CS246: Artificial Intelligence

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Course Description

Artificial Intelligence (AI) is a vast field. Nowadays people often think that AI is nothing but machine Learning and the reason is mainly the widespread use of machine learning. The fact is machine learning is just a part of the domain of AI. We will try to explore the full breadth of the course, which encompasses logic, probability, reasoning, learning, decision making, and action.
We will define AI as the study of intelligent agents where each such agent receives precept from the environment and act upon the precept. We will discuss goal-based models, knowledge-based models,
After a basic introduction, we will jump into different modules like problem-solving (for example, Sudoku solver), planning, and acting under uncertainty. Application of artificial intelligence in various fields like natural language processing, perception (computer vision), robotics will be covered.
Prerequisite(s): Basic knowledge of computer science such as algorithms, data structures, probability, linear algebra.
Credit Hours: 4

Textbook

The course textbook is: **Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig.** (This is the leading textbook in Artificial Intelligence used in over 1400 universities all over the world.)

Syllabus

A high-level summary of the syllabus is as follows:

1. **Introduction:**
    - Intro to AI
    - Agents and Environments
2. **Problem Solving:**
    - Solving problem by Searching
    - Informed search and exploration
    - Constraint satisfaction problems
    - Adversarial search
3. **Planning**
    - Planning and acting

- Uncertain knowledge and reasoning
- Making simple and complex decisions

4. **Learning**
   - Learning from observation
   - Supervised and unsupervised learning (overview)
   - Reinforcement learning
5. **Bayesian Network**
   - Probability
   - BNs: Representation, Independence, Inference, Sampling
   - Decision Networks / VPI
6. **Hidden Markov Models**
   - HMMs
   - Particle Filtering and Apps of HMMs
   - Naive Bayes
7. **Application:**
   - Robotics, Computer Vision, and Natural Language Process
   - Computer Games (Deep Refinforcement Learning)

Course Objectives

- Understand the fundamental concepts of Artificial Intelligence (AI), including intelligent agents, environments, and the broad scope of AI beyond machine learning.
- Learn various problem-solving strategies such as searching, informed exploration, and constraint satisfaction, and apply them to solve complex problems.
- Explore planning techniques and decision-making processes in the presence of uncertainty, including probabilistic reasoning and making both simple and complex decisions.
- Gain an overview of learning methodologies, including supervised, unsupervised, and reinforcement learning, and understand their applications in AI problem-solving.
- Understand the principles of Bayesian Networks and Hidden Markov Models (HMMs), including their representations, inference methods, and applications in real-world scenarios.
- Explore the diverse applications of AI in fields such as robotics, computer vision, natural language processing, and computer games, including deep reinforcement learning techniques.

  By achieving these objectives, students will develop a comprehensive understanding of AI principles and methodologies, enabling them to identify problems suitable for AI solutions, apply appropriate techniques to solve them effectively, and critically evaluate the applicability of AI methods in various domains.

Course Outcome:

Upon successful completion of the course, students will be able to:

- Analyze and identify problems suitable for the application of Artificial Intelligence techniques across various domains, including but not limited to problem-solving, planning, and decision-making.
- Implement selected AI techniques to effectively address and solve complex problems, demonstrating proficiency in foundational AI concepts such as problem-solving by searching, constraint satisfaction, and adversarial search.
- Evaluate and apply state-of-the-art AI techniques, including probabilistic reasoning, reinforcement learning, and Bayesian Networks, to address real-world challenges in diverse fields such as robotics, computer vision, and natural language processing.
- Demonstrate a comprehensive understanding of key AI principles and methodologies, as outlined in the course syllabus, including the principles of intelligent agents, uncertain knowledge and reasoning, and learning algorithms.
- Critically assess the applicability of basic and advanced AI techniques to different problem domains, making informed decisions about selecting and implementing appropriate methods based on problem characteristics and constraints.
- Through a combination of theoretical understanding, practical application, and critical analysis, students will develop the necessary skills and knowledge to contribute effectively to the field of Artificial Intelligence and apply AI techniques to solve complex real-world problems.

Grade Distribution:

- **Quizzes:** 20%
- **Projects and/or Assignments:** 30%
- **Midterm Exam:** 20%
- **Final Exam:** 30%

Course Outline (tentative)

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the earlier lectures and reading assignments. There will be 10 or more quizzes throughout the semester.

Week	Topic
1	Introduction, Intelligent Agents and Environments
2	Problem Solving: Solving problem by searching
3	Problem Solving: Informed search and exploration
4	Problem Solving: Constraint satisfaction problem
5	Problem Solving: Adversarial Search
6	Uncertain Knowledge and Reasoning: Uncertainity
7	Uncertain Knowledge and Reasoning: Probabilistinc reasoning
8	Uncertain Knowledge and Reasoning: Making simple decisions
9	Uncertain Knowledge and Reasoning: Making complex decisions
10	Learning: Brief overview of various learning methods
11	Learning: Reinforcement learning
12	Bayes Net (1)
13	Bayes Net (2)
14	Application: Computer vision, Natural Language Processing
15	Deep Reinforcement Learning
16	Course Wrap-up