MATH CS 120: Machine Learning: Foundations and Applications Fall 2018

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http://atzberger.org/teaching

Office: 6712 South Hall
Office Hours: TR 12:30pm – 2:00pm

CLASS TIMES TR 3:30pm – 4:45pm, CRST 143.

DESCRIPTION The course will develop mathematical foundations and theory behind learning algorithms as well as discussing practical aspects for their use in applications. More information can be found below and on the course website.

PREREQUISITES Calculus, Linear Algebra, Differential Equations, and 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

- Introduction and discussion of background for machine learning / data science.
  - Historic developments and recent motivations
  - Statistical Learning Theory, PAC-Learnability, related theorems
  - Rademacher Complexity, Vapnik–Chervonenkis Dimension
  - Concentration Inequalities and Sample Complexity Bounds
  - No-Free-Lunch Theorems
  - Motivating applications
  - Optimization theory and practice
- 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
  - Kernel methods
  - 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://atzberger.org/teaching