CSci 8980: Topics in Machine Learning

Course Overview

Instructor: Arindam Banerjee
General Information

- Course Number: 67760
- Class: Tu Th 12:45-2:00 pm
- Location: Room 28, Peik Hall
- Office Hours: Tu Th 2:15pm - 3:15pm
- Web page: http://www-users.itlabs.umn.edu/classes/Spring-2006/csci8980/
- Email: banerjee@cs.umn.edu, add [8980] on subject line
Course Work

Projects:
- Groups of 2 (or 3)
- Choose you own project, or, talk to instructor
- Proposals: Feb 14 (1-2 pages)
- Mid-Sem Progress Report: Mar 23 (3-4 pages)
- Final Submission: May 09 (10-12 pages)

Paper Reviews:
- Write reviews for all papers
- Submit review before class (1-2 pages)
- Main results, good/bad points, additional insights, (applications)
- Ok to discuss with others, you have to write on your own, put the name(s) of people you discussed with
Course Work (Contd)

Presentation:
- Present 1 paper from the list
- Assigned on first-come first-serve basis
- Plan for a 30-40 min talk
- Send me choice of paper before class on Tue, Jan 24

Participation:
- Ask questions, add comments
- Participate in discussions
Grading

- Project: 45%
- Paper Reviews: 30%
- Presentation: 15%
- Participation: 10%

A-F, S-N: Have to do all aspects (including presentation)

AUD: No presentations, Reviews are recommended
Course Objective

- Learn state-of-the-art methods in Machine Learning
- Understand the “What”, the “How” and the “Why”
- Applications—past, current and future
- Improvements and next steps

This is a topics course, so we will focus on a few topics.
Topics

Main Topics
- Online Learning
- Convex Analysis and Optimization
- Large Margin and Kernel Methods
- Learning in Games

Other Topics:
- Boosting, Learning Theory, Regression, Clustering, Mixture Models

Applications:
- Portfolio Design, Structured Prediction, Data Mining, Social Networks
Online Learning

- Learning with expert advice, repeated games
- Concepts of relative loss, internal and external regret
- A “new” gradient descent method
- Boosting
- Portfolio design
Online Learning: Reading List

- The Weighted Majority Algorithm
  Nick Littlestone and Manfred Warmuth

- A Decision-Theoretic Generalization of Online Learning and an Application to Boosting
  Yoav Freund and Robert Schapire

- Exponentiated Gradient versus Gradient Descent for Linear Predictors
  Jyrki Kivinen and Manfred Warmuth

- Online Portfolio Selection using Multiplicative Updates
  David Helmbold, Robert Schapire, Yoram Singer and Manfred Warmuth

- Regret in Online Decision Problems
  Dean Foster and Rakesh Vohra
Convex Analysis and Optimization

- Convex functions and optimization
- Conjugacy and Duality
- Convex optimization under affine constraints
- Bregman divergences
- Unified view and generalizations
Convex Methods: Reading List

- The Relaxation Method of Finding the Common Point of Convex Sets and its Applications to the Solution of Problems in Convex Programming
  L. M. Bregman

- Relative Loss Bounds for Multidimensional Regression Problems
  Jyrki Kivinen and Manfred Warmuth

- Logistic Regression, AdaBoost and Bregman Distances
  Michael Collins, Robert Schapire and Yoram Singer

- Clustering with Bregman Divergences
  Arindam Banerjee, Srujana Merugu, Inderjit Dhillon and Joydeep Ghosh
Large Margin and Kernel Methods

- Basics of large margin and kernel methods
- Boosting as a large margin method
- Large margin formulations of perceptrons, HMMs
- Structured prediction
Margins and Kernels: Reading List

- An Introduction to Kernel-Based Learning Algorithms
  Klaus-Robert Muller, Sebastian Mika, Gunnar Ratsch, Koji Tsuda, Bernhard Scholkopf

- Boosting as a Regularized Path to a Maximum Margin Classifier
  Saharon Rosset, Ji Zhu and Trevor Hastie

- Large Margin Classification using the Perceptron Algorithm
  Yoav Freund and Robert Schapire

- Hidden Markov Support Vector Machines
  Yasemin Altun, Ioannis Tsochantaridis and Thomas Hofmann
Margins and Kernels: Reading List (Contd)

- Large Margin Methods for Structured Classification: Exponentiated Gradient Algorithms and PAC-Bayesian Generalization Error Bounds
  Peter Bartlett, Michael Collins, Ben Taskar, and David McAllester

- Structured Prediction, Dual Extragradient and Bregman Projections
  Ben Taskar, Simon Lacoste-Julien and Michael Jordan
Learning in Games

- Correlated equilibrium
- Learning to achieve correlated equilibrium
- Maximum entropy and robust Bayesian decision theory
- Games on social networks
Learning in Games: Reading List

- Calibrated Learning and Correlated Equilibrium
  Dean Foster and Rakesh Vohra

- A Simple Adaptive Procedure Leading to Correlated Equilibrium
  Sergiu Hart and Andreu Mas-Colell

- Correlated Equilibria in Graphical Games
  Sham Kakade, Michael Kearns, John Langford and Luis Ortiz

- Game Theory, Maximum Entropy, Minimum Discrepancy and Robust Bayesian Decision Theory
  Peter Grunwald and Philip Dawid

- Query Incentive Networks
  Jon Kleinberg and Prabhakar Raghavan
“To Do”

- Work hard, Think hard, Ask questions
- Select a paper from the reading list and send me an email
- Find your project and project partner(s)
- Form your discussion group