MATH 6397: Probabilistic Methods in Reinforcement and Machine Learning

Lectures: TTh 4 − 5:20 in SEC 201

Instructor: Krešimir Josić
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Office Hours: Will be announced and by appointment
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Prerequisites:

Undergraduate calculus sequence, undergraduate probability, differential equations and two semesters of linear algebra.

Text:

There is no single textbook for this course, but I will follow the exposition in Kevin P. Murphy's books entitled "Probabilistic Machine Learning". In particular, I will focus on the second book (Advanced Topics). These books are pricey, but are worth the money if you are interested in the topics covered. The following references will also be helpful: R. Sutton and A. Barto. "Reinforcement learning: An introduction" (2018), D. MacKay "Information Theory, Inference, and Learning Algorithms", and S. Amari, "Information Geometry and Its Applications" (2016). I will also share a number other resources.

Topics Covered:

This course is an introduction to topics that are useful in designing learning algorithms with a focus on action, as well as understanding how makes these algorithms work, and how they could be implemented both in computers, and in brains. I will cover a number of different topics: 1) Introductory material with a focus on Bayesian inference, 2) Filtering, smoothing and prediction, 3) Markov decision processes, and reinforcement learning, 3) Machine learning and neuroscience, and, time permitting, 4) Information theory and information geometry with applications.

Viewing and Reading Assignments:

I will send reading assignments via email and Slack. For each class I will assign some reading, and potentially some lectures to watch. I will send the assignment via Slack and email. I expect you to view this before each meeting, and will occasionally give you a quiz. **Part of your grade will be determined by your score on this quiz.**

Computational component:

An important part of the course is to understand how different techniques are implemented. I will ask you to do this in Python, whenever possible. The code is available online, and you will have a brief presentation where you will explain how the different ideas were implemented. I will assign 3-4 people to present with possible extensions to the code each week. Your grade will be based on these presentations, and you can expect to have a turn every few weeks.

Even though you may not be presenting, it is important that you all do the assigned exercises!

Python: There are numerous helpful tutorials to help you get started with Python. Please use the Jupyter environment, as it makes the presentation a lot easier to follow.

How to get in touch with me:

The best way to get in touch with me is via Slack if you have a quick question. I will set up a Slack channel for the course where you can discuss programming challenges and other questions. You can also contact me by email. Quick questions may be better suited for Slack, but I don't mind emails.

Project:

There will be a research project for the course. You will be able to choose your own topic (as long as it is within the scope of the course). I am also happy to suggest a topic.

Because of the number of students in the course I will ask you to form teams of 3 students for each project.

Attendance:

Attendance is strongly encouraged. Each meeting will consist of an overview of the reading assignment and discussion. I may ask students to come up to present part of the derivation. This will be followed by the presentation and discussion of the implementation by the students.

Homework Assignments:

I will give about 4 assignments with exercises largely taken from the book by Kevin Murphy.

Grades:

Grades will be assigned on the following basis:

35%	class participation and presentations
35%	homework assignments
30%	project

Academic Honesty:

Dishonesty includes cheating on your homework, falsifying data, and misrepresenting the work of others as your own (plagiarism). I will take all instances of academic dishonesty very seriously. I urge you to read the sections of the student handbook discussing academic dishonesty and the disciplinary actions it entails.

Counseling and Psychological Services:

Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to college, or feeling sad or hopeless. You can reach CAPS (www.uh.edu/caps) by calling 713- 743-5454 during and after business hours for routine appointments or if you or someone you know is in crisis. No appointment is necessary for the Lets talk program, a (virtual) drop-in consultation service at convenient locations and hours around campus.

COVID-19 Information:

If you are experiencing any COVID-19 symptoms that are not clearly related to a pre-existing medical condition, do not come to class. Please see Student Protocols for what to do if you experience symptoms and Potential Exposure to Coronavirus for what to do if you have potentially been exposed to COVID-19. Consult the (select: Undergraduate Excused Absence Policy or Graduate Excused Absence Policy) for information regarding excused absences due to medical reasons.

Students are encouraged to visit the Universitys COVID-19 website for important information including diagnosis and symptom protocols, on-campus testing, and vaccine information. Please check the website throughout the semester for updates.

Vaccinations:

Data suggests that vaccination remains the best intervention for reliable protection against COVID-19. Students are asked to familiarize themselves with pertinent vaccine information and to consult with their health care provider. The University strongly encourages all students, faculty and staff to be vaccinated. Reasonable Academic Adjustments/Auxiliary Aids The University of Houston complies with Section 504 of

the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, pertaining to the provision of reasonable academic adjustments/auxiliary aids for disabled students. In accordance with Section 504 and ADA guidelines, UH strives to provide reasonable academic adjustments/auxiliary aids to students who request and require them. If you believe that you have a disability requiring an academic adjustments/auxiliary aid, please contact the Justin Dart Jr. Student Accessibility Center (formerly the Justin Dart, Jr. Center for Students with DisABILITIES).

Excused Absence Policy:

Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston Undergraduate Excused Absence Policy and Graduate Excused Absence Policy for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and

University-sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional policies address absences related to military service, religious holy days, pregnancy and related conditions, and disability.

Recording of Class:

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the Justin Dart, Jr. Student Accessibility Center. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructors recordings for their own studying and notetaking. Instructors recordings are not authorized to be shared with anyone without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Syllabus Changes:

Due to the changing nature of the COVID-19 pandemic, please note that the instructor may need to make modifications to the course syllabus and may do so at any time. Notice of such changes will be announced as quickly as possible through (specify how students will be notified of changes).