

SDSC6003: BAYESIAN DATA ANALYSIS

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Bayesian Data Analysis

Subject Code

SDSC - Data Science

Course Number

6003

Academic Unit

Data Science (DS)

College/School

College of Computing (CC)

Course Duration

One Semester

Credit Units

3

Level

P5, P6 - Postgraduate Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

The aim of this course is to provide students with an introduction to Bayesian statistics and to build students' ability to develop Bayesian models for practical data analysis problems. Students will learn to implement Bayesian models with

Markov chain Monte Carlo and other numerical methods in software (MATLAB or R) and interpret the results. In addition, they will learn about the Bayesian perspective and its underlying theory.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if DEC-A1 DEC-A2 DEC-A3 app.)			
1	Define Bayes theorem and concepts in Bayesian statistics.	10	x		
2	Apply Bayes theorem to derive the posterior distribution of statistical model parameters.	30	x	x	
3	Apply Markov chain Monte Carlo and other numerical algorithms in MATLAB or R to compute the posterior distribution of statistical model parameters.	30	x	x	
4	Explain Bayesian decision theory, types of prior distribution, and Bayesian model selection and averaging.	10	x	x	
5	Implement Bayesian methods to analyse a real dataset.	20		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 the theory and methods of Bayesian statistics.	1, 2, 3, 4, 5	26 hours/sem
2	Demonstration of computer codes	Students will develop an understanding of the computer codes included in the course materials by following an in-class demonstration and explanation of the codes.	2, 3, 4, 5	13 hours/sem

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("- " for nil entry)	Allow Use of GenAI?
1	Midterm exam	1, 2, 3, 4, 5	25	-	No
2	Assignments	1, 2, 3, 4, 5	30	-	No

Continuous Assessment (%)

55

Examination (%)

45

Examination Duration (Hours)

2.5

Minimum Examination Passing Requirement (%)

30

Assessment Rubrics (AR)**Assessment Task**

Midterm exam (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Midterm exam to assess students' level of achievement of CILOs 1-5 on material covered before the midterm exam.

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 (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Assignments are designed to assess student's level of achievement of CILOs 1-5, particularly CILOs 2-5.

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 (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Examination questions are designed to assess student's level of achievement of CILOs 1-5 on all material covered, with emphasis placed on correct application, mostly through precise mathematical exposition, clear explanation, and accurate 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

Assessment Task

Midterm exam (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Midterm exam to assess students' level of achievement of CILOs 1-5 on material covered before the midterm exam.

Excellent

(A+, A, A-) High

Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Assignments are designed to assess student's level of achievement of CILOs 1-5, particularly CILOs 2-5.

Excellent

(A+, A, A-) High

Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

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Assessment Task

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Examination questions are designed to assess student's level of achievement of CILOs 1-5 on all material covered, with emphasis placed on correct application, mostly through precise mathematical exposition, clear explanation, and accurate numerical calculation, of the various aspects of Bayesian statistics.

Excellent

(A+, A, A-) High

Good

(B+, B) Moderate

Marginal

(B-, C+, C) Basic

Failure

(F) Not even reaching marginal levels

Additional Information for AR

The test, assignments, and examination will be numerically-marked, and grades-awarded accordingly.

Part III Other Information

Keyword Syllabus

- Bayes theorem, prior distribution, posterior distribution
- Conjugate priors
- Decision theory, loss functions, Bayes risk, Bayes estimator
- Markov chain Monte Carlo simulation, Gibbs sampling, Metropolis-Hasting algorithm
- Hierarchical models, hierarchical linear models
- Bayesian model selection and model averaging

Reading List

Compulsory Readings

Title	
1	Press, S. J. (2003). Subjective and objective Bayesian statistics: principles, models, and applications (2nd Edition) . New Jersey: John Wiley & Sons.
2	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.
3	Turkman, M. A. A., Paulino, C. D., & Müller, P. (2019). Computational Bayesian Statistics: An Introduction (Vol. 11). Cambridge: Cambridge University Press.

Additional Readings

Title	
1	Kruschke, J. (2014). Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan. Academic Press.
2	Koch, K. R. (2007). Introduction to Bayesian statistics. Springer Science & Business Media.