

Course Title: Machine Learning
Course Code:
Credit: 3
Class Load: 3 hours

Course Objectives:

To provide knowledge on machine learning algorithms and build skills on applying machine learning algorithms in a diverse set of problems.

Detailed Syllabus

1. Introduction (3 hours)

Machine learning, types of machine learning; classification, regression, supervised learning, un-supervised learning, reinforcement learning

2. Supervised learning (12 hours)

Regression: Linear Regression (simple/multiple), Closed Solution vs Gradient Descent.

Classification: Logistic Regression, K-Nearest Neighbor, Kernel Methods (e.g. SVM), Bayes Classifier

Model Performance: Generalization, overfitting and underfitting, Validation, Cross-Validation, Regularization, Bias-Variance Tradeoff

Classification Performance: Accuracy, Sensitivity & Specificity, AUROC, Confusion Matrix

3. Deep Networks (12 hours)

Feedforward Networks, Gradient-based learning, Cost function, Output Units (Linear, sigmoid, softmax), Hidden Units (Relu, LeakyRelu), Architecture Design, Automatic Differentiation & Backpropagation

Regularization for Deep Learning: L1, L2 regularization, Dataset Augmentation, Early Stopping, Dropout

Optimization: SGD, Momentum, Adaptive learning rate. Plateau, Saddle point & flat regions. Cliffs & Exploding gradients, Parameter Initialization, Batch Normalization

4. Convolutional Neural Networks (6 hours)

Convolution Operation, *Properties of Convolution:* Sparse Connectivity, Parameter Sharing & Equivariance. Pooling, *Variants of Convolution:* Strided Convolution, Transpose Convolution, Dilated Convolution. Neuroscientific Basis for Convolutional Networks

5. Managing machine learning projects (3 hours)

Baseline Model, Hyperparameter tuning, Performance Metrics, Debugging Strategies

6. Unsupervised learning(Clustering) (3 hours)

Introduction to clustering, k-means, expectation maximization, mixture models

7. Project Work (6 hours)

Text books:

Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, The MIT Press, 2016. (openaccess www.deeplearningbook.org)

A First Course in Machine Learning, Simon Rogers and Mark Girolami, Chapman & Hall, Second Edition 2016.

Practicals References:

Weidman, Seth. *Deep learning from scratch: building with python from first principles*. O'Reilly Media, 2019.