Robot Learning - FRI I

CS 309 (50600)
Spring 2025

Instructor Info

Ben Abbatematteo, Ph.D.

(He / Him)

GDC 3.430

https://babbatem.github.io/

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Course Info

Tues & Thurs

3:30 p.m. - 5:00 p.m.

WEL 3.310

Course Description

This class provides students with an understanding of modern research in robot learning. Robot learning research seeks to bring to bear modern machine learning and artificial intelligence algorithms on problems in robotics, integrating learning with classical techniques in perception, planning, and control. This course will provide an overview of fundamental robotics and machine learning concepts and survey modern robot learning research. Students will learn the necessary technical skills to perform robotics research in the Robot Interactive Intelligence Lab (RobIn) Lab.

More details about RobIn Lab:
https://robin-lab.cs.utexas.edu/.

Philosphy & Goal

The goal of this class is to prepare students for robotics research. This class will discuss robotics and artificial intelligence, and will provide practical training in Robot Operating System (ROS) and modern machine learning libraries (i.e. torch). We will also discuss how to produce original scientific work, preparing students for research careers in robotics and beyond.

Required Course Materials

- There is no textbook for this course.
- You may wish to install Ubuntu Linux 20.04 on your personal computer.
  - We will provide assistance if you do.
- This course requires access to a computer with Ubuntu 20.04 and ROS Noetic.
  - Machines with ROS are available in CS Department labs (GDC 1.310)

Grading

Grades are based on:

- Class participation and attendance - 10%
- Homework - 40%
- Final Project - 50%

The final project grade will be determined by evaluating the quality of deliverables (proposal, checkins, final report, code) as well as each student's effort.

The following grading scheme will be employed.

A	94%	B	84%
A-	90%	B-	80%
B+	87%	C+	77%
C	74%	C-	70%
D	65%	F	<65%

Prerequisites

- There is no prerequisite for this course.
- This course involves extensive programming.
- This course begins with an assignment on python to ensure students are prepared.

Course Website

https://www.cs.utexas.edu/~abba/fri-robot-learning/

Course Mechanics and Policies

When and Where is Class

Class is on Tuesdays and Thursdays from 3:30-5:00pm in WEL 3.310.

Attendance and Absences

- Attendance is mandatory.
  - If you miss a class session, it will count against your final grade.
  - If you must miss a class session, notify Dr. Abbatematteo in advance.
  - If you miss a class due to illness, please email prior to the class session; but I understand if you cannot.
  - If you have an unexcused absence, I will not repeat (nor will the peer mentors) class content during office hours.

Late Work Policy

- Anything with an in-class component may not be late, because the in-class part requires the assignment for participation. These items will receive a zero. This includes, but is not limited to:
  - Final project proposal slides and 1-page proposals for the workshop and debugging sessions
  - Final presentations
  - (Note that slides are due after presentations, but failure to participate will be graded harshly.)
- Regular homework assignments will receive a 10% penalty per calendar day for being late.
  - Lateness starts at 1-minute tardy, which will receive the 10% penalty.

Class Recordings

Lectures will be recorded via Zoom and will be available in Canvas.

Creating a Space Where Everyone Can Learn

The university is committed to creating an accessible and inclusive learning environment consistent with university policy and federal and state law. Please let me know if you experience any barriers to learning so I can work with you to ensure you have equal opportunity to participate fully in this course. If you are a student with a disability, or think you may have a disability, and need accommodations please contact Services for Students with Disabilities (SSD). Please refer to SSD's website for contact and more information: http://diversity.utexas.edu/disability/. If you are already registered with SSD, please deliver your Accommodation Letter to me as early as possible in the semester so we can discuss your approved accommodations and needs in this course.

Academic Integrity

Students who violate University rules on academic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and / or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on academic dishonesty will be strictly enforced. For further information, please visit the Student Conduct and Academic Integrity website at: http://deanofstudents.utexas.edu/conduct.

Standards of Conduct

The University of Texas at Austin holds its students to a high standard that is grounded in the University Code of Conduct and Student Honor Code.

Code of Conduct

The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

Student Honor Code

As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity.

In addition, Longhorns are expected to abide by all state, and federal laws, statutes and all regulations of the University of Texas System. Please see the Institutional Rules on Student Services and Activities, Chapter 11 for detailed descriptions of student discipline and conduct standards.

The university's standards of conduct are described in a variety of university policies, and links to those policies are outlined below. However, please note that this is not a complete list of university conduct rules or policies. In fact, many campus

departments, including the Division of Housing & Food Service and Parking & Transportation Services, have instituted administrative rules specific to their areas. For more information on conduct rules of individual departments, please contact those offices directly.

University Policies and Resources for Students: https://utexas.instructure.com/courses/1413379/

Names and Personal Pronouns

I (Dr. Abbatematteo) believe that you should be referred to by your preferred name and pronouns. It is important to me to honor who you are as an individual.

Please help me by:

- Letting me know your pronouns.
- Helping me to correctly pronounce your name if I get it wrong.

Getting Help

I genuinely want to see you all thrive in this class. To do this, I provide many resources. It is up to you to use them. We will not provide you with solutions to your homework, but we will point you in the right direction.

Do Not Share Code or Answers

Students may discuss the assignment with each other. It is heavily encouraged to do so. When you do so, however, you may not share code.

You may look at another students incomplete code on your screen, for factors such as syntax or broad strokes. If you do this, you may not write down what you saw, and you are required to go do something else for 30 minutes before returning to your code. If you are caught copying code, it will be treated as cheating.

If you refer to an external resource in order to solve a problem (printed, online, etc.) you must cite it in your submission. If you reproduce content from another resource without citing it, it will be considered plagiarism.

Who to Ask for Help

My goal is to make you self-sufficient as a researcher, a scholar, a scientist, and a programmer. Telling you the answer, or immediately giving you help is not the recipe to build your self-confidence, your grit, or even your knowledge. You have to learn how to solve these problems for yourself as a researcher. The peer mentors have been told to give you guidance, not answers.

You should ask for help in this order:

1. Yourself
2. Google
3. A classmate (if you are both working in a laboratory, otherwise skip)
4. Ed Discussions (do not post code or answers)
5. A peer mentor
6. Dr. Abbatematteo (by email or in office hours)

This is by design to build up the lab group and build your abilities.

Peer Mentors

Many of you will continue on to FRI II, where you work alongside members of the laboratory doing research. Get to know these people and get help on your homework. This will help you become a part of our lab culture. We want you to become one of us!

Luca Macesanu	luca.m@utexas.edu
Tarun Kholay	tarunkholay@utexas.edu
Boueny Folefack	bouenyf@utexas.edu
Arnav Balaji	arnavbalaji21@utexas.edu

Office Hours

Dr. Abbatematteo's office hours are held in his office, GDC 3.430, by appointment:
Monday 4:30pm - 5:30pm
Booking link: https://calendar.app.google/BJHFKnduGgBHMpKL7

If you need to meet with Dr. Abbatematteo outside of these hours, please email abba@cs.utexas.edu.

Ed Discussion

Our class has a Ed Discussions page. It can be found here:
https://edstem.org/us/courses/73190/

Course Modules

A detailed schedule with lecture materials can be found on the course website. Here are the main modules for the course.

Class Introduction

Goal: Orient students to the class
Contents: Syllabus, course mechanics, general advice

Pick & Place

Goal: Provide a working background of robotic manipulation.
Contents: Rigid body kinematics, spatial transforms, forward/inverse kinematics

Introduction to ROS

Goal: Learn what Robot Operating System (ROS) is.
Prepare to use the tools used to operate the laboratory's robots.
Contents: Overview of ROS and why many state-of-the-art robots use it. This provides the framework for the rest of the semester's material.

Perception

Goal: Learn enough computer vision to apply it in projects.
Contents: Image formation, depth cameras, pointclouds, detection, segmentation

Supervised Learning

Goal: Provide working knowledge of machine learning.
Contents: We'll cover linear regression up through modern machine learning algorithms in torch. We'll use image classification as a running example.

Imitation Learning

Goal: Learn basic imitation learning algorithms.
Contents: Behavior cloning, basics of reinforcement learning. We introduce common policy representations and algorithms.

Project Component

Goal: Design and execute a project applying concepts from lecture and homework.
Contents: The latter half of the semester will be devoted to research projects. Students will draft a proposal and present it to the class. Course staff will conduct check-ins periodically to ensure steady progress. The course will conclude with final presentations and reports.

Special Topics

Goal: Provide an understanding of modern robotics research and more advanced topics.
Contents: While students work on projects, lectures will shift to more casual topics including: writing Latex, writing proposals, how to read research papers, how to do research in computer science, and an overview of recent work in reinforcement learning.

Homework Assignments

Pick & Place

Goal: Refresh python programming ability and test concepts from manipulation section.
Contents: Programming with numpy and matplotlib. Working with spatial transformations.

ROS

Goal: Learn to implement a ROS node.
Contents: Basic publishers and subscribers, commandline tools. Forward and inverse kinematics in ROS.

Torch

Goal: Gain a functional understanding of pytorch.
Contents: Basic torch tensor operations and machine learning problems. Basic imitation learning exercise.

Paper Analysis

Goal: Understand how to read scientific literature.
Contents: Read a research paper, identify the central research question and novel contributions.

Start the Robot

Goal: Demonstrate the ability to operate the robot.
Contents: Power on the robot and launch the basic functionality in ROS. A peer mentor will check you off. Repeat until you pass.

Final Project

Final Project Proposal

Goal: Learn to write and present project proposals.
Contents: Work with course staff to design a project, deliver a short presentation to the class, and write a short description of the planned research activities.

Project Checkins

Students will provide updates on their progress, identify what they're stuck on etc.

Final Presentation Proposal

Note that this class has final presentations instead of final exams. Final presentations will take place during the last week of classes. Final papers and code will be due at 11:59pm on May 6, 2025.