Math 184: Machine Learning: Foundations and Applications Winter 2018

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http://atzberger.org/teaching
Office Hours: TR 4:15pm – 5:45pm

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(Kerr Hall 1150)

CLASS TIMES R 11:00am – 12:50pm, South Hall 4607.

DESCRIPTION The course will develop mathematical foundations and theory behind learning algorithms as well as discussing practical aspects and applications. More information can be found 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
  - Historic developments and recent motivations
  - Statistical Learning Theory, PAC-Learnability
  - Rademacher Complexity, Vapnik–Chervonenkis Dimension
  - Concentration Inequalities and Sample Complexity Bounds
  - No-Free-Lunch Theorems
  - Motivating applications
- Supervised learning
  - Linear methods for regression and classification
  - Kernel methods
  - Parametric vs non-parametric regression
  - Model selection and bias-variance trade-offs
  - Support vector machines
  - Graphical models
  - Neural networks
  - Unsupervised learning
  - Clustering methods
  - Principle component analysis and related methods
  - Diffusion maps
  - Manifold learning
- Computational methods for machine learning
  - Stochastic gradient descent

- First-order non-linear optimization methods
- Markov-chain monte-carlo 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