ENEE759G: Advanced Topics in Computer Engineering - Unsupervised Learning

Fall 2015 (TuTh 12:30 – 1:45; EGR 2154)
Instructor: Joseph JaJa

Course Syllabus

Course Objectives: The course will cover core topics in unsupervised learning with a focus on statistical and optimization techniques. Topics covered will include: density estimation, latent variable models, mixture models, clustering, graphical models and inference, learning graphical models, and association rules. A significant background in probability and statistics, linear Algebra, and convex optimization is required for this course.

Course prerequisites: Graduate standing

Prerequisite topics: Strong background in probability and statistics, Linear Algebra, and convex optimization.

Textbooks: No textbook is required for this course but the following can be used as references:


Core Topics:

1. Introduction
   - Basic framework and concepts
   - Probability Review
   - Probability density estimates for low-dimensional data
   - Maximum Likelihood Estimation and Bayesian Estimation.
   - Matrix Factorization and Convex Optimization

2. Latent Variable Models
   - Principal Component Analysis
   - Gaussian Mixture Models and the EM algorithm
   - Introduction to Factor Analysis
   - Independent Component Analysis

3. Clustering
   - Proximity measures and evaluation methodologies
   - The k-means algorithm and its variant the k-medoid algorithm
   - Hierarchical clustering
   - Spectral clustering

4. Directed Graphical Models
   - Basic definitions and properties
   - Naive Bayesian networks
   - Inference: Exact and Approximate
   - Learning Bayesian networks
5. **Undirected Graphical Models**
   - Basic definitions and concepts
   - Markov properties
   - Factor graphs
   - Inference algorithms

6. **Association Rules**
   - Market Basket analysis and overall strategy
   - The Apriori Algorithm
   - Rule Generation

**Midterm:** October 22 – 40%; **Final:** Date TBA – 40%; **Homeworks:** 20%

**Homeworks:** We will have almost weekly homeworks, each of which will ask the students to describe a specific real-world application that has been addressed using some techniques covered in class. Your description must be *less than a 2-page pdf document* using the following format:

- **Statement of the Problem**
- **Data Used**
- **Technique Used**
- **Summary of Results**
- **Reference(s)**

**Contact Information**

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