Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2020-2021

Course Handout Part II

Date: 16-01-2021

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : *CS F441*

Course Title : *Selected Topics from Computer Science: Reinforcement Learning*

Instructor-in-Charge : *Dr. Paresh Saxena*

Scope and Objectives:

Reinforcement Learning (RL) is based on the idea where we learn by interacting with our environment. It is a collection of machine learning techniques where agent(s) learn how to behave in an environment by performing actions and assessing the results. RL approach is building programs that learn how to predict and act in stochastic environment, based on past experience. This course will provide an overview to students on some of the fundamental ideas on which modern RL is built including markov decision processes, value functions, monte carlo estimation, dynamic programming, TLD methods, approximation methods, Actor-Critic methods, etc. This course will help students to understand and apply RL in several systems including video distribution systems, game development, IOT devices, robotics, clinical decision making, industrial process control, finance portfolio balancing, etc.

This subject aims to achieve the following goals:

- To provide students with the knowledge to structure a reinforcement learning problem.
- To introduce students to learn and apply basic RL algorithms for simple sequential decision-making problems in uncertain conditions
- To introduce students research and development work in reinforcement learning by interpreting state-of-the-art RL research and communicating their results.
- To provide knowledge to students to build a RL system that knows how to make automated decisions.
- To give students opportunities to understand the space of RL algorithms including Temporal Difference Learning, Monte Carlo, Q-Learning, approximation solution methods, A2C, A3C, etc.

Textbooks:

- Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.

Reference Books:

- Algorithms for Reinforcement learning, by Csaba Szepesvari, 2012.
- Reinforcement Learning: State-of-the-Art. M. Wiering and M. van Otterlo. Springer, 2012.

Course Plan:

Lecture No	Learning Outcomes	Topics to be covered	Chapter in the Text Book
1-2	To Introduce Reinforcement Learning, its limitations and scope.	Introduction to Reinforcement Learning. A brief summary of the pre-requisites, mathematical and programming tools required.	Class notes
PART 1: Tabular Solution Methods			
3-4	To understand the application of RL for single-state Bandit problems.	Bandit problems	T1:Ch2
5-7	To introduce methods for solving finite markov decision problems	Finite Markov Decision Processes	T1:Ch3
8-9	To understand the utility of DP (require perfect model) in RL	Solution Methods: Dynamic Programming	T1: Ch4
10-12	To understand and apply Monte Carlo Methods (require only experience) for RL	Solution Methods: Monte Carlo Methods	T1:Ch5
13-18	To understand and apply the application of Temporal Difference Learning including Q-learning and Sarsa for RL	Solution Methods: Temporal-Difference Learning	T1:Ch6, Ch7 and Class notes
19-22	To develop a unified view of methods that require a model of the environment and methods that can be used without a model.	Planning and Learning with Tabular Methods	T1:Ch8
PART 2: Approximate Solution Methods			
23-28	To apply RL for applications where most states encountered will never have been experienced exactly before. To apply on-policy and off-policy approximation of action values.	Function approximation for generalization	T1:Ch9-Ch11 and Class Notes
29-34	To understand and learn the reinforcement learning in a multiagent setting	Multi-agent reinforcement learning	Class Notes
35-39	To understand the application of A2C and A3C (with multiple independent agents)	Actor-Critic (A2C, A3C)	Class Notes

PART 3: Case studies			
40-42	To present a few case studies of reinforcement learning of potential historical and economic significance.	Applications and Case Studies	Class Notes

Evaluation Scheme:

Component	Duration	Weightage	Date&Time	Mode
Mid-Term exam	90 Mins	35%	02/03 3.30 - 5.00PM	Open Book
Course Project (with final presentation/viva)	-	30% (5% will be evaluated before the mid-sem)	Details will be announced during 1st/2nd week of February.	Open Book
Comprehensive	120 Mins	35%	05/05 AN	Open Book

Chamber Consultation Hour: Online consultation hours will be announced in the class.

Notices: All notices pertaining to this course will be displayed on the CMS.

Make-up Policy:

- Prior permission of the Instructor-in-Charge is required to get make-up for the Mid-Sem and Comprehensive Exams. Only on producing documentary proof of possible absence, which proves that student would be unable to appear for the exam, the decision of granting the make-up will be taken.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge