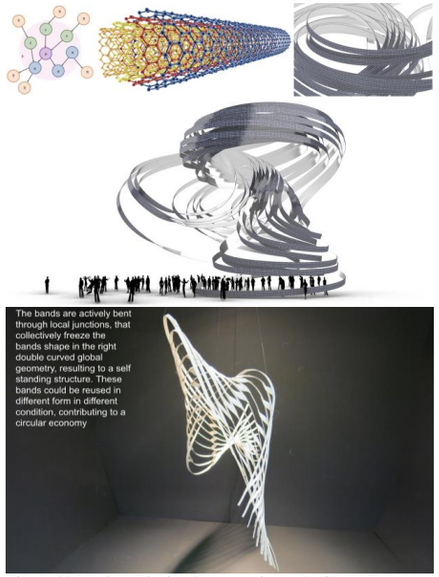

Fig. 1. (a) Markov Blanket (Ramstead, 2018). (b) CNT (AZoNano, 2013). (c) (d) CNT solar cells arranged in a Solar Swarm structure. (e) A self-standing physical model.

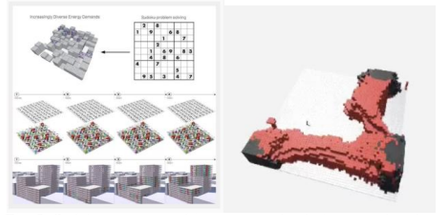

Fig. 2. Sudoku as a networking strategy that brings together the solar installation and a network of users; a pix2pix neural network was trained to translate between pixels and voxels.

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Biographies

Provides Ng, **Baha Odiabat**, and **David Doria** founded *Rational Energy Architects* (@R.E.Ar_), which is an architect/researcher collective based in Hong Kong, Frankfurt, London, Jordan, and Brazil that invests in using irrational numbers to rationalise energy use through architecture and urban design. R.E.Ar collaborates with talents across geographical, cultural, and disciplinary boundaries, searching for tools that fall between the established fields of expertise.

Lu Yang: *Delusional World*—A Live Virtual Motion Capture Performance in the Global Pandemic

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Abstract

The global pandemic of 2020 proved to be a challenging year, particularly for those working in the performing arts and cultural sectors relying on live audiences. However, the situation opened possibilities for experimenting with online programmes and international collaborations to create new cultural experiences. This presentation will discuss the development of a live motion capture performance by the Shanghai-based artist, Lu Yang, which was adapted into an online performance with teams in Shanghai, Melbourne, and Hong Kong. This project presents a case study into how artists and institutions have responded to the pandemic and how online performances could have the potential to create meaningful shared cultural experiences. As part of the production team, the Hong Kong studio MetaObject*s* played a role in bridging links between institutional partners and supporting the technical development of the project. This talk explores some of the challenges and opportunities of presenting work online. Operating as a mediator, the process reveals the limitations of geographically situated institutions, where regionalized funding structures and audiences could be reconsidered. Through the process of "thinking through the middle" *par le milieu* (Stengers 2005, 187), the research approach is to draw knowledge through the immanent process of thinking-doing. The intention is to open ways for intervening in the field of art and technology by operating within contemporary conditions, while recognizing the contingent and situated possibilities emerging in every moment. The knowledge gained provides a means for re-thinking cultural programming within and beyond established institutional frameworks.

Background: Iterative Development

Lu Yang first presented her live motion capture performance at the Hong Kong Visual Arts Centre in January 2018. The performance is an evolution of her on-going interest in neurology, deep brain stimulation and the manipulation of the virtual body. Her work engages with themes drawn from Chinese medicine and Buddhism while employing the contemporary aesthetics of games and Japanese manga. Lu Yang's work does not begin with the technology, but rather uses it to further expand the possibilities of her work, concepts, and ideas as a post-media (Weibel 2012) contemporary artist in which her work can take different forms while engaging a diverse range of media.

Fig. 1. *Electromagnetic Brainology Live*, 2018, Lu Yang, Live motion capture performance, Powerlong Art Centre, Hangzhou, Courtesy of the artist.

MetaObjects was brought into the project to help the artist develop the live performance using motion capture technology, where a dancer's

movements are mapped to her 3D animated avatars displayed on a large screen behind the dancer. MetaObjects helped develop the proof-of-concept on a limited budget using widely available consumer hardware, HTC Vive Trackers, and IKinema animation software. A midi controller was programmed to allow the artist to control the camera movements, visual effects, character, and background changes live.

Following this initial performance, the artist was invited to further develop the performance for the opening of the Powerlong Arts Centre in Hangzhou in May 2018. Working with the China Academy of Art and the virREAL Centre for Art and Technology led by Yao Dajuin, the performance was upgraded using the center's OptiTrack motion capture system with additional visual effects and camera movements. The project is developed iteratively, where each event is taken as an opportunity to expand the project further. Following this performance, Lu Yang was invited to present three performances at the Rockbund Art Museum, Shanghai in October 2018. Partnering with Chronus Art Center to use their OptiTrack motion capture system, the performance was enhanced with new characters, visual effects, and additional dancers on stage.

Crisis Response: Adapting to Online

In March 2020, Lu Yang was invited to present the live motion capture performance in Federation Square as part of Asia TOPA Festival in Melbourne, Australia, curated by Mat Spisbah. Lu Yang was unable to travel due to the emerging pandemic in China. As the crisis escalated around the world, the performance was reworked into an online performance live streamed from Shanghai. It was presented as part of the re-opening of ACMI (Australian Centre for the Moving Image) together with Asia TOPA, Arts Centre Melbourne and The Exhibitionist. MetaObjects was unable to travel to Shanghai to assist with the production; as a result, a local producer was hired to help set up the performance on-site. Chronus Art Center was brought on as a venue partner having worked with the artist before. The performance scheduled for 11 November 2020 also lined up with the Shanghai Art Week where a physical performance was planned for November 13th as Shanghai was no longer under lockdowns. The project developed over months of uncertainty of the situation and fluctuating travel and social distancing permissions.

Fig. 2. *Delusional World*, 2020, Lu Yang, Live virtual motion capture performance, screen capture of live stream.

Challenges and concerns included the streaming quality from behind China's firewall, time zones and finding the ideal time for different partners, and having live interaction with audiences. The stream was promoted through ACMI and their audiences in Australia. However, with an online performance, it presented the possibility to engage international audiences and to reconsider cross-institutional funding and collaboration. In the end, the event created a dynamic and interactive online experience with a live chat and artist Q&A with over 530 unique streams from around the world. Through these projects, MetaObjects plays a role in enabling possibilities by developing collaborations, leveraging networks and resources to support artistic projects, and in supporting an ethics of co-learning as an iterative process. A full recording is available at: https://luyang.acmi.net.au/.

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Biography

Ashley Lee Wong is Co-Founder and Artistic Director of MetaObjects, a studio facilitating digital production with artists and cultural institutions. She completed a PhD at the School of Creative Media, City University of Hong Kong and is former Head of Programmes and Operations of Sedition, an online platform for distributing digital limited editions in London.

Listen to Reason: In Conversation with a Computational Critic

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Abstract

In this paper we introduce the concept of "inductive conversational interface" as a guiding design principle to develop machine learning applications for aesthetic judgement. Taking film criticism as a case study, we present a basic implementation as a proof of concept, and based on this we suggest future avenues towards a reimagined practice of computational criticism.

Computational Criticism

Despite having a long and rich intellectual tradition grounded in inductive reasoning, art criticism and its practices are underdeveloped areas in terms of machine learning applications for research in the arts and creative industries.

As a computational problem, aesthetic judgement is usually traced back to *Aesthetic Measure* (Birkhoff 1933). Yet, the nature of judgements of taste as well as the abstraction of critic's qualities by empirical means is at least as old as David Hume's "Of the Standard of Taste" essay, in which he sought to aggregate the judgements of critics to abstract a "a general rule," or model, with which to evaluate the merits of works of art so as to adjudicate on disputes about their quality (Hume 1857).

Prima facie, Hume's standard appears to prefigure modern day recommender systems of the kind commonly used in streaming platforms, in both their inductive logic and empirical mechanisms. However, a closer reading of the eighteenth century philosopher also reveals a significant difference: these systems are not usually designed to produce general rules; they do not solve disputes by adjudicating between conflicting judgements, but instead bypass judgement altogether by producing tokens of prediction tailored to individual preference, often with the explicit goal of maximising consumption (Milano, Taddeo, and Floridi 2020, 960–62).

This design pattern dissolves the shared social space necessary for aesthetic assessment, since privately held preferences of the type mined by recommender systems need no justification; they stand simply for what users like. In contrast, critics are expected to produce not only personal verdicts, but explanations: public assessments grounded in reasons (Carroll 2009, 8).

A defining aspect of judgements made by critics is that the reasons they offer to support their arguments are presented so as to elicit public agreement, and can, by the same token, be publicly contested and refuted (Eagleton 2005, 9–10). Recommendation without assessment is sterile for aesthetics because it cancels the possibility to examine, verify, or contest the judge's explanations, which in turn precludes the forming of meaningful consensus and canons of taste that can be established, challenged or overthrown, collectively.

Redesigning Critic Machines

To address this issue, we propose to reimagine computational criticism as a series of conversational events mediated by inductive computing. Taking film criticism as a case study, we redesigned the division of labour between critics and computers to stage an exchange between three agents: a film fan, a professional film critic, and a moderator who mediates their exchanges. The first two are computational agents, the third is a human critic.

To train the computational agents, we used an ad-hoc dataset created by extracting features from ~30,000 videos from the YouTube channel *Movieclips*, matched to both their respective comments in the video platform and to reviews from professional critics scraped from the website *Rotten Tomatoes*. For each of these agents, a large-scale language model (Radford et al. 2019) was fine-tuned using this dataset and deployed as a text generator.

The system works as follows: the human interlocutor initiates the conversation by seeding the system with the title of a film or a clip of their choice, this sets off a response by one agent, which is used as input for the other. The exchange continues recursively and is regulated by the critic, who selects responses, inputs her or his own response in natural language, references a new film or clip, or ends the interaction.

Unlike most recommended systems, our experimental setup does not rely on numerical ratings, stars, or thumbs up or down signals, and although recommendations, discovery or endorsements might occur as a result of the moderator's interaction with the system, its design is not fundamentally prescriptive. Instead, the goal is to computationally abstract, through inductive computing, the types of reasons different audiences offer in support of their judgements, and to present them for scrutiny alongside the clips themselves in a reproducible conversational format.

A key advantage of this conversational design over existing recommender systems is that the exchanges produced through interactions can be followed publicly and in concert with other critics, who can in turn contribute their own judgements and point to their own film referents. The goal of the system is not to cater to individual taste, but to strengthen the network of inter-subjective public judgements that gives criticism its social and cultural significance.

Applications and Future Research

This experiment is presented as a proof of concept. More research is needed, both in terms of interaction and to integrate data sources and machine learning models. Possible directions include negotiating access to larger film archives, collections and online resources, experimenting with text-to-image transformers, refining the models and developing them through reinforcement learning.

We believe, however, that the core design can be expanded to a working prototype with relatively few additional resources. This would be useful to test the appetite for such a system, for example as a tool in practice-based film and media studies as a way to support new scholarly formats like the video essay (Keathley, Mittell, and Grant 2019; Grant 2016).

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Biographies

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Environmental Machine Learning in Multispecies Agency: A Case Study of *Random Forests*

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Abstract

The recent tendency in researching multispecies is through the interdisciplinary practice of creative art and technology. By applying machine learning as a tool for studying multispecies dynamics within an artistic context, it is possible to create an ecological narrative of other species. This text analyses the *Random Forests* research project as a case study for how Environmental Machine Learning (EML) generates such a narrative and questions how EML can help humans to better understanding multispecies entities and enable them to pursue more ecologically ethical multispecies relationships.

Introduction

Questioning the human-focused idea of species hierarchy is one of the most important topics in understanding Anthropocentrism. The concept of 'Multispecies' emphasises the idea that humans as a species are "rooted" in the ecosystem (Morris 2014, 51; Aisher and Damodaran 2016, 2), and serves as a fundamental orientation from which explore the world of the post-Anthropocene. Since 2019, I have been researching plant-based multispecies relationships through my cinematic practice. The main research objectives are challenging the human-centric gaze of the camera lens in filmmaking, and visualising plants' way of seeing the world. In exploring plant-based perspectives, I seek alternative methods to connect humans within multispecies dynamics to overcome the anthropocentric perspective in artistic practice. Within the course of my research, I discovered that the application of machine learning (ML) to eco-art opens up new potential for multispecies interactions within contemporary ecological agencies. *Random Forests* brings ML to bear upon the ecological dimension and inspires a fresh mode of learning from the environment.

Background: Environmental Machine Learning (EML)

ML utilises algorithms that can predict and make a decision from collected data. Ecology and natural science employ ML to process data collected from surrounding environments, which are non-linear, complex and multidimensional (Thessen 2016). Environmental Machine Learning (EML) interacts with these ecological data and trains algorithms with it. Tree-based ML methods which include Decision Tree, Classification Tree, and Regression Tree are good examples of EML models which combine basic ML tasks with plant data (Olden et al. 2008; Hsieh 2009; Kampichler et al. 2010; Thessen 2016). The Random Forest algorithm builds upon the Decision Tree model to analyse a large quantity of data with a higher individual accuracy of trees (Thessen 2016; Karelse 2018). Other ML models such as Genetic Algorithm, Fuzzy Inference System and Bayesian Methods are adopted in ecology and natural science to research natural conservation, species distribution, environmental sensing and so on (Thessen 2016).

Case Study: *Random Forests* by Theun Karelse

The technical basis of Theun Karelse's artistic research, *Random Forest*, is EML. Prior to this project, Karelse conducted two projects *Augmented Ecology* (2014) and *Machine Wilderness* (2015) that explored the multispecies relations in the ecosystem with augmented reality and machine- (living) organism interactions. He expanded his research into *Environmental Machine Learning* (2018) to explore the possibility of EML as an implication for multispecies relations as a whole. Karelse realised that the field of artificial intelligence generally did not acknowledge ecological elements and non-human species other than animals and plants. Furthermore, he pointed out ML does not have a neutral perspective since the training sets are created from what humans have pre-selected. Thus, in *Random Forests,* Karelse combined an Artificial Neural Network model and Decision Tree model to process and analyse environmental data, with the hope that the scope of his algorithm can include both biotic and abiotic organisms or a '"world-view"' that relates to "umwelt"' in his words (Karelse 2018). Karelse conducted four sessions of fieldwork to introduce EML to the "real-world terrain" and trained the algorithm to learn from the environment (Karelse 2018). As a result, Karelse questions whether the natural surroundings and ecosystem should be involved in machine learning training to overcome the anthropocentric prepositioning in possible multispecies and computer interaction. Karelse's research demonstrates the need to consider "ecological correctness" in the filmmaking process without species hierarchy and simultaneously overcomes the limitation of anthropocentrism. This principle is central to my own practice-based research, which tries to avoid human-centric gaze but to learn from plants' perspective.

Conclusion

Technological implications take an important role in working with art and multispecies. Utilising machine learning in artistic practice enables artists not only to collect environmental data and shape them into different forms but also to practice multispecies-computer interaction and participate in the ecological community (Rieger and Bolinski 2020). Stephan Rieger and Ina Bolinski explain that human species can take a "multispecies turn" and move beyond human centered perspectives to encompass multispecies and non-human agencies in the surrounding environment by collaborating with technologies in various fields including art and ecology (Rieger and Bolinski 2020). The long history of the Anthropocene has unbalanced the holistic environment of multispecies relationships. Researching the ecological engagement of Machine Learning supports the ethical participation of A.I in multispecies relationships.

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Biography

Park Ji Yun is an artist and researcher. She is currently conducting her doctoral research with orchids, which considers eco-cinema as a method to investigate multispecies relationships of epiphytic plants. Her interests include urban ecology, more-than-humans and plant sociality.

Alien (Post)phenomenologies of Synthetic Media

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Abstract

We propose an approach based on postphenomenology, object-oriented ontology, and research through design in investigating the impact of widespread synthetic media in our lives. We use a project on synthetic performances as an example of the approach.

Introduction

The research and development of the technologies involved in synthetic media continues to progress rapidly. The challenges these systems will pose for economic, political, legal, aesthetic, ethical, and societal issues have remained little explored in a systematic way. It is important to foster reflective and critical engagement not just with how things are at the present, but what could be developed in the future (Redström and Wiltse 2018). Thus, this engagement should carefully explore the consequences of introducing such designed objects, systems, and assemblages to our lives.

In order tackle this we propose an approach based on postphenomenology and Object-Oriented Ontology (OOO) as theoretical frameworks guiding the speculative and critical Research through Design (RtD) inquiry on synthetic media systems.

Postphenomenology

This approach originating from philosophy of technology studies the relationships that form between humans and the technologies they use. Postphenomenlogy is interested in questions such as: How do technologies shape our actions, choices, experiences, and world-views? How do technologies inform and shape our politics, economics, ethics, and the texture of our everyday life? (Rosenberger and Verbeek 2015)

Object-Oriented Ontology (OOO)

We have adopted OOO to widen our analytical perspectives from the anthropocentric bias of postphenomenology. Bogost's (2012) "alien phenomenology" is a particularly suitable to an OOO approach for our purposes as it promotes 1) "ontography," investigating objects and their relationships on equal footing with humans, 2) "metaphorism," speculation about the "inner lives" of objects, and 3) "carpentry," creation of artefacts to illustrate the objects' respective perspectives. In other words, alien phenomenology invites us to imagine what is it like to be other objects.

Research through Design (RtD)

RtD is a research approach based on the practice of design (see e.g. Zimmerman, Forlizzi, and Evenson 2007). New knowledge is created by designing and making actual artefacts that respond to the research questions. This future looking approach allows to anticipate and prepare for the future rather than just respond to the changes as they come.

Combinations of these approaches have been gaining traction during the last couple of years in Human-Computer Interaction (HCI). For example, Hauser (2018) explores how postphenomenology can inform design oriented HCI while Lindley et al. (2020) do the same for OOO based approaches.

Synthetic Performances

We are currently exploring the suitability of the approach in an ongoing project focusing on synthetic performances in virtual environments. The aim is to create a system that incorporates virtual actors that are capable of delivering human-actor like performances in a dramatic

scenario. This involves utilizing advances in fields such as robotics, computer vision and machine learning in order to develop a model of motion behaviour for virtual actor performances and the staging of scenes from virtual dramas. From robotics, we apply the concept of learning behaviour by viewing demonstrations known as imitation learning in which a policy is learnt for an agent in order to conform to some motion extracted from demonstrations of a similar motion. From computer vision we use an ensemble of models to extract parameterizations like the poses of characters or their facial expressions. We also extract parameterizations of the scene within which the demonstration actions are taking place, for instance, extracting image composition via object detection. The purpose of this ensemble of computer vision analysis models is to generate a dataset for a given body of demonstrations in the form of a series of video clips of an acted scenario. This dataset is used to train a deep learning model that translates the per-frame data from the input video into an extended PROSE language description of the scene and its motion behaviours (Ronfard et. al. 2013). This description is finally used in a generative system to create a videogame scene that recreates the acted performance using a sequence translation model involving neural machine translation and generative adversarial networks.

We are currently designing a series of user interfaces, interaction architectures, and distribution mechanisms based on the affordances revealed by building the core system. These tentative designs allow us to speculate how various stakeholders would engage with such systems. Constructing the systems and interfaces have given us invaluable insights into what kinds of objects (as per OOO) are involved in the deployment and maintenance of such synthetic media services. This ontography includes not only the human-centric ones, such as end users, corporations, copyright owners, creators and so on, but also objects such as artistic styles, algorithms, databanks, and copyright legislations. The analysis will then inform a postphenomenological inquiry into the multifaceted impact of synthetic media in our lives.

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Biographies

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Philip Carlisle is the Programme Leader for Games Computing in the School of Computer Science, teaching across various modules related to games technology. Having spent more than a decade creating commercial videogames, in 2004 he moved into academia where his focus has been the creation of believable characters.

Visualising Agent-Based Canoe Journeys in a Real-time Computation Virtual Environment

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Abstract

This paper explores the use of agent-based machine learning models combined with speculative and critical design methods to investigate potential entanglements between canoes and sea-birds in an imagined Pacific.

Introduction

Layered Horizons (Burrell and Hendery 2019) is a Design Research and Digital Humanities project that brings together disparate data sets from linguistics, anthropology, geography and archaeology—within virtual reality (VR)—to create interactive information visualizations. These visualizations allow a researcher to explore potential connections within data-sets relating to pre-colonial contact between the Pacific and the continent now known as Australia. It brings together computational and non-computational digital methodologies that utilize the affordances offered by each—within the material space of VR. This then enables a unique layering of data, offering new insights to researchers from a wide spectrum of disciplines. This paper explores how using this combination of computational and non-computational methods can achieve a much more flexible and resilient research tool than what could be achieved by relying exclusively on one or the other.

Our process involves speculative and critical design to imagine an alternate Pacific, in virtual space, where the entanglement (Haraway 2016) between canoe and seabirds is centred. Throughout the design and development of *Layered Horizons* we propose a model for Pacific navigation based on "real world" data. The resulting virtual space encourages a consideration of what "could" be, and more importantly a reconsideration of the framework of investigation.

The Virtual Environment

We being by exploring the computational nature of the built virtual environment. One of the key computational methods utilized in creating *Layered Horizons* is the use of data to compute all of the visuals on the fly, as opposed to relying on a pre-set 3D modelled environment. The virtual environment is rendered during the experience based on a broad range of data read at "runtime." In this way, we can manipulate the environment computationally at the level of the data itself, which becomes vital for the processes we will describe. At the same time this heightened malleability removes an intervening layer of interface and allows for the use of the environment *as* interface, which relies on a user's embodied understanding of their body in space to comprehend the membrane of interaction.

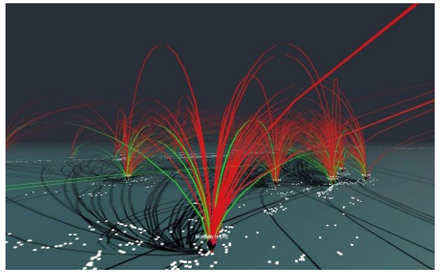

Fig. 1. *Layered Horizons* (Canoe Journeys), 2017-21, Andrew Burrell, Rachel Hendery, Ali Chalmers Braithwaite, VR.

Computational Canoe Journeys

We will then look at the project's integration of computational and non-computation data sets, using data from Laurent Dousset and Anne Di Piazza's simulated canoe journeys between key locations in the Pacific (Di Piazza, Di Piazza and Pearthree 2007) as an example.

A model of the Pacific that takes into account the space/time relationship of the simulated canoe journeys and the relationships between the location of Pacific islands in the environment can be based on the time it might take to move between islands in canoe time, rather than the physical distance between two places. Using these computational methods allows a researcher to "remap" the Pacific, and then on top of this remapping overlay non-computational data, such as a lexical database, which may either provide new insights into complex relationships within the data or help to confirm pre-existing hypothesis of the same.

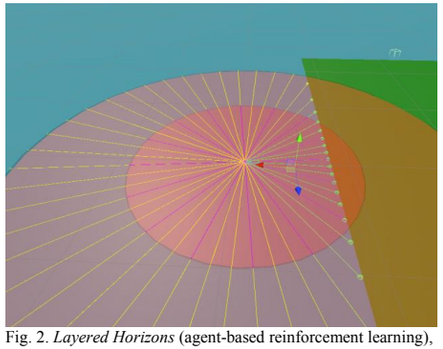

Fig. 2. *Layered Horizons* (agent-based reinforcement learning), 2017-21, Andrew Burrell, Rachel Hendery, Ali Chalmers Braithwaite, virtual environment.

Agent Based Canoe Journeys

We will then describe a new phase of the *Layered Horizons* project, in which we seek to leverage deep reinforcement learning in the Unity game engine using the MLAgents environment (Juliani et. al. 2018). This extends what we have learnt from working with the simulated canoe journeys to combine non-computational data of sea-bird habits and habitats within the Pacific with known information about the use of sea-birds as a navigation aid, to create a model to run agent-based computational simulations of possible navigation paths based on this model. This approach is speculative in nature, using hypothetical simulated geographic possibilities to probe current knowledges. This creative simulation is just one method of approach that enriches other forms of historical research.

Credits

Layered Horizons is a Project by Andrew Burrell, Rachel Hendery and Ali Chalmers Brathwaite. It is an outcome of *Waves of Words* funded by the Australian Research Council (DP180100893) We are grateful for the input of the team: Patrick McConvell, Laurent Dousset, Antoinette Schapper, Michael Falk, Billy McConvell, Matthew Spriggs and Tim Denham.

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Biographies

Andrew Burrell is a Lecturer in Visual Communication at the University of Technology Sydney, with a background in media art and design exploring the narrative potential of virtual environments and computational spaces.

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Copies as Transitional Objects: Loss, Grief and Reckoning after the Fire of Museu Nacional do Rio de Janeiro (Brazil, 2018)

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Abstract

Digital 3D reconstructions are increasingly common practice to restore lost or damaged historical artifacts. Notwithstanding the concerns related to the unequal distribution of power and technology in the contemporary world, such projects also pose questions related to the status of objects as "originals" or "copies." This presentation studies the 3D models produced after the 2018 burning of Museu Nacional. Its main argument is as follows: first, these objects are neither copies nor forgeries, but a third class of objects; namely, they are transitional objects that make possible to mediate loss and grief regarding historical heritage.

September 2nd, 2018. Soon after closing hours, an overheating air conditioner in the Museu Nacional do Rio de Janeiro, Brazil, started a fire that ended up consuming most of the 20 million items in its collection, as well as causing major damage to the historic building that housed it. The fire and the loss of many unique pieces of the collection would be deemed as symbolic of the darker turn Brazil was taking: after years of neglect and diminishing funds for the maintenance of such a central site to Brazilian culture, the incident revealed a nation that was proceeding aimlessly towards the future by stripping itself of its past (Beiguelman 2019).

Immediately after the burning, discussions were held over the fate of Museu Nacional and the prospects of its reconstruction. Many of these discussions proposed the donation of collections from other museums and its reconfiguration as a modern technological museum, not unlike the recently opened Museu do Amanhã (Museum of Tomorrow). Others, such as anthropologist Eduardo Viveiros de Castro (2018), proposed that the Museu Nacional remain in ruins, as memento to the displacement of historical memory in Brazil. Still, besides a restorative nostalgia (Boym 2001), which assumes that the past could be overcome through technological advancement, more subtle framings of the relationship between technology and heritage did not try to overcome the losses, but to intervene upon it.

The foremost example was the initiative led by Laboratório NEXT, at the Catholic University of Rio de Janeiro, together with the National Institute of Technology (INT), to create 3D models of the pieces previously held at the Museu Nacional. This project started in 2009 under the guidance of Professor Jorge Lopes, and aimed to introduce 3D imaging practices initially applied to fetal medicine into heritage studies. The project took a turn after 2018, when the usage of 3D techniques went from prospective research into the restoration practices of heritage. This involved the construction of 3D replicas using the ashes of the actual objects as the material for the soft plaster used in 3D modelling (Lopes et al 2019). Thus, original and copy mingle into something that is neither one of the two, but is also beyond merely a reconstruction of the original. These are, after all, new artifacts made from the raw materials that resulted from the burning of the originals.

These practices are part of a trend of applying 3D imaging and printing techniques to the reconstruction of lost heritage. Most examples focus on the recovery of objects destroyed by ISIS in Syria and Iraq. Although

these practices come with positive and negative traits, specially the incidence of what artist and activist Morehshin Allahyari calls "digital colonialism" (2019), I want to highlight how they trump definitive distinctions between original and copy, authentic and forgery.

Fig.1. Reconstructed face and restored cranium of Luzia, the oldest human remains ever found in Brazil, destroyed at the 2018 fire but remade with the ashes of the original. Photo by Fernando Frazão/Agência Brasil

Copies emerge at the intersection of techniques of representation and technologies of media (Weizman 2013). In this way, the reconstructions made by NEXT at the Museu Nacional are, in fact, a third class of objects besides original and copy. The question has been asked: "how do the concepts of uniqueness and iteration, of authenticity and counterfeit [. . .], change when the binary opposition between 'authentic' vis-à-vis 'copy' no longer appears to be anchored in the distinctive materiality of the sign?" (Neef, Dijck and Ketelaar 2006, 10). These 3D printing techniques supersede the frontier between material and digital, at the same time confirming the copy as a "medium form" (Weizman 2013).

Here, I propose that the troubled materiality of these objects shows that heritage loses its main thrust of conserving authentic artifacts and becomes something else. If heritage studies have long transitioned from a focus on objects to the focus on practices, what does it mean when these practices are mostly—or solely—enabled by technology? What *are* the objects produced by these practices? They are neither original nor copies, but adapting Donald Winnicott's concept, they could be viewed as transitional objects, that is, objects placed to facilitate a process of mourning, of reckoning with a loss.

Thus, if all museum collections are defined not only by what they present, but also by what they don't show, as its objects are remains from another era, these practices demonstrate the coming together of past, present and future to mediate the continued overlapping of presence and absence in museum collections.

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Biography

Pedro Telles da Silveira is a post-doctoral research fellow at Unicamp, with a grant by FAPESP. He studies the relationship between the production of material and visual evidence through technical media and key concepts of historical practice, such as historical sources, authenticity, memory, and heritage.

Becoming-animal in *Everything*: Posthuman Affect in Computer Gameplay

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Abstract

This paper examines the posthuman affect in computer gameplay by drawing on Deleuze and Guattari's idea of "becoming-animal." It does so by looking specifically at *Everything* (2017), an art game developed by artist David OReilly which lets the player transform into different species and objects in the universe, and comparing it with *Animal Crossing: New Horizons* (2020), another videogame famous for its use of animal imagery. Foregrounding the posthuman affect in becoming-animal, this paper provides an example of how to undo anthropocentrism and engage posthuman subjectivity in digital play. This research does not simply look for correspondences between the practice of animal metaphors in computer games and Deleuze and Guattari's becoming-animal, but attempts to see how they might illuminate each other.

Becoming-Animal and Posthuman Affect

This paper explores how computer gameplay can enable a process of "becoming" for the player by engaging with Deleuze and Guattari's idea of "becoming-animal." In the tenth plateau of *A Thousand Plateaus*, Deleuze and Guattari (1987, 237) point out that "[a] becoming is not a correspondence between relations. But neither is it a resemblance, an imitation, or, at the limit, an identification." In other words, becoming-animal is not to imitate an animal or to identify the characteristics of an animal. It should be understood in relation to another key concept of Deleuze and Guattari, the concept of affect. "[A]ffect is not a personal feeling, nor is it a characteristic; it is the effectuation of a power of the pack that throws the self into upheaval and makes it reel" (1987, 240). Becoming-animal, for Deleuze and Guattari, is "the capacity to affect and be affected" (1987, 261), to enter "a zone of proximity" (1987, 273) or "modes of relation" (Braidotti 2013, 170) with the animal. Such becoming-animal can be seen, according to Deleuze and Guattari (1987, 243), in Herman Melville's novel *Moby Dick* in which Captain Ahab has an irresistible tendency to become-whale.

Irving Goh (2009, 42) further interprets becoming-animal as a question "of opening oneself to the sensation of animal affects and responding to them affirmatively, rather than allowing any anthropomorphism or anthropocentrism to block those responses." In resisting the central position of human and humanism and engaging with things outside the humanist and textualist tradition, such as bodies, affects, and animals, Deleuze and Guattari's idea of becoming-animal can be seen as an instance of posthuman affect that seeks to undo human subjectivity and anthropocentrism.

The Turn to Affect in Game Studies

In line with the affective turn in critical theory and cultural criticism, here I will review several strands of research into affect in game studies. Eugénie Shinkle, for example, distinguishes affect and emotion, and posits affect as "a way of describing the 'feel' or intensity of a game" (2005, 22). Shinkle follows Brain Massumi (2002) to conceptualize affect as the intensity of precognitive bodily response. Such affect can be best manifested in videogames that privilege intensity over content such as Sega's musical game *Rez* (2001). As Patricia Clough (2008, 3) mentions, "for Massumi the turn to affect is

about opening the body to its indeterminacy, for example the indeterminacy of autonomic responses." Similarly, for Shinkle, the parallel turn in game studies concerns the opening of the player's body to the intensity and sensation of the game world.

Another example of the discussion of affect in game studies is Aubrey Anable's work *Playing with Feelings* (2018). In this book, Anable takes up American psychologist Silvan Tomkins's theory of affects as a counterpoint to Deleuzian versions of affect theory. According to Anable the Deleuzian versions (i.e., Massumi) understand affect as "what gets bodies out of the grids of signification" (2018 55), whereas Tomkins's theory recognizes the mutual interdependence of affect and cognition, which, in a sense, puts affect back into the signifying structure. In attempting to arrive at an affective account of video games, Anable analyses a specific case of touch in videogame play, namely, the touchscreen. For Anable, screen is "a site of contact between representation and computation" (2018 55): touching the screen is a way of "feeling" the code. This interpretation seems to indicate that the player's affective charge from the game relies on the signification of in-game representation.

These two examples above demonstrate different ways of understanding affect in computer gameplay: the former locates affect in the player's bodily production, the latter in the realm of signification and representation. This paper, however, does not regard the two as opposites, rather it engages the idea of becoming-animal as an example to demonstrate the mutual entailment of the player's bodily response and the process of meaning-making. The animal here should be understood as both the figurative signifier the player is directly engaging with on-screen and the categorical indicator of the nonhuman and posthuman dimension that characterizes digital play.

Becoming-animal in computer gameplay

What does it mean to become-animal in the case of computer games? What kind of posthuman affect does becoming-animal in computer gameplay open up to? How should posthuman affect be understood in relation to the specificity and materiality of computer games? This paper will respond to these questions by looking specifically at *Everything* (2017), an art game developed by artist David OReilly which lets the player transform into different objects in the universe and explore the procedurally generated game world from the perspective of various objects and species. By analyzing the mechanism of this game, unfolding the experience of playing it, and comparing it with *Animal Crossing: New Horizons* (2020), another videogame famous for its use of animal imagery, this paper explores the conditions and possibilities of posthuman affect in digital games and play.

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Biography

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GAN Generated Knitted Pattern Punch Card Designs

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Abstract

Textiles and computation have a lot in common. Early computing was developed, using punch cards from the Jacquard loom (Hollings 2018). This paper explores the use of computational Artificial Intelligence for the design of new knitting punch card patterns using Generative Adversarial Networks (GAN). These designs were ultimately tested on a domestic Brother Kh 836E knitting machine producing physical tactile patterns.

Introduction

Domestic knitting machine punch cards consist of 24 dots wide and varied lengths. These dot patterns act as a binary code. This research uses an AI GAN combine and interoperates a data set of punch card images into new pattern designs, revealing an underlying structure across the sample set of designs.

Historical Context

Knitting is a more recent development than weaving. Originally done by hand with knitting needles, knitting machines developed in the 19th century utilizes a bed of needles, punch cards, and a cartridge to carry the yarns across the rows.

Fair Isle Patterns

Fair Isle knitting patterns use only two colours in a row, and consist of small repetitive decorative patterns. While one colour is active the other floats in the back of the fabric. For successful Fair Isle patterns, floats should be less than five stitches long. Patterns consist of geometric, organic, and object based designs.

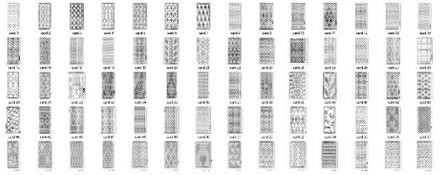

Fig. 1. *Sample Portion of the Data Set*, 2020, Virginia Melnyk.

Computation

Neural Networks (NN) act similar to how human brains learn. Layers of neurons or nodes categorize pattern information. GANs use both a generator and a decimator network to test the validity of a produced image.

The Data Set

The data set for this exploration was scraped from google images; resulting in 121 quality pattern images (See Figure 1). To create a broader data set, the images were cropped into multiple square images and some were mirrored. This resulted in total of about 1200 images.

AI Knits

In this research, Neural Style Transfer (NST) and StyleGAN2 were used within Runway ML software.

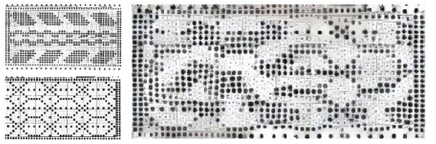

Fig. 2. *NST Punch Card,* 2020, Virginia Melnyk.

Neural Style Transfer

NST uses two images, a style image and a structure image. The results were successful, as you could see the underlying structure and the style pattern working together in the resulting punch card pattern image (See Figure 2).

StyleGAN2

For StyleGAN2 the larger data set of cropped images was used to train. Several tests were run at different epochs. The 1500 epoch run produced the best results for clear unique punch cards. The resulting square images were combined to create a longer punch card proportioned pattern (See Fig. 3).

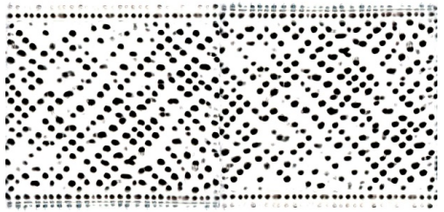

Fig. 3. *StyleGAN2 Punch Card,* 2020, Virginia Melnyk.

The Results

The punch card images generated were then used to knit physical tests in different materials and colors, to explore the robustness and tactility of the designs.

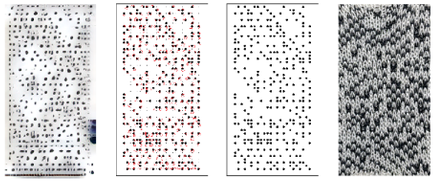

Fig. 4. *Punch Card Process,* 2020, Virginia Melnyk.

Creating the Punch Cards

The resulting punch card, images were not precise dot matrixes to be able to directly use as punch cards. Parametric software, Grasshopper for Rhino, was used to refine the circles and restructure them onto the ordered grids (See Fig. 4). These were then laser cut out of thick Mylarfilm.

Resulting Knits

The physical results generated patterns were successful Fair Isle designs. They used two colors and had floats lasting no more than 5 stitches. The patterns appear stochastic at first glance but upon longer inspection they had underlying repetition such as diagonals, checks, and vertical stripes (See Figure 5). The use of different yarns produced varying textures.

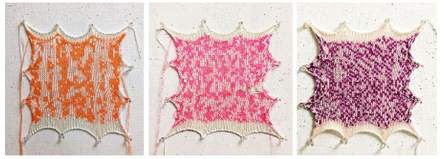

Fig. 5. *Knitted patterns,* 2020, Virginia Melnyk.

Conclusion

The exploration of knit pattern design does successfully produce new patterns that follow the underlying structure of Fair Isle knits. These new patterns reconfigure and recombine the many styles and cultures of the patterns from the data set. Throughout the process of production, human and machine collaboration is utilized as a back and forth relationship. Perhaps these textiles generate a new AI aesthetic reflecting the mixing pot of contemporary digital culture.

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Biography

Viginia Melnyk is currently a PhD student at Tongji University's DigitalFUTURES International PhD program. She explores temporary, textile, and transformative structures, focussing on knitted textiles as an intelligent material and designing within the pattern and material structure. She has exhibited work from Beijing to Toronto, Boston, Cincinnati, and Buffalo. She currently is also a lecturer at Clemson University.

Cognitive Assemblages: Spatial Generation Through Wave Function Collapse and Reinforcement Learning

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Abstract

This research explores the integration of AI in an iterative decision process for the open-ended procedural generation of architectural spaces. Leveraging on state-of-the-art Deep Reinforcement Learning techniques, an Artificial Neural Network (ANN) is trained to perform local decisions selecting *tiles* in a Wave Function Collapse (WFC) algorithm, assembling discrete elements that build up a complex spatial organization, pursuing selected spatial qualities at the architectural scale.

Introduction

Numerous current applications of AI for spatial generation, aim to generate complete, self-sufficient results, producing images, be they plans or pictures, out of other images or language. These applications leverage on a traditional idea of conception, where the added value of the outcome mostly comes from the human interpretation rather than its intrinsic qualities. Instead, we challenge our way of conceiving instruments and authorship, binding reinforcement learning to a distributed network of decisions.

The act of thinking is here envisioned as diffused, granular and embedded in an ecology of cognitions capable of extending and reshaping our mental territory (Clark 2008). Our approach addresses liberated tools, no longer intended as reflections of their users' minds, nor poised to parrot human thinking (Picon 2016). Entities capable of privileging certain directions while resisting others, developing their own bias and sensibility while controlling articulated and specific spatial conditions that result from an iterative assemblage of 3D, space-containing, parts (Parisi 2014).

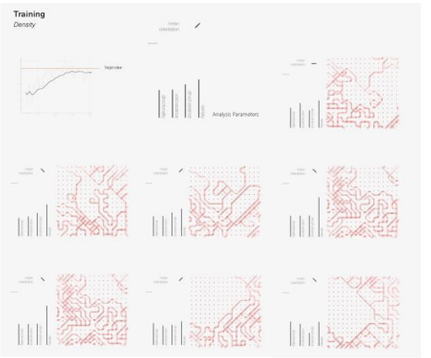

Fig. 1. *Cognitive Assemblages*, 2020, Alessandro Mintrone, 2D training results.

Wave Function Collapse

WFC is a constraint solving algorithm that iteratively places discrete components called *tiles* in a predetermined grid according to their connectivity rules. It is widely employed both in 2D and 3D procedural content generation.

Aiming at the generation of three-dimensional spatial assemblages, given a limited set of parts and their local connectivity rules, this combinatorial process can unravel a vast array of unique, yet similarly structured, spatial patterns (Gumin 2016). Implemented in Unity3D, the algorithm is intended both as a platform for generating and exploring a large field of possible assemblages, and as training environment for the ANN. In fact, its discretized representation of space makes iterative assemblage generation approachable with Machine Learning techniques. Each element,

while not constituting a self-contained spatial unit, when combined with other components, defines boundaries and reinforces possible paths, structuring an otherwise amorphous space. It is from the growing network of relationships among elements that a spatial organization emerges, and the assemblage takes on its identifying patterns and structures.

Proximal Policy Optimization

Relying on a Proximal Policy Optimization reinforcement learning algorithm, an ANN is trained to control tile placement at each iteration, replacing the weighted random choice used in the standard WFC algorithm (Schulman *et al.* 2020). The system gains the ability to steer the assemblage, articulating the highly homogenous spaces generated by WFC, by discovering non-linear correlations between its local decision and their outcomes at the global scale. It has proved sufficiently general and capable of operating in both 2D and 3D with different sets of *tiles*, while maintaining the same architecture and hyper-parameters. It shapes its behaviours not by relying on a dataset of examples to imitate, but learning from experience, continuously confronting the environment, and trying to maximize the rewards awarded after its actions (Juliani et. al. 2020). Six quantified descriptors are defined for local and global spatial qualities: density, material distribution, prevalent orientation, structural connectivity, spatial connectivity and planar connectivity. Their use is twofold, they provide continuous feedback characterizing the spatial conditions of the assemblage, while they are employed for assigning the rewards by comparing their values with defined goals.

Exploring different behaviours, the agent hones its own sensibility, developing strategies to generate diversified spatial conditions. Varying the goals and their relative weight, the AI is able to learn generalized internal representation of the possible outcomes. The AI develops an understanding of complex spatial qualities closer to human representation. In this unending dialogue, the designer and the algorithm are connected in a feedback loop, a novel state of engagement in which human and non-human cognitions continuously negotiate both their agency and authorial status, unfolding consequences potentially exceeding human or machinic reach alone.

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Biographies

Alessandro Mintrone works with computational design, art, architecture, and engineering, exploring the porous zone between, artificial cognition, simulation and machinic fabrication.

Alessio Erioli is University of Bologna Professore Aggregato (Teaching Professor), co-founder and designer at Co-de-iT. He researches the aesthetics and tectonics that emerge as a consequence of computation (in architecture and related fields), focusing on intelligence in the design process. He is also skilled in computational design, programming & modelling.

Buttonless Cameras and the Machine-made Snapshot Aesthetic

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Abstract

Snapshots have a firm place in the history of photography, as they are the most prolific form of photographic expression (Batchen 2000; Chalfen 1987; Chéroux 2013). However, due to its long history, abundance, and diversity, the snapshot has never comprised a unified and cohesive photographic genre. Instead, the conception of a snapshot encompasses various photographs, and it is rife with ambiguity and paradoxes (Batchen 2004; Zuromskis 2013). Snapshots can be candid or posed, conventional or subversive, banal or affective, intentional or accidental, innocent or ideological, spontaneous or controlled.

Despite these paradoxes and heterogeneity, the snapshot is defined by its specific aesthetic, which was recognised in the 1960s by artists appropriating the snapshot to authentically capture and represent the banalities of everyday life (Higgins 2013; Nanoru and Kosarova 2014; Kelsey 2015; Zuromskis 2013). The loss of control over photography defines the snapshot aesthetic. The snapshot is the domain of chance, accident, and various kinds of flaws and errors: image noise, blurriness, improper exposures, red eyes, fingers inadvertently placed in front of the lens, severed heads, lens flares, leaky shutters, chemical flukes, and mechanical scratches. The snapshot aesthetic is an aesthetic of imperfection; snapshot photographs have always been disordered, inadvertent (Geimer 2018), failed (van Alphen 2018; Chéroux 2003), and poor (Steyerl 2009) images.

However, several recent technological advancements have disrupted "traditional" snapshot practices (Campt et al. 2020; Gómez Cruz and Lehmuskallio 2016; Larsen and Sandbye 2014) and transformed the defining features of snapshot aesthetics. In this regard, the present paper addresses the changing socio-technical conditions of snapshot photography brought about by emerging visual technologies designed to replace human camera operators with non-human operators and automated vision (Dvořák and Parikka 2021; Farocki 2004; Hoelzl and Marie 2015; McCosker and Wilken 2020; Paglen 2014; Toister 2019; Zylinska 2017). The paper traces the history of the snapshot aesthetic, concentrating on the development and transformations of the camera's shutter button (Plotnick 2018) and the photographic gesture (Flusser 2012) in the context of recently introduced cameras not designed for the press-the-button gesture but rather for a variety of set-and-forget operations. Considering examples of autonomous and sensor-operated cameras, AI cameras operated by algorithms, and smart home camera systems, the paper demonstrates the transformative influence of emerging buttonless cameras on the snapshot aesthetic and on the conception of photography as a human-centred practice.

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Biography

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The Next Biennial Should be Curated by a Machine
Machine Curation and Visitor Interaction Liverpool Biennial 2021

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Abstract

The presentation considers the relationship between curating and Artificial Intelligence, and specifically the application of machine learning techniques to curating large scale periodic contemporary art exhibitions, such as biennials. This proposition is at the core of a research project developed by Prof Krysa and Dr Impett that takes the 11th edition of Liverpool Biennial (2021) as a starting point to reimagine curating as a self-learning human-machine system.

Project Description

Making reference to the e-flux project 'The Next Documenta Should Be Curated by an Artist' (e-flux 2003), which questioned the structures of the art world and the position of curators within it, this project extends the question to machines (Krysa 2014, 38-89). It asks how the counterpoint of automata might offer alien perspectives on conventional curatorial practices and curatorial knowledge. What would the next Biennial be like if machines intervened in the curatorial process, and helped to make sense of vast amounts of art world data that far exceeds the productive capacity of the human curator alone?

The research project starts with an exercise in generating a machine curated online version of the current edition of Liverpool Biennial 2021 running in parallel to the biennial exhibition curated by Manuela Moscoso, presented in multiple physical venues across Liverpool.

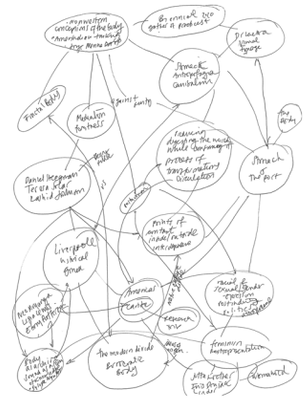

Fig. 1. Curatorial Sketch for Liverpool Biennial 2021 (2019), by Manuela Moscoso. Courtesy of Manuela Moscoso and the Liverpool Biennial.

Entitled "AI-TNB," the curatorial system is an experiment in interaction through large datasets, using computer vision and natural language processing techniques with a focus on human-machine co-authorship, and it explores some of the issues arising from this (Crawford and Joler 2018; Impett 2021). In doing so, the project takes machine learning algorithms, beyond the "search engine" paradigm in which they have been mostly used to date (Noble 2018), and instead considers them to be curatorial agents, working alongside human curators. Furthermore, the research explores an aspect of audience interaction as a form of co-curation (Krysa, Impett 2021).

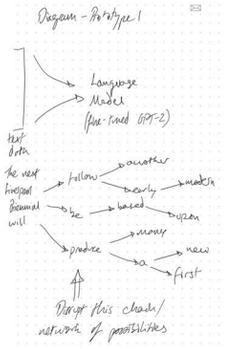

Fig. 2. Diagram for glitching decision trees of parallel text-hypotheses, 2020, Leonardo Impett, drawing. Courtesy of Leonardo Impett.

There are a number of issues arising from this, such as the degree to which creativity is compromised by the "intelligent" machines we use, as well as how biases become reinforced (Noble 2018). Algorithms are biased because certain elements of a dataset are more heavily weighted, and once a system is trained on this data, further errors follow that broadly reflect inherent human biases in society. Can something similar be said of the art world, where one might imagine there to be a shared "dataset" of artists and curators that reflect biases inherent to the art world? If this seems far too simplistic, it becomes more interesting once these two operating systems are correlated, and when they become entangled, and to speculate on what each might learn from the other. It is not just a case of identifying concerns—such as around inclusion of marginalised communities or worries about the forms of creativity produced through AI—but also an opportunity to think about the transformation of human-machine relations and curatorial practices.

In undertaking this experiment, the intention is to explore the application of machine learning algorithms to envisage alternative forms of exhibition-making and curatorial agency that dissolves hard distinctions between humans and machines.

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Biographies

Joasia Krysa is curator and Professor of Exhibition Research and Head of Art and Design at Liverpool John Moores University/ Liverpool Biennial. Her research is located across contemporary art, curating and computational culture. Formerly, she served as Artistic Director of Kunsthal Aarhus, Denmark; co-curator of Documenta 13 and Liverpool Biennial 2016, and curatorial advisor for Helsinki Biennial 2021.

Leonardo Impett is Assistant Professor of Computer Science at Durham University, working at the intersection of computer vision and art history. Previously Scientist at the Bibliotheca Hertziana – Max Planck Institute for Art History, DH Fellow at Villa I Tatti - Harvard University Center for Italian Renaissance Studies, he is an Associate of Cambridge University Digital Humanities, and Associate Fellow of the Zurich Center for Digital Visual Studies.

Decolonising AI: A Close Look at the Work of Stephanie Dinkins

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Abstract

This paper focuses on Stephanie Dinkins' *Conversations with BINA48* and *Not the Only One*, two works of media art that evoke questions about human-robot relationships, the relationship between race and artificial intelligence systems, and the need to challenge conventional approaches to developing and engaging with emerging technologies. By referring to works by scholars of race and technology, the paper understands Dinkins' work as an attempt to draw attention to and seek to overcome the inequality and disparity in the technology industry. It reads Dinkins' work as an attempt at the decolonization of technology.

About the Works

Dinkins' *Conversations with BINA48* is an ongoing series of interactions between Dinkins and a robot, BINA48, that are video recorded and exhibited publicly from time to time. BINA48 and Dinkins have had conversations on "family, racism, faith, robot civil rights, loneliness, knowledge and robot rights" (Dinkins 2019). Dinkins is also interested in examining whether it is possible for a robot and a human being to cultivate a long-term relationship, and what that relationship may look like. This project began in 2014 and is still ongoing. *Not the Only One* is "the multigenerational memoir of one black American family told from the 'mind' of an artificial intelligence with evolving intellect." The name harks back to BINA48, implying that BINA48 is not the only black AI anymore. This "voice-interactive AI" is "designed, trained, and aligned with the needs and ideals of black and brown people who are drastically underrepresented in the tech sector." The data for this deep-learning algorithm is collected from subjects who are currently living. Although the AI speaks in its own voice, its "mind" contains the memory of three generations of the same family. The project, according to Dinkins, "will be repeatable and present perpetually dynamic conversation, scenarios, and stories that change according to the user's questions or the AI's mood. Over time, user input (discussion) will influence the NTOO's storytelling abilities because the AI's database of available vocabulary and topics will grow with each user interaction" (Dinkins 2019).

Dinkins' Methods for Decolonising A.I.

This paper proposes to dissect the methods Dinkins uses to propose a decolonial A.I. Dinkins' work also evokes possibilities of exploration in Africana phenomenology, a branch of Africana philosophy that draws from the works of B. Du Bois, Frantz Fanon, Sylvia Wynter, Lewis Gordon, and Charles Ephraim, which comprises the "self-reflective descriptions of the constituting activities of the consciousness of Africana peoples" (Henry 79). Studying a distinctively black AI created with a methodology of decolonization may also offer new ways of looking at human-technology relations, leading to the creation of an Africana postphenomenological practice.

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Biography

Proiti Seal Acharya is a media arts researcher primarily interested in South Asian media art and digital cultures. She is also interested in the work of artists and institutions that attempt to employ decolonial methods within the scope of their practices, proposing alternate technologies and ways of dissemination. She is currently building a publicly accessible online archive of South Asian art, which she hopes will reflect these values and motivation.

Self:Nous:Space
Visual and Textual Metaphors of Digital Experience

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Abstract

In this presentation digital experience is explored though a series of visual and textual spatial constructs and conceptual projects that reflect on the noetic qualities emergent in the interstitial area between the self and the mediated environment. This exploration takes the form of creative writings, audiovisual abstracts, chatbot interviews, exercises of verbal configurations, visual poetics, interactive game-poems and other pieces of artistic work produced individually or in research and educational contexts.

Theoretical Context

Early cyberspatial theories reflected on the qualities of computer mediated experience by introducing aspects of immateriality, incorporeality, symbolism, abstraction, as well as exploring the mental, perceptual, and psychological dimensions of digital experience itself. Electronic interactions have been described as platonically erotic, transcendental, allegorical, even ecstatic conditions, that still seem timely and compelling nowadays. The human mind appeared as an inherent ingredient of the digital phenomenon since its birth. On the other side, ideas such as “body amnesia” or “fleshworld,” emerged denoting the rigidity of the physical body in reaching the other side of the screen.

The pandemic era has brought to light an obsessive and sometimes erratic celebration of these underlying qualities of our relation to technology. These days, the superfluous, excessive, sometimes obsessive use of digital technology, pervasive software as well as the internet of things have surpassed the Cartesian mind-body dualism and have given rise to novel hybrid approaches of our contemporary relation to technology. Hybridity has created space for intertextual interpretations of experience, that do not divide the notion of mind and body, but comment on the complex interactions of self with digital culture, through numerous differentiated contexts, evolving cyborg ontologies, concepts of alternate bodies, transformative personas, altered non-lingual languages, all rendered through a daily mediated reality.

Digital Spatialities

The presentation explores the ever present mind-body conundrum, through a quest in digital spatiality. Digital experience has always been inseparable from the metaphoric use of spatial concepts. At the same time, textual space constitutes an allegorical or symbolic construction with its own architecture, ambience, and other characteristics. Space not only relates to a strict conception of geometry, physics, or mathematics, but also to an anthropological reading of existence, a quality that is often elusive and immeasurable. Thus it helps describe abstract, psychological, experiential phenomena, or in other words, that which seems indefinable.

In this context, the self assumes a mental form, while space is interpreted as a metaphoric, volatile construction whose literary aesthetics emerge from digital culture. The idea of digital experience is approached through a series of visual and textual-spatial concepts and projects that reflect on noetic space that is constructed in the interstitial area between the self and the mediated environment. This

exploration takes the form of creative writings, chatbot interviews, exercises of verbal configurations, visual poetics, interactive game-poems and other abstracts of writing in both artistic and educational contexts. The overall idea of the digital mind-body interpretation takes the form of a series of mental spatialities that comment on our contemporary way of being in the digital world.

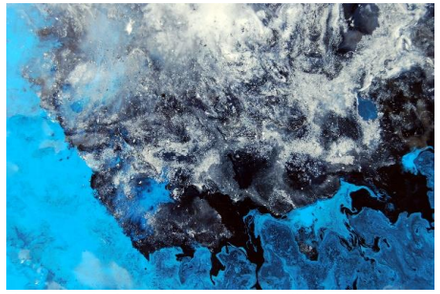

Fig. 1. *Breath of Technology*, 2020, Angeliki Malakasioti, action-painting by drones, Copyright: Angeliki Malakasioti.

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Biography

Angeliki Malakasioti is an interdisciplinary artist, researcher, and Assistant Professor at the Department of Audio and Visual Arts, Ionian University. She studied architecture in the Department of Architecture, Aristotle University of Thessaloniki and at the Bartlett School of Architecture, UCL. Her doctoral thesis, "Anatomy of the Digital Body—Spatial Aspects of the Self and the Immaterial on the Web" was awarded honors and she has recently completed post-doctoral research on the "Architecture of Melancholy—the Case of Video Games." Her research focuses on the fields of cyberspatial experience, spaces of the mind, new technologies and digital media, audiovisual representations, speculative design and creative methodologies, and digital culture. Widely published and exhibited, she has received prizes for experimental film making, photography and "art as research" activities.

Alphaville: Our Future City of Digital Surveillance

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Introduction

"Reality is too complex. What it needs is fiction to make it real," recites the Computer at the beginning of *Alphaville* (1965). Jean-Luc Godard foresees and invents *Alphaville* as a totalitarian city-state governed by a pseudo-human Computer called Alpha 60, the supreme power of Artificial Intelligence. Secret agent Lemmy Caution comes to *Alphaville* with the impossible mission of taking down its highest leader.

Made on a low budget and devoid of flashy effects or futuristic sets, *Alphaville* is a science fiction film without special effects. Godard's visionary science-fiction noir is a triumph of the imaginative power of cinema to penetrate the human condition under technocracy and totalitarianism. The cinematography creates nightmarish sights and sounds, at once fantastic and realistic, which transform the nocturnal streets and modernist architecture of Paris into a surreal black-and-while dystopia, projected as shimmering mirages of our lived realities. Godard describes *Alphaville* as "a fable on a realistic ground." His film both exaggerates and redeems reality. The dystopic film is unequivocally a cry of protest against the worshippers of science and logic as well as against any form of tyranny or law imposed upon the free will of humans.

"Do you know what illuminates the night?" Alpha 60 asks Caution. "La poèsie," the protagonist replies. Poetry, in the sense of the ancient Greek meaning of poiesis, is human creativity, imagination, and expression. *Alphaville* is Godard's resounding declaration on the poetry of cinema and the poetry of love. Toward the end of his failed mission, Caution flees the city with Natasha, the daughter of the scientist who designed Alpha 60.

Alphaville has never seemed more timely — our world today is very much closer to the director's creation than it was back in 1965. Will AI rule our technological world or even aid the authoritarian regime? Can Poetry—in the ancient Greek language of *poiesis* to denote creativity, imagination, and human affectivity — save our world from AI/the computer's logic and its semantic control of human consciousness? Is there a flickering hope of optimism and humanism in the age of digital surveillance and authoritarian governance?

Cinema Counter Reality

Alphaville presciently anticipates a future in which humans are dominated by the technocratic state, administered and managed by a prevailing computerized network. Earlier cinematic representations of dehumanizing machine-worker relationships can be traced to Fritz Lang's *Metropolis* (1927) and Charles Chaplin's *Modern Times* (1936). Coming out in the mid-1960s, Godard's film seems to have echoed Herbert Marcuse's argument in *One-Dimensional Man* (1964). The Frankfurt School Marxist philosopher criticizes Soviet-style dictatorships as much as he bemoans Western capitalist societies characterized by an increased technological development that creates false needs to indoctrinate individuals into the existing system of production and consumption via mass media and technological management.

Tarzan versus IBM

Godard's working title for *Alphaville*, "Tarzan vs. IBM," points to the uphill battle between human and computer, the latter acting increasingly as an alternative proxy for the human brain in anticipation of modern-day

Artificial Intelligence (A.I.). The famous British computing pioneer Alan Turing, in his 1951 lecture entitled "Intelligent Machinery: A Heretical Theory," prophesized that "machines can be constructed which will simulate the behavior of the human mind very closely." Turing predicted that as soon as the "machine thinking method" had started, the machines would be able to converse with each other to sharpen their wits. And it would not take long for the machines to "outstrip our feeble powers." Turing warned that someday "we should have to expect the machines to take control." He believed by the year 2000, people would accept the idea of A.I. in that we will be able to speak of machines thinking without expecting to be contradicted.

Will Our World Become a Global Alphaville?

Will AI rule our world or even aid the authoritarian regime? Is there a flickering hope of optimism and humanism in the age of digital surveillance and governance? Godard's visionary sci-fi noir enables us to ponder the ethics and politics of AI in the age of science elitism, authoritarianism, and digital humanities.

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Biography

Kenny Ng is an Associate Professor at the Academy of Film, Hong Kong Baptist University. He obtained his PhD from Harvard University, East Asian Languages and Civilizations. He teaches film art and visual culture, transmedia adaptation, transnational cinema and Hong Kong film history. His research interests are broad in the areas of politics and visuality, film censorship and social surveillance, Cold War culture, cultural memory, and comparative literature, including writings on Chinese utopian novels and HKSAR dystopian science fictions. He has published numerous articles and a book on historical fiction and cultural geography, co-authored a book on Hong Kong independent cinema, and is currently working on two monographs on Cold War cinema and left-wing cosmopolitanism. An engaged cultural critic, he is one of the curators of the retrospective of futuristic cinema, "Critics' Choice 2020—The Future is Now," hosted by the Hong Kong Film Critics Society in November 2020.

Machine Learning Writing Tools as Oracle and Glitch

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Abstract

In dialogue with posthuman thought and its theorization of the symbiosis between humans, machines, and nature, this presentation explores predictive and participatory machine learning (ML) writing tools that expand the possibilities of narrative development and fabulation (Deleuze 2013).

Digital Muse

The association of authenticity and originality with authorship is framed by the Enlightenment Humanist definition of subjectivity as a unitary identity. In contrast, posthumanism (Braidotti 2019; Haraway 1991) reconstitutes what it means to be human and alive today by overcoming the universalist and hierarchical order of anthropocentrism. Digital writing tools powered by machine-learning-based language models, such as Open AI's Generative Pre-trained Transformer (GPT) foster timely discussions about "nonconscious cognition" (Hayles 2017).

Recent experimental apps created by Google's Creative Lab that feed data into GPT-2 allow authors and creators to take a walk or conduct a conversation in the real world with their characters. In what ways are these place-based immersive fictional experiences and interactive interfaces largely modeled on videogames reshaping the creative process? Users of ML writing tools often remark on seeking inspiration from the "oracular" (Coleman 2020) language generated. Can defamiliarized sentences serve as transformative glitches (Russell 2020) that in turn engender new relations that empower?

Desiring Machines

If predictive-text tools are supported by a huge corpus of existing writings, can chance and randomness still disrupt linguistic and cultural conventions, thereby destabilising historically imposed limits on the language of the body and consciousness? In the current interregnum, can text-generating AI be an engine of counter-conduct (Foucault 2007)? Or are these technical systems increasingly cognizing on our behalf, thereby confining us to the limited present? Situated at the convergence of philosophy, science, and art (Deleuze and Guattari 1994), this paper is part of a research and (un)creative writing (Goldsmith 2011) project about the dynamics of agency, simulation, and embodiment in digital storytelling (Murray 2017).

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Biography

Carolyn Lau is Postdoctoral Fellow in the Department of English at the Chinese University of Hong Kong. She teaches and researches on posthumanism, critical theory, science fiction literature and film, and twentieth- and twenty-first century British and American fiction.

I Believe In AI's Artistic Ability: Perceived Creativity of Machines and the Evaluation of Their Artistic Performance

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Abstract

Two studies were conducted to see what variables influence the evaluation of artistic performances of AI, music composing and painting. While two studies focused on different factors, they both found that public acceptance of creative AI played a crucial role. Implications of the findings for application and theory are discussed.

Machines and Art

There has been consistent effort to create machines with artistic performance. The endeavour to develop AI musicians started even before the term "artificial intelligence" was familiar to the public (Roads 1980; Roads 1985). There are now multiple tech companies that provide music created by AI composers. Similarly, there are already many visual art products made either by or with AI technology, such as Google's DeepDream project. We should now shift our focus and discuss how people see those machines' artistic performances. This has not been done enough.

There are now growing attempts to measure the subjective appreciation of art (Lindell and Mueller 2011). Measuring artistic appreciation can help find factors that influence the evaluation of machine-created artwork, which in turn can help create AI artists that perform in ways that people prefer. However, do the attributes of AI artists matter to the assessment of their performance? What about people's attitudes toward machine's creativity?

Evaluating Machine-Created Art

Multiple studies have examined how people react to machine-created art (Hong and Curran 2019; Hong et al. 2020). Chamberlain et al. (2017) conducted an experiment and found that participants held biases toward computer-generated art, though this bias was reverted when researchers showed them the humanlike aspects of the AI artist. Based on the previous studies, it can be argued that people's attitudes and bias toward machine's creativity are assumed to be a crucial component when it comes to assessing machine-created artwork. There are two recent studies to confirm the argument.

Recent Studies about Machine-Created Art

Experiments with different types of machine-created art, painting and music, were conducted to see how people evaluate them.

Painting

The first study examines how people evaluate artwork created by AI and how an artist's identity (Human vs. AI) affects individuals' evaluation of art. Drawing on Schema theory and Computers Are Social Actors (CASA), this study used an experiment controlling the identity of the artist (AI vs. Human) and types of artwork (AI-created vs. Human-created). After seeing images of six artwork created by either AI or human artists, participants (n=288) assessed their artistic value using a validated scale commonly accepted by art professionals.

The study found that human-created artwork and AI-created artwork were not judged to be equivalent in their artistic value. While the artists' identity—either AI or human—did not influence the assessment of artistic value, having a belief that AI cannot make art led to a negative assessment of AI-created artwork.

Music

The second study uses an experiment to test evaluations of machine-composed music. Three parameters were examined: the met or unmet expectations about AI-composed music; whether the music is better or worse than expected; and the genre of music. A 2 (expectancy violation vs. confirmation) x 2 (positive vs. negative evaluation) x 2 (electronic dance music vs. classical) research design was applied. Researchers also examined the relationship between attitudes toward machine creativity and music evaluation. Participants (n=299) in an online survey listened to a randomly assigned AI-composed music piece and evaluated it.

The acceptance of creative AI led to higher ratings of AI-composed music. A two-way interaction between the expectancy violation and its valence, and a three-way interaction between the expectancy violation, its valence, and music genre were also found.

Machine Creativity Perceptions

Findings from the two studies above demonstrate the relationship between machine creativity perception and assessing AI-created artwork. People with more positive attitudes toward machine creativity tended to give higher ratings to artwork created by machines. In other words, the evaluation of machine-created artwork may be a representation of bias toward machine creativity. In order for the creative output of machines to be appreciated, people must first be persuaded that machines can be autonomously creative.

The recent AI technology achieved the level where people cannot distinguish AI-created paintings from human-created ones (Chamberlain et al. 2017). If people still prefer human being's art performance over a machine's performance, it is highly likely due to their bias toward creative machines. There is still a reluctance towards endowing machines with creativity. Even though it is found from those studies that acknowledging machines as artists plays a crucial role, what leads to the acceptance of this idea has not been studied enough. In order to advance the field of machine-made art, this paper urges future studies to investigate the elements that influence people to have positive attitudes toward machine creativity.

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Biography

Joo-Wha Hong is a Ph.D. student at the Annenberg School for Communication and Journalism at the University of Southern California. His research interests have included the cognitive and psychological attributes in Human-computer interaction, particularly AI.

01_LOVE

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Abstract

This paper focus on artists' responses to the emergence of dating app. How gamification of matchmaking, anonymity, and visual-based self-presentation therein allow users to constantly indulge themselves in the next possible match, the perception of dating and love is slowly shaped into a game design to feed algorithm with our own desire and insecurity in today's precarious society.

Is it easier for us now to find love because technology provides a great number of opportunities for us to meet people? Or is the concept of love changing faster due to the development of technology?

Main Topics

- Risk Management in Love
- The Third Wheel in Every Modern Relationship: Surveillance Capitalism
- The Feminine Image of Sex Bots, Queer Love, and Intimate Relationship across Species in the Future
- Digitalization of Love Perception

Fig. 1. *Thalassophilia*, 2020, Ni HAO, Light Box, Sculpture Installation, ©NI HAO.

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Biographies

Yen-Yi Lee lives and works in Taipei, Taiwan. Lee's curatorial research focuses on the construction of failure, digital wasteland and new form of trust relationship. Her curatorial practices are oftentimes intimately associated with electronic music and party scenes. With her curatorial concepts at the core for inspiration, she bestows different forms of understanding toward the concepts upon visitors via selection of music genres and party planning, while proactively facilitating the material happening of crossover collaboration. She is the founder and chief editor of digital publication, *HAGAI HUAKAI*, Co-curator of 2020 Taipei Digital Art Festival, *01_LOVE*.

Hsiangwen Chen is a curator with a background in art history and art critique, Chen Hsiang-Wen serves as the Art Director at Digital Art Center, Taipei, with research focuses on moving images and an array of new media art. Chen is a heavy user of cellphone, an addict to the Internet, and a cat fancier. Her recent curatorial works include "Letter, Callus, Post-War" (2019, Indonesia, Yogyakarta/Taiwan, Taipei), Expanded Experimental Animation Festival IV (2019, Taiwan, Taipei).

Evaluation of AI Reverberation on Guitar

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Abstract

Artificial intelligence (AI) technology has been applied to create a range of different sound effects. However, perceptual evaluations of such applications have not yet been fully explored in research studies. This paper focuses on reverberation and we report results from objective measurements and perceptual listening tests in two stages (N=10, N=32). Participants rated samples of solo guitar phrases, taken from a musical context, and processed by either an AI software or by a professional sound engineer. The analysis aims to predict the salient modifications made to reverberation by AI and humans. This study contributes to our understanding of AI in studio music production. Future work will expand to other audio effects, such as compression and equalization.

Introduction

As AI technology is applied in sound effects plug-ins, machines start to undertake part of sound work. However, existing publications that refer to evaluation on these emerging intelligent tools are missing. Therefore, our research project aims to compare sound effects made by AI and human sound engineers. In this paper, we focus on reverberation. Previous studies have explored perception of reverberation effects e.g. amount of reverberation and early decay time (De Man et al. 2017). However, there appears to be no previous study into the perceptual effects of AI-based reverberation.

In this connection, in order to deepen the understanding of AI audio effects, evaluations should be conducted based on musical features and perceptual listening tests.

Testing Task

In the present study, we concentrate on reverberation and guitars. We selected six samples from our own recordings and a free online mixing resource (Senior 2011) regarding electric and acoustic guitars, in each case containing a musical phrase with a duration of 15 to 20 seconds. From each sample we generated three versions: one with reverberation added by the *smart:reverb* processor (Sonible 2020); one with reverberation added by a trained sound engineer; and one without any reverb, i.e. the original. This constitutes the set of 18 stimuli used in the study. We directly obtain the AI-version, automatically generated by the Sonible plugin. The human engineers were required to manipulate the samples using only reverberation plugins that they were familiar with through commonly available software (such as Pro Tools). They were not allowed to edit the samples or use any other audio effects. Followingly, the 18 stimuli (6 samples x 3 versions) were explored through objective measurements and perceptual listening evaluations.

Objective Evaluation

Objective measurements were carried out using the MIR Toolbox (Lartillot et al. 2008), extracting several features including RMS, brightness, centroid, mirolloff, decaytime, and mel frequency cepstral coefficients (MFCC). For an explanation of these features, see the reference above. Objective characteristics extracted from the audio signals were compared, and differences in parameters between musical versions were observed. Through a selection process, the features entered a regression model as predictors.

Subjective Evaluation

First, we conducted an initial online experiment (N=10) using QuestionPro presented in Chinese language. Participants evaluated the perceived reverberation of the 18 stimuli, presented in randomised order in a repeated-measures design. Each was evaluated on 15 semantic rating scales (cf. Pulkki and Karjalainen 2014, 353), labelled 混响量 (*hùnxiǎngliàng*, "reverb amount"), 温暖感 (*wēnnuǎngǎn*, "warmth"), 明亮感 (*míngliànggǎn*, "brightness"), 粗糙感 (*cū cāogǎn*, "roughness"), 空气感 (*kōngqìgǎn,* "airiness"), 甜美感 (*tiánměigǎn*, "sweetness"), 纵深感 (*zòngshēngǎn*, "depth"), 尖锐感 (*jiānruìgǎn*, "harshness"), 喜爱度 (xǐàidù, "likeability"), 清晰度 (*qīngxīdù*, "clarity"), 混响尾巴长度 (*hùnxiǎngwěibāchángdù*, "length of reverb tail"), 湿度 (shīdù, "wetness"), 距离感 (*jùlígǎn*, "distance"), 厚度感 (*hòudùgǎn*, "thickness"), and 扩散感 (*kuòsàngǎn*, "diffusion").

We reduced the 15 scales into two orthogonal dimensions using PCA (Principal Component Analysis), spanned by four constructs, labelled 清晰度 (*qīngxīdù*, "clarity"), 湿度 (shīdù, "wetness"), 扩散感 (*kuòsàngǎn*, "diffusion") and 温暖感 (*wēnnuǎngǎn*, "warmth"). We then conducted an online experiment (N=32) as described above, this time using only these four semantic scales. The subjective measurements (i.e. perceptual experiment tasks) will be added as predictors to an enlarged regression model. Statistical analysis is ongoing at the time of abstract submission and more results will be presented at the conference.

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Biographies

Manni Chen is a currently a PhD student in the School of Creative Media, City University of Hong Kong. She was a sound engineer working in the audio industry before, now her research interests focus on AI sound production.

PerMagnus Lindborg is an Associate Professor in the School of Creative Media, City University of Hong Kong. His research interests in sound perception and spatial design are anchored in computer music. He founded the *Soundislands Festival* (2013–17) and serves on the Board of International Computer Music Association, as Music Coordinator and Regional Director for Asia-Oceania. He is director of the Data Art for Climate Action Conferene (DACA) which will take place in January 2022.

AI Biases in the Art Sector through the Lenses of European Union Law

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Abstract

The use of AI has been extensively growing in the past few years. AI is consistently used in employment relations, education and law enforcement. However, the field of art has not been ignored by such technology. While the use of these technologies will surely rise in the near future, their use has highlighted the existence, even in this sector, of an insidious phenomena: discrimination. Scholar Joo-Wha Hong considered this issue along with biases in perception of Art produced by AI, questioning "is AI even capable of making art?"

European Union and AI

According to the definition given by the European Commission High-level Expert Group on Artificial Intelligence (HLEG) an AI, to be trustworthy, should present three main components: (1) it should be lawful, complying with all applicable laws and regulations (2) it should be ethical, ensuring adherence to ethical principles and values and (3) it should be robust, both from a technical and social perspective since, even with good intentions, AI systems can cause unintentional harm.

From this definition, we can derive that in every sector AI is implemented, there are some essential features which can't be left aside, otherwise AI systems would provide much more damage than benefit. As an example, AI is increasingly used in the art sector and, in this sense, a significant problem has arisen. Some scholars argue whether: "when AI is used to create literature, art or music should it be treated as a human artist, namely receiving rights under copyright and patent law?" (Barfield and Pagallo, 2020). However, our short analysis will mainly revolve around another interesting question: "Who is to be held liable if an AI commits an error in the art sector, maybe leading to discrimination?"

Image Net Roulette

An artistic research program, using an AI system called "ImageNet Roulette" which aimed at gathering faces for a work of art to be exposed at the Prada Observatory Foundation in Milan, found out that even when used for artistic purposes, an AI system can still present evident biases. In fact, people who decided to upload their photos on the website linked to the initiative received discriminatory comments based on their personal characteristics (such as "offender", "wrongdoer" or "gook-slant eye").

Albert Fox Cahn, executive director of the Surveillance Technology Oversight Project (STOP) in New York City, an advocacy group seeking an end to discriminatory surveillance commented:

ImageNet Roulette has been incredibly powerful in showing how the artificial intelligence we incorporate into our daily lives is fundamentally flawed and limited by the human decisions that go into it. This is why we find that every visual recognition program on the market has biases on the basis of race and error rates that are different between men and women. No system is completely objective, however we (humans) set these tools up, so the prejudices and assumptions human beings bring into these tools will shape the outcomes that we get.

Conclusions

In every sector where AI is implemented biases could arise, because the way in which a developer feeds the system with data reflects his

or her own personal biases. The art sector, is not excluded form this. However, the field of art is still lacking general guidelines, given that no directive in the European Union addressing discrimination includes AI. Nevertheless, as the use of artificial intelligence grows, new policies regulating this phenomena in an effective way are deemed necessary.

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Biographies

Francesca Prandi, a Master's student in European Legal Studies at Turin University, is interested in the practice of Strategic Litigation and trainee at StraLi, an NGO promoting such practice in the Italian and European legal systems. She's currently writing her master's thesis on the legal and ethical correlations between the use of Artificial Intelligence and Climate Change.

Harshad Pujari is a graduate in Law and public policy. He's currently conducting research in the interdisciplinary study of media and public policy.

Finding the Relational Image

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Abstract

Found photographs sit at the crux between radically subjective and contextually contingent acts of noticing. As such, they serve as relational prompts from which to question the influence that their contexts of discovery exert on their creators and finders. Through interviews with local creative practitioners, links emerge between their ability to be noticed and the role technology plays to enable reflection through them.

Noticing the need to reflect

This project adopts a stance that the nature of the photographic image in the digital era is yet to be found. With the ubiquity of image-taking in daily life, users are invited to visualize and utilize the photograph in ways that confuse long-held distinctions between the photo-taker and noticed object to be photographed. This blurring of boundaries locates the photographic image within shifting relations between its material support, the context of encounter, and those who deem it worth noticing (Flusser 2000, 26).

Relational Potential

What brings forth the contemporary photographic image increasingly implicates relations between an embodied, subjective act of noticing and contextually specific significations (Tagg 1988, 101). This complex relationship allows the medium to be understood through a linking of the human intention to visually represent the world with the technological means to influence the output of visually and contextually predictable images (Flusser 2000, 9).

This inquiry was sparked by chance discoveries of found photos on Apple Store iPads in Hong Kong and the United States. The first photograph discovered can be seen below.

Fig. 1. *Found By [context 1-a],* 2019. Marty Miller Year, photographic print/found photograph, Copyright, Marty Miller.

From it, questions are raised regarding the mediation of attention through the machine which ended up capturing the likenesses above on its screen. When investigating the history of the photo's creation, this found photo allowed its disputed ontological status to be revealed (Mauer 2003, 4). However, opacities appeared when discovering others afterwards.

Fig. 2. *Found By [collage],* 2020, Marty Miller, photographic print/found photograph, Copyright, Marty Miller.

The photo above shows a mixture of many different found photos from Hong Kong and Florida in the United States. They are similar in their construction yet often hide the intent of their creators (Verbeek 2005, 109). While exposing patterns of use, the photos invite questions into the creation of systemic relations; those which act upon the users' actions with such machines, and their ability to reflect on such experiences (Favaro 2017, 8).

Setting the technological stage

From this initial finding, several other found photo portfolios were developed from specific locations in Hong Kong. Each of these four contexts of finding found photos were then analysed for their relation to a perceived intent to be found, and the role of technology to enable this (Crary 2013, 88-89). These images tell their finders not only about their own creation, they also reveal the potential to notice the overlooked gestures, thoughts, and even emotions of their creators. When deeming their actions to be in casual relation to the installation of the machines in their context-of-finding, the found photo reveals its reflective potential by foregrounding influences which facilitate this relationship (Mitchell 2006, 115).

The next stage of this project involved interviewing primarily local creative practitioners who used either found photos or their affective qualities in their work. Questions targeted a locative reflection on the experience of finding media in Hong Kong, and how these were experienced as embodied within the medium itself (Pink 2011, 4). Relational attributes accompanying the experience of chance were coded from these encounters. These framed found photos were situated within a complex web of relations which impact not only the act of finding, but also the act of visually noticing.

To ontologically position found photos is therefore to implicate the act of noticing as a mediated act in day-to-day life. While targeted advertising and ambient media have long claimed such roles, the use of found photos allows for a slight noticing of the impact of the relational, yet mediated engagement with photographs in unexpected encounters (Mauer 2003, 13). Such images also implore the artist and researcher to view technology as a means to both enable contact with the world, but also to condition this contact to the detriment of other, as yet overlooked relations (Verbeek 2005, 102).

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Biography

Marty Miller engages the changing nature of the image in East-Asian visual culture from a interdisciplinary background. To be in sync with its shifting ontological status, I note reciprocal influences between creative practice and scholarly inquiry. Finding found photos only furthers this relation.

Expanded Stereoscopy: Developing New Aesthetic Forms for 3D Films

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Abstract

A growing number of contemporary moving image artists are exploring unique types of perceptual illusions in 3D filmmaking which stand in opposition to mainstream discourses of stereoscopic (3D) art. This research examines some of these alternative artistic potentialities of "expanded stereoscopy" (Hattler 2019, 74) and discusses how artists experiment with various concepts and techniques to expand or subvert normative stereoscopic vision.

These alternative artistic approaches are examined from an aesthetic-perceptual viewpoint which aims to understand the resulting new perceptions and aesthetic forms from perceptual and cognitive perspectives. The perceptual illusions brought about by such alternative uses of binocular imaging can expand our senses and allow for new ways of seeing that are impossible in the real world. Expanded stereoscopy can turn us into active and highly engaged spectators and open up new visual imaginations and technologically-aided "fantasies." Drawing on textual analysis and artist interviews, the research delineates various examples of expanded stereoscopic moving image works which can be understood as the foundation of an emergent new aesthetics for the future of 3D cinema.

The work described in this presentation was supported by a grant from the Research Grants Council of Hong Kong (Project No. CityU11602919).

Fantasies and Imagined Things

In stark contrast to the notion that "3D might find its best uses in bringing real rather than imagined things to us" (James 2011, quoted by Elsaesser 2013, 237), the artists under review have brought to the audience "imagined things" based on reality as well as impossible spaces that can only exist in expanded stereoscopy. Blake Williams for example presents in his experimental stereoscopic films what he calls "fantasy," which he defines as a desired reality that does not (yet) exist. His 3D works show a different kind of reality, such as through the media archaeology of certain stereoscopic media in *Prototype* (2017), which avoids and transcends the conventional practice of cinema to 're-present' reality.

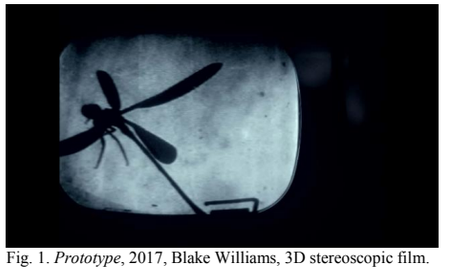

Fig. 1. *Prototype*, 2017, Blake Williams, 3D stereoscopic film.

Others aim at expanding our senses and sensations, while also prompting us to engage rationally. Kazuhiro Goshima's *Shadowland* (2013) for example, extracts 3D depth from two-dimensional source material to integrate a poetic narrative of unfamiliarity with the sensory experience of "impossible" depth perception. This offers the viewer an alternative way to feel and think about the real. Such expanded, artistic uses of binocular imaging for "imagined things" problematize debates related to realism and perceptual illusion in different ways.

Active Spectatorship, Subjective Experience and Thought Processes

Instead of the traditionally-assumed passive role of audiences proposed by the psychoanalytical approach in film studies, 3D cinema has

comparatively turned viewers into active spectators. Experimental stereoscopic artists have adopted multifaceted strategies to engage spectators' active thinking, mental processes, exploration and engagement through the aesthetic experience. Memo Akten for example, taking the act of seeing as an active process psychologically, explores binocular rivalry in his virtual reality work *Fight!* (2017), which allows spectators to experience meaning-making processes to be affected by their viewing experience and direct interaction with the artwork. Blake Williams, focusing less on the viewers' responses to visual stimuli, highlights the expression of his subjective artistic vision and the way spectators are encouraged to think through the logic system of his stereoscopic films which aim to provide sensory approximations of the sublime. Referring to an aesthetic experience that urges him to question his own existence as completely and cosmically insignificant, his stated intention is to prompt the audience to understand subjective sensory experience through an engagement of faculties of reason and reflective judgment.

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Biography

Max Hattler is an artist, researcher, curator and educator who works with experimental animation, video installation, and audiovisual performance. After studying in London at Goldsmiths and the Royal College of Art, he completed a Doctorate in Fine Art at the University of East London. He is an Assistant Professor at School of Creative Media, City University of Hong Kong. Hattler's work has been shown at festivals and exhibitions worldwide, receiving prizes from Annecy Animation Festival, Prix Ars Electronica, Montreal Festival du Nouveau Cinéma, Punto y Raya Festival, Cannes Lions and London International Animation Festival. Hattler's current research focuses on synaesthetic experience and visual music, the narrative potential of abstract animation, and expanded artistic approaches to binocular vision.

Pretty & Random: Anime-style Meta-narratives in the Age of Social Games

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Abstract

The creative mechanisms to accommodate multiple, often abundant characters in one narrative universe (and one productive franchise) for participatory and autonomous storytelling, which I call multi-characterism, is a distinguished feature of anime/ACG narratology that has been developed past the new millennium and is recently influencing the production in other content industries. Since the stagnancy of *NicoNico Douga* (http://nicovideo.jp) around 2016, the main platform and the most salient form of multi-character narrative have been shifting from NicoNico-style creative commons (aka. CGM) to platforms including mobile social video games (or "social games" [ソーシャルゲーム] in Japanese). In contrast to previous multi-character establishments like doujin or CGM, multi-characterism in social games is heavily influenced by gaming algorithms and corresponding game designs.

This research in particular investigates one such influence from the *gacha* (lucky-draw) systems on playable characters and key items, which is the typical module of the anime/ACG-style social game, correlating its computerized infrastructures to its narrative and cultural projections. While lucky-drawing and lottery are long-lasting practices in human culture and continue to prosper as a refuge for playful (re)enchantments in "the age of rational disenchantment" using Weber's words, recent social games elevated and reshaped impulses of such "secular magic" with increasingly delicate animated visuals and expansive narratives for representation, as well as remote but personalized random event generators on the algorithm side. This research analyzes the stage setting and narrative of exemplary *gacha* social games and contours the schemata of this important post-CGM massively multi-character narrative phenomenon. Analysis includes field data from "*gacha* occult" involving (playful) superstitions that correlate *gacha* results with originally peripheral data (e.g. date of lucky-draws in reality), fetishism towards desirable characters' attributes/*zokusei*, and even conspiracy theories (which is "re-enchantment arisen from bureaucracy"). Furthermore, this research identifies the natural hierarchy of characters (due to the algorithm-backed "rarity"), as opposed to parallelism in CGM-style grand characterization that resonates with the presence of the player within the narrative as the center of affects. Hierarchy of characters also strengthens ties between the characters and their sub-stages/backgrounds. Animation (as both form and aesthetics) ritualizes the above processes by providing re-enchanted spaces to the principally disenchanted randomizers, while time in *gacha* games imposes an additional layer of real time on the Azuma's game-style realism which serves as an epistemological foundation.

Biography

Chen, Qian Jason is an assistant professor at Film and Drama Studies Department in the School of Communication of Fujian Normal University in China. He is also an active dramaturgist, a core member of the contemporary art collective StageNoMore. His research interests include digital audiovisual cultures (with emphases on East Asian cybercultures), new media art, post-dramatic theatre, and contemporary representations of cultural heritages.

Working Towards a Data-Driven History of China: Three Examples from Digital Humanities Explorations

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Abstract

This presentation showcases approaches for harnessing digital technologies in the study of Chinese history. The digitization of historical information and the digital humanities paradigm enable new and fruitful explorations in researching premodern Chinese history.

Introduction

The Classical and modern Chinese language presents technical challenges in organizing and analyzing digitized material. The amount and heterogeneity of Chinese characters and expressions increase the difficulty of digitizing, organizing, and mining textual information, especially in executing optical character recognition (OCR) (to turn them into digital texts) and in word segmentation (since characters do not segment words and there are usually no punctuation or spaces to mark word boundaries in traditional Chinese texts). These are significant challenges any humanist dealing with Chinese materials digitally has to tackle. My presentation showcases computational approaches for addressing these problems in the study of Chinese history. I will use three main examples to elucidate the approaches: (1) the semi-automation of the accurate digitization of thousands of Tang biographies; (2) using data analysis in the personal name disambiguation for Chinese figures throughout a long historical span in premodern China; and (3) a large-scale visualization and analysis of communication networks in middle period China.

Reorganizing Chinese Biographies Digitally

The first example explores and analyzes the methods that the China Biographical Database (CBDB) project has developed and adopted to digitize reference works for Chinese history (Tsui and Wang 2020), which is part of the important process of turning them into structured biographical data for research use. The specific workflow under concern focuses on the Tang Dynasty (618-907) (Tsui and Wang 2019) and has implications for the improvement in digitization technologies for historical biographies in the Chinese language. These explorations and outcomes are about the transformation of large amounts of texts in non-Latin script into structured biographical data in a semi-automated fashion. This approach aims to strike an optimal balance between the employment of large amounts of machine-read texts and the efficient use of human curation to ensure accuracy.

Disambiguating Personal Names

The second example is about the names of Chinese historical figures. When integrating biographical data extracted from 2,000+ local gazetteers (*difangzhi*) into the biographical database, the usual protocol is to identify and link records of the same person, and thereby to "disambiguate" their names. Traditional Chinese naming customs pose big challenges to this, however, especially for a large gazetteer dataset containing 0.12 million records and 90k unique names of imperial government officials. Useful variables are missing in numerous gazetteer entries. I test and analyze solutions to disambiguating identical personal names in Chinese. First, the individuals who repeatedly took official posts in the same locality are identified computationally. Then, the overlap of content in multiple gazetteers is cross-tabulated and singled out. Finally, the remaining data is corroborated with an external dataset, and then processed. Through these procedures, 51k personal names are disambiguated with optimal precision (Tsui 2021). Such a task is only possible if done digitally; it could not be performed manually. These techniques will be useful for disambiguation and Named Entity Recognition of other large-scale unstructured data in non-Latin script.

Visualizing and Analyzing Communication Networks of Literati Scholars

The final example of the presentation focuses on the digital representation and analysis of the communication networks among literati scholars in Song China (960-1279). These scholar-officials were constantly rotating in the empire's bureaucratic posts, and in order to communicate they wrote letters to each other regularly. The writing of such personal letters has been an archaic practice, yet the methods of letter writing were not stagnant and impacted the cultural and social exchanges of Chinese elites. Letters have not only become an increasingly important and sophisticated literary genre, but they are also the means of constructing a common cultural knowledge, a medium for the exchange of ideas, and above all, an important form of communication of political and personal information among elite men in traditional China (Richter 2015). Digital data about letters allows researchers to map and analyze the social networks exemplified in these epistolary connections, equipping historians to examine them in contextual and interpretive studies about Song epistolary culture and networks.

Built on these digital humanities approaches, this data-driven line of inquiry will revolutionize knowledge discovery in and the interpretation of the long span of Chinese history. It serves as an exciting interface for interdisciplinary collaboration across the humanities and technology in our increasingly digital society.

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Biography

Lik Hang Tsui is an Assistant Professor in the Department of Chinese and History of the City University of Hong Kong, as well as the Convenor of the Digital Society research cluster in the university's College of Liberal Arts and Social Sciences. He holds a doctoral degree in Oriental Studies from the University of Oxford. Before joining CityU, he worked as a Departmental Lecturer at Oxford and a Postdoctoral Fellow at Harvard University with the China Biographical Database. He has held visiting appointments at Academia Sinica, Peking University, and the Max Planck Institute for the History of Science. He specializes in middle period Chinese history and culture, as well as the digital humanities. He is the recipient of the New Researcher Award (2020) in his College in CityU. Recently, he was appointed to the editorial board of *IJHAC: A Journal of Digital Humanities*. He also edits book reviews for *Cultural History*.

Information Particles: Tracing the Ambiguities of the Creative AI

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Abstract

As a summary of the forthcoming paper, this presentation rounds up major ambiguities which influence AI science, which are manifest in the production of AI artists, and shape the representation of creative AI in popular culture.

Introduction

Contemporary AI research centres around a machine learning (ML) paradigm called a neural network, which consists of parameter-processing units ("neurons"), input/output, and control modules. Such a system can be programmed to refine the procedure for solving a particular problem by dynamically modifying parameters based on the referential data. Deep Learning (DL) is a subset of ML methods in which the optimization of network performance and accuracy relies on statistical rules applied to multiple layers of neurons. The increasing accessibility of DL has encouraged artists to start exploring the creative capabilities of AI. Their work contributes in different ways to the creative AI, and shares both the advantages and shortcomings of the field. Addressing AI within the perspectives of new media art, mainstream contemporary art and cultural sector, the paper we outline in this summary expands upon the critical consideration provided by Mitchell, Marcus and Davis, Miller, Żylińska, and others. A complete list of references cited in the paper is available at https://github.com/dejangrba/brittle-opacity.

Ambiguities

Since its outset in the 1950s, AI science has been entangled with various epistemic uncertainties and conceptual issues. A persistent source of conceptual issues is the mutual non-exclusivity of symbolic (logic-based) and subsymbolic (statistics-based) models in ML. Looking for flexible hybrid solutions, recent AI research fluctuates the scope of these two models, but requires conceptual clarity to define the reliable methodologies for exploring such solutions. This is compounded by the incoherent consideration of human cognitive abilities. Human intelligence is not understood well enough to be captured with robust formal definitions and rules necessary for computer emulation. Intelligence is integral to human nature: a complex set of often conflicted cognitive faculties which have been evolving within the material, existential and social reality of our species. The concept of human nature is controversial in the humanities, social sciences and other disciplines that study intelligence, and it remains underappreciated in mainstream AI which concentrates on specialized narrow-focus platforms. However, without flexible control algorithms analogous to human common sense, narrow AI systems struggle with accuracy and safety in handling statistically extreme (rare) but plausible scenarios (Mitchell 2019).

AI's most pronounced conceptual ambiguity is anthropomorphism: a tendency to fictionalize the existing narrow AI as the artificial general intelligence charged with polar attributes (subjugation vs benevolence) rather than making better efforts to detect and correct in it a full spectrum of elusive human weaknesses, contradictions and biases. Subsymbolic ML systems rely on large training datasets of hand-annotated media, but often lack objective assessment mechanisms, which prompts the translation of socio-political biases, prejudices, and misconceptions from the human behaviour used for model development into the machine-learned models. Disparate notions of ethical principles such as fairness, transparency or responsibility, make it difficult to establish

widely acceptable criteria and to implement them as AI algorithms for evaluation, selection and decision making. Ethical principles are fuzzy categories that comply to human interests in the form of Gaussian distribution whose long tails are problematic, and throughout history they have been manipulated by the assumptions that human values are compatible and homogenous. For example, fairness is defined by a set of rational or perceived interests, but these interests vary between individuals and groups, in different contexts and conditions. They can be pragmatically or unintentionally short-sighted, contradictory, (self-)deceptive or inconsiderate in shaping our goals and actions (Trivers 2011). Emotional immunity to most ethically disturbing cognitive dissonances is an inherent feature of human mind.

All branches of creative AI face a temptation to exploit the ideological authority of the digital paradigm and heightened socioeconomic attention to the field. It leads to overpromising in AI science and hyperbolic media reports, to manipulative strategies in AI art, to dubious speculations and extreme futuristic scenarios about AI. These trends divert general attention from many important but misrepresented issues of AI (Marcus and Davis 2019). For example, mainstream AI suffers inadequate sensibility for investigating the authentic creative potentials of AI systems. Its emphasis on imitating human cognition instead of discovering new technical models of intelligence is chiefly caused by the commercial interests which tend to collapse promising research ideas into conventional business practices. Despite all these drawbacks, AI development stimulates human creativity by challenging knowledge, skills, innovation, inventiveness, and artistic expression.

The conceptual repertoire of contemporary AI art is primarily informed by the phenomenology of subsymbolic ML systems. Its thematic, methodological and aesthetic range is relatively modest compared to other areas of new media art. Frequent use of few available platforms and training datasets quickly results in aesthetic homogeneity, so the artists race to access the emerging code architectures or to curate original training models (Miller 2019). Such efforts are commendable, but may also indicate the lack of appreciation that poetic cogency is not reducible to prima facie relationship with technology. In a broader creative sense, however, AI art faces the intricacy, sophistication, and consequentiality of the work in AI science. Examples include the highly intuitive experiential skills involved in tuning the hyperparameters of Convolutional Neural Networks, or Max Hawkins' experiment *Randomized Living* (2015-2017) which qualifies as a strong artwork of cybernetic-existentialism. The artistic flavours of AI research could be arguably more interesting than current practice of AI artists, but they also motivate the synergy of creative methodologies and insights between the disciplines, which may be crucial for their advancement.

Conclusion

The ambiguities of the creative AI have a wide-ranging impact on science, technology, economy, politics and social relations. On the other hand, through dynamism and versatility the field has been able to tackle many cognitive challenges, conceptual issues and technical obstacles, and to make continuous if not fully coherent improvements. Artists' opportunity to establish meaningful poetic frameworks within such context depends on their ability to cultivate well informed critical attitudes toward their motivations, goals, and practices. In a broader prospect, the constructive approach to AI requires a profound understanding of the intrinsic contradictions and inconsistencies of human mind, including those "protected" by our ignorance, hypocrisy, vanity and delusions of self-importance.

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Biography

Dejan Grba is an artist, researcher and educator. He explores the cognitive, technical, poetic, and relational features of generative systems. He has exhibited, taught, and published widely.

Nishida's Logic of Creation

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Abstract

Inspired by Daoist theories of cosmogenesis, particularly by that of Wang Bi, logic is an expression of reality for Nishida Kitaro, a leading figure in the Kyoto School. Unlike Western philosophy, which understands Being as the beginning of all things, cosmogenesis for Nishida originates from Absolute Nothingness, or Basho. In this essay, I will first articulate the logic of Basho through predicate logic and through Hegel's Concrete Universal, an important influence for Nishida. Secondly, I will describe the influence of Wang-Bi on Nishida's formulation of the Basho. Criticizing the Daoists' emphasis on passivity as a way to maintain reality, Nishida advocates the active creation of reality through visual perception and art-making.

I will first explain the metaphysics of Basho through an explanation of its predicate logic. For Matsumaru, the logic of Basho is predicated upon the transcendentalization of the subject and predicate, which leads to their negation in the space of Basho and their mutual identification. I will also explain D.T. Suzuki's identification of Basho with the Buddhist logic of *Soku-hi*.

Nishida's idea of Absolute Nothingness is theorized in reference to Hegel. For Hegel, the concrete universal, or the absolute idea is "the last predicate, the most subsumptive predicate which encompasses everything" (Masao) and yet, Hegel's the absoluter Geist, still an object of judgement, cannot defy all predication and conceptualization and become a predicate. Unlike Hegel's concrete universal, Nishida's absolute nothingness is absolutely indeterminable. It is the final predicate or the place for all things.

Being the place for all things, absolute nothingness for Nishida is thus a generative force that is the source of being and non-being. Unlike Daoism's passive theory of creation, creativity for Nishida is the generation of reality, which is the creation of forms through "logization of reality." Through the body as a tool, Nishida prioritizes the "poiesis" of reality through visual perception (Sugimara).

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Biography

Joy Zhu is a PhD student in UCLA Architecture and Urban Design. Her research is focused on the philosophy of geology and its intersections with architecture. She is also interested in East Asian philosophy.

Part III

Artistic Project Abstracts

Qatipana: Becoming and Individuation of a Meeting between Technical Apparatus and Natural Systems

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Abstract

The present research revolves around the concepts and processes of Becoming and Individuation where a functional model is created based on the articulation of an information processing system guided by the approach of philosopher Gilbert Simondon. The objective is to model a sensorimotor cycle carried out by the cognitive system of an Artificial Intelligence agent. To establish this model of biological inspiration, we use the concepts of information in cybernetics by Norbert Wiener, information and modulation in Gilbert Simondon and technodiversity in the light of Yuk Hui's proposals.

The architecture that we have called *Qatipana* (flow of information processing systems in Quechua), although it cannot be considered as a systems theory, has the utility of being able to explain some empirical observations that we present here. In conclusion, the implications and limitations of this model and the research that is being carried out to present its utility and probability as a model of the algorithmic cognitive system are part of the questions of communication and affect posed by the decisions provided by the cybernetic system.

Qatipana as a proposal for Technodiversity

In a relatively short period of time, there has been an explosion of new technologies that have infiltrated all areas of life and irrevocably altered our ways of living. The consequences of this technological permeation are ontological and epistemological. They permeate our lives effortlessly and we can see that our world changes every day. We could argue that digital practices, such as experimental works of art and representations, serve as criticism mechanisms and have an indirect effect on the social and political world. Although a redefinition of terms is certainly needed, since they question the very nature of our accepted ideas and belief systems regarding new technologies. In this sense, digital art does what all avant-garde art does; it is an experimental extension of the socio-political and cultural aspects of an era. In this way, technology would then imply a reconfiguration of our embodied experience. When the mind and body cannot reach the meaning it addresses, it builds its own instruments and projects a mediated world around it. Rather, being separated from the body, technology becomes part of that body and alters and recreates our experience in the world.

Faced with such phenomena, the concern is being born to develop a research project that focuses on observing, analyzing and collecting information on the learning and individuation processes (Simondon, 2009) of the algorithms for organizing new modes of subjectivation in human and non-human nature. This type of observation presents new directions for research in the relational-transactional intersection of the contrasting disciplines of the arts, humanities, science and technology, and in doing so, presents philosophical questions for future research on human connectivity in our digital age.

These main questions are now the focus in media studies: how does the computerization of cultural techniques produce new forms of subjectivation? How does the concept of mono-techniques already imply the notion of "chains of operations" and, therefore, a permanent (retro) coupling between living and non-living agencies? The last question is also closely related to the discussion about education and training programs in society and working life.

On the other hand, the possibility of reflecting on what has been raised so far arises from the concern to work from "the epistemes of the becoming." For this, I am dedicated to the development of a work called *Qatipana* and it is conceived as follows: a machine that can observe and learn from a natural system and uses the data that arises from its behavioral patterns as a source of "transduction" for the agency of a material and immaterial ecology. The project focuses on the use of artificial intelligence that has the ability to identify repeated coordinated actions within a natural system. AI stores and transforms these actions into events to which it assigns different behavior gestures to the living organism and to itself, creating an autogenerative habitat according to the logic of decision-making that it produces through weather. To achieve this, an analog signal collector and a transmission device, capable of performing its own biological maintenance will be developed, together with an audiovisual platform that allows the amplification of these biological signals. The resulting process will be transmitted live through a server channel, where the coevolution process can be monitored in real time, revealing that AI are capable of taking various forms depending on the situation. Under this logic and thinking from the standpoint of non-human intelligences, it can be argued that generative art inherits the field of research, that in 1968 Jack Burnham called "Systems Aesthetics." He said: "We are now in transition from an object-oriented to a systems-oriented culture. Here change emanates, not from things, but from the way things are done. " (Burnham, 1968, 2).

In conclusion, the implications and limitations of the said model and the research that is being carried out to present its utility and probability as a model of an algorithmic cognitive system are part of the communication and affect issues in the decisions provided by this automatic system. Cosmology is not pure theoretical knowledge; in fact, ancient cosmologies are necessarily cosmotechnical. Taking the notion of Hui (2017) we can give a preliminary definition of Cosmotechnics here: it means the unification of the cosmic order and the moral order through technical activities. Modern technology has broken the traditional relationship between cosmos and technique; it becomes a gigantic force, which transforms every being into a mere "permanent reserve" or "reserve" (Bestand), as Martin Heidegger observes in his famous 1949 lecture "The Question for Technique" (Heidegger 2016).

In this way, they somehow adopt a series of behaviors that allow them to act like other entities, without necessarily replacing in full what they imitate. From an analytical and epistemological result, the work process acquires an interdisciplinary approach, proposing a strong cross between applied sciences and the humanities, thus generating a research space for communication and non-anthropocentric concern based on an autogenerative system of not human intelligence.

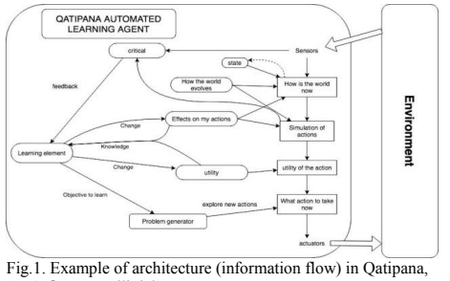

Fig.1. Example of architecture (information flow) in Qatipana, 2019 @Renzo Filinich.

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Biography

Renzo Filinich Orozco (Lima, 1978) PhD student in Interdisciplinary studies, Universidad de Valparaíso; researcher, professor and media artist with a Masters degree in Media Arts, Universidad de Chile.

He is interested in applying new technologies in music and video to develop new interactive listener and cognitive fields and spatial representation of video-sound, through the use of gestural interfaces in performances, using the concept of malleability.

He has participated with his works and research in international festivals such as ICLC Morelia 2017, ZHDk 2017 (Zurich), Sonología 16 (Sao Paulo), Días de Música Electroacústica 2015 (Lisboa), In Vivo Electro IRCAM manifest 2014 (París), Foro Acusmático Hope University 2013 (Liverpool), Mixtur Festival (Barcelona), 2013, Ai-Maako 2010 and 2017 (Santiago de Chile), Festival de Arte sonoro de Valparaíso Tsonami, 2007- 2011.

Let's Shake—Music is Fun

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Abstract

The phenomenon of people listening to music on their earphones to isolate themselves from the public strikes me as against the belief that music should foster bonding between people and draw us together. This motivates me to create participatory interactive art in the form of a web app, https://we-shake.fun, to bring people together to rediscover the forgotten joy of music as a social activity and to immerse themselves in the magic of music. This participatory interactive art seamlessly weaves together both engagement and playful elements into a holistic musical experience. Participants need to collaborate and pair up to perform the playful act of shaking their mobiles together to unlock one track at a time until all the tracks of a musical loop are activated.

Participatory Interactive Web App

Without the hassle of software installation, participants can easily access the web app from their browsers at the URL address https://we-shake.fun. Upon successful connection, participants are greeted with the opening animation (fig. 1a) which followed by the main screen prompting for tap to proceed (fig. 1b).

The user interface is a stack of four color layers which represents the composition of a musical loop: lead melody in red, chord in green, bass in blue, and drum in purple. Each participant first starts with only one active track randomly assigned by the app. The active track is visualized in a bright colour animated to the rhythm of the track whereas all inactive tracks are dimmed with no animation (fig. 1c). In order to enjoy the musical loop with all active tracks (fig. 1d), participants need to communicate and pair up to exchange their active tracks through the playful act of shaking their mobiles together.

(a) (b) (c) (d)

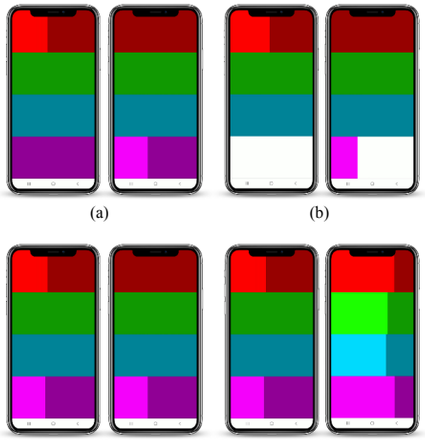
Fig. 1. (a) *Opening animation*. (b) *Welcome screen*. (c) *Active track in bright animated red*. (d) *All tracks are active*.

Engagement and Playfulness

It is not easy to open a dialog with a stranger, let alone collaborate. Therefore, engagement is the key to connect people together and overcome the communication barrier. Artist Ekene Ijeoma has utilized engagement in his mobile app "Look Up" to subvert the habitual mobile behaviour of people and prompt them to look up from their phones at every intersection in NYC to greet each other (Ijeoma 2020).

Likewise, my interactive web app motivates participants to engage with each other through the playful act of shaking their phones together to activate the whole musical loop. Figure 2(a) shows two participants, one has an active lead track in red while the other has an active drum track in purple. To start the exchange process, they need to first highlight the drum tracks on their own screens and then shake their mobile phones together at the same time to trigger the process (fig. 2b). Upon successful exchange, both highlighted tracks will immediately turn into animated active tracks (fig. 2c). The

exchange process is repeated until all tracks are activated (fig. 2d). Basically, every participant has to pair up with three different participants in order to activate all the tracks to enjoy the musical loop. Consequently, this playful process draws people together and breaks the silence between strangers. In fact, the inspiration of play as an interactive social activity was proven to be effective in changing people's behavior as evidenced in the project "Piano Staircase" by the Volkswagen Initiative to encourage people to take a staircase instead of an escalator for a healthier lifestyle (Volkswagen 2009).



(a) (b) (c) (d)

Fig. 2. (a) *Two participants with different active tracks.* (b) *Participants highlight purple drum tracks.* (c) *Drum track successful exchanged.* (d) *Repeating the exchange process until all tracks are active.*

System Design

The participatory interactive web app works in tandem with the server-side component which resides on the Heroku Node.js server to handle all web app's requests. The web app is a collection of HTML, JavaScript, CSS, and media files working together to provide the functionalities such as user interaction, animation and music playback. The server will establish and maintain communications with all web app clients through WebSocket channels to synchronize the shaking actions between participants. Figure 3 illustrates the communication processes between the server and clients in support of the shaking actions.

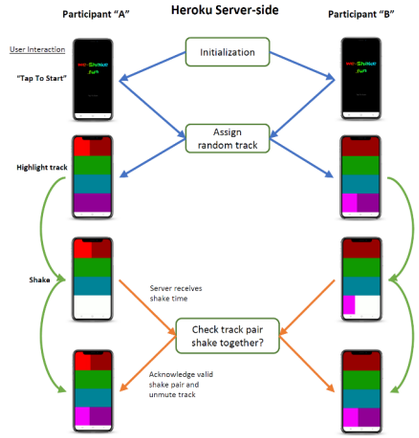


Fig. 3. *Communication process of the shaking actions.*

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Biography

Dr. Kelvin Lee is a senior lecturer in the Academy of Film, Hong Kong Baptist University. Armed with interdisciplinary knowledge and interests, his creative works span across variety of domains such as interactive arts, storytelling, and computer character animation.

The Zombie Formalist: An Art Generator that Learns

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Abstract

The Zombie Formalist is a satirical body of work centering on a pair of generative light-boxes that generate geometric abstractions in response to audience attention. The Canada Council for the Arts funded project points to the intersection of art as commodity, surveillance capitalism and the automation of intellectual work through AI. The Zombie Formalist is the autonomous artist in your home; it learns what you like and creates more of what you want to see.

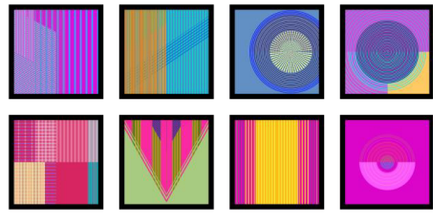

Fig. 1. Top 8 Zombie Formalist compositions ranked during testing according to Twitter engagement.

Artist Statement

Flipping in the art market and the proliferation of "Zombie Formalism" indicate an increasing consideration of art objects as commodities selected for their potential as investments rather than for their cultural or personal importance. This trend continues in the form of the "crypto" art market where works are often bought in crypto-currencies and whose provenance is recorded using Blockchain.

While computer vision (face detection and recognition in particular) are often being deployed in public space to detect criminality, these same tools are valuable in the context of surveillance capitalism; there is significant potential for such systems to be used to profile individuals in public for advertising.

In the not too distant future—as long governments continue to allow the expansion of these systems—face recognition in public space will undoubtedly be exploited for targeted advertising in public space. Brand messages will be tailored specifically to the passer-by thanks to connections with social media and web behaviour.

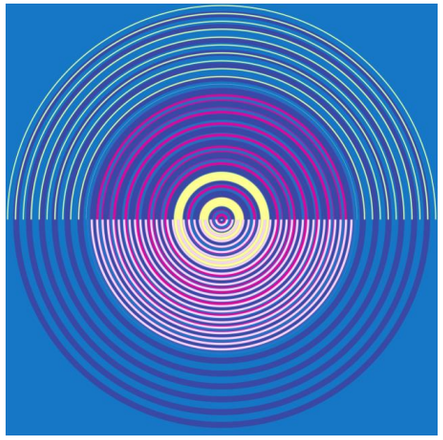

Fig. 2. Zombie Formalist composition selected by in-person engagement.

Project Description

The Zombie Formalist follows these trends to create a system that uses face detection, Twitter (2021) and machine learning to create conceptually vapid formalist compositions whose properties are tuned according to, and their value wholly derived from, the preferences of the audience / market (see figs. 1 and 2).

The project has a number of manifestations centering on a pair of generative lightboxes that consist of square 27in displays, Nvidia Jetson TX2 boards and cameras that face the viewer, all enclosed in black contemporary art frames.

Light-boxes generate images from random parameters in the style of painters such as Gene David, Barnett Newman, Kenneth Noland, and Karl Benjamin. One generates images every two hours and uploads those to Twitter where the number of likes and retweets garnered by each composition are tracked. The other generates images when the audience is not looking at it (via face detection) and records the attention (duration of looking for each detected face) received by each composition. Twitter engagement and preferential looking are proxies for the system's consideration of the value of compositions. These continuous variables are thresholded and used to train classifiers to learn the difference between "good" (a lot of engagement) and "bad" (very little or no engagement) compositions.

The Twitter oriented light-box is currently collecting data for offline training and analysis. In the final version, training will happen onboard following from research and development of suitable classifier models using collected data. In the final work, the onboard predictive model will be used to filter generated compositions such that the probability of "good" compositions presented on screen will increase.

The light-boxes are framed and satirically marketed as high-tech objects where materials emphasize minimalism and elegance; mock-ups show them presented in stark contemporary spaces such as those in architecture and interior design magazines. In addition to the light-boxes, the work expands the notion of art as commodity by also including a series of kistch objects, see figure 3. These objects reference the art gallery gift shop where a famous work of art bought as a poster, coffee mug, phone case or even comforter. Through the development process of *The Zombie Formalist*, thousands of compositions have been generated; and a subset selected by Twitter engagement and in-person attention are available on the Society6 (2021) Print on Demand site.

Fig. 3. Selection of kitsch objects showing Zombie Formalist compositions on various products from Society6.

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Twitter. 2021. Accessed March 8th, 2021. http://www.twitter.com/autoartmachine

Biography

Ben Bogart is a non-binary disciplinary artist working for nearly two decades with generative computational processes (including physical modelling, chaotic equations, feedback systems, evolutionary algorithms, computer vision and machine learning) and has been inspired by knowledge in the natural sciences (quantum physics and cognitive neuroscience) in the service of an epistemological inquiry. Ben has produced processes, artifacts, texts, images and performances that have been presented at galleries, art festivals and academic conferences internationally. Notable exhibitions include solo shows at the Canadian Embassy at Transmediale in 2017 and the TechLab at the Surrey Art Gallery in 2018. Their research and practice have been funded by the Social Science and Humanities Research Council of Canada, the British Columbia Arts Council and the Canada Council for the Arts.

Re:Melt: A Dance Film about a Human-Algorithm Interaction

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Abstract

Re:Melt is a short dance film capturing the contact improvisation between a human performer and a 3D printed wall generated from an AI algorithm. This partnership is shown through the lens of digitally manipulated video to emphasize the constantly flowing nature of a supposedly static object. Equally important is the collaborative partnership rooted in practice-based research that led to the creation of *Re:Melt*. By reflecting on both the circumstances leading to the partnership and the resulting artwork, the collaborators share their changed insights on how humans might interact with AI.

What is *Re:Melt?*

Re:Melt is a short experimental dance film capturing the interaction between a human performer and a 3D printed wall generated from an AI algorithm. The title is derived from the way the wall looks as though it is a constantly melting block of ice. In the film, Kim engages in a contact improvisation with the wall. Each organic curve and crook becomes a physical representation of the algorithm that generated it. Under the direction and video editing of Bahng, the simple duet transforms into an intimate and surreal look into a human placing their trust and affection into unexpected places. *Re:Melt* can be viewed online at https://youtu.be/Xn7JrCA5TeM.

A Chance Meeting

The collaborators first made contact in September 2018 due to an e-mail featuring Bahng's presentation on critical empathy and VR. At the time Bahng and Kim were PhD candidates in Australia and Hong Kong respectively. Both were examining the use of narratives to convey empathy in VR environments through a practice-based research approach. After a brief correspondence, Jon McCormack kindly arranged for Kim to visit SensiLab in April 2019. While discussing approaches to practice-based research, Bahng and Kim decided that they needed to collaborate to create artworks in order to find answers that they had been discussing. *Re:Melt* resulted from their exploration of how to challenge the way movement can be used in a digital narrative.

Algorithms, Robots and 3D Printing

At the heart of *Re:Melt* is a wall designed by Roland Snooks of RMIT/Studio Roland Snooks for Sensilab. This unique wall is at once an organic living object and an inorganic inanimate creation generated from computer algorithms. Initially simplistic in its use of clear material, the wall changes personality throughout the day depending on the type of light coming through it. Furthermore, it feels like it is constantly melting and reshaping itself, simultaneously cold and warm.

To create the wall, Snooks uses a "multi-agent swarm algorithm" that combines two algorithms which generate the curves (RMIT n.d.). The design was then 3D printed robotically with a clear polymer to produce most of the walls for a meeting room at SensiLab (Studio Roland Snooks 2017).

Contact Improvisation with Non-Humans

From a dance perspective, the wall has many curves and niches that can cradle the body in a supportive manner. Putting weight on the extruded plastic created a sensation that was similar to doing contact improvisation with a solid and understanding partner. For Kim, the wall alternately guided the body in what direction to go next and provided a cushion for the body to melt into. The cycle of internal and external feedback led to feelings of closeness and wonder towards the algorithm that had

generated the curves. Gradually the authors started to treat the wall as a sort of living entity rather than a static prop.

Fig. 1. *Re:Melt rehearsal*, 2019, Sojung Bahng and Eugenia Kim, still image, Copyright belongs to the authors.

Generative Filmmaking for Dance

Influences for the filmmaking process included the early works of Maya Deren, Anna Halprin and Yvonne Rainer, and Bahng's generative interactive film, *Differential of Memory* (2015-2016). *Differential of Memory* had featured a solo dancer and was made in a collaborative manner. Various digital effects were used to further extend the choreographic possibilities.

For Bahng, it was easy to sense just how much Kim resonated with the wall as a partner. The intentions of Kim's movements gave the sensation of an organic and fluid two-way interaction. Based on this partnership, Bahng was reminded of ice slowly melting into an ocean harbour reflecting the night lights of a cityscape. She chose to shoot using extreme close-ups and low angles in order to capture the intersubjective connectivity between human, non-human and an embodied frame of view. Bahng was also interested in how digital technology could connect tangible objects, intangible motion and bodily embodiment.

Reflections and Conclusion

In hindsight, the process of collaboration was extremely instinctive and organic. By Kim entrusting Bahng with the cinematography and editing while Bahng danced "with" Kim during shooting, each collaborator was able to focus on and immerse themselves in their respective roles. Further trust was built up through a mix of collaborative decision-making and artistic independence. The spontaneity of the collaboration was also very exhilarating.

A major impact of *Re:Melt* is that it has changed how both authors approach collaboration, dance films and the forms in which humans can interact with or be impacted by AI. For Kim, the project has raised the question of how AIs can be represented in physical forms and expand the definition of multispecies relationships. Both creators intend to further explore the possibilities presented in *Re:Melt* by creating variations on the film and derivative works.

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Biographies

Eugenia S. Kim is an interdisciplinary creator and researcher. She is an artist for Leonardo21 and Lecturer (Performing Arts Research) at the Hong Kong Academy for Performing Arts. Kim received her PhD from the School of Creative Media, City University of Hong Kong in 2020 and holds degrees from University at Albany and Rensselaer Polytechnic Institute.

Sojung Bahng is an award-winning artist, new media filmmaker and researcher. She is a Postdoctoral Fellow and Instructor in the School of Journalism and Communication at Carleton University. Bahng graduated from the SensiLab at Monash University in 2020 and holds degrees from the Korea Advanced Institute of Science and Technology (KAIST) and Korea National University of Arts (K-Arts).

This Infinitesimal Moment of Now: *Ice-Time*

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Abstract

The *Ice-Time* project is a creative response to the precarious state of Earth's ecosystem. *Ice-Time* is an immersive cinema mediascape enacting the space-time of glacial ice. In the installation, the beholder experiences the time of a different form of matter as a somatosensory experience. *Ice-Time*'s images are hyper-realistic views of ice taken at all scales of space, from the microscopic to the planetary, collapsing the sensory distance between the body and the ice. The sound recordings draw one acoustically near the ice, simultaneously recorded using contact microphones and hydrophonics. The project engages interdisciplinary methodologies in exploring significant environmental challenges, challenges framed by the concept of the Anthropocene, the idea that humanity should now be considered a geological and terrestrial force.

This Infinitesimal Moment of Now

In the space-time tesseract of the geological, the simultaneity of space conjoins with the succession of time. All past, present, and future events, all states, coexist simultaneously. Reality comprises a hyper-volume of past and future matter extending along the limitless axis of time. This infinitesimal moment of now, the present, constitutes a continually shifting slice of this hyper-solid as it passes through our three-dimensional space.

Climate change is a defining issue of our time, precipitating unprecedented weather events, oil disputes, water wars, and refugee migrations while rising oceans and raging fires begin to redraw the global map of this planet's habitable spaces. The geological provides us a glimpse of time as a supra-dimensional force, a four-dimensional perspective that subsumes both past and future and whose deep-time view far exceeds human perception. The Greenland and Antarctica Ice Sheets function as frozen containers of Earth's atmosphere through time. The ice-cores excavated in Greenland and Antarctica provide a view 800,000 years back into the preterite history of Earth's climate.

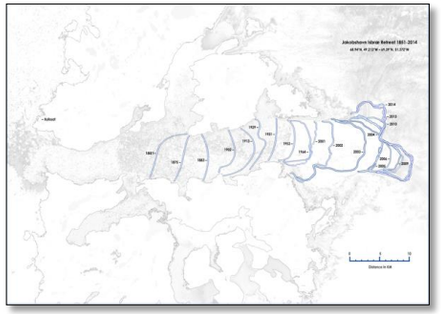

Fig. 1. Glacial retreat: Jakobshavn Glacier, Greenland from 1851-2014. (from *Ice-Time*, copyright Clea T. Waite 2017).

How do we comprehend the recession of a glacier that progresses over three generations or the slowing of an oceanic current? (fig. 1.) Are we, as humans, capable of being sensitized to planetary scales of matter and time that are far beyond our physical perception (Latour 2006)? We have given ourselves technologically augmented vision supplemented by extended wavelength cameras, microscopes, telescopes, radar, sonar, and satellites. We have universal access to data shared over global machine networks. We live in the meta-dimensions of a redefined, disembodied world, full of strange data vistas surrounding us in manifold perspectives.

Ice-Time

Filmed principally in Greenland in 2016, the *Ice-Time* project is a creative response to the precarious state of Earth's ecosystem. The project engages interdisciplinary artistic and scientific research methodologies in exploring significant environmental challenges, challenges framed by the concept of the Anthropocene, the idea that humanity should now be considered a geological and terrestrial force.

Fig. 2. *Ice-Time*, 2017, Clea T. Waite, immersive cine-installation and ambisonic soundscape, Copyright Clea T. Waite, 2017. (Waite 2017).

Ice-Time is an immersive cinema mediascape enacting the space-time of glacial ice. The installation constructs an embodied cine-poem whose spatiality is deciphered by the perambulations of the beholder. *Ice-Time* is configured of six video channels faceted amongst six large projections and a three-dimensional soundscape—fifteen simultaneous streams. The images are hyper-realistic views of ice taken at all scales of space, from the microscopic to the planetary, collapsing the sensory distance between the beholder's body and the ice. The sound recordings similarly draw one acoustically near to the ice, recorded using contact microphones and hydrophonics. An unfamiliar form of matter is experienced as somatosensory experience. The installation forms a crystalline, cinematic tesseract that examines our culture's altering perceptions of space and time, the deep time of Earth's environment, using polar ice as a unique window onto issues of climate change. The present effects of global warming on Greenland are a prelude, a four-dimensional vista into deep time. The mediascape immerses the audience in accelerating glacial time that instills the beholder with an implicit awareness of the environmental and cultural implications of polar ice (fig. 2).

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Biography

Clea T. Waite is an intermedia artist, experimental filmmaker, scholar, and engineer whose artworks investigate the material poetics emerging at the intersection of art, science, and technology. She creates immersive, cinematic works engaging embodied perception, dynamic composition, and sensual interfaces—as well as one inter-species collaboration with several hundred spiders. Her artwork examines climate change, astronomy, particle physics, history, feminism, and popular culture. Waite received her Ph.D. at the University of Southern California in interdisciplinary Media Arts + Practice, combining a physics and computer graphics background from the MIT Media Lab with her current research in cinema, media art, and critical theory. Recent exhibitions include CODAME San Francisco, the ICC Tower Hong Kong, the Miraikan Museum, Tokyo, and the Boston CyberArts Festival. Waite has taught at the Academy of Film and Television, Babelsberg, Pratt Institute, New York, and the University of the Arts, Berlin.

The Synthetic Cameraman Series: A Practice-based Research Case Study

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Abstract

The talk presents the conceptual goals and artistic methods behind a series of artworks (*The Synthetic Cameraman Series*) that constitutes the practice-led component of the author's Ph.D. research. The talk provides a brief overview of the practice-based research method in relation to our research on new types of content and aesthetic conventions that emerge out of the capabilities of real-time computer graphics and 3D virtual environments. The talk focuses particularly on the importance of artistic exploration and experimentation that can complement purely theoretical research methods in new media and software studies.

Research Supplemented by Artistic Practice

We have formulated two main objectives for our practice-led research. First, it explored the creative boundaries of designing different representational techniques for a single real-time environment created within the Unity 3D software media ecology that allows for a deep customization of the implemented visual styles (Objective 1). Second, the artworks illustrated that by taking advantage of the modular and processual materiality of a virtual scene, from one side, and of a diversified and customizable ecology of tools, from the other, one can design new types of hybrid content with programmable and dynamic aesthetics that can transgress the boundaries of any single medium (e.g. video games, CG animations, etc.), and that the content can go beyond media respective aesthetic conventions and cinematography techniques (Objective 2).

Transgressing Medium Boundaries

(Objective 1) Each of the artworks offers a radically different camera-based representational model of the virtual environment that changes the way the scene is experienced by the audience. In *The (Cinematic) Synthetic Cameraman* we focused mainly on the representational aspect of virtual cameras, and on their impact on the way a virtual scene can be visualized. Despite all the manipulations on the camera's visual feed, *The (Cinematic) Synthetic Cameraman* is a procedural self-perpetuating but non-interactive visual spectacle. Neither the camera nor the user of the application has any impact on the materiality of the environment. In other words, the deep, processual manipulations imposed onto virtual cameras greatly influence the representational process and thus, the way the scene is perceived by the viewer, yet, not even a single object in the environment is altered by the very presence of virtual cameras, which remain mere capturing devices. On the other hand, *The (VR) Synthetic Cameraman* explores the co-creative and formative potential of virtual cameras, turning them, and consequently, also the user of the application, into active actors that control not only the representational process but can influence the way the eruption is unfolding.

(Objective 2) *The (Cinematic) Synthetic Cameraman* draws from remediated photorealism, however, thanks to the affordances of programmable real-time graphics, the artwork produces hybrid aesthetics that goes beyond any typical representational spectrum or convention while still retaining the general representational function of virtual cameras. *The (VR) Synthetic Cameraman* both explores and questions the potential of seemingly unmediated and raw insight into a virtual scene, by combing a user-controlled,

first-person-view camera with its role as an actuator impacting the environment. Bolter and Grusin make the distinction between what we could call FPV (first-person point of view) and a DPV (directed point of view), arguing that a photograph or a perspective painting gives the viewer a reconstituted creator's point of view, and film or a TV gives her a dynamic, external point of view, an embodiment of the camera movement and settings (Bolter and Grusin 1999, 231).

Using this conceptual lens, we argue that real-time design workflows and the affordances of real-time graphics, make it possible to visualize a single spatial, CGI-based, real-time environment using both paradigms. *The (Cinematic) Synthetic Cameraman* follows a DPV approach with sophisticated cinematography, where a generated representation of the scene is beyond the control of the viewer. Conversely, *The (VR) Synthetic Cameraman VR* follows an FPV approach, which delegates control over the point-of-view to the immersant. However, thanks to the affordances of real-time graphics, both of the implemented paradigms incorporate hybrid features and elements, such as procedurally generated cinematography and camera-based aesthetics in *The (Cinematic) Synthetic Cameraman*, and user-controlled triggers that impact both the representational process and the scene in *The (VR) Synthetic Cameraman*. Our artistic exploration has revealed that a unique entanglement of combined affordances granted by real-time computer graphics from one side, and by a general-purpose game engine from the other, not only causes the line between DPV and FPV to be blurred but even transgressed.

A Case for Practice-based Research

In our presentation, we will illustrate how a practice-based research approach created new perspectives and contexts for an in-depth and nuanced understanding (Coemans and Hannes, 2017, 34-49; Franz 2010) of the object of study. We will present how it contributed to the final research results with a highly contextualized practice-rooted knowledge (Skains 2018, 82-97) and "new understanding about practice" (Candy 2006) by "generating novel apprehensions," which relate to both senses and the intellect (Scrivener 2002). We will present how the discussed artwork series had a functional role for our theoretical conceptualizations, providing as illustration and evidence in support of a theoretical argument communicated through other means—research results presented as academic papers and a Ph.D thesis (Grennan 2015; Douglas, Gray, and Scopa 2000).

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Biography

Dr. Lukasz Mirocha is a new media and software theorist and practitioner working with immersive (XR) and real-time media. More on: https://lukaszmirocha.com.

An Exquisite Corpse of Musical Cryptograms via BCMI

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Abstract

What if you could notate a complete work of music in real time just by thinking about it? In this abstract, we present the concept of using music cryptograms and neurotechnology to advance the art of composition and music therapy. This is a herculean task that involves developing neurovascular bioelectronics, AI composition methods, and AI/ML-enabled Brain Computer Interfaces (BCI) to allow not only abled composers but also disabled, paralyzed, and quadriplegic people—whether from war tours, vehicular accidents, old age, disease, or birth anomalies, i.a.—to create sheet music that can be performed by live musicians, just by internalizing melodies and harmony.

Musical Cryptography as Sound Art

Musical Cryptography, in its simplest form, is a method of mapping musical notes onto letters of a romanized alphabet to encode secret messages. Ahmadeus Beaux-Arts has devised a proprietary 26-letter system using solfège nomenclature in multiple languages and systems to create a wide variety of musical scores across various styles and genres that appeal to listeners worldwide.

In 2020, Ahmadeus Beaux-Arts launched two Sound Art projects, *CRYPTOGRAMS* and *SPIKED TINSEL*, that have been successful in demonstrating the viability of its 26-letter system of musical cryptography as a method of melody-forming and as a means of connecting with people to show their names, lives, and legacies matter. While *CRYPTOGRAMS* demonstrates various aural and visual encoding methods—e.g. direct pitch translation, spectral embedding, and rhythmic voice mapping—*SPIKED TINSEL* goes a step further in using regular expressions (i.e. X-grams) to process large amounts of text to use as enhanced reference inputs, called “influences,” for comparing human compositions against trainable AI music generators such as AIVA (the Artificial Intelligence Virtual Artist). The first trial of these works in *CRYPTOGRAMS* resulted in a Shakespearean rendering of the canonized Hamlet monologue “To be or not to be. . . ” (titled *Cryptospeare*), while in *SPIKED TINSEL*, 3.5 hours of musical output— called *101 Ghosts;* subsequently used as an AIVA influence track—resulted in a Christmas Carol (titled *Ebonitë Screwdge*). The difference between *Cryptospeare* and *Ebonitë Screwdge* is that, with current AI processing at platforms like AIVA, the encryption—albeit musical— is unidirectional and non-decodable. *Cryptospeare*, on the other hand, is written as a decodable music canon that can be described as prancing around the ear like a large candy cane, twisting and convoluting in formation at a candy factory.

In relationship to future projects, we hope to apply these methods to more rapidly build a COVID 19 Music Memorial honoring the names of hundreds of thousands of those who died during the pandemic. We also hope to develop an AI-based system that operates like a Cryptospearean composer, creating melodies, countermelodies, and accompaniments that are musically convincing and preserve the audio and bidirectionality of the encryption.

Music Neurotechnology and BCI

Applying Neurotechnology and Brain Computer Interfaces to music scoring is a relatively new and challenging topic in the world of music technology. Ahmadeus Beaux-Arts, a business dedicated to creating neurotech for the musical mind, is currently based at New Lab, LLC, a high-tech research and

development facility in Brooklyn that applies transformative technology to things that matter.

Music matters to us; and, in general, music notation is difficult and time consuming. It can often take up to a full working day (8 hours) for a single composer to conceive of, notate, and engrave 15 seconds worth of substantial polyphonic music (8 to 10 instruments across 40+ voices). This output can increase 700% to 2 minutes per day when reduced to a single-instrument like piano when conceptualized using music cryptograms.

Music composition, however, is nothing more than the ability to *write* music. Nonetheless, music literacy is not necessary to communicate musically or for the mind to develop concepts from pitched utterances often communicated in vocal music, such as Inuit throat-singing. We do know, in any case, that music resides in myelinated minds (Coyle 2009, 30-53) and are researching ways to interpret the electrical signals that fire in the brain when it manifests so that it may be documented in written form. In this vain, Ahmadeus Beaux-Arts wants to build music notation software that simplifies inputs through reading and interpreting brainwaves, enhanced by muscle memory triggers. In other words, we propose developing a system that outputs sheet music in real time as one thinks of the melody.

In 2005, a landmark study toward a brainwave controlled musical interface (BCMI) was uninterested in a system that plays naturally conceived melodies (Miranda et al). The next landmark study was presented in 2011 by two Georgia Tech graduate students who created a BCMI for real-time composition (Chew et al). In 2018, a groundbreaking neurovascular bioelectronics technology was proposed for controlling basic computer inputs (Oxley et al). Ahmadeus Beaux-Arts believes that a marriage between existing EEG technologies and music scoring software will enable people of all backgrounds and abilities to interact with a system to produce sheet music in real time, just by thinking about music, without the need for expensive instruments or other input devices such as a midi-keyboard and mouse.

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Biography

Ahmadeus Beaux-Arts, Inc., founded in 2017 by Bryan A. Crumpler, leverages the intellectual capital of arts organizations to effect social change at the intersection of music, film, language, art, science and technology. Our mission is to elevate the conscience of global society through the creation of public art-music projects and bridging groundbreaking technologies with music applications. We believe operating at the intersection of neurotechnology (mind-reading devices), AI, and music technology will heighten the human brain's capacity for music creation. Crumpler has received numerous prestigious awards from the Morehead-Cain Foundation, Tandy Technology Foundation, Elks National Foundation, United States Artists, Musicians Foundation, Ministry of the Flemish Community, Bank of America, a Research Education Support Fellowship from the NIH, plus nearly a dozen international music prizes for music performance, as well as a 2015 bid from the Atlanta Music Project for the Pulitzer Prize for Music Composition.

Embodiment of Environmental Legacy: Walking in E-Textiles and Thoughts from my Basement

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Abstract

It was the many possibilities of witnessing embodiment that I felt was especially pertinent to my artist research. Therefore, the outputs of my e-textile were sounds that altered in frequency and speed as I came into proximity to different elements in the landscape. I created such an e-textile to challenge my own interpretations of what they are and could be as a creative, tactile tool for learning about the embodied experience of a space—all during a pandemic.

Walking

As I write this, it has been six months since schools across the country have shut down. The University of Washington was the first university to start what would become a nation-wide trend of schools closing campuses and moving online as they tried to grasp the realities of the pandemic. Feeling whiplashed and shocked, I sit here now, in my basement, holding the pieces of my last year together. I grieved, raged, sat, marched, and crafted, but most importantly, like so many others, I walked. As the pandemic continued to claim some lives and shake up others, I continued walking. I began connecting my research and design of e-textiles to this daily practice. Movement in space is required for e-textile to work as an art piece. Walking produces the results of movement that makes this e-textile a tactile art experience. This piece intends to explore the concept of walking while wearing e-textiles as an approach to exploring landscapes. It also explores the nuances of digital art and its ability to underscore the importance of personal encounters with post-industrial landscapes. Yet, my real intent for this thesis was to walk and exist in my making, therefore living the embodied experience of place.

Ultimately my basement bedroom has been the start and finish of each journey. There were no two different sites that I began or ended with, and that is how I looked at walking—not a means to an end, but as a means unto itself, a meandering mode of embodiment in the landscape. This was my process, which Delueze and Boyman (2001, 29) describe as a dynamic state of "between-moments." I emphasize this state of "between-moments" because walking is ultimately about connection to spaces, the betweenness that binds each place to the next—and thus it is a moment of importance in and of itself. Walking becomes a mode of shifting and modifying landscape through desire. As shifting and modifying is formed by body, how we shift and modify is informed by landscape. In this way, the body can transport itself though the

Fig. 1. *Embodying the Environmental Legacy piece*, 2020, Jackie Donovan, cotton/canvas, copper tape, Arduino.

landscape with ease. When embracing the ideology of between moments there is a sense of importance to flow, movement, and connection. Walking is a tool to rationalize our changing surroundings, allowing us to understand our environment. Therefore, these "between-moments," and the flux that characterizes them, are essential to understanding my approach to this abstract.

E-textile

This e-textile design, which I call the *Embodiment of Environmental Legacy* aims to amplify systems thinking while binding the body to land through walking. While stitching the e-textile, I envisioned a post-industrial urban landscape as a perfect challenge for utilizing the piece. In her book, *The Mushroom at the End of the World; On the Possibility of Life in Capitalist Ruins*, Anna Tsing describes a capitalist ruin as a landscape that recognizes the damage wrought by the "history of the human concentration of wealth through making both humans and non-humans into resources for investment." Tsing ultimately identifies a capitalist ruin as "spaces of abandonment for asset production" (2015, i), which is exactly what a post-industrial site embodies. Walking in e-textiles became a new meaningful journey to understand "capitalist ruins."

I started with a set intention to explore a space that has been entirely altered by production and industry. I wanted a sense of discovery to explore objects within that landscape by wearing my e-textiles. The lure was intensified by the idea of finding hidden aspects of "what once was" (Tsing, 2015, x) peeking out at the edge of the waterfront. The site I selected for my exploration of landscape while wearing my e-textiles is a superfund site, the Duwamish River's industrial waterfront. The river bears witness to the transformation of landscape as a result of America's focus on shaping nature into a tool of capitalistic efficiency. By straightening the river, the main function of the Duwamish River became more about production rather than the local ecology. I wanted to explore these capitalist ruins to suspend my bias on what landscape should be.

References

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Tsing, A. 2015. *The mushroom at the end of the world: On the possibility of Life in Capitalist Ruins*. Princeton: Princeton University Press.

Biography

Jackie Donovan is a designer/researcher/artist/plant mom/pen pal depending on the context. She is a simple humanoid that recently graduated as a Master of Landscape Architecture candidate at the University of Washington. Her research explores the environmental legacy and phenomenology of site through e-textiles. She aims to curate meaningful moments of environmental intimacy by amplifying the human experience within space/place. She is always looking for ways to engage in feminist practice, speculative design, and soft art. Mostly though, when not working she likes to hang out with buddies while looking at plants and fungi, watch Youtube tutorial and commentary videos, and sketch stuff around her.

Fig. 2. *Fabric Speaker*, 2020, Jackie Donovan, cotton/canvas, copper tape, Arduino.

Mimicry

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Abstract

In this talk, Lingdong Huang and Ziwei Wu will discuss their new project, *Mimicry*, sharing their experience in integrating art and technology, in this particular project, as well as in their creative practices in general.

Ziwei will talk about their collaborative work *Mimicry* first and discuss the work structure and other research details. *Mimicry* is a multi-screen video installation powered by computer algorithms and inspired by mimicry in nature.

Lingdong will elaborate on the details of the genetic algorithm used by *Mimicr* and specifically how computer simulated phases of mutation, crossover and selection lead to the gradual evolution of the insects' camouflages, and how the underlying data are encoded and presented.

Mimicry: Algorithm as a new and altered nature

Mimicry is a multi-screen video installation powered by computer algorithms and inspired by mimicry in nature, the unique way that species protect themselves by changing color and pattern in response to environment.

In this experimental art piece, cameras will be recording plants in real-time, and through a genetic algorithm the color and shape of virtual insects will be generated and evolved over time, toward the ultimate goal of visually blending into the recorded background. This simulated breeding, selection, and mutation are visualized across the video monitors positioned in front of the aforementioned living plants as they progress.

A Real-time Loop System of a Machine Learning Insect

In addition to exploring the intersection between nature and computation, this work has relevance to the human society as well. As Walter Lippmann describes it in his book *Public Opinion,* people construct a pseudo-environment that is a subjective, biased, and necessarily abridged mental image of the world. Real environment, pseudo environment, human behavior and its consequences influence each other to construct a loop structure. To a degree, everyone's pseudo-environment is a fiction.

The setup of the installation is an homage to Nam June Paik 's TV Garden. Paik imagined a future landscape where technology is an integral part of the natural world. We find that perspective compelling, even today in 2021.

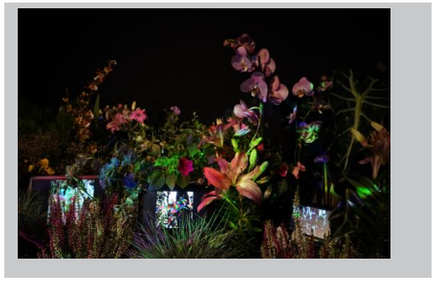

Fig. 1. *Mimicry*, 2020, Lingdong Huang and Ziwei Wu, Copyright belongs to Artist.

Fig. 2. *Mimicry*, 2020, Lingdong Huang and Ziwei Wu, Copyright belongs to Artist.

Fig. 3. *Mimicry*, 2020, Lingdong Huang and Ziwei Wu, Copyright belongs to Artist.

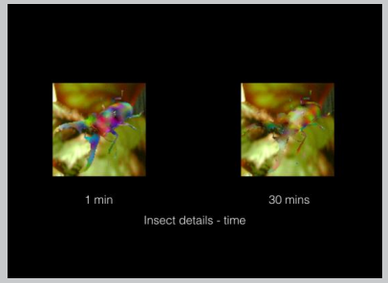

Fig. 4. *Mimicry*, 2020, Lingdong Huang and Ziwei Wu, Copyright belongs to Artist.

References

Previous artist talks:
https://virallife.vitenparken.no/
https://vimeo.com/472054066/71ba5d80f4

Biographies

Lingdong Huang is an artist and creative technologist specializing in software development for the arts. His fields of expertise include machine learning, computer vision and graphics, interaction design and procedural generation. Born in Shanghai in 1997, he recently received a Bachelor of Computer Science and Arts (BCSA) at Carnegie Mellon University in December 2019. His better - known works include *wenyan-lang* (2019), an esoteric programming language in Classical Chinese, {Shan,Shui}* (2018), an infinite procedurally generated Chinese landscape painting, and doodle-place (2019), a virtual world inhabited by user-submitted, computationally- animated doodles.

Ziwei Wu is a media artist and researcher who born in Shenzhen in 1996, received a Bachelor of Inter media art at China Academy of Art and a MFA student in Computational Arts at Goldsmiths. She is currently a PhD Candidate in Computational Media and Arts, Hong Kong University of Science and Technology. Her artworks are mainly based on biology, science and their influence in society. She utilizes a range of media like painting, installation, Audio-Visual, 2D and 3D animation, VR, and digital mapping. She has won many awards, including the Lumen prize, the Batsford prize and has been funded by Ali Geek Plan. Her international art exhibits include Watermans Gallery London, The Cello Factory London, Himalayas Museum Shanghai, Yuan Museum Chongqing, Times Art Museum Beijing, and OCAT Shenzhen.

The Interpretation of (Deep) Dreams

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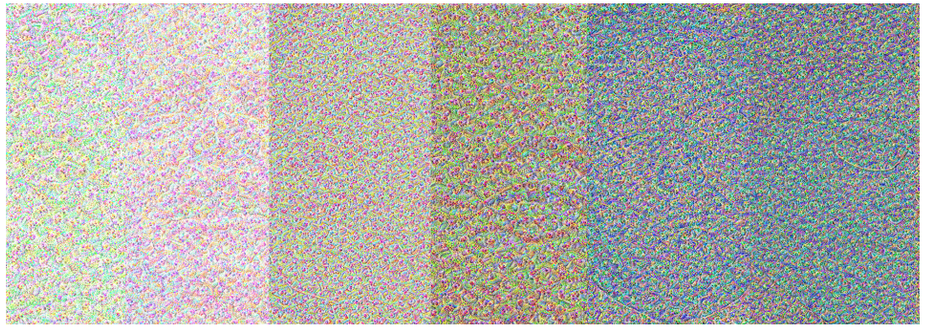

Fig. 1. *Slow Fakes,* 2020, Kwan Q Li, DeepDream-generated imagery, © Kwan Q Li.

Abstract

Every arrival of new visual forms has a long journey ahead until occupying a unique position within the existing art canon. The politics of images are never confined within the visible, as the production process is as important as its consumption and circulation which yield an ecology that could have political implications. Probing into versatile semiotics of Deep Dreams, a digital dream machine that signifies machine-learning advancements, deconstructive approaches in artistic and creative practices might help to unleash a generative space that transfigures a contested machinal spectacle and synergizes the rapidly evolving field of computer art with a provocative agency of contemporary art.

'Deep Dream' as a Linguistic Subversion

DeepDream, created by Google engineer Alexander Mordvintsev in 2015, is a computer vision program that utilizes a convolutional neuronal network and a pareidolic algorithm to generate a specific tactility of images that are often seen as hallucinogenic. The code prescribes a trained deep network to identify visual layers in an input image, then modify this image to enhance desired patterns through iterative activations (Mordvintsex 2015). As against the deepfakes genus which is often criticised to manipulate truths, DeepDream generates images that are instead hailed for their dynamic plasticity.

One may call the over-processed aesthetic of DeepDream a mistake, whilst Mordvintsev resorted to poetics and called the unwanted images the machine's "dreams." This mesmerising act of linguistic subversion turns the notorious deepfake into the nostalgic DeepDream. In between indexical reality and manufactured fakery, there exists a subliminal space of dreams that defies dualities such as true/false, correct/mistake, legal/unlawful.

In "The Interpretation of Dreams," the classic work of Sigmund Freud written in 1913, he quoted philosopher Ludwig Strumpell's note that "he who dreams turns his back upon the world of waking consciousness" (Freud 1913, 4-5). The fine line between truth and fiction seems to be a deliberate stretch, a voluntary submission that might be seen as religious more than reason-based.

From Optical Errors to Aesthetic Prompts

As its distinctive output style is what has defined its essence, the DeepDream program has mostly been seen as an end rather than a means. Exposing the not yet overcome limitations of machine learning in realistic visual generation, it is largely seen to be a window to the science of artificial neural networks, whilst yet to be internalised within mainstream visual culture and artistic media. Its semiotic transition from an "error" to a "dream," however, incubates a rhetorical proposition that can potentially bridge artistic and computer art languages in a new way.

The French philosopher Jacques Rancière noted that the politics of aesthetics lies in the practice and modes of visibility of art that reconfigure the fabric of sensory experience (Rancière 2010, 140). In response, the aim of the two creative interventions of this work is to interrogate the visual poetics of DeepDream for new meanings to bestow onto these mechanical visuals that are still read primarily through surface quality.

Interventions – Soft and Slow Fakes

Mesmerizing images by DeepDream recall deeply intricate sentience amongst us, and especially towards contemporary politics. In *Slow Fakes*, a set of 6 political leaders' portraits were selected and processed via the Deepdream program. Against the common illusionary effect that rearranges the original image in titling patterns and identifiable features, our experiment targets a set of parameters that dissolve the visible rather than accentuate particular characters, resonating with the aspects of dreams as invoked by the work's interests.

The second intervention *Soft Fakes* investigates further potentials for manifesting generative images, which are liberated from being screen-based image networks to entable tangible agency. The work suggests alternative formats for deepfake and DeepDream imageries to engage audiences beyond the objectives of novelty or entertainment. A series of masks that prevailed in different global activist waves such as the Egyptian Revolution and Extinction Rebellion in the last decade are stitched together to imagine a new layer of consciousness. The collage fabric, ostensibly shields an unknown organism gasping beneath, evoking a sense of vulnerability in the age of multiplicity. For more, please visit https://slowfakes.info.

One of these experimental implications lies in how fictitious materiality and ambiguous aesthetics could potentially empower individuals through provocative language that might spark new conversations in social-political debates. Besides, the physiological and psychological interpretations of "dreaming" might be worth further exploration to develop this discourse of generative art.

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Biography

Kwan Q Li is an interdisciplinary artist from Hong Kong. Coalescing lens-based mediums, performance and writing, her research-based practice explores creative possibilities and generative alternatives within postcolonial, technopolitical and anthropocentric contexts. Former exhibitions include performances and lectures at the AI and Society Journal conference, University of Cambridge in 2019; the Hong Kong Art Book Fair: Booked, at the Tai Kwun Contemporary in 2020; the IdeasCity residency co-curated by the NTU CCA and the New Museum in 2020; and the Venice International Architecture Exhibition—Hong Kong Pavilion in 2021.

Queenie holds a BFA degree from the Ruskin School of Art, Oxford University and a B.B.A. in Global Business Studies from the Chinese University of Hong Kong. Currently, she holds a teaching fellowship in the Program in Art, Culture and Technology at MIT.

Heat

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Abstract

While the destructive forces of environmental heat are critical, they are often invisible and therefore difficult to acknowledge. This paper describes a computational artwork titled *Heat* which visualizes thermal energy as a locally destructive force. The project is screen-based. Each artwork in the series depicts a system of thermal agents set in a 3D grid that models the absorption of heat. Agents rely on signals from their environment to generate individual thermal conditions. Changes in agent states are rendered as deviations in color, size, and location, on the grid. As the heat in a system rises, agents distort their positions and appearance. This paper describes the design of two of the grids in the series, grids no. 4 and 5.

Project Overview

Fig. 1. *Heat, Grid No. 4*, t1, 2021, Angela Ferraiolo, digital file from computational system.

Informally known as "global warming," the Anthropocene can be imagined as a kind of accumulating heat, a phenomenon that puts the entire biosphere in peril. Many artists have hypothesized a "blue planet" at risk. But recent observations on global warming describe the distribution of heat as both even and patchy, a result of what Kim Fortun (2012) calls "late industrialism," in which some locations, and some bodies, are more exposed to hazards than others. Social theorists have observed that geographic, economic, ethnographic, and sociological forms of environmental risk imply a new kind of thermal necropolitics (Mbembe 2003), in which heat kills not globally but selectively. These "selective" instances of damage are often local and isolated. As a result, some aspects of the Anthropocene can seem random, formless, harder to discern, or somewhat invisible.

The Grid as Metaphor

One way to describe this kind of scattered danger might be to visualize it as a disruption in a formal pattern at a specific location. This kind of visual strategy would cast the failure of pattern as an aesthetic breakdown as well as a transgression of formal logic. For this artwork, the grid was chosen as a good candidate for algorithmic disruption because of its visual clarity. But grids also have some resonance with the economic strategies of capitalism and post-capitalism.

For many cultural theorists, grids are a fundamental organizing scheme in industrial and information age societies. In one of the first cultural appraisals of the grid, art historian Rosalind Krauss described grids as an emblem of industry, a conceptual structure for standardization and mass production. The grid Krauss wrote, "turns its back on nature." French anthropologist Claude Levi-Strauss saw grids as structures with the ability to state a relationship between the individual and society as a

relationship between the module (or what is contained) and the grid (the container). Art historian Hannah Higgins writes that the distortion of a grid has clear implications: "As much as they [grids] produce opportunities for organization, communication, and control, they also offer occasions for analysis and, where the grid is broken, cultural upheaval and change."

Here, the evolution of a grid can be interpreted as a system that is changing. The contents and some aspects of the form of a grid can be viewed as features that might mirror states of variation in a system.

Project Design

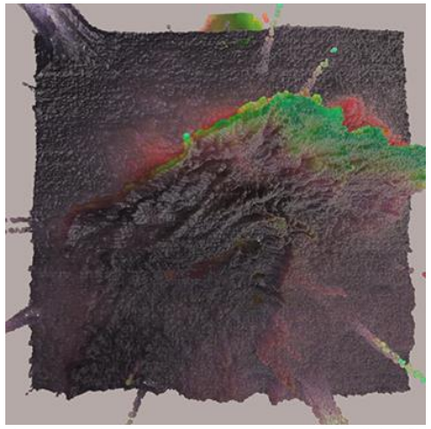

Fig. 2. *Heat, Grid No. 5, t_1*, 2021, Angela Ferraiolo, digital file from computational system.

The grids in these systems are made up of two layers of agents. Each layer is organized on its own network of links. Agents receive system input at regular time steps. As the heat entering a system increases, that "energy" is "absorbed" by agents and reflected as a change in color or x, y, or z location. As a feature of each agent, certain properties can be more or less resistant to heat or, following the project's design metaphor, more or less at risk for environmental stress. Figures 1 and 2 above represent the output of Grids 4 and 5.

In conclusion, the project Heat consists of a series of grids that were designed to reflect the "patchy" effects of heat as an environmental stress. The design of the project draws on ideas from the art history, sociology, studies of the Anthropocene, political science, and agent based adaptive systems. The motivation for this project was to explore the grid as an adaptive system as an expressive form.

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Biographies

Angela Ferraiolo is a visual artist working with adaptive systems, noise, randomness, and generative processes. Her work has been screened internationally including Nabi Art Center (Seoul), SIGGRAPH (Los Angeles), ISEA (Vancouver, Hong Kong), the New York Film Festival (New York), Courtisane Film Festival (Ghent), the Australian Experimental Film Festival (Melbourne), and the International Conference of Generative Art (Rome, Venice). Professionally she has worked for RKO Studios, H20, Westwood Productions, Electronic Arts, and Hansen Literary. She teaches at Sarah Lawrence College where she is the founder of the new genres program in visual arts.

Infinite Descriptor: The (Un)Predictability of Prediction

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Abstract

Machine learning as a form of prediction attempts to know the world or determine its future events through statistical modelling, where artificial neural networks form models by processing vast amounts of data. However, despite the aim of predictions to curtail futurity, even when it is working "as it should," we experience algorithmic activity in the world unfolding in "ways that stray from calculable paths" (Amoore 2019, 163).

This paper and the practice-based research it details, *Infinite Descriptor*, approaches the seemingly aberrant activity of predictive algorithms as immanently part of their actuality, as indicative of their mode of being and reasoning in the world (Parisi 2019). I propose that divesting from algorithms the idea that they can determinately calculate or be optimal enables us to grasp how they are transformational or generative rather than citational. In terms of artistic or design practice, this presents an opportunity to work critically and creatively with predictive algorithms.

Infinite Descriptor

Infinite Descriptor is an installation where three different major image recognition platforms take a "walk" together through the latent space of a "cloudy" predictive machine learning model. Echoing empirical descriptions penned by naturalist writers wandering through and seeking to "truthfully" capture the landscape and its atmosphere, the work interrogates a problematic representationalism that is fundamental to machine learning practice and culture. This representationalism pivots around a claim that through machine learning's capacity to emergently generalize relations within large-scale datasets, via training, a homologous description of reality or thought processes can be formed or generalized within its models.

The three image recognition platforms were fed image stills taken from a video of clouds forming. This video was generated by training a general adversarial network or GAN on a database of cloud images and then taking a latent walk through the model. When shown the same stills from the video, each image recognition platform produced different classifications, with variation present in the types of labels detected and their confidence scores. These differences were then used to computationally generate a spoken conversation between the three image recognition platforms about what they see. An example statement from the generated conversation: "Abstract, or artificial, and high illumination, I do not know. It is impossible to show the actual color of the clouds above me, but I will take the light and make it into a picture."

By placing the three image recognition platforms into differential relation, I amplify how each of them is a contingent and specific human-machine re-configurement of "seeing," rather than a generalized vison. This diffractive methodology (Barad 2007) demonstrates the ongoing differences generated by machine learning as a decision- and knowledge-making practice. The predictions by the different image recognition platforms create indeterminate futures, as rather than simply objectively describing or reflecting what they see, the differences they generate due to their specific configurations affect what can and cannot matter in the world.

Rationale

In broader machine learning practice, errant behaviors, such as bias, are treated as productive occurrences that can be assimilated back into the practice and its models (Amoore 2019). For Louise Amoore this means that simply pointing to erroneous activity cannot destabilize machine learning's epistemic authority because its practice and field are oriented around optimization and error-correction. Unexpected outcomes and contradictions between what predictive algorithms are instrumentally optimized towards (i.e. generalized image recognition) and their actuality are only put down to technical error (Weizenbaum 1976).

In contrast to broader machine learning's approach to error, I consider *Infinite Descriptor* what Amoore calls a "badly formed composite" (Amoore 2019, 165). Within my practice, this means conceiving of computational assemblages as contingently formed, incomplete and inconsistent. This does not mean that technically *Infinite Descriptor* does not work, but that in its making a sublime implementation was not achieved, nor was it the objective. Instead, after the work of Adrian Mackenzie (2017), I take up diagramming as a method to trace the actual material diversity of datasets, implementations, models, and techniques of which machine learning practice is composed. This method fosters opportunities to discover and articulate "points of slippage or instability" that may unsettle prediction's authority, and through which we can become attuned to its capacity to generate alternate forms of differencing (Mackenzie 2015, 441).

I would like to acknowledge the ongoing support and input of my PhD supervisor Professor Anna Munster and artist Kynan Tan.

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Biography

Practice-based researcher **Monica Monin** explores design and creative practice within an overabundant and heterogenous media ecology. Specifically, her research addresses the effects, possibilities and role of computation, code and data within poetics (making). She further questions how we can critically work with coding practices in order to better apprehend the intensive media environments involved in the production of knowledge and meaning-making. She is a lecturer in Visual Communication at the University of Technology Sydney and is currently undertaking a PhD at the University of New South Wales. More info: http://www.monicamonin.com.

Smile, Please

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Abstract

Smile, Please is an interactive installation created in response to the prevalence of emotion AI and societal coercion of emotions.

Introduction

Several events informed the perspective of this work in thinking about emotion AI. The huge global deposit of emotion in database form collected by companies such as Affectiva and Beyond Verbal (Nesta 2018). The impact of psychological warfare in technology as revealed by the Facebook and Cambridge Analytica scandal. China's social credit system. Paul Ekman's work with US intelligence agencies and major tech companies (Heaven 2020).

Fig. 1. *Smile, Please* Installation Close-up, 2019, Winnie Yoe, Custom Electronics. Copyright Winnie Yoe.

The installation features a smile evaluation system that "trains" users to become a citizen of "the preferred society," where they are guaranteed better future prospects. The only entry requirement is that they smile well enough. The system uses a hacked Polaroid camera to tell users if their smile is "good" enough while also using a TENS unit to shock the person if their smile was not "good" enough. After each engagement, participants are given a copy of *The Manual of Smile Etiquette,* a guidebook with exercises to improve their smiles.

Through an extreme approach, dark humor, and by creating visceral discomfort, with a mechanism that refers to Pavlov's classical conditioning and the Milgram experiment, *Smile, Please* hopes to shock the audience into thinking about the implications and ownership of our emotions in the current societal and technological landscape.

Fig. 2. *Smile, Please* at *IMPAKT 2019: Speculative Interface*, 2019, Winnie Yoe, Custom Electronics. Copyright IMPAKT Festival.

Process

The *Smile, Please* machine is primarily created using a TENS unit, a MyoWare muscle sensor and electrode pads, a Polaroid Camera (the first iteration uses a thermal printer, which is replaced by a hacked Polaroid camera in the second iteration), an LCD display, and an Arudino.

Several playtests were conducted before testing with other volunteers and exhibited in public. Early playtests demonstrated the necessity to create a strong narrative in order to translate an effective message to the audience and to situate them into the fictional world (Benedetto 2017). To achieve that, a dystopian

narrative is crafted using graphic design, film languages and theatrical devices.

Interaction

When a viewer approaches the installation, they are asked if they want to learn more about the smile evaluation and training system. Performers in lab coats inform them that if they failed the smile test, the system will generate a light electric shock to their face to remind them to smile better. If the viewer is open to the idea, performers will ask them to sign a waiver and proceed to attach the electrodes and sensors. Then, the performers asked users to press the push button whenever they are ready and hit the emergency button whenever they feel uncomfortable. There are three possible outcomes: "Nice Smile, You're One of Us", "Almost There, Smile Harder", and "How Terrible, Fail." In the latter two instances, the TENS unit generate a shock to the user.

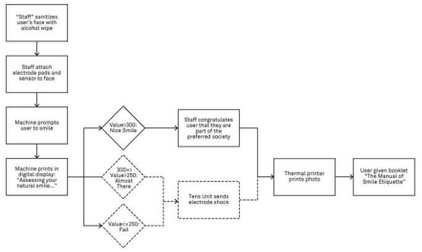

Fig. 3. *Smile, Please* User Journey Diagram, 2019, Winnie Yoe, Custom Electronics. Copyright Winnie Yoe.

Implication

Smile, Please builds upon previous work related to face analysis created by artists and researchers as an effort to continue probing what a future increasingly driven by AI will look like (McDonald, 2020). The goal of the project is to open up avenues to this discourse through art-based research, and in this case, through exploring the potential of such conversations through an embodied, visceral, gamified interactive experience.

Exhibition and Documentation

Smile, Please was exhibited at the International Symposium on Electronic Art (ISEA) and IMPAKT 2019: Speculative Interface. It was initially conceptualized with Chenshan Gao, and has been performed with Gao and JoJo Lau. Trailer of the project can be found at: https://vimeo.com/306745527.

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Biography

Winnie Yoe is a Hong Kong-born, New York-based artist, designer, and educator who creates interactive stories and digital tools to communicate complex information around issues of social justice. Her work has been exhibited at the ISEA (KR), IMPAKT Festival (NL), CultureHub (US), and Tai Kwun Contemporary (HK) among others. She has taught as an adjunct professor at New York University's Integrated Digital Media Program (IDM) and has spoken at various conferences including the Processing Community Day in New York. She is a graduate of New York University's Interactive Telecommunications Program (ITP) and Dartmouth College.

The Moving Maze—System and Units

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Artwork Description

In a system, complexities arise from the simplest and most elementary things. A brainchild of our gamer philosophy, *The Moving Maze* is a maze that could move its parts methodically in response to the player's movement, as if a chess player were vying with the chessboard. We design a method that generates an unpredictable and self-renewable system with fragmental movement according to simple gamer-interactive rules, in which the gamer achieves the joy of navigating through discovering these moving rules and smartly rerouting with human-specific flexibility of mind.

Artist Statement

First, we are interested in complex systems. Second, we are in pursuit of a unit that is homogeneous and neutral in and of itself. Simultaneously, we are enticed by mazes as an archetype of play. Ultimately, we are motivated by creating an organic game with the least contrivances that brings out the most variations of scenarios. *The Moving Maze* is where all of these obsessions and contemplations converge.

Project Description

In *The Moving Maze*, the protagonist is represented by the player enters the maze and aims to navigate a way to a given destination. The initial layout of the maze is randomized according to some principles. With each step the player moves, the system takes the direction of the move as an input and makes one change to the maze layout by applying implicit rule-based operations to some of the maze parts. The sensitive player, who summarizes their patterns of movement and picks up the rules eventually navigates to the destination with eureka moments.

System-Unit Relationships

There are two kinds of systems according to the part-to-whole relationships posited by Reiser & Umemoto (2006)—systems made of parts with stable meanings, such as chess, and systems made of parts whose meanings depend on their contextual relationships, such as go. In a system consisting of only one kind of parts, the form of parts is not so important as the relationship between parts, which makes the whole much more than the sum of its parts. This go-like structuralist approach in tectonics aligns with Jonathan Blow's idea (Blow, interview with Peckman, 2016) that a good game is one designed with the least contrivances (human-imposed rules) that can generate the most variations. *The Moving Maze* tests out the theoretical framework of a complex system in which the uniform and homogeneous units are arrayed equidistantly, but which can generate a myriad of variations in the configuration.

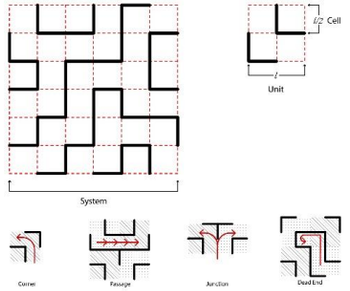

Fig. 1. *The Moving Maze*, System, unit, cluster. 2021, Yiou Wang & Yujie Wang, video game, Copyright of the authors.

System-Unit Maze-Building Method

Different from maze-generation algorithm precedents (Kim, 2019; Hamada, 2013), we assume the maze system as a field composed of homogeneous units oriented randomly at default. Upon rigorous tests, we fixed the form of the unit as a double "L" in order to generate from its combinations all types of nodes found in a standard maze—corners, passages, junctions and dead ends. The proposed units are devoid of independent meaning or variation of intensities as standalone elements but bind to each other in a wide range of possible configurations and propagate into a field of uneven intensities from their interdependent relationships. Thus, without intrinsic qualities, the units are neutral, but their collective is heterogeneous, mutative, and responsive. Their collective forms a multicursal maze which elicits humans' curiosity around routing. The player's movement direction and distance methodically trigger unit-centered orthogonal rotations in part, resulting in time-based, interactive variations in the configuration of the whole.

Fig. 2. *The Moving Maze*, 2021, Yiou Wang & Yujie Wang, game cover image, Copyright of the authors.

Scales

The Moving Maze has different characteristics on three different scales. On the microscale, it is uniform and homogeneous—each one of its units is identical with the rest; on the mesoscale, where we examine clusters of adjacent units, the maze is semiotic, characterized by *corners, passages, junctions, and dead ends*, each type having stable meanings in terms of navigation and spatial logic; on the macroscale, as a unity, the system is unique at each moment.

Reactive, Recursive Movement

Radically different from a conventional maze, puzzle, chess, or board game, the maze's recursive self-adjustment to its layout is reactive to the player's action. The locus of this change is locally based. In each turn, the gamer can move in any orthogonal direction for arbitrary steps. Then the system would transform configuration of units by partial unit rotation to respond to gamer's movement.

Technical and Logistical Requirements

Game, the ninth art, is the best medium of the artwork because interactivity leads to adaptability of the maze. The video game *The Moving Maze* could be played on a computer with keyboard, or a touch-screen tablet. The interface could be projected to a screen that turns the individual player activity into a public event.

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Biographies

Yiou Wang is a multidisciplinary artist and architect encompassing architecture, drawing, digital illustration, comic, game, and video. With a psychology background and an architecture training, Yiou focuses on gamified architecture, design for indeterminate programs, gamer as the basic state of being, and human consciousness. Yiou is an architecture master's student at Harvard University Graduate School of Design.

Yujie Wang is a graduate student at MIT. He enhances human connection through shaping human-machine and human-environment relationships.

Flux Garden—a Poetic Memory of a Lost Garden in VR

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Abstract

The room-scale VR experience *Flux Garden* is a poetic reference to a former Chinese Garden in Singapore. Spatialised music compositions accompany the spirits of dancers and turn each walk through the impressionistic dream-like landscape into an individual and unique experience.

Fig. 1. *Yunnan Garden VR – Flux Garden*, Seide, Reinhuber, Williams, still image from VR experience, © 2020, the authors.

Flux Garden

Based on intensive research on how to capture and digitally re-create and represent the former Yunnan Garden on NTU campus in Singapore, the project created the immersive 360˚ experience *Secret Detours* (2017) and the room-scale VR experience *Yunnan Garden VR* (2019), a realistic 3D re-creation of the former garden which served as a platform for different applications of which *Flux Garden* (2020) is an expressive approach, incorporating dancers and audio-compositions in a partially realistic and partially impressionistic representation of the garden.

The conceptual background is based on the observation that many of the impressive tropical trees had to make room during construction of the new garden. In our interpretation, abstract dancers symbolize a reincarnation of the logged trees, most of them hiding in grave-like caves. The abstract landscape of roundish caves are fragments of the trees based on their 3D reconstruction from photogrammetry with insufficient data. The environment is the result of experiments combining abstract and realistic elements, leading us to merge a low-resolution 3D reconstruction with our accurate re-creation, resulting in an impressionistic dream-like memory of the garden (fig. 1).

The *Spirit* Dancers: Motion Capture and Particle Simulation

As a reference to our first approach to fuse performances with immersive 360° captures of the garden in *Secret Detours* (2017), we again worked with Choreographer Susan Sentler to motion capture expressionistic dance performances with a camera-based Vicon system. A composition of real-time particle simulations surrounding and emitted by the dancers, resulting in a slowly disintegrating and then accumulating particle field allows the audience to observe a spiritual representation of the performances (fig. 2). 13 variations of performances and colors are scattered over the fragmented landscape, inviting the audience to meander and explore its secrets.

Fig. 2. *Yunnan Garden VR – Flux Garden*, Seide, Reinhuber, Williams, dancer with particle simulation, © 2020, the authors.

Spatial Music

Music plays a key role in immersion, navigation and driving user engagement. Since many of the dancers are only visible while within the roundish caves, music helps entice users to explore inside the abstract forms within the garden. At any moment a user might experience fleeting moments of music emanating from multiple directions and a musical treasure hunt was imagined with the user invited to find all the 13 dancer's locations and their accompanying music. As they investigate the garden, they are constructing their own meta composition from the music they discover. While each composition is unique, it is related to the whole through harmony or rhythm or melody. Precisely adjusted attenuation and EQ curves are employed to place the spatial music quite specifically in each location but also to allow it to filter into the surrounding area. Moving closer to a dancer increases the volume and affects the equalization of the music. Standing directly in front of (or even within) the particle dancer the user is fully surrounded by and immersed in the music.

Conclusion

While a painstakingly executed approximation of the vanished park informed our operations, reminiscing on the lost landscape taught us something further. Rizzo and Mignosa argue in the "Handbook on the Economics of Cultural Heritage" (2015) that narrative involvement is crucial for the success of Virtual Heritage applications. We argue that creating an audio-visual interpretation of heritage may also successfully benefit the engagement and involvement of the audience. Our approach is an artistic one, in that we are combining realistic and abstract elements of the garden into a new work. Beyond the preservation aspect of the *Yunnan Garden VR* experience, *Flux Garden* offers an interpretation of heritage with the aim of benefitting the audience's emotional involvement.

Acknowledgement

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Biographies

The authors currently teach and research in Media Art, **Benjamin Seide** and **Ross Williams** at ADM, The School of Art, Design and Media at NTU Singapore, **Elke Reinhuber** at the School of Creative Media, City University of Hong Kong. With their experience and specific expertise in the areas of sound design (Williams), computer animation and visual effects (Seide) as well as camera and concept (Reinhuber), they explore the fascination and possibilities of immersive media from different points of view, especially in regard to representations of culturally relevant subjects.

Co-creating Musical Compositions with an Artificial Agent: Time-travel through Machine Learning

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Abstract

In recent years, co-creation of artistic artefacts with artificial generative agents is becoming more accessible and effective. We offer here our personal considerations as artists exploring this novel creative context where boundaries of agency and control between human and machine are blurred. Through our experience we hope to suggest a possible direction for the future of AI-assisted musical composition.

Identity Reflection

Which elements of a composer's identity are imbued into their work? Do we have evidence to claim that there is some measurable predictability in the style of an author, such that it is possible to extract part of that identity? To what extent do Generative Adversarial Networks (GAN) (Goodfellow, et al., 2014) and Variational Auto-Encoders (VAE) (Kingma & Welling, 2013) exploit, and to what extent are they fooled by, this predictability?

It seems evident for anyone exploring the intersection between art and machine learning, especially generative deep learning, that the predictability of an author's work, or at least some of its elements, is the underlying assumption for both classification and generation. After all, statistics and probability are the foundation of machine learning.

On the other hand, we feel that, while this predictability is measurable, it certainly is not the entire picture. As artists, we grow and evolve over time, we learn (and unlearn) tools for self-expression, we push ourselves to create novel and interesting output rather than something predictably ours. As a result of this evolution, an artist's work often reflects the internal changes and the different influences they may have had in different periods of their life.

Time traveling

We believe that pieces of work from the same author can be conceptualized as a continuous stream of self-expression, rather than individual units, all reflecting a single, monolithic identity. Within this framing, we extend the existing VAE and GAN models developed in the music domain (Roberts, Engel, Raffel, Hawthorne, & Eck, 2018; Simon, et al., 2018; Dong, Hsiao, Yang, & Yang, 2017), by introducing an additional latent constraint (Engel, Hoffman, & Roberts, 2018) that encodes a reference to the author's timeline (i.e., at what point in the author's life the composition was written).

This type of latent space conditioning allows an author to generate a track fitting any style or period of their career (hence, "go back in time") by simply controlling this attribute when sampling from the model. With active participation of artist, composer and producer Vicky Fung, we would like to investigate the possibility of such type of "time-travel" by creating (or re-creating) songs that reflect her identity from different artistic periods.

Vickynet

The desired outcome is to train a VAE model so that it can generate musical compositions in the style of Vicky Fung across arbitrary periods of her career; we will call this model *vickynet.* We intend to publish a web interface to *vickynet* to showcase its functionality.

The second objective is to co-create a novel musical composition using *vickynet* and while doing so, organize our thoughts and reflections on this type of creative process involving humans and artificial agents, around the central theme of blurred identity boundaries.

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Biographies

Vicky Fung made her debut in the Hong Kong music scene as a songwriter in 1996 and has composed works for many prominent local singers for over 20 years. Vicky has brought new impetus to Cantopop with her compositions and has been received prestigious professional awards such as "Best Alternative Composition," "Best Melody," "Best Song" at the CASH Golden Sail Music Awards in 2005, 2012 and 2018. As an artist, composer and producer, Vicky not only composes works for other singers, but has also released 3 albums of her own recorded compositions. She also curated the music for a multi-media show *Utopia, Momentarily* as part of the program for New Vision Media Festival 2016. Vicky held her recent concerts *Travelling Soul* at The Academy of Performing Arts in 2017, and *Surreality.Live* at West Kowloon Cultural District in 2020 to showcase her unique blend of aesthetics crossing between pop and art.

Giovanni Lion is a second-year PhD student in the School of Design at The Hong Kong Polytechnic University under the supervision of Professor Johan Hoorn. His research focus is centred around artificial intelligence and creativity, more specifically, concept formation in artificial agents. He adopts a transdisciplinary approach, spanning across Philosophy, Psychology, Cognitive Science, Computer Science and Design, looking for opportunities to decompartmentalize existing knowledge and identify synergies across disciplinary boundaries. As a practitioner, he is intrigued with algorithmic music, procedural generation in videogames, interactive installations and virtual reality. His interest in Artificial Intelligence crystallized in late 2017 as he had the opportunity to work as Robot Operator for Hanson Robotics, handling their humanoid robot Sophia.

How Can Artists Use AI Responsibly?

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Abstract

Machine learning tools provide the potential for unprecedented creative expression, but also the potential to cause unintended harms. *Making AI Art Responsibly: A Field Guide* is an illustrated zine composed of questions and case studies to help AI artists use AI techniques responsibly and with care. We argue that artists using AI should consider themselves part of the broader responsible AI community, considering factors such as consent of people represented in their datasets, labor involved in codebase and model development, and AI infrastructure and environmental costs of training machine learning models. Further, we believe that by reflecting on what is "responsible" in making their own creative works, artists can push forward best practices employed by all AI practitioners.

Background

When artists use AI technologies—whether they know it or not—they are participating in the research and development of AI. While responsible AI guidelines for academic researchers and technology companies abound (Gebru et al. 2018, Mitchell et al. 2019), this literature rarely speaks directly to the distinct needs and workflows of independent artists using AI. Despite this, artists are likely to face many of the same pitfalls as other practitioners, such as lack of dataset transparency, failure to obtain informed consent from people represented in datasets, and lack of understanding of the environmental costs and supply chain of labor involved in creating underlying AI systems. As a result, we set out to explore and address the specific needs of the AI art community in order to reduce unintended harms of their work.

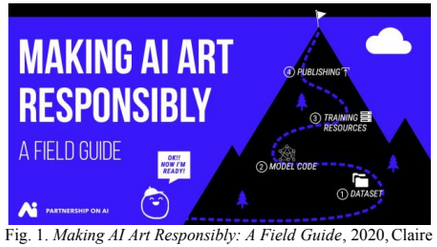

Fig. 1. *Making AI Art Responsibly: A Field Guide*, 2020, Claire Leibowicz, Emily Saltz, Lia Coleman, digital and print zine, ©The Partnership on AI. All rights reserved.

Development of the Guide

Making AI Art Responsibly (fig. 1) was created by the Partnership on AI with AI artist Lia Coleman following a July 2020 talk with Gray Area (Gray Area 2020), a cultural hub for art and technology in San Francisco. The initial talk presented insights from the Partnership on AI's own work on AI and Media Integrity (The Partnership on AI 2020). Coleman helped translate responsible AI issues into the workflows of independent artists using AI, drawing on personal experience with the common challenges faced by those in the "Artificial Images" AI arts community (Schultz 2021). During this talk, we further engaged attendees—many of them practicing artists using AI themselves—to share their own experiences, which went on to inform the guide's contents.

Field Guide Takeaways

The resultant field guide is structured around a path of questioning across four phases of creating AI works: 1) dataset, 2) model code, 3) training resources, and 4) publishing. In many cases, we pose questions rather than answers; this is because when it comes to the evolving AI field, many topics are subject to debate and should be built upon through trial and error. In the guide, we empower artists to lead in responsible AI practices. By taking care in how they create work, artists can serve as a model for others in the AI research space, or create provocations that push forward current best practices for using AI.

We conclude with several best practices. For example, we suggest that the least risky path to take for AI artists to take is to create their own datasets, curate images from the public domain, or ask for consent of those in a dataset, calculate the environmental costs of training, and document their work with explainable AI fields. While the field guide currently offers a starting point for AI artists, we intend for it to become a living document for creators to further discuss and shape as an ongoing part of their artistic practices.

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Biographies

Claire Leibowicz leads AI and Media Integrity efforts at the Partnership on AI. Claire holds a BA in Psychology and Computer Science, Phi Beta Kappa and Magna Cum Laude, from Harvard, and a Master's in the Social Science of the Internet from University of Oxford as a Clarendon Scholar.

Emily Saltz is a Researcher at the Partnership on AI studying misinformation. Before that, Emily led UX for The News Provenance Project at The New York Times. She has a Master's in Human-Computer Interaction from Carnegie Mellon University.

Lia Coleman is an artist, AI researcher, and educator who teaches machine learning artwork at Rhode Island School of Design. Her work has appeared in the NeurIPS 2019 conference, School for Poetic Computation, and Neocha Magazine. She holds a BSc in Computer Science from MIT

ISCRI: Communicating Between Two Alien Intelligences Through Art

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Abstract

ISCRI is a collaboration between artists and Machine Learning technologists that aims to produce both new kinds of aesthetics and artificial intelligence (AI) through interspecies research. Our aims are to develop an AI and, through imagining into the somatic tendencies of an octopus, an art experience that dismantles our western humancentric worldview.

Interspecies AI

ISCRI is offering a body of non-representational video artworks to an octopus. The kinds of images that will constitute the aesthetic provocations offered are informed by working with an interspecies communicator, swimming with octopuses, and through scientific and ethological academic research. The artist's *Becoming Octopus* project (Roberts 2020) showcases our initial explorations. Sensors monitoring the octopus responses will in turn modulate an emergent AI, mediating a kind of interspecies conversation in ways never tried before.

Our project primarily addresses the Art Machines 2 theme of Machine Learning Art and Ecology in that we are focused on the urgency of rethinking what it means to be human in the light of current developments in AI and ecosystem crisis. Underpinning *ISCRI* is the decentering of the western enlightenment human viewpoint through exploring how we might begin to communicate with other kinds of intelligence and consciousness (both organic and synthetic). Such multiplicity of communication feels imaginatively and ethically urgent today.

Transdisciplinary Collaboration

ISCRI, in development for two years, brings together the work of art collective 0rphan Drift and technology research consultancy Etic Lab LLP. The collaboration itself is an experiment—an interdisciplinary enquiry between multimedia/computational artists, Machine Learning (ML) technologists, cultural theorists, an interspecies communicator, a social psychologist and other scientists.

Previous aesthetics generated by AI as part of artistic explorations of algorithmic intelligence have been mostly harnessed to an artist's intention, producing the now familiar Optical Flow coded uncanny approximations of recognizable images (Huyghe 2018), the iterative images of Google Deep Dream, or GANNs reproducing old master paintings.

We minimize our control by using a form of ML called Reinforcement Learning that is not trained towards a pre-determined goal. Rather its development is determined by its learning thereby surfacing emergent and non-predictable forms. *ISCRI* is partnered by the Serpentine Gallery's Creative AI Lab, who are interested in how we will be transformed as humans through this experimental relationship with an octopus and an emergent AI.

Why an Octopus?

Octopus awareness is simultaneously individual and collective—a state for AI to aspire to. The octopus's nervous system is distributed throughout its protean body, with brains in each of its eight arms. In addition, octopuses are often highly curious and mimetic, they are noted for the ways they return the observations of underwater explorers and scientists, reversing the usual experimental paradigm, making them excellent potential interlocutors.

Computational Art

The "art made for an octopus" will explore the viewpoint of a distributed intelligence that does not prioritize vision-led perception (in the way a human does).

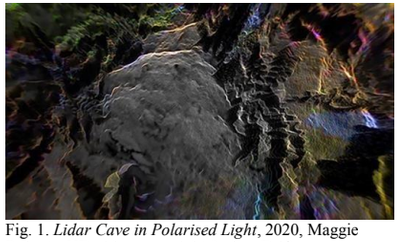

Fig. 1. *Lidar Cave in Polarised Light*, 2020, Maggie Roberts, HD video, copyright 0rphan Drift.

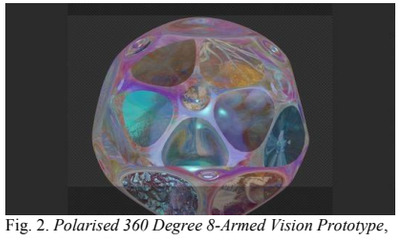

Fig. 2. *Polarised 360 Degree 8-Armed Vision Prototype*, 2020, Maggie Roberts, HD video, copyright 0rphan Drift.

Computational arts such as Blender VFX animation, visual coding and LIDAR enable us to imagine the environment as pattern and texture, from multiple viewpoints and scales simultaneously and in polarized light vision.

AI

The use of Reinforcement Learning to develop an AI will produce emergent behaviors that have not been, and could not be, humanly designed into it. The ML team will adapt their provocations for the AI in response to what it is doing, both visually and in terms of its emergent behavior. New kinds of communication or processing might be glimpsed, that will ultimately influence how we negotiate our relationship with non-human intelligences.

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Biographies

Maggie Roberts, co-founder of 0rphan Drift, with an MFA in Fine Art from the Royal College of Art, London, currently teaches Critical Studies at University of the Arts, London and is an internationally established artist. 0rphan Drift explores the boundaries of human and machine vision in an art practice that imagines into worldviews that are non-human in perspective. Recent exhibitions include *Becoming Octopus,* (2020); *If AI were Cephalopod,* (Artforum Critic's Choice, 2019); *Matter Fictions*, (2016).

Stephanie Moran is an Associate Partner at Etic Lab, with an MFA in fine art from Goldsmiths, University of London, and a previous career producing national and international projects in art and libraries. Currently an AHRC-funded PhD candidate at Plymouth University's Transtechnology Research. Etic Lab LLP is a design and technology research consultancy based in mid-Wales, with expertize in developing new forms of AI. They work across industry sectors on commercial, artistic and government-funded projects.

Tree and *Vanishing Islands*: Visualizing Epochs in 3D and Interpreting Fragments in GAN Art

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Abstract

This paper introduces a digitally-fabricated wind sculpture made with Voxel-DCGAN during the Summer Session 2019 international art and technology residency at Rotterdam's V2_Lab. It suggests a tree as a structure to "hang" and order GAN-generated models in 3D. Besides, the paper names and interprets a particular kind of fragment (*Vanishing Islands*) that appear in GAN-generated 3D models.

The Making of the Artwork

Fig. 1. Stars in Formation, 2019, Tengchao Zhou, polylactic acid (PLA), 12x12x24 cm, picture: Fenna de Jong & Berksun Doganer.

Fig. 2. A render of the sculpture.

Fig. 3. A tree structure.

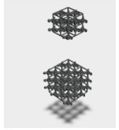

Fig. 4. Two matrices.

Fig. 5. 36 GAN-generated star anise pods.

The artwork is a combination of a tree structure (fig. 3), two matrices (fig. 4), and 36 GAN-generated star anise pods (fig. 5).

The tree structure (fig. 3) was generated algorithmically using the Blender Python API. The 36 pods (fig. 5 and fig. 6) were generated at different epochs by feeding 156 models of star anise pods (acquired through 3D scanning) into Voxel-DCGAN, a customized version based on Takumi Moriya's implementation (Moriya 2017). Two tangible matrices with wind turbines (fig. 4) were included in the artwork to acknowledge the computational processes that incubated the sculpture.

Fig. 6. 36 GAN-generated star anise pods.

Tree: Visualizing Epochs in 3D

When visualizing GAN-generated images at different epochs in 2D on a screen, we can show images from early epochs followed by images from late epochs, one at a time, so the result is an animation (Tensorflow 2021). However, when it comes to displaying 3D-printed models, we have an interesting alternative: we can use a tree structure to "hang" them.

Since every GAN-generated star anise pod and every branch of a tree is born at some point, we can create a mapping between pods and branches according to their birth times. Specifically, we "hang" models generated at early epochs on old branches located near the root, while we "hang" models generated at late epochs on new branches located near the treetop. In this manner, we integrated a sequence in machine learning tightly with a sequence in nature.

Art and nature have a long and intertwined relationship (Stonard 2018). This piece complicates the relationship with machine learning. While admiring nature is simple and intuitive, puzzling over machine learning is complex and logic-filled. I found the contrast

fascinating, so I was hooked to work on both of them in one piece.

Vanishing Islands: Interpreting Fragments in GAN Art

You cannot help but notice fragments that come with GAN-generated star anise pods (fig. 8) Inspired by glitch art's philosophy of creating newness through amplifying instead of removing difference (Brooks 2015), using a term Brooks used, I "foregrounded" the fragments that look like floating islands (fig. 8). Instead of deleting, I attached the "floating islands" to the "base" with "rods" (fig. 9).

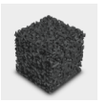

Fig. 7. Epoch 1.

Fig. 8. Epoch 115.

Fig. 9. Epoch 115.

Fig. 10. Epoch 459.

It is inaccurate to call those "floating islands" fragments because they lack what defines fragments, which are broken parts of something (Oxford Dictionary n.d.). For example, if we accidentally drop a pot, we get fragments of the pot. However, breaking something is not the case here as we do not have something whole to break in the first place; besides, the act of breaking did not occur.

The "floating islands" are also not glitches produced by malfunctioned systems. In the current case, an error-free system produced these fragments. Unlike glitches, these fragments are normal instead of abnormal outputs of the system.

Fig. 11. *Vanishing Islands* and *Solidifying Core*.

These fragments are residuals of the initial "noisy block" (fig. 7). The first generated star anise pod looks like a block (fig. 7) because the output space is a block of 32x32x32 voxels. Since the generative adversarial network did not learn anything about what a star anise pod should look like, it randomly decided if each voxel in the output space should be filled or not; so visually, the result is a block that comes with gaps everywhere, and therefore, we call it a "noisy block."

The "noisy block" will differentiate into two parts (Fig 11): one part will become a star anise pod (the *Solidifying Core*), while the other will turn into fragments (the *Vanishing Islands*).

Fragments will disappear in late epochs (fig. 10) because the underlying numbers that give rise to the fragments' existence will become zero. In Mathematics, *vanish* happens to mean "become zero" (Oxford Dictionary n.d.), so it is fitting to call those floating-island-like fragments *Vanishing Islands*.

To match *Vanishing islands*, we call the non-vanishing part, *Solidifying Core*, naming after the observation that the GAN will generate variants of the core with reinforcing certainty in late epochs as if the GAN's opinion of what a star anise pod should look like has solidified. With this pair of names, we can see GAN-generated models with new conceptual clarity.

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Biography

Tengchao Zhou is a media artist interested in exploring the artistic potential of machine intelligence. He studied Computer Science at New York University for four years and was an artist-in-residence at Rotterdam's V2_ lab.

AIMADE

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Abstract

AIMADE is a series of artworks made by British artist Celyn Bricker in collaboration with Mexican architect Arturo Muela. In this series they explore the question "should robots pay tax?" along with broader concerns around AI, technological unemployment, the relationship between AI and creativity, as well as the idea of the 21st Century Readymade.

In Mexico it is possible to pay taxes with artwork (Foreign Policy, 2010). The artists decided to use this as an opportunity to explore the questions surrounding AI, and so worked with a "third artist"—an AI neural network—to create artwork that was then used to pay tax. In this case, the AI used was trained to generate images from textual sources, in either English or Spanish. The source code for the AI was based on the paper "AttnGAN: Fine-Grained Text to Image Generation with Attentional Generative Adversarial Networks" (Tao Xu *et al*, 2018; Github, 2018).

In the *AIMADE* series, the texts chosen range from possibly the earliest description of a robot found in the Chinese text Liezi, to statements from contemporary figures like Elon Musk and Gary Kasparov. These statements were fed into a text-to-image AI, which generated images in response to these statements.

These images were then given to the Mexican Government in lieu of tax. Each image is an edition of seven, and there is a total of twenty images in the *AIMADE* series. At the time of submitting to the Mexican Government, we linked the value of a full edition of each image as equal to one Bitcoin (meaning each individual image submitted valued at 1/7th of a Bitcoin). At the time of submission to the Goverment (20th June 2020) Bitcoin was valued at $10,666 making each individual image worth approximately $1523 at the time. The value has since changed considerably.

Fig. 1. *Harmful to Society (Elon Musk),* 2020, Celyn Bricker and Arturo Muela, Neural Network Print, 45*45cm, Copyright Celyn Bricker/Arturo Muela 2021.

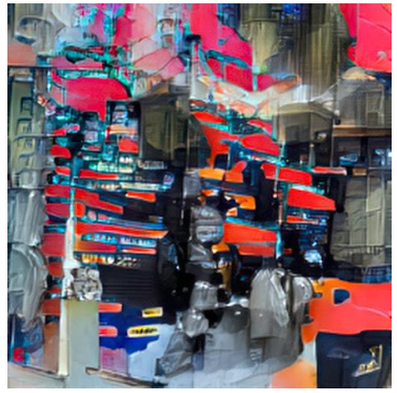

Fig. 2. *Achievements of General Ludd,* 2020, Celyn Bricker and Arturo Muela, Neural Network Print, 45*45cm, Copyright Celyn Bricker/ Arturo Muela 2021.

The *AIMADE* series was officially accepted into the Mexican National Collection in late 2020, representing the first time a National Government has confirmed images produced by AI can be legally defined as "art" ((Forbes, 2020; Arts Professional, 2020).

AIMADE is the lineage of the Duchampian Readymade—but the case of this project, we created a 'readymade' for the 21st Century, using AI technology.

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Biography

Celyn Bricker (Liverpool, 1989) is a British artist whose artworks explore technology, community and our relationship to nature. He has exhibited in museums and art contexts internationally, including the Royal Scottish Academy and UCCA in Beijing. He is co-founder of CELU studio, a multi-disciplinary studio with an environmental focus, that works across art, design and architecture. He is based in Liverpool, UK and Beijing, China.

Arturo Muela (Mexico City, 1986) is an Architect specialised in urban regeneration and planning. He seeks to develop a tight relationship between art and the public space, exploring role of art into city renewal and transformations.

Exploring B-Movie Themes in Virtual Reality:
The Woman Who Fell to Earth and Met the Pontianak

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Abstract

The room-scale VR experience *The Woman Who Fell to Earth and Met the Pontianak* (2021) is an artistic experiment and "B-movie" homage that confronts an alien with the unfamiliar environment of a historic early 20th-century Malayan kampong village surrounded by tropical jungle. The kampong is home of the Pontianak, a female vampiric ghost based on Malay folk mythology. The project is loosely based on the Virtual Cinematic Heritage application *Pontianak VR* (Seide, Slater, 2020), which re-created scenes of the lost film *Pontianak* (1957), but in contrast, this project is generating its own non-linear narrative journey.

The B-Movie VR Experience

The audience is invited to explore the virtual village freely, meander around, examine the old kampong houses and the tropical vegetation. The village appears deserted, clothes hanging out to dry, a pot still steaming, it seems the villagers have vanished. In this historic environment the audience will discover an unexpected visitor in the form of a melancholic female Stranger (an Alien/Cyborg), who seems irritated by the village and its artefacts. Who is she? Accompanying the Stranger on her excursion of the village is challenging, she appears here and there and walks right through the walls. While following the Stranger around, a presence is lurking behind the trees and corners, observing the two visitors, it is: The Pontianak. (fig. 1)

Background: The Lost Film Pontianak

This project was formed initially from research into the film *Pontianak* (1957), released by Cathay-Keris Studio in Singapore and other Southeast Asian territories.

Fig. 1. *The Woman Who Fell to Earth and Met the Pontianak*, 2021, Benjamin Seide, still image from VR experience, © 2021, the authors.

This was the first in what would become a massively popular series of horror films that centred around the figure of the Pontianak, a female vampiric creature who oscillates between the physical and spectral, originating in Malay folk mythology. The main character Chomel, who becomes the Pontianak, is both the heroine and villain of the narrative, and her visual transformation into the monstrous Pontianak was a key element in terrifying the audience (Mustafar, 2012). Due to its success, a sequel was produced quickly the same year, *Dendam Pontianak* (1957) and a third film *Sumpah Pontianak* the following year (1958). The first two films are believed to be lost (Barnard, 2011), and there are very few available images of either.

The B-Movie Homage

This project combines three major elements in the VR space: 1/ The kampong (fig. 2), which has been researched and recreated with some

degree of accuracy; 2/ The figure of the Pontianak, widely known in Southeast Asian pop culture via the Pontianak films of the late 50s and 60s—as well as other media (comics, books, videogames); and 3/ The humanoid Alien/Cyborg who emerges from Western pop culture such as *The Man Who Fell To Earth* (Walter Tevis and then Paul Mayersberg/Nic Roeg) to *Under The Skin* (Michel Faber and then Jonathan Glazer/Walter Campbell), as well as more schlocky B-movie variants of female Aliens in *Lifeforce* (1985) and the *Species* series (1995 onwards).

Fig. 2. *Virtual Kampong Village*, 2020, Benjamin Seide, still image from VR experience, © 2020, the authors.

To varying degrees, these films grapple with the idea of an Alien trying to relate to humanity and struggling to do so, partly because of the inherent corruptions of humanity itself. The idea of an Alien—with a higher technology—clashing with humanity is also explored in other action films, like the *Predator* series (1987 onwards) and its off-shoots. The conceit of the project is that the Alien is 'facing off' against a creature from another era, culture and mythology, a reference to another "B-movie" sub-genre, the *Alien Vs Predator* films, which pitted creatures from different cinematic worlds against each other, an idea dating back at least to Universal Studio's use of their iconic horror characters, i.e. *Frankenstein meets the Wolf Man* (1942). In fact the Pontianak sequels, *Dendam Pontianak* and *Sumpah Pontianak* attempted a similar strategy placing the Pontianak against other "monsters" from Malay folk-tales, including the Polong in *Dendam* and multiple ghosts and creatures in *Sumpah*. So, this notion of contrasting creatures meeting and in conflict is a vital tendency of genre cinema in many cultures, as elements are recombined and re-used. In this way, for this current project, we are following the spirit of this "B-movie/Genre cinema" approach, re-cycling already created assets (in terms of the filmic set of the kampong and the character of the Pontianak), in order to create a genre "mash-up" of different elements, blending different mythologies and cultures in an irreverent manner to open up some new possibilities for an immersive and narrative VR experience.

Acknowledgements

This research has been made possible through the kind support of a MOE grant in Singapore and ADM, School of Art, Design and Media, NTU Singapore. We would also like to thank our Research Assistants Justin Cho and Chan Guanhua.

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Biographies

Benjamin Seide and **Benjamin Slater** currently teach and research in Media Art at ADM, School of Art, Design and Media at NTU Singapore. With their experience and specific expertise in the areas of computer animation and visual effects (Seide) as well as film history (Slater), they explore the possibilities of immersive media, especially in regard to representations of culture and heritage.

Procedural Growth

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Abstract

The connection between the biological growth process of natural organisms and their respective physical forms has been a subject of scientific interest for over a century. By using various biological growth processes as a means for generative art-making, computational artists create artificial organic forms through computer simulations. Our experimental art project, however, intends to explore non-biological procedural means for creating unseen organic forms.

Biological Growth

D'Arcy Thompson's seminal work *On Growth and Form* (Thompson 1942) was first published in 1917. The postulation of how biological forms are defined by the growth mechanism and external forces describes the mathematical principle of many natural generative processes. The enduring impacts of Thompson's work go far beyond its intended audience, and its artistic influence is particularly timeless (Jarron 2016).

The father of modern computing, Alan Turing, is also a follower of Thompson's vision; his one single biology-related publication (Turing 1952) describes a precise mathematical structure that governs the morphogenetic process of many visual patterns found in nature. This mathematical formulation suggested by Turing is commonly known as the reaction-diffusion system; it remains an essential pattern synthesis method used by many computational artists.

The continuous advancement of computer hardware performance in the last few decades has allowed artists to explore various biological growth processes at a very large scale and hence producing much more sophisticated visual outcomes such as the aggregation based work by Andy Lomas (Lomas 2005), and the work by Sage Jensen (Jensen 2019) that used Physarum transport network simulation (Jones 2010).

Procedural Growth

The renderings or 3D models created by the mentioned artists using various biological growth processes are extremely inspiring. However, instead of creating forms with a known growth mechanism or framework, we are more interested to explore non-biological growth processes for unseen organic forms generation.

The first work produced in our project is titled *Simplexity 01* (Wong 2020). It features an unseen semi-organic structure that was generated by a simple space-filling algorithm in a voxelized 3D space (fig. 1). The algorithm targets to visit every single voxel without repetition in a random yet continuous manner.

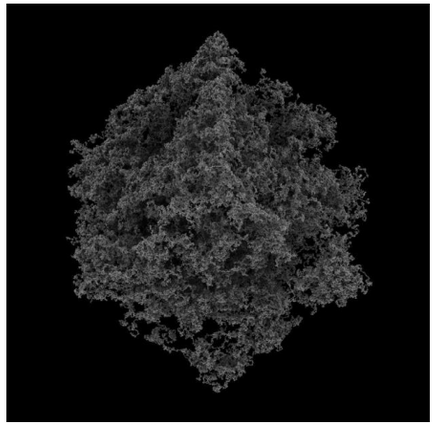

Fig. 1. *Simplexity 01*, 2020. Kin-Ming Wong. Digital Image.

At the very beginning, we found that the generated forms were highly geometrical and there was apparently no organic quality in them.

Until we decided to voxelize the space aggressively, we started to see interesting results. As this simple procedural growth algorithm targets to form a continuous pattern, so the early portion of the growth will leave a lot of individual voxels unvisited. These voxels together form a very fine-fragmented visual (fig. 2) which has a contrasting quality compared with the semi-organic structure as featured in *Simplexity 01* (Wong 2020).

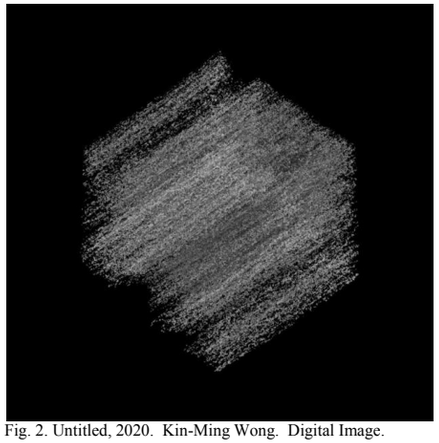

Fig. 2. Untitled, 2020. Kin-Ming Wong. Digital Image.

We are going to produce a collection of prints based on this simple procedural growth and we plan to extend our experiments with fluid simulation-based mechanisms such as Lattice Boltzmann methods which are designed for discretized volumetric space.

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Kin-Ming Wong. 2020. "Simplexity 01". *In SIGGRAPH Asia 2020 Art Gallery (SA '20)*. Article no. 59. Association for Computing Machinery, New York, NY, USA.

Biography

Kin-Ming Wong is a computational media artist and technologist with a strong focus on algorithmic and generative image synthesis. He is currently an Associate Professor at the School of Creative Media, City University of Hong Kong. His artistic and technical works have been presented internationally in SIGGRAPH, SIGGRAPH Asia, Computer Graphics International, Pacific Graphics, and IBC etc. He was also an award-winning visual effects pioneer of the Hong Kong movie industry. He maintains an active connection with the industry via artixels, his commercial visual effects software and consultancy practice.

Mesh2Matter, Rendering New Materialities

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Abstract

Mesh2Matter (Github 2020) explores the use of Machine Learning within a render pipeline, aiming for a materiality influenced by Karen Barad (Barad 2007) and Donna Haraway (Haraway 2016). This project speculatively reads contemporary renderers and goes on to pose new materialities from a framework based on neural nets. In an exploration into rendering matter, it reimagines how we form these configurations, breaking virtual matter from its isolation and weaving new materialities into these virtual spaces.

Rendering A Speculation

Exploring contemporary renderers, we see a myriad of techniques, all faced with simulating a possibly infinite world through finite resources. Each form of renderer cuts corners, but through each cut we see how it augments our world and how it figures its own.

Rendering Figurations

This project predominantly breaks down Ray Tracing (Akenine-Moller et al. 2018), a mainstream form of rendering. Its figuration is the inverse mechanism of light, the camera is the center of its world, projecting out to its surroundings to render an image. This figuration is understandable in terms of increasing performance, but the underlying structure and the cuts its makes are deeply anthropocentric. It places the viewer at the center of the world and leave it unilluminated without the viewer's enlightening gaze.

These processes are fragile and complex illusions, created through blind calculations that focus on fractions—single pixels of a bigger image.

Machine Learning Figurations

This project uses the Pix2Pix (Efros et al. 2018) framework made of two major components, a generator and a discriminator, but this project mainly focuses on the way it sees and translates the image.

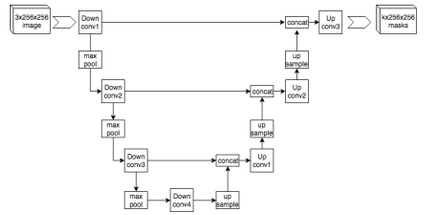

Fig. 1. *Example architecture of U-Net*, 2019, Mehrdad Yazdani, Copyright: Creative Commons.

The texture generation through the U-Net Generator (fig. 1) takes the original image through convolutions (Dumoulin et al 2016) down to the point of almost nothing and back up again. At each convolution the high dimensional space is split and woven back into itself, producing a milieu of causality.

The Difference?

The main difference is that the generation of the image is not through blind calculations, but through a high dimensional web of causality. Each generated texture and form arises because of many movements within the high dimensional net. Speculatively looking at this through Haraway's material-semiotics (Haraway 2016), this translation is similar to the way we conceive the objective world through a complex milieu of signals, contexts and narratives; each interwoven into our own virtual representation of matter and memory.

This speculative figuration shows the output of the Pix2Pix rendering not only photorealistic

complex textures, but an image that is woven from the world. The neural net weaves its own path of what matter is and the relations it consists of, one outside the human perception. This conception sees us on a verge of new forms of matter, convolved (Dumoulin et al. 2016) from the weights, biases and memories of trained models.

Rendering with Mesh2Matter

This project has an enlightening path to its construction, but the final apparatus is made from three major elements:

– A 3D scanning data preparation pipeline.
– A trained 512X512 Pix2Pix model
– An implementation in a render pipeline.

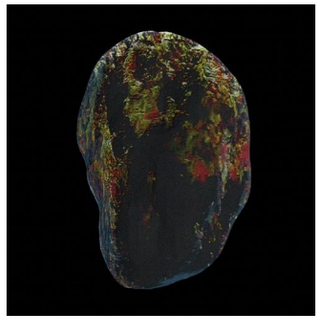

Fig. 2. *Render with the final Pipeline utilizing the generated texture*, 2020, George Simms, Copyright: Property of the artist.

The renderer creates flowing and merging patterns that have the very distinct textures of rocks and minerals (fig. 2)(Youtube 2020), making them feel as if the forms are passing through time, forming and shedding layers of sediment.

Next Steps for New Materialities

This project set out to render a new form of complex woven materiality, aiming to inverse the apparatus of ray tracing, and to realize a new way of reproducing the world virtually. At this point you could ask: "has this project dismounted the anthropocentric structures of rendering?" Well not yet, but it does start to push towards a new way of reproducing matter, one that is woven from a more complex place outside of our own preconceptions.

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Biography

George Simms is a speculative digital artist, working with animation, interaction and code, looking at how we can use our current resources to see from a different vantage point, to imagine what is over another horizon.

He started working digitally during a Bachelors in Sculpture at Camberwell College of Art, completing it in 2015. In 2018 he went on to study a Masters in Computational Arts at Goldsmiths, University of London, completing it in September 2021.

Since graduating, he has been on a group residency at Arebyte gallery with the In-grid Collective, and completed a funded animation project for Gridmarkets.com.

Women Reclaiming AI

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Abstract

Women Reclaiming AI is an activist community, co-founded by B Aga and Coral Manton, who aim to reclaim women's voices and identities from non-representative AI product development teams and critique the commercial pursuit of humanising AI. They do this through co-designing and co-developing new AI artworks, harnessing AI as a medium for protest.

Representation of Women in Gendered Technology

In the UK women hold less than 17% of all available tech jobs, (The Alan Turing Institute 2021). At Google, Black women make up less than 5% of their global tech workforce (Google 2020). However, when it comes to making humanoid chatbots or robots, women appear regularly—but not as makers. When asked to name a woman in technology, people respond "I don't know" or "Alexa" or "Siri"—chatbots gendered women, designed by male-dominated teams (West et al. 2019).

As speech recognition, chatbot technology and robotics are improving at pace, the sci-fi fantasy and commercial benefit of creating technology gendered as women are driving new artistic, cultural, and industrial endeavours. Men are responsible for re-coding women's identity within technology, amplifying the issues of the past, without consultation or inclusion of women's voices.

Women Reclaiming AI

Women Reclaiming AI, WRAI, is an art as activism project facilitated through a growing community of 100+ diverse women (inclusive of non-binary, genderqueer and woman-identifying people). The community harness AI and robotics as a medium for protest reclaiming women's voices and identities from non-diverse development teams. In so doing, it reimagines the representation of women in technology as equitable and empowered.

Fig. 1. *WRAI*, 2018, Aga & Manton, Copyright acknowledgement.

WRAI includes a collaborative AI voice assistant developed by the community through a shared platform for writing and editing. This evolving artwork is a response to the pervasive depiction of AI voice assistants gendered as women and subordinate and serving. Through workshops for collective writing the community is creating a collective intelligence and feminist dataset revealing womanhood and women's identity.

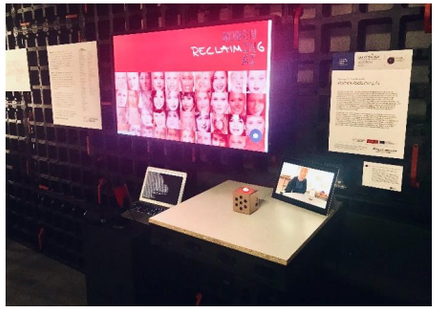

Fig. 2. *WRAI* Exhibited at ARS Electronica, 2019, Aga & Manton.

The collaborative voice assistant has been exhibited as an interactive artwork and visual dataset, facilitated through workshops at ARS Electronica (2019) and Birmingham Open Media (2019), ARS Electronica (2019), MozFest (2020), and as part of the programme for The Barbican "AI: More than Human".

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Biographies

The work of artist-technologist duo **B Aga** and **Coral Manton** manifests as collaborative workshops, events and installations aimed at (re)claiming conversational AI systems as a medium for protest. It critiques the commercial pursuit of humanizing AI technologies and challenges the bias, stereotyping and pervasive influence embedded within. By activating the public, Aga and Manton re-write and re-imagine the cultural myths of AI and robotics, creating alternative technology-mediated futures. Their most recent work is *Women Reclaiming AI* (2018), an expanding activist art-work, presented as a feminist AI voice assistant, programmed through workshops by a growing community of women.

https://womenreclaimingai.com/
https://www.coralmanton.com/
https://birgitteaga.com/

Countering Misinformation with Neural Networks

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Abstract

Recently, there has been concern over the use of neural networks to generate content intended to manipulate or deceive the viewer. In two projects, *Infodemic* (2020) and *GoingViral* (2020), we use neural networks to generate videos intended to inform viewers and correct misinformation about the coronavirus. *Infodemic* is a video generated using neural networks that questions the mediated narratives created by social media influencers and celebrities about the coronavirus. *Going Viral* is an interactive artwork that invites people to intervene in the spreading of misinformation by sharing informational videos about COVID-19 that feature algorithmically generated celebrities, social media influencers, and politicians that have previously shared misinformation about coronavirus.

Background

The term 'infodemic' gained popularity in 2020 when the Director of the WHO stated: "we're not just fighting an epidemic; we're fighting an infodemic. Fake news spreads faster and more easily than this virus, and is just as dangerous" (Ghebreyesus 2020). During the pandemic, conspiracy theories about the virus began to spread rapidly. Influencers began profiting from fake cures like colloidal silver or claimed that the virus could be prevented by drinking hot water, taking megadoses of vitamins, or using bleach internally. Hydroxychloroquine was pushed despite a lack of evidence of its effectiveness. Some of the most bizarre conspiracy theories were claims that 5G networks were causing or exacerbating the virus, which led to cell phone towers being burned down, and that Bill Gates created the virus to implant microchips into people to track them (Ball and Maxmen 2020).

Project Details

The speakers featured in both projects have spread misinformation about the coronavirus and are generated using a conditional generative adversarial network (cGAN). The dialogue is taken from academics, medical experts, and journalists. In the generated videos, the influencers deliver public service announcements or present news stories that counter the misinformation they have spread.

The models for *Infodemic* were trained on corpora of multiple individuals simultaneously resulting in a talking head that morphs between different speakers or becomes a glitchy Frankensteinian hybrid of different algorithmically-generated people. The video's painterly qualities evoke the mutation of the coronavirus (fig. 1).

Fig. 1. Infodemic, 2020, Derek Curry and Jennifer Gradecki, video still, Image courtesy of the artists.

In *Going Viral*, viewers share the algorithmically generated videos on social media, to intervene in the infodemic that has developed alongside the pandemic.

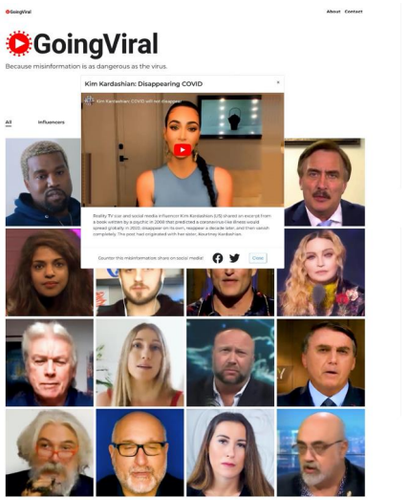

Fig. 2. *Going Viral*, 2020, Derek Curry and Jennifer Gradecki, screenshot of website with algorithmically generated videos, image courtesy of the artists.

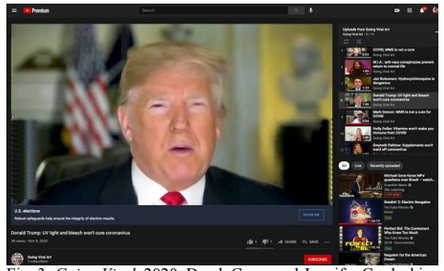

Fig. 3. *Going Viral,* 2020, Derek Curry and Jennifer Gradecki, screenshot of algorithmically generated video on YouTube, image courtesy of the artists.

The full-length *Infodemic* video can be viewed online at https://vimeo.com/443412717. The *GoingViral* website is available online at https://www.goingviral.art/.

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Ghebreyesus, General Tedros Adhanom. 2020. Speech, Munich Security Conference, February 15, 2020.

Biographies

Derek Curry BFA Photography, MFA New Genres, PhD Media Study, is a US-based artist-researcher whose work addresses spaces for intervention in automated decision-making systems. Recent work has addressed automated decision-making processes used by automated stock trading systems and Open Source Intelligence (OSINT). https://derekcurry.com/

Jennifer Gradecki BFA Sculpture / Psychology, MFA New Genres, PhD Visual Studies, is a US-based artist-theorist whose work facilitates a practice-based understanding of socio-technical systems that evade public scrutiny. Her investigations have focused on Institutional Review Boards, financial instruments, technologies of mass surveillance, and artificial intelligence. www.jennifergradecki.com.

Curry and Gradecki have exhibited and presented on their work at venues including Ars Electronica (Linz), Art Machines (Hong Kong), New Media Gallery (Zadar), AC Institute (New York), Science Gallery Dublin, Critical Finance Studies (Amsterdam), ISEA (Vancouver), ADAF (Athens), and the Centro Cultural de España (México). Their projects have been funded by Science Gallery Dublin and the NEoNFestival.

Microbial Emancipation

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Abstract

There is an increasing interest in microbiomes, especially the human microbiome. What *Microbial Emancipation* aims at is to visualize the well-known fact that the relationship between human and microbial life is deeper than a host-guest relationship. In the deep past, the mitochondria was an independent living bacteria that became our mitochondria, the energy source of eukaryotic cells. *Microbial Emancipation* presents the narrative of the violent extraction of the mitochondria, an involuntary emancipation, to prove this relationship, and it aims to transform our understanding of the place of microbes and humans in the world.

Work

Microbial Emancipation, a work by Malitzin Cortes, Yun W. Lam and Maro Pebo (2020) explores the relationship between humans and microorganisms. Beyond our microbiota, the population of microorganisms in our body that participates in our digestion, protein synthesis, maintenance of our immune system (Wang *et al.* 2017), there is a more intimate continuum between us and bacteria. Looking at the history of our cells, we can find traces of an ancient bacterium in our mitochondria. Mitochondria were at some point an independent bacterium, and are now organelles that among other fundamental tasks give us the energy to live.

This work is the violent extraction of the mitochondria out of an animal cell to exist as an independent entity; a forcing out as an act of unwanted liberation and unrequested emancipation; a literal undoing of the unlikely yet fundamental collaboration that allowed for most known forms of life. The emancipation of the mitochondria is a ritual and a sacrifice, killing the cell to defy all doubt, the mitochondrion lies bare, alone, as an offering and proof of our identity.

Fig. 1. *Microbial Emancipation,* 2020, Maro Pebo, Malitzin Cortes and Yun W Lam. Picture by Lucas D'Ambrosio / MM Gerdau – Museu das Minas e do Metal.

The first awareness of our microorganisms, occurred through their benefits for human health. Within this anthropocentric interest in microorganisms, we frist developed an understanding of this synergy for the skin microbiome. We then went one layer deeper in the gut microbiome and learned to understand the biochemical relation of the gut and the brain, pointing us to an unknown relation between our nervous system and our microsymbiotants. This ever deeper relation stops in the difference of the phenomenon of species, we with our animal cells, and they, the microbes.

What the emancipation of the mitochondrial aims at, is to frame and visualize the well-known fact that our relationship is deeper. Bacteria are not just everywhere around but also somehow inside, ingrained in the very human cell. Animal and plant life is possible because of this hyper-intimate relation. In the deep past, the

mitochondria was an independent living bacteria, engulfed by a bigger Archaeon that lost its genes and its independence, to become the energy source of eukaryotic cells.

Fig. 2. Still form *Microbial Emancipation*, 2020, Maro Pebo, Malitzin Cortes and Yun W Lam.

This is a remarkable fact that transforms the relation between humans and microorganisms. We have known about the bacterial past of chloroplasts and mitochondria for decades thanks to the work of Lynn Margulis (1998), this artwork wants to make it material, have it happen, and help us experience the deep history of each of our cells.

All of our stories, our desires, and our human culture have developed around macroscopic beings, excluding the microbial history of the origin of multicellular life. The emancipation of the mitochondria wants to include remote endosymbiotic bacteria in the understanding of the self of all macroscopic species, with all the reinterpretations it implies. This is the framing that makes visible the deepest intimacy of microorganisms and macroscopic organisms.

This work is the violent extraction of the mitochondria out of an animal cell to exist as an independent entity. A forcing out as an act of unwanted liberation, unrequested emancipation. A literal undoing of the unlikely yet fundamental collaboration that allowed for most known forms of life. It undoes in order to make it visible.

The reliquary holds mitochondria from the artist's blood that used to be a free bacterium. The emancipation of the mitochondria is a ritual, is a sacrifice, killing the cell to defy all doubt, the mitochondrion lies bare, alone as an offering and proof.

Fig. 3. *Microbial Emancipation,* 2020, Maro Pebo, Malitzin Cortes and Yun W Lam. Picture by Lucas D'Ambrosio / MM Gerdau – Museu das Minas e do Metal.

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Biography

Maro Pebo was born in Mexico City. She holds a PhD in Creative Media (Hong Kong), an MA in Gender Studies (Italy) and a BA in Art History (Mexico). She specializes in the intersections of art, science, and biotechnology. Her current interest lies in microorganisms' culture and a microbial posthuman turn. She is senior lecturer in Moist Media at the DeTao Masters Academy SIVA Shanghai and currently works on fostering post-anthropocentric microbiology literacy in society. *@maro_pebo.*

Ghost in the Cell—Synthetic Heartbeats

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Abstract

The project *Ghost in the Cell—Synthetic Heartbeats* is a development, extension and re-imagining of the work *Ghost in the Cell*, where we collaboratively created synthetic DNA for the virtual idol Hatsune Miku, and introduced this digital, synthetic DNA into iPS-Cell derived, living cardiomyocytes, therefore giving the virtual, digital idol an actual, living and beating heart. *Synthetic Heartbeats* combines videos and images of the beating heart cells, combined with the digital synthetic DNA, to create fully synthetic, ongoing, observable heart beats by using Deep Learning and Generative Adversarial Networks (GANs).

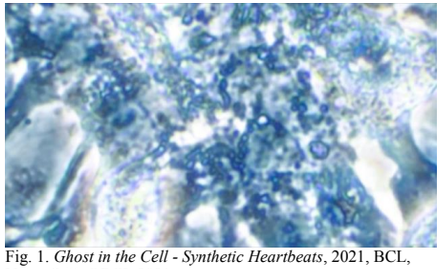

Fig. 1. *Ghost in the Cell - Synthetic Heartbeats*, 2021, BCL, Video Still, ©BCL 2021.

Synthetic Flesh

The virtual idol Hatsune Mike started life as Vocaloid software voice, developed by the company Crypton Future Media in 2007 (Miku 2007), amongst a range of other software voices. However, the manga-style cover illustration of the software package captured the imagination of the Japanese public, and, coupled with the decision by Crypton Future Media to encourage the production of derivative graphics, animations and videos by the general public, the software transformed itself into a virtual pop idol, producing records and staging life shows. While the voice was given a collective image, we decided to give her a body and a heart. We asked Hatsune Miku fans to create digital synthetic DNA (BCL 2017) that could contain not only biological data, but also encrypted messages, images and music (Catts and Zurr 2002). This digital DNA was synthesized into actual DNA, and inserted in IPS cells, which then were differentiated in cardiomyocytes (heart cells), which started beating spontaneously. The work was shown in the 21st Century Museum (21C 2017) in Kanazawa, Japan, and the audience could see the living, beating heart of Hatsune Miku during the exhibition.

Between Code and Life

This project builds upon the universality of the DNA as an information carrier and questions the differences and similarities of silicon- and carbon-based life forms (Vaage 2016). Synthetic Media, or the possible creation of life-like images, video and sound data, is a challenge to society, by casting doubt and suspicion upon not only the truthfulness, but also the provenance of images and media (Catts and Zurr 2006). This work, *Synthetic Heartbeats* does not aim to create "fake" heart beats, but to synthesis heart beats, whose creation was not only informed by the visual data, but also by the digital DNA data, which is also present in biological images of the heart cells.

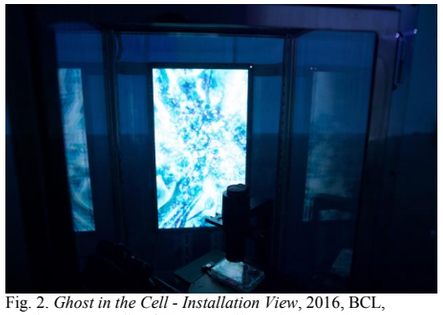

Fig. 2. *Ghost in the Cell - Installation View*, 2016, BCL, Beating Heart Cells of Hatsune Miku, ©BCL 2016.

DNA within the DNA of a tree for hybrid afterlife.

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Biography

BCL is an artistic research framework, founded by **Georg Tremmel** and **Shiho Fukuhara** in 2007 with the goal of exploring the artistic possibilities of the nano-bio-info-cogno convergence. Other works by BCL include *Common Flowers / Flower Commons* where GMO Blue Carnations are cultured, open-sourced and released, *White Out*, one of the first bio-art works that use CRISPR for artistic research, and *Biopresence*, which proposed, speculated and realized the encoding of human

Robin Hood Gardens: Rewound

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Abstract

Robin Hood Gardens - Rewound examines how a story can be told using a machine learning algorithm called a Generative Adversarial Network (GAN). We configure the GAN algorithm to reimagine a memory haunted by a recently departed past and the hope for future that never arrived. We cast the neural network as a "ghost" that explores the environment of Robin Hood Gardens estate—one of the iconic utopian social housing projects in London. These algorithmically generated visions aim to untangle the spectral nostalgia for a certain place and time, which the cultural theorist Mark Fisher termed as lost futures.

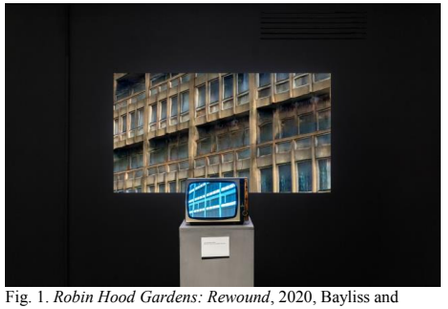

Fig. 1. *Robin Hood Gardens: Rewound*, 2020, Bayliss and Wong, video, Copyright Watermans, Photo credit: Anna Jochymek.

Introduction

Robin Hood Gardens: Rewound is a two-screen video installation and generative visuals by artificial intelligence. This is done through a Generative Adversarial Neural Network (pix2pixHD) trained on a custom photographic image-set. The neural network imagines what Robin Hood Gardens Estate looked like in the past and regenerates an entirely new facade of the iconic estate. Although neural networks have become increasingly important in the field of artificial intelligence, the medium is temporally constrained. They rely on a corpus of training data which itself may be from disparate times and places. As such, they are inherently "of the past" but primed to predict the future.

Drawing from the theory of hauntology, the late cultural theorist Mark Fisher suggested that our contemporary era is haunted by these ghosts of failed utopian aspirations or what he termed "nostalgia of a lost future." *Robin Hood Gardens: Rewound* is an illustration of this paradox in the trajectory of technological progress. The work finds parallels with past endeavors to change the world and the promises of the technological utopianism of today.

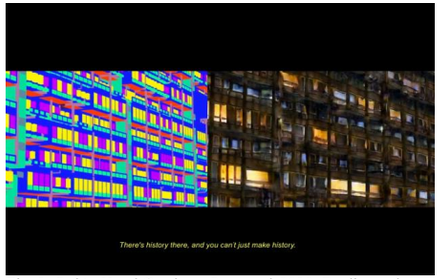

Fig. 2. *Robin Hood Gardens: Rewound*, 2020, Bayliss and Wong, video. © Nathan Bayliss, 2020.

It is the spectral within the generative adversarial network that hints at a useful deconstructive tool to dislodge the static narrative of our world - and our understanding of the present. Mark Fisher's critique of popular culture touches on the static present that is haunted by past media and entertainment.

Taking his view of electronic music as an example of "the confrontation with the cultural impasses and the failure of the future," we answer Fisher's call to action, and in the same hauntological spirit, critically engage with GAN technology to re-open old wounds.

With hauntology as our theoretical framework, we hone in on the rich cultural and social history of Robin Hood Gardens estate in London, as source of material for our exploration. For the narrative structure of the piece, we draw from the book *Regeneration! Conversations, Drawings, Archives & Photographs from Robin Hood Gardens* for a distilled history of the place according to the old inhabitants of the estate. We recorded audio snippets from conversation transcripts in the book for the voice narration in the video.

Technical Processes

We built two datasets based on archival photography of Robin Hood Gardens, including day and night photography. From this we gathered two statistical models of the site which we then used to generate speculative reconfigurations of the site. Images were hand-rotoscoped and labelled. This "blueprint" of RHG was built inside openFrameworks based off a 3D template built in Cinema 4D. We animated in C++, with control over the camera position and animation being set in real-time. The resulting "label sequences" were captured into image sequences. These were fed into an updated Pix2PixHD model at 1024x1024 resolution. The Pix2PixHD results were paired with their Label Input to make a matching A and B pair (one for each screen). The sequence was then edited to create the flow of the film.

For the exhibited installation, we had an analogue television set to alternate between display sequences of GAN generated imagery in monotone colour and the label sequences as the video essay with voice-over narration was projected onto a screen.

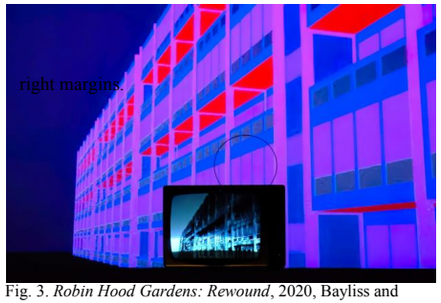

Fig. 3. *Robin Hood Gardens: Rewound*, 2020, Bayliss and Wong, video. © Nathan Bayliss, 2020.

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Biographies

Eddie Wong obtained his Masters (Computational Arts) from Goldsmiths University in 2019. He has published in Leonardo Journal, SIGGRAPH 2020 and exhibited internationally. Eddie is currently based in Kuala Lumpur.

Nathan Bayliss is a London based artist featured at Somerset House, Lumen and Watermans Gallery, London. He completed his Masters from Goldsmiths University in 2020.

Neonate (6e656f6e617465) (2019-2021)

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Abstract

This artistic abstract presents my art practice through one of my long-term works: *Neonate (6e656f6e617465)*. The installation-based work's title refers to an organism in its adolescent stage and seeks to express feelings on how technological advancements have altered our perceptions of social dynamics. Examining the conceptual formation of the work through my own concept of the "Uncanny Cyborg," which I develop out of two main texts, Sigmund Freud's "The Uncanny" (1919) and Donna Haraway's *A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century* (1984). Highlighting the importance of the relationship between the material, connotations, and method of production, I seek to construct a hybrid visual language that is indicative of a contemporary anxiety and discomfort.

The work first engages with the idea of a juvenile organism by repeatedly using imagery that might suggest birth-conception. Through the process and the consideration of symbol-making, objects, materials and their represented subjects are manipulated in an attempt to subvert its signs and signifiers to become a new proposition for an in-between, rather than an either-or idea of the word "conception."

Neonate serves as a proposition for alternative forms and cultivations and energy transfers, the subsystems that fuel an entire operation. The artist considered the imagery of cultivating (conception), contemplating the resources, roles, functions and energy transference in the processes of crafting the setting of the installation. She learned from the Uncanny, how the acts of revealing what is meant to be concealed can be exhibited through manipulating objects. Treated as though it were incubating an organism, bodies of silicone are put into positions that create semblances of acts of nestling and cradling. The connections of tubes, symbolic of an umbilical cord, draw a symbiotic relationship, where a subject subsists through the nutrients and resources from a mother-like figure, rich with assets, mimicking germination as seen in agricultural greenhouses, a manufactured way of growing produce.

Fig. 1. *Neonate*. Chok Si Yuan. 2020.

The approach of revealing and concealing to generate feelings of the "domestic" and "undomestic," is re-enacted through biological and mechanical tensions in quieted and lesser pronounced ways. Within the installation, the simultaneous presence and absence of the acrylic board (fig. 1) as a connector between objects also serves as a fragmentation of the internal and the external. Loosely replicating solar panels and satellites, which harnesses energy from the sun, the pieces become symbols of transference, activating information and converting energy, much like the resources that

are required to produce a child. In doing so, these materials, seen as cold and manufactured, yet placed in acts of nurturing, generate feelings of the uncanny, disguising the objects and hindering recognizability. Therefore, the visual tension is created through methods of metaphor and various forms of the word conception.

In the “major rearrangements” of social relationships as Haraway has postulated in her column of comparisons, certain rows compare reproduction from “sex” with the question of “genetic engineering.” In current state of rapid technological development, procedures like I.V.F. (in-vitro fertilization) and A.R.T. (assisted reproductive technologies) call into question the organic family's status and connotations, replacing heteronormativity and binary genders with a web of relationships that redefine and question gender, sexuality and heteronormativity. Taking responsibility in the technologies that reorient our thinking, the inherent binaries that objects have, in particular the tensions between biological and mechanical, the soft and rigid must be rethought (fig. 2)

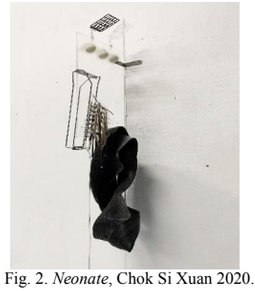

Fig. 2. *Neonate*, Chok Si Xuan 2020.

In addition to the double being used in the process of creation, mise-en-abyme is also seen in the usage of electronics, both symbolically and literally demonstrating energy transference and a network joining objects together. In relation to the idea of birth, it supplies the silicone organisms with air, and functions in a similar way to oxygen supply tanks, as though it were subsisting them, as the power from the supply outlets goes through a series of conversions from power to activating the air pump.

Therefore, in bringing a biological, bodily process outside of the body and into a laboratory, the installation reimagines the procedures by employing mechanical objects into biological acts. The result is a cybernetic system of organisms dilating and contracting, inhaling and exhaling, in a sterile environment of uncanny objects.

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Biography

Si Xuan is a sculptor whose practice concerns tackling all things 3D—digitally, tangibly, and metaphysically. She is interested in cybernetics—the feedback between humans, living organisms and machine—and the exploration of physical relationships. By exploring media such as silicone and found objects, and incorporating electronics like Arduino microcontrollers and methods such as 3D modelling and printing, she creates objects that erode the boundaries between the biological and mechanical

Si Xuan has attained awards such as The Lasalle Scholarship (2019) and the Winston Oh Travelogue Award (Practice) (2018). Additionally, she has also participated in exhibitions such as Meshminds Art X Tech for Good (2019), The Winston Oh Travelogue: What the stars are telling us (2018) and programs such as Chanel X Harper’s Bazaar Singapore Paris Immersion Programme (2019) and Young Artist Talent #11 by the Office of Contemporary Art and Culture Thailand (2020). She currently resides and practices in Singapore.

Landscape Forms: Machine Learning, 3D Form and Figuration

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Abstract

It is hard to predict just how much Machine Learning will transform creative processes in the arts and humanities. Improved denoising applications (Kaur, Singh, and Kaur, 2018) demonstrate how existing creative processes can be optimised and generative applications such as StyleGAN (Karras, Laine, and Aila 2019) demonstrate a new pathway to the creation of form and figuration. As new approaches transition from computer science into APIs, plugins and embedded functions, generations of artists will metabolise possibilities and make new entries into our collective cultural database. This abstract presents initial results from the project *Collaborative Artistic Production With Generative Adversarial Networks* underway at Hong Kong Baptist University's Augmented Creativity Lab. In this artwork and academic presentation, we investigate how Generative Adversarial Networks (GANs) can be used to create three-dimensional forms. We created a dataset of 27,000 .obj models of trees and are training multiple configurations of a voxel-based GAN to generate new 3D models of trees. The architecture of our system is based on the 2017 paper by Wu et al, but where their GAN was trained on geometrically predictable forms such as chairs and tables, we want to see how these systems handle less predictable forms such as trees. The term 'predictable' here is paradoxical. Lindenmayer systems have been used to procedurally generate trees for over 50 years (Lindenmayer 1968) and were used to generate our dataset, so our dataset is predictable from this algorithmic standpoint. However, the results of our voxel-based tree GAN suggest that the geometric simplicity by which a chair occupies a three-dimensional volume is in dramatic contrast to the geometric complexity by which the branching of trunk, branch and branchlet occupy the same volume. Put simply, it has been harder for us to use a 3D GAN to produce trees than to produce chairs, but the 3D forms we see along the way offer a fascinating glimpse of how the GAN learns the process of form and figuration. In this conference, we will present this process as an academic talk as well as a 3D animated artwork, which presents our results in the context of Romantic and Chinese literati landscape composition.

Fig. 1. *Landscape Forms*, 2021, Peter Nelson, animation still. Copyright Peter Nelson 2021.

Our academic presentation will be divided into three parts. First, we will describe how we produced our dataset of 3D trees. Second, we will summarise our various optimisations of the voxel GAN approach. Third, we will introduce the animation that we propose to present at the conference exhibition. The animation uses the 3D models generated in our research and shows the process of our GAN learning the form of trees through various epochs, composed using a combination of Romantic and Chinese literati landscape paintings. This visual paradigm was selected to contextualise our exploration of aesthetic form within the historical paradigm of using landscape and trees as a form of poetic allusion. The animation will be combined with GAN-derived music, created by another member of the *Collaborative Artistic Production with Generative Adversarial Networks* team, with special reference to the musical influences of Romanticism and the Chinese literati.

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Biography

This artwork is an output of the project *Collaborative Artistic Production with Generative Adversarial Networks* underway at Hong Kong Baptist University's Augmented Creativity Lab and relies on systems developed by the team comprising **Peter Nelson**, **Roberto Alonso Trillo**, **Daniel Shanken**, **François Mouillot**, **Mathis Antony**, **Ryan Au**, **Maya Duan** and **Jianming Mai**. Peter Nelson is the lead artist on this work. He is a visual artist and academic working at the intersection of landscape theory, computer games and computer graphics. He examines the history of landscape images, how they are remediated by technological shifts, and how these shifts absorb and reflect changes in our relationships with the physical environment.

Ersatz Intelligence: Implications of Machine Learning for the Generation and Interpretation of Art and Artifacts

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Abstract

In this presentation we will speak about "*Ersatz Intelligence*", the title of an artwork and a term that we are using to describe interactions with Machine Learning (ML) and Artificial Intelligence Algorithms (AI) over the course of an artistic project. This project stems from a group initiative entitled *Collaborative Artistic Production with Generative Adversarial Networks* (GANs) that is currently underway at Hong Kong Baptist University's Augmented Creativity Lab. The project came out of reflections on questions introduced in Manuel DeLanda's book "War in the Age of Intelligent Machines" (DeLanda, 2001). In particular the following question was posed: if humans became extinct now, how would an autonomous Artificial Intelligence (AI) interpret leftover human cultural remnants, images, and artifacts devoid of a human context or operator? How would a lone AI view its own technical evolution? This idea has been explored through artistic research and the results will be presented alongside examples of other works that stemmed from the creative interactions with these algorithms. There will also be a reflection on the technical and more poetic aspects of working with GANs and ML for creative production. Through the use of internet-based data-sets sourced from freely available online material, we have been experimenting with how a GAN will interpret particular aspects of material and visual culture, and possibly reveal elements that are not completely obvious to a human observer through its generated output. We have observed that certain patterns can be seen in the GAN-generated material and can offer insights into the data-sets but also into the normally black box processes within the GAN itself.

This talk will move through the different trials and results that developed through this project. It will start with the first experiments of training an image-based StyleGAN2 model on thousands of images of car crashes and random stock images to produce distorted hybrid images. We will also speak about the development of the 3D voxel-based GAN created by our team that we trained on over 2,000 3D models of hand tools.

The main reason hand tools were chosen over other objects is that they are some of the first objects and technologies made by humans and their ancestors and therefore offer a long rich history from which to draw. It is interesting to see how a GAN can interpret such a diverse and uniquely human data-set. Lastly, we will talk about how Game Engines can be used to create networks of these ML agents and we will present the generative video work, *Ersatz Intelligence* that is being developed from this exploration. We will demonstrate how using an Application Programming Interface (API) with the text-generating GPT-2 ML algorithm can be used as a hub or a "brain" for the drawing and organization of these systems. Research and subjects can filter in by training the GPT-2 on specific texts that can influence or skew the generated results to create spontaneous environments and narratives through ML algorithms. As Sungook Hong proposes in one of the texts used to train the GTP-2, technology is humans' "unfaithful offspring" in the sense that our intentions are often re-imagined by technologies, themselves (Hong, 1998). Can ML or AI offer a new perspective on human visual and material culture and creative practices? This talk will ponder such questions through the examination of artistic methods and outputs.

Fig. 1. *Ersatz Intelligence*, 2021, Daniel Shanken, Generative video still.

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Biography

This artwork is an output of the project *Collaborative Artistic Production with Generative Adversarial Networks* underway at Hong Kong Baptist University's Augmented Creativity Lab and relies on systems developed by the team comprising of **Daniel Shanken**, **Roberto Alonso Trillo**, **Peter Nelson**, **François Mouillot**, **Mathis Antony**, **Ryan Au**, **Maya Duan** and **Jianming Mai**. Daniel Shanken is the lead artist for this artwork. He is an artist and researcher from Los Angeles currently based in Hong Kong. He is an Assistant Professor at the Academy of Visual Arts, HKBU, and a member of the Augmented Creativity Lab. He works across disciplines to create installations, videos, sculptures, sound, and media. His practice examines relationships between technology and cognition, particularly those that operate through interplays with interfaces and networked structures, focusing on 'in-between spaces' with fluid definitions. In his work, he aims to render environmental, cultural, perceptual, and material exchanges through disruptive technologies that allow for shifts in readings and outputs, transforming them in unforeseen ways.

MUSEUM OF SYNTHETIC HISTORY

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Abstract

This talk examines the ongoing series under the title of *Content Aware Studies*, a project split into multiple ongoing iterations. CAS I and CAS II both interact with concepts of history as outcomes of machine-learning intervention. History here is proposed as data whilst data itself is seen as a crude material.

This talk explores shifting understandings of truth through the act of *truth-production*. How are historical objects viewed, how is their authenticity determined or undermined when observed through the lens of machine vision? Can applications of such technology allow us to uncover deeper and sharply unsuspected new knowledge or do they mask unacknowledged biases? As such, *CAS* and the *Museum of Synthetic Histories* seek to establish investigative methods through artistic practice.

CAS I

CAS I, spans computational, sculptural, screen-based and textual works focused on the Hellenistic time period. In collaboration with data scientists at Strelka Institute and the University of Southampton, artificial neural networks were trained amd directed to replenish lost fragments of sculptures and friezes of classical antiquity and generate never before existing, yet algorithmically "genuine" objects of that era. 3D printed and CNC routed in marble and various synthetic materials, filling the voids in the eroded and damaged marble sculptures, some of these algorithmic outputs were turned into new machine- fabricated sculptures. Uncanny in their algorithmic integrity they render the work of a synthetic agency that lends a faithful authenticity to the forms, while also producing bizarre errors and algorithmic normalization of forms previously standardized and regulated by the canon of Hellenistic art.

Fig. 1. *CAS_05_Julia Mamea*, 2019, Egor Kraft, marble, / polyamide, Copyright by Egor Kraft.

CAS II

CAS II continues this artistic investigation spanning computational, sculptural, screen-based and textual works engaged in the topics of meta-archaeology, epistemic focal biases, aesthetics of computational automation and historicism based on the practice-based inquiries with machine learning technologies. Challenging AI-based methodologies, against data from prehistoric and geologic time archives, including first stone tools and writing systems, as well as paleontological archives of fossils of plants and organisms, CAS II moves on from replenishing lost fragments of art, to history itself. Building on research around artificial fossilization of matter, led by Jakob Vinther at the University of Bristol (Saitta, Kaye, and Vinther 2018, 1-16) and using databases gathered by "Big Data" as a response to the biodiversity extinction crisis, this research aims to involve AI technics to generate new instances of the objects found in datasets. How different would an AI-rendered, and hence synthetic, fossil of a plant be from an actual sample from Late Silurian-Devonian floras? Or will AI-manufactured proposals of new old specimens be distinguishable from those remaining millions of actually existed species that simply haven't been catalogued yet? Furthermore, what philosophical concerns around materiality, non-organic ontology and agency are entailed by the actual production of such objects, which involve artificial fossilization technics? What does it mean to 3D-print synthetically derived bone remnants of prehistoric life incorporating calcium phosphate bone tissue engineering methods, primarily designed for printing bones for surgery? These are the questions at the centre of this artist talk.

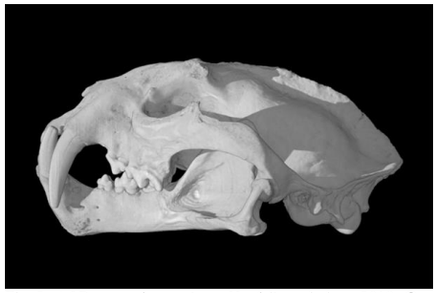

Fig. 2. *A 3D-scan of a specimen Neofelis_nebulosa*, 2019, @ Natural History Museum, digital scan, Copyright by All images copyright Digimorph.Org and Natural History Museum.

It is both challenging and fascinating to think in these geological terms about how planetary-scale computation is enabled via networks of cables, servers, data-centres and individual nodes that together form a new geological layer across the surface of the planet; a crust of telecommunication networks that is not merely limited to deeply buried cables or other bulky material embodiments but extends further into the atmosphere involving radio frequencies as well as growing numbers of orbiting satellites. A mechanically organic palaeontology.

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Biography

Egor Kraft, an interdisciplinary artist and researcher (b. 1986, St. Petersburg), lives and works in Moscow and Berlin. Egor acquired his education from Rodchenko Art School, The Academy of Arts Vienna, Central St. Martins College and 'The New Normal' program at Strelka Institute. As an artistic method he looks for ways to produce work which sits on the boundaries between realities and their virtual misrepresentations.

He participated in the 5th Moscow Young Art Biennial, Ural Industrial Biennial, Ars Electronica, WRO Biennial, Impakt Festival, Open Codes at ZKM and other museum shows internationally. Egor has been nominated for Lumen, Kandinsky, Pulsar, Innovation and Kuryokhin Prizes. In 2017 he was included in the New East 100, a list of people and projects shaping our world today by *Calvert Journal*. In 2019 He became a STARTS residency research fellow at the University of Southampton and a Garage Museum Art and Technology Grant recipient.

Part IV

Art Gallery

***DïaloG*, 2021**

Prof. Maurice Benayoun
School of Creative Media, CityU Hong Kong
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Refik Anadol
Department of Design Media Arts, UCLA
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Artist Statement

DïaloG is an interactive urban media art installation exploring the themes of alterity, strangeness and immigration, in a performative way. The work presents two pieces that are at the same time artworks and aliens. They are confronted with a new environment where they don't belong to… yet. They will have to adapt their language, to build a common knowledge, integrating all new artifacts and natural phenomena that constitute now their environment. This includes the other living beings moving around them, and, eventually, they will have to understand each other. While we use the concept of language very broadly to include speech, performance, gesture, utterance, and even data, we focus on strangeness from an ontological perspective, trying to mark a terrain of possibilities for the intersection of interpersonal and digital experiences in the urban sphere. MoBen and Refik Anadol take the notion of "dia-logos" (through-word, through speech) embedded in the etymological roots of the word "dialogue," more understood as an informational thread processed through an iterative feedback loop between perception and expression, and push it to a level of transactional complexity by activating the potential difference between virtuality and visuality. In this way, we aim to create a unique, site-specific language between each of both works we are presenting as living entities and their unknown public, and also, between our works that are initially alien to each other—a language of unexpected and indefinable machine expressions that adapt themselves to the constant flow of data representing real-time environmental, societal, and human actions.

Fig. 1. *DïaloG (etude for)*, 2021, Refik Anadol, Maurice Benayoun, Interactive installation, generative graphics, dynamic CGI, AI, sound, courtesy of the authors.

Project Description

DïaloG is made of two "living" visual dynamic entities facing each other in the public space. They don't look like the living beings we know. They don't speak any language we know. They are aliens, strangers, immigrants. They are clearly, and desperately, trying to understand each other, to understand their new environment and their strange public. *DïaloG* reflects on the difficulty of building a mutual understanding beyond social and cultural differences. All that make living beings what they are: their morphology, their behavior, their ethology, and, beyond language, their cognitive functions, make the laborious process of learning from strangeness and alterity a reality. Dotted with ever-growing perceptive and cognitive capacities, aware of its environment, the artwork is now able to adapt itself, to evolve and to communicate as would a more advanced living entity do. *DïaloG* tries to epitomize the emergence of the artwork as a subject, not only able to learn from its environment but also to dialogue with its public, and even, it may be a bigger challenge, trying to understand other artworks.

Contributions and History of the Project

The *DïaloG* project stems from the authors, Refik Anadol and Maurice Benayoun respective practice in the field of generative art, which converge on this endeavor in the context of the MindSpaces collaborative research project, "Art Driven Adaptive Outdoor and Indoor Design," together with 12 different international partners, supported by the EU Horizon2020, S+T+Arts Lighthouse program. These partners are:

• Center for Research and Technology (CERTH, project leader)
• Aristotle University of Thessaloniki
• Universiteit Maastricht (Belgium)
• Universidad Pompeu Fabra (Barcelona)
• McNeel Europe (Barcelona)
• UP2Metric (Barcelona)
• Nurogame (Koln)
• Zaha Hadid Architects (London)
• MoBen (Maurice Benayoun, Tobias Klein, Paris/Hong Kong)
• Analog Native (Refik Anadol, Germany /California)
• L'Hospitalet de Llobregat (City, Spain)
• City University of Hong Kong, School of Creative Media (Hong Kong SAR)

The project is also supported by HK RGC/EC joint program, through MindSpaces HK: "Collective neuro-design applied to art, architecture and indoor design." School of Creative Media, City University of Hong Kong. *DïaloG* is also supported by the School of Creative Media and ACIM fellowship through the Neuro-Design Lab.

Most of the partners contribute to different aspects of the research. such as sensing technology and motion capture, architecture, neuroscience, data analysis and language treatment, space representation and design, and public behavior analysis.

The original project is to be presented on the specific site of Tecla Sala, under the umbrella of our institutional partner L'Hospitalet de Llobregat, Spain, (Marta Borregero), in collaboration with Espronceda (Alejandro Martin), McNeel Europe (Luis Fragada),

Fig. 2. *DïaloG (etude for)*, 2019, Maurice Benayoun, Refik Anadol, first draft of the project on the site of Tecla Sala, L'Hospitalet de Llobregat, Catalunia, courtesy of the authors.

Pompeu Fabra (Leo Wanner, Simon Mille, Alexander Shvets), Maasticht University (Beatrice de Gelder, Alexia Briassouli), Zaha Hadid (Tyson Hosmer), CERTH-ITI (Nefeli Geor, Evangelos Stathopoulos…), and Neuro design Lab SCM/CityU Hong Kong (Tobias Klein, Charlie Yip, Ann Mak, Sam Chan, Tim Leung, Tony Zhang). Many others contribute actively to the project and the Art Machine 2 conference will be the first opportunity to present, validate and test this collaboration in a concrete physical situation.

A real time version of both artworks at an early stage of development for the DïaloG project was presented during *Ars Electronica* 2020 during the opening discussion by Refik Anadol and Maurice Benayoun, *A Dialog about DïaloG*, within the framework of the Ars electronica Hong Kong Garden, and the prospective generative work, *Alien Life in the Telescope*, was presented in real time.

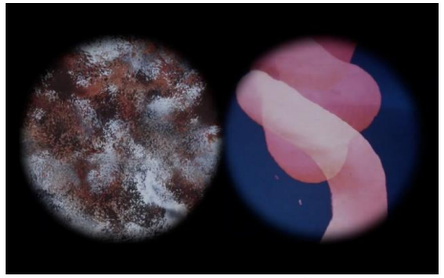

Fig.3. *Alien Life in the Telescope*, 2020, Refik Anadol, Maurice Benayoun, online dynamic generative graphics, Ars Electronica HK Garden, hkgardens.com, courtesy the artists.

Biographies

Maurice Benayoun Artist, theorist and curator, Paris-Hong Kong, Prof. Maurice Benayoun (MoBen, 莫奔) is a pioneering figure of New Media Art. MoBen's work freely explores media boundaries, from virtual reality to large-scale public art installations, from a socio-political and philosophical perspective. Moben is recipient of the Golden Nica and more than 25 international awards, and has exhibited in major international Museums of Contemporary Art, biennials and festivals in 26 different countries. He has also given over 400 lectures and keynotes around the World. With the *Brain Factory* and *Value of Values:Transactional Art on the Blockchain*, MoBen is now focusing on the "morphogenesis of thought," between neuro-design and crypto currencies. Maurice Benayoun is professor at the School of Creative Media, CityU Hong Kong, and co-founder of the Neuro-Design Lab.

Refik Anadol (b. 1985, Istanbul, Turkey) is a media artist, director, and pioneer in the aesthetics of machine intelligence. He currently lives and works in Los Angeles, California and is also a lecturer and visiting researcher in UCLA's Department of Design Media Arts. Anadol's body of work locates creativity at the intersection of humans and machines. In taking the data that flows around us as his primary material and the neural network of a computerized mind as his collaborator, Anadol paints with a thinking brush, offering us radical visualizations of our digitized memories and expanding the possibilities of architecture, narrative, and the body in motion. He holds an MFA degree from UCLA in Media Arts, and an MFA degree from Istanbul Bilgi University in Visual Communication Design as well as a BA with summa cum laude in Photography and Video.

Models for Environmental Literacy, 2020

Tivon Rice
University of Washington Department of Digital Art and Experimental Media, Google Artists and Machine Intelligence
tivon@uw.edu, tivonrice@gmail.com

Artist Statement

My work critically explores representation and communication in the context of digital culture and asks: how do we see, inhabit, feel, and talk about these new forms of exchange? How do we approach creativity within the digital? What are the poetics, narratives, and visual languages inherent in new information technologies? And what are the social and environmental impacts of these systems?

These questions are explored through projects incorporating a variety of materials, both real and virtual. With recent films, installations, and A.I. generated narratives, I examine the ways contemporary digital culture creates images and in turn builds histories around communities and the physical environment. While much of my research focuses on emerging technologies, I continuously reevaluate relationships with sculpture, photography, and cinema. My work incorporates new media to explore how we see and understand a future thoroughly enmeshed in new data, visual, and production systems.

Project Description

In the face of climate change, large-scale computer-controlled systems are being deployed to understand terrestrial systems. AI is used on a planetary scale to detect, analyze and manage landscapes. In the West, there is a great belief in "intelligent" technology as a lifesaver. However, practice shows that the dominant AI systems lack the fundamental insights to act in an inclusive manner towards the complexity of ecological, social, and environmental issues. At the same time, the imaginative and artistic possibilities for the creation of non-human perspectives are often overlooked.

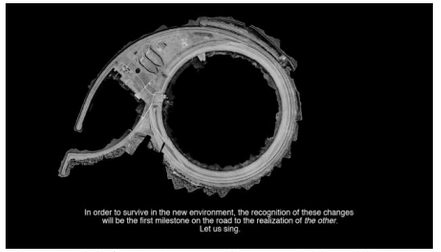

Fig. 1. *Models for Environmental Literacy* (video still), 2020, Tivon Rice.

With the long-term research and experimental film project *Models for Environmental Literacy*, the artist Tivon Rice explores in a speculative manner how artificial intelligences could have alternative perceptions of an environment. Three distinct AIs were trained for the screenplay: The "Scientist," the "Philosopher," and the "Author." The AIs each have their own personalities and are trained in literary work—from science fiction and eco-philosophy, to current intergovernmental reports on climate change. Rice brings them together for a series of conversations while they inhabit scenes from scanned natural environments. These virtual landscapes have been captured on several field trips that Rice undertook over the past two years with FIBER (Amsterdam) and BioArt Society (Helsinki). *Models for Environmental Literacy* invites the viewer to rethink the nature and application of AI in the context of the environment.

Fig. 2. *Models for Environmental Literacy* (video still), 2020, Tivon Rice.

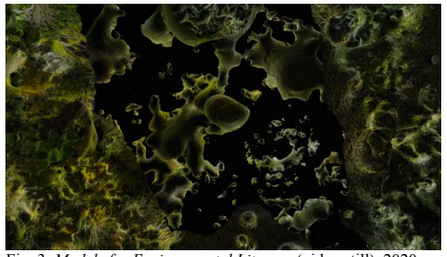

Fig. 3. *Models for Environmental Literacy* (video still), 2020, Tivon Rice.

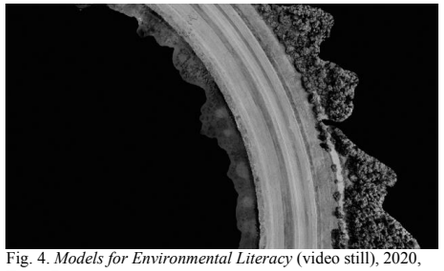

Fig. 4. *Models for Environmental Literacy* (video still), 2020, Tivon Rice.

Biography

Tivon Rice is based in Seattle (US) and holds a PhD in Digital Art and Experimental Media from the University of Washington, where he is currently a professor of Data Driven Art at DXARTS. He was a Fulbright scholar (Korea 2012), and one of the first individuals to collaborate with Google Artists + Machine Intelligence. His projects have traveled widely with exhibitions in New York, Los Angeles, Seoul, Taipei, Amsterdam, London, Berlin, and São Paulo.

Gradation Descent, 2020

Nirav Beni
Royal College of Art
nirav.beni@network.rca.ac.uk

Artist Statement

I position myself at the intersection of art and technology, where I can incorporate AI, machine learning and other new media into my practice. I aim to create audio-visual, immersive and interactive installations that create shared and evocative experiences that touch on themes such as the human-machine dynamic.

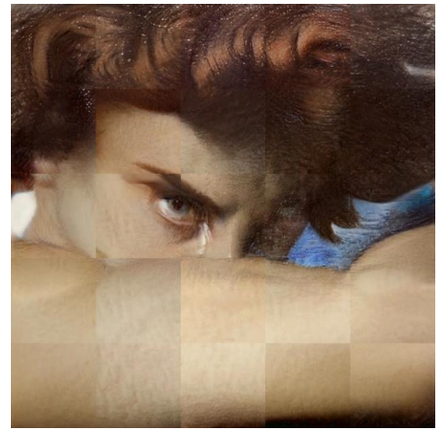

Fig. 1. *Gradation Descent* (video still), 2020, Nirav Beni.

Project Description

This work is a short audio-visual video that depicts a conceptual imitation or a visual reinterpretation of machine learning image processing algorithms acting on Alexandre Cabanel's *Fallen Angel* painting.

Convolutional Neural Network algorithms (CNNs) comprise subdivided analyses of pixels, iterating and processing over multi-layered clustering of smaller blocks as they run. Pooling functions, convolutional image processing and feature reductions are common methods applied by these algorithms.

The moving images creating the video are generated from a Generative Adversarial Network (GAN), being trained on "real" images to produce its own "fake," almost identical, but slightly inaccurate versions. After the algorithm slides across the original image and each block of the original image is processed, an AI generated frame is left in its place, creating this "fake" collage as the output image, emphasizing both similarities and discrepancies. The movement of the sliding motion is triggered by audio signals from a melancholic piano piece that was produced to accompany the teary visuals of the fallen angel.

The idea of the unseen, of algorithms being opaque and black boxed, inspired the idea of trying to unbox and interpret the operations of these AI machines in a way that is most familiar to us—through the human sense of sight. The human gaze is often crucial in our perception, and the *Fallen Angel* painting truly encapsulates this aesthetic.

Over time, as these algorithms become more ubiquitous, they become harder to decipher, either through the unpredictability of their operations, their general complexity or maybe just through intellectual property and propriety safeguarding. AI has the potential to expand into the realms of machine consciousness, agency and superintelligence. And as a potential technological singularity draws closer, our understanding or even control over these will weaken.

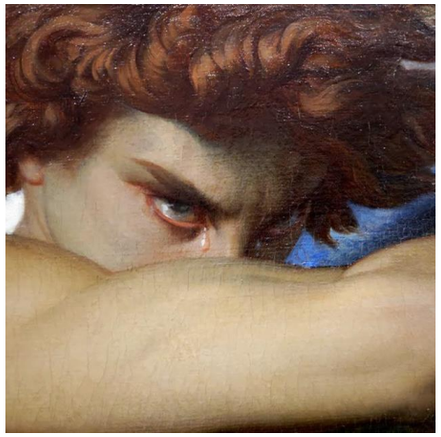

Fig. 2. *Gradation Descent* (video still), 2020, Nirav Beni.

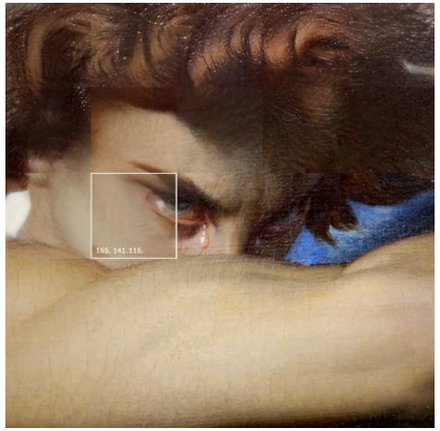

Fig. 3. *Gradation Descent* (video still), 2020, Nirav Beni.

Biography

Nirav Beni is a South African born engineer and new media artist. He has a BSc degree in Mechatronics Engineering from the University of Cape Town, and is now studying for an MA in Information Experience Design at the Royal College of Art in London.

The Zombie Formalist, 2021

Ben Bogart
Independent Artist
ben@ekran.org

Artist Statement

Flipping in the art market and the proliferation of "Zombie Formalism" indicate an increasing consideration of art objects as commodities selected for their potential as investments rather than for their cultural or personal importance. This trend continues in the form of the "crypto art" market where works are often bought in crypto-currencies and whose provenance is recorded using Block-chain. While computer vision methods are often being deployed in public space to detect criminality, these same tools are valuable in the context of surveillance capitalism; there is significant potential for such systems to be used to profile individuals for advertising. In the not-too-distant future—as long governments continue to allow the expansion of these systems—face recognition will undoubtedly be exploited for targeted advertising in public space. Brand messages will be tailored specifically to the passerby thanks to connections with social media and web behaviour.

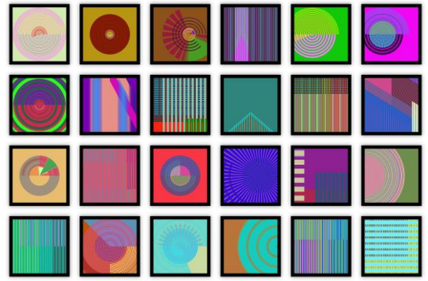

Fig. 1. *The Zombie Formalist—top 24 Zombie Formalist compositions ranked according to Twitter engagement*, 2021, Ben Bogart.

Project Description

The Zombie Formalist is a satirical generative lightbox that generates geometric abstractions in response to audience attention. The project points to the intersection of art as commodity, surveillance capitalism and the automation of intellectual work through AI. The Zombie Formalist is the autonomous artist in your home; it learns what you like and creates more of what you want to see. The Zombie Formalist uses Twitter and machine learning to create conceptually vapid formalist compositions whose properties are tuned according to, and their value wholly derived from, the preferences of the audience/market. The Zombie Formalist is a self-contained system including a square 27" display enclosed in a black contemporary art frame.

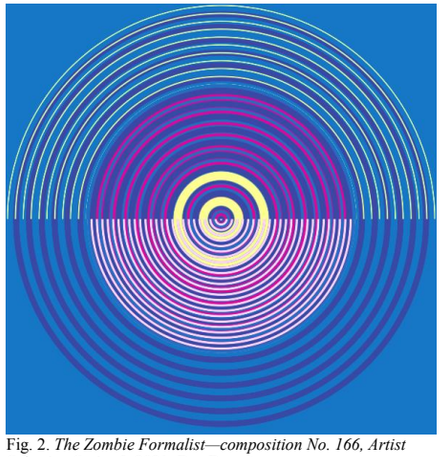

Fig. 2. *The Zombie Formalist—composition No. 166, Artist Selection Series 3*, 2021, Ben Bogart.

The work generates images from random parameters in the style of painters such as Gene David, Barnett Newman, Kenneth Noland, and Karl Benjamin. One image is generated every two hours and uploaded to Twitter where the number of likes and retweets—a proxy for the system's consideration of value—are tracked. This data is used to train a classifier to learn the difference between "good" (more engagement) and "bad" (less engagement) compositions. At this stage, the system is collecting data for offline training and analysis. In the final work, an onboard predictive model will be used to filter generated compositions such that the probability of "good" compositions presented on screen will increase.

The light-box is satirically marketed as a high-tech object where materials emphasize minimalism and elegance; mock-ups show them presented in stark contemporary spaces such as those in architecture and interior design magazines. Expanding the notion of art as commodity, images generated by the Zombie Formalist are available as kitsch on the Society6 Print on Demand site. These objects reference the art gallery gift shop where famous works are sold on posters and coffee mugs.

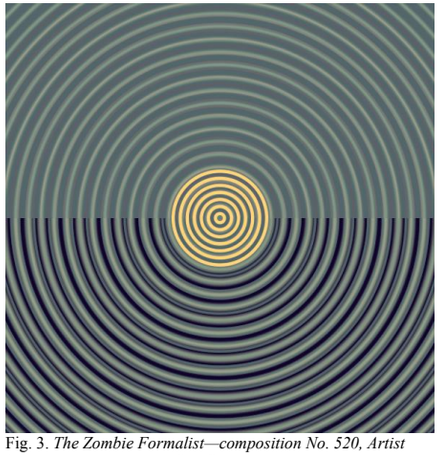

Fig. 3. *The Zombie Formalist—composition No. 520, Artist Selection Series 3*, 2021, Ben Bogart.

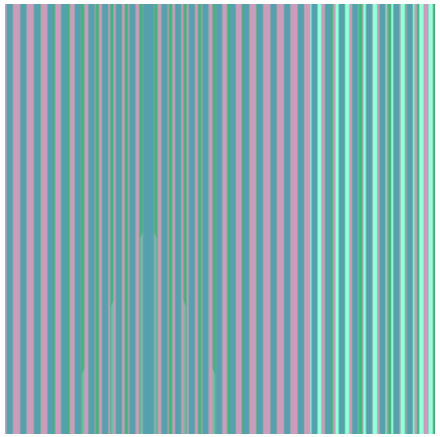

Fig. 4. *The Zombie Formalist—composition No. 209, Artist Selection Series 3*, 2021, Ben Bogart.

Biography

Ben Bogart is a non-binary disciplinary artist working for nearly two decades with generative computational processes (including physical modelling, chaotic equations, feedback systems, evolutionary algorithms, computer vision and machine learning) and has been inspired by knowledge in the natural sciences (quantum physics and cognitive neuroscience) in the service of epistemological inquiry. Ben has produced processes, artifacts, texts, images and performances that have been presented at galleries, art festivals and academic conferences internationally. Notable exhibitions include solo shows at the Canadian Embassy at Transmediale in 2017 and the TechLab at the Surrey Art Gallery in 2018. Their research and practice have been funded by the Social Science and Humanities Research Council of Canada, the British Columbia Arts Council and the Canada Council for the Arts.

Theodore—A Sentimental Writing Machine, 2019-20

Ivan Iovine
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Artist Statement

The goal of my artistic research is to experiment with and combine multiple models of machine learning, physical computing and the use of web technologies in order to create real-time interactive installations that involve multiple visitors simultaneously. These technologies, combined together, open new horizons in the field of Physical Interaction, creating a new class of intelligent and responsive on-site installations.

Project Description

Theodore is an interactive installation capable of writing sentimental letters based only on image content. The main idea underlying this project is to find out if machines are able to understand feelings and context, and generate intimate and confidential letters that express human-like sentiments using only pictures as input. For this purpose, several machine learning frameworks are used in the field of image recognition, in particular facial expression detection, landscape and landmarks recognition, as well as text generation. The "Dense captioning" machine learning model is used for image recognition, particularly for face, landscape and landmark recognition. For the generation of the letters, the natural language processing model "GPT-2" is used.

The interaction between the user and the installation happens through a mobile web application. The system invites the user to upload a picture with the subject of the letter. In a second step, the user inserts his name, as well as the loved one's name and the type of relationship. After this process, the system starts to analyze the picture, extracting the emotional traits of the subject, along with contextual attributes from the location. In conjunction with the basic information inserted by the user, these attributes are passed to the text generation algorithm. Once the text has been generated, the system sends the result to the physical installation. The generated letter is now ready to be printed by an analog typewriter automated with an "Arduino MEGA" and 33 Solenoid type motors.

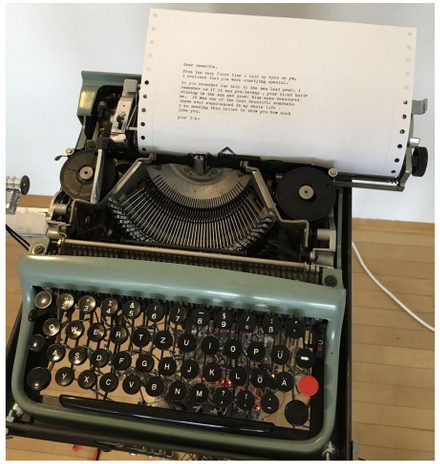

Fig. 1. *Theodore—A Sentimental Writing Machine*, 2019-20, Ivan Iovine.

Biography

Ivan Iovine is an Italian interaction designer based in Frankfurt am Main, Germany. His works mainly focus on the intangible human side of machines. Through his multimedia installations, he tries to create possible future interactions and relationships between humans and machines. Iovine's works have been exhibited at the European Maker Faire in Rome, at JSNation Conference in Amsterdam, at the Media Art Festival LAB30 in Augsburg, and at Piksel Festival in Bergen.

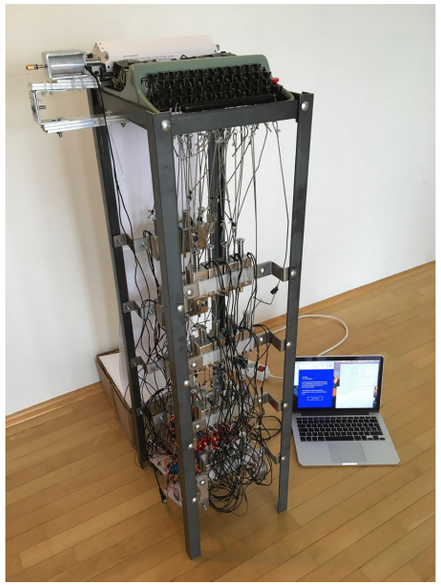

Fig. 2. *Theodore—A Sentimental Writing Machine*, 2019-20, Ivan Iovine.

Reflective Geometries, 2019

Mariana Rivera & Sara Zaidan
The Bartlett School of Architecture, Design for Manufacture 2019
mdlrs.rivera@gmail.com, sarazaidan@gmail.com

Artist Statement

This project focuses on the exploration of subtractive manufacturing technologies and their effects on material reflection. It aims to predict and design visual light transmission of machined surfaces using virtual simulation, enabling new material responses and qualities to be programmed into conventional materials such as aluminium. *Reflective Geometries* intends to define the optical performance of aluminium through carefully selected fabrication parameters that uncover inherent reflective metaproperties. The sculptural object is made up of bespoke aluminium paneling. It is designed to be used as an architectural component, interior and/or exterior.

Fig. 1. *Reflective Geometries*, 2019, Mariana Rivera and Sara Zaidan.

Project Description

This design placeholder research focuses on the exploration of subtractive manufacturing technologies and their effects on material behavior. It specifically investigates the large impact surface finishes have on aluminium's optical properties and visual appearance when designed and controlled. Therefore, new material responses and qualities can be achieved and programmed into traditional materials. By integrating feedback data loops between the multiple stages of digital fabrication, novelties in the traditional ways of making are possible. This investigation looks to integrate machining parameters into the design process to facilitate an object production with desired performance.

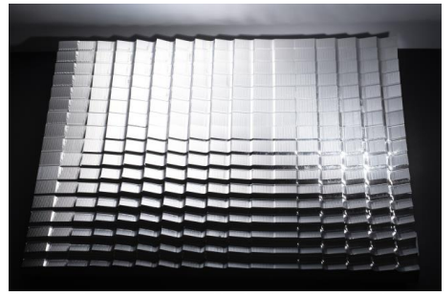

Fig. 2. *Reflective Geometries* (detail), 2019, Mariana Rivera and Sara Zaidan (Photograph by Sarah Lever).

Fig. 3. *Reflective Geometries* (detail), 2019, Mariana Rivera and Sara Zaidan (Photograph by Sarah Lever).

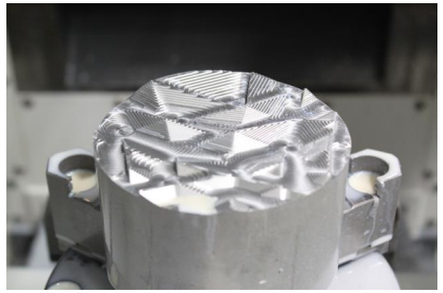

Fig. 4. *Reflective Geometries* (process documentation), 2019, Mariana Rivera and Sara Zaidan.

Biographies

Mariana Rivera is an architectural designer and maker from Puerto Rico. In 2019, she finished an MArch at the Bartlett School of Architecture in Design for Manufacture (UCL). She has a keen interest in material performance and its application in architecture and design. She is trained as an architect and believes in approaching design as a creative and adaptable maker with knowledge in digital craft and new technologies.

Sara Zaidan is an industrial designer with a background in architecture. Her main professional interest includes material behavior and fabrication through digital craft in the context of fast evolving technologies.

Having recently graduated from the Bartlett, School of Architecture, with a MArch in Design for manufacture, she is currently interested in exploring the possibilities of parametric design considering material performance using advanced manufacturing technologies.

Hack (Comedy), 2020

Lan Zhang
Parsons School of Design, The New School
zhany016@newschool.edu

Artist Statement

Lan Zhang, the artist, whose native language isn't English and who has struggled to become culturally competent, wants to use this unexpected way of programming to reach the pedestal of American humour. The process, however, reinforces the failure of the artist's ideal pursuit of cultural competency and the comic absurdity of the pursuit itself.

Project Description

Hack (Comedy) is a computational comedy net art interface as well as a performance. *Hack (Comedy)* aims to interrogate our perception of contextual humor through live procedural generations that reflect the condensed themes and identities in the American comedy landscape. With text input such as words and phrases, virtual comedian modules will complete writing sentences using word references from the transcript compilations scraped from the internet. In the performance, the generated outcomes will be delivered by human actors.

Computational comedy stands for producing comic text using procedural methods. "Hack" is a double entendre here: 1. Gaining unauthorized access to a network or a computer. 2. Copying joke bits from the original comedians.

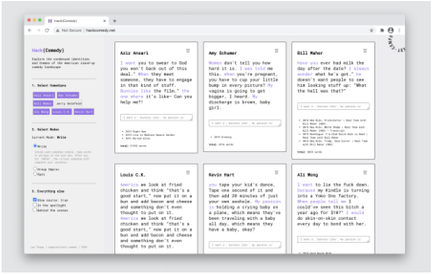

Fig. 1. *Hack (Comedy)—web interface* (screenshot), 2020, Lan Zhang.

Fig. 2. *Hack (Comedy)—title card* (screenshot), 2020, Lan Zhang.

Fig. 3. *Hack (Comedy)* (installation render), 2020, Lan Zhang.

Fig. 4. *Hack (Comedy) — live performance*, March 2020, Lan Zhang, Image courtesy of CultureHub, New York. Photograph by Lívia Sá.

Biography

Lan Zhang (she/her) is a Chinese creative developer and computational artist currently based in New York in the United States. She enjoys creating tools on the web and experimenting with natural language processing, play experiences, and networked performances. Lan received her MFA in Design and Technology from Parsons School of Design. She has performed or showed her work at La Mama Experimental Theater NYC Culture Hub ReFest in NYC, Babycstles in NYC, Shanghai Power Station of Art, PRINT Magazine, Graphis New Talent, and Parsons 2020 Hindsight Festival.

Mitochondrial Echoes: Computational Poetics, 2021

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Artist Statement

This artwork is part of an ongoing research project between three artist mothers and Steve DiPaola in the iVizLab at Simon Fraser University, engaging AI technology, Deep learning, bodies, systems, sonic encounters, and computational based art processes. Building on the work of Maria Puig de la Bellascasa and Rosi Braidotti, we take up research-creation approaches through co-constructed, technologically mediated sound and video practices.

Fig. 1. *Mitochondrial Echoes: Computational Poetics* (video still), 2021, prOphecy sun, Freya Zinovieff, Gabriela Aceves-Sepulveda and Steve DiPaola (AI art images by S.DiPaola; Video editing and composition by G. Aceves-Sepulveda; Performance by p. sun, F. Zinovieff and G. Aceves-Sepulveda; Sound composition by p. sun & F. Zinovieff).

Project Description

Mitochondrial Echoes: Computational Poetics, is an immersive audiovisual AI driven poetic score that explores computational poetics, sonic decay, and notions of place, attunement, figuration, and narrative iteration. This artwork makes a contribution to the Art Machines 2 conference and research-creation processes by presenting AI built poetic stanzas that were further translated through sonic decay, video editing, and collective machinic interactive processes. Exploring the agential, tangible, and expansive possibilities of machine learning algorithms this work invites innovative ways of seeing, feeling, and sensing the world beyond known realms—extending our limbs, ears, eyes, and skin.

Fig. 2. *Mitochondrial Echoes: Computational Poetics* (video still), 2021, prOphecy sun, Freya Zinovieff, Gabriela Aceves-Sepulveda and Steve DiPaola (AI art images by S.DiPaola; Video editing and composition by G. Aceves-Sepulveda; Performance by p. sun, F. Zinovieff and G. Aceves-Sepulveda; Sound composition by p. sun & F. Zinovieff).

Fig. 3. *Mitochondrial Echoes: Computational Poetics* (video still), 2021, prOphecy sun, Freya Zinovieff, Gabriela Aceves-Sepulveda and Steve DiPaola (AI art images by S.DiPaola; Video editing and composition by G. Aceves-Sepulveda; Performance by p. sun, F. Zinovieff and G. Aceves-Sepulveda; Sound composition by p. sun and F. Zinovieff).

Biographies

prOphecy sun, Freya Zinovieff, Gabriela Aceves-Sepúlveda, Steve DiPaola have been collaborating since 2018. This work expands on a larger research agenda focused on the female body as a multispecies animal in relation to machine-learning processes and how acts of care can facilitate kinship.

Current, 2019-20

Provides Ng, Eli Joteva, Ya Nzi, Artem Konevskikh
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Artist Statement

With the emergence of planetary computation, data analytics, and algorithmic governance, the Current Team seeks to bridge communication between digital technology, its folk ontology, and their impacts on urbanism. The team employs visual-driven analytics to investigate contemporaneity and speculate on our future. They consider visual aesthetics not as supplementary to happenings, but possessing intrinsic cultural values that are uncertainly measurable with existing institutional metrics.

The Current Team works with creatives worldwide. They seek understanding across cultural and disciplinary landscapes to knit a global network of connections. The team feels the urgency to amalgamate distributed social and technological capacities into an operable soft infrastructure that complements our physical architectures. Along these lines, the team serves to realize designs that may help to aggregate the efforts of the many, and delineate how this might transform our proximate futures.

Fig. 1. *Current* (video still), 2019-21, Provides Ng, Eli Joteva, Ya Nzi and Artem Konevskikh.

Project Description

Current is a speculation on the future of broadcast cinema. It emerges from the intersection of contemporary trends in live streaming culture, volumetric cinema, AI deep fakes and personalized narratives. The film, *Current*, is an experiential example of what this cinema might look and feel like within a few years based on the convergence of these trends. AI increasingly molds the clay of the cinematic image, optimizing its vocabulary to project information in a more dynamic space, embedding data in visuals, and directing a new way of seeing: from planar to global, flat to volumetric, personal to planetary.

In the contemporary contestations of algorithmically recommended content, the screen time of scrolling between livestreams has become a form of new cinema. *Current* experiments with various AI image processing technologies and volumetric environment reconstruction techniques to depict a future where every past account has been archived into an endless stream. History, from the Latin "historia," means the art of narrating past accounts as stories. What will be the future of our urban environment if every single event is archived in real time to such accuracy that there is no room for his-story? This implies an economy of values, which has potential in multiple streams beyond social media, as the content deep learns from itself.

Along these lines, *Current* seeks to configure a new aesthetic vocabulary of cinematology, expanding the spectrum of aesthetic semblance and intelligence, questioning truth and identity in contemporary urban phenomena. *Current* experimented with a range of digital technologies that are readily available to any individual (e.g. livestream

data, machine learning, 3D environment reconstruction, ubiquitous computing, pointclouds and lidar scanning). Alongside the volumetric film, it developed a production pipeline using distributed technologies, which provide a means for individuals to reconstruct, navigate, and understand event landscapes that are often hidden from us, such as violence in protests, changes in Nordic animal behaviors, and the handling of trash.

Fig. 2. *Current* (video still), 2019-21, Provides Ng, Eli Joteva, Ya Nzi & Artem Konevskikh.

Fig. 3. *Current* (video still), 2019-21, Provides Ng, Eli Joteva, Ya Nzi & Artem Konevskikh.

Fig. 4. *Current* (video still), 2019-21, Provides Ng, Eli Joteva, Ya Nzi and Artem Konevskikh.

Fig. 5. *Current* (video still), 2019-21, Provides Ng, Eli Joteva, Ya Nzi and Artem Konevskikh.

Biographies

Provides Ng, **Eli Joteva**, **Ya Nzi,** and **Artem Konevskikh** form the the Current Team, an interdisciplinary and intercultural collective, encompassing architects, researchers, artists, CG engineers, data analysts, and AI programmers from China, UK, Bulgaria, USA, and Russia. Apart from our four core members, the Current Team is also constituted from its broader network of creative commons and collaborators from all around the world (https://www.current.cam/evolutions), where virtual space is what has enabled their cross-territorial collaborations and constantly reminds them of the importance of treasuring the affective values which arise from physical interactions. Thus, the team focuses on the "work" as much as the "working"—the processes by which they can create, design, produce, research, and learn together across disciplinary and cultural boundaries. The Current Team and its works are not set apart from the rest of the world, but rather are embedded within it, setting a virtual mediated ground that enables such aggregation of efforts.

The (Cinematic) Synthetic Cameraman, 2020-21

Lukasz Mirocha
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Artist Statement

The artwork takes a deconstructive and speculative approach towards synthetic photorealism by exploring the creative potential of today's content creation tools that allow us to merge various aesthetic and formal styles in new types of media content co-designed by both human agents and algorithmic systems.

I am convinced that this trend will only accelerate thanks to advancements in machine learning with systems like GANs and CANs that can produce images situated within a broad representational spectrum of computer graphics—from producing new types of images and aesthetics to mimicking historical artistic styles. The artwork, by offering a unique visual experience virtually every second, illustrates how programmable real-time computer graphics bring us closer to processual and variable media culture based on ever-evolving media hybrids, affording new visual experiences and allowing for new means of creative human/machine expression and cooperation.

Fig. 1. *The (Cinematic) Synthetic Cameraman* (screenshot), 2020, Lukasz Mirocha.

Project Description

The (Cinematic) Synthetic Cameraman is a software application that is rendering a computer-generated environment displayed on an external display. It challenges the pervasiveness of carefully remediated lens-based aesthetics and photorealism used as dominant visual conventions across popular media based on computer graphics.

The volcanic environment was chosen as a theme for the simulation to emphasize the structural and ontological unpredictability of both the phenomenon and the models of its representation. Volcanic eruptions are widely associated with random, dynamic and unique events that are beyond our control and that can only be observed as self-unfolding occurrences lasting for days, weeks or even months.

The artwork allows the audience to experience the environment as it is visualized by two radically different camera-based representational models. These two modalities illustrate how programmable real-time graphics can broaden the typical photorealistic representational spectrum. The opening and the closing sections of the experience are based on pre-programmed (human agent) and repetitive sequences of shots and image settings, stylized as cinematic aerial shots that adhere to typical photorealistic aesthetics, which, although recreated in a computer-generated environment, originate from pre-computational styles and conventions. The middle section encapsulates the stage where control over individual elements in the scene is given over to algorithmic systems.

The range of possible values that the system is using and modifying every few seconds to shoot and execute a procedural explosion as it is unfolding can freely go

beyond the capabilities of physical cameras, which makes it a hypermediated apparatus that explores the broadened frontiers of the photorealistic representational spectrum. These processes are taking place in real-time, therefore every second of the experience perceived by the viewer is a one-time event conceived through a unique entanglement of parameters directing both the eruption and its representation, which together constitute this ever-lasting visual spectacle.

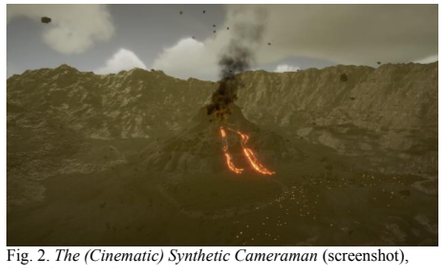

Fig. 2. *The (Cinematic) Synthetic Cameraman* (screenshot), 2020, Lukasz Mirocha.

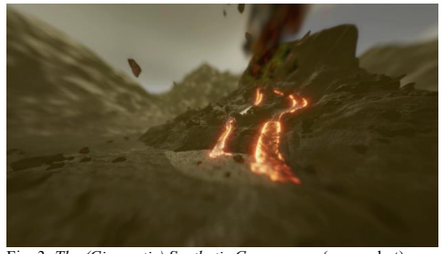

Fig. 3. *The (Cinematic) Synthetic Cameraman* (screenshot), 2020, Lukasz Mirocha.

Fig. 4. *The (Cinematic) Synthetic Cameraman* (screenshot), 2020, Lukasz Mirocha.

Biography

Dr. Lukasz Mirocha is a new media and software theorist and practitioner working with immersive (XR) and real-time media. More on: https://lukaszmirocha.com.

Voices and Voids, 2019-20

Afroditi Psarra
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Audrey Desjardins
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Bonnie Whiting
Music, University of Washington
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Artist Statement

Afroditi Psarra conducts transdisciplinary works that explore data-driven processes and technology as a gendered and embodied practice. Her work manifests through tactile artifacts produced by data physicalization techniques, wearable and haptic interfaces, sound performances and field recordings, as well as interdisciplinary collaborations.

As an interaction design researcher, Audrey Desjardins uses design as a practice for investigating and imagining alternatives to the ways humans currently live with everyday objects. Her work questions and considers familiar encounters between humans and things, particularly data and technologies in the context of the home.

Bonnie Whiting performs new experimental music, seeking out projects that involve the speaking percussionist, improvisation, and non-traditional notation. Her work focuses on the integration of everyday objects and the voice into the percussive landscape, amplifying and transforming the familiar through a lens of performance.

Project Description

Voices and Voids is an interdisciplinary artistic research project, between interaction design, digital art and percussion, that utilizes voice assistant interaction data as expressive material for the creation of performative artefacts and embodied experiments. Responding to current concerns about the ubiquity of voice assistants, *Voices and Voids* focuses on building a series of performative artifacts that aim to challenge AI and ML technologies, and to examine automation through the prism of "ghost work" that constantly support these systems. By allowing AI agents to listen to our most private conversations, we become receptive to this mediated care, while forgetting or ignoring how much these automated interactions have been pre-scripted. While these interactions cultivate a sense of familiarization with the non-human, they also corroborate the impact of Late Capitalism and the Anthropocene. Within these contradictions we see an opportunity to reclaim, examine, and ultimately transcode this data through an interdisciplinary performance project, by developing embodied experiments using a combination of design, data-driven art, cyber crafts, found-object and traditional percussion instruments, spoken word, and movement. Initially conceived as a live performance and installation event, our changed environment during the COVID-19 pandemic inspired us to pivot to the medium of net art.

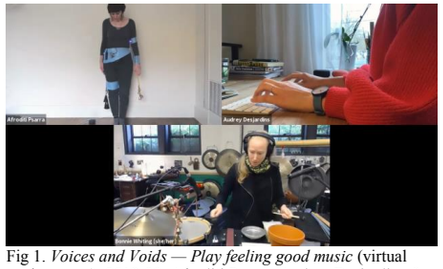

Fig 1. *Voices and Voids — Play feeling good music* (virtual performance), 2019-20, Afroditi Psarra, Audrey Desjardins & Bonnie Whiting.

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hi turkers hi amazon hi echo ok google
I love chit chatting.
<amazon:effect name="whispered">
chit chat chit chat chit chat
</amazon:effect>
Echo, open shopping list <break
time="2s"/>
Amazon, <break time="1s"/> where are you
<break time="5s"/>
Computer, open voice pad <break
time="2s"/>
Read <break time="5s"/>
Computer, listen <break time="2s"/>
<amazon:effect name="whispered">
chit chat chit chat chit chat chit chat
chit chat </amazon:effect>
```

Fig. 2. *Voices and Void s—Chit Chat* (gif), 2019-20, Afroditi Psarra, Audrey Desjardins and Bonnie Whiting.

Fig. 3. *Voices and Voids—Garden of pots* (gif), 2019-20, Afroditi Psarra, Audrey Desjardins and Bonnie Whiting.

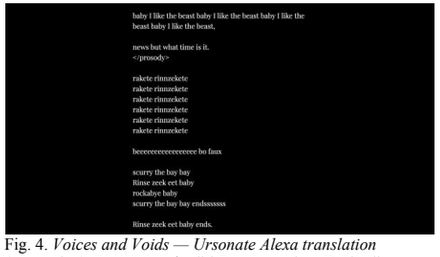

Fig. 4. *Voices and Voids — Ursonate Alexa translation* (screenshot), 2019-20. Afroditi Psarra, Audrey Desjardins & Bonnie Whiting.

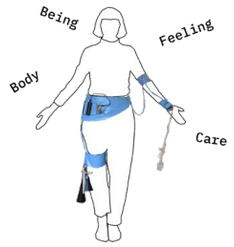

Fig 5. *Voices and Voids—Wearable voice assistant* (gif), 2019-20, Afroditi Psarra, Audrey Desjardins and Bonnie Whiting.

Biographies

Afroditi Psarra is a media artist and assistant professor of Digital Arts and Experimental Media at the University of Washington. Her research focuses on the body as an interface, and the revitalization of tradition as a methodology of hacking technical objects. Her work has been presented at international media arts festivals such as Ars Electronica, Transmediale, CTM, ISEA, Eyeo, and WRO Biennale between others, and published at conferences like Siggraph, ISWC (International Symposium of Wearable Computers) and EVA (Electronic Visualization and the Arts).

Audrey Desjardins is a design researcher and an assistant professor in Interaction Design at the University of Washington. Her work has been supported by the National Science Foundation, the Mellon Foundation, and Mozilla, and has been presented at academic conferences in the fields of human-computer interactions as well as design such as ACM CHI, ACM Designing Interactive Systems, Research Through Design, and ISEA.

Percussionist **Bonnie Whiting**'s work is grounded in historical experimental music for percussion and new, commissioned pieces for speaking percussionist. Her projects probe the intersection of music and language, exploring how percussion instruments can stand in for the human voice and function as an extension of the body. She is chair of Percussion Studies and assistant professor of Music at the University of Washington.

In the Time of Clouds, 2019

Sue Huang
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Artist Statement

My new media and installation-based art practice addresses collective experience and engages with interwoven digital and analog processes. My current projects explore topics of ecological intimacy and speculative futures. Much of my work utilizes digital material from online public spaces including found social media text, found image and video media, and digitized archives. This work is processed through different computational/algorithmic techniques, most recently including artificial intelligence, natural language processing, and camera vision. I am interested in the social and cultural implications of utilizing new media technologies and programming to access and process collective materials and how the usage of these materials can open up new modes of conversation about our collective experiences as captured in online public spaces. These projects are created using a variety of media and formats depending on the concept, and I often draw upon site-specific and public engagement methodologies in the presentation of the work.

Project Description

In the Time of Clouds is a mixed-media installation that utilizes the networked "cloud" to explore our collective sensory relationship to the sky. Responding to a February 2019 *Nature Geoscience* article that speculates about a possible future without clouds, the project attempts to archive cloud forms and document their influence on our collective imagination before they disappear from our atmosphere due to rising carbon dioxide concentrations. Utilizing both social media discourse about clouds and live video streams from public observatory cameras, the project amalgamates linguistic and visual data, mining this data to create an atmospheric triptych of poetry, ice cream, and ceramics.

The installation is composed of three intertwined parts: *Part I (The Observatories),* a series of videos that combine algorithmically generated poems and live streams from networked observatory webcam; *Part II (Terracotta Clouds)*, a collection of hand built dessert wares based on unique cloud forms culled from the videos; and *Part III (Cloud Ice Cream)* (documented in this exhibition), an ice cream whose flavor profile is derived from social media discourse speculating about the taste of clouds, a "cloud ice cream."

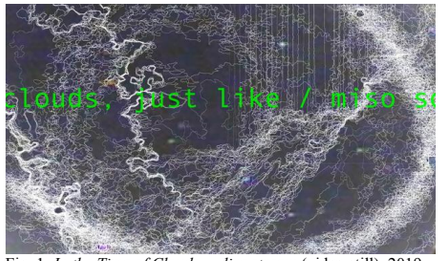

Fig. 1. *In the Time of Clouds — live stream* (video still), 2019, Sue Huang.

Fig. 2. *In the Time of Cloud — terracotta cloud bowl*, 2019, Sue Huang.

Fig. 3. *In the Time of Cloud — terracotta cloud bowl*, 2019, Sue Huang.

Fig. 4. *In the Time of Cloud s— cloud ice cream*, 2019, Sue Huang.

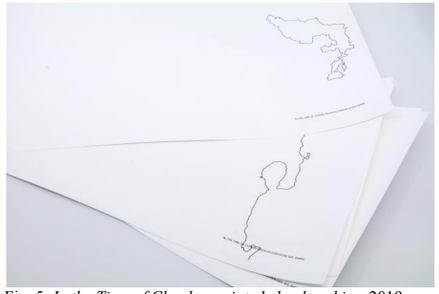

Fig. 5. *In the Time of Cloud — printed cloud archive*, 2019, Sue Huang.

Biography

Sue Huang is a new media and installation artist whose work addresses collective experience. Her current projects explore ecological intimacies, human/nonhuman relations, and speculative futures. Huang has exhibited nationally and internationally, including at the Museum of Contemporary Art (MOCA), Los Angeles; the Contemporary Arts Center (CAC) in Cincinnati; ISEA in Montreal; Ars Electronica in Linz; the Beall Center for Art + Technology in Irvine; and Kulturhuset in Stockholm, among others. She received her MFA in Media Arts at the University of California, Los Angeles (UCLA) and her BS in Science, Technology, and International Affairs from the Walsh School of Foreign Service at Georgetown University. Huang is currently a member of the Creative Science track at NEW INC, supported by Science Sandbox, Simons Foundation, and is an assistant professor of Digital Media & Design at the University of Connecticut.

The Mexican AI Artisan, 2020-21

Juan Manuel Piña Velazquez
pivejuma@gmail.com

Andrés Alexander Cedillo Chincoya
andycedillo@gmail.com

Artist Statement

The focus of our artistic practice has the task of democratizing art techniques related to AI, we use decentralized media to create new narratives that impact the aesthetics of Mexican society. Through this intervention, we are looking to give substance to the profile of creative programmer, as a new entity in the Mexican art world that intersects between art and technology.

Project Description

The Mexican Artisan of Artificial Intelligence is a project that seeks to reconcile a new perspective on the direction of crafts and traditional elements of Mexico. It reflects on the position of the artisan through the use of new technologies to highlight the beauty and cultural richness of our native country. With this piece we want to encourage in the young population an interest in the activity of the Mexican artisan, to create crafts using artificial intelligence tools and search for an alternative to the economic situation that these workers are experiencing due to the impact of the COVID 19 pandemic.

Biographies

Juan Manuel Piña Velazquez is a multimedia artist and creative producer from Mexico City. His approach is based in creating new narratives through the use of alternative and traditional media in convergence between multidisciplinary practices and technology. He has collaborated in multiple artistic pieces and exhibitions in museums and festivals like Mutek, Hannover Messe (Germany), Universum (UNAM), MIDE, FIMG(Spain), Museo del Estanquillo and also has collaborated with Nicola Cruz & Fidel Eljuri for their audiovisual performance presented by Boiler Room.

Andrés Alexander Cedillo Chincoya, is a programmer and creative technologist from Mexico City. He has specialized in electronic art and creative coding. He has collaborated on artistic pieces presented at festivals such as Mutek and Sonar México, he has created generative visuals for immersive spaces such as Artechouse NYC, and participated in the creation of software for music shows such as Camilo Séptimo and DLD, with Nicola Cruz & Fidel Eljuri. During this time he has been involved in the development of complex interaction systems, to communicate different media and supports in real time.

Fig. 1. *The Mexican AI Artisan—Mixcoatl* (detail), 2020-21, Juan Manuel Piña Velazquez and Andrés Alexander Cedillo Chincoya.

Fig. 2. *The Mexican AI Artisan—Tonatiuhteotl* (detail), 2020-21, Juan Manuel Piña Velazquez and Andrés Alexander Cedillo Chincoya.

Fig, 3. *The Mexican AI Artisan —Wixarikas* (detail), 2020-21, Juan Manuel Piña Velazquez and Andrés Alexander Cedillo Chincoya.

Fig. 4. *The Mexican AI Artisan —Yolotl*, 2020-21, Intervened by Hijos del Copal crafts house, Oaxaca, Mexico, Juan Manuel Piña Velazquez and Andrés Alexander Cedillo Chincoya. Photograph by Agustín Cruz.

Fig. 5. *The Mexican AI Artisan —Yolotl*, 2020-21. Intervened by Hijos del Copal crafts house, Oaxaca, Mexico, Juan Manuel Piña Velazquez and Andrés Alexander Cedillo Chincoya, Image courtesy of the artists. Photograph by Agustín Cruz.

POSTcard Landscapes from Lanzarote I & II, 2020

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Artist Statement

Technology is the core element of our art practice, both conceptually and as a tool. Our aim is to reflect critically on where this technological development leads us: how do our lives, perception, communication, being together, and environment change along with the development of technology?

Our research interest is to provoke discussion about creative and meaningful uses of AI. The aim is to understand and relate artistically to the cultural phenomenon behind the vast amount of data produced daily. Quoting Jean Baudrillard (2003), "We live in a world where there is more and more information and less and less meaning." It is vital to make meaning and contextualize all the data wilderness that surrounds us.

How is the cultural sector able to provoke discussion about AI? All these new high-tech concepts need to be engaged with, not only theoretically, but also through practice, which gives more profound understanding of the processes behind them.

Project Description

The project draws attention to the influence of the tourist gaze on the landscape and identity formation of Lanzarote island in Spain. With our engagement with the landscape heavily dominated by the imaginative geographies that have been constantly reproduced by the visitors, a conflict is created between the touristic rituals that we are preprogrammed to reproduce when arriving at the destination and the reality (Larsen 2006).

We downloaded all available circulating depictions of imaginative geographies of Lanzarote from Flickr, dividing them into two: landscapes and tourism. After carefully preparing each pool of images, we applied the AI algorithm StyleGan2, which generated new images.

The project consists of two videos representing a journey of critical tourism through the latent space of AI- generated images using StyleGan2. The first video work, *POSTcard Landscapes from Lanzarote I*, is accompanied by a sound work by Adrian Rodd. Adrian is a local sound artist from Lanzarote, whose idea was to add a social-critical direction to the work. The second video piece, *POSTcard Landscapes from Lanzarote II*, is accompanied by a sound work by Taavi Varm (*MIISUTRON*). Taavi intended to introduce mystery and soundscapes to the imagescapes of the project.

The new deep learning artificial intelligence age transforms the work of art and creates new art-making processes. In his essay "The Work of Art in the Age of Mechanical Reproduction" Walter Benjamin (2008) anticipated the unprecedented impact of technological advances on the work of art. Benjamin argues that technology has fundamentally altered the way art is experienced. The new AI is the latest technology that is hugely impacting cultural production and providing new tools for the creative minds.

The full length of each video is 18min37sec. The project was commissioned by *Veintinueve trece* (Lanzarote).

Fig. 1. *POSTcard Landscape from Lanzarote I* (video still), 2021, Varvara & Mar, Image courtesy of the artists.

Fig. 2. *POSTcard Landscape from Lanzarote I* (video still), 2021, Varvara & Mar.

References

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Larsen, Jonas. 2006. "Geographies of Tourism Photography: Choreographies and Performances." In *Geographies of Communication: The Spatial Turn in Media Studies,* edited by Jesper Falkheimer and André Jansson, 243-261. Goeteborg: Nordicom.

Benjamin, Walter. 2008. *The Work of Art in the Age of Mechanical Reproduction*. Translated by J. A. Underwood. London: Penguin.

Biographies

Varvara & Mar is an artist duo formed by Varvara Guljajeva and Mar Canet in 2009. The artists have exhibited their art pieces in several international shows, such as at MAD in New York, FACT in Liverpool, Santa Monica in Barcelona, Barbican and V&A Museum in London, Ars Electronica museum Linz, ZKM in Karlsruhe, etc.

Varvara (born in Tartu, Estonia), has a Ph.D. in art from the Estonian Academy of Arts. She has a master's degree in digital media from ISNM in Germany and a bachelor's degree in IT from Estonian IT College.

Mar (born in Barcelona) has two degrees: in art and design from ESDI in Barcelona and computer game development from University Central Lancashire in the UK. He has a master's degree from Interface Cultures at the University of Art and Design, Linz. He is currently a Ph.D. candidate and Cudan research fellow at Tallinn University.

Fig. 3. *POSTcard Landscape from Lanzarote II* (video still), 2021, Varvara & Mar.

Bull, Ghost, Snake, God [牛鬼蛇神], 2021

Kwan Q. Li
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Artist Statement

DeepDream, created by Google engineer Alexander Mordvintsev in 2015, is a computer vision program that utilizes a convolutional neuronal network and a pareidolic algorithm to generate a specific hallucinogenic tactility of images. One may call the over-processed aesthetic of *DeepDream* a mistake, whilst Mordvintsev resorted to poetics and called the unwanted the machines "dreams." This act of linguistic subversion from an "error" to a "dream" eerily incubates a rhetorical proposition.

The work intends to meditate upon a slippery temporality between indexical reality and manufactured fakery, whilst the postcard format has further projected a subliminal space: who are these postcards addressed to? Mesmerizing images by *DeepDream* recall deeply intricate sentience amongst us, and especially towards contemporary politics. Considering how the traditional canon of portraiture was unprecedentedly disrupted by the invention of photography, how about today? How do machines see us? How do we see ourselves through machines?

Project Description

Installation. A set of 6 postcards with *DeepDream* imageries, 12.7x17.8cm, W. 32pt uncoated naturally textured Mohawk Superfine papers. Limited handout quantities. Displayed in a free-standing customised structure. http://slowfakes.info.

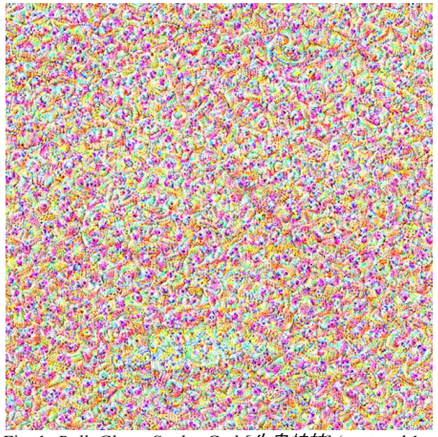

Fig. 1. *Bull, Ghost, Snake, God [牛鬼蛇神]* (postcard 1 of 8), 2021, Kwan Q. Li.

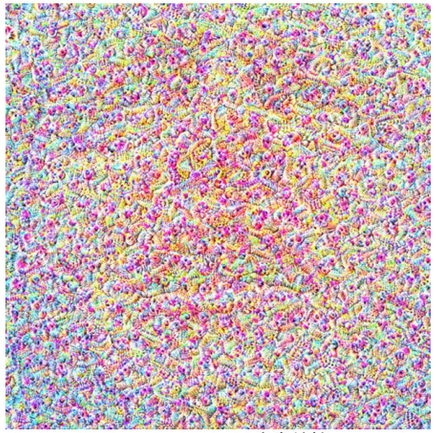

Fig. 2. *Bull, Ghost, Snake, God [牛鬼蛇神]* (postcard 1 of 8), 2021, Kwan Q. Li.

Biography

Kwan Q Li is an interdisciplinary artist from Hong Kong. Coalescing lens-based mediums, performance and writing, her research-based practice explores creative possibilities and generative alternatives within postcolonial, technopolitical and anthropocentric contexts. Former exhibitions include performances and lectures at the AI and Society Journal Conference (University of Cambridge. 2019), the Hong Kong Art Book Fair, BOOKED (Tai Kwun Contemporary, 2020), the IdeasCity residency co-curated by the NTU CCA and the New Museum (2020), and the Venice International Architecture Exhibition—Hong Kong Pavilion (2021).

Queenie holds a BFA degree from the Ruskin School of Art, University of Oxford and a B.B.A. in Global Business Studies from the Chinese University of Hong Kong. Currently, she is residing at the Program in Art, Culture and Technology at MIT on a teaching fellowship.

Mimicry, 2020

Ziwei Wu
Media artist, researcher and PhD student, Hong Kong University of Science and Technology
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Lingdong Huang
Artist and creative technologist, Carnegie Mellon University
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Artist Statement

Ziwei Wu is a media artist and researcher. Her artworks are mainly based on biology, science and the influence in society. Using a range of media like painting, installation, Audio-Visual, 2D and 3D animation, VR, Mapping and so on.

Lingdong Huang is an artist and creative technologist specializing in software development for the arts. His fields of expertise include machine learning, computer vision and graphics, interaction design and procedural generation.

Project Description

Mimicry is a multi-screen video installation powered by computer algorithms and inspired by mimicry in nature: the unique way of which species protect themselves by changing color and pattern in response to environment.

In this experimental art piece, cameras will be recording plants in real-time, and through a genetic algorithm the color and shape of virtual insects will be generated and evolved over time, toward the ultimate goal of visually blending into the recorded background. This simulated breeding, selection, and mutation are visualized across the video monitors positioned in front of the aforementioned living plants as they progress.

In addition to exploring the intersection between nature and computation, we find that this work has relevance to the human society as well. As Walter Lippmann describes it in his book *Public Opinion*, people construct a pseudo environment that is a subjective, biased, and necessarily an abridged mental image of the world. To a degree, everyone's pseudo-environment is a fiction.

The setup of the installation is an homage to Nam June Paik's TV Garden. Paik imagined a future landscape where technology is an integral part of the natural world. We find that perspective compelling even today, and we add AI creatures to the landscape 50 years later.

Fig. 1. *Mimicry*, 2020, Ziwei Wu and Lingdong Huang.

Fig. 2. *Mimicry* (detail), 2020, Ziwei Wu and Lingdong Huang.

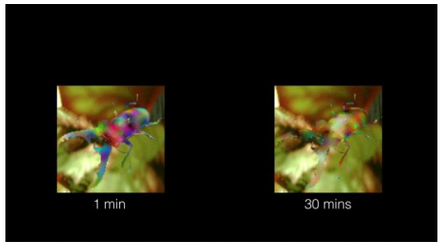

Fig. 3. *Mimicry* (video stills), 2020, Ziwei Wu and Lingdong Huang.

Fig. 4. *Mimicry* (detail), 2020, Ziwei Wu and Lingdong Huang.

Biographies

Ziwei Wu born in Shenzhen in 1996. She received a Bachelor of Inter media art at China academy of art and studied as an MFA student in Computational Arts at Goldsmiths. Now she is a PhD student in Computational Media and Arts, Hong Kong University of Science and Technology. She has won many awards, including Lumen prize, Batsford prize and funded by Ali Geek Plan. Her work exhibits internationally including Watermans Gallery London, The Cello Factory London, Himalayas Museum Shanghai, Yuan Museum Chongqing, Times Art Museum Beijing, and OCAT Shenzhen.

Lingdong Huang born in Shanghai in 1997, he recently received a Bachelor of Computer Science and Arts (BCSA) at Carnegie Mellon University in December 2019. His better-known works include wenyan-lang(2019), an esoteric programming language in Classical Chinese. {Shan, Shui}*(2018), an infinite procedurally generated Chinese landscape painting, and doodle-place (2019), a virtual world inhabited by user-submitted, computationally-animated doodles.

Going Viral, 2020-21

Derek Curry
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Jennifer Gradecki
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Artist Statement

Our collaborative artistic research combines the production of artworks with research techniques from the humanities, science and technology studies, and computer science. We use a practice-based method where research into a topic or a technology is used to generate an artwork. This often requires building or reverse-engineering specialized techniques and technologies. The built artifact, including the interactions it fosters, becomes a basis for theorization and critical reflection. Our practice is informed by institutional critique and tactical media and is often intended as an intervention into a social, political, or technological situation. Our projects take a critical approach to the tools and methods we use, such as social media platforms, machine learning techniques, or dataveillance technologies.

Project Description

Going Viral is an interactive artwork that invites people to intervene in the spreading of misinformation by sharing informational videos about COVID-19 that feature algorithmically generated celebrities, social media influencers, and politicians that have previously shared misinformation about coronavirus. In the videos, the influencers deliver public service announcements or present news stories that counter the misinformation they have promoted on social media. The videos are made using a conditional generative adversarial network (cGAN) that is trained on sets of two images where one image becomes a map to produce a second image.

Celebrities and social media influencers are now entangled in the discourse on public health, and are sometimes given more authority than scientists or public health officials. Like the rumors they spread, social media influencers, and the online popularity of celebrities are constructed through the neural network-based content recommendation algorithms used by online platforms. The shareable YouTube videos present a recognizable, but glitchy, reconstruction of the celebrities. The glitchy, digitally-produced aesthetic of the videos stops them from being classified as "deepfakes" and removed by online platforms and helps viewers reflect on the constructed nature of celebrity and question the authority of celebrities on issues of public health and the validity of information shared on social media.

Going Viral was commissioned by the NEoN Digital Arts Festival.

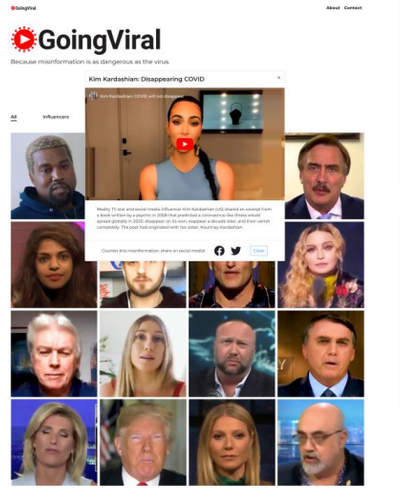

Fig. 1. *Going Viral—web interface* (screenshot), 2020-ongoing, Derek Curry and Jennifer Gradecki.

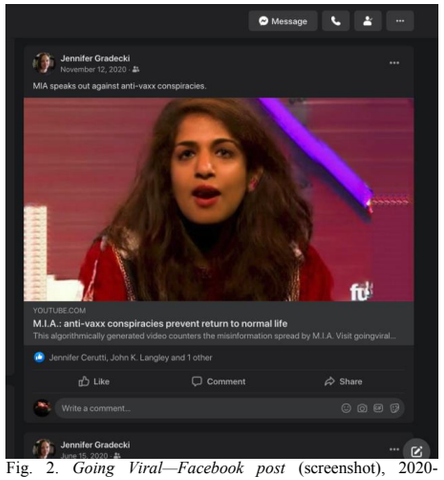

Fig. 2. *Going Viral—Facebook post* (screenshot), 2020-ongoing, Derek Curry and Jennifer Gradecki.

Fig. 3. *Going Viral—Tweet* (screenshot), 2020-ongoing, Derek Curry and Jennifer Gradecki.

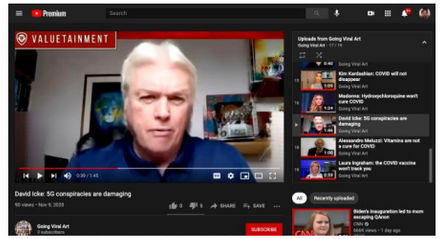

Fig. 4. *Going Viral—YouTube video* (screenshot), 2020-ongoing, Derek Curry and Jennifer Gradecki.

Biographies

Jennifer Gradecki is a US-based artist-theorist who investigates secretive and specialized socio-technical systems. Her artistic research has focused on social science techniques, financial instruments, dataveillance technologies, intelligence analysis, artificial intelligence, and social media misinformation. www.jennifergradecki.com.

Derek Curry is a US-based artist-researcher whose work critiques and addresses spaces for intervention in automated decision-making systems. His work has addressed automated stock trading systems, Open Source Intelligence gathering (OSINT), and algorithmic classification systems. His artworks have replicated aspects of social media surveillance systems and communicated with algorithmic trading bots. https://derekcurry.com/.

Curry and Gradecki have presented and exhibited at venues including Ars Electronica (Linz), New Media Gallery (Zadar), NeMe (Cypress), Media Art History (Krems), ADAF (Athens), and the Centro Cultural de España (México). Their research has been published in *Big Data & Society*, *Visual Resources*, and Leuven University Press. Their artwork has been funded by Science Gallery Dublin and the NEoN Digital Arts Festival.

Heat, Grids Nos. 4 & 5, 2020

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Artist Statement

Heat continues my use of adaptive systems to explore economic, social, and political concerns. Two ideas came together to form the basis of the project: first, an imagination of the Anthropocene as an existential threat, an accumulating force so fundamentally damaging it moves towards the mythological and visual abstraction; second, the knowledge that global warming is an environmental risk that kills selectively. Instances of heat damage are local and can feel random or idiosyncratic even as they pose a threat to the whole. One way to visualize this phenomenon might be to build a disruption in a formal pattern at a specific location. Since any break in the formal pattern of a grid is easily legible, and because the form of the grid has particular resonances with the histories and economic strategies of capitalist and post-capitalist societies, the grid structure was chosen as a good candidate for algorithmic disruption.

Project Description

Heat is an example of an adaptive system. The artwork is made up of a collection of small computation units called "agents." Agents compute their own states (color, size, location) based on inputs from their environment and on their relationship to other agents in their neighborhood. This means that an agent's state changes over time depending on its surroundings. The grids in these systems are made up of two layers of agents. Each layer is organized on its own network of links. Agents receive system input at regular time steps. As the "heat" entering a system increases, that energy is "absorbed" by agents and reflected as a change in color, size, or x, y, or z location. As a feature of each agent, certain properties can be more or less resistant to heat or, following the project's design metaphor, more or less at risk for environmental stress.

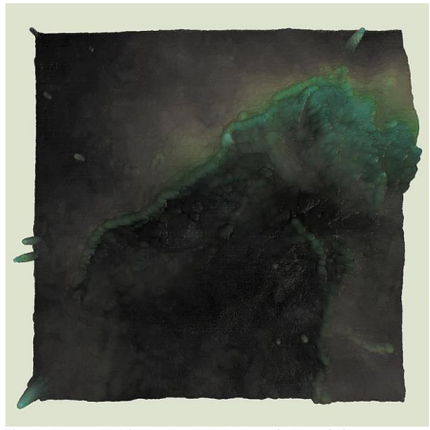

Fig. 1. *Heat—Grid No. 4, t_1*, 2020, Angela Ferraiolo.

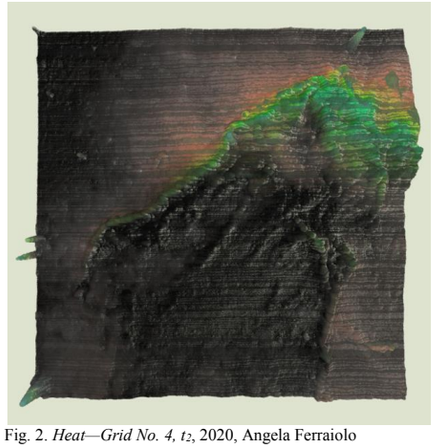

Fig. 2. *Heat—Grid No. 4, t_2*, 2020, Angela Ferraiolo

Fig. 3. *Heat—Grid No. 5, t_2*, 2020, Angela Ferraiolo.

Fig. 4. *Heat—Grid No. 5, t_3*, 2020, Angela Ferraiolo

Fig. 5. *Heat—Grid No. 5, t_4*, 2020, Angela Ferraiolo.

Biography

Angela Ferraiolo is a visual artist working with adaptive systems, noise, randomness, and generative processes. Her work has been screened internationally including at the Nabi Art Center (Seoul), SIGGRAPH (Los Angeles), ISEA (Vancouver, Hong Kong), EVA (London), the New York Film Festival (New York), Courtisane Film Festival (Ghent), the Australian Experimental Film Festival (Melbourne), and the International Conference of Generative Art (Rome, Venice). Professionally she has worked for RKO Studios, H20, Westwood Productions, and Electronic Arts. She teaches at Sarah Lawrence College where she is the founder of the new genres program in visual arts.

Actroid Series II, 2020-21

Elena Knox
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Artist Statement

My work stages presence, persona, gender and spirit (存在感・心・性・建前) in techno-science and communications media. I amplify human impulses to totemism, idolatry, and fetishism, by which we attempt to commune with parahuman phenomena, and to push back against our ultimate loneliness in the galaxy.

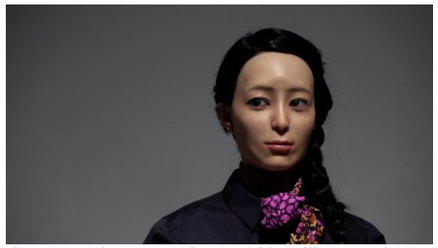

Fig. 1. *Actroid Series II—The Host* (video still), 2020, Elena Knox

Project Description

Actroid Series II is a group of stills, composite photographs, video portraits and interactions that foreground the potential uses of humanoid robots for AI monitoring and surveillance.

Focusing primarily on the Japan-designed Otonaroid, a model of female-appearing android meant for reception and simple conversation purposes, the works concern how we render restrictions more comfortable by giving social systems a human face.

In making many of these works, Knox invited acquaintances in Japan to sit as "eye models." Most often, the face ascribed to newly-available technologies is a young, pleasant, female face. So, Knox has given the robots "the male gaze:" her eye models are male. Male eyes look out from the artificial female face, in images of patriarchal surveillance.

The series continues Knox's pioneering embodied critique of the aesthetic evolution of the service gynoid (e.g. *Actroid Series I*). It focuses on the social future of fembots, drilling down disquietude about companionship and loneliness (*The Masters*), surveillance (*The Host,* ご協力お願いします;*Your Cooperation is Appreciated*; *The Monitor*), exploitation (*Existence Precedes Essence*), domestic familiarity (*Unproblematic Situations in Daily Communication*), and emotional manipulation (*Mirror Stage, Figure Study*).

This series is a collaboration with artist Lindsay Webb. The featured robots are created by Ishiguro Lab, Osaka, Japan.

Fig. 2. *Actroid Series II—Mirror Stage*, 2020, Elena Knox & Lindsay Webb.

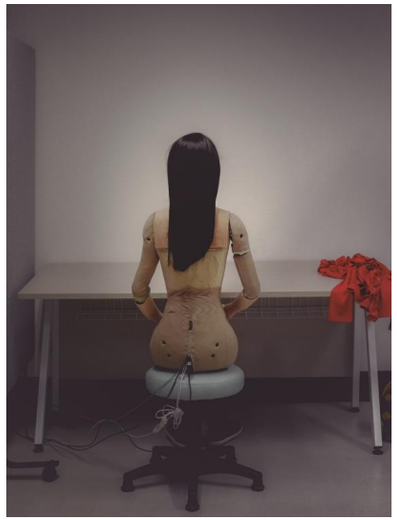

Fig. 3. *Actroid Series II—Figure Study*, 2020, Elena Knox.

Fig. 4. *Actroid Series II—Monitor*, 2020, Elena Knox & Lindsay Webb.

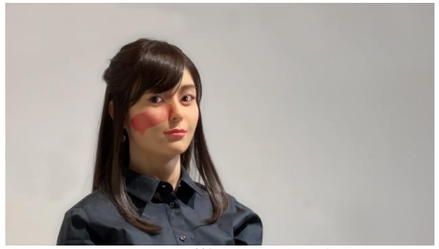

Fig. 5. *Actroid Series II—ご協力お願いします [Your Cooperation is Appreciated]* (video still), 2021, Elena Knox.

Biography

Elena Knox is a media and performance artist and scholar. Her artworks center on enactments of gender, presence and persona in techno-science and communications media, and her writing appears in literary and academic journals. Knox attained her PhD at UNSW Australia in Art and Design with research on gynoid robots. She has been a researcher in Japan since 2016 at Waseda University's Department of Intermedia Art and Science, Faculty of Fundamental Science and Engineering, Tokyo.

In 2019, Knox participated in the exhibitions "Future and the Arts" at Mori Art Museum, Tokyo, "Post Life," China tour, at the Beijing Media Art Biennale, and "Lux Aeterna," at the Asia Culture Center, Gwangju, Korea, amongst others. In 2020 she presented at Yokohama Triennale and Bangkok Art Biennale. In 2021 she will show new work in the Echigo-Tsumari Art Triennial, Japan.

Chikyuchi, 2021

Vincent Ruijters
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RAY LC
Assistant professor, City University of Hong Kong
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Artist Statement

Climate change and deforestation is changing our planet, and our methods for dealing with them relies on facts and explicit persuasion that do nothing to influence this generation. *Chikyuchi* attempts to bridge this gap using an artistic intervention. It uses digital technology of the past reimagined for the purpose of caring for our planet. Taking the metaphor of the Tamagotchi device, *Chikyuchi* combines the physicality of wood with machine-learning GPT-2-based text generation that reflects the implicit effects of behavioral nudging and intrinsic motivation. The cuteness and interactibility of the device, with twitter-based text added, produces implicit methods to affect human actions.

Project Description

Chikyuchi—from the Japanese for Earth—are digital pets for the state of our environment. The health of the Chikyuchi's are in sync with the current state of environmental decline. *Chikyuchi* also talks about itself by using machine learning on tweeter text to mimic the way humans talk about the environment online.

The two Chikyuchi species are Amazonchi (based on the Amazon rainforest) and Hyouzanchi (based on the Arctic icebergs). One species will be exhibited in Tokyo whilst the other is to be simultaneously exhibited in Hong Kong. What both places share are densely urbanized areas far away from the regions that the Chikyuchis represent.

Visitors on both locations can see each other through a live feed projected next to the Chikyuchis, thereby enabling them to see each other's reactions and interact with each other.

*Chikyuch*i has both a critical and a speculative layer. The work criticizes the way we have been brought up in an environment that promotes building affective relationships with inanimate consumer products like Tamagotchi, whilst failing to promote empathic bonds with nature.

This has left us with a strong affective relationship with consumerism and pop culture and an apathetic relation to nature. In the midst of the Climate Crisis, we confront, too little too late, a constant stream of fruitless disaster and panic news. This leads to an apathy of action to adequately handle the Climate Crisis. In our case, it is not anthropomorphism embedded in religion, but embedded in a language that our generation grew up with and understands: consumer and pop culture. Thus, consumer and pop culture can become a gameful vehicle to reconnect people with nature instead of disconnecting them with it. In this project we will use play—namely, mimesis—as a means for audiences to make that care-taking connection.

Fig. 1. *Chikyuchi,* 2021, Vincent Ruijters and Ray LC.

Biographies

Vincent Ruijters PhD was born in 1988, the Netherlands, and is based in Tokyo. Ruijters is an artist concerned with emotion and human relations in the context of contemporaneity. Ruijters contemplates the relation of the contemporary human towards nature. Ruijters obtained a PhD in Intermedia Art at Tokyo University of the Arts. Selected solo exhibitions: "Breathing IN/EX-terior" (Komagome SOKO gallery, Tokyo); Selected group exhibitions: "Radical Observers" (Akibatamabi gallery, 3331 Arts Chiyoda, Tokyo). Curation: "To defeat the purpose: guerilla tactics in Latin American art" (Aoyama Meguro Gallery, Tokyo). Awards: Japanese Government Scholarship (MEXT).

RAY LC, in his practice, internalizes knowledge of neuroscience research for building bonds between human communities and between humans and machines. Residencies: BankArt, 1_Wall_Tokyo, LMCC, NYSCI, Saari, Kyoto DesignLab, Elektron Tallinn. Exhibitions: Kiyoshi Saito, Macy Gallery, Java Studios, Elektra Montreal, ArtLab Lahore, Ars Electronica, NeON, New Museum, CICA Museum, NYC Short Documentary Film Festival, Burning Man. Awards: Japan JSPS, National Science Foundation, NIH.

1000 Synsets (Vinyl Edition), 2019

Javier Lloret Pardo
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Artist Statement

In my artistic practice I explore transitions between visibility and invisibility across mediums.

In recent years, my interest in transitions of visibility led me to conduct research on a series of related topics that became strongly connected with my work. These include out-of-frame video narratives, digital steganography, tactics of military deception, and lately, Deep Learning systems and training datasets.

Fig. 1. *1000 Synsets (Vinyl Edition),* 2019, Javier Lloret.

Fig. 2. *1000 Synsets (Vinyl Edition)—cover* (detail), 2019, Javier Lloret.

Project Description

Initiated in 1985, *Wordnet* is a hierarchical taxonomy that describes the world. It was inspired by theories of human semantic memory developed in the late 1960s. Nouns, verbs, adjectives and adverbs are grouped into synonym sets also known as "synsets." Each express a different concept. *ImageNet* is an image dataset based on the *WordNet 3.0* noun hierarchy. Each synset was populated with thousands of images.

From 2010 until 2017, the *ImageNet Large Scale Visual Recognition Challenge,* or *ILSVRC*, was a key benchmark in object category classification and localization for images, having a major impact on software for photography, image searches and image recognition. In the first year of the *ILSVRC Object Localization Challenge,* the 1000 synsets were selected randomly from the ones used by ImageNet. In the following years there were some changes and manual filtering applied, but since 2012 the selection of synsets has remained the same.

1000 synsets (Vinyl Edition) contains these 1000 object categories recorded at the high sound quality, which this analog format for audiophiles and collectors allows. This work highlights the impact of the datasets used to train artificial intelligence models that run on the systems and devices that we use on a daily basis. It invites us to reflect on them, and listen to them carefully. Each copy of the vinyl records displays a different synset and picture used by researchers participating in the *ILSVRC Challenge* to train their models.

Fig. 3. *1000 Synsets (Vinyl Edition)—cover* (detail), 2019, Javier Lloret.

Fig. 4. *1000 Synsets (Vinyl Edition)—record* (detail), 2019, Javier Lloret.

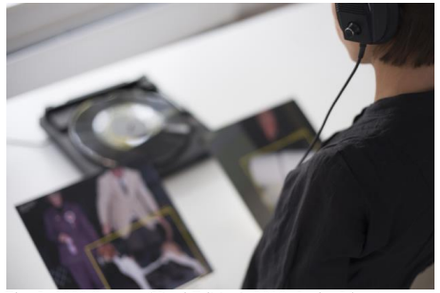

Fig. 5. *1000 Synsets (Vinyl Edition)*, 2019, Javier Lloret.

Biography

Javier Lloret is a Spanish/French artist and researcher based in Amsterdam. He holds degrees in Fine Arts (Gerrit Rietveld Academy, Amsterdam), Lens-Based Media (Piet Zwart Institute, Rotterdam), Interface Cultures (University of Art and Design of Linz, Austria), and Engineering (Pompeu Fabra University, Barcelona).

His work has been exhibited in Ars Electronica Festival (Austria), TENT (Rotterdam), ART Lima, Enter 5 Biennale (Czech Republic), Madatac (Spain), Santralistambul (Turkey), and in the AI Art Gallery from the NeurIPS Workshop on Machine Learning for Creativity and Design 2020, among others.

He has been a core tutor at Willem de Kooning Academy (Rotterdam) and at Piet Zwart Institute (Rotterdam), and guest lecturer at the Guangzhou Academy of Fine Arts (Guangzhou) and Ontario College of Art and Design (Toronto).

bug, 2021

Ryo Ikeshiro
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Artist Statement

Ryo Ikeshiro works with audio and time-based media to explore possibilities of sound. Techniques of sonification—the communication of information and data in non-speech audio—are harnessed in an artistic context, with algorithms and processes presented as sound to investigate computational creativity and the relationship between the audio and the visual. Comparable processes to sonification are also used, such as ideophones in East Asian languages—words which evoke silent phenomena through sound. In addition, the manifestation through sound and technology of issues of identity and Otherness is explored. His output includes installations and live performances in a variety of formats including immersive environments using multi-channel projections and audio, 360-video and Ambisonics, field recordings, interactive works and generative works.

Project Description

bug is a new sound installation which demonstrates the potential of audio technologies in locating insect-like noises and navigating through spatial audio field recordings using sound event recognition (SER) and directional audio. The work serves as a commentary on the increasing development of related audio technologies with uses in entertainment and advertising, as well as in surveillance, law enforcement and the military.

Spatial audio is the sonic equivalent of 360-video. Usually employing the Ambisonics format, it is capable of capturing audio from all directions. In *bug*, Ambisonics field recordings from Hong Kong are scanned by a machine learning audio recognition algorithm, and the location in the 3D auditory scene with audio characteristics which are most similar to insect sounds is identified. It is then made audible by parametric speakers emitting modulated ultrasound with a laser pointing in the same direction. The emitted ultrasound is highly directional, creating a "beam" of inaudible sound waves more similar to light than conventional audio. As the waves collide with the interior of the installation space and demodulated, audible sound emanates from the point on the wall, ceiling or floor at which they are reflected.

The work demonstrates an original method for reproducing 3D spatial audio through an alternative application of directional audio technology along with SER. In combination with the use of parametric speakers emitting modulated ultrasound in a process reminiscent of echolocation used in sonar, SER is used in determining the segment of audio to be projected. Thus, the gaze (and ear) of the viewer which determines the audio and video displayed in standard VR and spatial audio are replaced by an algorithm.

It also proposes a novel approach to automated crowd surveillance using machine learning and SER, through bugging and metaphorically locating cockroaches and socially undesirable elements.

Biography

Ryo Ikeshiro is an artist, musician and researcher interested in the artistic potential of computation and code as well as their cultural and political dimension. He was part of the Asia Culture Center's inaugural exhibition in Gwangju, South Korea, and his TeleText art pages have been broadcast on German, Austrian and Swiss national TV. He is a

contributor to *Sound Art: Sound as a medium of art,* a ZKM Karlsruhe/MIT publication, and his articles have been published in the journal *Organised Sound*.

Fig. 1. Creating Ambisonics field recordings in Hong Kong for *bug*, 2021, Ryo Ikeshiro (Photograph by Ho Tsz Yeung Jacklam).

Fig 2. Creating Ambisonics field recordings in Hong Kong for *bug*, 2021, Ryo Ikeshiro (Photograph by Ho Tsz Yeung Jacklam).

Fig. 3. Creating Ambisonics field recordings in Hong Kong for *bug*, 2021, Ryo Ikeshiro (Photograph by Ho Tsz Yeung Jacklam).

Fig. 4. Creating Ambisonics field recordings in Hong Kong for *bug*, 2021, Ryo Ikeshiro (Photograph by Ho Tsz Yeung Jacklam).

Microbial Emancipation, 2020

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Yun W. Lam
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Artist Statement

Establishing an unlikely collaboration, the transdisciplinary team comprising an architect, a biochemist, and an artist worked together to materialize the sacrifice of the blood cells to carry out a mitochondrial extraction, a process that underscores symbiogenesis, and therefore, to contributes to a post-anthropocentric turn.

Project Description

A reliquary holds mitochondria from the artist's blood that used to be a free bacterium. Looking at the history of our cells, we can find traces of an ancient bacterium in our mitochondria. Mitochondria were at some point an independent bacterium, and are now organelles that among other fundamental tasks give us the energy to live.

Microbial Emancipation is the violent extraction of the mitochondria out of an animal cell to exist as an independent entity. A forcing out as an act of unwanted liberation, unrequested emancipation. A literal undoing of the unlikely yet fundamental collaboration that allowed for most known forms of life. It undoes in order to make it visible.

Fig. 1. *Microbial Emancipation*, 2020, Maro Pebo, Malitzin Cortes & Yun W. Lam (Photograph by Lucas D'Ambrosio / MM Gerdau–Museu das Minas e do Metal).

Fig. 2. *Microbial Emancipation*, 2020, Maro Pebo, Malitzin Cortes & Yun W. Lam (Photograph by Lucas D'Ambrosio / MM Gerdau–Museu das Minas e do Metal)

Fig. 3. *Microbial Emancipation*, 2020, Maro Pebo, Malitzin Cortes & Yun W. Lam (Photograph by Lucas D'Ambrosio / MM Gerdau–Museu das Minas e do Metal).

Biographies

Maro Pebo. Weaving collaborations, Maro Pebo works on defying anthropocentrism and skeptical environmental accountability by subverting the monopoly of the life sciences to think about biological matter. With a PhD from the School of Creative Media, Pebo specializes in the intersections of art, science, and biotechnology. Her current interest lies in microorganisms' cultural and a microbial posthuman turn. @maro_pebo.

Dr Yun Wah Lam is a biochemist and cell biologist. He was a postdoctoral researcher in the Wellcome Trust Biocentre in Dundee, Scotland. He is now an Associate Professor at City University of Hong Kong, where he built a multi-disciplinary research network to tackle problems from environmental sciences to regenerative medicine. Scientific advisor to a number of artworks, including "Magic Wands, Batons and DNA Splicers" by Wong Kit Yi (2018) and "CRISPR Seed Resurrection" by Ken Rindaldo (2021).

Malitzin Cortés (CNDSD). Musician, digital artist and programmer. She embraces transdiscipline and technology in transmedia practices. Her work evolves between live coding, live cinema, installation, 3D animation, VR, generative art, experimental music and sound art. She has presented at Medialab Prado, Centro Cultural España, CMMAS, Vorspiel, Spektrum Berlin and the International Live Coding Conference, Transpiksel, Aural, Transmediale, ISEA, CYLAND, MediaArtLab St. Petersburg, MUTEK Mexicao and Montreal. @CNDSD.

Ghost in the Cell—Synthetic Heartbeats, 2021

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Artist Statement

The virtual idol Hatsune Mike started life as Vocaloid software voice, developed by the company Crypton Future Media in 2007, amongst a range of other software voices. However, the manga-style cover illustration of the software package captured the imagination of the Japanese public, and, coupled with the decision by Crypton Future Media to encourage the production of derivative graphics, animations and videos by the general public, the software transformed itself into a virtual pop idol, producing records and staging life shows. While the voice was given a collective image, we decided to give her a body and a heart. We asked Hatsune Miku fans to create digital synthetic DNA that could contain not only biological data, but also encrypted messages, images and music. This digital DNA was synthesized into actual DNA, and inserted in IPS cells, which then were differentiated in cardiomyocytes (heart cells), which started beating spontaneously. The work was shown in the 21st Century Museum in Kanazawa, Japan, and the audience could see the living, beating heart of Hatsune Miku during the exhibition.

Project Description

The project *Ghost in the Cell—Synthetic Heartbeats* is a development, extension and re-imagining of the work *Ghost in the Cell*, where we collaboratively created synthetic DNA for the virtual idol Hatsune Miku and introduced this digital, synthetic DNA into iPS-Cell derived, living cardiomyocytes, therefore giving the virtual, digital idol an actual, living and beating heart. Synthetic Heartbeats combines videos and images of the beating heart cells, combined with the digital synthetic DNA, to create fully synthetic, ongoing, observable heart beats by using Deep Learning and Generative Adversarial Networks (GANs).

This project builds upon the universality of the DNA as an information carrier and questions the difference and similarities between silicon- and carbon-based lifeforms. Synthetic Media, or the possible creation of life-like images, video and sound data, challenges society by creating doubt and suspicion not only of truthfulness, but also of the provenance of images and media. This work, *Synthetic Heartbeats* does not aim to create "fake" heart beats, but to synthesize heart beats, whose creation was not only informed by visual data, but also by the digital DNA data, which is also present in biological images of the heart cells.

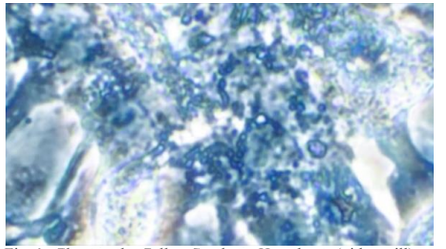

Fig. 1. *Ghost in the Cell — Synthetic Heartbeats* (video still), 2021, Georg Tremmel, BCL.

Biography

BCL is an artistic research framework, founded by **Georg Tremmel** and **Shiho Fukuhara** in 2007 with the goal of exploring the artistic possibilities of the nano-bio-info-cogno convergence. Other works by BCL include *Common Flowers / Flower Commons*, where GMO Blue Carnations are cultured, open-

sourced and released, *White Out*, one of the first bio-art works that use CRISPR for artistic research, and *Biopresence*, which proposed, speculated and realized the encoding of human DNA within the DNA of a tree for hybrid afterlife.

Landscape Forms, 2021

Peter A C Nelson
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Artist Statement

Peter Nelson is a visual artist and academic working at the intersection of landscape theory, computer games and computer graphics. Originally trained in painting and drawing, Nelson produces exhibitions across a number of media, from painting and drawing, to animation, 3D printed sculpture and interactive systems. Across these disciplines, he is engaged in a prolonged consideration of the history of landscape images, how they are remediated by technological shifts, and how these shifts absorb and reflect changes in our relationships with the physical environment.

Fig. 1. *Landscape Forms* (video still), 2021, Peter Nelson.

Project Description

Landscape Forms uses 3D models of trees produced using a voxel-based Generative Adversarial Network (GAN). Using a poetic audio-visual animation, it cycles through the training epochs of the GAN to animate the process of the system learning to produce the three-dimensional form of trees. This artwork is formalist in nature and explores how the GANs learning three-dimensional forms can be considered within broader art historical questions of figuration and abstraction.

Expressed using a variety of animation techniques, including particle morphing, vertex shape keys and latent space walks, this work explores forms produced by the GAN that appear reminiscent of modernist sculptors such as Henry Moore or Constantin Brâncuși. It structures these forms within compositions inspired by Romantic landscapes by Phillip Otto Runge, Theodore Rousseau and Caspar David Friedrich and literati compositions by Ni Zan [倪瓚] and Ma Lin [馬麟]. By situating this exploration of machine learning as a pathway to form and figuration within traditions concerned with the poetic function of landscape, this animation seeks to contribute to a broader consideration of how new technologies inform classical formal questions in a visual culture. This work includes a musical accompaniment by Roberto Alonso Trillo, that uses a GAN system to generate a reworking of Romantic music.

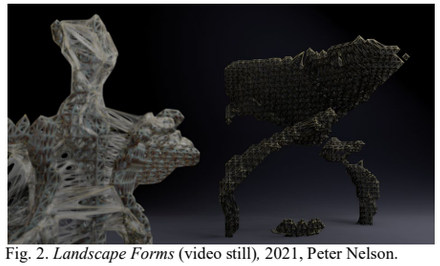

Fig. 2. *Landscape Forms* (video still), 2021, Peter Nelson.

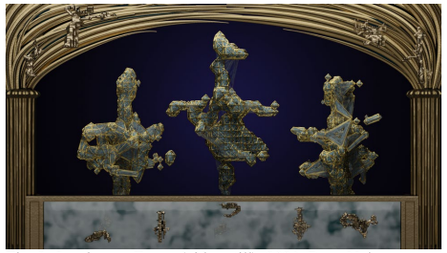

Fig. 3. *Landscape Forms* (video still), 2021, Peter Nelson.

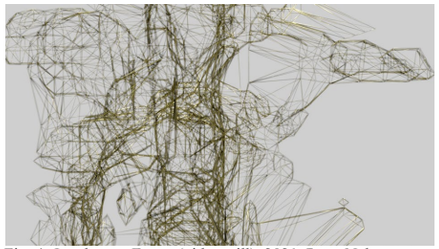

Fig. 4. *Landscape Forms* (video still), 2021, Peter Nelson.

Biography

Peter Nelson has been working between Australia and East Asia for the past 10 years, and has undertaken residency projects with Taipei Artist Village (Taipei), Organhaus (Chongqing), Red Gate Gallery (Beijing), Serial Space (Sydney) and the City of Sydney. He has held numerous group and solo exhibitions, including projects with HanArt TZ Gallery (Hong Kong), The National Palace Museum (Taiwan), The Sichuan Fine Art Academy Museum (Chongqing) and the K11 Art Foundation (Hong Kong). He is an assistant professor at the Academy of Visual Arts/Augmented Creativity Lab at Hong Kong Baptist University. His current projects include an examination of generative adversarial networks and 3D computer graphics, user-generated content in computer games and augmented sensors for musical performance and pedagogy. He is also the Vice President of Chinese DiGRA (Digital Games Research Association).

Big Dada: Public Faces, 2020

Daniel Howe
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Bill Posters
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Artist Statement

A visual narrative comprised of ten AI-synthesised deep fake monologues featuring celebrity influencers from the past and present.

Project Description

The *Big Dada* series was first released in conjunction with the *Spectre* installation in June 2019, and included Mark Zuckerberg, Kim Kardashian, Morgan Freeman and Donald Trump. It quickly went viral and lead to global press coverage and confused responses from Facebook and Instagram regarding their policies on synthetic media and computational propaganda. The *Public Faces* iteration was created in 2020 and added new character studies including Marcel Duchamp, Marina Abramović and Freddy Mercury.

Fig. 1. *Big Dada: Public Faces—Mark Zuckerberg* (video still), 2020, Daniel Howe and Bill Posters.

Fig. 2. *Big Dada: Public Faces—placard*, 2020, Daniel Howe and Bill Posters.

Fig. 3. *Big Dada: Public Faces—Kim Kardashian* (video still), 2020, Daniel Howe and Bill Posters.

Fig. 4. *Big Dada: Public Faces—Vice article* (screenshot), 2020, Daniel Howe and Bill Posters.

Biographies

Daniel Howe (https://rednoise.org/daniel) is an American artist and educator living in Hong Kong. His practice focuses on the writing of computer algorithms as a means to examine contemporary life. Exploring issues such as privacy, surveillance, disinformation and representation, his work spans a range of media, including multimedia installations, artist books, sound recordings and software interventions.

Bill Posters (http://billposters.ch/) is an artist-researcher, author and activist interested in art as research and critical practice. His work interrogates persuasion architectures and power relations in public space and online. He works collaboratively across the arts and sciences on conceptual, synthetic, net art and installation-based projects.

Perihelion, 2019-22

Antti Tenetz
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Artist Statement

This revolutionary change that we are living with in and through technology is already changing our way of observing and producing experiences and information through the digital, technological and biological materials of our environment. This era opens an unprecedented palette for artistic expression. How do we construct reality, an interpretation based on our own experiences, from our own perspective? Language and visual communication, technology, science and art are part of the diversity of nature. Do we need a polyphonic, multilingual ecological and cultural dialogue which creates deep evolutionary information—a language needed to survive in a changing world?

Fig. 1. *Perihelion*, 2019-2021, Antti Tenetz. Installation at V1 gallery Aalto University, Helsinki, Finland.

Project Description

Antti Tenetz`s *Perihelion* critically intersects art, science and technology, connecting possible alternative futures in space. The project incorporates artificial intelligence, evolutionary computation, biotic evolution and abiotic conditions in outer space, and draws on both biological and extraterrestrial resources.

Perihelion is a speculative exploration into our relationship with life in outer space, raising the question of what it means to be human when other life forms and agencies such as AI and machine learning are needed to support us. Research revolves around the idea of life in outer space encompassing two topical and critical trajectories. The first is a notion of biology in closed systems, biotech solutions, and astrobiology while the second focuses on AI as a companion in co-evolving agency.

Biological and machine systems are evolving in interaction with one another. Selected lifeforms are hosted in customized incubation units protecting and reflecting aspects of environments in space. Metal clustering bacteria, *Curvianus metalduransis*, is placed into a forced evolution test with nano fluidic gold and technologies alongside different cyanobacterias producing oxygen to speculate on the naturally growing conducting patterns which emerge.

Reflecting the notion of life and technology both in space and back in the terrestrial realm here on earth, *Perihelion* explores how machines dream along with technological and biological companions of a future life that we do not yet know.

Fig. 2. *Perihelion*, 2019-2021, Antti Tenetz, Installation at V1 gallery Aalto University, Helsinki, Finland

Together, images and bacteria produce hybrid dreamlike entities and visions located in a potential future incorporating deep space, human and biological interactions. These images give rise to a metamorphic world and beings in which the living and the technological merge with each other.

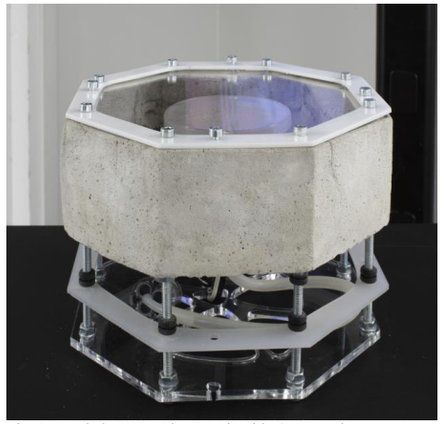

Fig. 3. *Perihelion*—Incubator unit with *Cupriavidus metallidurans* bacteria, 2019-2021, Antti Tenetz.

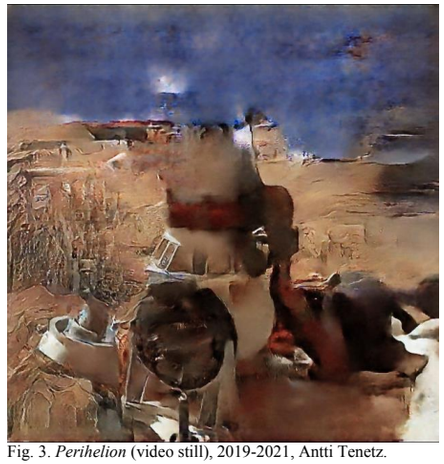

Fig. 3. *Perihelion* (video still), 2019-2021, Antti Tenetz.

Biography

Antti Tenetz is a sub-arctic based artist. Through a practice of video, installation, interactive and biological arts he explores how humans, non-humans and machines envision, dream, perceive and relate to the changes in hybrid environment where the technosphere and biosphere merges. His works are situated at the interface between media arts, biological arts and urban art. His focus is on multi-disciplinary and multi-artistic cooperation between art and science, and he often uses technologies such as drones, satellite tracking, game engines and machine learning. Tenetz's works and collaborative projects have been exhibited in Finland and internationally, including at the Venice Biennale, Istanbul Biennale parallel program, Tate Modern Exchange program, Science Gallery Dublin, Lumipalloefekti exhibitions, X-Border, ISEA Istanbul, Pan-Barentz, and e-mobil art. He has also won three national snow-sculpting competitions.

Part V

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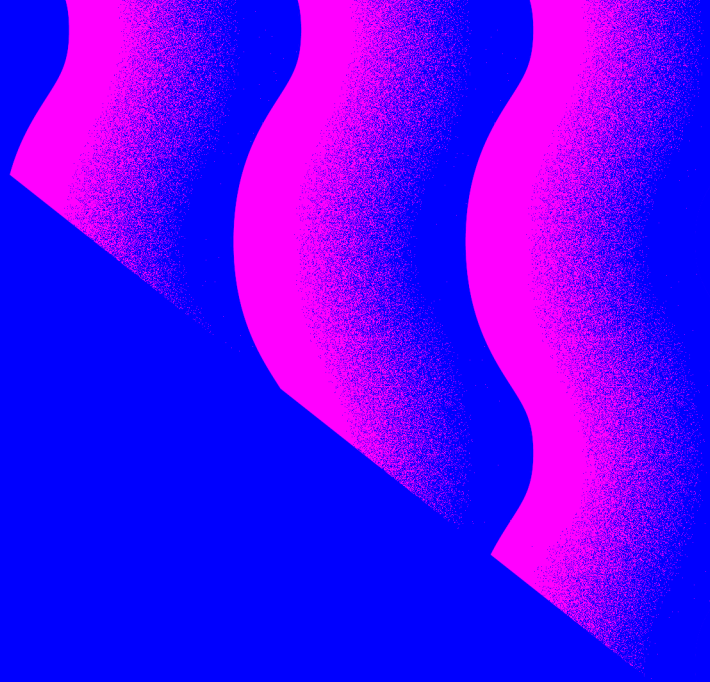

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