CS485/685
Lecture 24: March 29, 2012

Course wrap up

Outline

- Course wrap up
- Final exam info
- Other Machine Learning courses
- Machine Learning research
- Machine Learning jobs

Topics Covered

- Algorithms
  - Classification
    - Decision trees, nearest neighbor, mixture of Gaussians, perceptrons, neural networks, support vector machines
  - Regression
    - Linear regression, Gaussian Processes, neural networks
- Theory
  - Overfitting
  - Probably Approximately Correct framework
    - No-free-lunch theorem
    - VC dimension
    - Sample complexity computational complexity

Topics that we didn't cover

- Graphical Models
- Unsupervised learning
- Semi-supervised learning
- Reinforcement learning
- Online learning
- Active learning
- Ensemble learning

Other Machine Learning Courses

- CS786: Prob. Inference and Machine Learning (S12)
- CS870: Applied Optimization for Finance and Machine Learning (S12)
- CS486/686: Artificial Intelligence (every term)
- STAT440/840: Computational Inference
- STAT441/841: Statistical Learning – Classification
- STAT442/890: Data visualization
- STAT444/844: Statistical Learning – Regression
- STAT450/850: Estimation and hypothesis testing

CS786: Probabilistic Inference and Machine Learning

- Instructor: Pascal Poupart
- Term: Spring 2012
- Textbook: Koller and Friedman, Probabilistic Graphical Models (2009)
- Topics:
  - **Representations:** Bayesian networks, undirected graphical models, relational models, continuous models, temporal models
  - **Inference:** variable elimination, model counting, inference as optimization, lifted inference, sampling techniques, maximum a posteriori inference
  - **Learning:** parameter estimation, structure learning, partially observable data

CS486/686 Artificial Intelligence

- Instructors: Pascal Poupart, Kate Larson, Jesse Hoey, Peter van Beek, Chrysanne DiMarco
- Offered every term (I will teach it in F2012)
- Textbook: Russell and Norvig, Artificial Intelligence, A Modern Approach (2010)
- Topics
  - **Search algorithms:** A* search, constraint programming
  - **Reasoning under uncertainty:** Bayesian networks, Markov networks, Markobv logic networks
  - **Decision Making under Uncertainty:** decision networks, Markov decision processes
  - **Machine Learning:** decision trees, maximum likelihood, MAP and Bayesian learning for Bayesian networks, expectation maximization

Machine Learning and Data Analytics

- New Collaborative Master's degree in Computer Science and Statistics
- Currently under review for approval
- Structure:
  - 1 year Master's program
  - First two terms: 3 courses/term in CS and Stats (at least 2 courses in each department)
  - Last term: research project

Machine Learning and Data Analytics

- Core courses (take at least 4 courses from this list)
  - CS640: Principles of Database Management and Use
  - CS666: Algorithm Design and Analysis
  - CS685: Machine Learning
  - CS686: Artificial Intelligence
  - CS786: Probabilistic Inference and Machine Learning
  - STAT840: Computational Inference
  - STAT841: Statistical Learning – Classification
  - STAT890: Data visualization
  - STAT844: Statistical Learning – Regression
  - STAT850: Estimation and hypothesis testing

Computational Statistics Research Group

- Web: compstats.uwaterloo.ca
- Professors:
  - Computer Science
    - Shai Ben David (learning theory)
    - Pascal Poupart (reinforcement learning, decision making under uncertainty, temporal models)
    - Jesse Hoey (applied machine learning, health informatics)
    - Daniel Lizotte (applied machine learning, health informatics)
  - Statistics
    - Wayne Oldford (data visualization)
    - Ali Ghodsi (dimensionality reduction)
    - Mu Zhu (kernel methods)

My Research Projects

- Reasoning Under Uncertainty and Machine Learning
  - Partially observable Markov decision processes
  - Bayesian reinforcement learning
  - Policy Explanation
  - Maximum A Posteriori (MAP) inference
- Health Informatics
  - Smart walkers
    - Activity recognition (machine learning)
    - 3D lower limb tracking (computer vision)
  - Symptom monitoring for Alzheimer's disease
    - Speech processing

Machine Learning Jobs

- Machine Learning is becoming more and more pervasive
  - It is embedded in many applications
- Machine Learning and Data Analytics
  - MGI and McKinsey's Business Technology Office
    - http://www.mckinsey.com/en/Features/Big Data.aspx
    - US: shortage of 140,000 to 190,000 people with analytical expertise and 1.5 million managers and analysts with the skills to understand and make decisions based on the analysis of ever larger data.
  - 2011 Survey by Accenture SAS Analytics Group
    - http://www.sas.com/news/preleases/accenturestudy-pblsorlando11.html
    - 258 North American companies surveyed,
      - 70% of them plan to improve analytical skills of current employees
      - 52% of them plan to hire analytical talent.

Vision

- Machine learning instead of machine programming
  - Some day we won't program computers anymore.
  - We will simply train them with some examples to exhibit a desired behavior
- Lifelong learning
  - Computers will continuously adapt and evolve by learning
  - This may be the key to natural language understanding and computer vision