Short Syllabus

BCSE424L Machine Learning for Robotics (2-0-0-2)

Introduction to Machine Learning - Supervised Learning – I - Linear and Non-Linear – Multi–Class & Multi-Label classification – Naïve Bayes Classifier – Decision Trees – CART – Fine tuning of algorithms for robotic environment; Supervised Learning – II - K-NN classifier – Logistic regression – SVM; Unsupervised Learning - Reinforcement Learning - RL Framework – Markov Decision Process; Real time Datasets – Pre-processing - Robotics & Machine Learning Alliance - Design constraints and considerations – setting up the environment – Applications and case studies in Robotics;

Course Code	Course Title	L	T	P	C
BCSE424L	Machine Learning for Robotics	2	0	0	2
Pre-requisite	NIL	Syllabus version			
Course Objectives:		1.0			

1. To teach the theoretical foundations of various learning algorithms.
2. To understand the context of supervised and unsupervised learning through real-life examples.
3. Apply all learning algorithms over appropriate real-time dataset.
4. Evaluate the algorithms based on corresponding metrics identified.
5. Analyze the requirements of Machine Learning applications in context-aware robotic environment.

Course Outcomes:

Student will be able to

1. Understand, visualize, analyze and preprocess the data from a real-time source.
2. Apply appropriate algorithm to the data.
3. Analyze the results of algorithm and convert to appropriate information required for the real – time application.
4. Evaluate the performance of various algorithms that could be applied to the data and to suggest most relevant algorithm according to the robotic environment.

Module:1	**Introduction to Machine Learning**	**3 hours**
Introduction – Exploration – Learning Paradigms – Role of Machine Learning in Robotic applications		
Module:2	**Supervised Learning – I**	**6 hours**
Linear and Non-Linear – Multi–Class & Multi-Label classification – Linear Regression – Multilinear Regression – Naïve Bayes Classifier – Decision Trees – ID3 – CART – Fine tuning of algorithms for robotic environment.		
Module:3	**Supervised Learning – II**	**6 hours**
K-NN classifier – Logistic regression – Perceptrons – Single layer & Multi-layer – Support Vector Machines – Linear & Non-linear – Error Bounds Fine tuning of algorithms for robotic environment.		
Module:4	**Unsupervised Learning**	**5 hours**
Clustering basics (Partitioned, Hierarchical and Density based) - K-Means clustering – K-Mode clustering – Principal Component Analysis – Kernel PCA - Error Bounds – Ensemble Learning (Random Forest, XGBoost) – Fine tuning of algorithms for robotic environment.		
Module:5	**Reinforcement Learning**	**3 hours**
Basics of RL – RL Framework – Markov Decision Process – Exploration Vs Exploitation		
Module:6	**Real time Datasets – Pre-processing**	**3 hours**
Class Imbalance – SMOTE – One Class SVM – Optimization of hyperparameters.		
Module: 7	**Robotics & Machine Learning Alliance**	**3 hours**
Design constraints and considerations – setting up the environment – Applications and case studies in Robotics		
Module:8	**Contemporary Issues**	**1 Hour**

	Total Lecture:	**30 Hours**

Text Books:	
1	Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
2	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2012.
3	Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, Richard S. Sutton and Andrew G. Barto, A Bradford Book; 2018, ISBN 978-0262039246
References Books:	
1	Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.
2	Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022