Winter 2024

CS 237B: Principles of Robot Autonomy II

Instructors:
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Location and time: Packard 101, Monday and Wednesday, 1:30pm – 2:50pm.

Office Hours:
Prof. Bohg: Wednesdays, 9:00am – 10:00am in Gates 244 and on Zoom.
Prof. Pavone: Tuesdays, 1:00pm – 2:00pm in Durand 261.
Prof. Sadigh: Fridays, 9:00am – 10:00am in Gates 246 (or by appointment).
Course assistants:
Mondays from 10:00am to 11:30am (Tanmay, Gates 287)
Tuesdays starting week 2 from 10:30am to 12:00pm (Claire, Gates 200)
Wednesdays from 10:00am to 11:30am (Tanmay, Zoom)
Wednesdays from 4:30pm to 6:00pm (Abhyudit, Gates 287)
Fridays from 9:30am to 11:00am (Abhyudit, Zoom)

Units: 3 or 4. Taking this class for 4 units entails additionally presenting a paper at the end of the quarter, with details to be announced later.

Prerequisites:

- Familiarity with basic techniques for robot autonomy (e.g., AA274A or equivalent).
- Familiarity with programming (e.g., CS 106A or equivalent) and Python.
- College calculus, linear algebra (e.g., CME 100 or equivalent).

- Basic probability and statistics (e.g., CME 106 or equivalent).

Course websites:

- For course content and announcements: `https://cs237b.stanford.edu`
- For course-related questions: `https://edstem.org/us/courses/51553/discussion/`
- For homework submissions: `https://www.gradescope.com/courses/696498`
- For lecture videos: `https://canvas.stanford.edu/courses/182770`
- For urgent questions: `cs237b-win2324-staff@lists.stanford.edu`

Textbooks: There is no required textbook.

Course Content: This course teaches advanced principles for endowing mobile autonomous robots with capabilities to autonomously learn new skills and to physically interact with the environment and with humans. Concepts that will be covered in the course are: Reinforcement Learning (RL) and its relationship to optimal control, contact and dynamics models for prehensile and non-prehensile robot manipulation, imitation learning and human intent inference. Students will learn the theoretical foundations for these concepts.

Course Goals: With this course, students will obtain a fundamental understanding of advanced principles of robot autonomy, including robot learning, physical interaction with the environment, and interaction with humans.

Course Structure and Homework Policy: The class comprises three modules, roughly of equal length, namely:

1. learning-based control and perception (01/08 – 01/29);
2. interaction with the physical environment (01/31 – 02/21);
3. interaction with humans (02/14 – 03/11);

There will be a total of **three** problem sets. Rules:

- Because of the multiple topics that will be pursued in the course, it is important to keep up with the assignments. To account for unforeseen extraordinary circumstances, students are given a total of 6 free late days that may be used for the homeworks; a maximum of 3 late days will be allowed on a given assignment.

- Cooperation is allowed in doing the homework. You are encouraged to discuss approaches to solving homework problems with your classmates, however **you must always prepare the solutions on your own**. You **must** write on your problem set the names of the classmates you worked with. Copying solutions, in whole or in part, from other students or any other source will be considered a case of **academic dishonesty**.
- **Homework submissions must be typeset** (e.g., in LaTeX or Word.)

Exams: Exams will be held in person from 5:00 - 6:00pm PT.

For SCPD students: The exams will be taken remotely. They will be released at 12:00am (midnight) PT and they will be available until 12:00am PT the next day. The students are expected to complete and submit their work in a time interval within this time period (e.g. students have 1 hour to complete the exam, but they can choose any 1 hour interval from midnight to the deadline). Timestamps will be used to check the start and the end times for each student.

Further details will be announced when they are finalized.

Participation on Ed: Ed will be the main tool for class discussion. A student will get an extra point each time they (1) ask a question about lecture material; (2) answer a question about lecture material; or (3) answer a question about homework. Questions or answers should be endorsed by one of the CAs in order to receive credit. A student can accrue a maximum of five extra points.

Course Grade Calculation:

- (60%) homework.
- (40%) exams (for each student, the lowest exam grade will be dropped).
- (extra 5%) participation on Ed.

Schedule: subject to some slippage

Date	Topic	Assignment
01/08	Course Overview, Intro to ML for Robotics	
01/10	Neural Networks and TensorFlow Tutorial	
01/12		HW1 out
01/15	Martin Luther King, Jr. Day (no classes)	
01/17	Markov Decision Processes	
01/22	Intro to RL	
01/24	Model-based and Model-free RL for Robot Control	
01/29	Learning-based Perception	
01/31	Fundamentals of Grasping and Manipulation (1)	
02/02		HW1 due, HW2 out
02/05	Fundamentals of Grasping and Manipulation (2)	
02/07	Learning-based Grasping and Manipulation	
02/09		Exam 1
02/12	Interactive Perception	
02/14	Imitation Learning (1)	
02/16		HW2 due, HW3 out
02/19	President's Day (no classes)	
02/21	Guest Lecture (TBD)	
02/23		Exam 2
02/26	Imitation Learning (2)	
02/28	Learning from Human Feedback	
03/04	Interaction-Aware Learning, Planning, and Control	
03/06	Shared Autonomy	
03/08		HW3 due
03/11	Guest Lecture (Sidd Karamcheti)	
03/13	Paper Presentations	
03/15		Exam 3

Students with Documented Disabilities: Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is made. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: `http://studentaffairs.stanford.edu/oae`).

Lecture Recordings: All lectures will be recorded. For your convenience, you can access these recordings by logging into the course Canvas site. These recordings might be reused in other Stanford courses, viewed by other Stanford students, faculty, or staff, or used for other education and research purposes. Note that occasionally a part of your image or voice might be incidentally captured if your microphone is on. If you have questions, please contact a member of the teaching team.