

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

1. Name of the Academic Unit: Computer Science and Engineering

2. Subject Name: Foundations of Artificial Intelligence and Machine Learning
L-T-P: 3-1-0 Credits:4

3. Pre-requisites:

4. Syllabus and reference books:

Syllabus:

This course serves as an introduction to Artificial Intelligence and Machine Learning. This course will introduce the main components of an intelligent system. Students will be made familiar with the big picture aspects of developing fully autonomous intelligent agents and some modern applications of Artificial Intelligence such as in natural language processing or computer vision. The course will introduce the major concepts of machine learning.

An overview of representation, learning, reasoning and inference. Familiarity with the big-picture aspects of developing fully autonomous intelligent agents.

State space abstraction for representing task-relevant information. Algorithms to search among alternatives to find optimal or near-optimal solutions. An exposure to reasoning and knowledge representation.

Principles, algorithms and applications of machine learning from the point of view of modeling and prediction. The formulation of learning problems and concepts of representation, model selection, over-fitting, and generalization, bias and variance. An introduction to cross-validation and regularization.

Supervised methods for regression and classification. Some ML models such as Linear models, decision trees, neural networks, instance-based methods.

A brief introduction to generative and discriminative probabilistic models, Bayes rule, MLE, MAP and the naïve Bayes algorithm.

Unsupervised learning problems, clustering (k-means clustering, Gaussian mixture models), dimensionality reduction.

The course will be associated with a tutorial and students are expected to implement some machine learning algorithms, and run appropriate supervised and unsupervised learning algorithms on real and synthetic data sets and interpret the results.

Some example applications of Machine Learning in Natural Language Processing or Computer Vision will be demonstrated.

Reference Books:

1) Artificial Intelligence: A Modern Approach, by Stuart Russell and Peter Norvig

- 2) Machine Learning, First Edition, by Tom Mitchell
- 3) Introduction to Machine Learning, Fourth Edition, by Ethem Alpaydin; The MIT Press
- 4) Pattern Recognition and Machine Learning, by Christopher Bishop, Springer
- 5) The Elements of Statistical Learning: Data Mining, Inference, and Prediction, by Trevor Hastie, Robert Tibshirani, and Jerome Friedman, Springer

5. Lecture-wise break-up:

Sl. No.	Topic	No. of lectures
1.	Overview: A brief overview of the fundamental building blocks of an intelligent system and the inter-relationship between them. Representation and Modelling, Inferencing and Reasoning, Machine Learning, Communicating, Perceiving and Acting	4
2.	State space formulation and representation of transitions: explicit, implicit and feature based. Vector representation. DFS, BFS, Uniform Cost Search A* Search	4
3.	Machine Learning Concepts and Introduction: Definition, Types of Learning, Features and Hypothesis space	2
4.	Linear Regression, Logistic Regression, Gradient Descent.	3
5.	Decision Trees: Algorithm, Information Gain and other heuristics, Overfitting and Pruning	3
6.	Bias, Variance, Cross-Validation	2
7.	Regularization in Linear Regression: Ridge and Lasso	2
8.	Feature Extraction: PCA and LDA	2

9.	Bayesian learning, Maximum Likelihood Estimation, MAP, Naive Bayes	3
10.	Clustering: Kmeans algorithm, Gaussian Mixture Model, Agglomerative Hierarchical Clustering	4
11.	Multilayer Neural Networks and the backpropagation algorithm. A brief exposure to some Deep Learning Architectures.	6
12.	Application of ML in thematic domain: NLP or Vision.	3
13.	High level introduction to Generative AI	2
Total number of hours		40

Tutorials

Sl. No.	Topic	No. of lectures
1.	Case study of an intelligent system	1
2.	A* search example	1
3.	Programming assignment on searching	1
4.	Loading Data and Plotting for Machine Learning	1
5.	Linear Regression, Logistic Regression	1
6.	Decision Tree	1
7.	Bias Variance tradeoff	1
8.	Regularization program	1
9.	Clustering	1
10.	NN and backprop	1
11.	NN and backprop	1
12.	ML application in NLP or Vision - demo	1
13.	Generative AI demo and discussion	1
Total number of hours		13