CS 551: Pattern Recognition
Fall 2014

Description: This course concentrates on statistical pattern recognition techniques. We will talk about Bayesian decision theory, parametric and non-parametric density estimation, probabilistic graphical models, feature reduction and selection, and non-Bayesian classifiers. We will also introduce structural and syntactic pattern recognition at the end of the semester.

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Schedule: Tue 13:40–15:30, Thu 15:40–17:30 (EA 502)


Prerequisites: Probability theory, statistics, linear algebra

Texts:

Grading (tentative):
Midterm exam: 25%
Homework: 40%
Project: 30%
Class participation: 5%

Exam: There will be one midterm exam.

Assignments: There will be three homework assignments that will involve both programming and essay type questions.

Term Project: There will be a term project that will involve application of multiple pattern recognition techniques on different data sets. The project will require a project proposal, an interim progress report, and a final report written in a conference paper format at the end of the semester.
Lecture Schedule:

- **Introduction to Pattern Recognition**
  - Pattern recognition systems
  - The design cycle
  - An example

- **Bayesian Decision Theory**
  - Modeling using continuous and discrete features
  - Discriminant functions
  - The Gaussian density
  - Error estimation

- **Parametric Models**
  - Maximum-likelihood estimation
  - Bayesian estimation
  - Expectation-Maximization and mixture density estimation
  - Hidden Markov Models

- **Non-parametric Methods**
  - Density estimation
  - Histogram-based estimation
  - Parzen windows estimation
  - Nearest neighbor estimation

- **Probabilistic Graphical Models**
  - Directed graphical models — Bayesian networks
  - Undirected graphical models
  - Inference using graphical models
  - Learning graphical models

- **Feature Reduction and Selection**
  - Problems of dimensionality
  - Component analysis
    - Principal components analysis (PCA)
    - Linear discriminant analysis (LDA)
  - Manifold learning
  - Feature selection

- **Non-Bayesian Classifiers**
  - $k$-nearest neighbor classifier
  - Linear discriminant functions
  - Support vector machines

- **Structural and Syntactic Pattern Recognition**
  - Graph-theoretic methods
  - Recognition with strings
  - Grammatical methods