446.672 고급기계설계문제연구 2 (3학점)--- 기계학습 및 로보틱스 (Machine Learning and Robotics)

Lectures: Building. 301 Room 303, Tuesday and Thursday 17:00~18:15
Course materials:

1) Course notes
2) Bishop, C. M. (2006) *Pattern Recognition and Machine Learning*, Springer (http://research.microsoft.com/en-us/um/people/cmbishop/PRML/index.htm)
3) Trevor, H., Robert, T., and Jerome, F. (2008) *The elements of statistical learning*, Springer (http://www-stat.stanford.edu/~tibs/ElemStatLearn/)

Grading: Project (20%), Homework (20%), Mid-term Exam (20%), Final Exam (40%)

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Course description:
This course is a 3-unit course that provides an introduction to the machine learning for robotics. Machine learning algorithms provide very powerful methods in analyzing real time data from many noisy sensors as well as in extracting information from a pile of collected dataset. This course introduces many standard algorithms that can deal with multivariate data based on their statistical dependencies. Key issues to be addressed also include understanding the problems arising in high dimensional data, visualizing data, and evaluating algorithms. Example datasets will be provided from various application domains to help understand the introduced concepts of analyzing high dimensional data.

Week 1: linear classifiers (Perceptron, logistic regression, minimizing least square)
Week 2: convex optimization, lagrange multiplier, kkt condition, svm
Week 3: kernel, inductive bias, model, VC dimension
Week 4: Bayes classification, class conditional model
Week 5: nonparametric method (parzen window, kernel density estimation)
Week 6: Naive Bayes, graphical model, d-separation
Week 7: generative vs. discriminative comparison
Week 8: Gaussian processes, Kalman filter

Week 9: evaluation method (cross validation, LOO), training error, testing error
Week 10: dimensionality reduction, PCA, FDA, kernelization, NMF
Week 11: nonlinear dimensionality redunction (Isomap, LLE)
Week 12: k-nearest neighbor classification
Week 13: information theory in machine learning, feature selection
Week 14: clustering (k-means)
Week 15: spectral clustering, graph cut

Additional topics

1) Mathematics in machine learning:
   Linear Algebra, Optimization (gradient descent, convex optimization, KKT condition), Probability Theory
2) Matlab
3) Ensemble method:
   Boosting
4) EM algorithm:
   Gaussian mixture, Probabilistic PCA, Factor Analysis

Goal:
Can deal with high dimensional data (Classification, Regression, Clustering, …)
Can visualize important features of data
Understand how to evaluate one's method
Understand basic mathematical skills for engineers (Vector calculus, Probability theory, Estimation, …)

Required background: Linear Algebra, Probability theory, Programming skills