Welcome to CSE 571 Robotics

Instructor

Dieter Fox

Teaching Assistants

Jiafei Duan

Chaoyuan Zhang

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Organization

- Lectures: Tue/Thu 10:00 – 11:20
  (will also put Zoom recordings on Canvas)
- Office hours
  - Dieter: Thu 11:30-12:30pm
  - Jiafei: Wed 5-6pm
  - Chaoyuan: Fri 10-11am
- Tasks and grading
  - **3 assignments (**15% each)
    Python programming: particle filters, RRT planning, and RL
  - **Project** (45%), teams of 2-3 students, guided and self specified versions
  - **Attendance** (5%), **paper Q&A** (5%), **attendance** (5% bonus)
- Late policy on assignments
  - Up to 6 late days without penalty. Beyond that, 20% off max points per day. No late days on 3rd assignment.
- Readings: Papers and chapters from *Probabilistic Robotics,* papers

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Academic Honesty

While we encourage students to discuss homeworks, each student must write up their own solution. It's fine to use a source for generic algorithms (with attribution), but it is not allowed to copy solutions to the problems. Additionally, students may not post their code online. If we determine that a student posted their code online, they will get an automatic 50% reduction on the entire assignment (math + code) and if they copy code for the problems from another student or from online, they will get an automatic 0% for the entire assignment (and possibly reported to the college). While we can't check for the use of tools such as ChatGPT, we strongly encourage you to develop your own solution and be honest about how you used such a tool in case you did.

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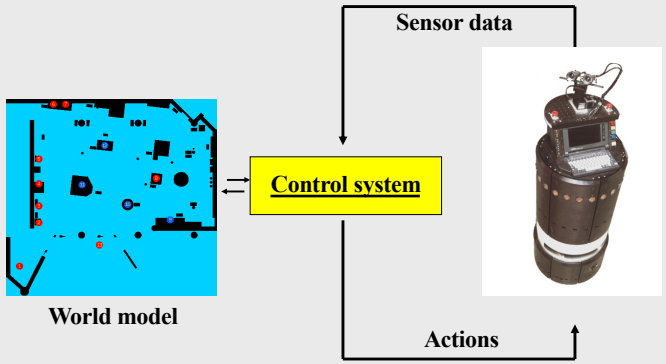
High-level View on Robot Systems



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Industrial Robotics Today

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Minerva (CMU + Univ. Bonn, 1998)

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DARPA Urban Challenge 2007

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Self-Driving Cars

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Robots in Warehouses
(Kiva@Amazon)

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Amazon Prime Air

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DARPA Robotics Challenge 2015

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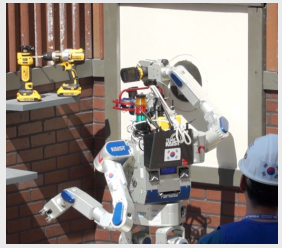
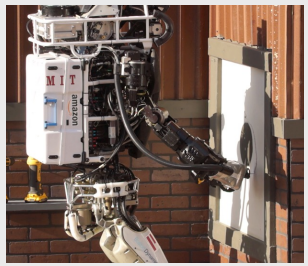
Drilling Hole





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Boston Dynamics BigDog (2008)

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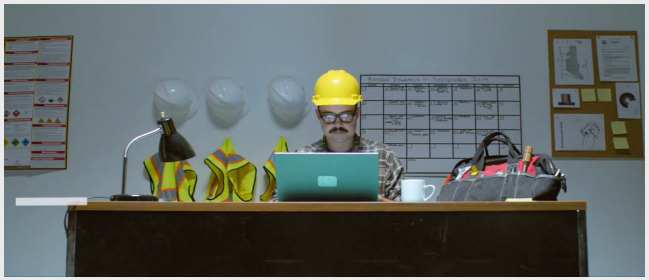
Boston Dynamics Spot



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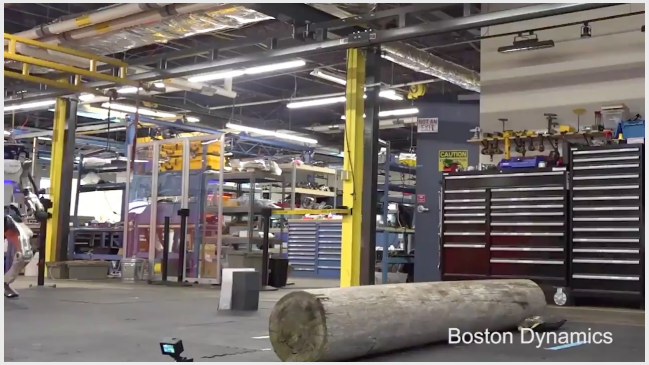
Boston Dynamics Atlas



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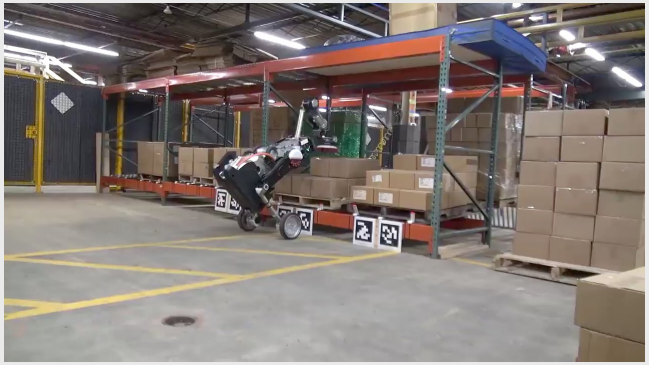
Boston Dynamics Handle



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Industrial Pick and Place

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Service Robots





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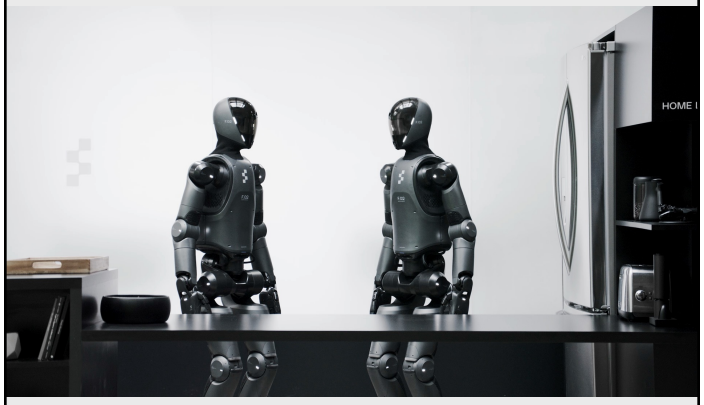
Figure.ai Helix



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Highly Impressive Capabilities within Isolated Task Domains


Toyota Research Institute: Diffusion Policies


Physical Intelligence: PI0

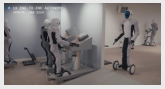

Figure.ai: Figure 01


Tesla Optimus Gen 2


Stanford: Mobile Aloha

Google/Deepmind: RT2

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Humanoids and Teleop

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UW RACER

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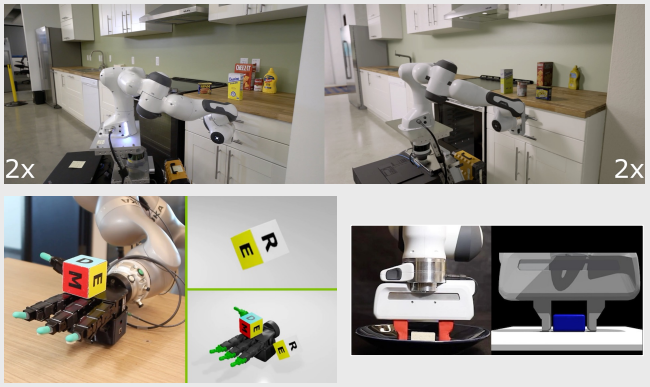
Simulation



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Current Trends / Topics

- Self-driving cars, sidewalk delivery robots, warehouses, manufacturing sites, …
- Drones
- Industrial pick and place
- Humanoids

- Manipulation of everyday objects
- Complex household tasks (cooking, folding, …)
- Cobots, human robot interaction
- Deep learning for perception, control, imitation learning, recognition, LLMs/VLMs/VLAs

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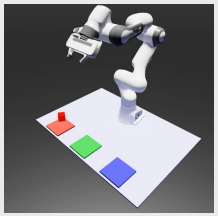
Goal of this course

- Provide an overview of fundamental problems / techniques in robotics
- Understanding of estimation and decision making in dynamical systems
  - Probabilistic modeling and filtering
  - Deterministic and non-deterministic planning
  - Learning for perception and modeling
- Trends in Gen-AI for robot manipulation

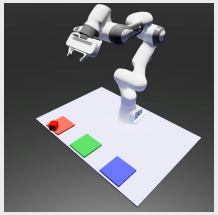
Course Outline

Week	Content	HW / Project
#1	Introduction / Particle filters	
#2	Bayes filters / Motion and sensor models	
#3	Kalman filters	~HW1 due
#4	Mapping	
#5	Deterministic and sampling-based planning	
#6	Manipulation and grasping	~HW2 due
#7	Markov decision processes / Reinforcement learning	
#8	Imitation learning / Behavior cloning	
#9	Readings in Generative AI for robotics	
#10	Readings in Generative AI for robotics / Summary	HW3 due

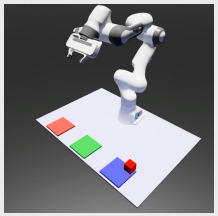
BC uses demonstrations to learn to map images and joint configurations to control commands



1K demonstrations
red block on red path

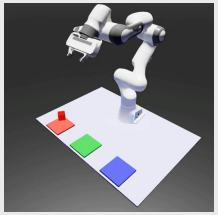


Policy succeeds on
similar block poses

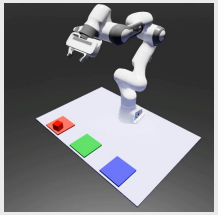


Policy cannot handle new locations

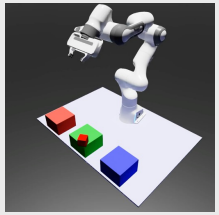
BC uses demonstrations to learn to map images and joint configurations to control commands



3K demonstrations on
all patches



Policy succeeds in
all patches



Policy cannot handle variations
in block height or texture