EE P 545 A Au 25: The Self Driving Car: Introduction To Ai For Mobile Robots

Professor:

- Joshua Smith
- **Email:** jrs@cs.washington.edu

Teaching Assistants:

- Jack Lowry, Kedi Yan
- **Emails:** jrl712@cs.washington.edu, kedi@uw.edu

Schedule:

- **In-person Lecture:** Tuesday 6:30 PM - 9:50 PM (**ECE 045**)
- **Zoom (use as a back up... please attend in person if possible): https://washington.zoom.us/j/99243997258**
- **Lab/car work: ECE B011 (sub-basement)**
- **Josh Office Hours** (https://washington.zoom.us/my/jrsjrs): Wednesday 9AM
- **TA Office Hours** (In Person B011): Monday 5 PM & Wednesday 5 PM in ECE B011.
- **Final: Primary Tues Dec 9; alternate date: Thursday December 11th**, 6:30 PM - 9:30 PM (**ECE Basement Atrium**)

Class Meeting #	Date	Topic	Links	Ass. due
1	Tu 9/30	Course Logistics. Intro to Python and ROS. Slides Video 2025 Assignment 1		0: Team formation. Due Thu 10/2 Form here
2	Tu 10/7	Localization Pt 1: State Estimation, Bayesian Filtering Slides		

		Video		
3	Tu 10/14	Localization Pt 2: Particle Filters; Sampling Slides Video 2025 Assignment 2		1: Intro to ROS. Due Mon 10/13 @ 11:59PM
4	Tu 10/21	Introduction to Control Slides		
5	Tu 10/28	More Control Methods Slides Video 2025 Assignment 3		2: Localization. Due Mon 10/27 @ 11:59PM
6	Tu 11/4	Introduction to Planning and Search Slides Video		
7	Th 11/13	Planning and Search Cont'd Slides Video		3: Control. Due Weds 11/12 @ 11:59PM
8	Tu 11/18	Introduction to Computer Vision for Autonomous Driving Slides Video		
9	Tu 11/25	Introduction to Neural Networks and PyTorch Slides Video		

10	Tu 12/2	Introduction to Reinforcement Learning	qlearn_anim3.py DQN paper (2015) Policy grad. paper (1999)	4: Planning. Due Mon 12/1 @ 11:59PM
11	Primary date: Tu 12/9 Alternate date: Th 12/11			Final Race. Starts 6:30PM

Course Overview:

In this course, we will cover topics related to state estimation (particle filters, motion models, sensor models etc), control (PID and other control methods), planning, and perception and learning. Each of the assignments will involve student teams implementing the algorithms learned in lecture on 1/10th sized rally cars. Concepts from all of the assignments will culminate into a final project with a final demo on the rally cars. Another final project option is for you to propose, execute, and present a research project extending concepts covered in the course. The course will involve programming in a Linux and Python environment along with ROS for interfacing to the robot.

Course Goals:

By the end of this course, students will

- Become comfortable with tools such as ROS and Python for operating a real robot platform
- Understand algorithms from state estimation, control, planning, perception, and learning, as well as how each of these areas contributes to the development of autonomous vehicles
- Implement these algorithms on a real robot platform

- Analyze both the theoretical and practical strengths and weaknesses of these algorithms

Prerequisites:

- Proficiency in coding in a procedural language (e.g. C, C++, Python, Java, etc) is required
- Knowledge of basic probability is required
- Experience with Python is recommended

Grading:

- **Assignments:** 60%
- **Final Project:** 35%
- **Class Participation:** 5%

Assignments are typically due Monday before midnight (by 11:59PM) the evening BEFORE lecture. This is to ensure that during the working session after lecture, you are not still trying to finish the previous assignment.

Late turn-in policy: 5% of the total possible points docked for each day past the deadline (e.g. a 98/100-point project will score 93/100 if 1 day late, 88/100 if 2 days late, etc). If your team is struggling to finish a project, let the instructor and TAs know prior to the deadline if possible.

Participation policy:

- There will be in-class activities every week, such as short (10-15 minute) ungraded quizzes, project work, and discussions; participating in these activities will make up your participation grade. If possible, please inform the instructor PRIOR to the start of class if you will be unable to attend. We will individually work with students to make up missed material, such as submitting a written paragraph for a missed discussion or completing an ungraded quiz outside of class. You can drop your lowest participation grade day (one free day not in class without makeup material).

Assignments:

The course includes the following assignments:

- **Getting Started:** Introduction to Python, Numpy, ROS, and the robot
- **Localization:** Let your car know where it is by implementing localization algorithms.
- **Control:** Implement feedback controllers to follow pre-planned paths.
- **Planning:** Implement a planning algorithm to create new paths.

- **Final Project**: Put it all together to autonomously navigate a course as quickly as possible. Another option is for you to propose, execute, and present a research project extending concepts covered in the course.

Lecture and Assignment Schedule (approximate and subject to change):

- Week 1: Course Logistics. Introduction to Python and ROS
- Week 2: State Estimation, Bayesian Filtering
- Week 3: Particle Filters for Localization, Sampling (Project 1 due)
- Week 4: Introduction to Control
- Week 5: More Control Methods (Project 2 due)
- Week 6: Introduction to Planning and Search
- Week 7: Planning and Search Cont'd (Project 3 due)
- Week 8: Introduction to Computer Vision for Autonomous Driving
- Week 9: Introduction to Neural Networks and PyTorch (Project 4 due)
- Week 10: Introduction to Reinforcement Learning
- Exam week: (Final Project due)

Schedule notes/ exceptions: Tuesday November 11 is a holiday (veteran's day), so that week we will meet Thursday November 13 in the usual room (ECE 045). The homework that week will be due at 11:59 Wednesday November 12. The lectures on October 21 and 28 will be given by TA Jack Lowry. The final race is Thursday December 11 at 6:30PM (which is the course final exam time). When anything is happening on an unusual day of the week, it is highlighted in red below.

Textbook:

There is no required textbook for this course, but we will be providing reading notes as the course progresses. These reading notes will be shared through Canvas posts and/or class emails.

Questions and Discussion: We encourage you to use the discussion board on our Canvas page. If you have class/lab related questions, check the discussion board first to see if the question has already been asked and answered. Post your questions on the discussion board if you can’t find feasible answers. And you are more than welcome to help your classmate if you know the answers to questions from other students!

Resources:

- ROS Tutorials (Links to ROS Tutorials)
- Python Tutorials (Python)

SSH information:

You may want to access the provided computers remotely. To do so, you can use SSH to connect to your team's computer; we will share the SSH access information with teams upon request. We recommend using X11 forwarding (already set up on each team's computer). If accessing via SSH from off-campus, you will need to use a VPN, provided by UW: https://itconnect.uw.edu/tools-services-support/networks-connectivity/husky-onnet/.

Religious accommodation policy:

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodationsrequest/).

Access and Accommodations:

Your experience in this class is important to me. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law. If you have already established accommodations with Disability Resources for Students (DRS), please activate your accommodations via myDRS so we can discuss how they will be implemented in this course.

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), contact DRS directly to set up an Access Plan. DRS facilitates the interactive process that establishes reasonable accommodations. Contact DRS at disability.uw.edu.

Academic Integrity:

We expect you to follow the Academic Integrity rules of the Department of Electrical and Computer Engineering (link (https://vannevar.ece.uw.edu/academics/undergrad/AcademicMisconduct.html)), the College of Engineering, and the University of Washington. For example, solutions you submit must be

your own work. You are not allowed to re-use solutions from prior years or the TA's prior solutions. Students suspected of plagiarism will be reported to the College of Engineering for investigation and possible punishment.

AI Use Policy:

Students in this course may explore the use of AI-based tools (such as ChatGPT) when completing assignments. All sources, including AI tools, must be properly cited. Use of AI without proper citation will be considered academic misconduct and subject to investigation.

Please note that AI results can be biased and inaccurate. It is your responsibility to ensure that the information you use from AI is accurate. Additionally, pay attention to the privacy of your data. Many AI tools will incorporate and use any content you share, so be careful not to unintentionally share copyrighted materials, original work, or personal information.

Learning how to thoughtfully and strategically use AI-based tools may help you develop your skills, refine your work, and prepare you for your future career. If you have any questions about citation or about what constitutes academic integrity in this course or at the University of Washington, please feel free to contact me to discuss your concerns.