Computer Science CS 4013/5013: Artificial Intelligence

Instructor: Dr. McGovern

Spring 2012

1 Course Overview

Imagine that you are traveling to San Francisco for work and a friend tells you that you "absolutely must" try the same restaurant that she ate at when she went to SF. However, she only remembers that it started with a A and was in Chinatown. You look it up on your handheld device with only the clues above and it finds the place, makes a reservation, and calls you a taxi to get there. You don't have to worry about any taxi accidents since the taxi is completely automated and is much safer than any human driving. Imagine planning a dinner for all of your friends and not having to worry about shopping for any ingredients because the minute you tell your smart house the planned menu, it pre-orders exactly the right ingredients to arrive fresh in time for your cooking.

This semester, you will learn how to create intelligent agents. Although the scenario described above is futuristic, it will be possible with intelligent searches and networks of agents (just look at what Google can do already). You will create intelligent teams of agents in a game that must search, adapt, and communicate in order to thrive. As with agents in a heterogenous real-world environment, these agents will require you to design and implement them to fit into an existing software framework.

2 Learning Objectives

The general/overall learning objectives are:

- Select the AI technique best-suited for a novel problem/domain and justify your choice, including an analysis of the complexity of your choice
- Implement an AI solution to a complicated real-world problem and evaluate its effectiveness

- Gain the skills, confidence, and experience to implement your own AI solutions within an existing large codebase
- Function effectively in a team

The specific topics we will cover include:

Search and Planning

- Uninformed search
- Informed search
- Adversarial search
- Constraint satisfaction
- Classical planning

Machine learning

- Decision trees
- Nearest neighbor
- Kernel regression
- Clustering
- Evolutionary Computation

Multi-agent coordination

- Communication/Coordination
- Knowledge representations
- Cooperative and Competitive teams
- Homogeneous and Heterogeneous teams
- Multi-agent planning

The specific objectives for these detailed topics are:

- Formulate a search problem given a written or verbal description of a domain
- Explain the differences between breadth first search and depth first search to a non-CS and non-engineering/science adult
- Create an appropriate admissible heuristic for a novel problem domain
- Evaluate a heuristic for a domain and decide if it is admissible
- Demonstrate the mechanics of BFS, DFS, IDFS, A*, Hill-climbing, and Greedy searches

- Demonstrate the mechanics of Minimax search with and without alpha-beta pruning for both 2-player and multi-player games
- Design an appropriate evaluation function for a two or multi-player game situation
- Formulate a solution to a search problem (adversarial and regular) that addresses uncertainty in the situation. This could include implementing rollouts or dynamically replanning based on stochasticity in the environment or from the other agents.
- Explain why a particular search algorithm was chosen for a problem, including any computational tradeoffs.
- Formulate a constraint satisfaction problem with appropriate variables and domains given a verbal or written description of a novel domain
- Demonstrate the mechanics of Backtracking, forward checking, and arc-consistency
- Formulate a problem using a logical representation suitable for classical planning
- Demonstrate the mechanics of progression and regression search for planning
- Grow a standard decision tree given example data
- Explain information gain to a non-technical person
- Explain clustering and nearest neighbor techniques including a demonstration to a non-technical person
- Formulate a solution to a search problem in continuous space
- Design an evolutionary solution to a large search problem
- Demonstrate the mechanics of crossover, mutation, selection, and fitness functions
- Design a solution to multi-agent coordination in a heterogeneous or homogeneous team. Explain why the characteristics of the team members matter to coordination.
- Explain the difference and tradeoffs between centralized and decentralized control
- Formulate an appropriate knowledge representation to communicate among agent-based team members
- Design and implement a solution for a cooperative team operating in a competitive environment

ABET Student Outcomes to be addressed

- B: An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- C: An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- D: An ability to function effectively on teams to accomplish a common goal
- I: An ability to use current techniques, skills, and tools necessary for computing practice

- J: An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices
- K: An ability to apply design and development principles in the construction of software systems of varying complexity

3 General Information

Class time: TR 12-1:15pm

Class location: Devon Hall 270

Prerequisites: CS 2413 and CS 2813. Note that prior programming experience and the knowledge or ability to learn java are assumed.

Required materials: The **Third** edition of *Artificial Intelligence: A modern approach*, by Stuart Russell and Peter Norvig, Second Edition, Prentice Hall. This book has a blue cover. Do not use the older editions (brown or green covers). Note that the authors have a very good website for the book: http://aima.cs.berkeley.edu/. This includes errata and sample code.

Instructor: Dr. McGovern

- *Office:* Devon Hall 251
- *Phone:* 325-5427 (voice mail available)
- *URL for class:* http://learn.ou.edu
- *Personal URL:* http://www.cs.ou.edu/∼amy
- *Email:* amcgovern@ou.edu Tuesday: 10-11:30, Thursday 1:30-2:45. Also by appointment. Also available via AIM at *dramymcgovern*.

Teaching assistant: Diana M. Vanegas Pinilla: dvanegas@ou.edu

Office hours: By appointment

4 Evaluation

This semester you will be learning and practicing many aspects of artificial intelligence. What you get out of a course will depend on what you put into it! In order to give you a fair grade at the end of the semester, I will evaluate you on a combination of your projects (40%), homeworks and quizzes (30%) and exams (30%). Participating in class is one of the best ways to learn so please ask questions and attend class. Students in CS 5013 will have additional project requirements but the percentages remain the same.

Grade questions: To maintain fairness in grading, the items should be brought to the person who graded it. To maintain fairness, all disagreements about the grading of projects should be brought to our attention within one week of when the item was returned. For exams, I ask that you either discuss the dispute with me at the end of the class that I return the item or that you return the exam and discuss it during office hours. In fairness to all students, once a test has been removed from the classroom after it has been returned, the grade is final.

Online Grade Summary: Desire2Learn has a grade book that I will use to store all of your grades. It is your responsibility to verify that the grades on D2L are correct. If an error is found, bring the document to me and I will correct Desire2Learn.

Borderline grades: Borderline final grades will be decided by two factors: class participation and your final exam grade. If you are close to a border and you did well on the final, that can push you over a grade boundary. Likewise, being an active participant in class can push you over a grade boundary.

Final Examination: The final examination is May 7 from 1:30-3:30. No final examinations can be given early, except as required by University policy.

Due dates: Projects can be turned in up to three days late with the grade dropping 10% per day that it is late. No project will be accepted beyond 72 hours after the original due date. Homeworks and quizzes are due at the announced time and no late submissions will be accepted.

Projects: Your final project will be due the last week of classes. Per university policy, you may turn this project in prior to pre-finals week if you have completed the project.

5 Course Policies

The following set of rules will help keep us all on the same page all semester and help to ensure fair treatment for all students.

Academic Misconduct: Academic misconduct hurts everyone but particularly the student who does not learn the material. All work submitted for an individual grade should be the work of that single individual and not her friends. It is fine to ask a fellow student for help as long as that help does not consist of copying any computer code, or solutions to other assignments. Students working on joint projects may certainly help one another and are expected to share code within the project group. However, they may not share beyond the group.

1. Collaboration is encouraged for homework and projects. For the projects, you will work within your groups. For the homework, you may form study groups so long as each homework is in your own words. Write your study partners' names on your homework when you turn it in.

2. Do not show another student (or group) a copy of your projects or homework before the submission deadline. The penalties for permitting your work to be copied are the same as the penalties for copying someone elses work.

3. Make sure that your computer account is properly protected. Use a good password, and do not give your friends access to your account or your computer system. Do not leave printouts or mobile drives where others might access them.

Upon the first documented occurrence of academic misconduct, I will report it to the Campus Judicial Coordinator. The procedure to be followed is documented in the University of Oklahoma Academic Misconduct Code[1]. In the unlikely event that I elect to admonish the student, the appeals process is described in `http://integrity.ou.edu/`.

Project code: Your project code and writeups must be written exclusively by you or your group. **Use of any downloaded code or code taken from a book (whether documented or undocumented) is considered academic misconduct and will be treated as such.**

Classroom Conduct: Disruptions of class will not be permitted. Examples of disruptive behavior include:

[1] http://integrity.ou.edu/files/Academic_Misconduct_Code.pdf

- Allowing a cell phone or pager to repeatedly beep audibly.
- Playing music or computer games during class in such a way that they are visible or audible to other class members.
- Exhibiting erratic or irrational behavior.
- Behavior that distracts the class from the subject matter or discussion.
- Making physical or verbal threats to a faculty member, teaching assistant, or class member.
- Refusal to comply with faculty direction.

In the case of disruptive behavior, I may ask that you leave the classroom and may charge you with a violation of the Student Code of Responsibilities and Conduct. If you have repeated disruptive issues, I will seek to withdraw you from the class.

Laptops in class: Laptops, iPads, and gaming devices are prohibited in class. Leave them in your backpack and focus on your learning! There are two exceptions to this rule.

1. If you are using your laptop/iPad/electronic device to take notes, please show me this on the first day of class. Respect those around you and do NOT use your laptop to surf the net, participate in IM chats, game, etc. If I find that you are violating this rule, I will require you to go back to notes on paper.
2. We will have some group project work days where you and your project partner will want to bring your laptops to work. I will announce these in advance.

Class Web Page: Login to the Desire2Learn website using your 4+4 (first four letters of your last name followed by the last four digits of your student number), using your standard OU password. If you have difficulty logging in, call 325-HELP. This software provides a number of useful features, including a list of assignments and announcements, an electronic mailing list, newsgroups, and grade book. All handouts are available from Desire2Learn. You should check the site daily. When I update the site, I will post an announcement telling you what has been added and where it is located.You are responsible for things posted on the site with a 24 hour delay.

Class Email Alias: Urgent announcements will be sent through email. It is your responsibility to:

- Have your university supplied email account properly forwarded to the location where you read email.

- Make sure that your email address in Desire2Learn is correct, and forwards email to the place where you read it. I'll send out a test message during the first week of class. If you do not receive this message, it is your responsibility to get the problem resolved immediately.
- Have your email program set up properly so that replying to your email will work correctly the first time. You can send email to yourself and reply to yourself to test this.

If you need assistance in accomplishing any of these tasks, contact 325-HELP.

Newsgroups and Email: The newsgroup on Desire2Learn should be the primary method of communication, outside of class. This allows everyone in the class to benefit from the answer to your question. If you email me a question of general interest, I may post your question and my answer to the newsgroup. Matters of personal interest should be directed to email instead of to the newsgroup, e.g. informing me of an extended personal illness. Posting guidelines for the newsgroup are available on Desire2Learn.

Religious Holidays: It is the policy of the University to excuse the absences of students that result from religious observances and to provide without penalty for the rescheduling of examinations and additional required classwork that may fall on religious holidays.

Incompletes: The grade of I is intended for the rare circumstance when a student who has been successful in a class has an unexpected event occur shortly before the end of the class. I will not consider giving a student a grade of I unless the following three conditions have been met. 1. It is within two weeks of the end of the semester. 2. The student has a grade of C or better in the class. 3. The reason that the student cannot complete the class is properly documented and compelling.

Accommodation of Disabilities: The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodations in this course are requested to speak with the professor as early in the semester as possible. Students with disabilities must be registered with the Office of Disability Services prior to receiving accommodations in this course. The Office of Disability Services is located in Goddard Health Center, Suite 166, phone 405/325-3852 or TDD only 405/325-4173.