STAT 7730 Syllabus
Advanced Computational Statistics
Autumn 2015

Instructor: Dr. Lo-Bin Chang
E-Mail: chang.1539@osu.edu
Office: TBA
Office Phone: TBA
Class Times: MWF 11:30AM-12:25PM
Class Location: Watts Hall 379
Office Hours: W 1:00-2:00PM, other times by appointment

Main Text: *Computational Statistics* by G. Givens and J. Hoeting
Other Useful Texts:
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

Tentative Schedule:
1. Linear Methods for Regression Analysis/Matrix Decomposition: basic numerical analysis, multiple regression analysis, orthogonalization by Householder transformation, singular value decomposition, QR decomposition, principal component analysis, linear discriminant analysis – 2 weeks
2. Numerical Methods for Maximum Likelihood Estimation: univariate/multivariate numerical optimization, maximum likelihood estimation, expectation-maximization (EM) algorithm and extensions – 3 weeks
3. 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 – 2 weeks
4. Monte Carlo Integration: general formulation, importance sampling, variance reduction, numerical integration and differentiation – 2 weeks
5. Markov Chain Monte Carlo (MCMC) Methods: properties of Markov chains, Metropolis-Hastings algorithm, Gibbs sampler – 2 weeks
6. Bootstrap: plug-in estimator, non-parametric/parametric bootstrap, bootstrap estimate of standard error, confidence intervals based on bootstrap – 1 week
8. Additional Topics: graphical models - time permitting

Prerequisites: 6802 (622) and 6950 (645) or permission of instructor. Not open to students with credit for 773. 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. I will provide example R or Matlab code that goes along with the material covered in class. Students are expected to be able to analyze the code, and apply the basic structure of the code to new problems assigned as homework. **Note:** Students who have had no prior programming experience should expect to spend extra time outside of class reviewing the example 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 on a Friday and be due the following Friday at the beginning of class. *Late assignments will not be accepted*. 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.

Final Project: The final project will be a take-home project. You will be asked to write a report on the project similar to a research paper. The project is graded for both the solutions and the quality of presentation. I encourage all students to use Latex to generate their project reports (this is not a class requirement). The Latex typesetting language is very popular for creating mathematical documents, and I hope that you will become at least somewhat familiar with Latex by the end of this class. I will provide an example of a document written in Latex as a reference.

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. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

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.