Semester: III	
Programme: M.Sc. Data Science	
Course: Machine Learning 2	
Paper code: M2C4DS26032CT / M2C4DS26032CP	**Credits: 6**
Hours/week: 8 (4Th + 4Pr)	
Category: Core/MDC/SEC/VAC: Core	
Theory / Practical / Composite: Composite	
No of Modules: 1	

Course Outcome:

Remember the fundamental definitions, concepts, and terminology of Support Vector Machines (maximal margin classifiers, support vector regression), association rule mining, matrix factor decomposition techniques, Reinforcement Learning frameworks, and MLOps lifecycle workflows.

Understand the theoretical principles underlying support vector classification and regression, factor decompositions (Independent Component Analysis, Factor Analysis, Canonical Correlation Analysis, Multidimensional Scaling), Multi-Armed Bandit optimality (UCB1, PAC bounds), and pipeline deployment patterns.

Apply Support Vector Machines, association rule algorithms (Market Basket Analysis), matrix factor decomposition methods, and Reinforcement Learning decision frameworks (value function-based methods, UCB1) to solve complex analytical problems.

Analyze high-dimensional data using advanced matrix decomposition methods (ICA, Factor Analysis, CCA, MDS) and perform error analysis and performance auditing on machine learning models.

Evaluate model performance, value function-based Reinforcement Learning strategies, pipeline monitoring metrics, and deployment patterns to address production deployment challenges and data iteration baseline changes.

Create end-to-end production-grade MLOps pipelines and intelligent systems by synthesizing supervised learning models, unsupervised matrix factorization, reinforcement learning algorithms, and continuous monitoring workflows

Prerequisites: Knowledge about the fundamental concepts of Machine Learning.

SYLLABUS

UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I.	**Supervised learning techniques:** Support vector - maximal margin classifier**,** support vector classifier**,** support vector machines, support vector regression.	**8**	**CO 1,** **CO 2,** **CO 3,**	**K1, K2, K3, K6**

			CO 6	
II.	**Unsupervised learning techniques:** Learning from association - association rules. Market basket analysis**.** Generalized association rules**.** Decomposition of data matrices by factors. Independent component analysis. Factor analysis. Canonical correlation analysis, Multidimensional scaling.	**16**	**CO 1, CO 2, CO 3, CO 4, CO 6**	**K1, K2, K3, K4, K6**
III.	**Reinforcement Learning (RL):** RL framework and applications. Immediate RL. Bandit Optimality. Value function-based methods. UCB 1. PAC Bounds. Median Elimination.	**8**	**CO 1, CO 2, CO 3, CO 5, CO 6**	**K1, K2, K3, K5, K6**
IV.	**Machine Learning Operations (MLOps):** Steps of an ML project. Challenges in model deployment. Deployment patterns. Pipeline monitoring. Select and train an ML model. Error analysis and performance auditing. Data iteration. Data definition and establish baseline. Label and organize data.	**20**	**CO 1, CO 2, CO 4, CO 5, CO 6**	**K1, K2, K4, K5, K6**

Text Books

1. **Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber, Jian Pei. The Morgan Kaufmann Series in Data Management Systems.**
2. **R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press.**
3. **An Introduction to Statistical Learning with Applications in Python by Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Jonathan Taylor. Springer.**
4. **Introducing MLOps: How to Scale Machine Learning in the Enterprise by Mark Treveil, Nicolas Omont, Clément Stenac. O'Reilly.**

Suggested readings

1. **Introduction to Machine Learning with Python: A Guide for Data Scientists by Andreas C. Müller, Sarah Guido. O'Reilly.**

Web Resources

1. **Reinforcement Learning by Prof. Balaraman Raindran, IIT Madras. NPTEL course**
2. **Machine Learning in Production by Andrew Ng. Coursera**

Evaluation

Marks	CIA:	Continuous Assessment: 40

	Class Performance: 2 Attendance: 3 Mid-term Exam: 10 Total: 15 End Semester Exam: 45	
Paper Structure for Theory Semester Exam	Short Questions: 5 marks each	Long Questions: 10 marks each
	3 out of 5	3 out of 5

Course outcomes (COs) and Cognitive Level Mapping

COs	**CO Description**	**Cognitive levels**
CO1	**Remember** the fundamental definitions, concepts, and terminology of Support Vector Machines (maximal margin classifiers, support vector regression), association rule mining, matrix factor decomposition techniques, Reinforcement Learning frameworks, and MLOps lifecycle workflows.	K1
CO2	**Understand** the theoretical principles underlying support vector classification and regression, factor decompositions (Independent Component Analysis, Factor Analysis, Canonical Correlation Analysis, Multidimensional Scaling), Multi-Armed Bandit optimality (UCB1, PAC bounds), and pipeline deployment patterns.	K2
CO3	**Apply** Support Vector Machines, association rule algorithms (Market Basket Analysis), matrix factor decomposition methods, and Reinforcement Learning decision frameworks (value function-based methods, UCB1) to solve complex analytical problems.	K3
CO4	**Analyze** high-dimensional data using advanced matrix decomposition methods (ICA, Factor Analysis, CCA, MDS) and perform error analysis and performance auditing on machine learning models.	K4
CO5	**Evaluate** model performance, value function-based Reinforcement Learning strategies, pipeline monitoring metrics, and deployment patterns to address production deployment challenges and data iteration baseline changes.	K5
CO6	**Create** end-to-end production-grade MLOps pipelines and intelligent systems by synthesizing supervised learning models, unsupervised matrix factorization, reinforcement learning algorithms, and continuous monitoring workflows	K6