Preliminaries

- Class Meeting Time: MW 1:30-2:45 (389 Holmes)
- Website: http://www-ee.eng.hawaii.edu/~kuh/ee645.s07/outline.html
- Office Hours: MWF 3-4 (or by appointment)
- Prerequisites:
  - Probability: EE342 or equivalent
  - Random variables, Bayes analysis, Gaussian processes
  - Linear Algebra: vector and matrix operations
  - Programming: Matlab or C experience
Objectives and Grading

Topics: Adaptive signal processing, machine learning, neural computation.

Objectives: obtain basic understanding and knowledge of fundamental concepts, learn about current research in area, conduct project on topic of current research

Grading:
- Homework: 20%
- Exam: 30%
- Final project: 50% (oral presentation and written report)
Motivation

- Develop paradigms for learning that mimic features of natural learning for applications in engineering and science
- Processing data: CPUs and storage device technology have improved dramatically, algorithm development to process data has not increased nearly as rapidly
- Multidisciplinary area requiring tools from EE, CS, Statistics, Physics, Math, Biology
Overview of Course Material

- Linear algorithms for classification and regression
  - Linear Threshold Unit (Perceptron Learning Algorithm)
  - Optimum margin classifiers
  - Linear Unit
    - LMS Algorithm
    - Least Squares Algorithm
Overview Continued

- **Kernel Methods**
  - Optimization methods
  - Kernels
  - Support Vector Machines
  - Least Squares kernel algorithms
  - On-line algorithms

- **Other learning algorithms**
  - Generative classifier: Naive Bayes
  - Discriminative classifier: Logistic regression
  - Multilayer networks: Backpropagation
Overview Continued

● Learning Theory
  – Bayesian decision theory
  – Learning and generalization theory
  – Structural risk minimization
  – Machine learning algorithms
  – Boosting
Overview Continued

- Unsupervised Learning
  - Component Analysis: PCA, Kernel PCA, ICA
  - Competitive Learning
    - Self – Organizing Feature Maps
    - Vector quantization
Overview Continued

- Reinforcement learning:
  - Markov decision processes and dynamic programming
  - TD learning, Q learning, Least squares learning
Historical Notes

- **1940s**: Hebb, *The organization of behavior*, McCulloch-Pitts model, Von Neumann
- **1950s-1960s**: Rosenblatt, Minsky-Papert, *Perceptrons*, artificial intelligence, Widrow
- **1970s-1980s**: Pioneers (Grossberg, Amari, Kohonen), Hopfield, PDP Group
- **1990s-2000s**: Multidisciplinary area (machine learning, statistics, physics, biology), mathematical rigor (learning theory, kernel methods, reinforcement learning, Bayesian learning, unsupervised learning)
Applications

- Character recognition
- Text classification
- Biomedical classification: disease diagnosis
- Bioinformatics: gene sequencing and protein classification
- Time series prediction
- Communication applications
References

- Websites: IEEE, INNS, Neural Computation, NIPS, IJCNN, kernel machines, machine learning