Syllabus: Math 462 Data Analytics Theory

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Course description

Co-convenes with M 562. Offered spring. Prereq., M 221 and two other Mathematics / Statistics classes at the 200-level or above, or consent of instr. The main goal of this course is to provide students with the opportunity to acquire conceptual knowledge and theoretical understanding of mathematical methods applicable to data analytics and real-time computations.

Course Format

Three meetings per week MWF 2:00-2:50 a.m. Friday will usually, but not always, be reserved for the discussion of mathematically-advanced aspects of the subject material. After a methodological topic is introduced, students will apply the method to the problem by coding the method, or using existing software.

Learning Outcomes

1. Understand the theory and foundations of predictive analytics and dimension reduction.
2. Develop understanding and practical experience in optimizing objective functions.
3. Ability to formulate and implement algorithms for predictive analytics.
4. Understand the mathematical basis for artificial neural networks.

Topics

Predictive Analytics

1. Objective functions
2. Optimization methods: least squares, direct search, steepest descent, Newton's method
3. Accuracy assessment and randomization techniques
4. Cluster analysis

Data reduction methods

1. Dimension reduction: eigenvector techniques, projection onto lower-dimensional subspaces
2. Discrete wavelet transform

Artificial Neural Networks

1. Architecture
2. Optimization
3. Application

Textbook

We will use several textbooks posted online on the Moodle website. These include but are not limited to:

1. *Algorithms for Data Science* Steele, B., Chandler, J., and Reddy, S.
2. *An Introduction to Statistical Learning* James, G., Witten, D., Hastie, T., and Tibshirani, R.
3. *Principal Components Analysis* Jolliffe, I.
4. *Deep Learning* Goodfellow, I., Bengio. Y., and Courville, A.

Grading

Course grade is based on homework. Homework assignments often consist of a set of problems, both mathematical and Python programming, from which students choose and complete/solve. M 462/562 students sometimes differ with respect to mathematical preparation and domain knowledge and so the assignments will contain problems that are appropriate to preparation. Approximately 10 homeworks will be assigned and the point value will vary between 15 and 30. Homework will be collected approximately every 10 days (depending on the difficult of the task). Students are encouraged to work together. The final is take-home, and is due on the scheduled day of the final, Monday April 29.

Students enrolled in the graduate-level course, M 562, will give expository talks to the class related to the methods or the subject-matter aspects of the project. Total time engaged in expository talks usually will not exceed 50 minutes.

There will be time after class on Mondays and Wednesdays to get assistance from the instructor (in addition to Tuesday and Thursday office hours) and to work with other students.