City University of Hong Kong
Course Syllabus

offered by Department of Computer Science
with effect from Semester A 2020/21

Part I Course Overview

Course Title:	Introduction to Computational Probability Modeling
Course Code:	CS2402
Course Duration:	1 semester
Credit Units:	3 credits
Level:	B2
Proposed Area: *(for GE courses only)*	☐ Arts and Humanities ☐ Study of Societies, Social and Business Organisations ☐ Science and Technology
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	CS1102 Introduction to Computer Studies or CS1103B Media Computing or CS1302 Introduction to Computer Programming
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	GE2326 Probability in Action: From the Unfinished Game to the Modern World
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

(A 150-word description about the course)

Due to the inherent uncertainty in the world, probability and statistics are used in many areas of computer science, such as data science, artificial intelligence, bioinformatics, networking, algorithms, and software testing. In this course, students will learn concepts for computational modeling of random phenomenon, probability, and statistical inference. Students will write computer programs to simulate random phenomenon and analyze real-world data with computational probability models.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs[#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Understand and explain how computational probability models are used in computer science, information technology, and data science.			✓	
2.	Develop critical thinking skills to use computational probability models to explain random phenomenon through independent investigation.			✓	
3.	Write computer programs to simulate random phenomenon, and analyze data with computational probability models.			✓	
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

Teaching pattern:

Suggested lecture/tutorial/laboratory mix: 2 hrs. lecture; 1 hr. tutorial.

TLA	Brief Description	CILO No.				Hours/week (if applicable)
		1	2	3		
Lecture	The lecture will present selected materials on computational probability models. To motivate the students' understanding, concepts will be illustrated with both toy examples, demonstrations, computer simulations and programs, and case studies related to computer science, information technology, and data science.	✓				2 hours
Tutorial	In the tutorials, students will write computer simulations and conduct experiments to explore the concepts introduced in lecture. Students will examine and analyze their collected data with computer programs.	✓	✓			1 hour
Assignments	Students will independently investigate a small case-study of a random phenomenon in computer science, write computer programs to simulate and analyze the phenomenon, and relate it to the concepts learned in class.		✓	✓		

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3					
Continuous Assessment: 50%								
Class participation	✓	✓					10%	
Assignments		✓	✓				20%	3 individual assignments
Midterm	✓	✓					20%	1 midterm
Examination^: 50% (duration: 2 hours)								
** The weightings should add up to 100%.*							100%	

^ For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Class participation	1.1 CAPACITY for LEARNING about computational probability models. 1.2 CAPACITY for LEARNING how computational probability models are used in computer science.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignments	2.1 ABILITY to EXPLAIN computational probability models are used in computer science. 2.2 ABILITY to SIMULATE random phenomenon, CONDUCT an experiment, DEVISE computer programs, and INTERPRET and ANALYZE experiment results.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Midterm	3.1 ABILITY to EXPLAIN computational probability models, and how they are used in computer science. 3.2 ABILITY to SIMULATE random phenomenon, CONDUCT an experiment, DEVISE computer programs, and INTERPRET and ANALYZE experiment results.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

(An indication of the key topics of the course.)

- Introduction to Python
  - variables, data types, operators
  - conditional statements, loops
  - functions, classes
  - scientific computing packages: Jupyter, scipy, numpy, matplotlib
- Simulating random phenomenon
  - Frequentist probability, laws of probability
  - Games of chance, expected gain, expected utility
  - Failure rates and redundancy, birthday problem
  - Arrival time, Brownian motion
- Measuring random phenomenon
  - Estimating parameters, confidence intervals
  - Hypothesis testing
- Inference with Bayes Rule
  - Conditional probability, Bayes' rule
  - Text analysis with Naïve Bayes classifiers
  - Decision making with subjective probability and optimal Bayes search
  - Prediction with logistic regression
  - Time-series modeling with Markov models

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	*Introduction to Scientific Computing in Python.* Robert Johansson [online]
2.	*Think Stats: Probability and Statistics for Programmers*. Allen B. Downey. O'Reilly. 2011.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Additional reading material will be provided as needed.
2.	*Introduction to Probability, 2nd edition.* Dmitri P. Bertsekas and John N. Tsitsiklis. Athena Scientific, 2008.
3.	*The Unfinished Game – Pascal, Fermat, and the Seventeenth-Century Letter that Made the World Modern.* Keith Devlin. Basic Books, 2008.
4.	*The Theory that Would Not Die -- How Bayes' Rule Cracked the Enigma Code, Hunted Down Russian Submarines, & Emerged Triumphant from Two Centuries of Controversy*. Sharon Bertsch McGrayne. Yale University Press Books, 2011.