Fall 2010: Stat 992

Interface between Statistics and Optimization

Time and Place: 2335 STERLING, 11:00 AM - 12:15 PM, MW

Instructor: Peter Qian
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Office Hours:
1:30 - 2:30 PM, MW and by appointment

Course description:
It is a common perception among statisticians and computer scientists that optimization methods are critical to solving many statistical inference problems. Notable examples include Fisher's scoring algorithm for finding maximum likelihood estimators and the method of iteratively reweighted least squares for estimation in nonlinear models. To expand this perception further, in this course I will present modern optimization methods for solving a large array of complex problems in statistics, including regularized variable selection with missing data, estimation in random-effect models and hierarchical models, calculation of Bayesian posteriors and etc. On the flip side, I will present recent advances in using statistical ideas and tools to tackle difficult optimization problems such as stochastic programs and chance-constraint problems.

Prerequisite:
One undergraduate-level course on mathematical statistics. No prior exposure to optimization is required.

Topics:
- The EM algorithm.
- The Monte Carlo EM algorithm.
- MM algorithm.
- MCM algorithm.
- Trust region method.
- Optimization of black-box functions.
- Recursive estimation for linear models.
- Stochastic approximation.
- SPSA algorithm.
- Reinforcement learning.
- Optimal designs.
- Algorithms for the Lasso and other variable selection methods.

- Stochastic programming with applications in statistics.
- Statistical enhancement of the sample average approximation method.
- Multi-step methods for kernel learning.
- Quasi-Monte Carlo.
- Robust optimization.
- Chance-constraint problems.

References:
The course is based on journal papers.

Class notes: will be posted on
https://learnuw.wisc.edu/

Requirements:
(a) For one credit, show up (rather frequently) and serve as discussants for presentations by others.
(b) For two credits, (a) plus present two journal papers.
(c) For three credits, (b) plus a class project (computational, applied or methodological).

No exam. No homework. Stop by my office if you have any questions about this course.

Useful references:

1. The EM Algorithm and Extensions, McLachlan Geoffrey and Thriyambakam Krishnan, Wiley; 2nd Edition, 2008, ISBN-10: 0471201707, ISBN-13: 978-0471201700

2. Introduction to Stochastic Search and Optimization, James C. Spall, Wiley-Interscience; 1st Edition, 2003, ISBN-10: 0471330523, ISBN-13: 978-0471330523

3. Handbooks in Operations Research and Management Science: Stochastic Programming, Andrzej Ruszczynski and Alexander Shapiro, Elsevier; 1st Edition, 2004, ISBN-10: 0444508546, ISBN-13: 978-0444508546.

4. Lectures on Stochastic Programming: Modeling and Theory (MPS-SIAM Series on Optimization) by Alexander Shapiro, Darinka Dentcheva, and Andrzej Ruszczynski, SIAM-Society for Industrial and Applied Mathematics, 2009, ISBN-10: 089871687X, ISBN-13: 978-0898716870.

5. Optimum Experimental Designs, with SAS (Oxford Statistical Science Series), Anthony Atkinson, Alexander Donev and Randall Tobias, Oxford University Press, 2007, ISBN-10: 019929660X, ISBN-13: 978-0199296606.