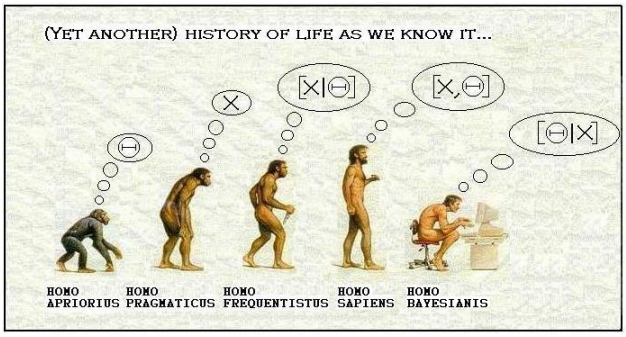
JOHN JAY COLLEGE OF CRIMINAL JUSTICE
The City University of New York
524 West 59th Street, New York, NY, 10019

Syllabus for: MAT/FOS 705, Applied Bayesian Data Analysis



credit: unknown, or maybe Søren Højsgaard 🤔...

Professor: Nicholas Petraco
Room: 6.61

Contact hours: Tuesdays 6:00pm-8:00pm

E-mail address: npetraco@gmail.com
Course website: https://npetraco.github.io/MATFOS705/

Course Description:
The classical "work horse" statistical methods learned in a first year undergraduate statistics course are known as "frequentist" and "Fisherian" methods. They are extremely useful and have been successfully applied for almost one hundred years. They have well known limits and flaws however. Complementary sets of statistical tools are known as "Bayesian" based methods. Related to Bayes' Theorem and relying on a definition of probability as "belief", they offer very intuitive interpretation and a naturally "coherent" methodological framework for inference. Within the last 20 years, as computing power has increased Bayesian methods have become practical for standard scientific applications.

The purpose of this course is to acquaint forensic science and forensic computing graduate students with Bayesian statistical tools. The course will also pay special attention to their relationship with classical methods, as well as issues, flaws and pitfalls to be aware of when applying Bayesian based methods.

Course lecture materials will be posted on the following website:

https://npetraco.github.io/MATFOS705/

Announcements and important reminders will be emailed to you. As such **you must give me an email address that you check on a regular basis**.

Course Learning Goals:

1. Recognize the importance of accuracy and objectivity in collecting/sampling data for applications to the law and policy.

2. Acquire an understanding of the types of data that can be recorded and analyzed.

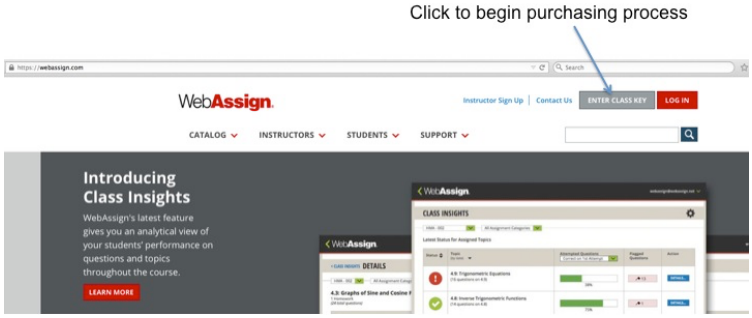
3. Acquire an understanding of Bayesian statistical tools that can be used to analyze collected data.

4. Understand the limitations of the Bayesian statistical methods used for data analytics and how not to misrepresent the capabilities of these methods to the courts or clients (ethics).

5. Obtain skill with the general programming/computing/statistical software **R** (http://www.r-project.org/), parametric Bayesian software packages **Stan** (http://mc-stan.org/) and **JAGS** (https://mcmc-jags.sourceforge.io/).

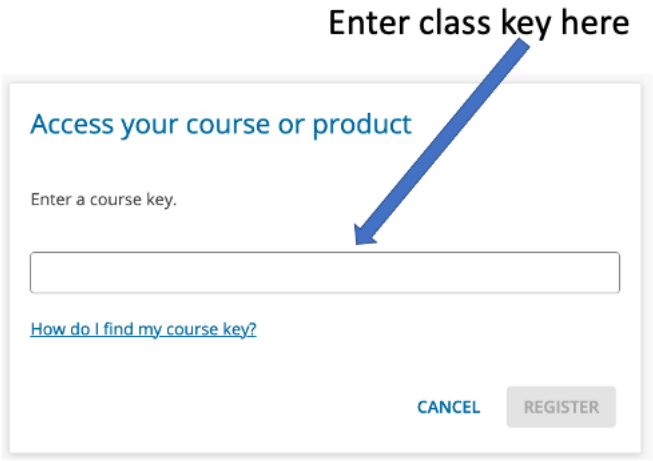
Required Electronic Resources:

- **Webassign**: Can be purchased at:
    - **https://webassign.com/**
    - In order to purchase click on "**Enter Class Key**":

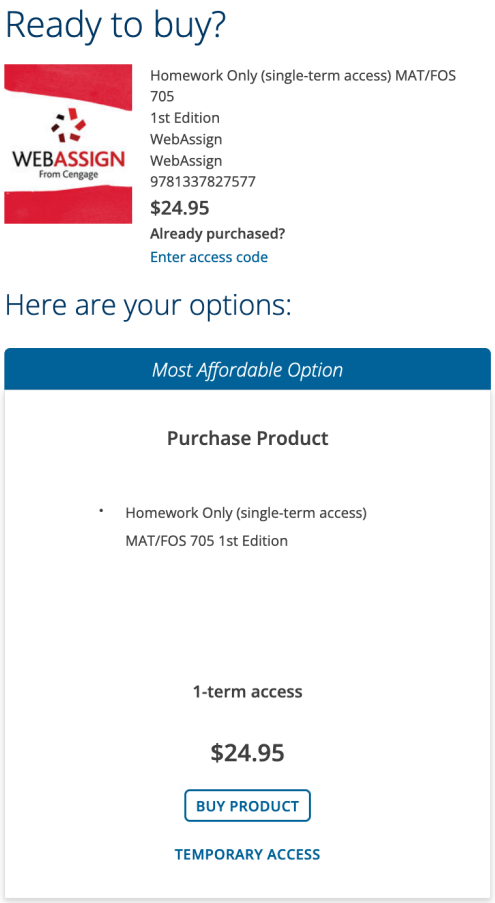


- The WebAssign website will probably prompt you to log into your account. If you don't have an account, create one.
- When you log in, you should see a place to enter the class key:

- Class Key: **jjay.cuny 7604 1064**



- After logging in/creating-account, select your class and the website will prompt you to purchase the required materials:



- Purchase "MAT/FOS 705", which should be ~$24.95

Textbooks:
Bayesian Data Analysis, 3rd Edition.
http://www.stat.columbia.edu/~gelman/book/
Electronic: http://www.stat.columbia.edu/~gelman/book/BDA3.pdf
ISBN-10: 1439840954

A Student's Guide to Bayesian Statistics, 1st Edition.
ISBN-10: 1473916364
Author's website: https://ben-lambert.com/
Author's YouTube Channel: https://www.youtube.com/user/SpartacanUsuals/featured
Author's Book YouTube Playlist:
https://www.youtube.com/playlist?list=PLwJRxp3blEvZ8AKMXOy0fc0cqT61GsKCG

The BUGS Book: A Practical Introduction to Bayesian Analysis, 1st Edition.
ISBN-10: 1138469483

Web resources:
Stan: https://mc-stan.org/
http://mc-stan.org/documentation/

JAGS: https://mcmc-jags.sourceforge.io/

Grading:

The grades for this course are based on homework sets (100%). We'll have about HW set one week.

Topics and Schedule:

Lecture Topics	**Sub Topics**
Introduction Introduction and Tutorial for R	Introduction to Bayesian Perspectives Review: Common Defininitions in Statistics Review: Basic Graphing
Review: Summary Statistics	Review: Measurs of Central Tendency Review: Standard Measures of Uncertainty Review: Range and Quantiles
Probability	Definitions Axioms and Some Useful Theorems Conditional Probability and Bayes' Theorem
Moments Important Distributions	Discrete Moments Important Discrete Distributions Important Continuous Distributions
Introduction and Tutorial for Stan and JAGS	
Single Parameter Models	Intro to single parameter inference Inference by MCMC Sampling
Multiparameter Models	Multiparameter inference Graphing Results, Diagnostics and Troubleshooting
Change of Variable and Jacobians	Definitions and Theory Exmples
Introduction to Regression Modeling	Basic Bayesian Regression Linear Models Generalized Linear Models
Practical Model Assessment	Kullback-Leibler Divergence WAIC LOO
Formal Model Comparison	Marginal Likelihood and Bayes Factors Bridge Sampling
Multilevel/Hierarchical Models	Definitions and Theory Linear Multilevel Models Generalized Linear Multilevel Models

College wide policies for undergraduate courses *(*see the *Undergraduate Bulletin*, Chapter IV Academic Standards)

A. **Incomplete Grade Policy**

B. **Extra Work During the Semester**

C. **Americans with Disabilities Act (ADA) Policies**

"Qualified students with disabilities will be provided reasonable academic accommodations if determined eligible by the Office of Accessibility Services (OAS). Prior to granting disability accommodations in this course, the instructor must receive written verification of a student's eligibility from the OAS which is located at L66 in the new building (212-237-8031). It is the student's responsibility to initiate contact with the office and to follow the established procedures for having the accommodation notice sent to the instructor."

> Source: *Reasonable Accommodations: A Faculty Guide to Teaching College Students with Disabilities*, 4th ed., City University of New York, p.3. (http://www.jjay.cuny.edu/studentlife/Reasonable_Accommodations.pdf)

Statement of the College Policy on Plagiarism

Plagiarism is the presentation of someone else's ideas, words, or artistic, scientific, or technical work as one's own creation. Using the ideas or work of another is permissible only when the original author is identified. Paraphrasing and summarizing, as well as direct quotations require citations to the original source.

Plagiarism may be intentional or unintentional. Lack of dishonest intent does not necessarily absolve a student of responsibility for plagiarism.

It is the student's responsibility to recognize the difference between statements that are common knowledge (which do not require documentation) and restatements of the ideas of others. Paraphrase, summary, and direct quotation are acceptable forms of restatement, as long as the source is cited.

Students who are unsure how and when to provide documentation are advised to consult with their instructors. The Library has free guides designed to help students with problems of documentation. *(John Jay College of Criminal Justice Undergraduate Bulletin,* http://www.jjay.cuny.edu/academics/654.php , see Chapter IV Academic Standards)