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SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Master of Technology

Year: M. Tech. II (Semester – III)

Subject Name: Recent Trends in AI - ML
Subject Code: MTCO24303
Type of course: Professional Elective - V
Prerequisite (if any): AI, ML

List of Courses where this course will be a prerequisite: --

Rationale: This course helps students understand the recent trends in AI and machine learning (ML). The course gives students an understanding of Reinforcement learning methods and advanced ensemble based methods. It also gives students an insight into Explainable AI (XAI), which is gaining traction to address the need for transparency and interpretability, crucial for fostering trust in AI systems. Further, they learn about Federated learning, which enables decentralized model training and various generative adversarial models for enabling tasks such as image generation, data augmentation, and unsupervised learning.

Teaching and Examination Scheme:

Teaching Scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests. CA2: Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems TEE: Term End Examination TEP: Term End Practical Exam (Performance and viva on practical skills learned in course) CA3: Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Content	Total Hrs
1	Reinforcement learning: Overview, Components, Markov decision process (MDP), Value iteration and policy iteration, Q-learning, Value function approximation, Policy search, Ethical implications of RL.	5

2	Distributive Learning: Definition and significance, comparison with centralized learning approaches, Data parallelism vs. model parallelism. Decentralized and local Stochastic Gradient Descent. Federated Learning: Definition, categories, current development in Federated Learning, preserving privacy and reducing latency for FedML. Federated Transfer Learning: Heterogeneous Federated Learning, The FTL Framework. MLops: Introduction to MLOps, ML Pipeline, MLOps for containers, Continuous Integration, Continuous Deployment for ML models, CI/CD pipeline	12
3	Advanced Ensemble methods: Overview of Bagging, boosting, stacking and its types, Random forest , Gradient Boosting, XGBoost, Ensemble Pruning, Mixture of Experts, Hierarchical v/s Flat MoE architectures, Applications of MoE architectures.	8
4	Explainable AI (XAI) : Introduction, Threats of advancement in AI/ML, Black Box v/s Glass Box Models, model agnostic v/s model specific, Interpretability vs. Performance Trade-offs, Explainability with libraries, XAI for tabular and image data, Use Cases of XAI, challenges in achieving explainability, overview of Ethical and responsible AI, Regulatory Landscape and XAI Standards	8
5	Generative Artificial Intelligence & Generative Adversarial Networks: Generative AI, Overview of GANs, Adversarial Training, Basic GAN Architecture, Data Augmentation with GANs, Evaluation Metrics, Optimization of GANs. Text Generation with GANs: TextGAN, Large Language Model (LLM) - Language models and LLM architectures, BERT and its variants, GPT and its variants, Conversational AI. Prompt Engineering: Introduction, relevance, prompt variations and their impact on model outputs, prompts' influence on behavior of LLMs. Image generation with GANs: conditional GANs: Stable Diffusion, Deepfake with GANs, Style transfer using GAN	12

Reference Books:

Sr No	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Federated Learning, Artificial Intelligence and Machine Learning 2019.	Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, and Han Yu			Latest

2	Artificial Intelligence (AI): Recent Trends and Applications	Suguna, S.K., Dhivya, M., & Paiva, S. (Eds.).	CRC Press.	2021
3	The Elements of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer	2008
4	Generative AI with Python and TensorFlow 2	Joseph Babcock, Raghav Bali	Packt	2023
5	Explainable AI: Foundations, Methodologies and Applications	Mayuri Mehta, Vasile Palade , Indranath Chatterjee	Springer	2023
6	Explainable AI for Practitioners	Michael Munn, David Pitman	O'Reilly	2022

Course Outcomes:

Sr.No.	CO statement	Marks % weightage
CO-1	Develop advanced reinforcement learning based applications to address real-world challenges	12
CO-2	Compute MLops for ML applications developed using federated and distributive learning for accurate deployment	26
CO-3	Assess advanced ensemble-based methods for ML applications	18
CO-4	Examine Explainable AI principles and techniques to enhance transparency and interpretability	18
CO-5	Create and deploy advanced generative models for various tasks in artificial intelligence.	26

List of Open learning website:

List of Open Source Software:

1. Spacy
2. LIME
3. SHAP

FOR LAB SESSIONS:

List of Experiments: The recommended list of practicals is as follows

Sr. No.	Practical
1.	Forecasting stock using deep reinforcement learning.
2.	Demonstrate the MLOps pipeline for any suitable classification problem.
3.	Implement ensemble learning techniques (bagging and boosting) on the dataset (https://www.kaggle.com/c/house-prices-advanced-regression-techniques)
4	Implementation BERT model
5	Image generation using GAN
6	Implement XAI technique LIME (Local Interpretable Model-agnostic Explanations) and SHAP (SHapley Additive exPlanations) for a Classification Dataset
7	Implement XAI technique LIME (Local Interpretable Model-agnostic Explanations) and SHAP (SHapley Additive exPlanations) for a Regression Dataset