**Name of the Paper: Machine Learning**

**Paper Code: CS802B**

**Contact (Periods/Week): 3L/Week**

**Credit Point: 3**

**No. of Lectures: 35**

**Prerequisite:**

1. Basic programming skills, Algorithm design.
2. Probability, Axioms of Probability, Conditional Probability, Bernoulli Distribution,Binomial Distribution, Multinomial Distribution, Uniform Distribution, Normal(Gaussian) Distribution, Chi-Square Distribution, t Distribution, F Distribution.Probability Distribution and Density Functions, Joint Distribution and Density Functions,Conditional Distributions, Bayes' Rule, Expectation, Variance, Weak Law of LargeNumbers.
3. Linear Algebra; Convex Optimization; Statistics; Calculus.

**Course Objective(s)**

CS802B.1 Able to formulate machine learning problems corresponding to different applications.

CS802B.1 Understand a range of machine learning algorithms along with their strengths and weaknesses.

CS802B.1 Understand the basic theory underlying machine learning.

CS802B.1 Able to apply machine learning algorithms to solve problems of moderate complexity.

CS802B.1 Able to read current research papers and understand the issues raised by current research.

**Course Outcomes**

CS802B.1 Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.

CS802B.2 Have an understanding of the strengths and weaknesses of many popular machine learning approaches.

CS802B.3 Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised, un-supervised learning and reinforcement learning.

CS802B.4 Able to design and implement various machine learning algorithms in a range of real-world applications.

**Module – 1: Introduction [3L]**

Applications and problems, learning scenarios, concepts of tasks (problems to be solved by machine learning), models (output of machine learning) and features (workhorses of machine learning). Geometric models, probabilistic models, logical models. [3L]

**Module – 2 Classification Schemes [5L]**

Binary classification, assessing and visualizing performance of classification, scoring and ranking, turning rankers into classifiers, class probability estimation. [3L]

Multiclass classification, multiclass scores and probabilities, regression, unsupervised and descriptive learning, predictive and descriptive clustering. [2L]

**Module - 3: Various Models [15L]**

**Tree Models [3L]**

Decision trees, ranking and probability estimation trees, tree learning as variance reduction, regression trees. [3L]

**Rule Models [2L]**

Learning ordered rule lists, learning unordered rule sets, descriptive rule learning, rule learning for subgroup discovery, association rule mining, first-order rule learning. [2L]

**Linear Models [4L]**

Least squares method, multivariate linear regression, regularized regression. [1L]

Perceptron, support vector machine, soft margin SVM, probabilities from linear classifiers, beyond linearity with kernel methods. [3L]

**Distance-based Models [3L]**

Nearest neighbour classification, distance-based clustering,K-means algorithm, clustering around medoids. Hierarchical clustering. [3L]

**Probabilistic Models [3L]**

Normal distribution, probabilistic models for categorical data,naïve Bayes model for classification, probabilistic models with hidden variables,Gaussian mixture model, and compression-based model. [3L]

**Module - 4: Features [4L]**

Types of features, calculation on features, categorical, ordinal and quantitative features, structured features, thresholding and discretization, normalization and calibration, incomplete features, feature selection - matrix transformations and decompositions. [4L]

**Module - 5: Model Ensembles and Machine Learning Experiments [4L]**

**Model Ensembles [2L]**

Bagging and random forests, boosted rule learning, mapping the ensemble landscape – bias, variance and margins, meta learning. [2L]

**Machine Learning Experiments [2L]**

What to measure, how to measure, how to interpret, interpretation of results over multiple data sets. [2L]

**Module - 6: More Selected Topics in Machine Learning [4L]**

Support vector machines – separable and unseparable cases, primal optimization and dual optimization problems, kernel methods – positive definite symmetric kernels and negative definite symmetric kernels, kernel-based algorithms. [4L]

Text Book

* Peter Flach, Machine Learning. Cambridge University Press, 2012.

Reference Books

* M. Mohri, A. Rostamizadeh and A. Talwalkar, Foundations of Machine Learning, MIT Press,2012.
* Kevin P. Murphy, Machine Learning: A Probabilistic Perspective. MIT Press, 2012.