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.

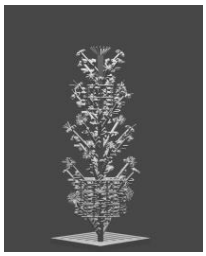

Fig. 2. A render of the sculpture.

Fig. 3. A tree structure.

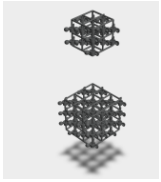

Fig. 4. Two matrices.

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.

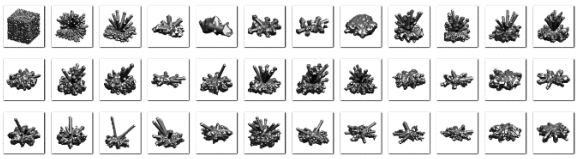

Fig. 6. 36 GAN-generated star anise pods.

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).

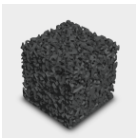
Fig. 7. Epoch 1.


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.

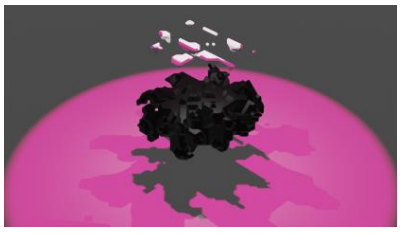
Fig. 11. *Vanishing Islands* and *Solidifying Core.*

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.

References

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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.