

Maulana Abul Kalam Azad University of Technology, WB
(Formerly known as West Bengal University of Technology)
Syllabus of B.Sc. in Computer Science
Effective from academic session 2023-24

Semester-VII

Paper Name: Machine Learning/ Machine Learning Lab

Code: CS 701/ CS 791

Contacts: 3L + 2P

Course Objective:

1. To introduce Machine Learning models and architectures
2. To study MLOPs infrastructures and different tools for implementation
3. To have a through understanding of MLOPs packaging procedure
4. To deploy the ML modules in different scenarios for monitoring, testing, evaluation and improvement.

Unit:

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|---|---|--------------|
| 1 | <ul style="list-style-type: none">● Basic concepts of learning, Basic statistics: Probability, Bayes Theorem, Naïve Bayes, Bayesian network● Regression Analysis: Correlation, Bivariate and Multivariate regression, Types of regression – Linear, Logistic, Non-linear or Polynomial | [3L] |
| 2 | <ul style="list-style-type: none">● Supervised, Unsupervised, Semi-supervised learning, Instance-based learning, k-Nearest Neighbourhood, Ensemble methods – Bagging, Boosting and Stacking● Support Vector Machine: Working principle, Linear Discriminant Analysis (LDA), Non-linearity and kernel methods | [5L] |
| 3 | <ul style="list-style-type: none">● Decision Trees: Introduction and building, Algorithms used – ID3, Information Gain, Gini Index, Chi-square, Reduction in variance, Overfitting and Under fitting, L1 and L2 regularisation, Random Forest● Dimensionality reduction: Principle Component Analysis (PCA), t-SNE(t-distributed stochastic neighbor embedding), Independent Component Analysis (ICA), Singular Valued Decomposition (SVD) | [10L] |
| 4 | <ul style="list-style-type: none">● Artificial Neural Network: Biological Neuron, MP Neuron, HEVNet, Perceptron, Multilayer Perceptron, Gradient descent, Back-propagation algorithm● Convolution Neural Network(CNN), Recurrent Neural Network(RNN), Long Short Term Memory Network(LSTM) | [8L] |

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- 5 • Clustering techniques: k-means, Mean-Shift Clustering, [6L]
 Clustering of Applications with Noise (DBSCAN), Hierarchical clustering
- Reinforcement Learning: The Learning Task, Q Learning, Algorithm, Non-deterministic
 Rewards and Actions
- 6 • Advanced topics: Modelling Sequence/Time-Series Data, Deep Learning and Feature [6L]
 Representation Learning, Inference in Graphical Models
- Evaluating Machine Learning algorithms and Model Selection and real life applications

Machine Learning Lab
Practical: Based on Theory

Model Assignments

- 1 Write a program to demonstrate the working of decision trees algorithm.
Use an appropriate dataset for building the decision tree and apply this knowledge to classify a new sample.
- 2 Write a program to demonstrate the working of support vector machine algorithm. Use an
appropriate dataset and apply this knowledge to classify a new sample.
- 3 Write a program to implement k-Nearest Neighbour algorithm to classify a real life dataset.
Print both correct and wrong predictions. Python ML library classes may be used for this problem.

BOOKS FOR STUDY:

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. Tom M. Mitchell, Machine Learning, McGraw-Hill, 1997 (freely available online)
5. Machine Learning in Action - Peter Harrington
6. Machine Learning: An Algorithmic Perspective - Stephen Marsland

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Paper Name: Research Methodology / Research Methodology Lab

Code: CS 702/ CS 792

Contacts: 3L + 2P

Course Objective:

1. To develop rigorous research thinking by introducing students to modern research foundations, contemporary methodologies, mixed-method designs, and emerging analytical paradigms.
2. The course aims to make students capable of identifying real research problems, designing robust studies, applying qualitative and quantitative tools, interpreting data meaningfully, and integrating new-age research technologies.

Unit 1 – Foundations of Research [4L]

- Meaning, nature, and scope of research
- Purpose and function of scientific research
- Characteristics of high-quality research
- Classical vs. contemporary research paradigms
- Types of research: Fundamental, applied, exploratory, descriptive, explanatory
- Motivation of Research
- Interdisciplinary and transdisciplinary research
- Review of literature: Sources, methods, PRISMA approach, research gap identification

Unit 2 – Identifying and Formulating Research Problems [6L]

- Sources of research problems
- Techniques for defining and refining research problems
- Research questions, aims, objectives, and hypothesis formulation
- Feasibility analysis and ethical considerations
- Problem contextualization using theoretical frameworks and logic models

Unit 3 – Research Design and Strategy [7L]

- Importance and components of research design
- Exploratory, descriptive, diagnostic, experimental, and mixed-method designs
- Advanced designs: Longitudinal, cross-sectional, quasi-experimental, case-control
- Validity and reliability in research design
- Use of digital tools: Reference managers, AI-assisted search, data repositories
- Pre-registration, reproducibility, and research transparency

Unit 4 – Qualitative & Quantitative Approaches [7L]

- Qualitative approaches: Phenomenology, grounded theory, ethnography, case study
- Quantitative approaches: Numerical measurement, variables, generalization

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- Mixed-methods integration: Convergent, sequential exploratory/explanatory
- Tools for qualitative analysis: Coding, thematic analysis.
- Tools for quantitative analysis: Measurement scales, operationalization, validity tests

Unit 5 – Sampling & Data Analytics [7L]

- Sampling frame, sampling error, sample size calculation
- Probability sampling: Simple random, stratified, cluster, systematic
- Non-probability sampling: Purposive, snowball, convenience
- Data preparation: Cleaning, coding, transformation
- Statistical analysis: Univariate, bivariate, multivariate (intro)
- Introduction to statistical software: SPSS, R, Python (Pandas), Excel
- Data visualization and interpretation

Unit 6 – Emerging Research Concepts [5L]

- Research ethics in the age of AI
- Open science, FAIR principles, data sharing practices
- Systematic reviews & meta-analysis fundamentals
- Bibliometrics: Impact factor, h-index, citation analysis
- Plagiarism, similarity checks, and academic integrity

Reference Books:

- C.R. Kothari & G. Garg – Research Methodology: Methods and Techniques
- John W. Creswell – Research Design
- Uma Sekaran & Roger Bougie – Research Methods for Business
- Ranjit Kumar – Research Methodology
- Deborah Padgett – Qualitative Methods in Social Research
- David Silverman – Interpreting Qualitative Data