

**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**

**WORK INTEGRATED LEARNING PROGRAMMES**

**COURSE HANDOUT**

**Part A: Content Design**

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| **Course Title** | Machine Learning |
| **Course No(s)** | IS ZC464 |
| **Credit Units** | 3 |
| **Course Author** | VANDANA AGARWAL |
| **Version No** |  |
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**Course Objectives**

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| **No** | Objective |
| **CO1** | Machine Learning is an exciting sub-area of Artificial Intelligence, which deals with designing machine to learn and improve their performance from examples/experience. This course introduces the student to the key algorithms and theory that forms the core of machine learning. |
| **CO2** | The course will cover the major approaches to learning namely, supervised, and unsupervised. |
| **CO3** | The course emphasizes various techniques, which have become feasible with increased computational power. The topics covered in the course include Regression, Decision Trees, Support Vector Machines, Artificial Neural Networks, Bayesian Learning, Genetic Algorithms etc. |

**Text Book(s)**

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| T1 | Tom M. Mitchell, Machine Learning, The McGraw-Hill Companies, Inc. International Edition 1997  **(http://personal.disco.unimib.it/Vanneschi/McGrawHill\_-\_Machine\_Learning\_-Tom\_Mitchell.pdf)** |
| T2 | Christopher M. Bhisop, Pattern Recognition & Machine Learning, Springer, 2006  **(http://www.rmki.kfki.hu/~banmi/elte/Bishop%20-%20Pattern%20Recognition%20and%20Machine%20Learning.pdf)** |

**Reference Book(s) & other resources**

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| --- | --- |
| R1 | Michael Bowles, *Machine Learning in Python*, Wiley Publishers, Wiley India Pvt. Ltd |
| R2 | Henrik Brink, Joseph W. Richards and Mark Fetherolf, *Real World Machine Learning*, Published by Dreamtech press |
| R3 | Christopher M. Bishop, *Neural Networks for Pattern Recognition*, Oxford university press. |

**Learning Outcomes:**

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| No | Learning Outcomes |
| LO1 | Introduction to Machine Learning algorithms |
| LO2 | Study and analysis of Supervised learning techniques |
| LO3 | Data Visualization |
| LO4 | Evaluation of Machine learning algorithms |
| LO5 | Understanding mathematics of Artificial Neural Networks |
| LO6 | Evolutionary algorithms in Machine Learning |
| LO7 | Study and analysis of unsupervised learning |

**Part B: Lecture Plan**

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| **Academic Term** | Second Semester 2018-2019 |
| **Course Title** | Machine Learning |
| **Course No** | IS ZC464 |
| **Lead Instructor** | **VANDANA AGARWAL** |

**Course Contents**

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| **Contact Sessions(#)** | **List of Topic Title**  **(Content structure)** | **Text/Ref Book/external resource** | **Learning Objective** |
| 1 | **Introduction**  Objective, What is Machine Learning? Application areas of Machine Learning, Why is Machine Learning important? Design a Learning System, Issues in Machine Learning, training, learning from examples, artificial intelligence and intelligent systems, types of learning, learning algorithms, features/ attributes in learning, generalization, traditional vs. machine learning | Lecture slides and discussions  Additional Reading  Chapter 1 (T1, R1, R2) | LO1 |
| 2 | **Regression**  Understanding prediction process, training data – single variable, error computation, parameters of best fit line, multivariate regression, visualization of error surface, | Lecture slides and discussions  Additional Reading  Chapter 1 (T1)  Chapter 3 (R1, R2) | LO2 |
| 3 | **Classification**  Binary classification, linearly separable data and linear decision boundary, discriminant functions. | Lecture slides and discussions  Additional Reading  Chapter 1 (T1)  Chapter 3 (R1, R2) | LO2 |
| 4 | **Classification algorithms**  k-nearest neighbor, Naïve Bayes classifier, Decision tree classifier | Lecture slides and discussions  Additional Reading  Chapter 8, sections 8.2 and 8.3 (T1)  Chapter 6, section 6.9 (T1)  Chapter 3, sections 3.1 to 3.5 (T1) | LO2 |
| 5 | **Data visualization for classification**  Example datasets, data as tables-rows as instances and columns as features/ attributes, numeric and categorical features. Using Python and associated libraries to visualize the relationship between features- scatter plots, parallel coordinate graphs, Pearson correlation | Lecture slides and discussions  Additional Reading  Chapter 2 (R1, R2) | LO3 |
| 6 | **Feature Engineering**  Feature extraction algorithms, dimensionality reduction, feature selection algorithm-forward selection and backward elimination, feature vector dimension | Lecture slides and discussions  Additional Reading  Chapter 5 (R2) | LO2 |
| 7 | **Evaluation of classification models**  Overfitting and model optimization, cross validation, Class-wise accuracy, true/false positives/negatives, precision, recall, sensitivity analysis, ROC curves, and confusion matrix etc. | Lecture slides and discussions  Additional Reading  Chapter 5 (T1)  Chapter 3 (R1)  Chapter 4 (R2) | LO4 |
| 8 | Review of sessions 1-7 | Lecture slides and discussions |  |
| 9 | **Artificial Neural Networks**  Introduction, Perceptron model, relation between classifier boundary and neurons for binary/multiclass classification, perceptron training rule, error functions, error surface, classification as an optimization problem. | Lecture slides and discussions  Additional Reading  Chapter 4 (T1) | LO5 |
| 10 | **Parameter learning**  Weight Space search, Gradient descent algorithm, delta rule, local optima of error. | Lecture slides and discussions  Additional Reading  Chapter 4 (T1) | LO5 |
| 11 | **Multi-Layer Perceptron Model**  Multi layer perceptrons (MLP), backpropagation algorithm, derivation of the backpropagation rule, convergence and local minima, feedforward neural networks | Lecture slides and discussions  Additional Reading  Chapter 4 (T1) | LO5 |
| 12 | **Neural Network Architectures**  Recurrent neural network (RNN), Radial basis functions (RBF) neural networks, | Lecture slides and discussions  Additional Reading  Chapter 4, chapter 8, section 8.4 (T1) | LO5 |
| 13 | **Support Vector Machines**  Support vectors, margin, maximization of margin, kernel functions for non-linearly separable data | Lecture slides and discussions | LO2 |
| 14 | **Optimization using evolutionary algorithms**  Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) algorithm, representation of candidate solutions, exploration and exploitation process, fitness function, algorithm parameters and algorithm convergence. | Lecture slides and discussions  Additional Reading  Chapter 9 (T1) | LO6 |
| 15 | **Unsupervised Learning**  K-Means, Hierarchical learning and DBSCAN algorithms | Lecture slides and discussions | LO7 |
| 16 | Review of Session 9 to 15 | Books, Web references and Slides |  |

**Evaluation Scheme**:

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

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| **No** | **Name** | **Type** | **Duration** | **Weight** | **Day, Date, Session, Time** |
| EC-1 | Quiz-I | Online | - | 5% | February 14 to 28, 2019 |
| Quiz-II | Online | - | 5% | March 14 to 28, 2019 |
| Assignment | Online | - | 10% | April 14 to 28, 2019 |
| EC-2 | Mid-Semester Test | Closed Book | 2 hours | 30% | 10/03/2019 (FN)  10 AM – 12 Noon |
| EC-3 | Comprehensive Exam | Open Book | 3 hours | 50% | 05/05/2019 (FN)  9 AM – 12 Noon |

***Note*** *- Evaluation components can be tailored depending on the proposed model.*

**Important Information**

Syllabus for Mid-Semester Test (Closed Book): Topics in Weeks 1-8

Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study

Evaluation Guidelines:

1. EC-1 consists of either two Assignments or three Quizzes. Announcements regarding the same will be made in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
3. For Open Book exams: Use of prescribed and reference text books, in original (not photocopies) is permitted. Class notes/slides as reference material in filed or bound form is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam. The genuineness of the reason for absence in the Regular Exam shall be assessed prior to giving permission to appear for the Make-up Exam. Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.