Robot Learning

Project

Topics of today

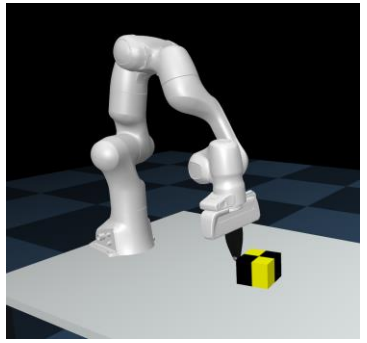
- Sim-to-real Transfer and Domain Randomization
- Hopper environment
- Uniform Domain Randomization
- Project extension

Sim-to-Real Transfer and Domain Randomization

Problem: teach a robot how to push a box to a target location

Simulation (Source)

Training in simulation



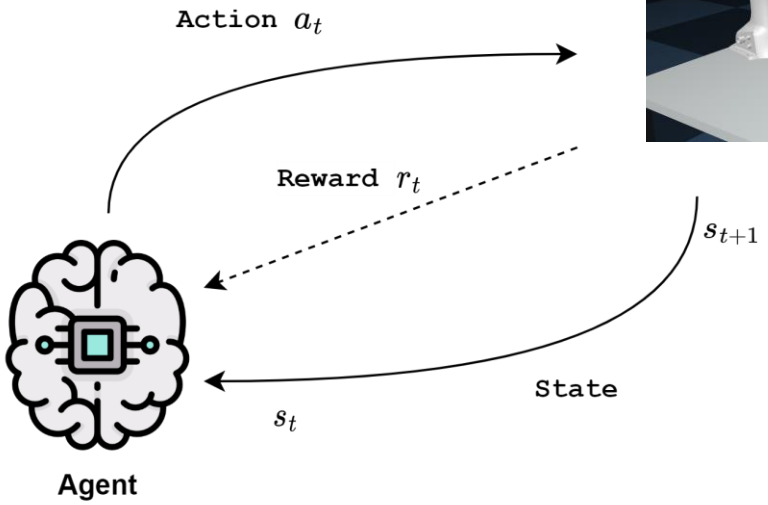
$\pi_\theta(a|s)$

$\neq$

Reality gap

Real World (Target)

Testing in the real world

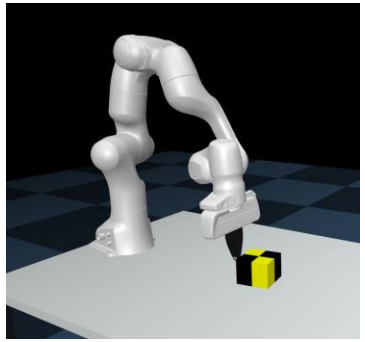


Sim-to-Real Transfer and Domain Randomization

Problem: teach a robot how to push a box to a target location

Simulation (Source)

Training in simulation on **randomized dynamics**



$\xi \sim p_\phi(\cdot)$

$\pi_\theta(a|s)$

Real World (Target)

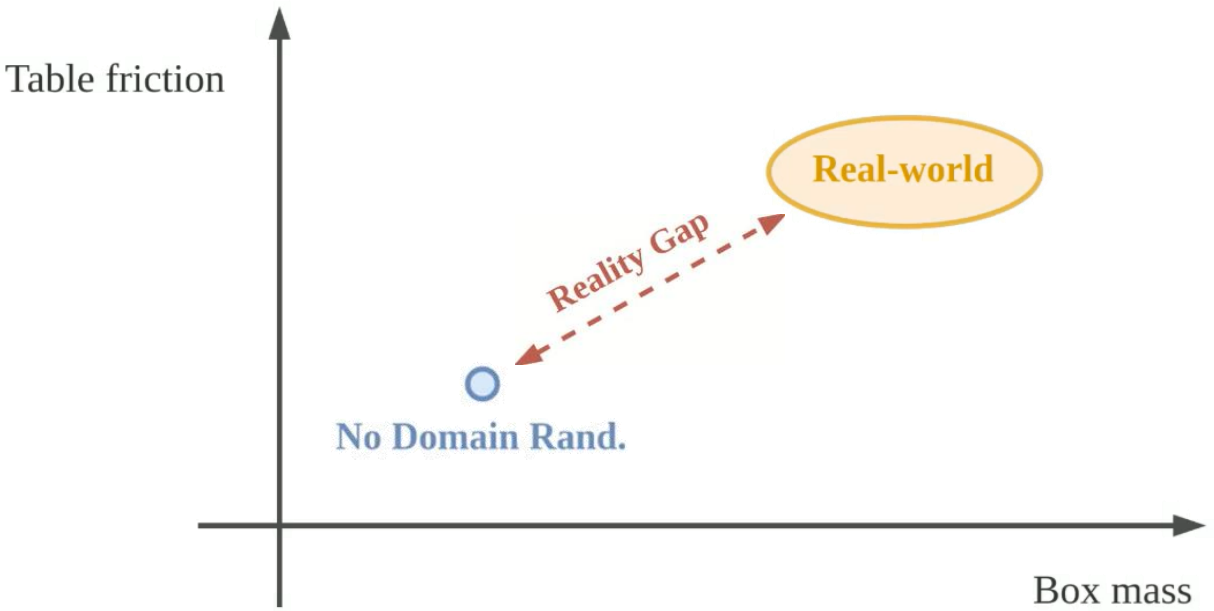
Testing in the real world

Solution:

Training with Domain Randomization

Sim-to-Real Transfer and Domain Randomization

Problem: teach a robot how to push a box to a target location



Solution:
Training with Domain Randomization

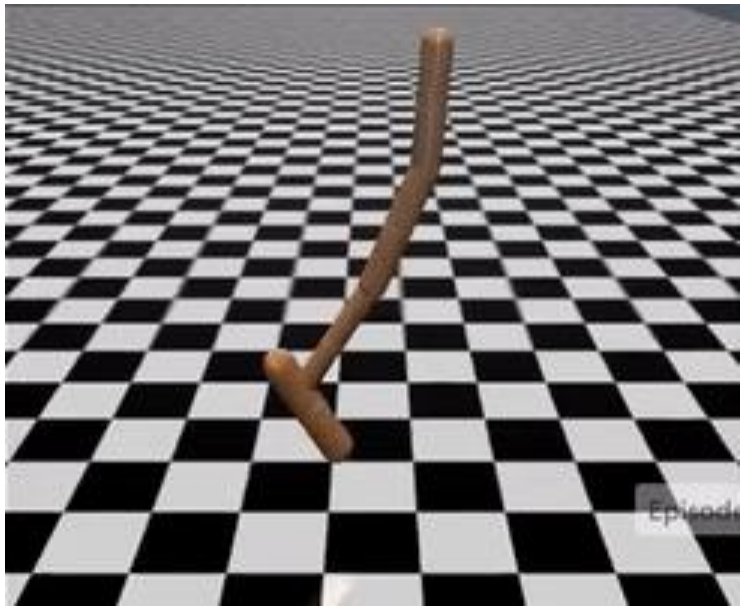
Sim-to-Real Transfer and Domain Randomization

Problem: teach a robot how to push a box to a target location

Solution:
Training with Domain Randomization

Hopper environment

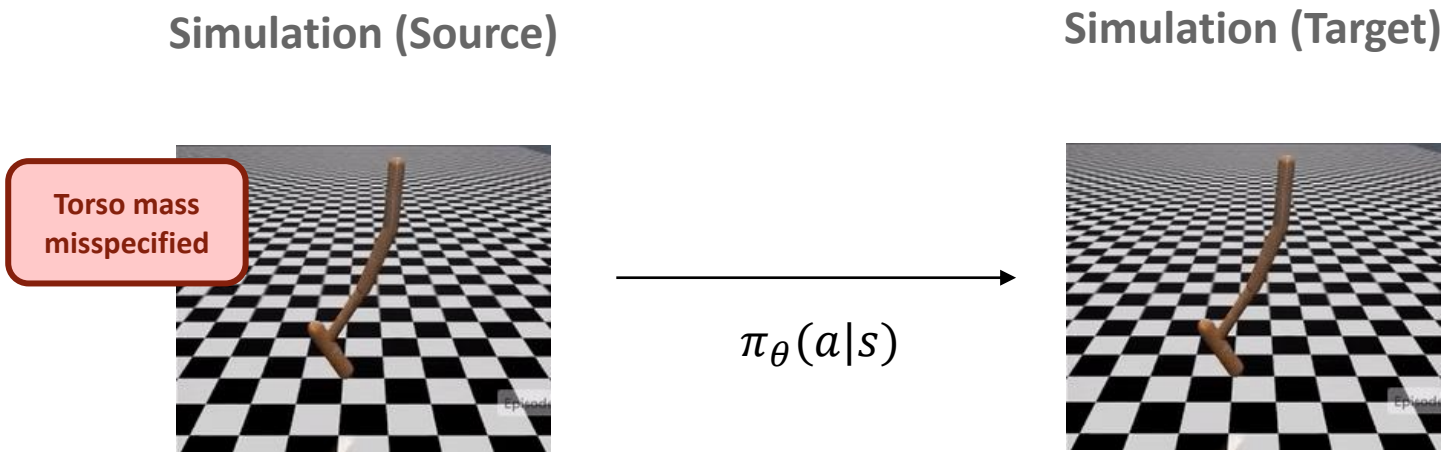
- Learn how to hop forward with a one-legged robot without falling, while achieving the highest possible horizontal speed.
- **Mujoco**
  - Physics engine for detailed, efficient rigid body simulations with contacts
  - Cross-platform GUI with interactive 3D visualization in OpenGL



MuJoCo
Advanced physics simulation

Core part: Sim-to-Sim transfer

1. Train the Hopper agent with one algorithm of choice between PPO and SAC



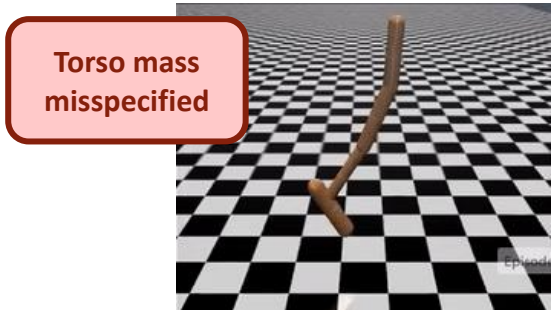
Core part: Sim-to-Sim transfer

1. Train the Hopper agent with one algorithm of choice between PPO and SAC

2. Implement Uniform Domain Randomization (UDR) for the link masses of the Hopper robot

Simulation (Source)

Training in simulation on **randomized dynamics**

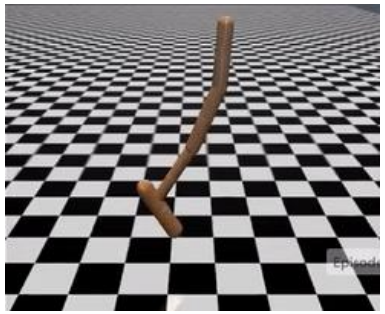


$\xi \sim p_\phi(\cdot)$

$\pi_\theta(a|s)$

Simulation (Target)

Testing in **another** simulated environment



Project extension

- It’s your turn!
- Feel free to be ambitious
- Let your work reflect a research-inspired approach

Mujoco Installation and other libraries

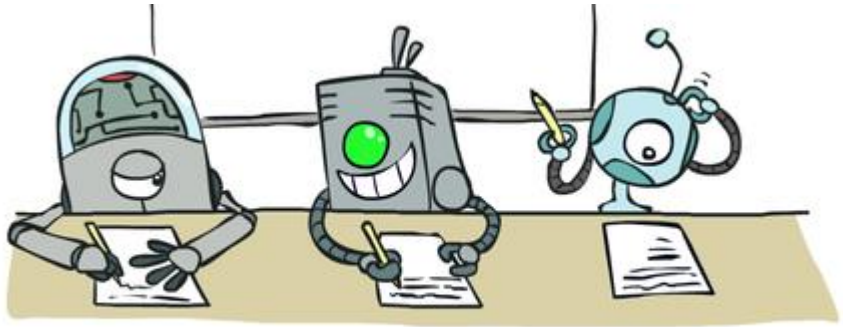
- Use conda environments

```
# pip install <lib>

importlib-metadata==4.13.0
gym==0.21.0
stable-baselines3[extra]==1.7.0

pip install -U 'mujoco-py<2.2,>=2.1'
```

- Follow this guideline for installing Mujoco and mujoco-py

Project Exam

- **Groups are allowed** (up to 3 people)
- **Deadline**: one week before the exam call
- **Report and code**:
  - Core part (1.5 points)
  - Project extension (4 points)
  - Follow this template for the report
  - Group submission (on the team's repo)



- **Oral exam** (20 points)
  - **Team members must take the exam on the same day**
  - Project presentation with slides (approx. 15 mins in total, divided equally between team members)
  - Theory questions