Title: Algorithmic and Computational Statistics

Instructor: Robert S. Maier (Professor, Mathematics; Professor, Physics; Affiliate Member, Statistics Program)

Textbook: G. H. Givens and J. Hoeting, "Computational Statistics", second edition, Wiley, 2013.

Outline:

This Topics course was last successfully taught in Fall 2013 and is proposed for Fall 2017. It will be a higher-level counterpart to the existing course STAT 675 ("Statistical Computing"). Unlike STAT 675, it will not provide training in the use of statistical software, such as R. Instead, it will focus on theory: the mathematics of advanced computational statistics. It should appeal to students in the Mathematics and Applied Mathematics graduate programs who would like to see statistical applications of analysis and numerical analysis, and to students in the Statistics graduate program.

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

Topics:

Aspects of maximum likelihood and Bayesian inference. (Review.)

Numerical optimization and the numerical solution of nonlinear equations (Newton-Raphson and more advanced multivariate schemes; statistical applications).

Simulated annealing.

Numerical integration, with applications to Bayesian inference and simulation. Related mathematical topics, such as orthogonal polynomials of many types; how orthogonal polynomials are related to standard probability distributions.

The issue of limited machine precision: the IEEE format for floating point numbers, and how it affects the accuracy of numerical computations.

Sampling from a Bayesian posterior distribution: MCMC (Markov chain Monte Carlo), etc. Much background information on Markov chains and their structure.

Smoothing and nonparametric density estimation; mathematical aspects.

Information criteria for model selection, i.e., deciding between fitted statistical models on the basis of data; connections with information theory.