CS2402: INTRODUCTION TO COMPUTATIONAL PROBABILITY MODELING

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Introduction to Computational Probability Modeling

Subject Code
CS - Computer Science
Course Number
2402

Academic Unit
Computer Science (CS)

College/School
College of Computing (CC)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
CS1102 Introduction to Computer Studies or
CS1103B Media Computing or
CS1302 Introduction to Computer Programming

Precursors
Nil

Equivalent Courses
GE2326 Probability in Action: From the Unfinished Game to the Modern World

Exclusive Courses
Nil

Part II Course Details

Abstract

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe and explain how computational probability models are used in computer science, information technology, and data science.			x	
2	Design critical thinking to use computational probability models to explain random phenomenon through independent investigation.			x	
3	Write computer programs to simulate random phenomenon, and analyze data with computational probability models.			x	

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 real-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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Students will learn selected materials on computational probability models. To motivate the students' understanding, concepts will be illustrated with both toy examples, mathematical formulations, practical demonstrations, and case studies related to computer science, information technology, and data science.	1	3 hours/week

2	Tutorial	Students will work on toy examples and mathematical problems to gain better understanding of the probability concepts introduced in lecture.	1, 2	8 hours / semester
3	Assignments	Students will work on more advanced mathematical problems so that they can have a deeper understanding of various probability concepts. Meanwhile, students will 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.	2, 3	After class, 1 every 4 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Class participation	1, 2	10	-	Yes
2	Assignments	2, 3	20	3 individual assignments	No
3	Midterm	1, 2	20	1 midterm	No

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

Class participation

Criterion

CAPACITY for LEARNING about computational probability models.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Class participation

Criterion
CAPACITY for LEARNING how computational probability models are used in computer science.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Assignments

Criterion
ABILITY to EXPLAIN computational probability models are used in computer science.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)

Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Assignments

Criterion
ABILITY to SIMULATE random phenomenon, CONDUCT an experiment, DEVISE computer programs, and INTERPRET and ANALYZE experiment results.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Midterm

Criterion
ABILITY to EXPLAIN computational probability models, and how they are used in computer science.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Midterm

Criterion

ABILITY to SIMULATE random phenomenon, CONDUCT an experiment, DEVISE computer programs, and INTERPRET and ANALYZE experiment results.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- 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

Reading List

Compulsory Readings

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

Additional Readings

	Title
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.