

## # Introduction to Artificial Intelligence

### Target Audience:

This course is designed for freshman or sophomore students who plan to major in Artificial Intelligence (AI). It serves as one of the introductory courses in the AI curriculum alongside ESE 2000.

### Prerequisite:

CIS 1110

### Modules and Topics:

1. Introduction to AI
  - What is AI?
  - AI in philosophy, science fiction, and real-world applications
  - Types of AI systems and agents
2. Large Language Models (Part 1)
  - Introduction to language models
  - Neural language models and transformers
  - Capabilities and limitations of modern language models
3. Large Language Models (Part 2)
  - Few-shot learning and in-context learning
  - Fine-tuning and instruction tuning
  - Controlled generation and alignment with human values
4. Language Models (Part 3)
  - Multimodal language models
  - Retrieval-augmented language models
  - Code generation with language models
5. K-Nearest Neighbors, Vector Representations, and Embeddings
  - K-Nearest Neighbors algorithm
  - Vector representations and distance metrics
  - Document and word embeddings
6. Introduction to Robotic Agents and R2D2 Setup
  - Types of robots and their applications
  - R2D2 robot overview and setup
  - Basic R2D2 programming and sensor data
7. R2D2 Programming with LLMs
  - Using LLMs for code generation
  - Prompt engineering for robotics
  - Debugging and optimizing LLM-generated code
8. Introduction to Search and Uninformed Search Strategies
  - Search problems and robot navigation
  - Breadth-First Search, Depth-First Search, Uniform-Cost Search
  - Iterative Deepening Search
9. Informed Search Strategies

- Heuristics and Best-First Search
- Greedy Best-First Search and A\* algorithm
- Designing heuristics for robot navigation
- 11. Classical Planning and Logic-Based Representations
  - Classical planning and STRIPS representation
  - Propositional and first-order logic
  - Knowledge bases and inference
- 12. Markov Decision Processes (MDPs) and Reasoning Under Uncertainty
  - Introduction to MDPs and stochastic environments
  - Solving MDPs with value iteration and policy iteration
  - Partially Observable MDPs and applications
- 13. Reinforcement Learning
  - Foundations of reinforcement learning
  - Model-free prediction and control
  - Advanced RL techniques and applications
- 14. AI Ethics and Societal Impacts
  - Key ethical principles in AI
  - Bias, fairness, and transparency in AI systems
  - Societal impacts of AI and responsible development

#### Foundational Concepts:

1. AI fundamentals and terminology (CIS 4210: Introduction to Artificial Intelligence)
2. Large language models and their applications (CIS 5300: Natural Language Processing)
3. Vector representations and embeddings (CIS 5200: Machine Learning)
4. Robotic agents and programming (MEAM 5200: Robotics)
5. Search algorithms and heuristics (CIS 3200: Algorithms)
6. Classical planning and logic (CIS 6250: Computational Learning Theory)
7. Reasoning under uncertainty with MDPs (ESE 6800: Foundations of Reinforcement Learning)
8. Reinforcement learning (ESE 5460: Principles of Deep Learning)
9. AI ethics and societal impacts (CIS 4230: Ethical Algorithm Design; LAWM 5060: Machine Learning: Technology Law)

#### Relationship to ESE 2000:

This course is designed to complement ESE 2000 by focusing on different aspects of AI. While ESE 2000 covers topics such as machine learning, neural networks, and dynamical systems, this course delves into language models, robotic agents, search algorithms, planning, and reinforcement learning. The two courses together provide students with a comprehensive introduction to the field of AI, preparing them for more advanced courses in the AI curriculum.

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