CS4910: Deep Learning for Robotics

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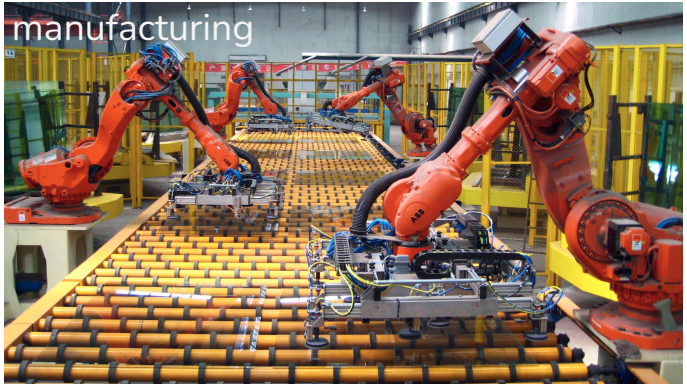
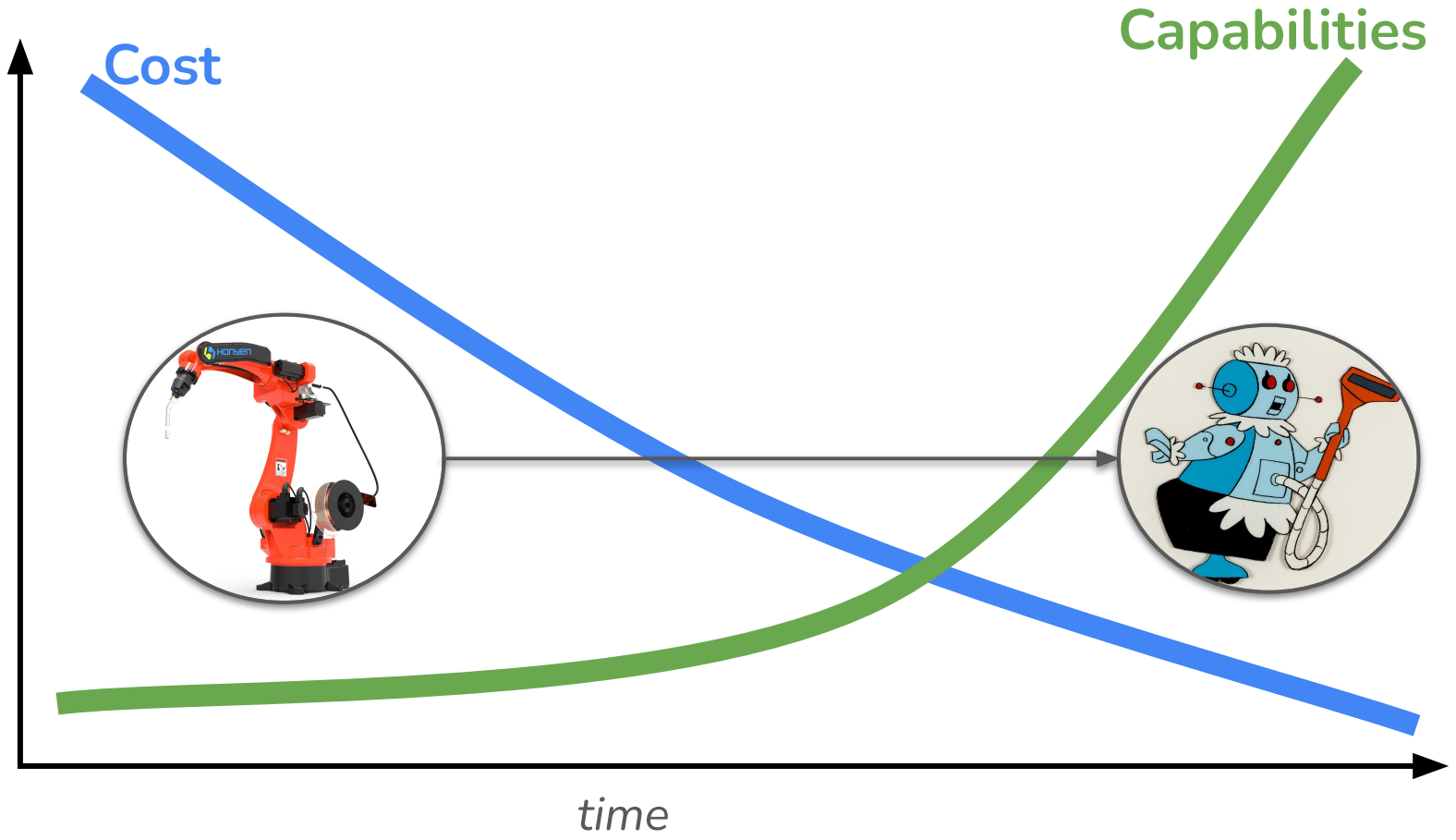
T/F, 3:25-5:05pm
Behrakis Room 204

https://www.ccs.neu.edu/home/dmklee/cs4910_s22/index.html

Autonomous systems are jk the rise



From the factory to your home



The Age of Collaborative Robots (Cobots)

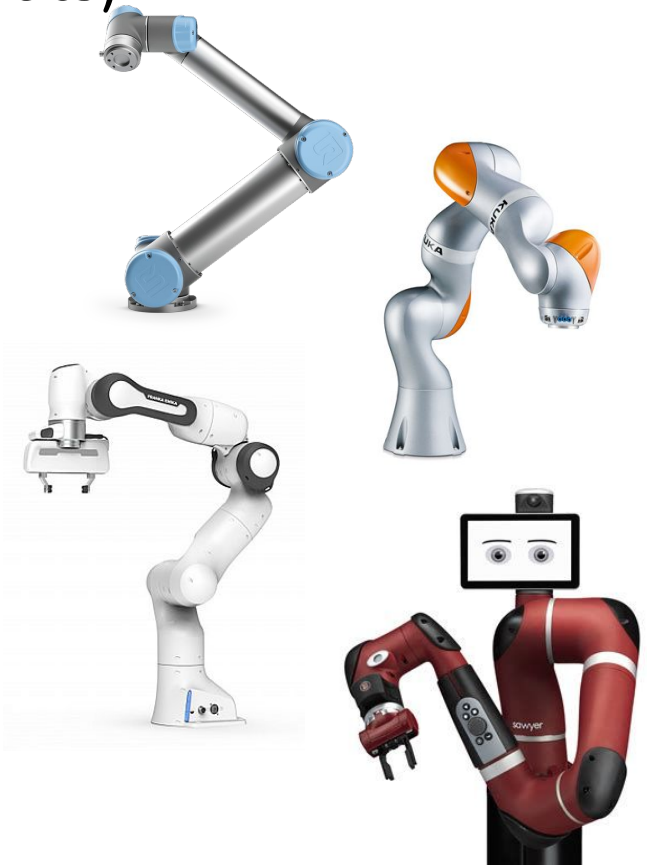
$20-40k + sensors

Safety features allow humans to work alongside

High precision and near-human throughput

Simple use cases: bin picking, machine tending

Leverages new grasping technology for more open-world applications



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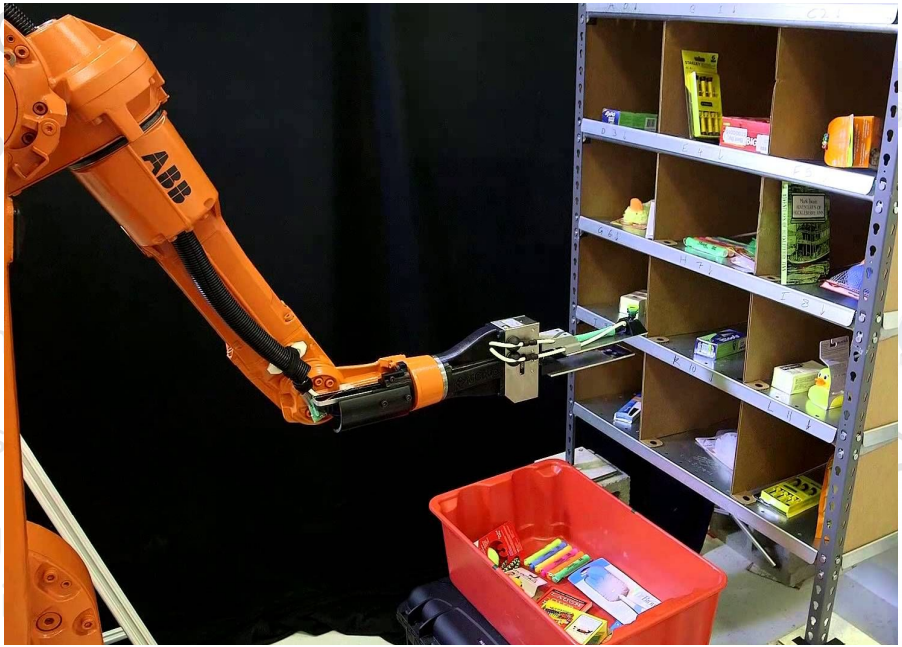
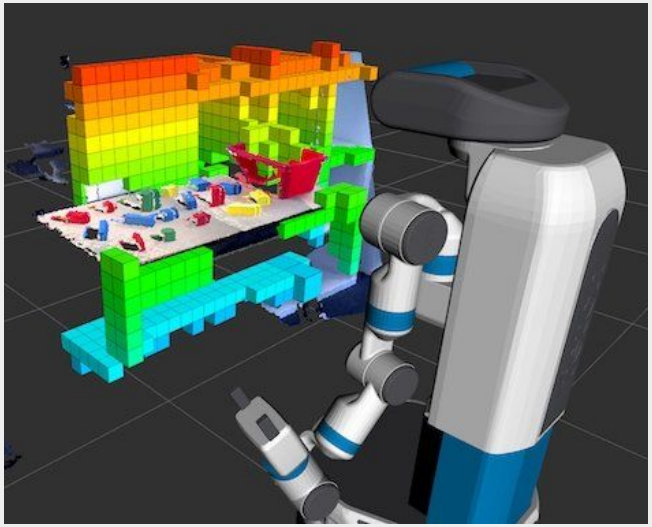
open-world appl



Amazon picking challenge

Classical Methods

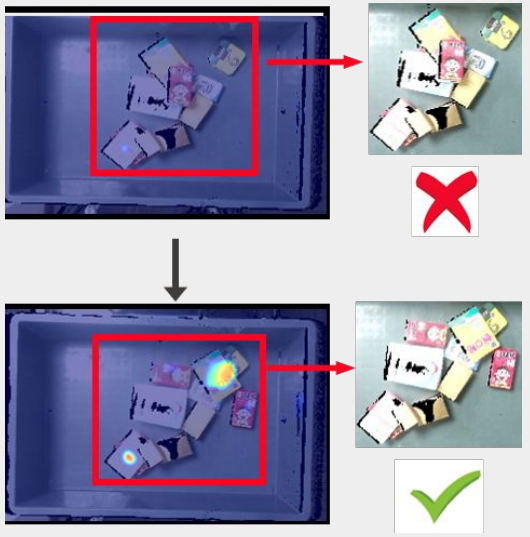


Understandable

Formal Guarantees

Closed world

Deep Learning Methods



Black box

Generalize & finetune

Open world

The case for this course

To develop a *practical* understanding of concepts in deep learning and how to apply them to robotic manipulation

Simulators

Data, Safety & Cost

Adding robot & objects

Sending motor commands

Placing Sensors

Nvidia’s Omniverse

Deep Neural Networks

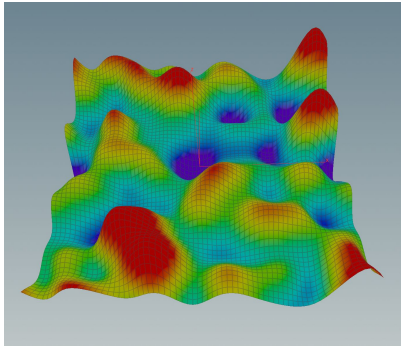
PyTorch

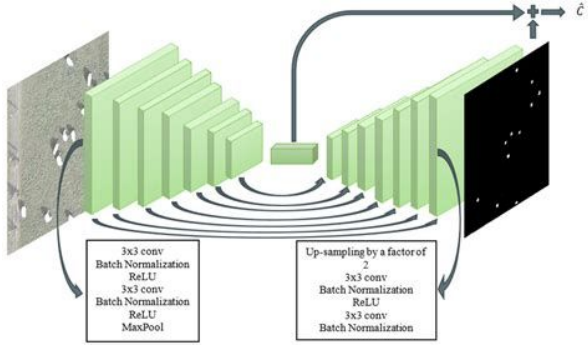
Designing MLP and CNNs

Best-practices for hyperparameters

Creating Datasets and Dataloaders

Improving robustness with data-augmentation





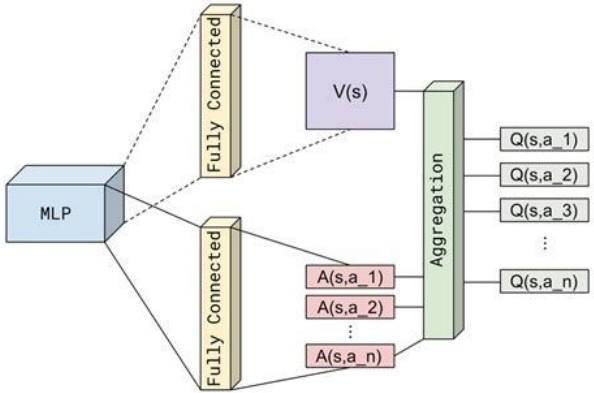
Reinforcement Learning

Deep Q-Networks

Design choices around state/action/reward

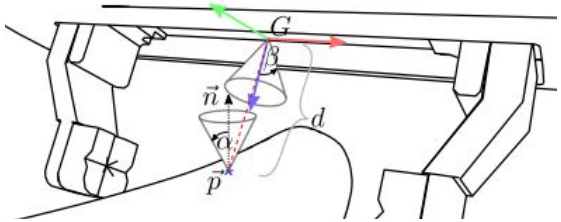
Stabilizing training

Common techniques to improve performance

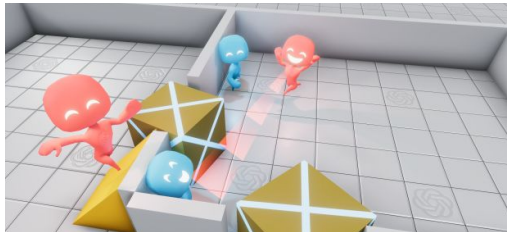


Special Topics

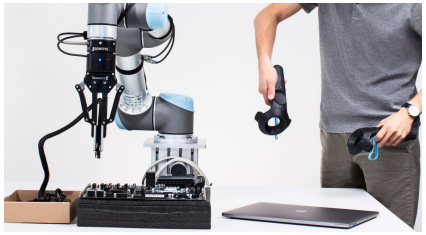
Grasp Mechanics



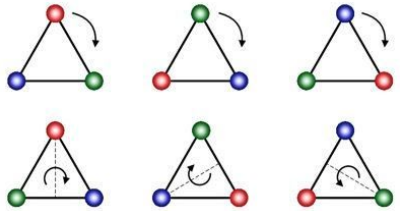
Policy Learning



Learning from Demonstrations

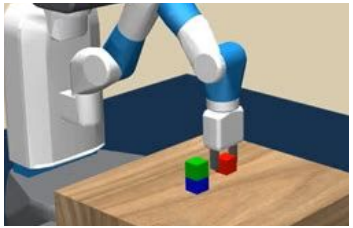


Symmetry in Neural Networks



Prehensile Manipulation

Goal-conditioned RL



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Three Programming Assignments [20%]

1. Using Robot in Simulator
2. Datasets and Supervised Learning
3. Grasping with Deep Reinforcement Learning

All assignments are in Python and are made to take 4-6 hours

Due at the beginning of the class specified on the schedule

Submit via email

Three late-days, include it in email if you wish to use them, otherwise incur 20% penalty every day late

Final Project [50%]

Goal : use deep learning to perform an interesting task on the robot

- Work in groups 2-4
- Preferably, run some experiments on the real robot
- More details will come in the next week
- Start thinking about it now, reach out if you have questions

robot

+

sensors

+

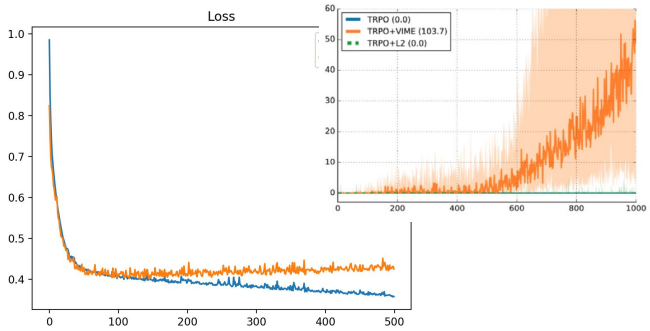
objects

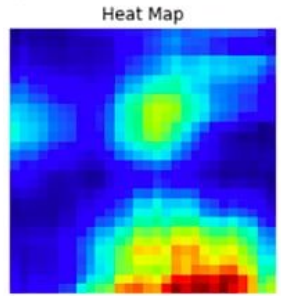
Participation [30%]

Friday classes will be discussion based

Representatives from each group will present recent findings or sticking-points

In-group discussions will take up rest of time





Other logistics

Surveys: 1-2 minutes every class, to give feedback on the material and pace

Office hours: I will send out a poll

Robots: should they be available in class or do you want to take them home?

Remote Learning: slides and code will be available before class, recordings maybe if requested

Questions Outside of Class: piazza...?

Robot demo

Installing pybullet

conda create -n cs4910 python=3.8

conda activate cs4910

conda install -c conda-forge pybullet

Downloading class material

git clone https://github.com/dmklee/nu-cs4910-s22.git

Pybullet GUI keyboard commands

Scroll : zoom in/out

Ctrl + LButton : rotate view

Ctrl + MButton : pan view

“g” : toggle gui panels

“s” : toggle shadows

“w” : show bounding boxes

“ESC” : exits