CSE6052: Machine Learning and Pattern Recognition

Programme: B.Tech. / M.Tech Year: 4th / PG Semester: 6th

Course: Program elective Credits:4 Hours: 40

Course Context and Overview (100 words):

Machine Learning algorithms are data analysis methods which search datasets for useful patterns and specific structures. Machine Learning has emerged mainly from artificial intelligence and draws on methods from a variety of inter-related subjects including data mining, applied mathematics and more specialized fields such as pattern recognition and neural computing. This course introduces fundamental concepts, theories and algorithms for machine learning and pattern recognition. The main objectives of this course are:

1. Gain a deep understanding of the principles of machine learning and pattern recognition.
2. Acquire the skills to apply machine learning to various real world problems.

Prerequisites Courses: M2 (MTH108), Data Structures (CSE215)

Course Outcomes (Cos):

After Completion of this course, Students will be able to	
CO1	Advance their theoretical knowledge of artificial intelligence methodologies and optimization strategies in different applications through instance based learning & dimensionality reduction algorithms.
CO2	Learn the structure and design concepts of neural networks and support vector machines applications to solve classification and functional approximation problems
CO3	Advance their communication and presentation skills on research topics depending upon machine learning algorithms and pattern recognition problems
CO4	Develop learning algorithms for supervised, unsupervised and reinforcement tasks through Bayesian decision theory, inductive mechanisms, parameter estimation and Q learning etc.

Course Topics: (Machine Learning and Pattern Recognition)

Topics	**Lecture Hours**	
UNIT – I **1. Introduction**	1	2

1.1. Need of learning, Introduction to Machine Learning, Brief introduction of application area of Machine Learning, Taxonomy of application: Learning Association, Supervised, unsupervised and reinforcement learning 1.2. Introduction to pattern recognition: Machine Perception, Pattern recognition example, pattern recognition systems, design cycle, learning and adaptation	1	
2. Supervised Learning: Overview and Inductive Algorithms		6
2.1. Learning a class from examples, VC dimension	2	
2.2. PAC learning, Noise, Learning multiple classes,	1	
2.3. Regression, Model selection and generalization, Different Dimensions of supervised learning algorithms, Occam Razor principle	1	
2.4. Inductive Learning Algorithms- ID3 (Decision Tree Induction), ILA, C4.5 and C5, Censored Production Rules, Performance measures of rules, Assignment 1	2	
UNIT – II **3. Supervised Learning: ArtificialNeural Networks (ANN)**		7
3.1. Introduction and basic terminology of ANN, ANN representations, Appropriate problems for ANN learning, Taxonomy of different types of learning- memory based, competitive and Boltzmann Learning etc.	2	
3.2. Perceptron: Representational power, perceptron training rule, Gradient descent and Delta rule, visualizing the hypothesis space, derivation of gradient descent rule for perceptron learning, Stochastic approximation to gradient descent.	2	
3.3. Multilayer Networks and the Backpropagation algorithm : A differential threshold unit, backpropagation algorithm, adding momentum, derivation of backpropagation rule, Remarks on Backpropagation algorithm	2	
3.4. Advanced Topics of ANN: Alternate error function, error minimization procedures, recurrent networks, Assignment 2	1	
4. Supervised Learning: Bayesian Decision Theory and Learning		6
4.1. Introduction to Bayesian rule, conditional probability, Bayesian Decision theory for continuous features- two category classification and multi category classification	1	
4.2. Minimum error rate classification for two and multi-category, discriminant functions for binary and multi-category classes and classifiers	1	
4.3. Bayesian Decision theory for discrete features and dealing with missing and noisy features	1	
4.4. Bayesian Belief Networks	1	
4.5. Maximum -likelihood and Bayesian Parameter Estimation, Assignment 3, Mid term	2	
5. Supervised Learning: Nearest Neighbour (NN) based Classifier		5
5.1. Nearest Neighbour Algorithm, Variants of NN algorithm-kNN, Modified k-NN, Fuzzy k-NN and r near neighbours	1	
5.2. Enhancement of k-NN classifier- Branch and bound(BB) and CUBE algorithms for k-NN classifier, Incremental NN search,	2	

5.3. Prototype Selection Algorithms- Minimal Distance Classifier (MDC), Condensation Algorithms, condensed nearest neighbour algorithms, modified condensed nearest neighbour algorithm and edited algorithms	2	
6. Supervised Learning: Support Vector Machines (SVM)		
6.1. Introduction to SVM- Linear discriminant function, Linear Separable and Nonlinear separable cases, Hard and Soft Margin	1	2
6.2. Kernel trick and applications, advantages and disadvantages of SVM, Assignment 4	1	
UNIT - III **7. Data Structures for Representation of patterns and Dimensionality Reduction**		
7.1. Representation schemes of patterns- vector representation, logical representation, Introduction to fuzzy sets & rough sets, fuzzy and rough patterns, patterns as trees and graphs,	2	
7.2. Proximity Measures- Metric and non-metric distance measures, Edit Measures, Mutual Neighbourhood distance, kernel based similarity functions	1	
7.3. Feature Extraction- Principle Component Analysis (PCA), Fisher Linear Discriminant Analysis	2	7
7.4. Feature Selection-Exhaustive Search, Branch and Bound Search, Selection of best individual features, Sequential Selection, Max-Min approach to feature selection,	2	
UNIT - IV **8. Unsupervised Learning**		
8.1. Unsupervised Learning, Clustering- Partition based, Hierarchical methods, density based methods, Grid based and model based methods	1	3
8.2. Genetic- k means and fuzzy c means algorithm	1	
8.3. Unsupervised neural network- Self organizing maps (SOM),	1	
UNIT – V **9. Reinforcement Learning**		2
9.1. Q-Learning, Assignment 5	2	

Textbook references (IEEE format):
Text Book:

1. T. Mitchell, "*Machine Learning*", 2nd Edition, McGraw Hill Education (India) Private Limited

Reference books:

1. C.M. Bishop, "*Pattern Recognition and Machine Learning*", Springer.
2. R.O. Duda et al., "*Pattern Classification*", John Wiley & Sons
3. E. Alpaydin, "*Introduction to Machine Learning*", 2nd Ed., MIT Press.

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

During the course, additional literature (available online) will be recommended as additional reading.

Evaluation Methods:

Item	Weightage
Prog. Assignments	10
Research Paper Presentation & Implementation	20
Assignments/ Regularity	10
Midterm	20
Final Examination	40

Note: Some contents (App 15%) can be updated based on current applications.

Prepared By:
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