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| IQRA University (IU) | | |
| Faculty of Engineering Sciences and Technology (FEST) | | |
| Computer Science Department (CS) | | |
| Course Code | Course Name | Credit Hr |
| AIC 221- L | INTRODUCTION TO MACHINE LEARNING | 2+1 |

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| 1. Basic Information | | | |
| Instructor | Muhammad Mubashir | Designation | Lab Instructor |
| Prerequisite(s) | AIC211 | Semester | Fall 2024 |
| Email | Muhammad.mubashir@iqra.edu.pk | Phone | NA |
| Consulting Hours | Tuesday (12:00 – 14:00) | Office Location | Room # 602, 6th floor |

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| 1. **Course Objective(s)** |
| Develop a comprehensive understanding of machine learning techniques, including supervised, unsupervised, and reinforcement learning, while effectively applying algorithms such as decision trees, Naive Bayes, SVMs, clustering methods, and ensemble models. Demonstrate the ability to evaluate model performance, mitigate overfitting, and design adaptive solutions for real-world problems through the integration of advanced methods like Markov Decision Processes, bagging, boosting, and EM algorithms for semi-supervised learning. |

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| 1. **Course Contents** |
| Introduction to machine learning; concept learning: General-to-specific ordering of hypotheses, Version spaces Algorithm, Candidate elimination algorithm; Supervised Learning: decision trees, Naive Bayes, Artificial Neural Networks, Support Vector Machines, Overfitting, noisy data, and pruning, Measuring Classifier Accuracy; Linear and Logistic regression; Unsupervised Learning: Hierarchical Agglomerative Clustering. k-means partitional clustering; Self-Organizing Maps (SOM) k-Nearest-neighbor algorithm; Semi supervised learning with EM using labeled and unlabeled data; Reinforcement Learning: Hidden Markov models, Monte Carlo inference Exploration vs. Exploitation Trade-off, Markov Decision Processes; Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting.sy data, and pruning, Measuring Classifier Accuracy; Linear and Logistic regression; Unsupervised Learning: Hierarchical Agglomerative Clustering. k-means partitional clustering; Self-Organizing Maps (SOM) k-Nearest-neighbor algorithm; Semi supervised learning with EM using labeled and unlabeled data; Reinforcement Learning: Hidden Markov models, Monte Carlo inference Exploration vs. Exploitation Trade-off, Markov Decision Processes; Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting. |

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| 1. **Course Learning Outcomes** | | | | | | |
| **CLOs** | **CLO Statement** | **BT Level** | **Mapping** | | | **% Weight** |
| **GAs** | **ACM KA** | **SGDs** |
| CLO1 | **Apply** and evaluate foundational machine learning algorithms to solve problems**.** | C3 - Apply | GA2 | #9  IS | 4 | 65% |
| CLO2 | Apply machine learning techniques to **design** and develop a moderately complex project, demonstrating practical skills. | P2 –  Set | GA5 | 35% |
| ***Note: On successful completion of course GA 1 (Academic Education) will automatically attain.*** | | | | | | |

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| 1. **Course Textbook / Reference Books and Supplementary Reading Material** | | | |
| **S No** | **Book Title** | **Author(s)** | **Edition/ publication year/publisher** |
|  | Python Machine Learning | Sebastian Raschka and Vahid Mirjalili | Edition: 4th (2023) |
|  | Machine Learning with TensorFlow | Nishant Shukla | Edition: Latest (2022) |

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| 1. **CLO Outcome Based Assessment (OBA)** | | | | | | |
| **Assessment Tool** | | **CLO Mapped** | **CLO Marks** | **% Weight** | **Total Marks** | **Assessment Date** |
| **Lab Manual**  **5** |  | ***CLO 1, 2*** | 5 | 100% | 5 | TBD |
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|  |  |  |  |  |  |
| **Total Quizzes %** | | | **100%** | 5 |  |
|  | | | | | | |
| **Assignments**  **15** | Assignment #1 | *CLO1* | 10 | 30% | 3 |  |
| Assignment #2 | *CLO2* | 10 | 40% | 6 |  |
| Assignment #3 | *CLO3* | 10 | 40% | 6 |  |
|  |  | | | **100%** | **15** |  |
|  | | | | | | |
| **Midterm**  **25** | Midterm Q1 | *CLO1* | 5 | **20%** |  |  |
| Midterm Q2 | *CLO1* | **5** | **20%** |  |  |
|  | Midterm Q3 | *CLO2* | 5 | **20%** |  |  |
|  | Midterm Q4 | *CLO2* | 10 | **40%** |  |  |
|  | **Total Midterm %** | | | **100%** | **25** |  |
|  | | | | | | |
| **Project/OEL**  **15** | Project/CCP | *CLO3* | 10 |  |  |  |
|  | **Total Project /CCP %** | | | **100%** | **15** |  |
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| **Final Exam**  **40** | Final Exam Q1 | *CLO1* | 10 | 25% |  |  |
| Final Exam Q2 | *CLO2* | 10 | 25% |  |  |
| Final Exam Q3 | *CLO3* | 10 | 25% |  |  |
|  | Final Exam Q4 | *CLO1* | 10 | 25% |  |  |
|  | **Total Final Exam %** | | | **100%** | **40** |  |
| **100** | **Total Marls** | | | | **100** |  |
| ***Note: Please make sure every CLO must be assessed at least 3 time.*** | | | | | | |

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| 1. **Weekly Plan** | | | | |
| **Week**  **No** | **Lab No** | **Lab Description** | **Contact**  **Hr** | **CLO** |
| 1 | 1 | Explore machine learning fundamentals and Python libraries like scikit-learn; set up libraries, understand datasets, features, labels, and apply basic data preprocessing. | 3 |  |
| 2 | 2 | Implement the Version Space and Candidate Elimination algorithms to explore hypothesis spaces and apply general-to-specific ordering on a small dataset. | 3 |  |
| 3 | 3 | Build and evaluate decision tree classifiers using the ID3 algorithm, visualize the tree structure, and assess performance on a dataset. | 3 |  |
| 4 | 4 | Implement and analyze a Naive Bayes classifier by training it on a text dataset (e.g., spam detection) and evaluating performance with various smoothing techniques. | 3 |  |
| 5 | 5 | Train and evaluate a simple feedforward ANN using TensorFlow or PyTorch on the MNIST dataset and assess its accuracy. | 3 |  |
| 6 | 6 | Train and analyze an SVM classifier using linear and RBF kernels, and evaluate the impact of hyperparameters like C and gamma on performance. | 3 |  |
| 7 | 7 | **Open Ended Lab/Project Assigned** |  |  |
| 8 | **Midterm Exam** | | | |
| 9 | 8 | Perform clustering using k-means on a numerical dataset and visualize dendrograms with hierarchical agglomerative clustering. | 3 |  |
| 10 | 9 | Train a Self-Organizing Map (SOM) on a small dataset for dimensionality reduction and visualize patterns. | 3 |  |
| 11 | 10 | Implement the Expectation-Maximization (EM) algorithm using labeled and unlabeled data to classify a dataset and evaluate the impact of labeled data on performance. | 3 |  |
| 12 | 11 | Implement a Markov Decision Process (MDP) in a grid-world environment and explore Monte Carlo inference for policy evaluation. | 3 |  |
| 13 | 12 | Build ensemble models using bagging with decision trees and boosting with AdaBoost, and analyze their performance. | 3 |  |
| 14 | 13 | Evaluate models using k-fold cross-validation, implement decision tree pruning, and apply regularization to prevent overfitting. | 3 |  |
| 15 | 14 | **Revision / Open Ended Lab/Project Assessment** |  |  |
| 16 |  | **Open Ended Lab/Project Assessment** |  |  |
| 17 | **Final Exam** | | | |

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| 1. **IU Assessment / grading Policy** | **Instructor grading for course \*** |
| Lab Manual 0-10%  Labs Task Assessment 10-20%  Projects/OEL/PBL 5-20%  Mid Semester Examination/ 20-30%  End Semester Examination 40-50% | 5  15  15  25  40 |