Course Handout

Semester: III

Academic Year: 2019-20

Course Code: CS 4131

Course Title: Machine Learning

LTPC: 3024

Programme: Bachelor of Technology

Course-in-charge: Ms. Sweta Sharma

Co-instructor: Dr. Prosenjit Gupta

1. Course Description

- This course will provide an introduction to machine learning, particularly to approaches that are widespread throughout research and applications of machine learning.
- The students will be made able to design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate and interpret the results of the algorithms.
- The course also offers delivering a more in-depth knowledge of the specific analytical techniques relevant to their research projects.

2. Course Content

Unit 1. Introduction to Machine Learning: Problem Definition, Examples of Machine Learning Applications, Learning Associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning.

Unit 2. Decision Tree Learning: Univariate Trees (Classification and Regression), Pruning, Multi-variate Trees

Unit 3. Bayesian Decision Theory: Review of Probability and Estimation, Naïve Bayes, Gaussian Naïve Bayes, Bayesian Network

Unit 4. Dimensionality Reduction: Subset Selection, Principal Component Analysis, Linear Discriminant Analysis

Unit 5. Supervised Learning: Review of Optimization, Linear and Logistic Regression, Support Vector Machine, Hidden Markov Models

Unit 6. Unsupervised Learning: k-means algorithm, Expectation Minimization, Hierarchical Clustering

Unit 7. Semi-supervised Learning: Active Learning

Unit 8. Reinforcement Learning

3. Course Outcomes: After the completion of the course the student will be able to:

CO1	Get in-depth knowledge of the fundamental concepts of machine learning and their applications.
CO2	Understand supervised and unsupervised learning. Discuss regression, classification and clustering models.
CO3	Understand in detail support vector machines, decision trees, ensemble methods, density estimation, neural networks, dimensionality reduction, reinforcement learning.
CO4	Learn to implement the well-known machine learning algorithms to solve known engineering and research problems.
CO5	Understanding of the nature of data and problem possessed and understanding advantages and limitations of the different machine learning methods.

4. Course Outcomes Mapping with Programme Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	H	H	H	M	M	H	L	L	M	L	L	H	H	H	H
CO2	H	H	H	H	H	H	M	L	L	L	M	H	H	H	M
CO3	H	H	H	H	H	H	L	L	L	L	L	M	H	H	H
CO4	H	H	H	H	H	M	M	L	M	L	H	H	H	H	H
CO5	H	H	H	M	M	H	L	L	L	H	M	H	H	H	M

Note: H- High**, M-** Moderate**, L-** Low and **NA**- Not Applicable

5. Session Plan

Lecture No.	Topics	Course Outcome
1-3	**Introduction to Machine Learning:** Problem Definition, Examples of Machine Learning Applications, Learning Associations, Classification, Regression,	CO1, CO2

	Unsupervised Learning, Reinforcement Learning, Bias variance Tradeoff	
4-8	**Decision Tree Learning:** Univariate Trees (Classification and Regression), Pruning, Multi-variate Trees	CO1, CO2, CO5
9-16	**Bayesian Decision Theory:** Review of Probability and Estimation, Naïve Bayes, Gaussian Naïve Bayes, Bayesian Network	CO1, CO3, CO5
17-22	**Dimensionality Reduction:** Subset Selection, Principal Component Analysis, Linear Discriminant Analysis, Locally Linear Embedding	CO1, CO2, CO4
23-33	**Supervised Learning:** Review of Optimization, Linear and Logistic Regression, Support Vector Machine, Hidden Markov Models	CO1, CO3, CO5
34-39	**Unsupervised Learning:** k-means algorithm, Expectation Minimization, Hierarchical Clustering	CO1, CO2, CO5
40-43	**Semi-supervised Learning:** Active Learning	CO1, CO2, CO4, CO5
44-45	**Reinforcement Learning**	CO1, CO4, CO5

6. Evaluation Scheme

Evaluation Components	Mode of Exam	Date & Day	Time	Weightage
Med Sem I	Written	As per academic calendar	1 h	20%
Med Sem II	Written	As per academic calendar	1 h	20%
Comprehensive/ End Sem	Online	As per academic calendar	2 h	30%
Practical *	Lab Performance, Report Submissions and Presentations	Before comprehensive exam	Duration will be announced subject to availability of lectures	20%
Attendance		Throughout the course		10%

***Practical will be evaluated based on Term paper Performance in terms of understanding and implementations and report submission.**

7. Course Outcomes Mapping with Evaluation Components

Course Outcomes	Mid-Sem I	Mid-Sem II	Comprehensive/ End Sem	Practical	Term Paper	Quiz
CO1	H	L	H	H	H	H
CO2	H	L	H	H	H	H
CO3	M	H	H	H	H	H
CO4	L	H	H	H	H	H
CO5	L	M	H	H	H	H

H- High**, M-** Moderate**, L-** Low and **NA**- Not applicable

8. Attendance Policy

As per Attendance policy of the University

9. Make up Policy

Students who are likely to miss a component of evaluation on a genuine reason may be given a make-up of that component by the Course In-Charge. The students are

required to approach either of the Course In-Charge immediately for the same before the conduct of the evaluation component. It is the responsibility of the student to approach the Course In-Charge. The Course In-Charge will not allow makeup, if student approach 7 days after the Examination.

10. Plagiarism

We are committed to upholding standards of academic integrity and honesty. Plagiarism in any form is unacceptable and will be treated seriously.

11. Grading Policy

Marks obtained in all the components of Evaluation shall be totaled and the final marks shall be converted in the letter grades, namely, A, B, C, D, E and NC. The grading is relative and normally it is centered around the average of a class. Mid-semester grading will be announced on completion of about 50% of the evaluation components.

12. Pedagogy

MS-PowerPoint Presentations, Videos and Animation of few lectures, as well as Open Course Ware Websites will be used as teaching methodologies.

13. Text Books

TB1. Ethem Alpaydin, Introduction to Machine Learning (MIT Press; 2010, 3nd Revised Edition; ISBN-978-81-203-5078-6)

TB2. Tom M. Mitchell, Machine Learning Paperback (McGraw Hill Education (India) Private Limited; 2013, First edition; ISBN-978-12-590-9695-2).

TB3. M. J. Zaki, W. Meira Jr, and W. Meira, Data mining and analysis: fundamental concepts and algorithms (Cambridge University Press; 2013, First Edition, ISBN-978-05-217-6633-3).

14. Reference Books

RB1. E Simon Rogers, Mark Girolami, A First Course in Machine Learning (Chapman & Hall/Crc Machine Learning & Pattern Recognition; 2011, First Edition; ISBN-978-149-87-3848-4).

RB2. J Christopher Bishop, Pattern Recognition and Machine Learning (Springer, 2006, First Edition; ISBN 978-038-73-1073-2).

RB3. Prof David Barber, Bayesian Reasoning and Machine Learning Paperback, (Cambridge University Press, 2014, First Edition; ISBN 978-0521-51-8114-7).

RB4. Vladimir N. Vapnik, Statistical Learning Theory Paperback (Wiley India Pvt Ltd, 2010, First Edition; ISBN 978-047-10-3003-4)

RB5. Trevor Hastie, Robert Tibshirani, Jerome Friedman , The Elements of Statistical Learning: Data Mining, Inference and Prediction, (Springer, 2009, Second Edition; ISBN 978-0-387-84858-7)

15. List of Practical/Experiments

Will be announced in the class depending to the topic covered.

16. Consultation Hour

All information regarding course will be posted on Moodle. Students are requested to check Moodle for any updates twice a day. The student may approach the Course-In-Charge Monday - Friday (Office hours) for any clarification or removal of their difficulties.