Course Syllabus

CS 1571 Foundations of Artificial Intelligence

Lectures: Monday, Wednesday 3:00pm - 4:15pm

Classroom: IS 405

Instructor: Dr. Patrick Skeba (pts27@pitt.edu)

Office: SENSQ 5409

Office Hours (in-person, unless virtual requested):

- Tuesday 3-5pm
- Wednesday 5-6pm
- Friday 12-2pm
- Contact me for other times

Grader: Hongbo Lon (hol101@pitt.edu)

Course description

This course will provide an introduction to the fundamental concepts and techniques underlying the construction of intelligent computer systems. Topics covered in the course include:

- Problem solving and search,
- Knowledge representation, reasoning and planning,
- Reasoning and decision-making in the presence of uncertainty
- Selected topics in AI. Machine learning.

Prerequisites

Knowledge of math (calculus and algebra), probabilities, algorithm design, and programming skills are necessary to successfully complete the class.

Textbook

S. Russell, P. Norvig. Artificial Intelligence: A Modern Approach. 4th edition, Pearson, 2021

Homework assignments.

There will be weekly homework assignments that will include a mix of theoretical and programming problems. The homework assignments files (reports and programs) will be submitted via Canvas. Please see homework assignments guidelines for more detail.

Collaboration

All the work in this course should be done **independently**. Collaborations on quizzes, exams and homework assignments are not permitted.

Generative AI Policy

The homeworks and examinations will require you to think critically and explain your work in your own words. You **may not** use ChatGPT or any other generative AI software to create answers for anything in this course. In my experience, it is often easy to tell when ChatGPT has been used to generate answers from question prompts, and those answers are usually not very good. "Prompt engineering" is not worth your time. Writing down your thoughts, and iterating on those thoughts, is one of the most effective ways to build your own knowledge on a subject - don't deprive yourself of that opportunity by asking a program to generate your "thoughts" for you.

If I feel that a response shows clear evidence of generative AI, I will award zero points for that question. I will provide an explanation of my evidence and offer you the opportunity to resubmit the offending questions.

Grading

The grade for the course will be determined by:

- Homework assignments 70%
- Exams 30%

The midterm exam will be held on (approximately) Tuesday, October 22, 2024 during the regular class time. The final exam will be held during the finals week during the regular class time.

Policy on Cheating

Cheating and any other anti-intellectual behavior, including giving your work to someone else, will be dealt with severely. The penalties, depending on the severity of the offense, may range from the no-credit for the problem, the assignment, to the Fail (F) grade from the course. In addition, the cheating incidence may be reported to SCI school and further disciplinary actions may be taken by the school. If you feel you may have violated the rules speak to us as soon as possible.

Disability guidelines

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Office of Disability Resources and Services, 140 William Pitt Union, at 412-648-7890 or 412-383-7355 (TTY) as early as possible, but no later than the fourth week of the term or visit the Office of Disability Resources website as early as possible, but no later than the 4th week of the term. DRS will verify your disability and determine reasonable accommodations for this course.

Topics covered in the course

Course overview

- History of AI
- Applications of AI

Search

- Problem solving by searching.
- Search problem formulation.
- Search methods: uninformed, informed (heuristics) methods.
- Constraint satisfaction search.
- Combinatorial optimization. Iterative optimization methods. Hill climbing, Random search, Simulated annealing. Genetic algorithms.
- Parametric optimization. Linear programming, Gradient descend. Other higher order methods.
- Game search. Minimax. Alpha-Beta pruning. Early tree cutoffs and heuristic evaluation functions.

Knowledge representation

- Goals of knowledge representations.
- Propositional logic. English translations.
- Propositional logic inferences: truth table, inference rules. Normal forms. Resolution refutation.
- Efficient inference on propositional symbols. Forward and backward chaining.
- First order logic. Syntax, semantics, English translations.
- Variable substitutions. Generalized inference rules.
- Normal forms. Resolution refutation in first order logic.
- Horn normal form in First order logic. Forward and backward chaining.

Planning

- Modeling time and change due to actions
- Using inferences to solve planning problems.
- PDDL planning. Inferences.

- Task decompositions. Task dependences: Sussman paradox.

Representation and reasoning with uncertainty

- Extensions of propositional logic and inference rules to handle uncertainty
- Probabilities. Basics. Distributions: marginal, joint, full joint. Independences: marginal, conditionals.
- Bayesian belief networks. Definition. Efficiency of representation.
- Bayesian belief networks: Inferences on joint and conditional probabilities.
- Efficiency of inferences. Variable elimination. Factor algebra.

Reasoning with uncertainty over time

- Markov chain models. Hidden Markov models. Dynamic Bayesian belief networks.
- Filtering, prediction, and smoothing of state space distribution given some environmental evidence.
- Forward-backward, Viterbi algorithm