CPSC 4420/6420: ARTIFICIAL INTELLIGENCE

Basic Information

Sections

Sec: 4420-001, CRN: 87349 Clemson Campus
Sec: 6420-001, CRN: 87350 Clemson Campus
Sec: 6420-301, CRN: 82295 ICAR

Class meeting times

Tu/Th 5: 00 pm - 6: 15 pm

Class Location

- McAdams, Room #114
- ICAR Campus: TBD
- The class will be broadcast on Zoom.
  Meeting ID: 940 1374 9617
  Password: 4420
  Link: https://clemson.zoom.us/j/94013749617?pwd=Uy9uUUpMdlBJbjNIVVJpTlp5VW9jUT09

Instructors

Main Instructor: Abolfazl Razi, e-mail: arazi@clemson.edu [Only use this email for your communications]
Teaching Assistant: Hazim Alzorgan, e-mail: halzorg@g.clemson.edu
Instructor Office Hours:
Wednesday 9:30 am – 11:30 pm
Tuesday 3:30 pm – 4:30 pm
@McAdam#203, or online upon request
Extra Office hours: in-person and zoom by appointment with 24 hour prior request

TA Office Hours:
Monday 11:00 am – 12:00 pm
Thursday 2:00 am – 4:00 pm

Link: https://clemson.zoom.us/j/97922375554

Canvas link: https://www.clemson.edu/canvas

Course Overview

This course provides an introduction to fundamental concepts in Artificial Intelligence. Specific topics include uninformed and informed search techniques, game playing, Markov decision processes, reinforcement learning, uncertain knowledge and probabilistic reasoning, constraint satisfaction problems, and supervised learning. The course is suitable for undergraduate and

graduate students who would like to gain a solid theoretical and practical background in the basics of modern AI and will serve as the foundation for more advanced studies in AI and Machine Learning. This course is meant to be usable by students from different backgrounds as long as the perquisites are met. If we have more time, we may have the journal club component and optional project components.
The course will involve programming assignments in Python, homework assignments, quizzes, a midterm, and a final exam. Success in this course requires some Python programming experience and knowledge of basic computer science principles.

Learning Objectives

The main goal of the course is to expose students to the fundamental techniques and representative applications of modern AI, and to provide them with experience with implementing such techniques in real-world problems. A secondary goal for this course is that students develop and exercise the skills needed to prepare themselves for more advanced work in AI and other related application areas.
By the end of the semester, you will know how to build agents that plan and make autonomous decisions in different environments and settings. You will also be able to write algorithms that solve a variety of classification and regression problems such as recognizing images or articles of clothing and predicting house pricing. The techniques you learn in this course apply to a wide variety of artificial intelligence problems and will serve as a foundation for further study in AI and Machine Learning.

Course Delivery

The course will be offered as an in-person course on three campuses (Clemson main campus, ICAR in Greenville, and Zucker in Charleston). We may also offer a blended model that will involve both synchronous lectures, as well as flipped lectures if the Covid conditions get worse during the semester. In particular, the course will be delivered using:

- In person on two main campuses (McAdams Room #114, ORD CL1, ZGERC 104). This is the main attendance mode, and everybody is expected to attend in person unless under rare situations with the instructor's prior approval. Otherwise, the student will be considered absent.
- The class will also be broadcast on Zoom (information is given above). So the students can attend in real-time the lecture using Zoom if they have legitimate reasons to avoid the in-person class. All students are strongly urged to attend the class in-person, or in synchronous mode.
- Recorded lectures posted the same day or the day after the class on Canvas, Zoom, or Ensemble systems, mostly for students who missed real-time attendance.
- Occasionally pre-recorded lecture videos may be posted the same day or the day before the class on Canvas, with additional engagement during the day of the class in terms of brief Q&As, online quizzes, discussion, etc. This choice will be used, in rare cases and especially if the school goes to fully online mode due to the COVID pandemic.
- Extra reading material like lectures, tutorials, solutions to assignments, etc. posted by the instructor and TAs on Canvas as prerecorded videos and/or pdf documents.

Prerequisites

Official prerequisites include:
CPSC 1020 or CPSC 1070 or ECE 2220; and MATH 3020 or STAT 3090 or STAT 3300. Students must have earned a grade of C or higher in all prerequisite courses.

The students are also expected to have:

- Familiarity with basic principles of computer science and probability
- Some programming experience (all assignments will be in Python)

Textbooks

There is no required textbook for the course. Selected articles, course notes, and video lectures will be made available as the course goes on. The following books and resources are likely to be useful:

- Artificial Intelligence: A Modern Approach (3rd edition), S. Russel and P. Norvig (Available online at: http://aima.cs.berkeley.edu)
- Reinforcement Learning: An Introduction (2nd edition), R.S. Sutton and A.G Barto (Available online at http://www.incompleteideas.net/book/the-book-2nd.html)

Tentative Schedule/Topic List (subject to minor changes)

1. What is AI?
   - History of AI
   - The evolution of AI
   - Examples of AI in the modern era
2. Search
   - Uninformed search: depth-first search, breadth-first search, uniform cost search
   - Informed search: greedy search, A*, heuristics
   - A* and autonomous navigation
3. Game Playing
   - Minimax and alpha-beta pruning
   - Expectimax
   - Mastering games with AlphaZero
4. Constraint Satisfaction Problems
   - The map coloring problem
   - Backtracking search, arc consistency, dynamic ordering
   - Local search
5. Markov Decision Processes
   - Value iteration
   - Policy evaluation
   - Policy iteration
6. Reinforcement Learning
   - Temporal difference learning / Q-learning
   - Function approximation
   - Success stories of (deep) reinforcement learning
7. Uncertain Knowledge and Probabilistic Reasoning
   - Probabilities, Bayes rule

- Bayesian networks & inference
- Sampling in Bayes nets
- Hidden Markov models
- Particle filtering

8. Intro to Machine Learning
   - Gradient descent
   - Prediction with linear regression
   - Perceptrons and logistic regression
   - Activation functions
   - Neural networks
   - Image classification with (deep) neural networks
9. Advanced Topics
   - Beating ATARI games with DQN
   - Policy optimization for character control
   - Applications of AI to robotics, graphics, and computer vision
10. Conclusion
    - The future of AI. What's next?

Note 1: The syllabus and the offered content are tentative and subject to minor changes based on student feedback and based on the instructor's discretion.

Note 2: Some of the above content may not be covered as a regular lecture, but rather will be touched as extra reading materials, and journal club presentations.

Grading

Grading will be based on performance on a set of written and programming assignments, class quizzes, a mid-term, and a final exam or Term project. We also will offer opportunities for projects and presentations for extra credits after the instructor's approval.

The grade breakdown is as follows:

- Written/Programming Assignments: 25%
- Quiz and Class Activity: 25% (Includes attendance)
- Two In-class Exams: 25% (15% for highest, and 10% for lowest)
- Final Exam or Term Project: 25%
- Journal Club: Up to 5% Extra Points

A	90% – 100%
B	80% – 90%
C	65% – 80%
D	50% – 65%
F	0% – 50%

The instructor may adjust grades upward based on class participation, extra credit, etc.

Note 1: There will be some lecture content and extra problems in assignments, quizzes, and exams only for graduate students.

Note 2: joining Journal Club is optional but highly recommended, especially for graduate students.

Note 3: Students can choose between the Final Exam and Term Projects.

Assignments
Most assignments involve developing software in Python. Some other assignments may involve problem-solving and conceptual questions. For some programming assignments, a starter code may be given. Each assignment is centered around an application and will help you deepen your understanding of the theoretical concepts covered in class. Only online submissions are permitted.

The deadlines are strict, and no quiz/assignment will be accepted after the due date. Under emergency cases with a strong personal excuse, the instructor may accept a late submission (for assignment) after receiving the student's **request prior to the deadline**. These decisions will be made on a case-by-case basis, so I encourage you to submit your request ahead of time. If the student provides a legitimate excuse and the instructor approves a late submission, *a late penalty of 5% per day until a maximum of 5 days will be incurred*. To be on time, I encourage you to submit the work a few hours before the deadline, so you don't run into last-minute problems.

All assignments are individual unless the instructor explicitly allows teamwork (work in pair). It is ok to share your thoughts and initiate discussions in Canvas, Discord, and class sessions, but ultimately y*ou must work by yourself and submit your own answers. Any copy and plagiarism will face severe consequences.*

The assignments will be graded using a 100-point scale. For teamwork, both students will receive the same points. The final programming assignment average will be computed by averaging the student's assignment scores, excluding one assignment with the lowest grade.

The details of each assignment are subject to change, but here is a list of the type of typical projects that will be assigned:

- *Grid Search*
- *Playing connect four.*
- *gent Control Using Q-Learning*
- Car Localization and Tracking
- Linear and Logistic Regression
- *Digit Classification*

Quiz
We will have in-class and take-home quizzes, with and without prior notice. In-class quizzes will be assigned during the class and the submission will be either online or in-person, depending on the quiz type, and students' preference. We will have individual and group quizzes. The individual quiz content will be mainly from topics covered in the last few sessions. However, group quizzes may include questions from the content covered in the same session. The questions will help me gauge the learning progress of students in the class and will help you deepen your grasp of the class

lectures by teamwork and understanding the areas on which you need to work more. Take-home quizzes will be assigned during the session and must be submitted by the assigned deadline, which will be in a few days. *No quizzes will be accepted after the deadline*. Each quiz will typically consist of multiple questions and will be graded on a 100-point or 10-point scale.

The final quiz average will be computed by averaging the student's quiz scores excluding the one with the lowest grade.

In-class Exam
We will have two in-class exams to be taken in Late September and Early November. The exact date will be announced at least 1 week ahead of time. The exam will cover material from all lectures, quizzes, and programming assignments covered by then. The exam will consist of a mix of short answers, problem-solving, and essay-style questions. A programming part may be included as a take-home part. The exam will be taken in person, at the same time for all students.

Final Exam
The final exam will be cumulative and will cover material from all lectures, quizzes, and programming assignments. The exam will consist of a mix of short answers and essay-style questions. Short answers will require at most a short paragraph, and/or a figure to answer. Essay questions will ask you to extend or combine basic ideas and algorithms from class. The final exam format will be announced later but will be at the same time for all students.

The tentative date is according to Clemson Calendar (Thursday, December 14th , 7:00 pm – 9: 30 pm) unless another date is announced by the instructor.

Note: The students can choose to take Final Exam or Term Projects.

Term Project
The term project is optional and replaces the final exam. The terms project will be similar to the programming assignments with some more aspects to it. Sample topics will be provided by the instructor by the students can also offer a project topic. Projects can be individual, or team-based. The best choice would be a team of undergraduate students led by a graduate student to work on a problem related to the role of AI in unmanned vehicles. Each team will offer 3 deliverables, including a 5-page final report, a 15-minute presentation, and the developed source code. Projects may involve Python programming, RL/QL, robotics simulator ROS/Gazebo, etc. More details and time-plan will be provided in the class.

We will make arrangements that all teams to present in regular class time, but we may also need to set up extra make-up sessions for presentations. Attendance beyond regular class times, if happens, will be optional. More details about the expectation, timeline, and evaluation will be provided in the class.

Note: The students can choose to take Final Exam or Term Projects.

Journal Club

We will have Journal clubs on a volunteer basis and will reward extra credits (up to 5% of the final grade). The presentations will be in regular class time, but we may also plan to have separate sessions of Journal clubs if most students join the club. Presentation is optional but attending JC sessions is not. All students are expected to attend JC sessions in regular class time, but attending JC sessions beyond the regular class times is optional. This activity can be individual or team-based. I encourage all students, especially graduate students to participate in this activity. The process is easy. The instructor will provide a list of topics.

Also, students are welcome to suggest their own topic (related to AI and content covered in the class, including tree/graph search algorithms, MDP, constraint satisfaction problems, RL and Q learning, deep Q learning, adversarial search, MCTS, etc.). Considering the recent advances in AI tools, you can also opt for presenting newly emerged AI tools/enterprises and make a presentation on its use cases and present some novel findings. You can also make comparisons between similar tools and draw your own conclusions, or you can develop an interface/script to communicate with these AI tools and present some results. Some of the tools include, but are not limited to ChatGPT, Bard, Claude2, Facebook SAM (segment anything), Copy.AI, X.AI, Midjourney, Synthesia, Pictory AI, Mojo, ….

After the topics are approved and finalized by the instructor, the team's job will start. Each team is expected to read a few papers on the selected topic and make a short presentation for the class (10 min for individual presentation and 15 min for teamwork). You can consult the instructor to find the right papers. In addition to the summary of content from the papers, a good presentation would involve the student's ideas, criticisms, and thoughts on the topic. Demonstrations and programming are not necessary but will reward extra credit. The evaluation will be based on the instructor's observation as well as student feedback based on a rubric to be provided by the instructor.

Grading Differences Between 4000 and 6000

Graduate students at the 6000 level may have been asked to complete more questions and problems from advanced material in assignments, quizzes, and exams. These questions will reward extra points for undergraduate students who enrolled in the 4000-level session. Note that I expect all graduate students to be enrolled in the 6000-level session, and all undergraduate students to be enrolled in the 4000-level session. Let me know if it is otherwise because we may need you to switch the session.

COVID-19 related information

Notification of Absence

For a student who reports testing positive for COVID-19 or is being asked to quarantine/isolate because of exposure to the virus, it will be up to the student to inform the instructor. Students are directed to use the Notification of Absence module in Canvas to initiate this notification. Additional communication via email is encouraged; students should follow up with their instructor to develop a continued plan of study for each course. The instructor and the students will follow the CDC guidelines and the university policy.

Use of Masks for In-Person Classes
Students physically present in class will be encouraged (required if that would be the university policy) to wear a face mask during lectures. Please be familiar with the additional information on the Healthy Clemson website (https://www.clemson.edu/covid-19/), such as the use of disinfectant wipes for in-person classes. If the mask is required, and a student does not have a face covering or refuses to wear an approved face covering without valid documented accommodation, the instructor will ask the student to leave the academic space and may report the student's actions to the Office of Community & Ethical Standards as a violation of the Student Code of Conduct.

Policies

Attendance
Roll will be taken for the first one or two weeks while the class roll fluctuates. Attendance is mandatory and it (along with class discussions and activities) will account for 5% of your final points. We will also have in-class quizzes, so you will lose points if you skip a class. Absence, excused or not, does not change the responsibility for assigned work. The course staff strives for a lively and inclusive course, encouraging active, informed participation in classroom and Canvas discussions, quizzes, and homework reviews. If you can not attend a class, please submit the absence form at least 24 hours before the class.

Class Cancellation
Students are expected to wait for 15 minutes after the beginning of class before leaving if the instructor is late.

Assignment Late Policy
No late submissions will be accepted for assignments and take-home quizzes. Under emergency conditions, the instructor may or may not approve your late submission, and even in this case, a late penalty of 5% of total points will be applied for each of the first five days that an assignment is submitted late. All extension requests should be submitted before the deadline.

Re-Grade Requests
A student may request a regrade of an assignment within 3 days of the assignment feedback being returned or posted. For a re-grade request, a student should email their course instructor with a detailed justification for the re-grade. Please note your lecture instructor or TA will regrade your entire assignment. Thus, your re-grade could result in a higher or lower grade.

Academic Integrity
As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a "high seminary of learning". Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately and expeditiously to charges of violations of academic integrity.

Accessibility Statement

Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the professor know, and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848 or by emailing studentaccess@lists.clemson.edu. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here at http://www.clemson.edu/campus-life/campus-services/sds/ .

Non-Discrimination Policy
Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is located at http://www.clemson.edu/campus-life/campus-services/access/title-ix/ . Ms. Alesia Smith is the Clemson University Title IX Coordinator and the Executive Director of Equity Compliance. Her office is located at 110 Holtzendorff Hall, 864.656.3181 (voice) or 864.565.0899 (TDD).

Inclement Weather Policy
If a class is cancelled due to inclement weather, the instructor will make alternative arrangements for submitting work that was due that day. Please see Canvas for details on assignments and quiz deadline extensions.

Academic Continuity Plan
Clemson has developed an Academic Continuity Plan for academic operations. Should the university administration officially determine that the physical classroom facility is not available to conduct classes, classes will be conducted in a virtual (online) format. The University issues official disruption notifications through email /www /text notification/Social Media.
When notified, use one of the following links to navigate to Clemson Canvas where you will find important information about how we will conduct class:
Primary access link: www.clemson.edu/canvas
Secondary access link, if needed: https://clemson.instructure.com/
You can also use the Canvas Student App.

Our activities for teaching and learning will occur through our Canvas course. This includes: handout materials, and/or online real-time lectures, and/or video recorded lectures, and/or online quizzes.

Tech Support
If you have trouble with Canvas or another university system, check here first: Clemson System Status (https://status.ccit.clemson.edu/).

CCIT's IT Support Center offers a wide range of support options and hardware repair with several contact methods to help you answer your questions as quickly as possible:

- Phone: (864) 656-3494
- Email: ITHelp@clemson.edu
- Chat: Live Online Chat (http://support.clemson.edu/)
- Web Form: Help Request Form (https://ccit.clemson.edu/support/get-help#help-req-form)
- Troubleshoot: Knowledge Base (https://ccit.clemson.edu/support/kb/kb-login/)
- Everything CCIT Does: Browse Services (https://ccit.clemson.edu/services)

Academic Success Center
The Academic Success Center (https://www.clemson.edu/asc/) offers a variety of free learning and success services for all undergraduate students that include

Mastery of course content

- Tutoring – students can expect a 1:1 meeting with a trained undergraduate peer leader (who made an A or B in the course and was recommended by a faculty member) during which the student can share specific questions they have about course content with the tutor focused on helping the student, through questioning techniques and identification of helpful learning strategies, and master course concepts. Tutors do not help with homework or other class assignments.
- Peer-Assisted Learning (PAL) – students can expect collaborative and active group learning and study sessions focused on mastery of course content and learning strategies that is facilitated by a trained undergraduate peer leader (who made an A or B in the course and was recommended by a faculty member). PAL leaders do not help with homework or other class assignments.

Copyright Notice
Materials used in the course may be copyrighted and are intended for use only by students registered and enrolled in the course for the duration of the course. They may not be retained in another medium or disseminated further.

Syllabus Update Policy
The instructor plans to follow the offered syllabus and make minimal changes to it. However, some minor changes may be required to adapt to the students learning pace and cover new material. Therefore, the instructor reserves the rights to make changes to the syllabus at any times.