ST4234: Bayesian Statistics

Classroom:	LT34
Time:	Tuesday 6pm - 10pm (45min lecture + 5min break + 45min lecture + 10min break + 40min tutorial)
Dates:	January 14 - April 14
Instructor:	LI Cheng
Office:	S16/06-104
Email:	*stalic@nus.edu.sg*
Textbook	*A First Course in Bayesian Statistical Methods* by Peter D. Hoff, published by Springer. *Bayesian Computation with R* by Jim Albert, published by Springer.
Website:	*https://luminus.nus.edu.sg/*
Consultation:	Via email or arrange for appointment
Exams:	Midterm: Tuesday, March 3, 6:15pm - 7:45pm, venue TBA Final Exam: Saturday, April 25, 1pm - 3pm, venue TBA
Holidays:	Tuesday, Feburary 25 (Recess week)
Prerequites	ST2132, or departmental approval

Module Description

This module will cover selected topics in Bayesian statistics, with a focus on practical implementation in R language. Tentative topics include conjugate priors, normal models, Bayesian hyponthesis testing, Laplace approximation, Markov chain Monte Carlo, linear and generalized linear models, and hierarchical models. If time allows, we will cover more advanced topics such as Bayesian regression, model comparison, variational Bayes, programming in Stan, etc.

References

Besides the recommended textbook above, the following reference books are also helpful if you would like to know more details and more data examples. The e-books from Springer are usually available from the NUS library website. You can download the e-books on your own and please do this individually, so that you do not violate copyright stipulations.

1. *Tools for Statistical Inference: Methods for the Exploration of Posterior Distributions and Likelihood Functions* by Martin A. Tanner, published by Springer.

2. *Bayesian Data Analysis (2nd or 3rd Edition)* by Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin, published by CRC Press.

Programming

The module has an emphasis on practical implementation. We will introduce and use the free software R (https://cran.r-project.org/). All sample codes will be written in R. We may include some light use of WinBUGS/OpenBUGS/JAGS, and Stan (https://mc-stan.org/), all called from R.

Grading

Your final grade will be comprised of the following.

Tutorial Submission and Presentation	10%
Midterm Exam	20%
Project	15%
Final Exam	55%

Lectures

Lectures will include a combination of theory and derivations together with illustrative examples. Lecture notes will be posted before each lecture but subject to changes. These notes are detailed but not exhaustive, so it is highly recommended that you take your own notes during the lectures. My handwritten whiteboard notes in class will be posted in LumiNUS after each class. All lectures will be webcasted. The webcast videos will be posted on LumiNUS. You are responsible for all the material covered in lectures and tutorials. Please ask questions after class, in office-hours or by email if you are struggling. Do not wait until too late.

Tutorials

Students in the class will be grouped for tutorial works and 1 group project. Tutorial problem sets will be assigned every week starting from the 2nd week. Every week, each group that has been assigned to do the presentation needs to submit 1 copy of their solutions. The groups who are not presenting do not need to submit the solutions. During the semester, each group will present their work once or twice, depending on

the total number of enrollment. Since this is teamwork, it is highly recommended that you work together with your group members on the tutorial problems before the presentation. Lack of contribution to the group work and absence from the group presentation will result in mark deduction.

The tutorial hour is the 3rd hour on each Tuesday, starting from the 3rd week. Details of group information and presentation schedule will be announced to the class after the 1st week. The tutorial submissions will be marked based on only the completeness but not the correctness. Suggested solutions to the tutorial problems will be posted on LumiNUS after each tutorial session. Submission of your solutions should be done electronically to the designated folder in LumiNUS before the deadlines. No late submission will be accepted.

Project

There will be 1 project in the second half of the semester, which involves Bayesian analysis on an assigned dataset. You will be required to achieve some goals and answer some questions about the datasets. The project will be assigned after the midterm. You will be asked to submit your individual final report before the reading week. You are encouraged to work with your classmates on the project. However, copying the report is strictly prohibited (see Academic Integrity section below). You are also encouraged to ask the instructor for help on your report (in person or by e-mail). Submission of your solutions should be done electronically to the designated folder in LumiNUS before the deadlines. No late submission will be accepted.

Website

All lecture notes, tutorial problems and solutions, sample codes, announcements, and webcasts will be posted on LumiNUS. Announcements will also be sent to every student via email. Make sure to check your email and LumiNUS regularly.

Exams

Both midterm and final exams are closed-book exams. However, you are allowed to bring one two-sided A4/letter size help sheet. You can also bring a calculator (either programmable or non-programmable) capable of computing exponentials, powers, and logarithms. No phones, tablet devices, or computers are allowed.

The midterm exam is tentatively scheduled to be on Week 7, Tuesday, March 3, from 6:15pm to 7:45pm. The final exam will be a comprehensive 2-hour exam on Saturday, April 25, from 1pm to 3pm. Exam dates cannot be changed. No make-up exams will be given. If you cannot take the exams on these dates, you should drop this module immediately. You cannot pass this module if you do not take the final exam, regardless of your scores on the other components of this class.

Academic Integrity

The University is committed to nurturing an environment conducive for the exchange of ideas, advancement of knowledge and intellectual development. Academic honesty and integrity are essential conditions for the pursuit and acquisition of knowledge, and the University expects each student to maintain and uphold the highest standards of integrity and academic honesty at all times. The University takes a strict view of cheating in any form, deceptive fabrication, plagiarism and violation of intellectual property and copyright laws. Any student who is found to have engaged in such misconduct will be subject to disciplinary action by the University. Please review the NUS *Code of Student Conduct*.

Excused Absences

Students who request leave for periods of absence from the university and miss graded work due to medical, academic, or personal reasons should review the University's *Leave of Absence* Policy. It is recommended that you consult your relevant Faculty/School directly for advice. If you cannot complete an assignment on the due date due to a short-term illness, you have until the end of the following day to complete it at no penalty. Then the regular late work policy will apply.

Tentative Timeline

Week	Date	Topics
1	Jan 14	Introduction
2	Jan 21	One-parameter models
3	Jan 28	One-parameter models; The normal model
4	Feb 4	The normal model
5	Feb 11	Hypothesis testing
6	Feb 18	Monte Carlo approximation
	Recess Week	
7	Mar 3	**Midterm Exam**
8	Mar 10	Monte Carlo approximation
9	Mar 17	Multivariate normal model; Gibbs Sampler
10	Mar 24	Metropolis-Hastings algorithm
11	Mar 31	Hierarchical modeling
12	Apr 7	Bayesian regression, Model comparison
13	Apr 14	Variational Bayes
	Reading Week	
	Apr 25	**Final Exam**