

Machine Learning & AI for Research

Course Outline

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 B.Sc. Applied Mathematics, University of Rajshahi
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Content	
Day 1	Foundations of AI, ML & Essential Mathematics - AI vs. Machine Learning vs. Deep Learning — conceptual map - Python ecosystem — NumPy, pandas, scikit-learn - Essential mathematics — linear algebra & probability, intuition-first - Bangladesh research context — agriculture, healthcare, finance
Day 2	Data Preprocessing for Research - Data quality & outlier detection - Handling missing data — MCAR / MAR / MNAR - Feature engineering — encoding & scaling Train-test split & cross-validation
Day 3	Supervised Learning I — Regression & Classification - Linear regression — model, diagnostics - Logistic regression — sigmoid, odds ratios - Confusion matrix fundamentals Bangladesh case study — crop yield & maternal mortality
Day 4	Supervised Learning II — Classification & Ensemble Methods - K-Nearest Neighbors - Decision Trees & Random Forests - Support Vector Machines Bangladesh case study — crop disease & land cover classification
Day 5	Model Evaluation, Validation & Ethical AI - Classification metrics — Accuracy, Precision, Recall, F1 - Bias-variance trade-off & regularisation

	Ethical AI — bias, explainability, privacy
Day 6	Unsupervised Learning & Dimensionality Reduction • Clustering — K-Means & hierarchical methods • Principal Component Analysis Bangladesh case study — patient clusters & disaster vulnerability mapping
Day 7	Deep Learning Basics & Research Applications • Neural networks — Perceptron to MLP • Model building with Keras / TensorFlow — live coding • Large Language Models — research assistance & limitations Bangladesh case study — TB detection, flood forecasting, Bengali NLP
Final Project End-to-End ML Research Pipeline — problem framing, data collection, model selection, ethical review, written report & presentation.	

