SDSC3105: BAYESIAN ANALYSIS

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Bayesian Analysis

Subject Code
SDSC - School of Data Science
Course Number
3105

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
MA2506 Probability and Statistics or MA2510 Probability and Statistics

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims at offering students rigorous knowledge of Bayesian statistical theory and methods, developing students' abilities of interpreting and communicating results, as well as training students to apply software packages such as R or Matlab to fit Bayesian models and conduct Bayesian analyses.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe basic concepts and theory of Bayesian statistics	30	x		
2	Apply Bayes theorem to derive the posterior distribution of statistical model parameters, and various approximation methods to approximate the posterior distribution	30	x	x	
3	Apply numerical methods (e.g. numerical integration, Monte Carlo simulation) to perform Bayesian inference with the help of software packages	25	x	x	
4	Implement Bayesian methods to analyse data	15	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	Lectures	1, 2, 3, 4	3 hours/week

Assessment Tasks / Activities (ATs)

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

Criterion
Assignments and/or participation

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
Test

Criterion
Midterm test to assess students' understanding of Bayesian statistics.

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
2-hour examination to assess students' understanding of Bayesian statistics. 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 aspects of Bayesian statistics.

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
Examination, test, and assignments, will be numerically-marked.

Part III Other Information

Keyword Syllabus

Bayes theorem and decision theory
- Bayes theorem, prior distribution, posterior distribution
- Bayes risk

Types of prior distributions
- Conjugate priors, noninformative priors

Some basic Bayesian models
- Inference for discrete parameters
- Inference for binomial proportion and Poisson mean
- Inference for normal mean and variance
- Conjugate Bayesian models

Bayesian linear models
- Simple linear regression
- Multiple linear regression

Bayesian computation
- Normal approximation
- Numerical integration
- Monte Carlo simulation

Reading List

Compulsory Readings

	Title
1	Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2014). Bayesian data analysis (3rd Edition). Boca Raton: CRC press.

Additional Readings

	Title
1	Kruschke, J. K. (2014). Doing Bayesian data analysis: A tutorial with R, JAGS and Stan. Burlington: Academic Press.
2	Press, S. J. (2003). Subjective and objective Bayesian statistics: principles, models, and applications (2nd Edition) . New Jersey: John Wiley & Sons.
3	Bolstad, W. M., & Curran, J. M. (2017). Introduction to Bayesian statistics (3rd Edition). New Jersey: John Wiley & Sons.