UC San Diego

Deep Learning for Semantics, Geometry, and Physics in Robotics

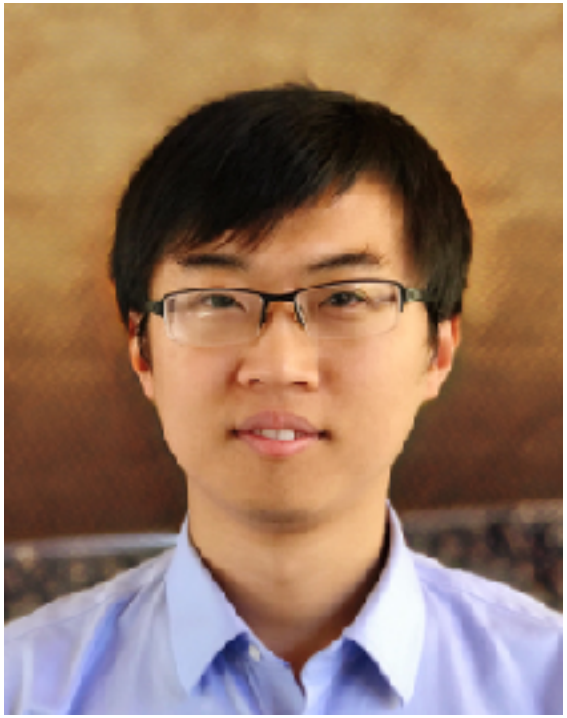
Hao Su

Course website

- http://robotmlcourse.github.io

Who are we?

Instructor: Hao Su



Teaching Assistant: Jiayuan Gu

Goal

- A research-driven course
- Explore how to apply machine learning for object manipulation tasks
- We study the topic together!

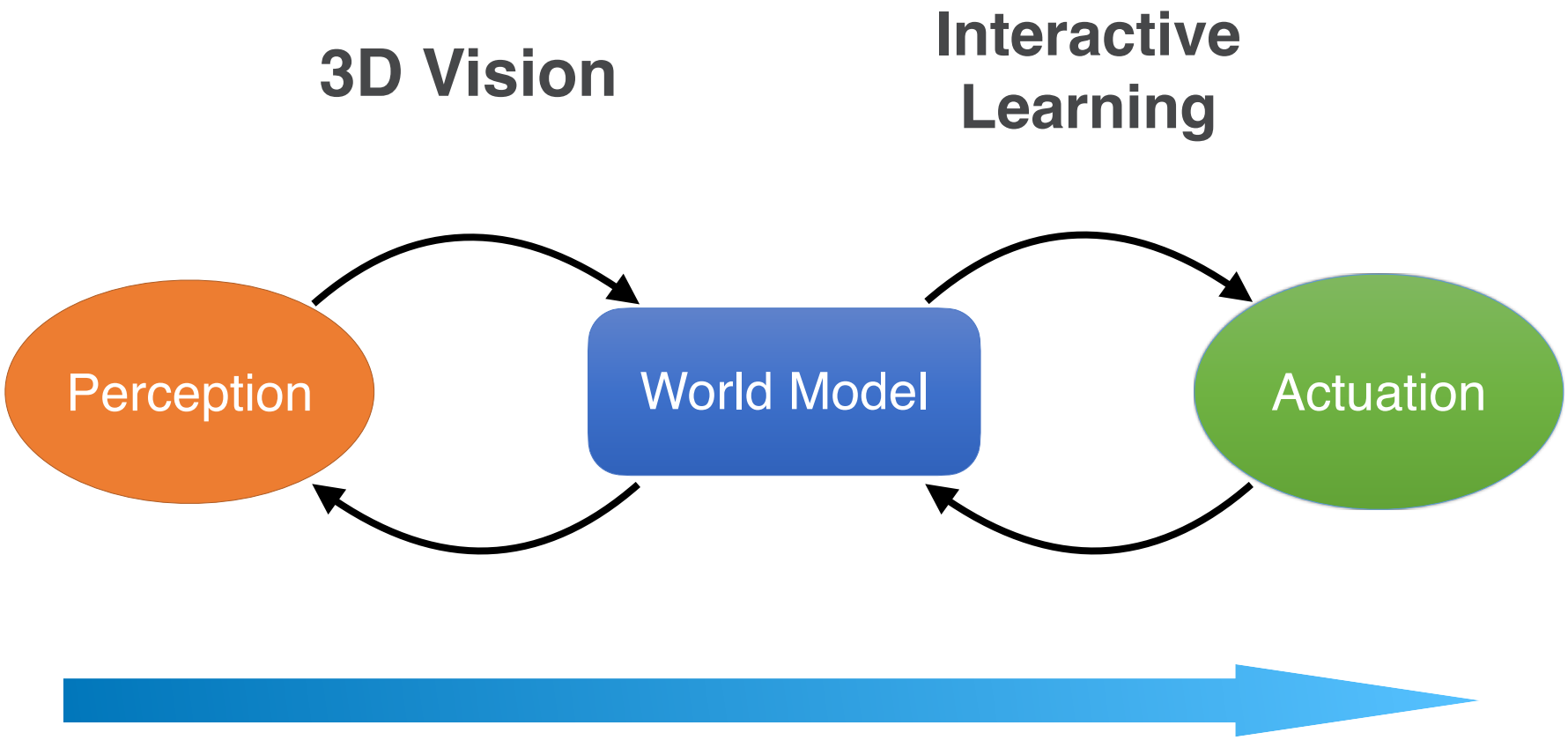
Why we are interested in this topic?

Passive AI

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

Why we are interested in this topic?

- We aspire that autonomous agents can discover knowledge by itself through exploration
  - Need the ability to **interact**


3D Vision
Interactive Learning
Perception
World Model
Actuation

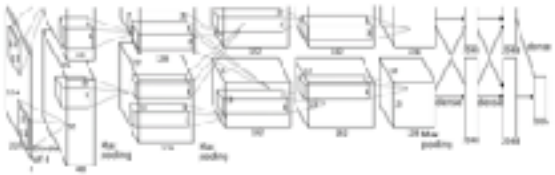
Three Components of Interaction

To interaction with the environment, we need

- Observe the environment (perception)
- Build the environment model (modeling)
- Select the actions (planning)

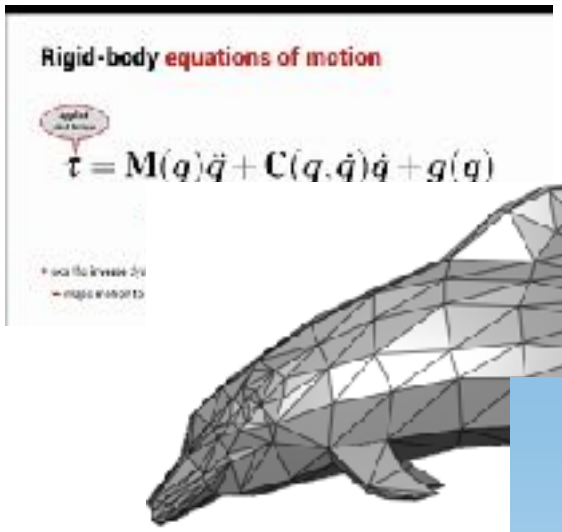
Perception

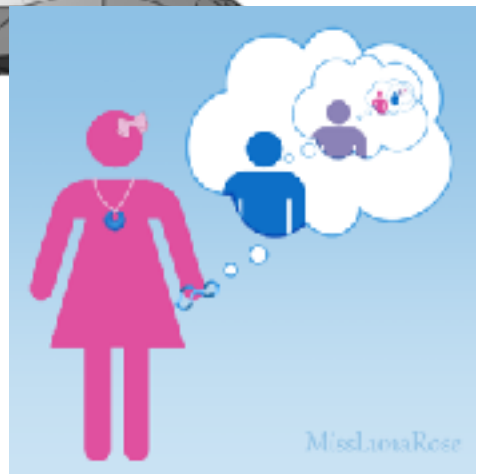
- Perception: observe the status of the environment
  - Classification
  - Detection
  - Reconstruction



Environment Modeling

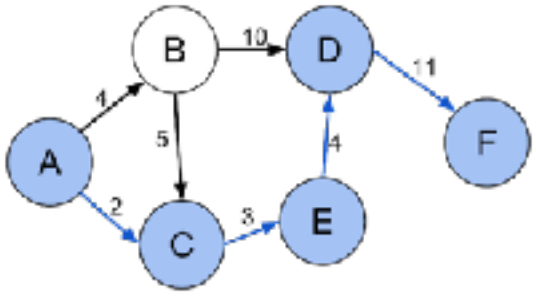
- Models: structured knowledge about the current environment from the observation.
  - Physical laws
  - 3D geometry
  - Theory of mind



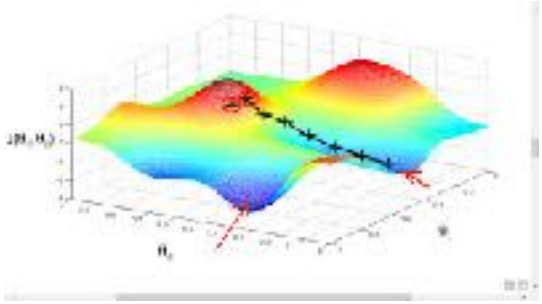


Planning

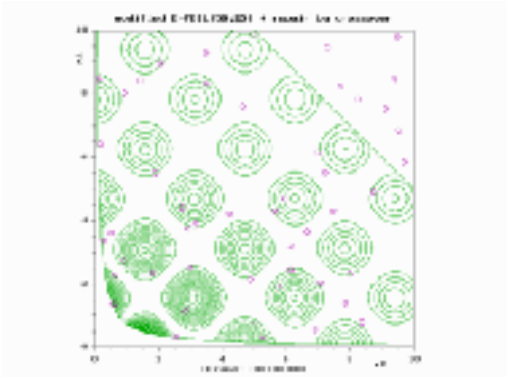
- Planning: select the action based on the model



Shortest path



Gradient descent

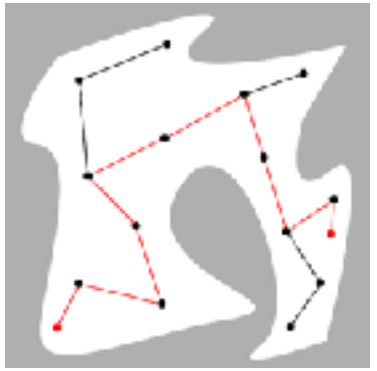


Evolutionary Algorithm

Environment Modeling

Modeling

Perception



Planning

Structure of the Course (I)

- First semi-quarter: My Ph.D. students will teach the basics of robotics
  - Deep reinforcement learning
  - Basics concepts in mechanics
  - Forward/inverse kinematics/dynamics
  - Motion planning
  - Control
  - Rigid-body simulation
  - Fluid simulation
- Students are asked to finish a small project to implement a robot arm for object movement (mid-term project)

SAPIEN: A SimulAted Part-based Interactive Environment

https://sapien.ucsd.edu/

Structure of the Course (II)

- Second semi-quarter: Paper presentation by students
  - Cover classic and latest papers

- Students are asked to work on an object manipulation challenge using SAPIEN benchmark (final project)

Logistics

Grading (tentative)

- Class presence: 10%
- Mid-term project: 30%
- Paper presentation: 30%
- Final project: 30%
- There will not be a final exam.

Pre-requisite

- Try to be as self-contained as possible
- Proficiency in Python and C
- Calculus, Linear Algebra
- Machine learning