APPM 4/5720, Section 001, Fall 2018

COMPUTATIONAL BAYESIAN STATISTICS

Welcome to Computational Bayesian Statistics! Bayesian statistics provides a principled and powerful way of combining expert knowledge with the analysis of observed data. It allows one to update inferences about parameters and hypotheses as new evidence accumulates. Applications of Bayesian statistics to practical problems range far and wide in, for example, areas as diverse as econometrics, signal processing, clinical medicine, and particle physics. However, with the power of Bayesian statistics comes computational complexity.

In addition to providing an introduction to the theory of Bayesian statistics, this course will include the theory and application of Markov chain Monte Carlo algorithms to aid in the analysis of both low and high-dimensional data sets.

Class Days/Times: MWF 2-2:50PM

Instructor: Jem Corcoran, ECOT 238, corcoran@colorado.edu

Office Hours: MW 3-4PM, F 1-1:50PM

Text: *Bayesian Data Analysis* (any ed.), by by A. Gelman, J.B. Carlin, H.S. Stern, D.B. Dunson, A. Vehtari, and D.B. Rubin , CRC Press.

Prerequisite: APPM/MATH 4/5520 or equivalent (Mathematical Statistics)

Credits: 3

Software: Your choice. In class we will use some **R** and mostly pseudocode.

Grade Components:

- 8 HW assignments (30%)
- 1 in class midterm (25%)
- 1 project (25%)
- final exam (20%)

In addition, **5720** students will have extra problems on assignments, a take-home midterm and a take-home final and will be held to a higher standard of grading.

Topic List:

- Review of essential elements from MathStat and probability, especially
  - Bayes' Rule
  - maximum likelihood estimation
  - asymptotics
- Bayesian Inference: Parameter Estimation, including
  - priors and conjugate priors
  - point estimation, single parameter and multiparameter
  - confidence regions
  - elimination of nuisance parameters
  - exchageability and inference for exchangeable data
  - comparisons with classical frequentist approaches

- Bayesian Inference: Hypothesis Testing
  - Bayes factors
  - choosing prior distributions for testing
  - a case against P-values
  - sequential testing
  - decision theory and minimax testing
  - comparisons with classical frequentist approaches
- Computation: with applications driven by student interest
  - numerical approximations
  - EM algorithm
  - Metropolis-Hastings algorithm
  - Gibbs sampling
  - particle filtering
- Additional Topics
  - Bayesian linear regression
  - hierarchical modeling
  - model selection and model averaging

Course Website:
`www.colorado.edu/amath/course-pages/spring-2018/appm4720bayesianstats`