CSE 478:

Autonomous Robotics

Instructor: Chris Mavrogiannis

TAs: Kay Ke, Gilwoo Lee, Matt Schmittle

*Slides based on or adapted from Sanjiban Choudhury

We will be programming RACECARs!

RACECAR 1.0

RACECAR 2.0

RACECAR 3.0

Big thanks to the MuSHR team!

Multi-agent System for non-Holonomic Racing

https://mushr.io

Patrick Lancaster

Johan Michalove

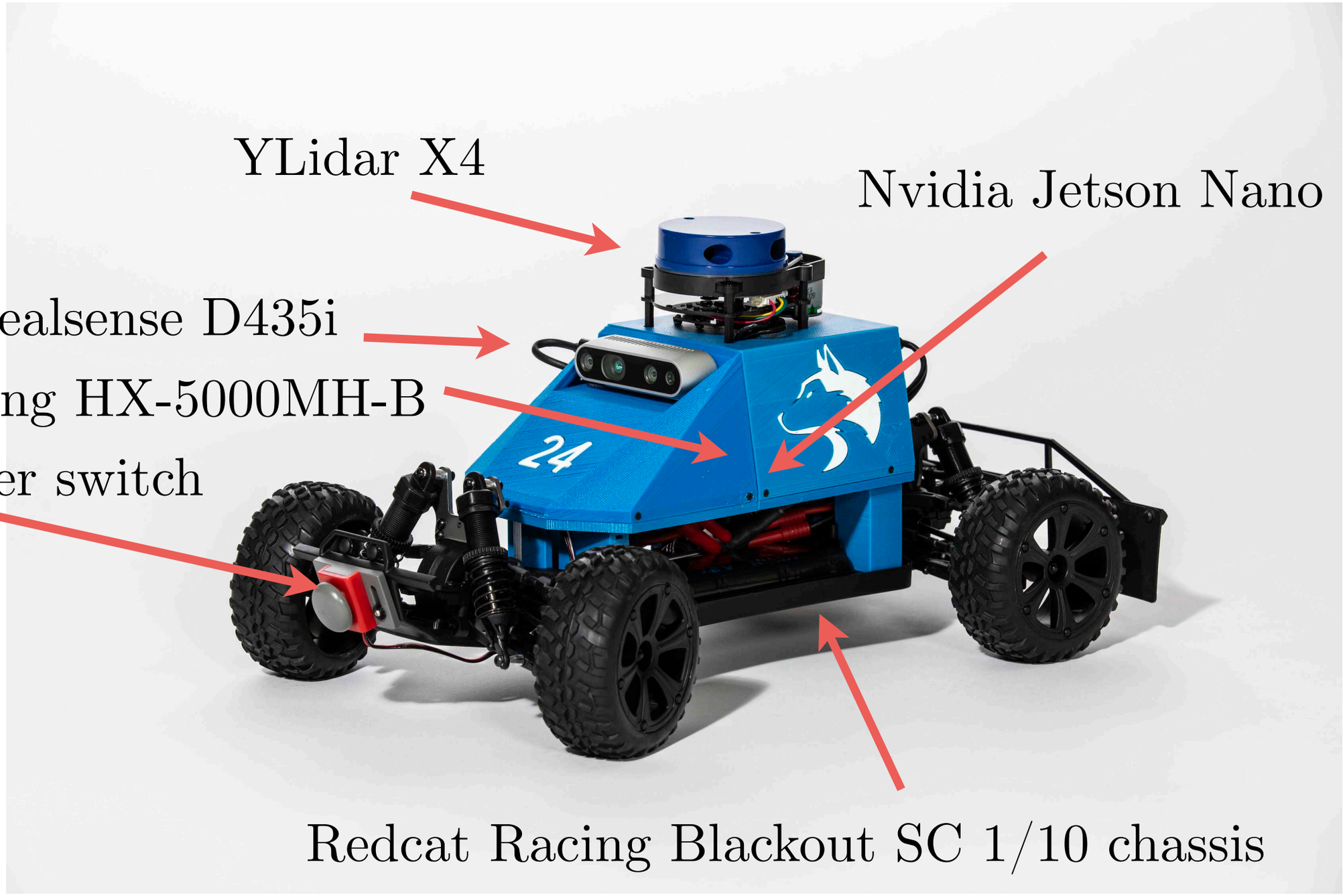
Matt Schmittle

Matthew Rockett

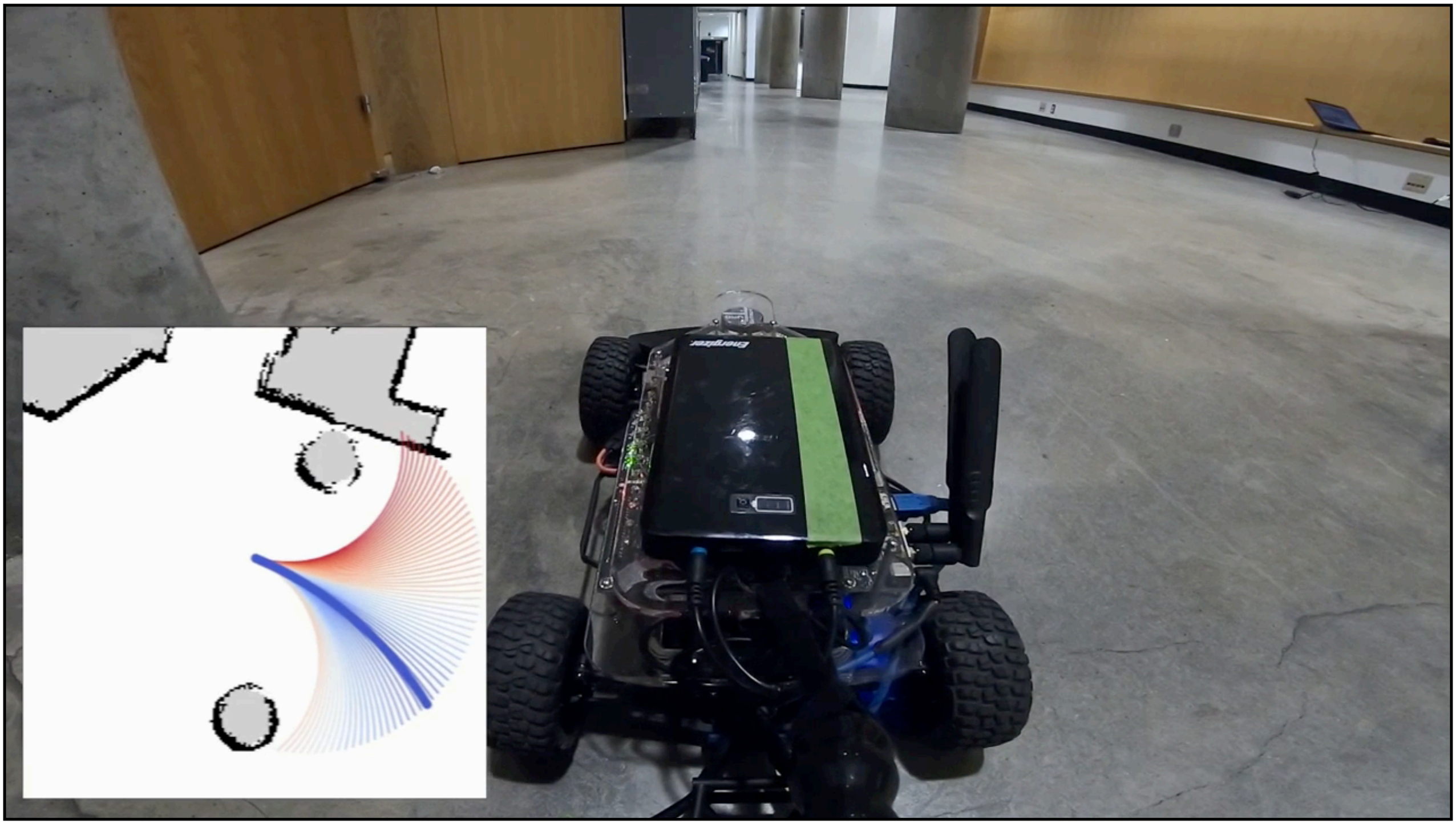
Colin Summers

... and growing!

Overview of the RACECAR



Where you will be by week 7!



Highlights from last year ...

Video credit: Max Thompson

Thanks to Sanjiban Choudhury, Gilwoo Lee, Matt Schmittle, Matthew Rockett!

... and what's different this year!

1. Updated assignments that guide you towards the final project

2. Higher standards for robots - faster, more precise, more robust (RACECAR 3.0)

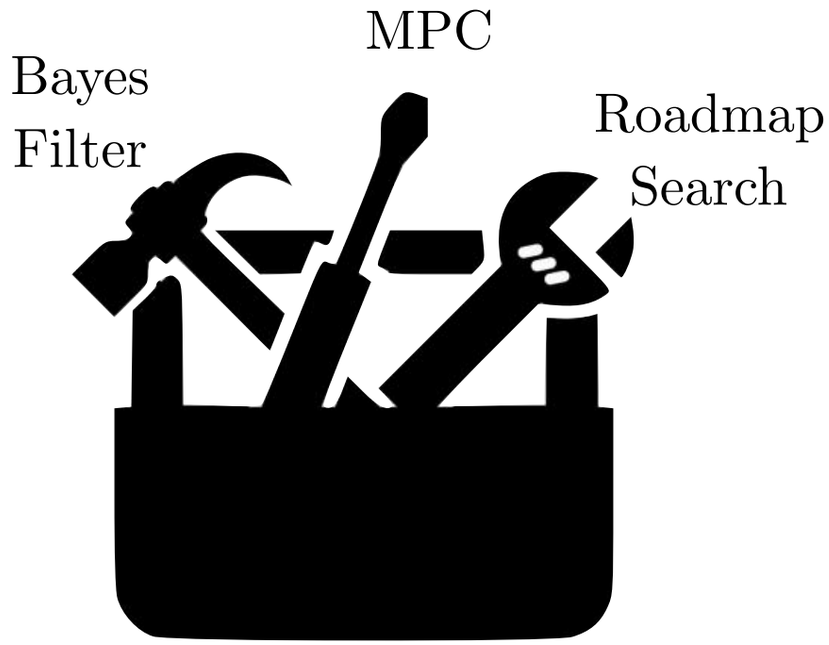
Objective 1

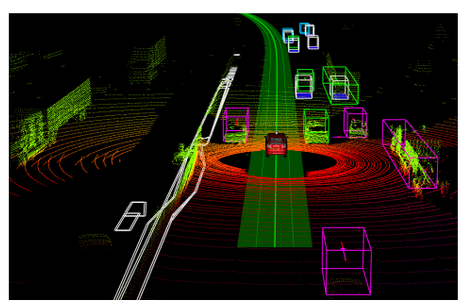
Learn algorithms for autonomous driving and implement them on the RACECAR

in 11 weeks!

Objective 2

Learn a small set of fundamental tools that solve a wide range of robotics problems



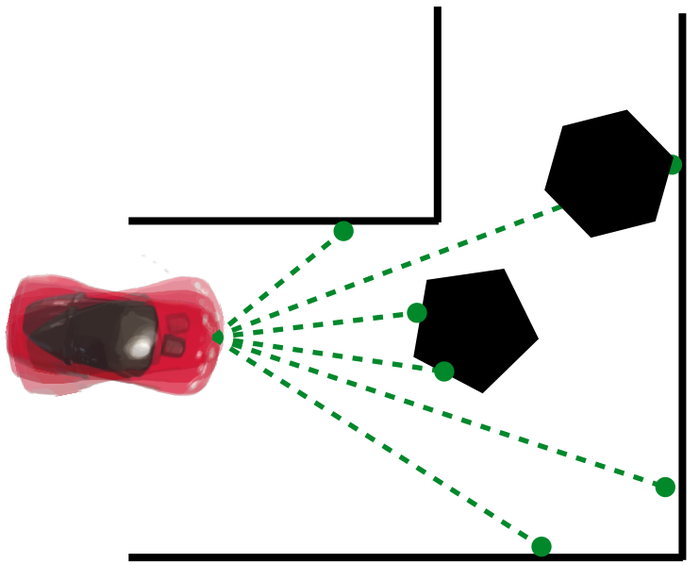


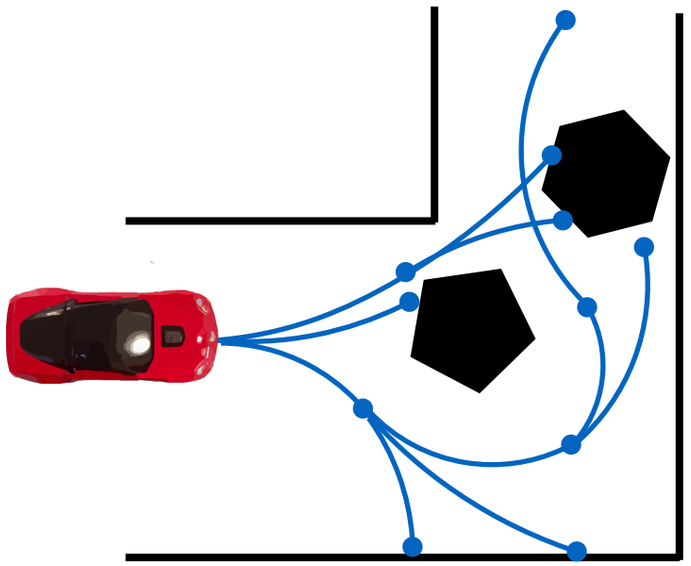
Concrete learning objectives

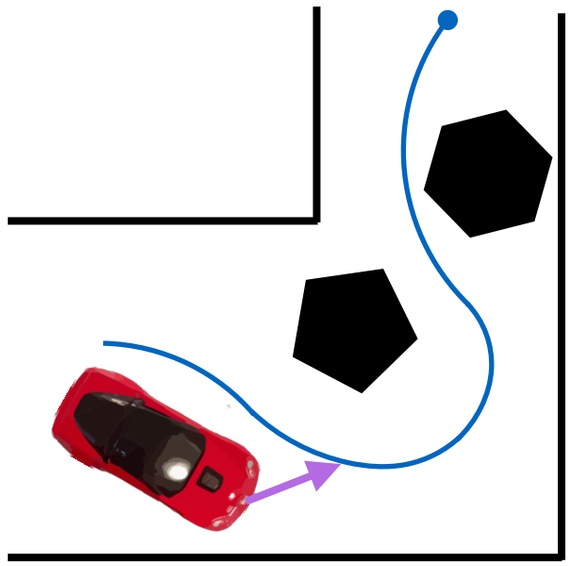
Estimate state

Plan a sequence of motions

Control robot to follow plan





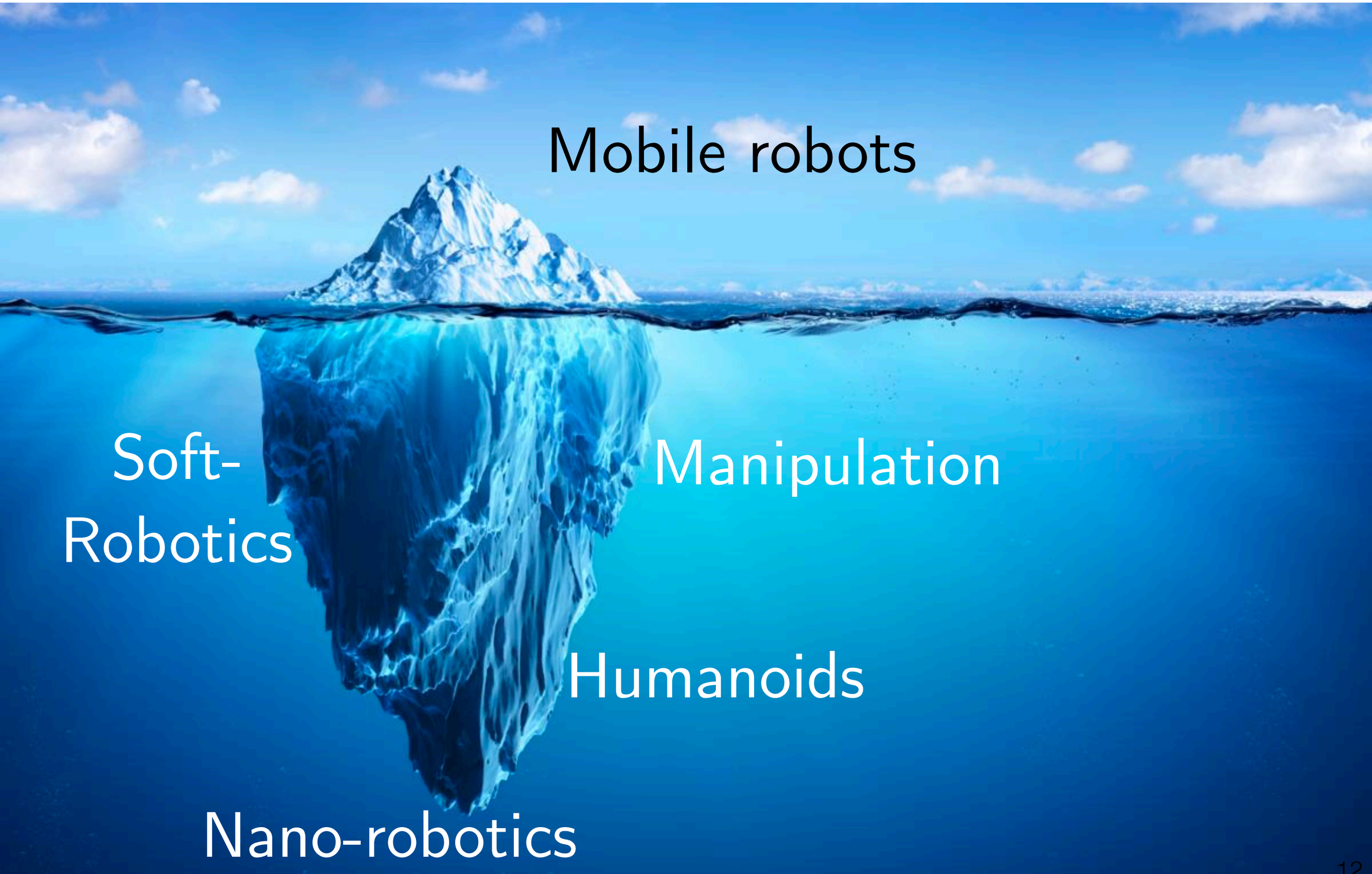


Course outline

Week	Lectures	Assignments
Week 1	Introduction	Lab 0: Introduction to ROS, Python, Simulation, RACECAR
Weeks 2-4	State Estimation	Lab 1: Localize robot on a known map with particle filters
Weeks 5-6	Control	Lab 2: Feedback control to track paths while avoiding obstacles
Weeks 7-8	Planning	Lab 3: Plan a complex maneuver around obstacles at high speeds
Weeks 9-10	Special Topics	Final project

Week 11, Final project: Combine modules to navigate around a track and solve tasks!

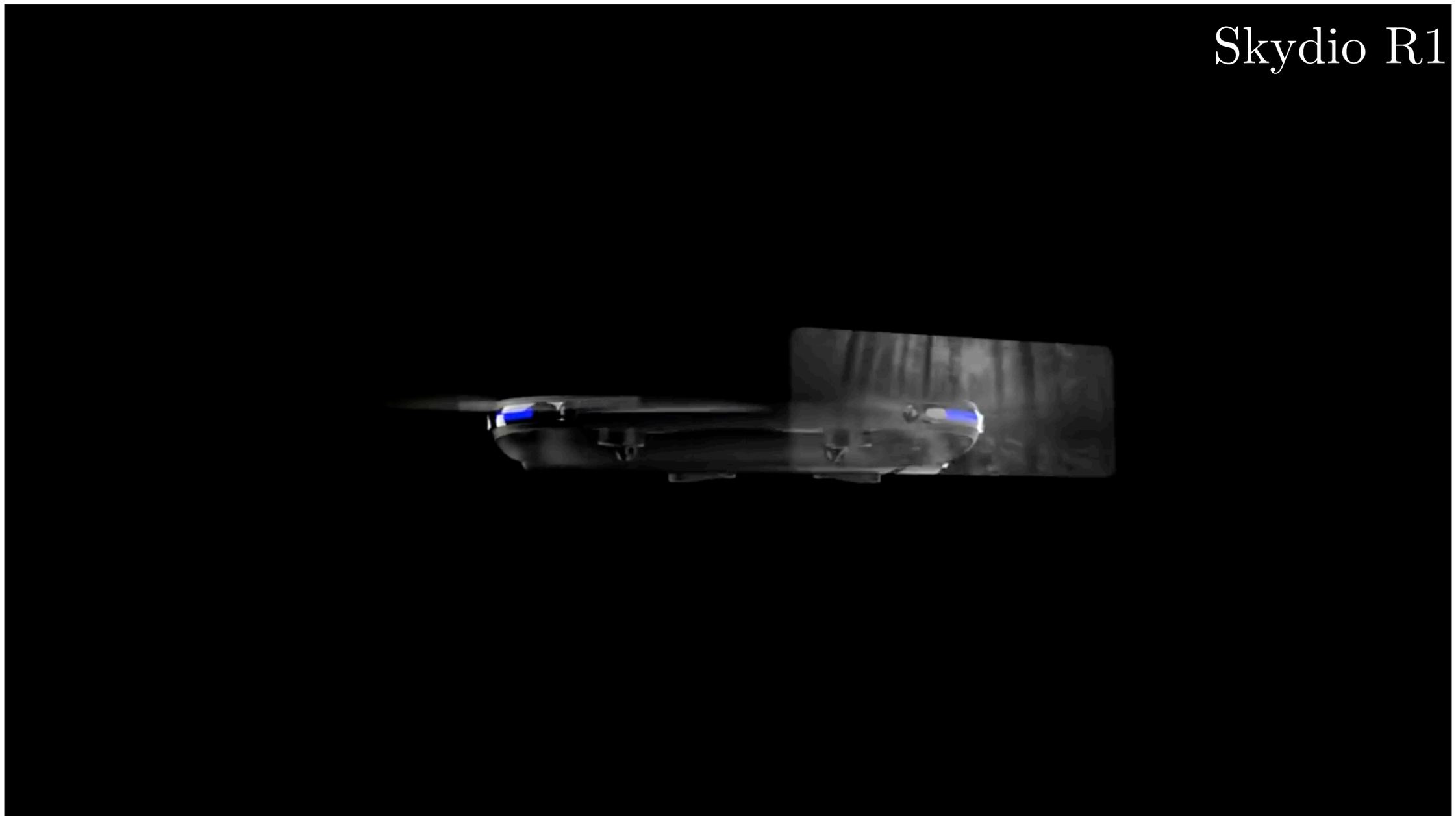
Scope of this course



Mobile robots are exciting!

Dealing with uncertainty in the real world outside of laboratory

Old algorithms - new technology! (better compute, sensors, batteries)



Today's objective

1. Team introductions

2. Logistics

3. Getting started

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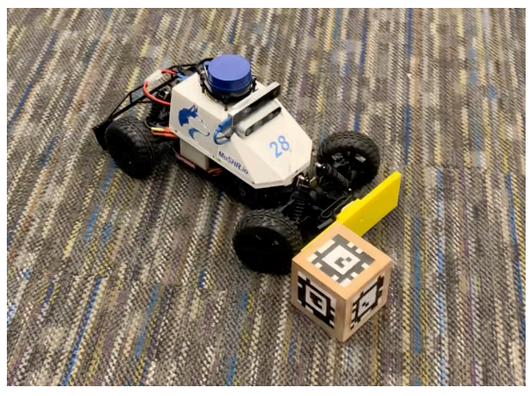
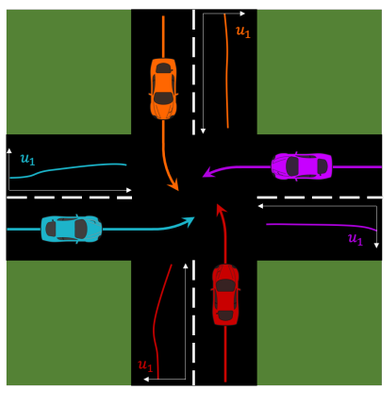
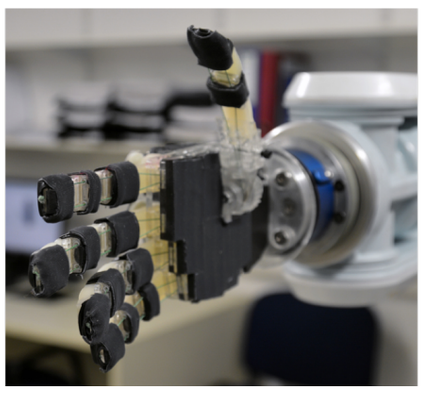
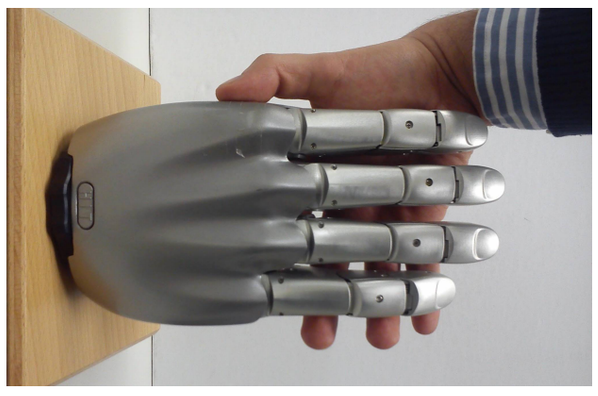
Christoforos “Chris” Mavrogiannis

Postdoc, University of Washington
Personal Robotics Lab

Ph.D., Cornell University
“Motion planning for socially competent robot navigation”

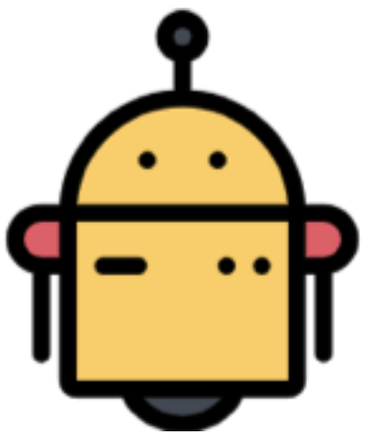
Research interests:
Motion planning; Multi-robot systems; Navigation, Manipulation; Human-robot interaction.

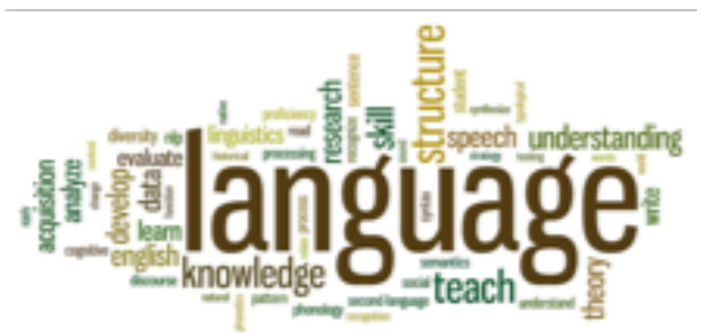
Liyiming “Kay” Ke

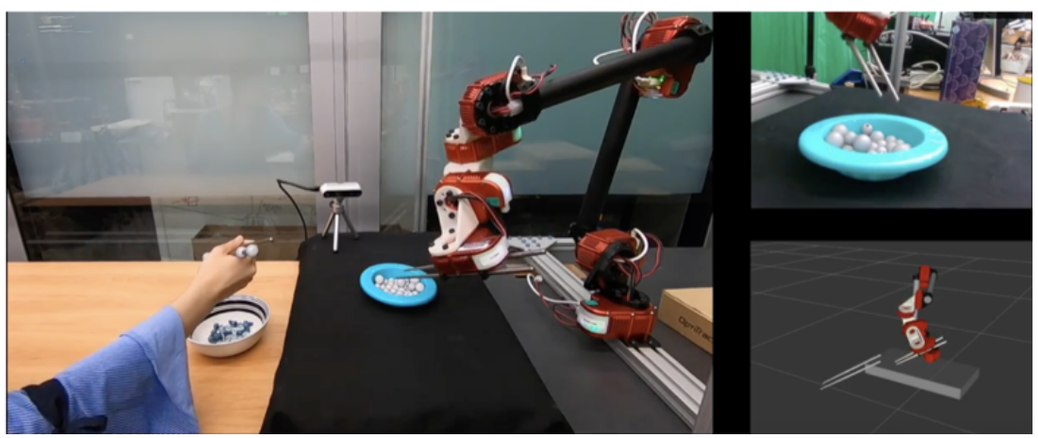
PhD student on Robotics & Learning

Research on **imitation learning**, applied machine learning.

Currently, teaching robot to use **chopsticks**!





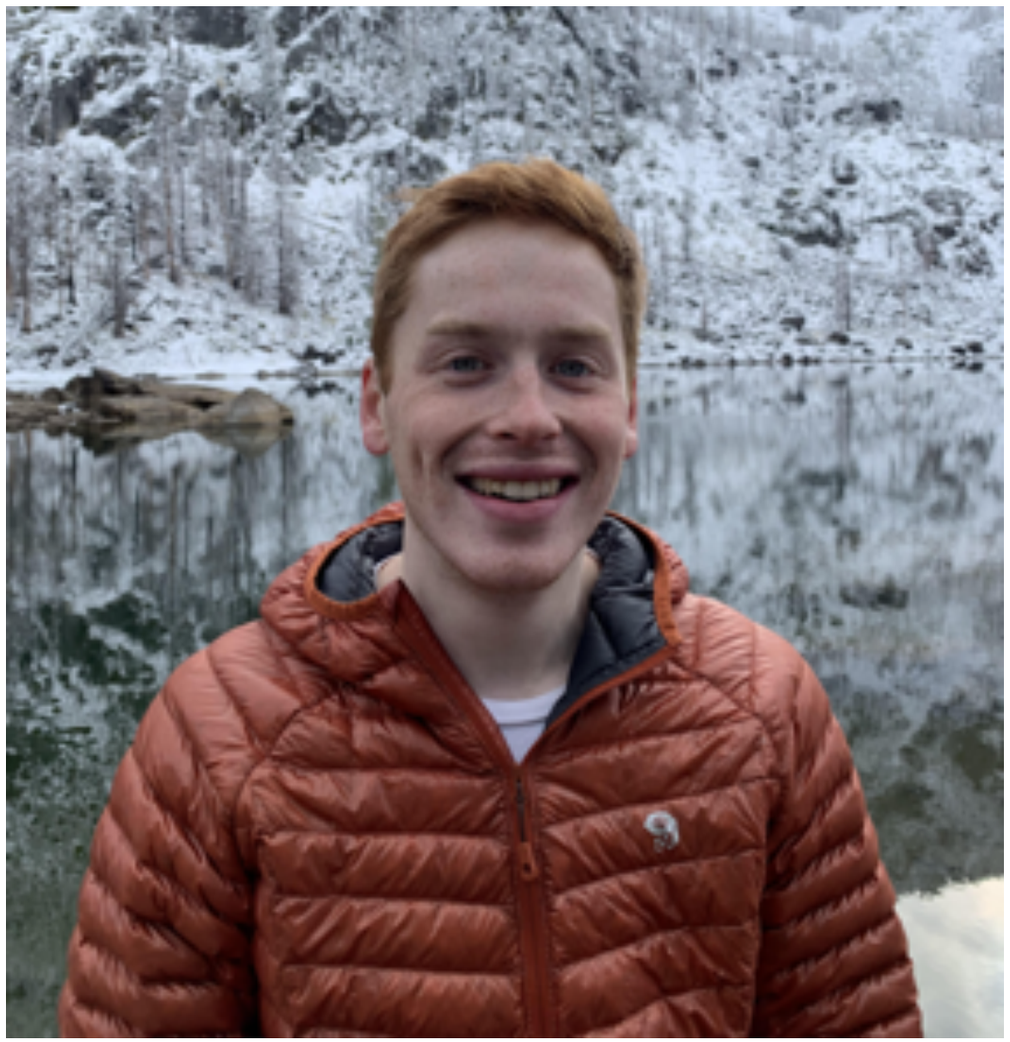


Gilwoo Lee

Ph.D. student, Personal Robotics Lab

Research:

- Reinforcement Learning
- Bayes-Adaptive RL
- Autonomous Assistive Feeding



Matt Schmittle

Ph.D. student, Personal Robotics Lab

Research:

- Imitation Learning
- Corrective Feedback

MuSHR Project

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1. Team introductions

2. Logistics

3. Getting started

Course management tools

- Website: https://courses.cs.washington.edu/courses/cse478/20wi
  - one stop for all information, slides, notes, assignments
  - Sign up piazza.com/washington/winter2020/cse478
- Piazza: https://piazza.com/class/k3tbbeofifd6ai
  - announcements, discussions, **finding teammates**, contacting instructors

- Canvas: https://canvas.uw.edu/courses/1352219
  - submitting assignments, receiving grades

Lectures / Recitations

- Lectures on Mon Wed Fri, 13:30-14:20, THO 125
  - Will introduce the topic and focus on fundamental principles, algorithms and theory

- Recitation *this* Thursday 1/9, 13:30-14:20 / 14:30-15:20, CSE1 022
  - Important!
  - Will focus on specific implementation details, hardware / software details and issues relevant to assignments / projects.
  - Rest of the quarter as needed

Deliverables/Grades

- 4 Lab assignments (60%)
  - Implementation of algorithms on the racecar
  - Demo
- 1 final project (30%)
  - Use implemented components to complete a task
  - Demo day
- Participation (10%)
  - Piazza, classroom
  - Course evaluation

Assignments

- All assignments will be done as a team of 3
- All assignments involve work with the robot
- Each team submits one writeup
- Assignments are due 11:59 p.m on Friday
- Assignments have live demos on Thursday (day before)
  - TA will test your code on the robot
  - Timeslot for each group announced on Piazza

Lab logistics

- We have a separate lab for teams to work on robots
  - CSE1 022 (Basement)
  - Card-key operated

- Each team gets a desktop (same machine for duration of class)
  - Ubuntu + Python + ROS-Kinetic pre-installed.

- Each team gets 1 racecar (same for duration of class)

When can I get a car?

- First you need to form a team of 3
  - Everything as a team - assignments, projects, etc
  - Team remains the *same* throughout course
  - Use Piazza to find team members
  - Send a private note to instructors with team member names
  - Form a team by Wednesday 1/8

- Each team will get a car during the first recitation on Thursday 1/9

Car logistics

- Please treat cars with respect.
- Do not change the passwords on the cars.
- Each team maintains own batteries - don't use others.
- Keep your space clean.
- Robots stay in 022.

Office hours

- Come to office hours!

- Office hours:
  - Chris Mavrogiannis: Mondays, 11:00-noon, CSE1 436
  - Kay Ke: Wednesdays, 12:30-13:30, CSE1 022
  - Gilwoo Lee: Thursdays 9:00-10:00, CSE1 022
  - Matt Schmittle: Fridays, 10:00-11:00, CSE1 022

- For assignment-specific clarifications, it is more fruitful to talk to TAs - they worked hard to design them!

Administrative policies

- Check website/canvas for details

- Late day policy
  - Each team gets 4 late days
  - After which 10 pts deduction every day

- Collaboration policy
  - Ok to discuss with other groups, but no sharing of writeup / code
  - Ok to look at online resources (cite when you do!) but don't use code.
  - https://www.cs.washington.edu/academics/misconduct/

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Knowledge survey

- We have posted a knowledge survey on the website.
  - Ubuntu / Python experience
  - Math knowledge
  - Robot experience, etc
- Not crucial to know everything in depth
- But it will help us customize the class to you

Assignment 0 out Wednesday

- Introduction to Python, ROS, Simulator & Robot
  - Introduction to ROS Tools
  - How to receive, process, and send data in ROS
  - Control the racecar in simulation
  - Interface and operate with robot (involves significant time with the robot)

- Due date: Jan 17
  - Submit write-up, data, videos
  - More details in Canvas / Piazza
- Crucial to Come to recitation on Thursday 1/8

TL;DR

- Submit knowledge survey TODAY

- Form a 3 person team by Wednesday 1/8 (send a private note to instructors on Piazza)

- Assignment 0 released Wednesday and due on 1/17.
  - Familiarize yourself with ROS

- Come to recitation on Thursday, get your robot and start working on Assignment 0.

Next lecture: Anatomy of an autonomous vehicle

Urmson et al. 2008