STATS 230: Statistical Computing Methods

Department of Statistics, UCI

Objective

The objective of this course is to learn computational methods in statistics. By the end of this course, students are expected to be able to write their own computer programs (as opposed to relying on existing packages) to perform statistical analysis. The two main components of this course are optimization methods and sampling algorithms. Primarily, we discuss optimization methods within the frequentist framework and sampling algorithm with respect to their application in Bayesian inference. Additionally, we discuss a variety of other computational methods (e.g., numerical linear algebra, bootstrap) that are commonly used in modern statistics. Students participating in this class are expected to have some background in statistics and probability (at least two quarters of upper division or graduate coursework). Also, they need to be proficient at a programming language.

Instructor

Babak Shahbaba, 2224 Donald Bren Hall

Syllabus

We will cover the following topics:

- Basic concepts in computational methods
- Numerical linear algebra
- Optimization methods
- Numerical integration and approximation
- Fourier series and integrals
- Sampling algorithms
- Hamiltonian Monte Carlo and its variants

- Posterior approximation
- The EM algorithm
- Bootstrap and resampling

References

Textbooks

I will use my own lecture notes mainly based on the following books:

- "Computational Statistics," by Givens and Hoeting (available online through UCI Library)
- "Computational Science and Engineering," by Gilbert Strang
- "Handbook of Computational Statistics," by Gentle et al. (available online through UCI Library)
- "Elements of Statistical Computing," by Ronald Thisted
- "Convex Optimization," by Boyd and Vandenberghe
- "Elements of Statistical Learning," by T. Hastie, R. Tibshirani, and J. Friedman.
- "Probabilistic Inference using Markov Chain Monte Carlo Methods," by R.M. Neal.
- "Bayesian Data Analysis," by A. Gelman, J.B. Carlin, H.S. Stern, and D.B. Rubin.