

Algorithmic and Computational Statistics

Instructor: Robert Maier (Professor, Mathematics and Physics).

Textbook: Geoff Givens and Jennifer Hoeting, “Computational Statistics” (Wiley, 2005).

Outline: This proposed topics course will be a higher-level counterpart to the existing course STAT 675 (“Statistical Computing”). Unlike STAT 675, this course will be primarily theoretical. It will not focus on the use of statistical software, such as R. Instead, it will focus on theory. It should appeal to students in the Mathematics and Applied Math Ph.D. programs who are interested in seeing statistical applications of analysis and numerical analysis, and especially to mathematically oriented students in the statistics Ph.D. program.

Prerequisites: Any of the core courses MATH 523, 527, 575, or 564/566.

Topics:

1. Aspects of maximum likelihood and Bayesian inference. (Review.)
2. Optimization and solving nonlinear equations (Newton–Raphson and more advanced multivariate schemes; emphasis on statistical applications).
3. Simulated annealing.
4. EM [Expectation Maximization] methods for optimization, in both frequentist and Bayesian inference.
5. Multivariate numerical integration methods, in detail; emphasis on applications to Bayesian inference.
6. Sampling from a Bayesian posterior distribution: MCMC (Markov chain Monte Carlo), etc. Much background information on Markov chains.
7. Mathematical aspects of smoothing and nonparametric density estimation.
8. Information criteria for model selection, i.e., deciding between fitted statistical models on the basis of data; and connections with information theory.