IE 598 Special Topics

Dynamic Programming and Reinforcement Learning

Instructor: Yingying Li
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Time & Place: Tuesday/Thursday 2:00pm–3:20pm
1304 Siebel Center for Computer Science

Attendance: Pending future campus announcements, lectures will be in person when possible except during the times where the instructor is traveling. Remote lectures over Zoom will be recorded.

Office Hours: Wednesday 2pm–3pm or by appointment

Textbook: Bertsekas, Dimitri. Dynamic programming and optimal control: Volume I and II

Grading: Assignments, 50%; Midterm exams, 30%; Final project, 20%.

Homework: Every other week before the midterm,
one assignment + one quiz or two assignments after midterm.

Assignments are due at the class on Thursdays.

Assignments may be discussed with other students. However, students are expected to submit **independent write-ups** and **independent code** for computer assignments. Assignments may be checked for similarity.

Midterm dates: TBD
The use of any electronic device will **not** be allowed during examinations.

Modifications: The instructor reserves the right to modify any and all parts of this syllabus throughout the semester. Any modifications will be announced to the students and posted on the course website.

Final project: There will not be a final exam. Instead, there will be a final project. For the project, the students are expected to participate in groups and present their results at the final presentation (dates TBD). The students are also expected to submit a final report.

Course Description

This course will discuss the algorithm design, theoretical analysis, and simulations of dynamic programming (DP) and reinforcement learning (RL) in either finite horizon or infinite horizon, with either full observations or partial observations. Most discussions will focus on the tabular case. DP and RL with function approximations will also be introduced if time permits.

Prerequisites

MATH 257, MATH 415, or equivalent course on linear algebra and MATH 362, MATH 461, or equivalent course on probability.

List of Topics (tentative)

- Principle of optimality introduction
- Deterministic, minimax, & shortest path problems
- Review: Markov chains
- Stochastic problems: Bellman equation & value iteration
- Stochastic shortest path
- Finite horizon linear quadratic control
- Imperfect state information
- Linear quadratic Gaussian and Kalman filter
- Infinite horizon problems: discounted case and averaged case
- Value iteration,
- Policy iteration
- Infinite-horizon stochastic linear quadratic control
- Q-learning
- Approximate dynamic programming
- Policy gradient methods
- Review: concentration inequalties
- Multi-armed bandit

Campus Policies

Covid: Please visit: https://covid19.illinois.edu/on-campus/on-campus-instructors/#responsibilities

Emergency Response Recommendations: Emergency response recommendations can be found at the following website:

http://police.illinois.edu/emergency-preparedness/

You are encouraged to review this website and the campus building floor plans website within the first 10 days of class:

http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/

Academic Integrity: Students are expected to adhere to the Student Code:

http://studentcode.illinois.edu

and in particular, *Article 1, Part 4: Academic Integrity*.

Academic dishonesty will result in a sanction proportionate to the severity of the infraction, with possible sanctions described in 1-404 of the Student Code (https://studentcode.illinois.edu/article1/part4/1-404/). Every student is expected to review and abide by the Academic Integrity Policy as defined in the Student Code: https://studentcode.illinois.edu/article1/part4/1-401/. As a student it is your responsibility to refrain from infractions of academic integrity and from conduct that aids others in such infractions. A short guide to academic integrity issues may be found at https://provost.illinois.edu/policies/policies/academic-integrity/students-quick-reference-guide-to-academic-integrity/. Ignorance of these policies is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

In this course you are expected to produce your own work in all assignments. Written assignments will be submitted through SafeAssign, a software tool that compares your writing against a large database as well as to the work of your current classmates and previously submitted assignments. Assignments with close matches to other work will be flagged and investigated.

In this course the use of calculators or electronic devices (cell phones or others) will **not** be allowed during examinations. If you are found using one, it will be investigated as potential cheating.

Religious Observances: In the case of missed exams or project presentations for religious observations, students should complete the *Request for Accommodation for Religious Observances* form:

https://cm.maxient.com/reportingform.php?UnivofIllinois&layout_id=19

Please make requests for absence letters as early as possible in the semester.

Privacy & FERPA: Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See

https://registrar.illinois.edu/academic-records/ferpa/

for more information on FERPA.

Accommodations: To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the as soon as possible. To ensure that disability-related concerns are properly addressed from the beginning, students with disabilities who require assistance to participate in this class should contact Disability Resources and Educational Services (DRES) and see the instructor as soon as possible. If you need accommodations for any sort of disability, please speak to me after class, or make an appointment to see me or see me during my office hours. DRES provides students with academic accommodations, access, and support services. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TDD), or e-mail disability@illinois.edu. For more information, please visit:

http://www.disability.illinois.edu/

Misconduct Reporting: The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here:

http://wecare.illinois.edu/resources/students/#confidential

Other information about resources and reporting is available here:

http://wecare.illinois.edu