Fall 2014 ECE 532 Theory and Applications of Pattern Recognition

ECE 532 is a introduction to machine learning and pattern recognition that focuses on matrix methods and features real-world applications, ranging from classification and clustering to denoising and data analysis.

Overview: Students will be exposed to real-world applications in machine learning and pattern recognition, learn to translate physical problems in to mathematical models, and develop basic computational skills for problem-solving. The proposed course tackles this aim by studying the basics of linear algebra in the context of applications such as handwritten character recognition, neural data analysis, and collaborative filtering.

Lectures: Tuesday and Thursday, 11:00am-12:15pm, 2317 Engineering Hall
Instructor: Prof. Robert Nowak, www.ece.wisc.edu/~nowak
Office Hours: TBA
Assistants: TBA

Textbook: **Matrix Methods in Data Mining and Pattern Recognition**
by Lars Elden

http://epubs.siam.org/doi/book/10.1137/1.9780898718867

Grading and Exams: The course grade will be determined by a combination of exams, projects and homework, and course participation according to the distribution:
Exam 1, Thursday October 9, 6-8pm, (**15%**)
Exam 2, Thursday November 20, 6-8pm (**15%**)
Projects, (**45%**)
Homework Assignments, usually 1 per week (**15%**)
Course Participation (**10%**)

Laboratories and Matlab: The project component of the course will investigate theory, methods and applications using Matlab, "a high-level language and interactive environment that enables you to perform computationally intensive tasks faster than with traditional programming languages such as C++, and Fortran," www.mathworks.com/products/matlab/. Matlab widely used in industry and academia for scientific data analysis and engineering development. For more information and tutorials, see en.wikipedia.org/wiki/MATLAB and Mathworks "Matlab Primer," www.mathworks.com/help/pdf_doc/matlab/getstart.pdf.

Course Syllabus (tentative)

Week 1	Chapter 1: Vectors and Matrices in Machine Learning
Week 2	Chapter 2: Vectors and Matrics
Week 3	Chapter 3: Linear Systems and Least Squares
Week 4	Chapter 4: Orthogonality
Week 5	Chapter 5: QR Decomposition
Week 6	Chapter 6: Singular Value Decomposition
Week 7	Chapter 7: Reduced-Rank Least Squares Methods
Week 8	Chapter 8: Tensor Decomposition
Week 9	Chapter 9: Nonnegative Matrix Factorization
Week 10	Chapter 10: Classification
Week 11	Chapter 11: Text Mining
Week 12	Chapter 12: Pagerank
Week 13	Chapter 13: Key Word Extraction
Week 14	Chapter 14: Face Recognition
Week 15	Chapter 15: Computation of SVD

Other Possible Topics to be Cover:
Probabilistic Models, Generalized Linear Models

Possible Project Topics

Recommender Systems and Collaborative Filtering
http://www.slideshare.net/erikbern/collaborative-filtering-at-spotify-16182818

Matrix Completion
http://statweb.stanford.edu/~candes/papers/SVT.pdf

Support Vector Machines
http://svms.org/tutorials/Moore2001.pdf

Neuronal Spike Sorting
http://www.scholarpedia.org/article/Spike_sorting

Sparse Methods for Machine Learning
http://www.di.ens.fr/~fbach/nips2009tutorial/nips_tutorial_2009_sparse_methods.pdf

Image Denoising
http://2013.ieeeicip.org/proc/pdfs/0000440.pdf

Topic Modeling
http://www.cl.uni-heidelberg.de/courses/ss12/topicmodels/intro.pdf

Independent Component Analysis
http://www.stat.ucla.edu/~yuille/courses/Stat161-261-Spring14/HyvO00-icatut.pdf

Spectral Clustering
http://cs.nyu.edu/~dsontag/courses/ml14/notes/Luxburg07_tutorial_spectral_clustering.pdf

Climate Data Analysis
http://www.princeton.edu/~rvdb/tex/LocalWarming/LocalWarming.pdf

Image Segmentation
http://www.cis.upenn.edu/~jshi/GraphTutorial/

Anomaly Detection
http://www.cs.bu.edu/faculty/crovella/paper-archive/sigc04-network-wide-anomalies.pdf

Deconvolution and Deblurring
http://www.mathcs.emory.edu/~nagy/courses/fall06/ID_lecture1.pdf

Genomic Data Analysis and Classification
http://public.lanl.gov/mewall/kluwer2002.html

Spectral Learning Algorithms for Natural Language Processing
http://www.cs.columbia.edu/~scohen/naacl13tutorial/