SDSC3005: COMPUTATIONAL STATISTICS

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Computational Statistics

Subject Code
SDSC - School of Data Science
Course Number
3005

Academic Unit
School of Data Science (DS)

College/School
School of Data Science (DS)

Course Duration
One Semester

Credit Units
3

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

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
SDSC3007 Advanced Statistics

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract
This course introduces students to algorithms and techniques for statistical computing and their implementations through R software. Students will learn important computational statistics methods such as the EM algorithm, Fisher’ s scoring,

Monte Carlo simulation, Markov chain Monte Carlo, and bootstrap. Additionally, students will learn statistical applications of these methods, the key advantages of using each method, and how they can be coded in R. Efficient programming methods for R will be taught. Therefore, students gain knowledge of many different tools that can be combined to solve statistical computing problems. Assignments will involve the use R.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the application background of statistical computing algorithm and techniques.	10	x		
2	Explain the theories behind the algorithms in computational statistics.	20	x	x	
3	Build various types of statistical computing algorithms in R.	20		x	x
4	Apply the correct algorithm to solve a statistical computing problem.	30	x	x	x
5	Discuss tuning parameters for various statistical computing algorithms.	20	x	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	Lectures	Students will engage in formal lectures to gain knowledge about statistical computing. Students will participate in mini-lectures and small-group exercises to consolidate their knowledge of principle concept and applications of various statistical tools and techniques.	1, 2, 3, 4, 5	39 hours/semester

2	Tutorial Exercises	Students will engage in team-based tutorial exercises (e.g., practical problem solving) to extend their use of statistical techniques learnt during the lectures and computer software tools for the statistical computing	3, 4, 5	In or after classes

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Test	2, 3, 4	30	
2	Assignments	1, 2, 3, 4, 5	30	

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2

Additional Information for ATs

Note: To pass the course, apart from obtaining a minimum of 40% in the overall mark, a student must also obtain a minimum mark of 30% in both continuous assessment and examination components.

Assessment Rubrics (AR)

Assessment Task

Test

Criterion

2-hour test to assess students' understanding of computational statistics methods and algorithms.

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
Students' ability to correctly apply computational statistics methods in R to solve given statistics problems.

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
Examination

Criterion
Examination questions are designed to assess student's level of achievement of the intended learning outcomes, with emphasis placed on understanding and correct application, mostly through mathematical exposition, clear explanation, and numerical calculation, of the various computational statistics techniques.

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

Additional Information for AR
The test and assignments will be numerically-marked, while examination will be numerically-marked and grades-awarded accordingly.

Part III Other Information

Keyword Syllabus
Introduction to R

Programming in R
Monte Carlo simulation
Random number generation: inverse transform method, rejection sampling, ratio-of-uniforms method
Monte Carlo methods, importance sampling
Computation of maximum likelihood estimate
Fisher scoring and Newton’s method
EM algorithm
Computationally intensive frequentist inference methods
Jackknife
Bootstrap methods
Cross-validation
Bayesian computation
Metropolis-Hastings algorithm
Gibbs sampling
Sliced sampling
Reversible jump Markov chain Monte Carlo

Reading List

Compulsory Readings

	Title
1	Rizzo, M. L. (2007). Statistical computing with R. Chapman and Hall/CRC.
2	Givens, G. H., & Hoeting, J. A. (2012). Computational statistics (Vol. 710). John Wiley & Sons.

Additional Readings

	Title
1	Nil