Faculty of Science Course Syllabus

Department of Mathematics & Statistics
&
Department of Oceanography

STAT 4130/5130
Bayesian Data Analysis
Fall 2018

Instructor:
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Lectures:
Tuesday and Thursday 1135-1255, Chase Building 227

Office Hours: MW 12:35 - 13:25

Course Description
This course is intended to make advanced Bayesian methods genuinely accessible to advanced students, graduated students and researchers in applied statistics.

The course covers all the fundamental concepts of Bayesian methods. We will start with exploring the simple familiar models such as those based on normal and binomial distributions, to illustrate basic concepts such as conjugate and non-informative prior distributions, posterior and predictive distributions. We then discuss more advanced tools in Bayesian analysis. We will consider different models, including linear regression, random effect model, generalized linear models, and mixed models.

Some aspects of modern Bayesian computational techniques, including Markov Chain Monte Carlo (MCMC) technique such as Metropolis Hastings algorithm and Gibbs Sampler will be discussed.

Throughout the course, we will discuss variety of examples of real statistical analyses.

Course Prerequisites

The formal pre-requistes are:

- **STAT 3360 - Probability**
- **STAT 3460 - Intermediate Statistical Theory**

or *Permission of the Instructor*.

The Bayesian data analysis course will be of interest to:

- Graduate students (Masters and Ph.D) in statistics, biostatistics or other quantitative fields who acknowledge the need for advanced modeling tools in their research.

- Advanced undergraduate students, faculty, and other researchers from all disciplines, who seeking to learn advanced methods for analyzing complex real data sets from public health, biomedical science, biology, agriculture, industry, and other related fields from Bayesian perspective.

Course Objectives & Learning Outcomes

This class deals with the analysis of different types of lifetime data, such as complete data, censored and progressively censored. The emphasis of this course is on Bayesian theory, Bayesian inferences and application. The main objective of this course is to provide a solid practical grounding in Bayesian data analysis. The Learning Outcomes are:

- Develop an understanding of the theory underlying Bayesian analysis in statistical models.
- Provide an understanding of the practice of Bayesian data analysis, as well as the ability to apply methods to real data sets and to interpret the results.
- Provide experience in technical writing skills, and also with the use of modern statistical software (R or Matlab) for Bayesian data analysis.

Course Materials

- The textbook for the course is “Bayesian Computation with R, 2nd edition, by Jim Albert, Springer, 2009”. This textbook will be followed in a broad sense, and it is a useful reference.
- A Dalhousie Brightspace site will be used for the course where all announcements, selected class notes, assignments, and computer code will be posted.
- We will be using the R statistical software extensively in the course. R is available for download at http://www.r- project.org/ . This is state-of-the-art free, open source software for statistical computing. It is available for all platforms.

Course Assessment (*NOTE: tentative exam dates - subject to change***)**

Component Weight (% of final grade) Date
Exam 1 *20% Early October (TBA), in class*
Exam 2 *20% Early November (TBA), in class*
Exam 3 *20% Early December (TBA), in class*
Assignments *40% weekly to bi-weekly*

- There will be three in-class exams worth a total of 60% (each worth 20% of your grade).
- There will be eight regular assignments worth 40% of the total mark (each worth 5% of your grade). They will involve theoretical questions, development of computer code (R), as well as reports on the analysis and interpretation of real time series and designed to develop your technical writing skills. Your marks will reflect both the technical correctness of your answers, as well as clarity and organization of your written presentation. *I'd recommend students to use either latex or word to present their assignments*.
- **Note:** Graduate scheme is the same as the undergrad scheme, but with different material on exams and assignments to differentiate undergrad vs grad.

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)B+ (77-79)C+ (65-69)D(50-54)
A (85-89)B (73-76)C (60-64)F(<50)
A- (80-84)B- (70-72)C- (55-59)

Graduate must achieve a letter grade of B- in order to pass the course.

Course Policies

- *Assignments:* late assignments will receive a zero grade.
- *Midterms:* non-attendance at a midterm will result in a zero grade unless a legitimate excuse is provided, ideally well in advance of the scheduled midterm date. In such a case, and at the instructor's discretion, a makeup may be scheduled or else the midterm not counted toward the final grade.
- Note that any disputes over grading will be resolved by a re-grading of the entire assignment or exam.
- All information relevant to class logistics (class cancellation, due date changes, etc) will be communicated via messages posted on the course website

Course Content

Listed below are the topics to be covered:

- Introduction to Bayesian Thinking
- Single-Parameter Models
- Multiparameter Models
- Introduction to Bayesian Computation
- Markov Chain Monte Carlo Methods
- Hierarchical Modeling

ACCOMMODATION POLICY FOR STUDENTS

Students may request accommodation as a result of barriers related to disability, religious obligation, or any characteristic protected under Canadian Human Rights legislation. The full text of Dalhousie's Student Accommodation Policy can be accessed here: http://www.dal.ca/dept/university_secretariat/policies/academic/student-accommodation-policy-wef-sep--1--2014.html

Students who require accommodation for classroom participation or the writing of tests and exams should make their request to the **Advising and Access Services Centre (AASC)** prior to or at the outset of the regular academic year. More information and the ***Request for Accommodation*** form are available at www.dal.ca/access.

ACADEMIC INTEGRITY

Academic integrity, with its embodied values, is seen as a foundation of Dalhousie University. It is the responsibility of all students to be familiar with behaviours and practices associated with academic integrity. Instructors are required to forward any suspected cases of plagiarism or other forms of academic cheating to the Academic Integrity Officer for their Faculty.

The Academic Integrity website (http://academicintegrity.dal.ca) provides students and faculty with information on plagiarism and other forms of academic dishonesty, and has resources to help students succeed honestly. The full text of Dalhousie's ***Policy on Intellectual Honesty*** and ***Faculty Discipline Procedures*** is available here: http://www.dal.ca/dept/university_secretariat/academic-integrity/academic-policies.html

STUDENT CODE OF CONDUCT

Dalhousie University has a student code of conduct, and it is expected that students will adhere to the code during their participation in lectures and other activities associated with this course. In general:

"The University treats students as adults free to organize their own personal lives, behaviour and associations subject only to the law, and to University regulations that are necessary to protect

- the integrity and proper functioning of the academic and non – academic programs and activities of the University or its faculties, schools or departments;
- the peaceful and safe enjoyment of University facilities by other members of the University and the public;
- the freedom of members of the University to participate reasonably in the programs of the University and in activities on the University's premises;
- the property of the University or its members."

The full text of the code can be found here: http://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

SERVICES AVAILABLE TO STUDENTS

The following campus services are available to help students develop skills in library research, scientific writing, and effective study habits. The services are available to all Dalhousie students and, unless noted otherwise, are free.

Service	Support Provided	Location	Contact
General Academic Advising	Help with - understanding degree requirements and academic regulations - choosing your major - achieving your educational or career goals - dealing with academic or other difficulties	**Killam LibraryGround floor** Rm G28 ***BissettCentre for Academic Success***	In person: Killam Library Rm G28 By appointment: - e-mail:advising@dal.ca - Phone: (902) 494-3077 - Book online throughMyDal
Dalhousie Libraries	Help to find books and articlesforassignments Help with citingsources in the text of your paper and preparation ofbibliography	**Killam Library** **Ground floor** Librarian offices	In person:Service Point(Ground floor) By appointment: Identify your subject librarian(URL below)and contact by email or phone to arrange a time: http://dal.beta.libguides.com/sb.php?subject_id=34328
Studying for Success **(SFS)**	Help to develop essential study skillsthroughsmall group workshopsorone-on-one coaching sessions Match to a tutor for help in course-specific content (for areasonable fee)	**Killam Library3rdfloor** Coordinator Rm 3104 Study Coaches Rm 3103	To make an appointment: - Visit main office(KillamLibrary main floor, Rm G28) - Call (902) 494-3077 - email Coordinator at:sfs@dal.ca or - Simply drop in to see us during posted office hours **All information can be found on our website:www.dal.ca/sfs**
Writing Centre	Meet with coach/tutorto discuss writing assignments(e.g.,lab report, research paper, thesis, poster)	**Killam LibraryGround floor**Learning Commons&Rm G25	To make an appointment: - Visitthe Centre(Rm G25)and book an appointment - Call(902)494-1963

	-Learn to integrate source material into your own work appropriately -Learn about disciplinary writingfroma peer or staff member in your field		-emailwritingcentre@dal.ca - Book online throughMyDal We are open six days a week **See our website: writingcentre.dal.ca**