

STA6468: Matrix Algebra and Optimization for Statistics and Machine Learning

Lecture: Tuesday and Thursday 12:30am - 1:45pm, OSB 215

Instructor: Yiyuan She, OSB 209F (yshe@stat.fsu.edu)

Office hour: Thursday 2:00pm - 3:00pm and by appointment

Text: None. I will make lecture notes and slides.

Some useful reference books (optional):

1. *Matrix Algebra From A Statistician's Perspective*, Harville, 1997
2. *Matrix Algebra*, Gentle, 2007
3. *Convex Optimization*, Boyd and Vandenberghe
4. *Numerical Optimization*, Nocedal and Wright, 1999

Prerequisites: Linear regression, (basic) optimization, and a linear algebra course (or permission of instructor). [Matrix notation will be heavily used.]

Course Objectives: Matrix algebra and optimization are at the core of modern statistics. By the end of this course, students will be able to acquire knowledge of matrix algebra and popular optimization techniques in related research areas, as well as implementing fast and scalable algorithms.

Course topics: The course covered includes a range of modern computational and statistical topics. Some topics include: eigenvalues and eigenvectors, singular value decomposition, Cholesky decomposition, QR decomposition, partitioned matrices, generalized inverse, Kronecker products, vec operator, Hadamard product, matrix differentiation, projections, intersection and direct sum of subspaces, canonical angles; convexity, generalized inequality, semi-definite programming, proximal methods, linearization, Bregman divergence, mirror descent, MM algorithms, Lagrange duality, Dykstra projections, augmented Lagrangian, ADMM, block coordinate descent and randomization, gradient boosting, Johnson-Lindenstrauss lemma, random projection, Stochastic approximation/optimization; graph learning, network clustering, ranking, approximate message passing.

Exams: There will be no exams.

Project: Students must complete course project and paper to get a grade for the course.

You may choose to apply one or multiple methods taught in class to solve a real-world multivariate optimization problem. Perform systematic computer experiments (simulations) to study the performance of your algorithm(s). Real-life data analysis is also required. You MUST discuss with me your problem and research goal.

Alternatively, you can read one theoretical paper carefully and write a report. You need to go beyond the paper in some way, say, giving a new proof of some theorem. It is recommended to stay focused on one or some parts of the paper. You MUST discuss with me which paper you want to study. (I may provide a list of candidate papers.)

In either way, you are required to turn in a 10-15 page typed paper by 5pm on Dec 5, 2017.

Course Website: All pertinent information for this class will be posted on the course website at [FSU's Blackboard](#).

Grades: Your course grade is based on the project.

Software: R will be used in class.

Syllabus Change Policy: 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 advance notice.

University Attendance Policy:

Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

Academic Honor Policy:

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "...be honest and truthful and...[to] strive for personal and institutional integrity at Florida State University."

(Florida State University Academic Honor Policy, found at <http://fda.fsu.edu/Academics/Academic-Honor-Policy>)

Americans with Disabilities Act:

Students with disabilities needing academic accommodation should: (1) register with and provide documentation to the Student Disability Resource Center; and (2) bring a letter to the instructor indicating the need for accommodation and what type. This should be done during the first week of class. This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact the: Student Disability Resource Center 874 Traditions Way 108 Student Services Building Florida State University Tallahassee, FL 32306-4167 (850) 644-9566 (voice) (850) 644-8504 (TDD) sdrc@admin.fsu.edu
<http://www.disabilitycenter.fsu.edu>
