GUJARAT TECHNOLOGICAL UNIVERSITY

BACHELOR OF ENGINEERING SYLLABUS

Subject Code : 3174208

Subject Name : Reinforcement Learning

WEF Academic Year :	2023-24
Semester :	7
Category of the Course :	Professional Elective - VI

Prerequisite: Linear algebra, probability, statistics, machine learning

Rationale : In this course, we will investigate the process of learning through an agent's mistakes. This is very dissimilar to supervised machine learning and more closely resembles how people learn via experience. The focus of Reinforcement Learning (RL) is on issues that call for a series of decisions to be made in order. The fundamentals of reinforcement learning are the focus of this course.

Course Scheme :

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content :

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Introduction** Course logistics and overview. Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.	6	15
2	**Probability Primer** Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	6	15
3	**Markov Decision Process** Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state	8	20

	and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.		
4	**Prediction and Control by Dynamic Programing** Overiew of dynamic programing for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evalutation and value iteration algorithms, DP extensions.	8	20
5	**Monte Carlo Methods for Model Free Prediction and Control** Overiew of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.	6	15
6	**TD Methods** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	6	15

Reference Book:

- "Reinforcement Learning", Sutton and Barto, MIT Press, 2018
- "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Rahul Dubey, Cengage India Publication
- "Reinforcement Learning: Theory and Algorithms" Alekh Agarwal, Nan Jiang, Sham Kakade, and John Langford
- Machine Learning: A Reinforcement Approach" by Satinder Singh and Sanjay Lal
- "Artificial Intelligence: Reinforcement Learning in Python: Complete guide to artificial intelligence and machine learning", Lazy Programmer, Kindle Edition

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Learn how to define RL tasks and the core principals behind the RL,	RM
02	Understand the basics of probability and distribution functions	UN
03	Understand and work with tabular methods to solve classical control problems	UN
04	Apply approximate methods to solve problems	AP

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List :

Implement 10 practical which are covering basics of course.

List of Laboratory/Learning Resources Required :

https://www.synopsys.com/ai/what-is-reinforcement-learning.html
https://www.simplilearn.com/tutorials/machine-learning-tutorial/reinforcement-learning
https://www.udemy.com/course/beginner-master-rl-1/
https://www.guru99.com/reinforcement-learning-tutorial.html
https://towardsdatascience.com/reinforcement-learning-101-e24b50e1d292

* * * * * * *