CSE276:ARTIFICIAL INTELLIGENCE FOUNDATIONS

L:2 T:0 P:2 Credits:3

Course Outcomes: Through this course students should be able to

CO1 :: explain the the foundations, evolution, characteristics and applications of Artificial Intelligence.

CO2 :: apply state-space formulation and classical search techniques for solving Artificial Intelligence problems.

CO3 :: describe knowledge representation, reasoning techniques and intelligent agent models in Artificial Intelligence.

CO4 :: explain the evolution of Machine Learning, Deep Learning and modern Artificial Intelligence paradigms.

CO5 :: apply prompt engineering principles and Responsible AI concepts for effective use of Generative AI and Large Language Models

CO6 :: describe the Artificial Intelligence development ecosystem, emerging technologies and future trends.

Unit I

Foundations of Artificial Intelligence : Introduction to Artificial Intelligence: Its history and evolution, characteristics and types of Artificial Intelligence, Artificial Intelligence vs Machine Learning vs Deep Learning vs Data Science, Intelligent systems & Artificial Intelligence lifecycle, applications of Artificial Intelligence in healthcare, agriculture, finance, education, manufacturing, robotics and smart cities

Artificial Intelligence Problem Solving : Artificial Intelligence problem formulation and state-space representation, problem characteristics, search space and solution space, performance measures, overview of Artificial Intelligence based problem-solving approaches.

Unit II

Problem Solving using Search Techniques : Uninformed search (Breadth First Search and Depth First Search), informed search (Best First Search, Hill Climbing and A* Search), heuristic functions, comparison and applications of search algorithms

Knowledge Representation and Reasoning : Knowledge representation, semantic networks & frames, Production systems & expert systems, Propositional logic & first-order predicate logic, Reasoning under uncertainty using Bayes' theorem

Unit III

Intelligent Agents : Introduction to intelligent agents and agent architecture, PEAS Framework: Performance Measure, Environment, Actuators and Sensors, Rational agents & agent environments, simple reflex agents & model-based agents, goal-based agents, utility-based agents & learning agents, Autonomous intelligent systems and multi-agent systems, cooperation and coordination, human-AI collaboration and applications of intelligent agents

Unit IV

Evolution of Modern Artificial Intelligence : Symbolic and statistical Artificial Intelligence, Overview of Machine Learning and its types: supervised, unsupervised and reinforcement learning, Introduction to Deep Learning, Types and applications of Deep Learning

Foundation Models and Modern Artificial Intelligence Paradigms : Foundation models, multimodal Artificial Intelligence, Agentic Artificial Intelligence, Edge Artificial Intelligence and Tiny Artificial Intelligence

Unit V

Generative Artificial Intelligence : Generative Artificial Intelligence concepts and their applications, Large Language Models, prompt engineering fundamentals and prompt design techniques, Retrieval-Augmented Generation (RAG), Hallucination in Large Language Models and their mitigation strategies

Responsible and Explainable Artificial Intelligence : Explainable Artificial Intelligence, fairness, bias and transparency, Responsible Artificial Intelligence principles: privacy and security, Artificial Intelligence governance, ethical and societal implications.

Unit VI

Unit VI **Artificial Intelligence Ecosystem and Future Trends** : Artificial Intelligence development ecosystem and Python ecosystem, TensorFlow and PyTorch, Hugging Face, Ollama and LangChain, vector databases (conceptual overview), Artificial Intelligence development workflow, future trends in Artificial Intelligence (Artificial General Intelligence (AGI) and sustainable AI)

List of Practicals / Experiments:

Practicals:

- Develop an Intelligent Route Planner using Classical Search Algorithms:Design an AI-based route planning system for emergency response or campus navigation by implementing Breadth First Search (BFS) and Depth First Search (DFS). Compare both algorithms in terms of path quality, explored states and execution time.
- Design an AI-Based Puzzle Solver using Heuristic Search: Develop an intelligent solver for problems such as the 8-Puzzle or maze navigation using Hill Climbing and A* Search algorithms. Evaluate how heuristic functions improve search efficiency compared to uninformed search methods.
- Build an Intelligent Medical Expert System: Develop a rule-based expert system to assist in the preliminary diagnosis of common diseases based on symptoms using production rules and logical reasoning. Analyze how expert systems support decision-making in healthcare.
- Develop a Smart Decision Support System using Knowledge Representation: Implement knowledge representation techniques such as semantic networks, frames, propositional logic or predicate logic to model a real-world problem like university admission, loan approval or career guidance. Demonstrate intelligent reasoning using the developed knowledge base.
- Design an Intelligent Autonomous Agent for Smart Environments: Develop a simple intelligent agent capable of making decisions in a simulated environment such as a robotic vacuum cleaner, warehouse robot or traffic signal controller. Demonstrate different agent architectures and compare their behaviors.
- Develop a Multi-Agent Simulation for Collaborative Problem Solving: Implement a multi-agent system where multiple intelligent agents cooperate to accomplish tasks such as warehouse management, disaster response or autonomous traffic management. Analyze communication and coordination among intelligent agents.
- Explore the Evolution of AI through a Comparative Machine Learning Study: Implement simple examples demonstrating supervised and unsupervised learning using publicly available datasets. Compare these approaches conceptually with classical AI methods to understand the evolution of intelligent systems.
- Build an AI Assistant using a Large Language Model: Develop a domain-specific AI assistant (such as a Student Assistant, Healthcare Assistant or Travel Guide) using an open-source or publicly available Large Language Model through Ollama or Hugging Face. Design effective prompts to improve response quality.
- Enhance AI Responses using Prompt Engineering: Experiment with different prompt engineering strategies to improve the accuracy, reasoning and creativity of responses generated by a Large Language Model. Analyze the impact of prompt design on AI-generated outputs across different application scenarios.
- Investigate Responsible AI using Explainability Techniques: Develop an AI application and evaluate its fairness, transparency and interpretability using Explainable AI concepts. Analyze prediction bias and discuss ethical implications in domains such as healthcare, education or finance.
- Develop an AI Application using the Modern AI Development Ecosystem: Build a simple AI application using tools from the modern AI ecosystem such as TensorFlow, PyTorch, Hugging Face or Ollama. Understand the complete AI development workflow from model selection to inference without focusing on complex model training.
- Capstone Mini Project: Artificial Intelligence for Social Good: Design and implement an AI-based solution addressing a real-world societal challenge such as crop disease advisory, waste segregation, fake news detection, smart attendance, disaster response, traffic monitoring or AI-assisted education. Integrate multiple Artificial Intelligence concepts studied throughout the course and evaluate the effectiveness of the proposed solution.

Text Books:

1. ARTIFICIAL INTELLIGENCE: A MODERN APPROACH by STUART RUSSELL & PETER NORVIG, PEARSON

References:

1. ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS by N. P. PADHY, OXFORD UNIVERSITY PRESS