Fundamentals of Machine Learning

(20B12CS331)

Odd Semester 2022 (5th Semester)

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Course Outcomes

At the end of this course, you will be able to :

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Understand the mathematical concepts of machine learning approaches.	Understand Level (Level 2)
CO2	Apply the fundamentals of linear algebra and probability theory to the machine learning problems.	Apply Level (Level 3)
CO3	Apply the concepts of regression analysis and vector calculus to the machine learning models.	Apply Level (Level 3)
CO4	Analyze the role of dimensionality reduction and density estimation for machine learning problems	Analyze Level (Level 4)
CO5	Evaluate and test the significance of machine learning results statistically.	Evaluate Level (Level 5)

Course Outline

Module	Title of the Module	Topics in the Module	No. of Lectures
1.	Introduction to Machine learning	Why machine learning, learning problems, types of learning: supervised, unsupervised, semi-supervised learning, fundamentals of machine learning	02
2.	Linear Algebra	Linear equations, solving linear equations, matrices, Cholesky Decomposition, singular value decomposition, matrix approximation, vector space, Norms, inner product, length and distances, angles and orthogonality, orthogonal complement, inner product, orthogonal projections and rotations, linear independence, linear mapping, Affine spaces	09
3.	Probability Theory	Discrete and continuous probability, sum rule, product rule, Baye's Theorem, Gaussian Estimation, conjugacy and exponential family, inverse transform, Hidden Markov model	05
4.	Regression Analysis	Problem formulation, parameter estimation, linear regression vs non-linear regression models, univariate vs multivariate regression, regression using least squares, logistic regression in machine learning	05

Course Outline

Module	Title of the Module	Topics in the Module	No. of Lectures
5.	Vector Calculus	Gradients of vector valued function, gradient descent learning, lagrange's function in supervised learning, automatic differentiation, linearization and multivariate taylor series in machine learning	07
6.	Dimensionality Reduction and Density Estimation	Maximum variance, Low rank approximation, PCA, ICA, LDA, latent Variable, GMM, Maximum Likelihood estimation, expected maximization machine learning	08
7	Statistical Validations	T test, paired T test, Z test, hypothesis testing, ANOVA, Pearson coefficient, significance testing	06
		Total number of Lectures	**42**

Resources: Text Books/Reference Books

Text Books

1.	Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016.
2.	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. Mathematics for machine learning. Cambridge University Press, 2020.

Reference Books

1.	Mitchell, Tom M. "Machine learning." (1997).
2.	Bishop, Christopher M. Pattern recognition and machine learning. springer, 2006.
3.	Hastie, Trevor, Robert Tibshirani, and Jerome Friedman. The elements of statistical learning: data mining, inference, and prediction. Springer Science & Business Media, 2009.

Assessment / Marking Scheme

Component	Maximum Marks
T1	20
T2	20
End Term Examination	35
TA (breakup below)	25
Attendance	10
Project based Learning (PBL)	10
Quiz/Assignments	5
Total	100