CS 281B / Stat 241B, Spring 2008:

Statistical Learning Theory

People

			Office hours
Instructor	Peter Bartlett	bartlett at cs	Tue, Wed 9:00-10:00, Soda 723.
GSI	David Rosenberg	drosen at stat	Mon, 2:00-3:00, Evans 357; Thu, 2:00-3:00, Soda 551.

Lectures: Soda 310. Tuesday/Thursday 12:30-2:00.

Course description

This course will provide an introduction to the design and theoretical analysis of prediction methods, focusing on statistical and computational aspects. It will cover methods such as kernel methods and boosting algorithms, and probabilistic and game theoretic formulations of prediction problems. We will examine questions about the guarantees we can prove about the performance of learning algorithms and the inherent difficulty of learning problems.
Prerequisites: CS281A/Stat241A, or advanced training in probability or statistics, at the level of Stat 205A or Stat 210A.
[More details]

Assignments

The grade will be based 50% on homework, 40% on the final project, and 10% on lecture notes.

There will be roughly five homework assignments, approximately one every two weeks. Late homeworks will not be accepted. You are welcome to discuss homeworks with other students, but please work out and write up the solutions completely on your own, and specify in your solutions who you've discussed which problems with. Some of the problems have appeared in the literature. Please attempt them yourself, and if you need help, ask the instructor or GSI for assistance, rather than searching for someone else's solution. If you happen to have seen a problem before, please write up a solution on your own (and indicate that you've seen it before - it would also be helpful to point out where).

You will need to act as scribe for a small number of lectures, preparing a latex version of lecture notes (including figures if appropriate) and emailing it to the GSI within two weekdays of the lecture. These notes will be posted to the web site. Please use this latex template in preparing your lecture notes. Also, see the latex file of the notes for lecture 1.

There will be a final project. This can be in any area related to the topics of the course. You might implement an algorithm, run experiments on an algorithm for a particular application, try to extend an existing method or theoretical result, or do a combination of these. You will need to submit a brief written report and give a presentation in class in the last week of semester (a poster presentation or a talk, depending on the class size). It is OK to work on projects in groups of two (please email me an explanation if there's a good reason to work in a larger group). In all cases you will need to write the report individually.
Project proposals are due on March 31 (please send one or two plain text paragraphs in an email message to

bartlett at cs).
Project reports are due on May 6.

Readings

See also the previous incarnation of the course: Spring 2006.

Homework

- 1. Due Friday, Feb 1, at noon, in the box outside Soda 723. pdf (new version posted Jan 29) solutions code
- 2. Due Thursday, Feb 14, at the lecture. pdf solutions
- 3. Due Thursday, Feb 28, at the lecture. pdf solutions
- 4. Due Thursday, March 20, at the lecture. pdf solutions
- 5. Due Tuesday, April 22, at the lecture. (New version posted Wednesday April 16 correcting Q2a.) pdf solutions

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Announcements

- Wed, Apr 30: Project reports are due on Tuesday, May 6, at 5pm in the box outside Soda 723. Although there is no set page limit, aim to produce a brief report of less than 10 pages.
  We will have project poster presentations on Tuesday, May 6 and Thursday, May 8, in the usual lecture time slot and location. If you are enrolled in CS281B, you'll be presenting your poster on Tuesday, May 6. If you are enrolled in Stat241B, you'll be presenting your poster on Thursday, May 8. If you did a project in a group, you can choose to present your poster on the appropriate day for any of the group members. When you are preparing your poster, the target audience should be other students in the class. Be ready to stand by your poster and give a brief overview of your project.
  Please attend both poster sessions.
- Tue, Apr 29: David's office hours this week have been moved from Thursday 2-3:30 to Friday 10:30-12 in Evans 357.
- Wed, Apr 16: Another revised version of Homework 5 has been posted, again correcting question 2(a). It is now due on Tuesday, Apr 22, at the lecture.
  Final project reports are due on May 6. Poster presentations of the projects will be held in the lecture time slots on May 6 (for students enrolled in CS281B) and May 8 (for students enrolled in Stat241B).
- Tue, Apr 15: Concerning question 4 on homework 5, the parameter eta must be positive. As we have seen in lectures, regret bounds of the form (1) arise for *positive* values of eta.
- Mon, Apr 14: A revised version of Homework 5 has been posted, correcting a typo in question 2(a) (a missing positivity constraint). Notice also that the notation '-G' denotes the set {-g s.t. g in G}, as in lectures.
- Mon, Apr 7: Homework 5 has been posted.
- Please sign up (via email to David) for a lecture when you will act as scribe.

Lecture notes

- 1. Tuesday, January 22. Probabilistic Formulations of Prediction Problems. pdf latex
- 2. Thursday, January 24. Linear Threshold Functions and the Perceptron Algorithm. pdf
- 3. Tuesday, January 29. Minimax Risk Bounds for Linear Threshold Functions. pdf
- 4. Thursday, January 31. Kernel Methods: Support Vector Machines. pdf
- 5. Tuesday, February 5. Review of Constrained Optimization. pdf
- 6. Thursday, February 7. Soft-margin SVMs. pdf

- 7. Tuesday, February 12. Reproducing kernel Hilbert spaces. pdf
- 8. Thursday, February 14. Representer theorem. Constructing kernels. pdf
- 9. Tuesday, February 19. Convex loss versus 0-1 loss. pdf
- 10. Thursday, February 21. AdaBoost. pdf
- 11. Tuesday, February 26. AdaBoost and large margin classifiers. pdf
- 12. Thursday, February 28. AdaBoost, logistic regression. Risk bounds. pdf
- 13. Tuesday, March 4. Concentration inequalities. pdf
- 14. Thursday, March 6. Glivenko-Cantelli classes and Rademacher averages. pdf
- 15. Tuesday, March 11. Rademacher averages and Vapnik-Chervonenkis dimension. pdf
- 16. Thursday, March 13. Sauer's Lemma. pdf
- 17. Tuesday, March 18. Rademacher averages and growth function. pdf
- 18. Thursday, March 20. Growth function bounds for parameterized binary classes. pdf
- 19. Tuesday, April 1. Covering numbers. pdf
- 20. Thursday, April 3. Model selection. pdf
- 21. Tuesday, April 8. Online learning: Halving algorithm. Exponential weights. pdf
- 22. Thursday, April 10. Online convex optimization: gradient descent. pdf
- 23. Tuesday, April 15. Online convex optimization: mirror descent. pdf
- 24. Thursday, April 17. Online convex optimization: ridge regression, adaptivity. pdf
- 25. Tuesday, April 22. Follow the perturbed leader, online shortest path. pdf
- 26. Thursday, April 24. Online bandit problems. pdf
- 27. Tuesday, April 29. Universal portfolios. pdf additional notes
- 28. Thursday, May 1. Online to batch conversions. pdf
- 29. Tuesday, May 6. Final project poster presentations, for students enrolled in CS281B.
- 30. Thursday, May 8. Final project poster presentations, for students enrolled in Stat241B.
