

CS 551: Pattern Recognition

Fall 2017

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.

Instructor: Selim Aksoy (Office: EA 422, Email: saksoy@cs.bilkent.edu.tr)

Schedule: Tue 10:40–12:30, Fri 8:40–10:30 (EB 204)

Web page: <http://www.cs.bilkent.edu.tr/~saksoy/courses/cs551/index.html>

Prerequisites: Probability theory, statistics, linear algebra

Texts:

- K. P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.
- C. M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006.
- R. O. Duda, P. E. Hart, D. G. Stork, *Pattern Classification*, 2nd edition, John Wiley & Sons, Inc., 2000.
- S. Theodoridis, K. Koutroumbas, *Pattern Recognition*, 3rd edition, Academic Press, 2006.
- D. Koller, N. Friedman, *Probabilistic Graphical Models: Principles and Techniques*, MIT Press, 2009.
- A. Webb, *Statistical Pattern Recognition*, 2nd edition, John Wiley & Sons, Inc., 2002.
- T. Hastie, R. Tibshirani, J. Friedman, *The Elements of Statistical Learning*, Springer, 2003.
- K. Fukunaga, *Introduction to Statistical Pattern Recognition*, Academic Press, 1990.
- R. Schalkoff, *Pattern Recognition: Statistical, Structural and Neural Approaches*, John Wiley & Sons, Inc., 1992.
- A. K. Jain, R. C. Dubes, *Algorithms for Clustering Data*, Prentice Hall, 1988.

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
 - 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