CSE 490R:

Mobile Robots

Instructor: Sanjiban Choudhury

TAs: Matthew Rockett, Gilwoo Lee,
Matt Schmittle

We will be programming RACECARs!

RACECAR 1.0

RACECAR 2.0

Big thanks to the MuSHR team!

Multi-agent System for non-Holonomic Racing

Patrick Lancaster

Johan Michalove

Matt Schmittle

Matthew Rockett

Colin Summers

... and growing!

Overview of the RACECAR

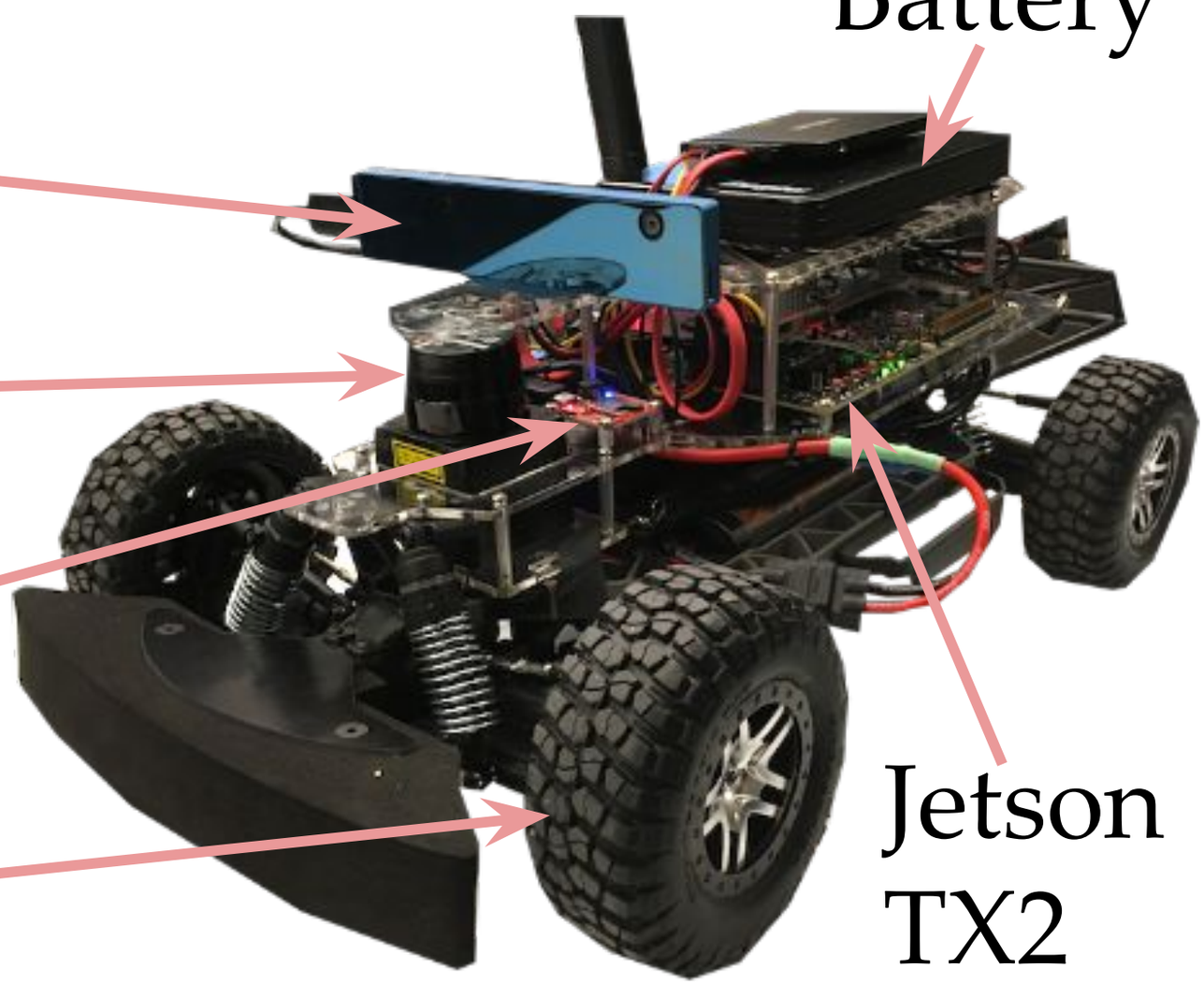
Laptop Battery

Intel Realsense RGBD Camera

Hokuyo LiDAR

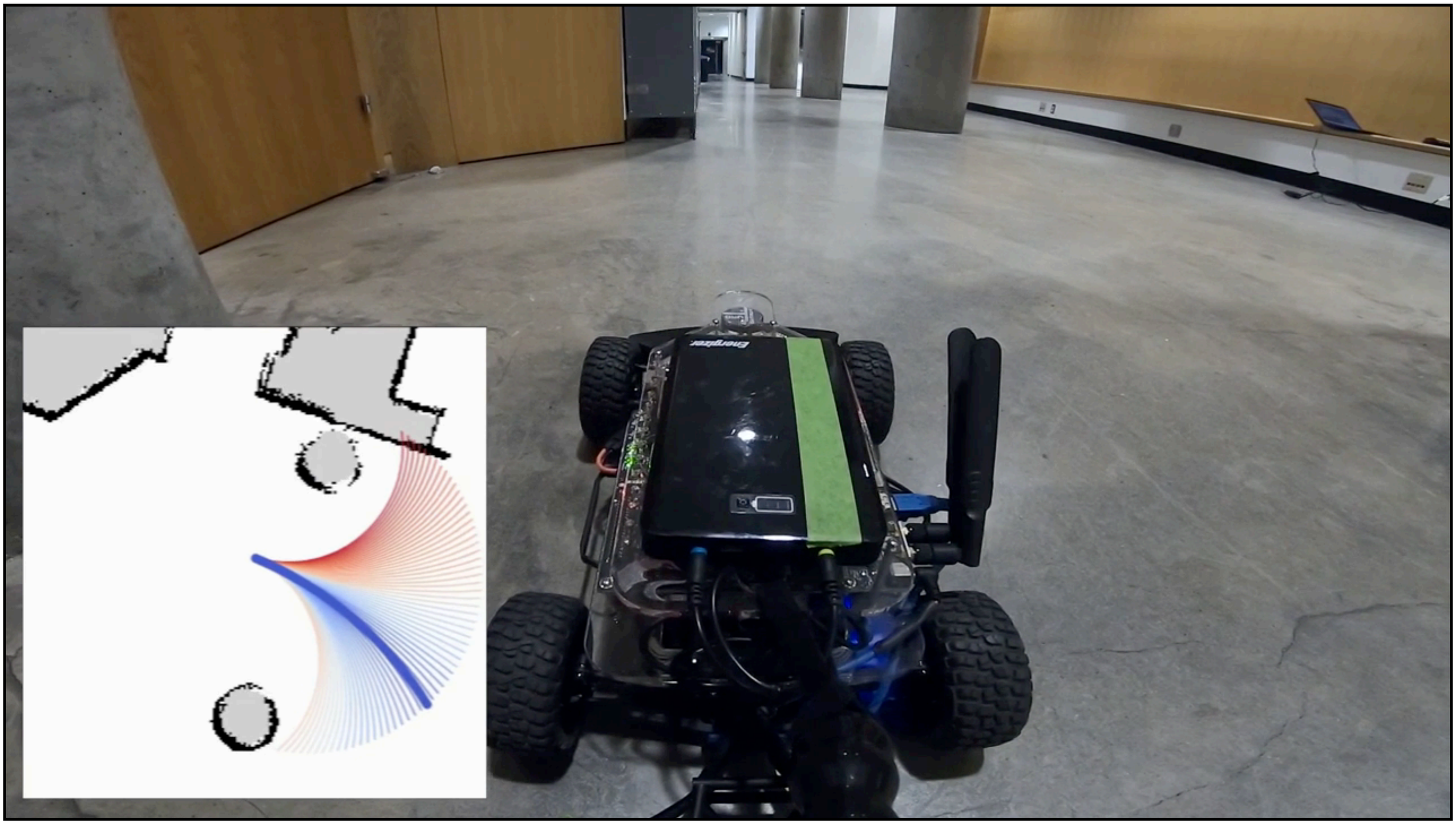
Razor 9 DOF IMU

Traxxas 1/10 Scale Rally Chassis

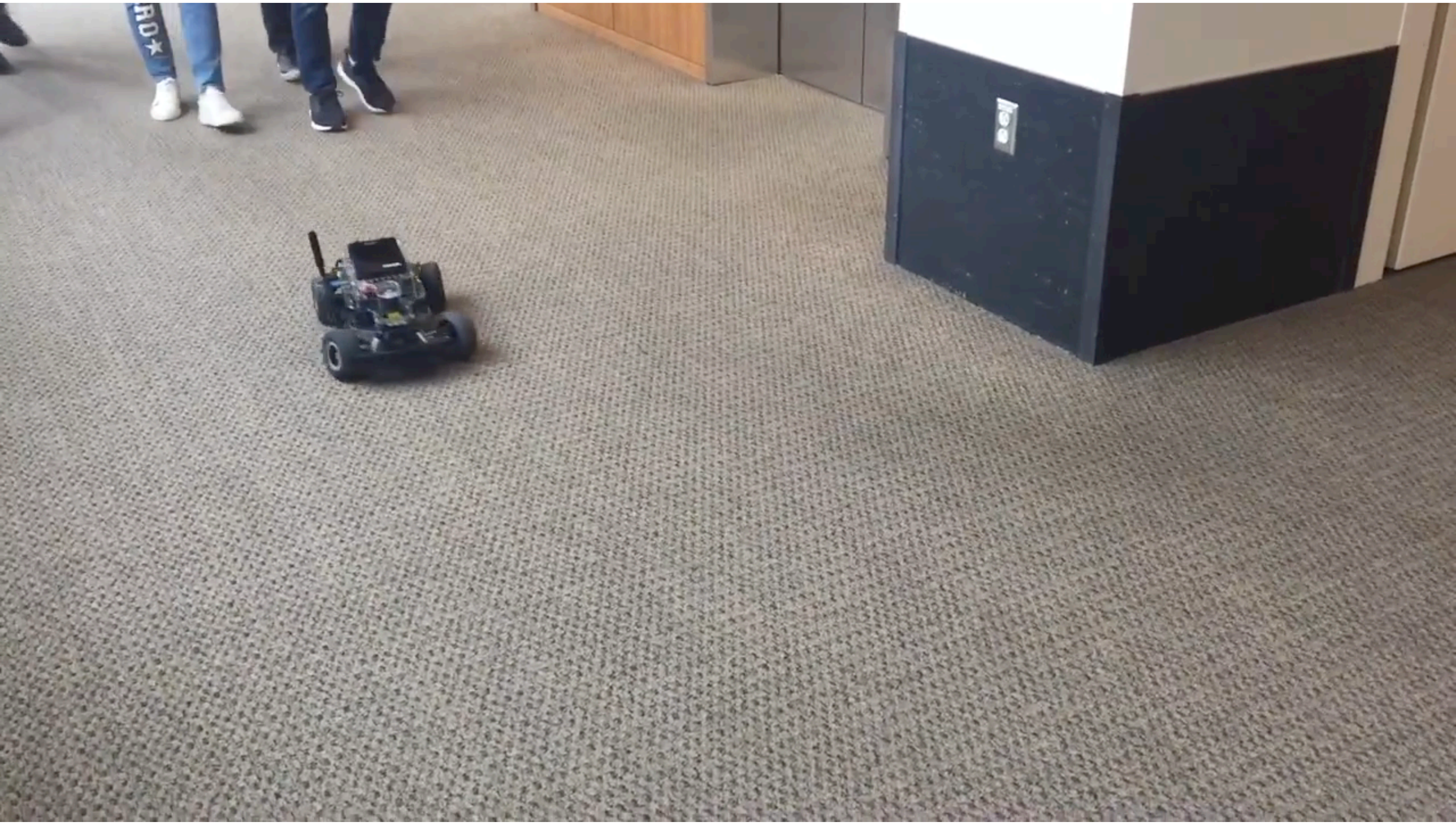


Jetson TX2

Where you will be by week 7!



Highlights from last year ...



Thanks to Johan Michalove, Nicholas Ruhland, Ariel Lin and Rajat Chand!

… and what's different this year!

1. New content that dives deeper into fundamentals

2. New assignments that emphasize robustness and repeatability.

3. Higher standards for robots - faster, more precise, more robust

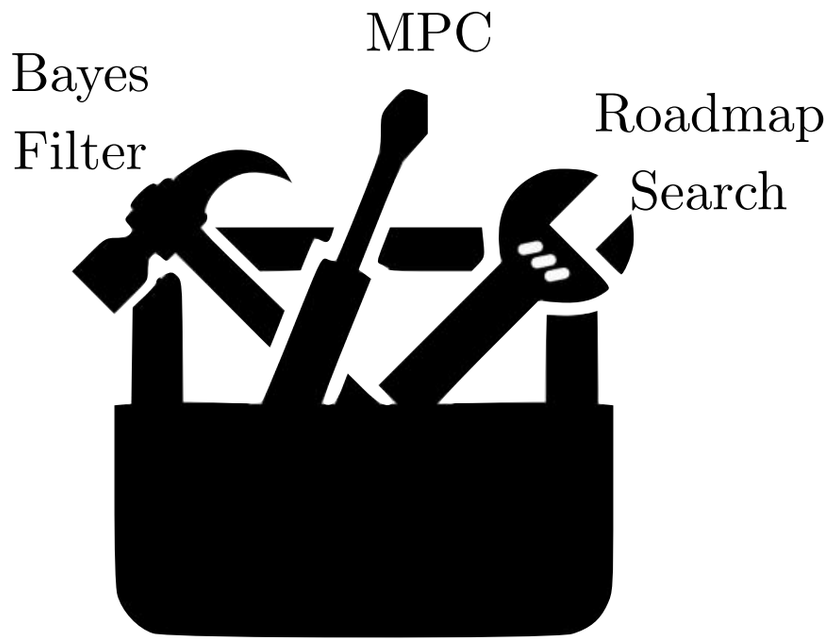
Objective 1

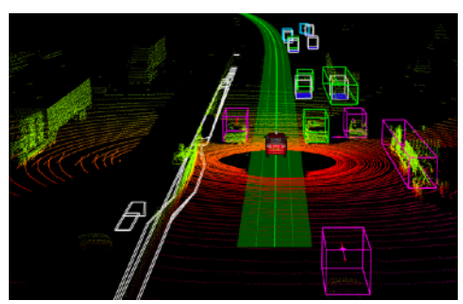
Learn algorithms for autonomous driving and implement them on the RACECAR

in 11 weeks!

Objective 2

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



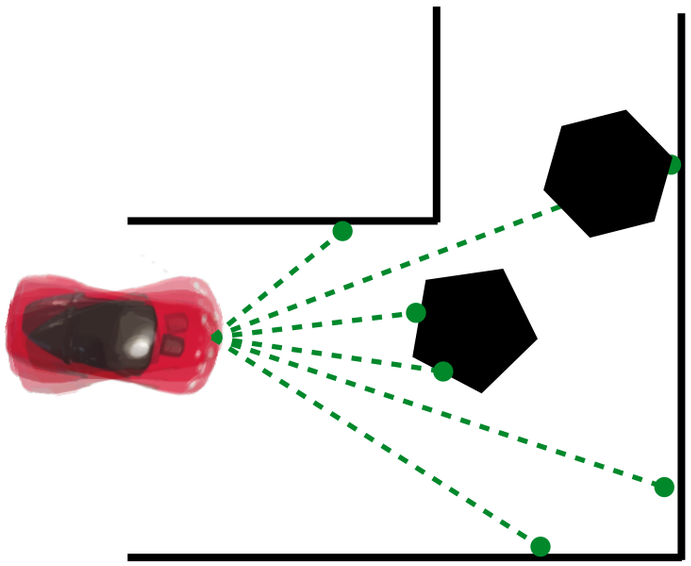


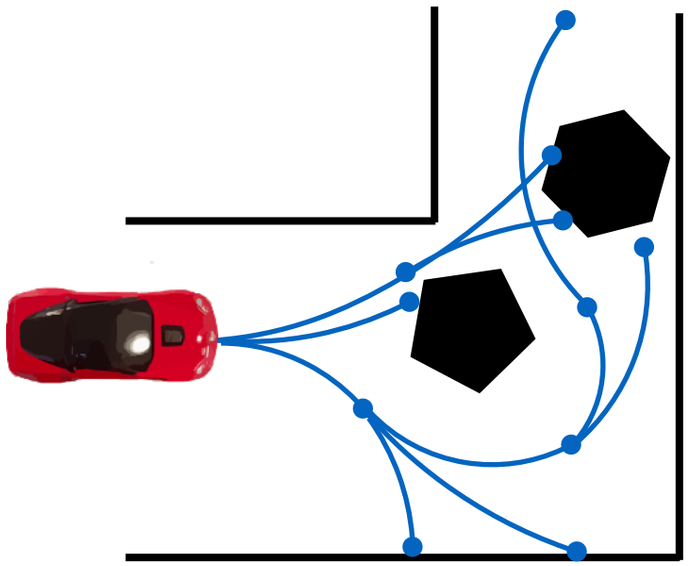
Concrete learning objectives

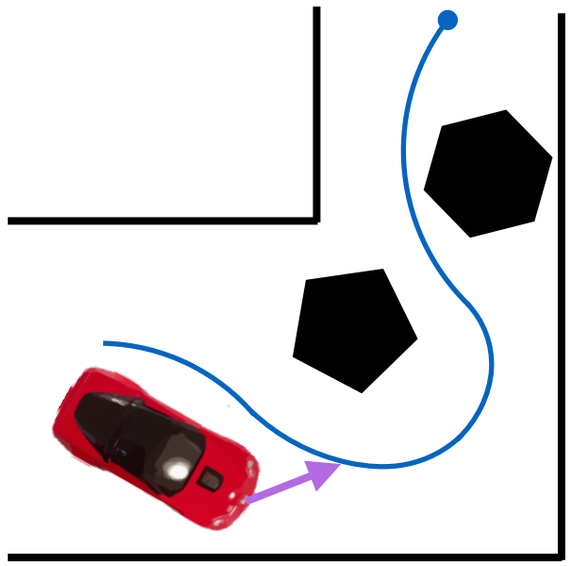
Estimate state

Plan a sequence of motions

Control robot to follow plan





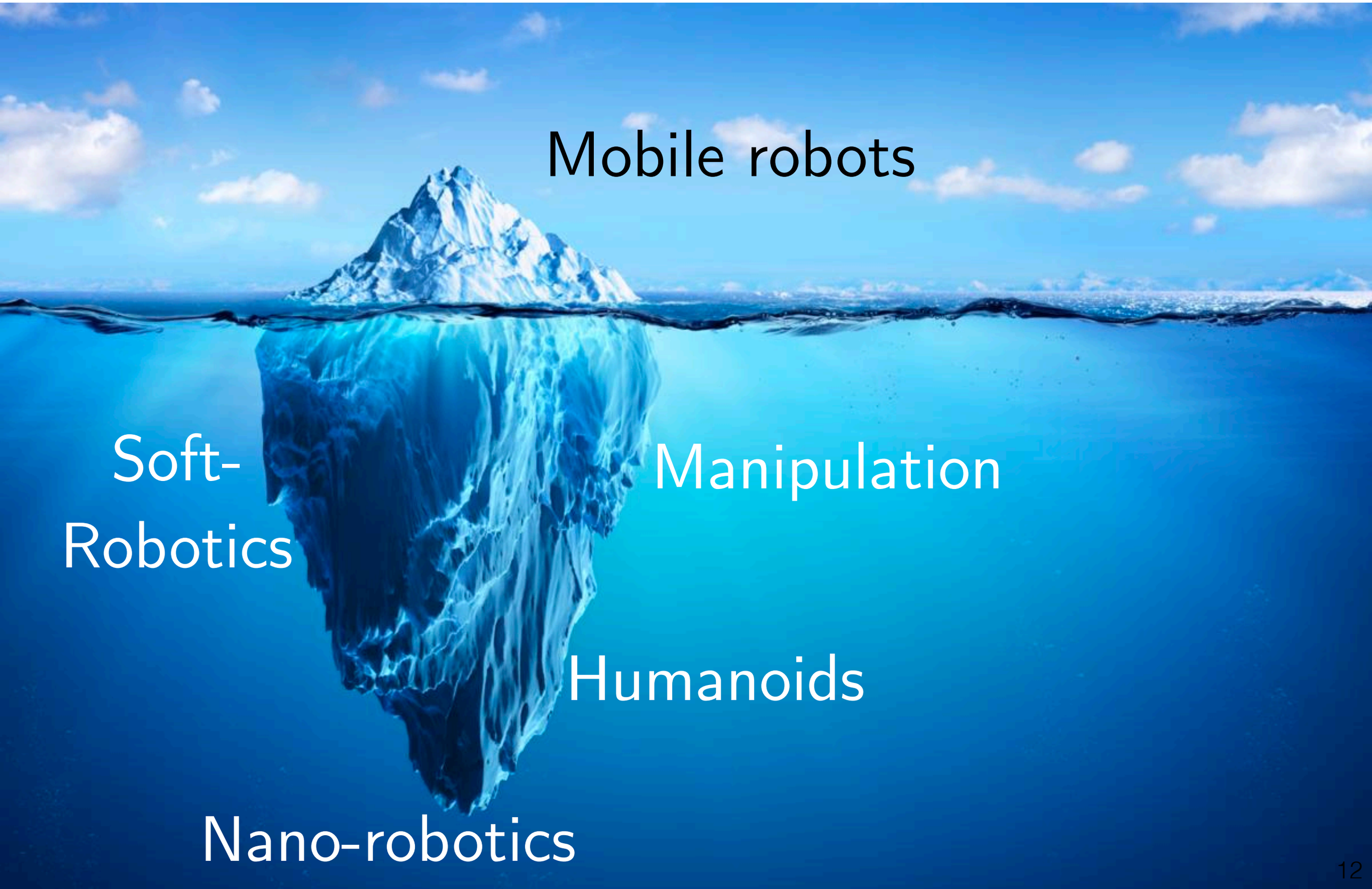


Course outline

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	Learning / Special Topics	Final project

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

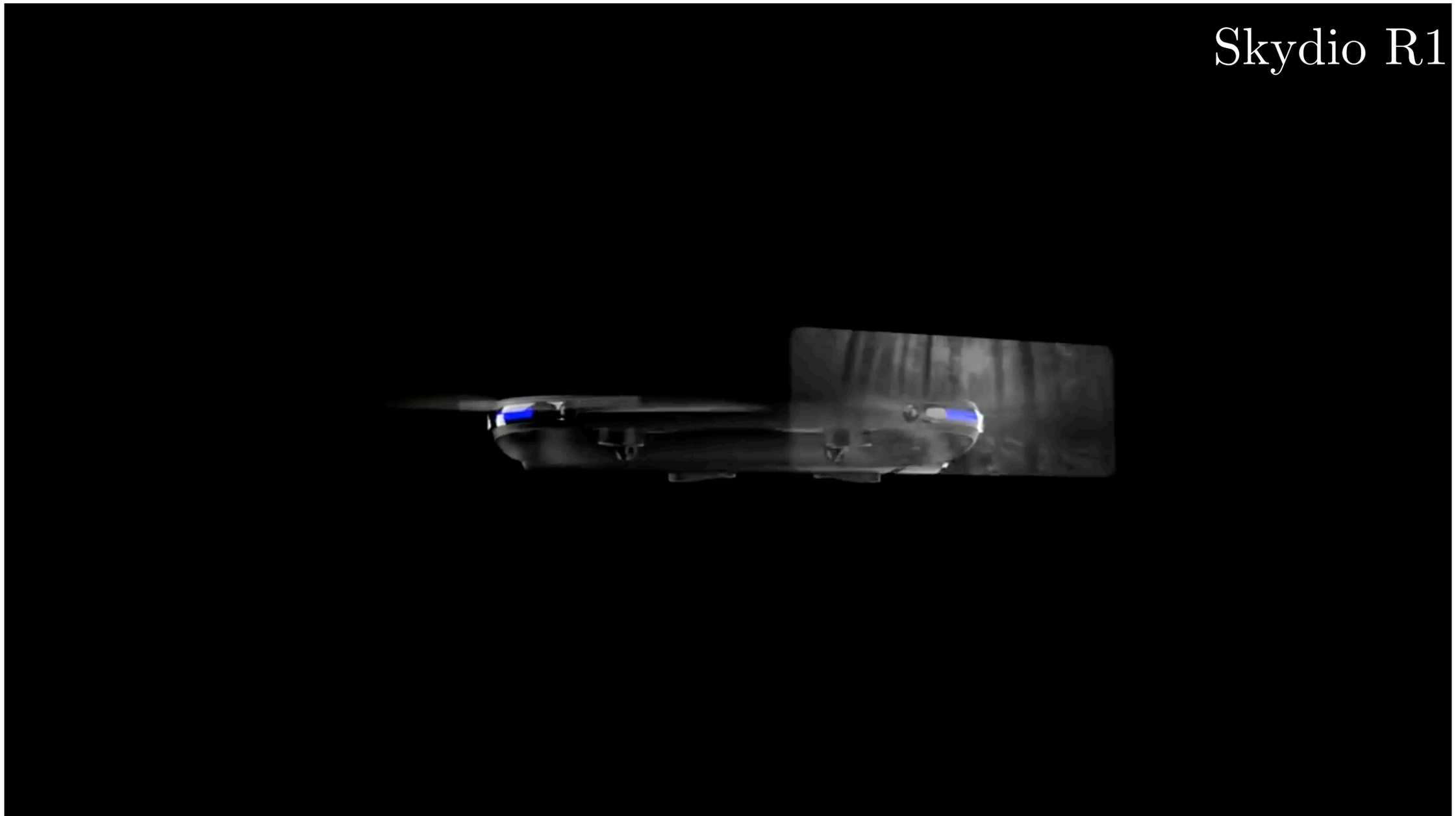
Scope of this course



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

Today's objective

1. Team introductions

2. Logistics

3. Getting started

Sanjiban Choudhury

Post-doc in Personal Robotics Lab

Ph.D from Carnegie Mellon University

Worked on motion planning for full-scale helicopters, bunch of smaller UAVs

(explore forest canopies, fly inside submarines, long-term autonomy, aerial cinematography, etc)

Research:

How should robots leverage prior experience when planning?

Matthew Rockett

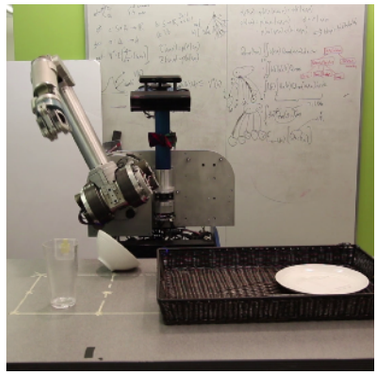
-5th BS/MS Student.

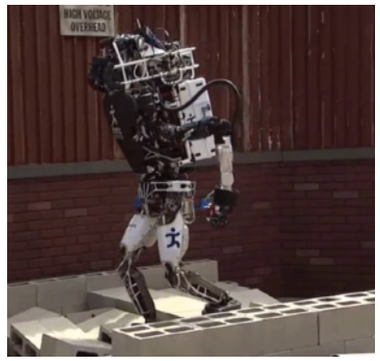
-Maintains MuSHR code base with ~3 other grad students.

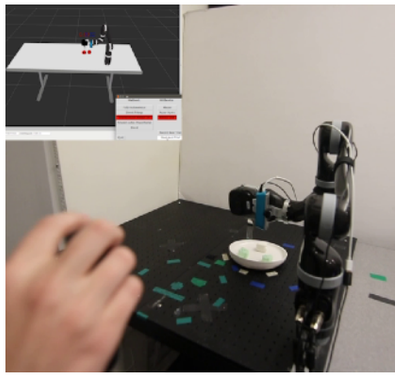
-Interests lie broadly in control and planning of mobile robots.

-Working towards “fast” indoor navigation of the cars.

Gilwoo Lee



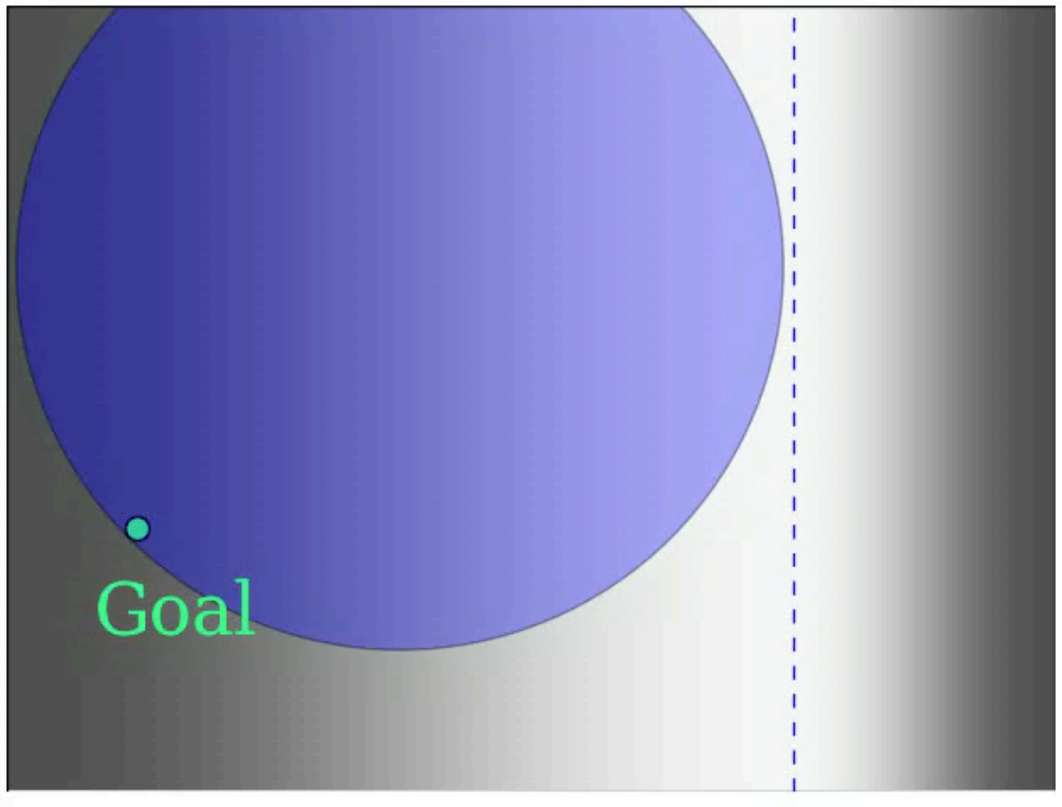




Object pose, friction,
terrain,
human intention,
...

The world is full of uncertainty

Bayesian RL:
Bayes-optimal way for **robust** and
belief-aware agents



Matt Schmittle

- P.h.D. Student in PRL & RSE Labs

- Advised by Dieter Fox and Sidd Srinivasa

- Interested in mobile robot navigation, learning and vision

- Current Research: Learning online from corrective feedback

Today's objective

1. Team introductions

2. Logistics

3. Getting started

Course management tools

- Website: https://courses.cs.washington.edu/courses/cse490r/19sp/
  - one stop for all information, slides, notes, assignments

- Piazza: https://piazza.com/class/jtf0fx11ysxmw
  - announcements, discussions, finding team-mates, contacting instructors

- Canvas: https://canvas.uw.edu/courses/1272916
  - submitting assignments, receiving grades

Lectures / Recitations

- Lectures on Mon Wed Fri, 10:30-11:20, MOR 234
    - Will introduce the topic and focus on fundamental principles, algorithms and theory

- Recitation on Thur, 9:30-10:20/10:30-11:20, CSE1 022
    - Will focus on specific implementation details, hardware / software details and issues relevant to assignments / projects.
    - Topic announced every week on Piazza

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 4/3

- Each team will get a car during the first recitation on Thursday 4/4

Lab logisitics

- 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 a racecar (same robot for duration of class)
  - Robots need to stay in Room (unless TA present)

Car logistics

- Please treat cars with respect.
- Do not change the passwords on the cars.
- Each team maintains own batteries - do not use others.
- Keep your space clean

Office hours

- Come to office hours!

- TA office hours:
  - MR: Thur 11:20-12:30, CSE1 022
  - GL: Tue 9:00 - 10:00, CSE1 022
  - MS: Tue 11:00 - 12:00, CSE1 022

- Sanjiban's office hours: Mon 3:00 - 4:00, CSE1 212

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

Assignments

- All assignments will be done as a team of 3
- All assignments involve work with the robot
- Each team submits one writeup
- Assignments 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

Team blog

- Each team will maintain a blog. Why?
  - Consistently making progress on your assignments
  - Record of what you did over the course

- Format: A repo with a template will be provided

- Content:
  - Progress on the assignment
  - 1 para from EACH member on what they worked on
  - Challenges faced, lessons learned and videos (if any).

- Update blog every week
  - 10% of your grade will go towards regularly updating the blog.

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/

Today's objective

1. Team introductions

2. Logistics

3. Getting started

Knowledge survey

- We have sent out a knowledge survey on Piazza.
  - Ubuntu / Python experience
  - Math knowledge
  - Robot experience, etc

- Help us customize lectures and assignments to the class

Assignment 0 is out!

- 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: April 12 (get started now!)
  - Submit write-up, data, videos
  - More details in Canvas / Piazza
  - Come to recitation on Thurs 4/4

TL;DR

- Submit knowledge survey TODAY

- Form a 3 person team by Wednesday 4/3 (send a private note to instructors in Piazza)

- Assignment 0 is released and due on 4/12.
  - 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