STAT 489-01: Bayesian Methods of Data Analysis

Syllabus and Course Information – Spring 2017

Revised Version 2017 February 14

Course Information

Lectures:
TR 2pm-3:15pm, GOS(08)-1300, beginning 2017 January 24 and ending May 12.

Holidays (no lecture):
March 22 & 24: Spring Break.

Instructor:
Dr. John T. Whelan; LAC(74)-2063, 475-5083; `jtwsma@rit.edu` or `john.whelan@astro.rit.edu`
Office Hours: MT 10am-11:30am, or by appointment. (Please email to make an appointment.)

Course Website: `http://ccrg.rit.edu/~whelan/STAT-489/`

Official Textbooks:

- Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., and Rubin, D. B., *Bayesian Data Analysis*, 3rd edition (CRC, 2013)
- McElreath, R., *Statistical Rethinking: A Bayesian Course with Examples in R and Stan* (CRC, 2017)

Recommended Textbooks:

- Bolstad, W. M. and Curran, J. M., *Introduction to Bayesian Statistics*, 3rd edition (Wiley, 2017)
- Bolstad, W. M., *Understanding Computational Bayesian Statistics* (Wiley, 2009)
- Sivia, D. S. with Skilling, J., *Data Analysis: A Bayesian Tutorial*, 2nd edition (Oxford, 2006)
- Kruschke, J., *Doing Bayesian Data Analysis: A Tutorial with R, JAGS and Stan*, 2nd edition (Academic Press, 2014)

Other Useful Resources:

- Jaynes, E. T., *Probability Theory: The Logic of Science* (Cambridge, 2003)

Prerequisites:
Probability and Statistics II (COS-MATH-252)

Course Outline:
http://ccrg.rit.edu/~whelan/courses/2017_1sp_STAT_489/COS-STAT-489-ST-BayesianInference.pdf

Scope of Course:
The course will cover a range of topics in Bayesian Inference and Data Analysis, likely to include

1 Bayesian interpretation of probability
  1.1 Probability as extended logic
  1.2 Sum and product rules
  1.3 Bayes's theorem and conditional probabilities
2 Bayesian parameter estimation
  2.1 Calculation of posterior probabilities
  2.2 Marginalization over nuisance parameters
  2.3 Choice of prior probability distributions
  2.4 Point estimates and plausible intervals
3 Bayesian hypothesis testing
  3.1 Model comparison using the Bayes factor
  3.2 Bayesian decision theory
4 Numerical methods
  4.1 Markov chain Monte Carlo
  4.2 Gibbs sampler

A very tentative timetable for the pace of the course, which will evolve over the semester. is at http://ccrg.rit.edu/~whelan/courses/2017_1sp_STAT_489/calendar.html

Computer Environment:
Computational assignments and projects will be expected to be carried out in the R statistical programming language. Please install R (which is free software[1]), available from http://r-project.org/, on your laptop or personal computer. You may also find the RStudio integrated development environment, available from http://rstudio.com/, useful.

Homework and Problem Sets:
Students are expected to read the lecture notes online and complement the presentation with the outside reading. Whenever possible, please consult the relevant material *before* each class, to be prepared for class discussions.

Additionally, about once per week, there will be a problem set due, which should be written up neatly and handed in on the due date. If you choose to submit a homework electronically, it must be in pdf format unless otherwise specified. Problem sets will not be accepted after solution sets have been distributed.

Exams:
Two preliminary exams, in class, **tentatively** planned for Tuesday, Feb. 28 and Tuesday, Apr 11. Final exam (cumulative) scheduled for Tuesday, May 16 12:30pm-2:30pm, GOS(08)-1300.

[1] both in the sense of being covered by an open license and in the sense of not costing money

Email List: `discuss-bayesian-data-analysis@lists.rit.edu`
Everyone registered for the course as of January 23 should have been subscribed with their RIT address. You can edit your settings via
`https://lists.rit.edu/mailman/listinfo.cgi/discuss-bayesian-data-analysis`

All students are expected to be subscribed to the course email list from address which they read frequently, as organizational announcements may be sent there. Students are also encouraged to use the email list to discuss concepts and issues related to the course.

I will also use the email list to respond to student questions, so that the entire class can benefit from the exchange. If you email me a question which you don't want shared with the class, you must specify that explicitly in the email. (Similarly, if you want to ask a question anonymously, specify that you'd like your name left out of any reply posted to the email list.)

Course Policies

Attendance and Class Participation:
There is no attendance grade for the course, and no penalty for missing class. However, most students will find themselves at a disadvantage on the homeworks and exams if they neglect to take advantage of the full range of tools (including both lectures and reading) to gain understanding of the material. Additionally, I expect class discussions to be an important part of the learning process, so you'll be missing out if you don't participate in these.

Exam Attendance:
Makeup exams will only be granted in extreme circumstances. Unless you have a documentable emergency or an illness which requires medical attention, you should not expect to be able to make up a missed exam. If you do have a serious illness or emergency, please contact me as soon as possible.

Class Disruptions:
Please try to avoid disrupting the class by arriving late and/or leaving early. Please switch off or silence all mobile devices if possible. In case of an urgent need to be reachable during 75 minutes of lecture (on-call EMT, critically ill loved one, etc.), please use silent/vibrate mode.

Collaboration:
Collective brainstorming is a time-honored tool of scientists attacking a problem, be they freshmen or tenured professors. That said, working through the homework problems is an important aid to gaining mastery of the material, and a student who simply transcribes the solution of another student or of the group will likely have trouble come exam time. In light of this, solutions which are clearly (in my judgement) transcriptions from other sources or from each other will receive reduced or no credit. You should use outside sources or group discussions as needed to get the idea of how to do a problem, then go off and write up your own solution.

Additionally, in the interest of learning proper academic procedures, you should acknowledge any outside help you get on homeworks, whether from other students or from references outside the textbook.

Working together on exams or copying off of someone else's test is of course cheating and will not be tolerated.

Grades:
Grades will be based on the following components:

25% Problem Sets, Including Project
20% First Prelim Exam
20% Second Prelim Exam
35% Final Exam

Your score on each component of the course (each prelim, the final, all the homeworks together, and class participation) will be converted to a numerical "grade point" score, and the weighted average of those five scores will be your final grade, converted to a letter grade according to the scale below.

Grading Scale:

A	3.83–4.5	C+	2.17–2.5
A-	3.5–3.83	C	1.83–2.17
B+	3.17–3.5	C-	1.5–1.83
B	2.83–3.17	D	0.5–1.5
B-	2.5–2.83	F	(−0.5)–0.5

Special Arrangements for Students with Disabilities:
Students with disabilities who wish to receive accommodations in this class should contact the Academic Accommodations Office at 475-2023 or via their website
`http://www.rit.edu/studentaffairs/disabilityservices/accommodations.php`
as soon as possible so that warranted accommodations can be implemented in a timely fashion. The Academic Accommodations Office is located in SAU(04)-1150.