

CS 4710 Artificial Intelligence

Spring 2020

Instructor: Haifeng Xu

TTh 9:30-10:45pm, Rice Hall 130

1 Overview

Artificial Intelligence (AI) is an exciting field that has enabled a wide range of cutting-edge technology, from driverless cars to grandmaster-beating Go programs. The goal of this course is to introduce the basic ideas and techniques underlying the design of intelligent computer systems. Topics covered in this course are broadly be divided into 1) planning and search algorithms, 2) probabilistic reasoning and representations, 3) machine learning, and 4) multi-agent systems (although, as you will see, it is impossible to separate these ideas so neatly). Within each area, the course will also present practical AI algorithms being used in the wild and, in some cases, explore the relationship to state-of-the-art techniques. The class will include lectures connecting the models and algorithms we discuss to applications in robotics, computer vision, digital markets, and related domains.

Specific topics covered include classical graph search methods, constraint satisfaction problems, Markov decision processes, reinforcement learning, probability theory, Bayes nets, hidden Markov models, filtering, basic optimization, classification, and regression, multi-agent systems. The course will provide a good foundation for topics covered in advanced AI courses. CS 4710 complements CS 4774. In particular, CS 4774 emphasizes *machine learning*, which is part (though probably the most hot part currently) of AI, whereas CS 4710 provides a *more comprehensive overview of the whole AI landscape*. Students who take both CS 4710 and CS 4774 will have a solid background for understanding and contextualizing modern AI research and experience implementing algorithms in several key areas of the field.

Finally, in spite of its practical usefulness this course is also quite fun. AI also has a long history of research into topics like puzzle-solving, game-playing, robotics, and conversational chat-bots. In this spirit, problem sets will include programming intelligent robot/game agents.



Learning Outcomes Students completing this course should be able to:

- choose the appropriate representation for an AI problem or domain model, and construct domain models in that representation,
- choose the appropriate algorithm for reasoning within an AI problem domain,
- implement and debug core AI algorithms in a clean and structured manner,
- design and analyze the performance of an AI system or component,
- describe AI algorithms and representations and explain their performance,
- and critically read papers on AI systems.

2 Tentative Schedule

Below is a *tentative* schedule for the semester. Please refer to the updated weekly course schedule posted on UVA Collab.

Date	#	Topic	Reading	Assignments
1/14/2020	1	Introduction to AI	AIMA 1, (2)	P0: Python and Math Review
1/16/2020	2	Uninformed Search	AIMA 3.1-3.4	
1/21/2020	3	A* and Heuristics	AIMA 3.5, 3.6	P0 due @ 5 PM; P1: Search
1/23/2020	4	Adversarial Search and Games	AIMA 5	
1/28/2020	5	Constraint Satisfaction Problems I	AIMA 6.1	
1/30/2020	6	Constraint Satisfaction Problems II	AIMA 6.2-5	
2/4/2020	7	Local Search	AIMA 4.1-3	P1 due @ 11:59 PM; P2: Games/CSPs
2/6/2020	8	Markov Decision Processes 1	AIMA 17.1-3, S&B 3-4	
2/11/2020		AAAI Conference, No Class		
2/13/2020	9	Markov Decision Processes 2		
2/18/2020	10	Reinforcement Learning 1	AIMA 21, S&B 6.1-3,5	P2 due @ 11:59 PM; P3: MDPs/RL
2/20/2020	11	Reinforcement Learning 2	''	
2/25/2020	12	Hidden Markov Models 1	AIMA 13.1-5, 15.2-5	
2/27/2020	13	Hidden Markov Models 2		P3 due @ 11:59 PM;
3/3/2020	14	Ethics in AI		
3/5/2020		Midterm #1 Covering L1-11		
3/10/2020		spring break		
3/12/2020		spring break		
3/17/2020	15	Bayes Nets 1	AIMA 14.1-2	Project Proposal Due @ 11:59 PM; P4: Bayes/Classify
3/19/2020	16	Bayes Nets 2	AIMA 14.4-5	
3/24/2020	17	Classification	AIMA 18.1-2	
3/26/2020	18	Regression	AIMA 18.6	
3/31/2020	19	Clustering	AIMA 18.8	Project Update Due @ 11:59 PM
4/7/2020	20	Multi-Agent Systems	S&LB 2.1-3	P4 due @ 11:59 PM; P5: game theory
4/9/2020	21	Game Theory 1	S&LB 3.1-3	
4/14/2020	22	Game Theory 2	S&LB 11.1	
4/16/2019	23	Bayesian Optimization + Course Wrapup		
4/21/20	24	TBD (guest lecture or some fun topics)		P5 due @ 11:59 PM
4/23/2020		Midterm #2 Covering L12 - 23		
4/28/2020		Project Poster Presentation	Location TBD	Poster Presentation @TBD
				Project report due 05/08/2020 @ 11:59 PM

3 Course Requirements

The course has several components:

- Two in-class midterm exams (40%)
- Six problem sets; each will have a programming part (optionally done in pairs) and written/analytical part (to be done individually) (35%)
- A final project (done in groups of 2-4) (25%)

Final grades take into account each component. You must achieve a passing grade in all components to pass this course. Although we won't publish hard grade cutoffs, just note that to receive an "A" you must have high performance in all categories.

Readings Each class meeting is preceded by a reading assignment, which will be assumed during the lecture and discussion in class. You should set aside 2 hours to complete each reading. We do not expect you to fully understand everything before coming to class, but the goal is to prepare for class, familiarize yourself with new terminology and definitions, and to determine which part of the subject you want to hear more about. We encourage you to bring questions to class about material that is confusing. Other students might share your confusion.

Problem Sets The 6 problem sets (P0–P5) will be published on UVA Collab. Most problem sets have two components: programming and written. The programming part can be done in pairs or individually. The written part will focus more on conceptual/analysis questions and must be done individually. Computational assignments will ask you to develop implementations of algorithms discussed in class. We expect that all code will run, be well-written and be commented appropriately. All problem sets will be submitted through Collab.

Collaboration Policy Each assignment will include a programming component and a written component. HW0 (more of an entrance test) must be done individually. *HW1–5 can be done and submitted in pairs.* This implies writing the code and homework together and both submitting the same HW and receiving the same grade. You will need to mention the name of your partner on the homework, and you can work with different partners for different HWs. Note that we will treat pairs/non-pairs the same from a grading perspective. We expect you and your partner to implement and write the solutions together. You may also consult with your classmates in other groups as you work on the problem, but you should not talk in terms of pseudocode or real code, and you should not share answers. In addition, you must cite any books, articles, websites, lectures, etc. that have helped you with your work. If you are doing the HW individually, then the same rules apply: talking is ok, sharing answers is not. Note that understanding the concepts in HWs is important for the exams.

Late days Each student is allotted a total of **five** late days for use on problem sets. A late day extends the due date by **24 hours** and a **maximum of 2 late days** can be used towards any individual assignment. Weekends are not counted as late days. If you have used up your 5 late days, you will be penalized 25% per day, up to two days max, with no credit after two days.

In cases of medical or other emergencies which interfere with your work, have your Resident Dean contact the instructor. Any grading disputes on written assignments must be submitted as Piazza private messages *within one week of the grades being posted* after which the grade is final. Except in extraordinary circumstances, *no regrades will be accepted on programming assignments*. The work in question will be fully regraded and the grade may go up or down as a result. Programs will be graded based on correctness, performance and documentation. Written components will be graded based on correctness, depth of analysis, and clarity.

Late days *cannot* be used on any of the components of the final project.

Exams There are two in-class midterm exams (closed book, no notes), one covering the first half of the course material and the second covering the second half of the course material. See the schedule for dates and topics covered. The exams are in-class because we want to leave sufficient time for you to complete the final project during the examination period, described as follows.

Final Project During the second half of the course students will design and carry out a final project in groups of 2-4 students. The final project is of your choosing: it can describe a system you have built or discuss more theoretical issues or even survey cutting edge work in an active area of AI research. We will provide a list of potential topics. Most people who have taken the course consider this one of the most fun and rewarding parts of the course, and we hope you'll have fun with it too. Students will have to submit a proposal, an update, and give a poster presentation which will all allow the teaching staff to provide feedback before submission of the final report at the end of examination period. Attendance at the poster session is mandatory.

Note: All group members will receive the *same score* for a project. Thus it is your responsibility to find collaborative partners to work together on the project. In the past, we have received complaints about some group members not doing the work. You should try to *figure out this as early as possible and, if necessary, re-organize the group*. For such situations, we cannot do much from our side unfortunately, especially when it comes close to the end of the semester.

4 Other Related Statements

Diversity and Inclusion In an ideal world, science would be objective. However, much of science is subjective and is historically built on a small subset of privileged voices. We acknowledge that it is possible that there may be both overt and covert biases in the material due to the lens with which it was written, even though the material is primarily of a scientific nature. Since integrating a diverse set of experiences is important for a more comprehensive understanding of science please contact the course staff (in person or electronically) or submit anonymous feedback if you have any suggestions to improve the quality of the course materials.

We would like to create a learning environment that supports diversity of thoughts, perspectives, and experiences, and honors your identities. If you have a name and/or set of pronouns that differ from those that appear in your official records, please let us know! If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to contact us.

Honor code (Adapted from [Honor Syllabus Example Statement of UVA](#)) I trust every student in this course to fully comply with all of the provisions of the University's Honor Code. By enrolling in this course, you have agreed to abide by and uphold the Honor System of the University of Virginia, as well as the policies specific to this course. All suspected violations will be forwarded to the Honor Committee, and you may, at my discretion, receive an immediate zero on that assignment regardless of any action taken by the Honor Committee.

Please let me know if you have any questions regarding the course honor policy. If you believe you may have committed an Honor Offense, you may wish to file a Conscientious Retraction by calling the Honor Offices at (434) 924-7602. For your retraction to be considered valid, it must, among other things, be filed with the Honor Committee before you are aware that the act in question has come under suspicion by anyone. More information can be found at [here](#).

Students with disabilities or learning needs We thrive to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Students with disabilities may also wish to work with the Student Disability Access Center to discuss a range of options to removing barriers in this course, including official accommodations. Please visit their website for information on this process and to apply for services online: sdac.studenthealth.virginia.edu. If you have already been approved for accommodations through SDAC, please send me your accommodation letter and meet with me so we can develop an implementation plan together.

Discrimination and power-based violence The University of Virginia is dedicated to providing a safe and equitable learning environment for all students. To that end, it is vital that you know two values that I and the University hold as critically important:

- Power-based personal violence will not be tolerated.
- Everyone has a responsibility to do their part to maintain a safe community on Grounds.

If you or someone you know has been affected by power-based personal violence, more information can be found on the UVA Sexual Violence website that describes reporting options and resources available - <https://eocr.virginia.edu/>

As your professor and as a human, I care about you and your well-being and stand ready to provide support and resources as I can. As a faculty member, I am required by University policy and federal law to report what you tell me to the University's Title IX Coordinator. The Title IX Coordinator's job is to ensure that the reporting student receives the resources and support that they need, while also reviewing the information presented to determine whether further action is necessary to ensure survivor safety and the safety of the University community. If you wish to report something that you have seen, you can do so at the [Just Report It portal](#). The worst possible situation would be for you or your friend to remain silent when there are so many here willing and able to help.

Religious accommodations It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements.

Students who wish to request academic accommodation for a religious observance should submit their request in writing directly to me via Email as far in advance as possible. Students who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the University's Office for Equal Opportunity and Civil Rights (EOCR) at UVAEOCR@virginia.edu or 434-924-3200.