Machine Learning
Computer Sciences 760
Fall 2016

www.biostat.wisc.edu/~craven/cs760/

Class enrollment

• typically the class is limited to 30
• we’ve allowed 90 to register
• ~ 40 are on the waiting list

• unfortunately, many on the waiting list will not be able to enroll
• but 760 will be offered in the Spring semester!
Instructor

- Mark Craven
  - email: craven@biostat.wisc.edu
  - office hours: 11-12:30 Monday, 4-5:30 Thurs, or by appointment
  - office: 4775A Medical Sciences Center

Finding my office

- 4775A Medical Sciences Center
- easiest to enter from Charter St. and take elevator immediately to your right
TAs

- Kirthanaa Raghuraman
  email: kirthanaa@cs.wisc.edu
  office hours: 3:00-4:00 Mon and Wed
  office: TBA

- Heemanshu Suri
  email: hsuri@cs.wisc.edu
  office hours: 3:00-5:00 Wed
  office: TBA

Monday, Wednesday and Friday?

- we’ll have 30 lectures in all, just like a standard TR class
- most weeks we won’t meet all three days
- this arrangement facilitates making up for days I’m out of town
- see the schedule on the course page
Course emphases

• a variety of learning settings: supervised learning, unsupervised learning, reinforcement learning, active learning, etc.

• a broad toolbox of machine-learning methods: decision trees, nearest neighbor, neural nets, Bayesian networks, SVMs, etc.

• some underlying theory: bias-variance tradeoff, PAC learning, mistake-bound theory, etc.

• experimental methodology for evaluating learning systems: cross validation, ROC and PR curves, hypothesis testing, etc.

Two major goals

1. Understand what a learning system should do

2. Understand how (and how well) existing systems work
Course requirements

- 6 homework assignments: ~72%
  - programming
  - computational experiments (e.g. measure the effect of varying parameter $x$ in algorithm $y$)
  - maybe some written exercises
- final exam: ~28%

Expected background

- CS 540 (Intro to Artificial Intelligence) or equivalent
  - search
  - first-order logic
  - unification
  - deduction
- good programming skills
- basics of probability: but we'll review
- calculus, including partial derivatives
Programming languages

• for the programming assignments, you can use
  C
  C++
  Java
  Perl
  Python
  R

• programs must be callable from the command line

Course readings

Buy one of three recommended books
Course readings

• all three books will be on reserve at Wendt Commons Library
• additional readings will come from on-line articles, surveys, and chapters

What is machine learning?

• the study of algorithms that improve their performance $P$ at some task $T$ with experience $E$

• to have a well defined learning task, we must specify: $< P, T, E >$
ML example: spam filtering

- $T$: given new mail message, classify as spam vs. other
- $P$: minimize misclassification costs
- $E$: previously classified (filed) messages
ML example: mammography
[Burnside et al., Radiology 2009]

- $T$: given new mammogram, classify each abnormality as benign vs. malignant
- $P$: minimize misclassification costs
- $E$: previously encountered patient histories (mammograms + subsequent outcomes)
ML example: predictive text input

- $T$: given (partially) typed word, predict the word the user intended to type
- $P$: minimize misclassifications
- $E$: words previously typed by the user
  (+ lexicon of common words + knowledge of keyboard layout)
ML example: Netflix Prize

- $T$: given a user/movie pair, predict the user’s rating (1-5 stars) of the movie
- $P$: minimize difference between predicted and actual rating
- $E$: histories of previously rated movies (user/movie/rating triples)

ML example: Netflix
ML example: reinforcement learning to control an autonomous helicopter

video of Stanford University autonomous helicopter from http://heli.stanford.edu/

ML example: autonomous helicopter

- $T$: given a measurement of the helicopter’s current state (orientation sensor, GPS, cameras), select an adjustment of the controls
- $P$: maximize reward (intended trajectory + penalty function)
- $E$: state, action and reward triples from previous demonstration flights
Reading assignment

• for Friday, read
  – Chapter 1 of Mitchell or
  – Chapter 1 of Murphy or
  – Chapter 1 of Duda et al.

  – article by Dietterich on web site

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