L1: Introduction

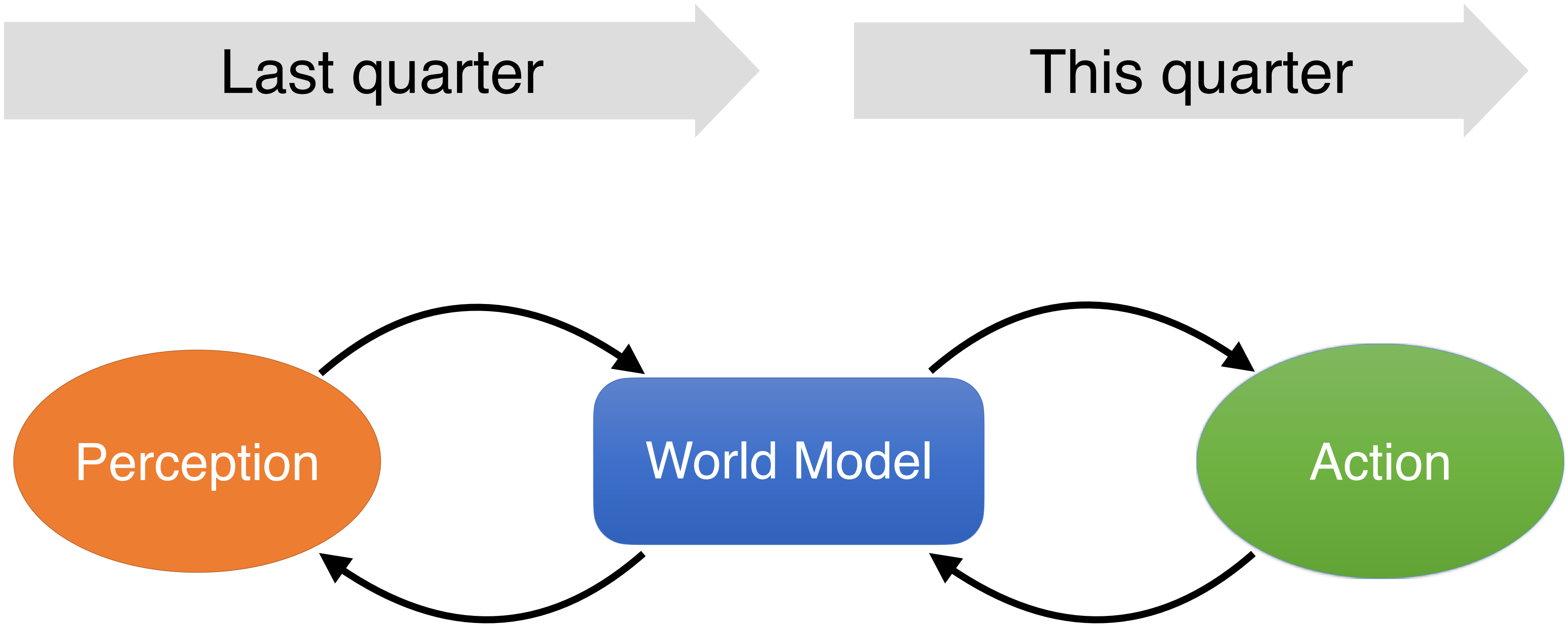
Hao Su

- https://www.youtube.com/watch?v=fn3KWM1kuAw

Agenda

- Syllabus
- Logistics
- $\mathbb{SO}(3)$

Syllabus


Last quarter
This quarter
Perception
World Model
Action

Vision → Robotics

Passive AI

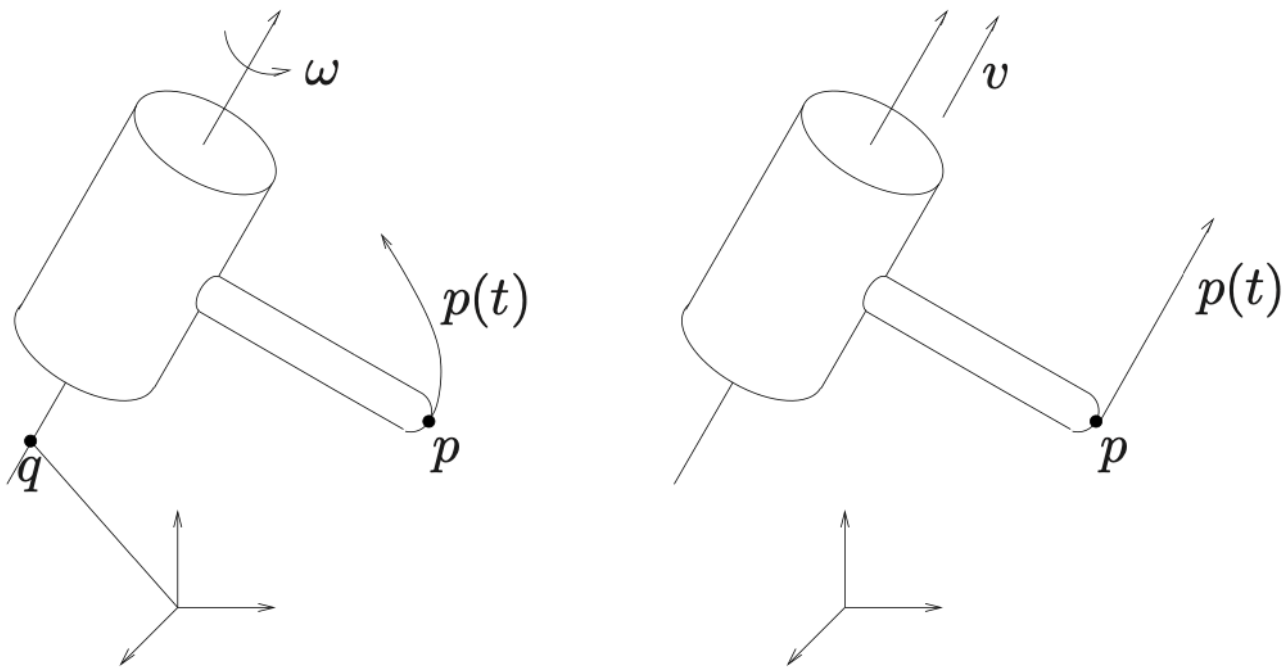
- We know how to fit data well (by “deep learning”)
  - e.g., computer vision, natural language processing

Vision → Robotics

- We aspire that autonomous agents can perform tasks and "grow" through interaction experiences
  - Need the ability to **interact**

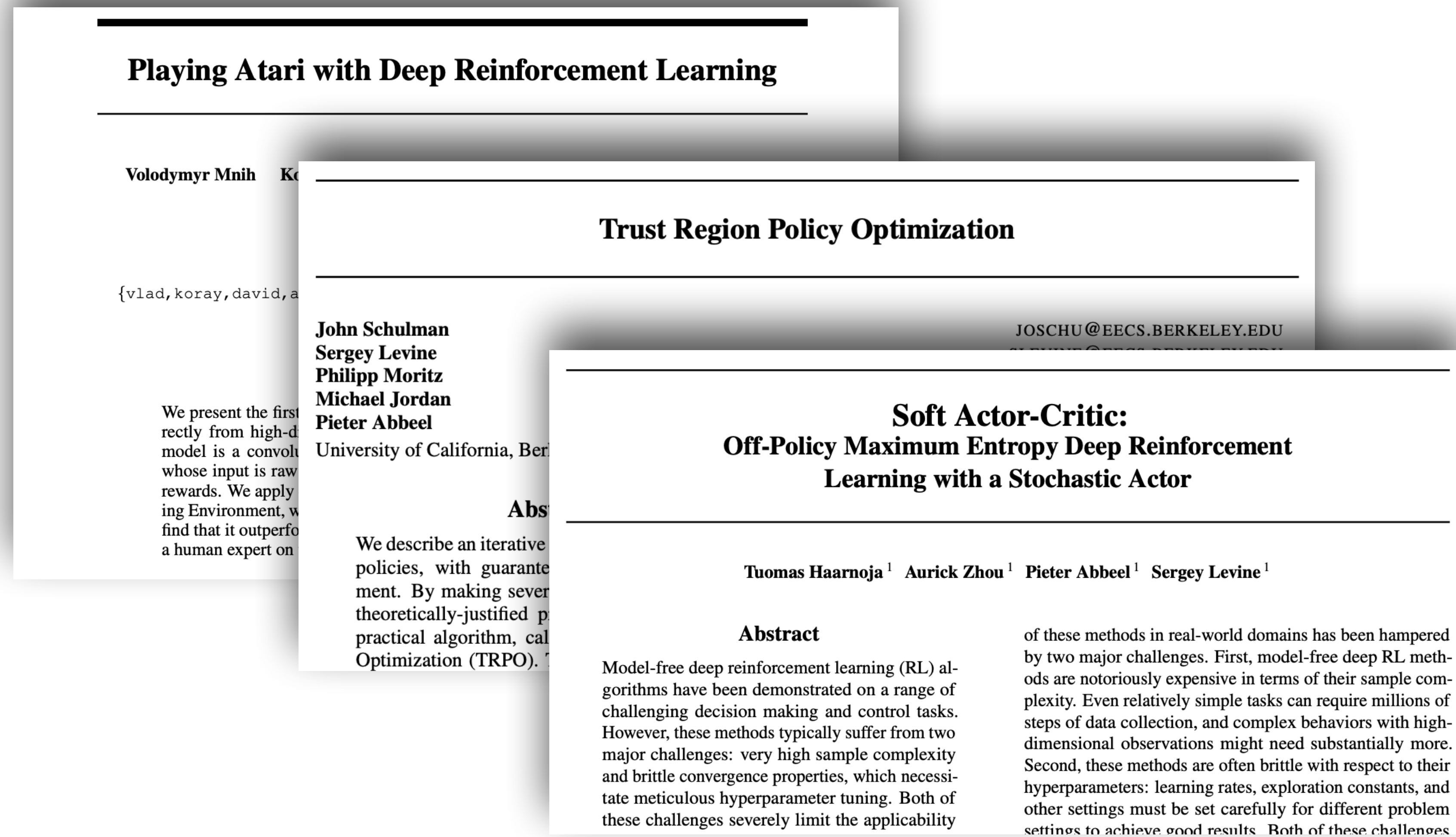
Topics Covered in This Course

- Modeling Robots by Rigid-Body Geometry



Topics Covered in This Course

- Deep RL Frameworks



Playing Atari with Deep Reinforcement Learning

Volodymyr Mnih Ko

{vlad,koray,david,a

We present the first
rectly from high-d
model is a convolu
whose input is raw
rewards. We apply
ing Environment, w
find that it outperfo
a human expert on

Trust Region Policy Optimization

John Schulman JOSCHU@EECS.BERKELEY.EDU
Sergey Levine
Philipp Moritz
Michael Jordan
Pieter Abbeel
University of California, Berk

Abs

We describe an iterative
policies, with guarante
ment. By making sever
theoretically-justified p
practical algorithm, cal
Optimization (TRPO).

Soft Actor-Critic:
Off-Policy Maximum Entropy Deep Reinforcement
Learning with a Stochastic Actor

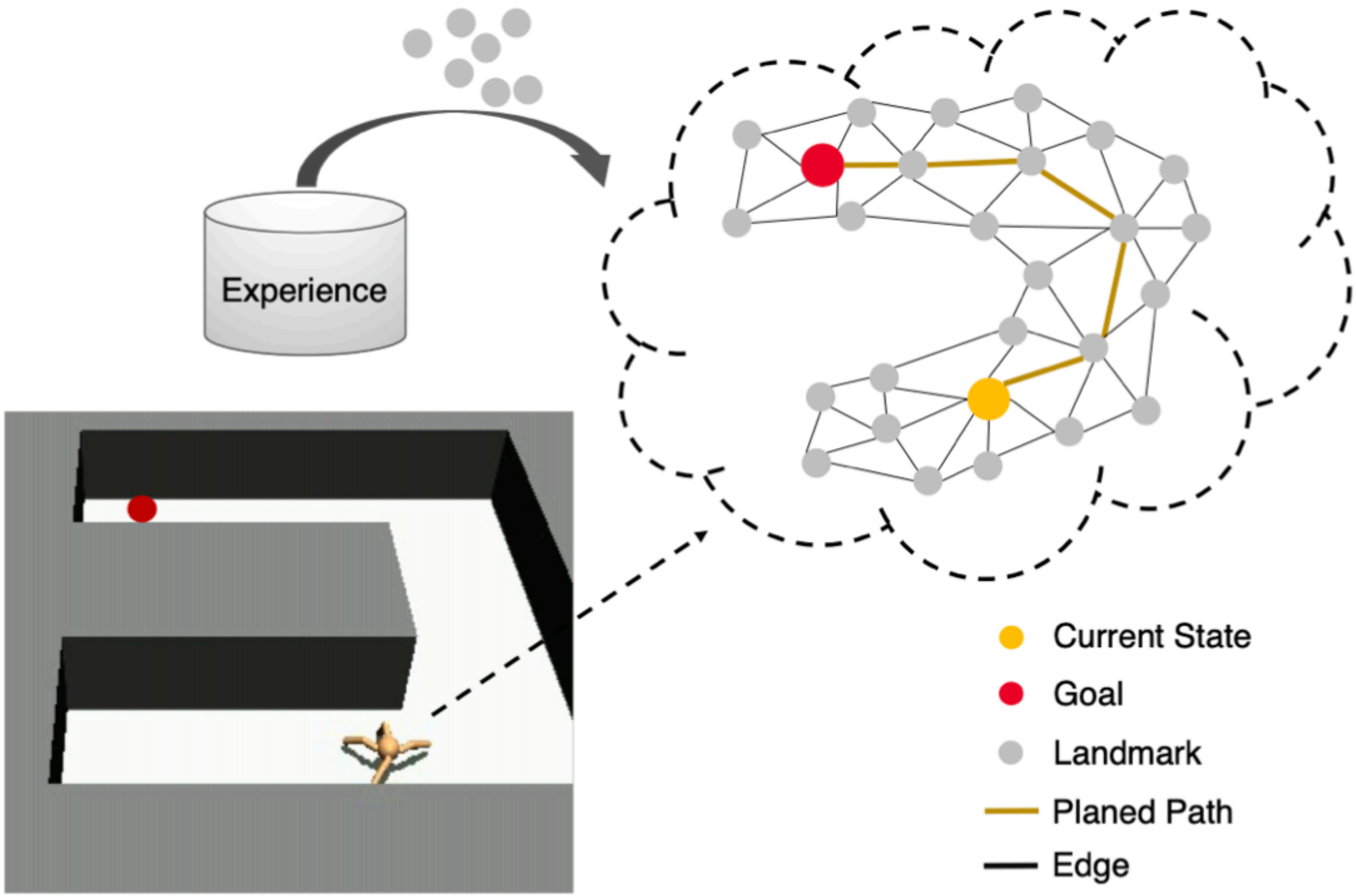
Tuomas Haarnoja [1] Aurick Zhou [1] Pieter Abbeel [1] Sergey Levine [1]

Abstract

Model-free deep reinforcement learning (RL) algorithms have been demonstrated on a range of challenging decision making and control tasks. However, these methods typically suffer from two major challenges: very high sample complexity and brittle convergence properties, which necessitate meticulous hyperparameter tuning. Both of these challenges severely limit the applicability of these methods in real-world domains has been hampered by two major challenges. First, model-free deep RL methods are notoriously expensive in terms of their sample complexity. Even relatively simple tasks can require millions of steps of data collection, and complex behaviors with high-dimensional observations might need substantially more. Second, these methods are often brittle with respect to their hyperparameters: learning rates, exploration constants, and other settings must be set carefully for different problem settings to achieve good results. Both of these challenges

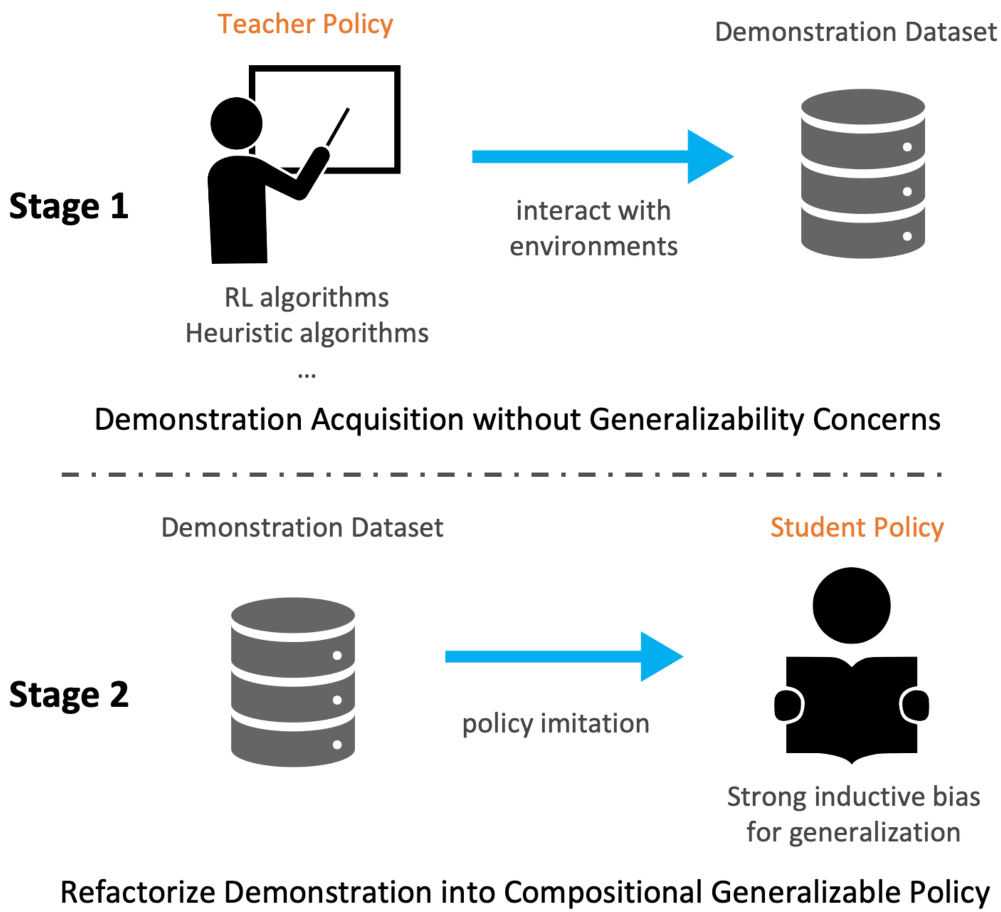
Topics Covered in This Course

- Hierarchical RL



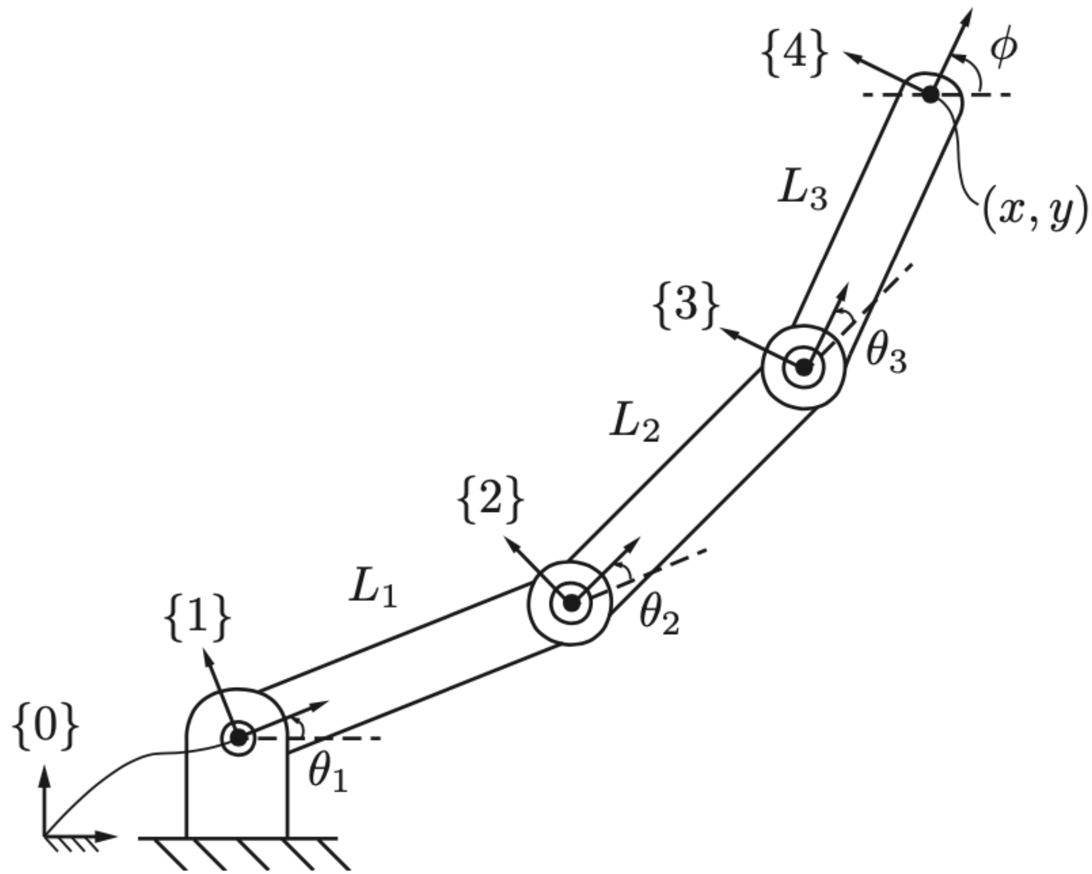
Topics Covered in This Course

- Generalizability of RL



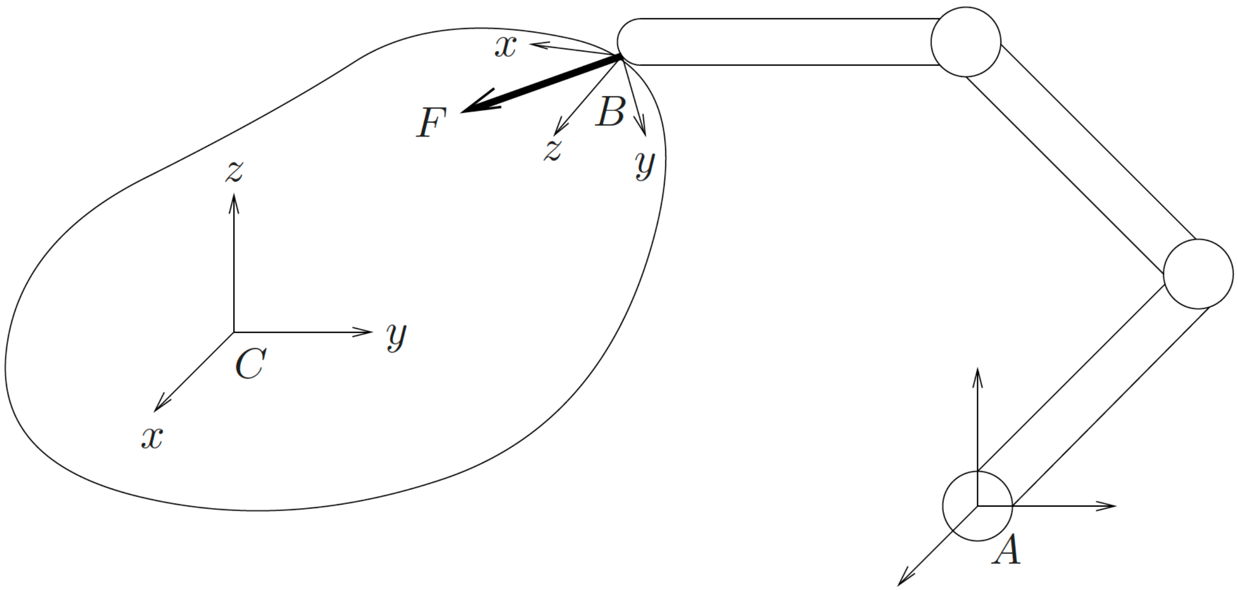
Topics Covered in This Course

- Forward and Inverse Kinematics of Robots



Topics Covered in This Course

- Generalized Force and Inertia



Topics Covered in This Course

- Friction, Contact Model, and Grasp

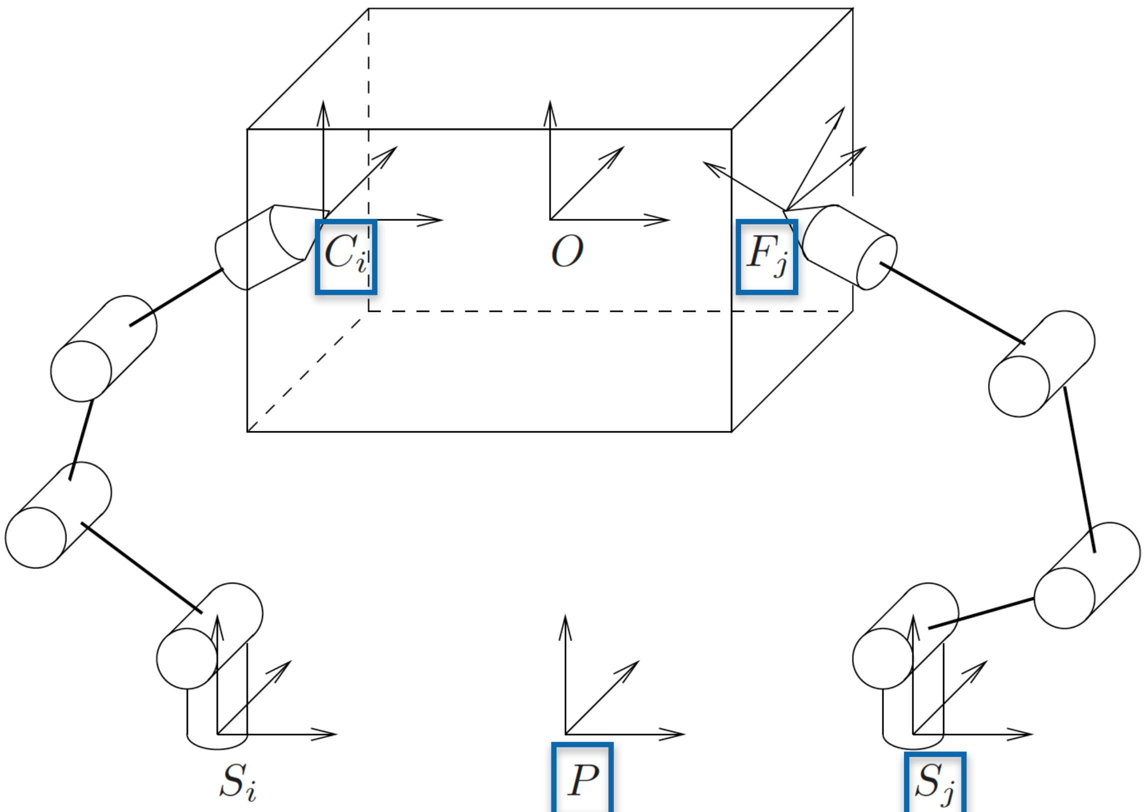
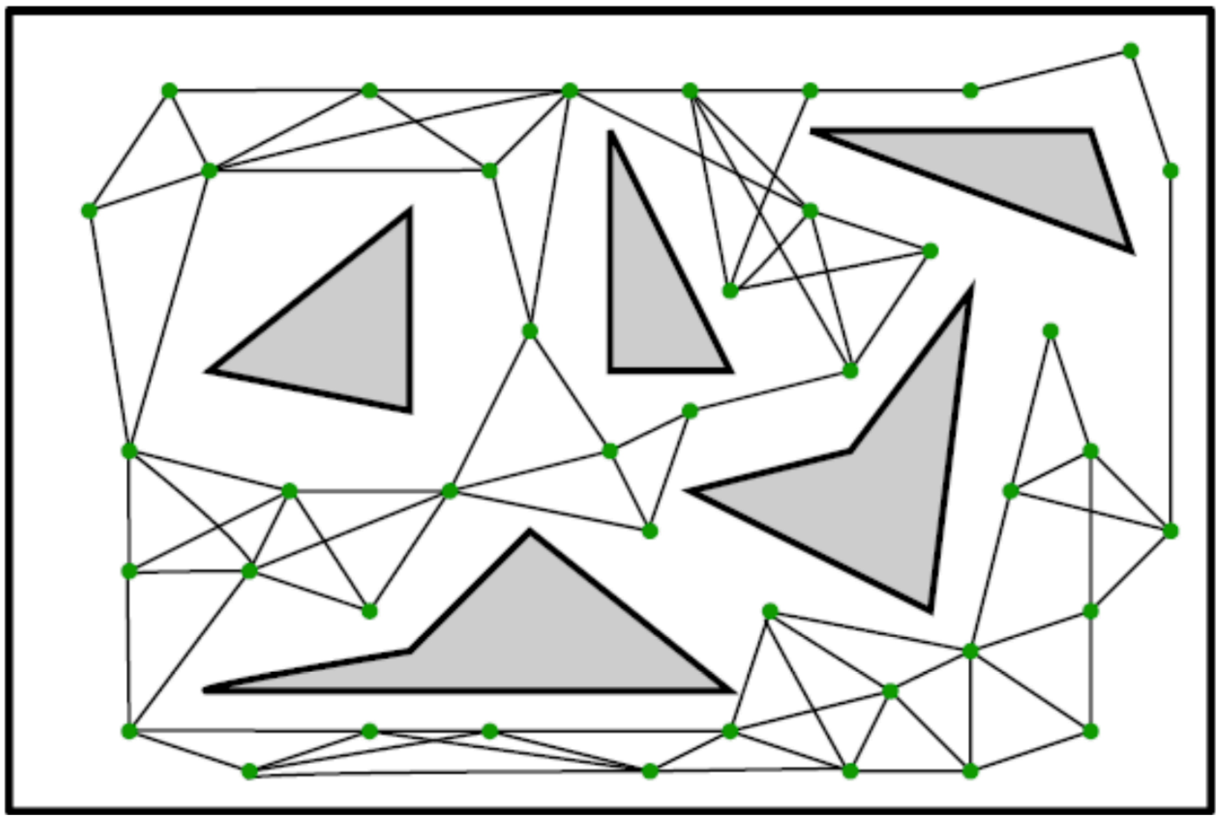


Figure 5.14: Grasp coordinate frames.

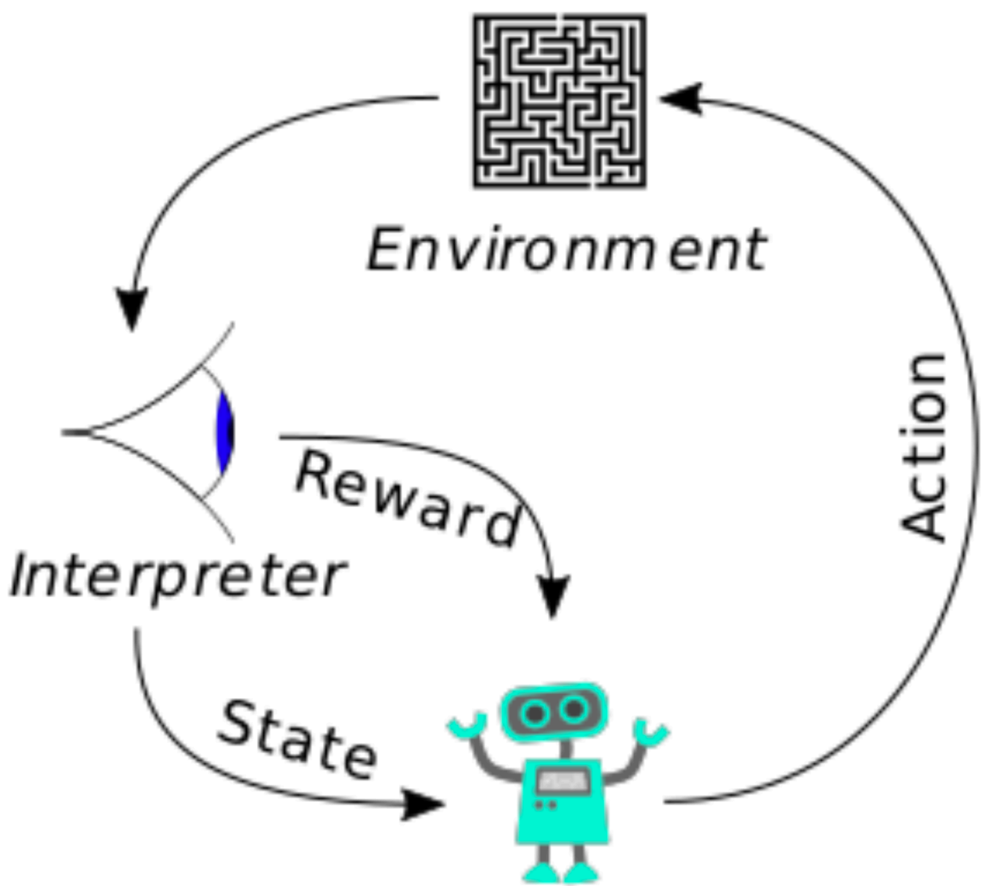
Topics Covered in This Course

- Classical Planning and Control



Topics Covered in This Course

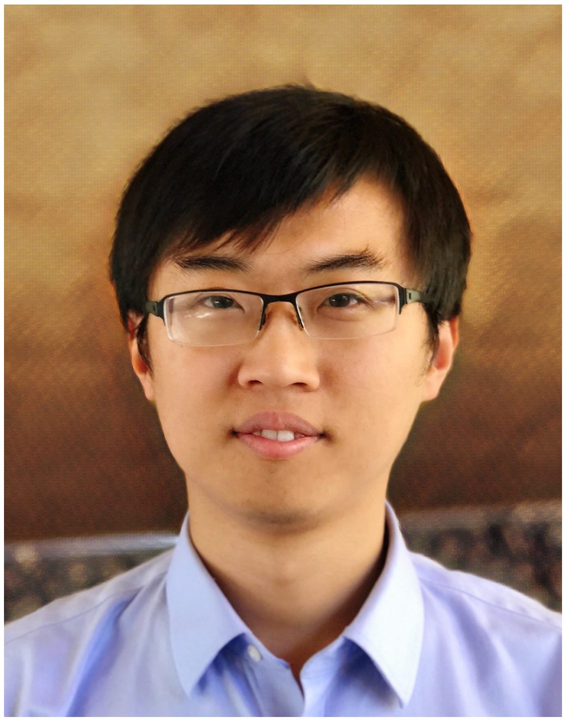
- Concepts of Reinforcement Learning



Course Logistic

Instructors

Instructor: Hao Su



TA: Zhiwei Jia

Teaching Goal

- Foundational
  - Programming problems ask you to **implement low-level modules from scratch**
- Hands-on
  - **Heavy** programming assignments to exercise what are taught in class

Pre-requisite: Technique

- **Skilled** in Linear Algebra, Multi-variable Calculus, and Deep Learning
- **Familiar** with Probability and Numerical Methods
- **Strong** programming skills
  - Familiar with Linux Toolchain
  - Familiar with python, numpy, and pytorch
- Course/project experiences in deep learning

Background Check

- On Piazza now (HW0)
  - Visible to enrolled and waitlist students
- 5 points in your final grade
- **Mandatory!** We will not grade your subsequent homeworks without seeing your HW0.
- If you are in the waitlist and intend to enroll, you need to submit HW0 by this deadline
- Due: 01/17/2023

Pre-requisite: Resources

- This course requires deep learning resources (to run reinforcement learning challenges)

- Ideally, you should have your own computing machine with the following configuration:
  $\geq$ 50G disk space
  $\geq$ 1 GPU for deep learning

- Google Colab can satisfy most needs

Exam Policy

- No mid-term/final exams

Projects & Assignments

- (80 pts) Course project (one big project to solve in teams)
  - To release in the 4th week
  - Biweekly report, final presentation & writeup
- Homeworks
  - Biweekly
  - (20 pts) First two homeworks (HW0 & HW1) are mandatory
  - (40 pts) Later homeworks are optional (as bonus)
- We estimate **>=15 hrs per week** (out of class) solid time commitment

Collaboration Policy

- You can form teams of at most two members for homeworks and projects can work in

- But HW0 has to be completed **independently**

- Each team submits a single copy of the solution/ project paper

Course Resources

- Course website: https://haosulab.github.io/ml-for-robotics/WI23/index.html (Google "Hao Su" → Prof. Homepage → Teaching → this link)
  - Lecture slides
  - Office hour and location
- Piazza
  - Homework/Solution release
  - Discussions
- Homework
  - Gradescope

Office Hour

- Check course website

Questions?

Knowledge from Here

- https://docs.google.com/presentation/d/1xlxwfeEyWyqjBdbhklH0lX3O-VosE2iHFFmEc_zF-BI/edit#slide=id.g132e6c0ce7c_22_144