Course Notes

# EECS 445

Introduction to Machine Learning


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**Abstract**

Theory and implementation of state-of-the-art machine learning algorithms for large-scale real-world applications. Topics include supervised learning (regression, classification, kernel methods, neural networks, and regularization) and unsupervised learning (clustering, density estimation, and dimensionality reduction).

# 1 Introduction

- Formal definition: A computer program A is said to learn from experience E with respect to some class of tasks T and performance measure P , if its performance at tasks in T, as measured by P, improves with experience E
- Informal definition: Algorithms that improve their prediction performance at some task with experience (or data)
- e.g., spam filtering, handwritten digit recognition
- **Training**: given some example data you update parameters of your machine learning algorithm
- **Testing**: evaluating how well your algorithm performs on new data
- Machine learning tasks:
  - Supervised learning:
    - Classification
    - Regression
  - Unsupervised learning:
    - Clustering
    - Density estimation
    - Dimensionality reduction
  - Reinforcement Learning
    - Learning to act

## 1.1 Supervised Learning

- Goal:
  - Given data X in feature space and the labels Y
  - Learn to predict Y from X
- Labels could be discrete or continuous
  - Discrete labels: classification
  - Continuous labels: regression
- Classification:
  - Given a feature space (e.g., words in a document)
  - Predict a label space (e.g., topic of document)
- Regression:
  - Given a continuous feature space (e.g., market infromation up to time t)
  - Predict a label space (e.g., shapre price "$24.50")

### 1.2 Unsupervised Learning

- Goal:
  - Given data X without any labels
  - Learn the structures of the data
- "Learning without teacher"
- Clustering:
  - "Grouping into similar examples"
  - TODO: Image
- Lecture cut early, possibly add skipped here.

# A Linear Algebra Review