CS3331 (4-0): Basics of Applied Artificial Intelligence

Catalog description:

Basics of artificial-intelligence concepts illustrated with military examples. Topics include knowledge representation, logical reasoning, probabilistic reasoning, heuristic search, agent-based systems, and social artificial intelligence. The course is intended for students who are not computer-science majors.

Prerequisite: CS4000

Course Objectives:

Students will gain an understanding of core artificial intelligence concepts underlying a variety of systems including automated reasoning and expert systems, natural language processing, wargame simulations, robot mission planning. With a focus on applications, students will be presented with a series of hands-on and practical scenarios to motivate the development of the fundamental algorithms and methods of problem solving in artificial intelligence. By the end of the course, students should be able to decide when the use of artificial intelligence techniques is appropriate, formulate an approach to solving specific problems, and simulate simple methods with paper and pencil.

Course Plan:

Lecture hours will consist of 75% synchronous lectures covering the core topics in the course outline and 25% in-class discussions. These will be recorded for an option to take the course in an asynchronous format. Lectures will be augmented with a discussion forum and synchronous exercises conducted by small teams of students (2 or 3) to encourage class participation.

Grading:

Homework assignments: 40%
Quizzes/projects: 50%
Class participation: 10%

Homework assignments will reinforce concepts covered during lectures. These include thought experiments, essay questions, and algorithm tracing. Quizzes are open-book and delivered through Sakai. The quizzes will be treated as pass-fail towards the course grade and the score will not be counted.

Students will form teams and each team will be assigned a term project. The project will simulate a mock AI capability needed by a customer and involve project planning, design, and documentation. The instructor will serve the role of the customer, and teams will submit source code and a whitepaper describing their work at the end of the quarter.

Class participation is based on questions/discussion during online lectures, interaction with the instructor outside of lecture hours, or activity on the discussion forum if taken asynchronously.

Reading materials
M. Mitchell, *Artificial Intelligence: A Guide for Thinking Humans*, Farrar, Straus, and Giroux, 2019.

Course Policies:

- Quizzes are pass/fail, and only completion of each quiz is counted.
- Rules for collaboration differ from problem to problem. Some homework problems are to be completed individually, and some are to be completed in teams.
- Each homework assignment contains 2 or 3 problems, and each problem will receive a grade on a 3-point scale (total 6 or 9 points). Late submissions are marked down by 1 point per day past due, up to the total number of points for the assignment.

Course outline

The course is broken up into 6 units. Each unit covers a set of related concepts and includes a motivating application that homework problems and in-class discussions will center on. The schedule follows.

Week	Topics	Homework and Tests	Readings
1	Knowledge representation • Overview of artificial intelligence (measuring intelligence, AI subfields, open problems) (1 hour) • Fact, rules, queries (1 hour) • Semantic networks (1 hour) • **Application:** coding and acquisition (1 hour)		Chapter 1
2	Logical reasoning • Propositional and predicate logic (3 hours) • **Application:** policies and doctrine (1 hour)	Homework assignment 1 due: Logical representation of an application	Chapter 4
3	More about logical reasoning • Methods of inference (1 hour) • Self-referential systems (1 hour) • **Application:** Automated application of policies (2 hours)	Test 1 on material so far	Chapter 11

4	Probabilistic reasoning • Bayes' theorem and variants (1 hour) • Language models and entropy (1 hour) • Application: natural-language processing (2 hours)		Chapters 2 and 5
5	Other forms of probabilistic reasoning • Automatic speech recognition (1 hour) • Introduction to artificial neural networks (2 hours) • **Application:** Texture recognition in computer vision (1 hour)	Homework assignment 2 due: Simulation of logical reasoning and simulation of probabilistic reasoning	Chapter 6
6	Heuristic search • Blind vs informed search (1 hour) • A* search (1 hour) • **Application:** robot mission planning (2 hours)	Test 2 on material since last test	Chapter 8
7	Adversarial heuristic search • Game search (1 hour) • Minimax and alpha/beta pruning (1 hour) • **Application:** military mission planning (2 hours)		Chapter 9
8	Agent-based AI • The agent concept (1 hour) • Reinforcement learning as alternative to minimax (2 hours) • **Application:** wargames (1 hour)	Homework assignment 3 due: Simulation of search	Chapter 10
9	More speculative AI • Evolutionary algorithms (1 hour) • Q-learning (1 hour) • **Application:** wargame strategy (2 hours)	Test 3 on material since last test	Chapters 14 and 15
10	Week 10: Social AI • Cellular automata (1 hour) • Multi-agent systems (1 hour) • Swarm intelligence (1 hour) • **Application:** crowd dynamics (1 hour)	Homework assignment 4 due: Simulation of an evolutionary algorithm	Chapter 16
11	Review	Final exam on whole course	

Learning objectives:

- Students can define and recognize key artificial-intelligence concepts in knowledge representation, logical reasoning, probabilistic reasoning, heuristic search, and agent-based systems.
- Students can recommend appropriate artificial-intelligence techniques for key applications including advisory systems, planning systems, natural-language understanding, computer vision, and sensor systems.