STAT 7730 Syllabus
Advanced Computational Statistics
Autumn 2019

Instructor: Lo-Bin Chang
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Office: Cockins Hall 440D
Class Times: MWF 11:30AM-12:25PM
Class Location: Cockins Hall 228
Office Hours: M 3:00-5:00PM, other times by appointment
Grader: Hengrui Luo

References:
Computational Statistics by G. Givens and J. Hoeting
Monte Carlo Statistical Methods by C. Robert and G. Casella
An Introduction to the Bootstrap by B. Efron and R. Tibhsirani
Pattern Recognition and Machine Learning by Christopher M.Bishop
Information Theory, Inference, and Learning Algorithms by David MacKay
Statistical computing with R by Maria L. Rizzo

Tentative Schedule:
I. Basic Numerical Analysis and Matrix Decomposition: basic numerical analysis, multiple linear regression analysis, QR decomposition, singular value decomposition, principal component analysis
II. Numerical Methods for Parameter Estimation: maximum likelihood estimation, univariate/multivariate numerical optimization (gradient methods, Newton's methods), maximum entropy principle, MM and EM algorithm and extensions
III. Random Number and variable Generation: uniform random number generators, modular arithmetic, combination generators, discrete and continuous random variables, inverse transform method, acceptance-rejection method, tilted sampling
IV. Monte Carlo Integration: general formulation, importance sampling, variance reduction, numerical integration and differentiation, bootstrap
V. Markov Chain Monte Carlo (MCMC) Methods: properties of Markov chains, Metropolis-Hastings algorithm, Gibbs sampler, perfect sampling
VI. Graphical models: undirected graph, Gibbs random field, dynamic programming, Bayesian network, Gaussian random field
VII. Additional Topics: classification problems, deep learning, convolutional neural network and image classification - time permitting

Prerequisites: 6802 (622) and 6950 (645) or permission of instructor. Additionally, working knowledge of linear algebra, advanced calculus, and some programming background is helpful.

Course Description: STAT 7730 is a graduate level course in modern statistical computing methods. This course is not about the use of pre-packaged statistical software. The main goal of this course is to gain an understanding of advanced techniques and ideas used in implementing mathematical/statistical formulations on computers, with a focus on common statistical approaches. Students will be expected to implement the methods we cover in class by programming in a language of their choice. Students can use *any* programming language for this course. **Note:** Students who have had no prior programming experience should expect to spend extra time outside of class reviewing how to write computer code and familiarizing themselves with a statistical programming environment.

Grading: The final course grade will be based on homework assignments (70%) and a final project (30%).

Homework Assignments: Homework assignments will be given approximately once every two weeks. The assignments will require the derivation of analytical results as well as the implementation of the computational methods we discuss in class. Please write clear and detailed answers to the homework problems and provide a statement interpreting the obtained results. If a problem involves writing a program, submit a printout of the code with the solution. It is important to provide illustrative outputs of your programs to accompany the homework solutions. For instance, all graphs should be labeled and placed close to the associated written part. Points are allocated to both the correctness of the solution and the level of presentation. Students may consult with each other on the homework problems, but each student must complete and turn in his or her own work. DO NOT copy or use computer code written by another student. *Late assignments will not be accepted*.

Final Project: To be announced.

Academic Misconduct: Academic misconduct will not be tolerated and will be dealt with procedurally in accordance with university policy, which can be found at http://oaa.osu.edu/coam.html. Students are allowed to consult with each other on homework assignments. However, each student must complete and turn in his or her own work. The discussions should be at the ideas level and not the details level. DO NOT copy or use computer code written by another student.

Addressing Issues of Differing Abilities: If you have a documented disability please register with the Office for Disability Services (ODS). After registration, make arrangements with me as soon as possible to discuss your accommodations so that they can be implemented in a timely fashion. If you have any questions about this process please contact ODS.

Note: Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advanced notice.