STAT 7250
Bayesian Computational Analysis
Winter Term 2014

Class Time: Tuesday / Thursday 8:30 a.m. - 9:45 a.m.)
Location: 316 Machray Hall
CRN: 23129

Instructor: Dr. Saman Muthukumarana
Office: 327 Machray Hall
Telephone: 474-6274
Email: Saman_Muthukumarana@UManitoba.CA

Office Hours: Tuesday 1:30 - 3:00 p.m.
Thursday 1:30 - 3:00 p.m.

Description: The aim of this course is to introduce students to the Bayesian statistical methods and their implementation and related computational strategies using various languages. The course starts with concepts of Bayesian paradigm, conjugate and non-informative priors and the Bayesian treatment of simple models. More advanced models are then treated, including hierarchical models and regression models. Bayesian computational methods including MCMC, Gibbs sampling and Metropolis-Hastings algorithms are presented with an emphasis to the issues related to their implementation and monitoring of convergence. The course will be fairly mathematical but more computation with applications.

Prerequisite: You must have a fair knowledge of statistical inference including point estimation, interval estimation and hypothesis testing. I also assume that you have basic familiarity with the use of the computer and computer softwares.

Assignments: Assignments are due at the beginning of class on the due date. Late assignments will not be accepted. You are encouraged to discuss your answers and computer codes with your classmates and me, but final submission must be written independently.

Midterm Test: The tentative date for mid-term test is **February 27, 2014**. There will be no makeup midterm for any reason. If you miss the exam due to a legitimate reason, your exam weight will transfer to the final exam. The exam will be 90 minutes in length. The exam will have a take-home component which require computing.

Final Exam: The final exam will be 150 minutes in length. It will also have a take-home component. The exams (including mid terms) are closed book.

Grading Scheme: The final grade will be determined as follows.

Assignments	20%
Mid-term Test	30%
Final Exam	50%

Course Web Site: Course materials are posted on the UoM JUMP portal.

Computing: This course will expose you to R, C++ and BUGS languages throughout the course, allowing you to learn their merits and demerits as well. This will also help you to select a suitable computing method for a given problem based on your interest and the scope of the problem. Note that R and BUGS are easy to learn and implement while C++ is the gold standard for the speed. You must have an account on statistics computational cluster in order to complete this course and you can obtain a user account from Dave Gabrielson at Dave.Gabrielson@UManitoba.CA.

- R is a free software environment for statistical computing and runs on Windows, Linux, UNIX and Mac. You can download your own copy from R Project (CRAN) homepage at `http://www.r-project.org/`. The introductory tutorial for R can be found here. The official R Short Reference Card contains basic frequently used functions in this course. You will also get access to R through the cluster using web interface and Secure Shell (SSH) via command-line interface.
- A collection of useful resources for C++ beginners can be found at `http://www.cplusplus.com/`. You will have access to the GNU compiler collection through the cluster for C++ program compilation.
- The BUGS project at the University of Cambridge offers the BUGS language in various forms. It does both Gibbs and Metropolis-Hastings sampling and can be downloaded here.

Course Outline: The course aims to provide a solid understanding of Bayesian statistical methods through computational techniques including following areas.

- Basics of Bayesian Paradigm: Bayes theorem, Choice of priors, Conjugate families, Posterior distributions, Predictive distributions
- Bayesian Inference: Point and interval estimation, Hypothesis testing
- Inference using Simulations: Integration and Monte Carlo methods, Use of R, C++ and the cluster
- Computational Methods: Importance sampling, MCMC methods, Gibbs sampling, Metropolis-Hastings algorithm, Model selection
- Further Topics: Parallel computing, Bayesian computing using BUGS, Dirichlet Process

Recommended Texts: The following textbooks are recommended for reading and extra exercises.

- *Bayesian Data Analysis* (Second Edition),
  Andrew Gelman, John B. Carlin, Hal S. Stern and Donald B. Rubin, Chapman and Hall/CRC (2003).
- *Bayesian Theory* (Second Edition),
  José M. Bernardo and Adrian F. M. Smith, Wiley Series (1994). (On reserve in Science Library).
- *Bayesian computation with R* (Second Edition),
  Jim Albert, Springer (2009). A copy of e-book is available from SpringerLink via UoM Library server.
- *Statistical computing in C++ and R* (First Edition),
  Randall L. Eubank and Ana Kupresanin, CRC Press (2012). (On reserve in Science Library).

Voluntary Withdrawal: The voluntary withdrawal deadline is **March 19, 2014**.

Registration Advisory: Important Note from the Dean of Science:
It is your responsibility to ensure that you are entitled to be registered in this course. This means that you:

- have the appropriate prerequisites, as noted in the calendar description, or have an appropriate permission from the instructor to waive these prerequisites;
- have not previously taken, or are concurrently registered in, this course and another that has been identified as ”not to be held with” in the course description.

The registration system may have allowed you to register in this course, but it is your responsibility to check. If you are not entitled to be in this course, you will be withdrawn, or the course may not be used in your degree program. There will be no fee adjustment. This is not appealable. Please be sure to read the course description for this and every course for which you are registered.

Pandemic Advisory: Should major disruptions to university activities occur as a result of a pandemic, the course content, marks breakdown, and other provisions of this document may be adjusted as the circumstances warrant.

Academic Dishonesty: You are expected to be familiar with what constitutes academic dishonesty and it's consequences. Academic dishonesty is a serious offence and can be severe as suspension or expulsion from the University. More details of these terms and related issues are available at: www.umanitoba.ca/science/undergrad/resources/webdisciplinedocuments.html.