CMPT 726 - G100 Machine Learning

Instructor(s): Oliver Schulte

Calendar Objective/Description:
Machine Learning is the study of computer algorithms that improve automatically through experience. Provides students who conduct research in machine learning, or use it in their research, with a grounding in both the theoretical justification for, and practical application of, machine learning algorithms. Covers techniques in supervised and unsupervised learning, the graphical model formalism, and algorithms for combining models. Students who have taken CMPT 882 (Machine Learning) in 2007 or earlier may not take CMPT 726 for further credit.

Instructor's Objectives:
Machine Learning is the study of computer algorithms that improve automatically through experience. Machine learning algorithms play an important role in industrial applications and commercial data analysis. The goal of this course is to present students with both the theoretical justification for, and practical application of, machine learning algorithms. At the end of the course, students should:

- be familiar with the strengths and weaknesses of important statistical models (e.g. Gaussians, neural networks, logistic regression).
- Understand the applications and use of general computational-statistical methods such as the EM algorithm and maximum likelihood estimation
- Know the main methods for solving the key problems that arise for these models, including
  - Model selection: select a model based on data.
  - Parameter estimation: use data to assign values to adaptive parameters.
  - Inference: use a parametrized model to derive probabilistic predictions.

No previous knowledge of pattern recognition or machine learning concepts is assumed, but students are expected to have, or obtain, background knowledge in mathematics and statistics.

Prerequisites:
None

Topics:
- Graphical models: directed graphs
- Temporal models and algorithms: hidden Markov Models, Kalman filtering
- Classification: nearest neighbour, linear models, decision trees, naive Bayes, neural nets
- Regression: linear regression, logistic regression, regularization, neural nets
- Unsupervised learning: kmeans, Gaussian mixtures
- Latent variable models: Principal Components, Expectation-maximization
- Ensemble learning, Boosting
- Theory: Maximum Likelihood, Bias-Variance, time permitting: consistency
- Time permitting: learning to act, reinforcement learning

**Grading:**
The course grade will be based on homework assignments, in-class quizzes, a final project, and a midterm (in-class) examination. Details and weights to be discussed in the first week of classes.

**Required Books:**
Russell/Norvig Artificial Intelligence, CMPT 726 - Custom Courseware, Oliver Schulte, Pearson Canada, 9781323677247, Based on chapters from Russell and Norvig, A Modern Introduction to Artificial Intelligence - Available at SFU Bookstore

**Reference Books:**
Pattern Classification (2nd ed.), Richard O. Duda, Peter E. Hart, and David G. Stork, Wiley Interscience, 2000, 9780471056690
All of Statistics, Larry Wasserman, Springer, 2009, 9780387402727

**Academic Honesty Statement:**
Academic honesty plays a key role in our efforts to maintain a high standard of academic excellence and integrity. Students are advised that ALL acts of intellectual dishonesty will be handled in accordance with the SFU Academic Honesty and Student Conduct Policies (http://www.sfu.ca/policies/gazette/student.html).