Fall 2020

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FSAN/ELEG815

Analytics I: Statistical Learning

Course Description

Introduction to the mathematics of data science. Theory that stablishes the conceptual framework for learning is included, and so are heuristics that influence the performance of real learning systems. The Singular Value Decomposition and the Principal Component Analysis. Statistical models for inference and prediction in finance, marketing, and engineering applications. Overfitting, regularization methods and principles of sparsity priors are applied.

Topics

1. Probability and Stationary processes
2. Eigen Analysis, Singular Value Decomposition (SVD), Principal Component Analysis (PCA), and Matrix Completion
3. The Learning Problem
   - 3.1. Problem Setup
   - 3.2. The Perceptron
   - 3.3. Types of Learning
   - 3.4. Is Learning Feasible?
   - 3.5. Error and Noise
4. Training vs Testing
   - 4.1. Theory of Generalization
   - 4.2. The VC Dimension

5a. The Linear Model and Optimization
5b. Nonlinear Transformation and Logistic Regression
6. Overfitting and Regularization
7. Lasso regression
8. Support Vector Machines
9. Neural Networks
10. Convolutional Neural Networks

Requirements

Prerequisites: First course in linear algebra (eigen decomposition, matrix algebra, and determinants). First course in probability and statistics (probability density functions, conditional density functions, moments, Bayes theorem), calculus (derivatives, partial derivatives, integrals). Basic Python or MATLAB programming skills.

Suggested Textbooks and Reading Material

Textbook 1: Learning from Data, Yaser S. Abu-Mostafa, Malik Magdon-Ismail and Hsuan-Tien Lin, AMLbook 2012.

Lecture slides available in

https://www.eecis.udel.edu/~arce/courses/statisticallearning/

Evaluation

Homework and computer assignments (40%)
Midterm 1 (20%)
Midterm 2 (20%)
Final Exam (20%)