Math 260J: Machine Learning: Special Topics — Winter 2020

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Office: 6712 South Hall
Office Hours: R 10:45am – 12:45pm

CLASS TIMES TR 9:00am – 10:45am, Buchn 1920.

DESCRIPTION The course will cover special topics in machine learning. This course will develop materials from the perspective of mathematical foundations and theory behind learning algorithms as well as discussing practical computational aspects and applications. More information can be found on the course website.

PREREQUISITES Linear Algebra, Probability, and ideally some experience programming.

TEXTBOOKS *The Elements of Statistical Learning: Data Mining, Inference, and Prediction,* Hastie, Tibshirani, Friedman.

Foundations of Machine Learning, Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar.

TOPIC AREAS

- Background for Machine Learning / Data Science
  - Introduction discussing historic developments and recent motivations
  - Concentration Inequalities and Sample Complexity Bounds
  - Statistical Learning Theory, PAC-Learnability, related theorems
  - Rademacher Complexity, Vapnik–Chervonenkis Dimension
  - No-Free-Lunch Theorems
  - High Dimensional Probability and Statistics
  - Optimization theory and practice
  - Motivating applications
- Supervised learning
  - Linear methods for regression and classification
  - Model selection and bias-variance trade-offs
  - Support vector machines
  - Kernel methods
  - Parametric vs non-parametric regression
  - Graphical models
  - Neural network methods
- Unsupervised learning
  - Clustering methods
  - Principle component analysis and related methods
  - Manifold learning
  - Neural network methods
- Additional topics
  - Stochastic gradient descent

- First-order non-linear optimization methods
- Markov-Chain Monte-Carlo (MCMC) sampling for posterior distributions
- Sampling with ito stochastic processes
- Variational inference
- Iterative methods and preconditioning
- Dimensionality reduction
- Sparse matrix methods
- Stochastic averaging and multiscale methods
- Example applications

WEBSITE http://teaching.atzberger.org