CS344: MACHINE LEARNING

Credits and Hours:

Teaching Scheme	Theory	Practical	Tutorial	Total	Credit
Hours/week	3	2	-	5	5
Marks	100	50	-	150	

A. Objective of the Course:

The intent of this course is to present a broad introduction to Machine Learning, the study of computing systems that improve their performance with experience; including discussions of each of the major approaches. The primary focus of the course will be on understanding the underlying algorithms used in various learning systems.

At the end of the course the student will understand:

- To understand the basics of Machine Learning.
- Basic concepts of various learning methods.
- To learn mathematical concepts, and algorithms used in machine learning.
- To have exposure to machine learning concepts and range of problems that can be handled by machine learning.
- To compare and parameterize different learning algorithms.
- To apply the machine learning concepts in real life problems.

B. Outline of the Course:

Sr. No.	Title of the unit	Minimum number of Hours
1.	Fundamental concepts and Statistical Learning Techniques	06
2.	Neural Networks	12
3.	Bayesian Learning	03
4.	Supervised and Unsupervised Learning	12
5.	Reinforcement learning	02
6.	Deep Neural Networks	10

Total Hours (Theory): 45

Total Hours (Lab): 30

Total Hours: 75

C. Detailed Syllabus:

1	**Fundamental concepts and Statistical Learning Techniques** **Fundamental concepts:** Introduction to Data science, Theory and practices in machine learning, Designing a Learning System, Issues in Machine Learning, Applications of ML, Global Developments of ML, Key challenges to adoption of ML in India. **Statistical Learning Techniques:** Descriptive statistics, Simple Linear Regression, ANOVA, Logistic Regression, Multi Linear regression, Correlation, Moving Average, Random Number Generation, Histogram Smoothing, Sampling, Rank Percentile.	**06 hours**	**10%**
2	**Neural Networks** Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training, Perceptron learning rule, Hebbian learning rule, Delta Learning rule, Loss Functions (L1 loss, L2 loss, Cross-Entropy), Multilayer networks and Backpropagation Learning Algorithm, Feed Forward, Activation Functions, Types of Neural Network Architecture, Bias-Variance trade-off. Regularization and model/feature selection, Optimizers (Gradient Descent, Adagrad, RMSProp, Adam), Learning Rate	**12 hours**	**20%**
3	**Bayesian Learning** Bayes Theorem, Maximum Likelihood and Least Squared Error Hypothesis, Maximum likelihood hypothesis for Predicting probabilities, Bayesian Belief Network.	**03 hours**	**15%**
4	**Supervised and Unsupervised Learning** **Supervised Learning:** Classification, Decision Trees, Random Forest Classifier, Bayes Optimal Classifier, Naïve Bayes Classifier, Support Vector Machine, K - Nearest Neighbours, Ensemble Methods – Bagging and Boosting **Unsupervised Learning:** Clustering, K-means, K-medoids, Hierarchical clustering, Density based clustering, Association Rules, Dimensionality Reduction - Principal Component Analysis **Evaluation:** Cross-Validation, Measures of Performance for Classification (Accuracy, Confusion Matrix, Precision, Recall, F1-Score), Measures of Performance for Clustering (Homogeneity, Completeness, V-Measure)	**12 hours**	**20%**

5	**Reinforcement learning** Q Learning, Non deterministic rewards and Actions	**02 hours**	**05%**
6	**Deep Neural Networks** Introduction to Deep Learning, Deep Neural Network, Restricted Boltzmann machine, Convolution Neural Network, AutoEncoders, Deep Belief Network, Recurrent Neural Network, Transfer learning.	**10 hours**	**20%**

D. Instructional Method and Pedagogy:

- At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Minimum 5 experiments shall be there in the laboratory related to course contents.
- Research / technical papers in relevant areas must be covered.
- Minimum two internal exams will be conducted and average of two will be considered as a part of 15% overall evaluation.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.

E. Student Learning Outcome:

- Student will know how prediction from data can do.
- The course introduces an approach to thinking about machine learning.
- The students will be able to describe why a particular model is appropriate in a given situation, formulate the model and use it appropriately

F. Recommended Study Material:

❖ **Text Books:**

1. Machine Learning, Tom Mitchell, McGraw Hill, 1997. ISBN 0070428077
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, 2004

❖ **Reference Books:**

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Richard O. Duda, Peter E. Hart & David G. Stork, "Pattern Classification. Second Edition", Wiley & Sons, 2001.

3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, "The elements of statistical learning", Springer, 2001.
4. Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", MIT Press, 1998.