PSYC 757 Advanced Topics in Quantitative Methods: Bayesian Statistics SPRING 2016

Instructor: Patrick E. McKnight, Ph.D. **Office:** David King 2064/2065
Office Hours: Thurs 1:30pm-2:30pm and by appointment **Phone:** (703) 993-8292 **E-mail:** pmcknigh@gmu.edu
Class Location: Robinson B102 **Class Date/Time:**Thurs 9:00am-11:40am
Class website: **https://sites.google.com/site/psyc757fall2016/**
Class TA: Jake Quartuccio (jquartuc@gmu.edu) **Office (Hours):** DK 2065 (Thurs 2pm-3pm)

Course Overview

PSYC 757 covers fundamental probability theory, Bayesian statistics, and Bayesian applications using common social science statistics. During the semester, you will learn how to design, conduct, and interpret basic Bayesian models including univariate statistics, bivariate models, linear models, and multivariate models using R and other related software packages including but not limited to Stan, BUGS/JAGS, and JASP to name a few. The purpose of the course is to familiarize students with these methods and provide the necessary tools for further self-directed learning.

Course Requirements

The course requires you to become familiar with new concepts in probability theory, statistics, and the logic of inquiry. I assign readings and expect you to read them prior to class. Failure to read the assigned material in a timely manner may result in your inability to contribute to your group's project. You will not be able to catch up if you fall behind. The readings assigned are lengthy and novel. **Procrastinate at your own peril**.

Required Reading

I deliberately chose reading materials that are freely available to you via either our library (Springer agreement) or the generosity of the authors. Here are the books you must download right away and begin reading:

1. Bayesian Essentials with R by Jean-Michel Marin & Christian P. Robert (link requires GMU sign-in)
2. Subjective Probability: The Real Thing by Richard Jeffrey (free pdf book)
3. R Tutorials by Tal Galili (free online resource)
4. Various readings linked in the tentative schedule below

Optional Reading and Resources

You may find the following resources useful to supplement the required readings.

1. Doing Bayesian Data Analysis (Second Edition) by John Kruschke (link requires GMU sign-in)
2. Think Bayes by Allen B. Downey (free book in HTML or pdf)
3. Blog on Bayesian Statistics (Why and How) by Fabian Dablander (free blog link)
4. CRAN Task View: Bayesian Inference by Jong Hee Park (maintained on r-project website)
5. Many Bayesian articles available for your reading pleasure - courtesy of me and my Google drive folder

Attendance and Learning Policy

I do not require attendance in lecture but what you miss, you must make up without my assistance. Get lecture notes from your classmates, read additional and optional materials from online resources, and discuss what you miss with your classmates or with others who are knowledgeable about the course content. Take responsibility for your own learning; I will not enforce any policy that manages your behavior other than the final grades I assign and you earn.

Project-based learning

The course emphasizes project-based learning where students work in teams of 4 to 5 students and complete 3 projects throughout the semester. Each of you will be responsible for different aspects of the project and your responsibilities will change for each project. The project aspects include 1) designing the analysis, 2) manipulating or generating the data, 3) writing the analysis code, 4) interpreting and writing up the results, and 5) presenting the results to the class. Every lecture provides you the necessary (but not sufficient) material to complete aspects of the project but you will need to learn more than just what I cover during lecture. You and your teammates must divide the responsibilities for each project and work together to produce the best product. After the project deadline, each team must present the results to the class and we will collectively assign quality scores for each presentation (more details about grading below). The project details are as follows:

Projects

Generate the story, data, and analysis that provides convincing evidence for these three project goals:
Univariate Project 1 Goal: The outcome of a study does not significantly differ from "no effect." In short, you must defend the null for a single variable.
Bivariate Project 2 Goal: A single variable predicts a single outcome at or above a particular level (i.e., something different than zero).
Multivariate Project 3 Goal: A predictive model **accurately and reliably** predicts an outcome at or above a particular level (i.e., something different from zero).

Project objectives

Each team must develop the story and either gather the data from an existing study (not recommended) or generate their own data (recommended) suitable for providing the required evidence. Each team will have different ideas, data, and solutions to the problem. Differences are fine but all solutions must be in the form of a Bayesian approach. You may select the approach from the myriad of options discussed in class.

Grading

Each student's grade is based upon the **quality of the group product** (40%), the ratings assigned by your teammates (40%) and my assessment of your contribution to the final product (20%). The quality of the group product gets assessed by the entire class immediately following the 10 minute presentation via web form ratings of the following equally-weighted (i.e., 20% each) criteria: 1) statement of the problem, 2) rationale for the approach, 3) effectiveness of meeting the objective, 4) communication of the results, and 5) persuasiveness of the final result. Each person must rate the quality of contribution of each of the other teammates. It is important that you learn to contribute to the project equally and with respect for one another's contributions. Finally, I will rate each aspect of the final product and assign the grade to the person who assumed responsibility for that aspect. Again, these aspects were listed above but I reiterate them here: 1) designing the analysis, 2) manipulating or generating the data, 3) writing the analysis code, 4) interpreting and writing up the results, and 5) presenting the results to the class. All three projects for each team get graded on this basis and your final grade will be determined based upon the the combined total for all three projects using this weighting system. Grade assignments are as follows: A (87-100%), B (74-86%), C (60-73%), and F (<60%) where percents are the percent of total points available from the three project grades (max of 100 points each). I reserve the right to assign the grade based upon the highest grade of a single project should the student improve throughout the semester.

Administrative Details

University Honor Code: I enforce George Mason's honor code policy outlined in this document and reserve the right to enter a failing grade to any student found guilty of an honor code violation.
Students with Disabilities: If you are a student with a disability and you need academic accommodations, please see me and contact the Disability Resource Services (DRS) at 703-993-2474.
Communication and Lecture Cancellation Policy: Mason uses electronic mail (gmu.edu) to provide official information to students. Examples include communications from course instructors, notices from the library, notices about academic standing, financial aid information, class materials, assignments, questions, and instructor feedback. Students are responsible for the content of university communication sent to their Mason email account and are required to activate that account and check it regularly. I will alert you via email when class must be cancelled for any reason; otherwise, assume we have class at our normal time and location.

Tentative Schedule

Date	Readings	Objective	Optional but strongly recommended
9/1	Syllabus, Jeffrey Chapters 1-5, and R setup with Rstudio	Introduce course, probability theory, and R	Rstudio install, R tutorial #1, R tutorial #2, How to become a Bayesian
9/6		LAST DAY TO ADD/DROP	
9/8	Count Bayesie	Bayes theorem, subjective probability, and updating priors	Kahn Academy Probability and Combinatorics

9/15	Bayesian Essentials pages 1-61	R basics and normal distribution theory	Solutions to problems, bayess package
9/22	The Likelihood and Updating your Priors	Simple(r) distributions and update functions	Plot different distributions
9/29		PROJECT 1 PRESENTATIONS	
10/6	ggplot2	Display better results	Hadley Wickham's book
10/13	NY Times article, Little (2005), Meehl (1997)	Frequentists and Subjectivists	See Goodman articles hosted on my Google Drive
10/20	Spiegelhalter & Rice (2009)	Bayesian methods - start to finish	
10/27	Baath (2013) & Baath (2013)	Correlations, predictions, and spurious relationships	Whoa! (must see)
11/3		PROJECT 2 PRESENTATIONS	
11/10	Bayesian Essentials pages 65-137	Linear models	
11/17	Bialik (2011), Gelman (2011), and Morey, 2016	Evidence and Bayes Factor	Replicability-Index, Goodman (1999)
11/24	NO READINGS	Thanksgiving: Be with your family, be thankful, enjoy yourself	RELAX
12/1	NA	Q & A session	NA
12/8		PROJECT 3 PRESENTATIONS	