STAT 414: Introduction to Bayesian Data Analysis

- **Web site**: ctools.umich.edu.

- **Instructor**: Yves Atchadé
  Office: 272 West Hall   Phone: 734-763-5238

  E-mail: yvesa@umich.edu   Office Hours: Tues. 2:30-4:00pm.

- **Prerequisite**: (STATS 426 and STATS 406) or equivalent courses. Familiarity with R programming is required.

- **Lectures**: Mo-Wed.: 10:00am-11:30am, 142 Lorch Hall.

- **GSI**: Dao Nguyen (nguyenxd@umich.edu), OHs: TBA.

- **Description**: The course is an introduction to both the principles and practice of Bayesian data analysis using the statistical software R. At the end of this course students will be familiar with the Bayesian paradigm, and will be able to use R to analysis different classes of statistical models. The course also introduces students to the computational tools (Markov Chain Monte Carlo) needed for Bayesian data analysis. An outline of the content is as follows.

  1. Foundation: Statistical models, Parameters, Prior distributions, Bayes rule, Posterior distributions.

  2. One/two parameter models: inferring the proportion in the binomial distribution, inferring the parameters of the normal distribution.

  3. Computational tools: The Metropolis-Hastings algorithm, the Gibbs sampler and Metropolis-within-Gibbs sampler.

  4. Linear and generalised linear models. Prior distribution elicitation. Model selection and comparison, model checking.

  5. Mixed effect models, hierarchical models, analysis of spatial data.

- **Suggested Textbook**:

  - *Introduction to Applied Bayesian Statistics and Estimation for Social Scientists (Statistics for Social and Behavioral Sciences)*, Lynch, S. (2010). Springer.

  - *Doing Bayesian data analysis*, Kruschke, J. K. (2011). Academic Press, Burlington, MA.

  - *Bayesian Computation with R*, Albert, J. (2009). Springer Science, New York.

- **Assessment**: The final grades will be based on homework (35%), a project (35%) and a final exam (30%).

  Homework. Problem sets will be given regularly, with a total of about 8 HWs. The problem sets will involve a mix of theoretical questions and computer code writing. You

may discuss the homework problems in general terms with other students, but the code and written responses that you submit must be your own.

Project. A final project is due at the end of the semester where students by group of two will be asked to analyze a real dataset using the Bayesian framework, and writing code in R. A 5 pages project report must be submitted. Further instructions will be given by mid-term.

Final Exam. The date of the final is Wednesday, April 29, 4:00 pm - 6:00 pm. The exams will test your understanding of the material studied during the semester. A review session will be scheduled before the final exam. Practice problems will be available before each exam.

<u>Important guidelines for homework submission:</u> Most of the HWs will have a R code component which must be submitted electronically using ctools (by going under the menu "Assignments"), and a hand-written component which must be submitted in class. Do not email your code directly to me or the GSIs. Emailed HWs, or late submissions may not be accepted. In submitting your R code in ctools, your electronic file must be in a <u>plain text</u> format (Notepad on Windows, TextEdit on Mac, and the built-in text editor in R, all produce plain text formats). Other electronic text formats such as pdf, or Word are not allowed.