Math 260HH: Machine Learning: Special Topics Fall 2022

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Office: 6712 South Hall
Office Hours: TR 11:00am – 12:00pm

CLASS TIMES TR 12:30pm – 1:45pm.

DESCRIPTION The course covers special topics in machine learning aiming to 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

Foundations of Machine Learning / Data Science
- 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.

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.
- Neural network methods: deep learning.
- Convolutional Neural Networks (CNNs).
- Recurrent Neural Networks (RNNs).

Unsupervised learning
- Clustering methods

- Kernel principal component analysis, and related methods
- Manifold learning
- Neural network methods.
- Autoencoders (AEs)
- Generative Adversarial Networks (GANs)

Additional topics

- Stochastic approximation and optimization.
- Variational inference.
- Generative Methods: GANs, AEs.
- Graphical models.
- Randomized numerical linear algebra approximations.
- Dimensionality reduction.

MATERIALS The instructor retains rights to the course materials and there is a policy of no student recording (i.e. video/audio) or posting of course materials.

WEBSITE http://teaching.atzberger.org