राष्ट्रीय प्रौद्योगिकी संस्थान पटना / NATIONAL INSTITUE OF TECHNOLOGY PATNA
संगणक विज्ञान एंव अभियांत्रिकी विभाग / DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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**No:-** **Date:**

***CSX4234 Reinforcement Learning*** **L-T-P-Cr: 2-0-2-3**

**Pre-requisites:** Fundamental knowledge Machine Learning

**Objectives/Overview:**

1. To introduce the basics of reinforcement learning
2. To introduce the reinforcement learning algorithms
3. To introduce dynamic programming and its usage in RL
4. To introduce state of the art applications in RL

**Course Outcomes:**

On completion of this course, the student will be able to:

**CO 1:** Knowledge of basic and advanced reinforcement learning techniques.

**CO 2:** Identification of suitable learning tasks to which these learning techniques can be applied.

**CO 3:** Appreciation of some of the current limitations of reinforcement learning techniques.

**CO 4:** Formulation of decision problems, set up and run computational experiments, evaluation of results from experiments.

**Course Outcomes–Cognitive Levels–Program Outcomes Matrix – [H: High relation (3); M: Moderate relation (2); L: Low relation (1)]**

| Course Outcomes | Program Outcomes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO-1 Engineering knowledge | PO-2 (Problem analysis) | PO-3 (Design/development of solutions) | PO-4 (Conduct investigations of complex problems) | PO-5 (Modern tool usage) | PO-6 (The engineer and society) | PO-7 (Environment and sustainability) | PO-8 (Ethics) | PO-9 (Individual and team work) | PO-10 (Communication) | PO-11 (Project management and finance) | PO-12 (Life-long learning) |
| CO-1 | 3 | 3 | 3 | 3 | 2 | 3 | | | 3 | 3 | 1 | 3 |
| CO-2 | 3 | 3 | 3 | 3 | 2 | 3 | | 1 | 3 | 3 | 1 | 3 |
| CO-3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 3 | 1 | 3 |
| CO-4 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 3 | 3 | 1 | 3 |

**UNIT I: Introduction to Reinforcement Learning Problem:** **Lectures: 02**

Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example: Tic-Tac-Toe, History of Reinforcement Learning.

**UNIT II: Multi-arm Bandits:** **Lectures: 03**

An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound

**UNIT III: Finite Markov Decision Processes:** **Lectures: 05**

The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation.

**UNIT IV: Dynamic Programming:** **Lectures: 04**

Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming.

**UNIT V: Monte Carlo Methods:** **Lectures: 05**

Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Returns.

**UNIT VI: Temporal-Difference Learning:** **Lectures: 05**

TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On-Policy TD Control, Q-Learning: Off-Policy TD Control, Games.

**UNIT VII: Policy Approximation:** **Lectures: 04**

Actor–Critic Methods, Eligibility Traces for Actor–Critic Methods, R-Learning and the Average-Reward Setting, Vanilla policy gradient method,

**Text Books:**


1. RS Sutton Reinforcement Learning: An Introduction – Stanford University.
2. Enes Bilgin, Mastering Reinforcement Learning with Python, Packt.

Reference Books:

3. Sudharsan Ravichandiran, Hands-On Reinforcement Learning with Python: Master Reinforcement and Deep Reinforcement Learning Using OpenAI Gym and TensorFlow.
4. Aske Plaat, Deep Reinforcement Learning, Springer Singapore