Machine Learning

1 Machine Learning Description

Machine learning is a branch of artificial intelligence, concerned with the construction and study of systems that can learn from data. Data may be numeric or symbolic and typically has the form of an N-tuple. The anthropomorphic term learning in the machine learning context means being able to predict some unobserved components of an N-tuple given some observed components of the N-tuple. This course provides a detailed explanation of many of the techniques used in machine learning and statistical pattern recognition.

2 Topic List

Topics can include but are not limited to:

- Bayesian Classification
  - Class conditional probabilities
  - Prior Probabilities
  - Gain Matrix
  - Maximizing Expected Gain
  - Minimax Classification
- Non-Parametric Probability Models
  - Parametric Probability Models
  - Making Decisions in Context
  - Conditional Independence
  - Hidden Markov Model
  - Forward Backward Algorithm
- Graphical Models
  - Semi-graphoids

  - Graphoids
  - Bayesian Nets
- Decision Trees
- Nearest Neighbor
- Linear Regression
- Principal Component Analysis
- Logistic Regression
- Neural Networks
  - The Perceptron Algorithm
  - The Back Propagation Algorithm
  - Deep Learning Networks
- Linear Decision Rules
  - Fisher Linear Decision Rule
  - Support Vector Machines
  - Kernel Methods
- Clustering
  - K-Means Clustering
  - Expectation Maximization
  - Linear Manifold Clustering
  - Gaussian Mixture Models
  - Clustering Evaluation Measures
- Experimental Protocols
  - Training Sets
  - Test Sets
  - Cross-Validation
  - Performance Characterization

3 Learning Goals

The student must be able to demonstrate a working knowledge of the theoretical foundations and software of machine learning represented by the topics of

- Bayesian Classification
- Regression
- Clustering
- Dimensionality Reduction
- Performance Characterization

4 Assessment

The software and theoretical aspects will be assessed by a midterm project (40%) and by a final project (60%).