ID5055: Foundations of Machine Learning

Faculty: B. Ravindran (CS) and Nirav Bhatt (BT)

ID5055: An Overview

Objective
The objective of this course is to introduce fundamentals of machine learning techniques and their applications in different problems

Core Course
IDDD-DS, IDDD- QuanFin, IITM-UoB MSc, I2MP DS Students

Prerequisite
Basics of Linear Algebra, Probability, and Statistics

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Credits: 12
Lectures: 3 (50 minutes), Tutorial: 1 (50 minutes), Self-study: 8 (50 hours)

Lectures (G Slot)
Monday: 12-12:50, Wednesday: 17-17:50, Thursday: 10-10:50, Friday: 9-9:50

Grading Policy
(To be announced)

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- Modules: 5
  - Module 1: Unsupervised Learning
  - Module 2:Supervised Learning and Regression
  - Module 3:Binary Classification
  - Module 4:Advanced Methods for classification
  - Module 5:Sequential Decision Making

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- Module 1: Unsupervised Learning
  - Representation Learning - PCA
  - Estimation - Review of MLE, Bayesian estimation
  - Clustering - K-Means, Hierarchical Clustering, Spectral Clustering

- Module 2: Supervised Learning
  - Functional Approximations and regression
  - Regression
  - Linear Regression, Ordinary Least Squares, PCR
  - Non-linear regression (basis functions)
  - Ridge Regression, LASSO

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- Module 3: Binary Classification
  - K-Nearest Neighbors
  - Decision Trees, CART
  - Bias-Variance Dichotomy, Model Validation: Cross validation
  - Bayesian Decision Theory
  - Generative vs Discriminative Modeling for classification
    - Generative
      - Naive Bayes, Gaussian Discriminant Analysis
      - Hidden Markov Model
    - Discriminative
  - Logistic Regression

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- Module 4: Advanced Methods for Classification
  - Support Vector Machines - Kernels
  - Ensemble Methods:
    - Bagging - Random Forest
    - Boosting - Adaboost/GBDT/XgBoost
    - Artificial Neural Networks
    - Multi-Class Classification - one vs all, one vs one

- Module 5: Sequential Decision Making:
  - Online learning,
  - Bandit Problem,
  - Reinforcement Learning

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- Text book:
  - Hastie, T., Tibshirani, R., Friedman, J. H., & Friedman, J. H. (2009). *The elements of statistical learning: data mining, inference, and prediction*. New York: Springer.
  - Bishop C. M. & Nasrabadi. N. M. (2006). *Pattern Recognition and Machine Learning*, New York: Springer.
- Reference Materials
  - Duda, R. O. & Hart, P. E. (2006). Pattern Classification. John Wiley & Sons.
  - James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning*. New York: Springer.
  - Notes and scientific papers