Reinforcement Learning for Path Planning of Robotic Arms

Anton Mai
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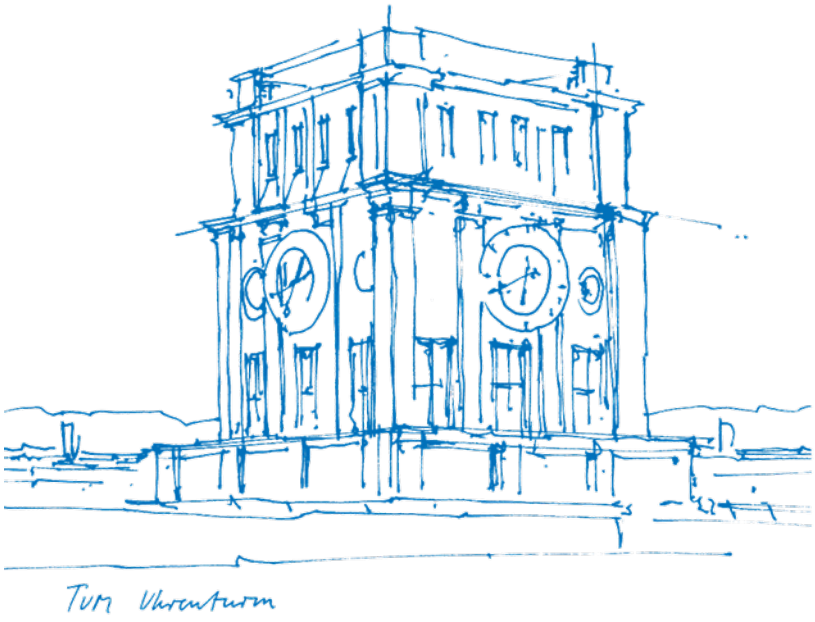
Munich, March 27th 2020



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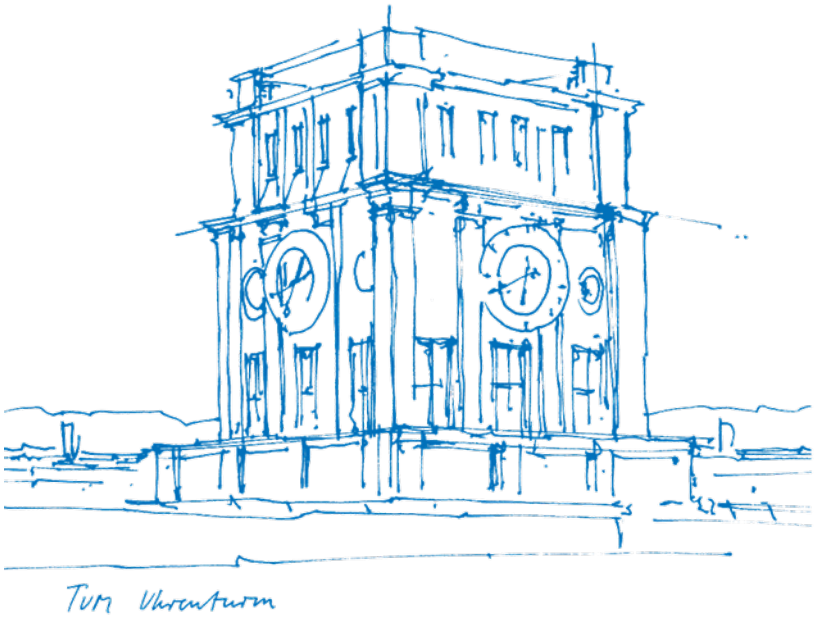
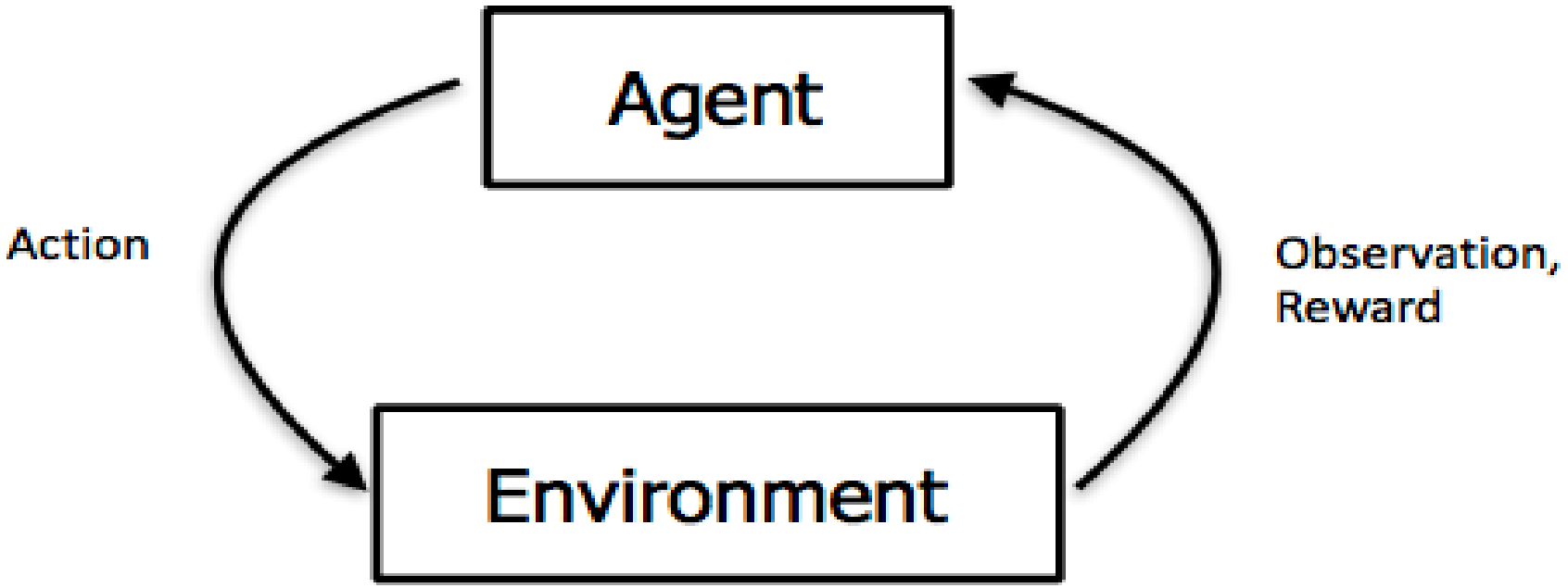


Motivation

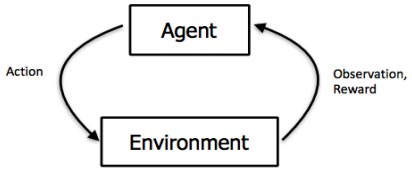
Outline

- Motivation
- Reinforcement Learning
- Hindsight Experience Replay
- Methodology
- Experiment 1: FetchSlideball (Golf)
- Experiment 2: FetchToss
- Conclusion/Future Work

Reinforcement Learning



Hindsight Experience Replay



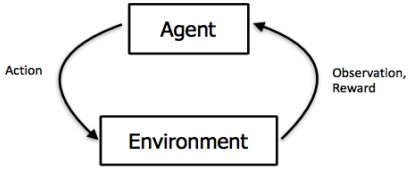
Achieved Goal: x
Desired Goal: y

Replay Buffer:

Actions taken : A
Achieved Goal : x
Desired Goal : x

Replay Buffer:

Actions taken : A
Achieved Goal : x
Desired Goal : x



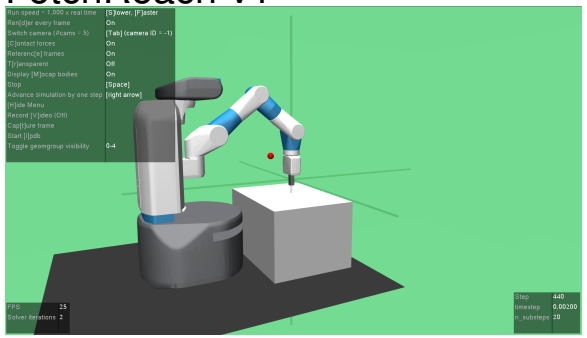
Achieved Goal : x
Desired Goal : x

Methodology

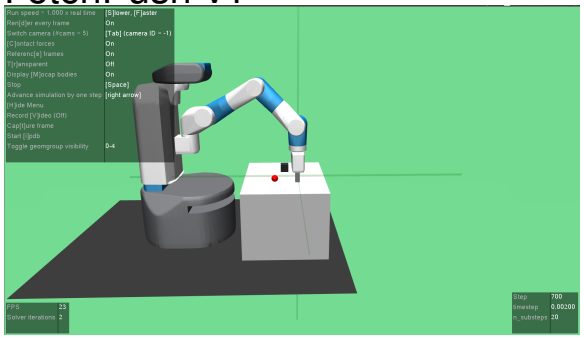
- Run Benchmarks (by OpenAI)
- Test a simpler environment first (Golf/Slideball)
- Then create the tossing environment (Basketball)
- For both golf and toss:
  - Compare using a ball
  - Try different distance, height, weight etc.

Benchmarks

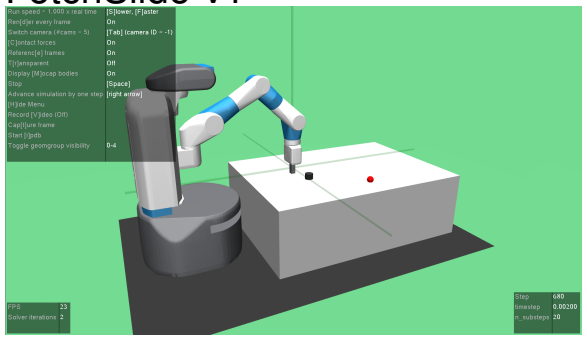
FetchReach-v1



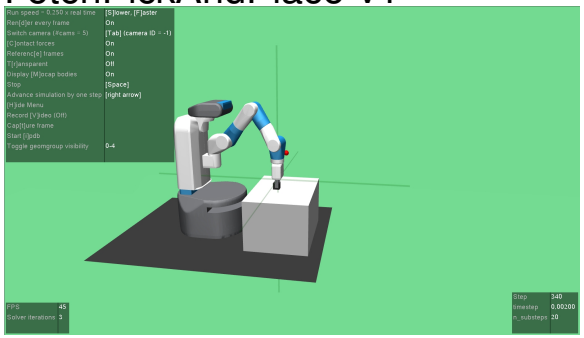
FetchPush-v1



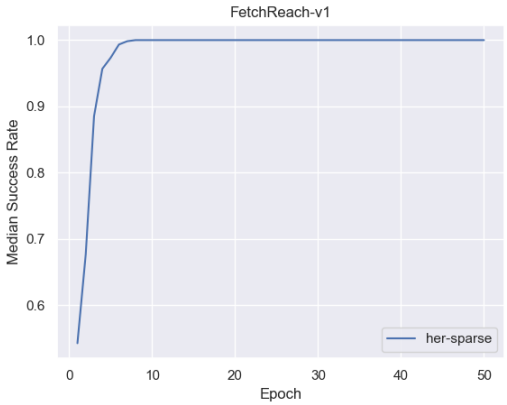
FetchSlide-v1

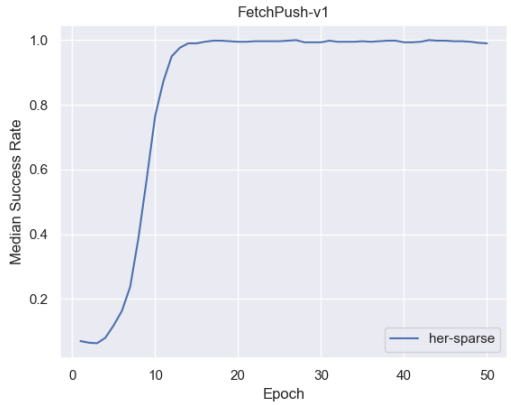


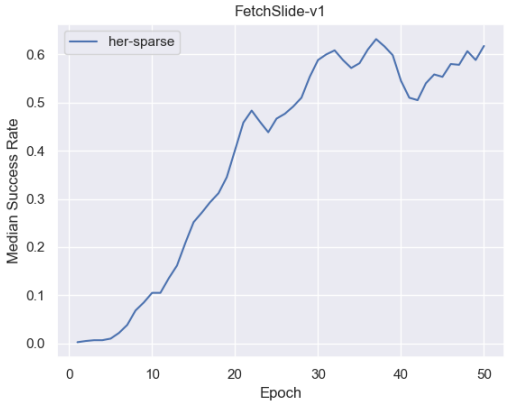
FetchPickAndPlace-v1

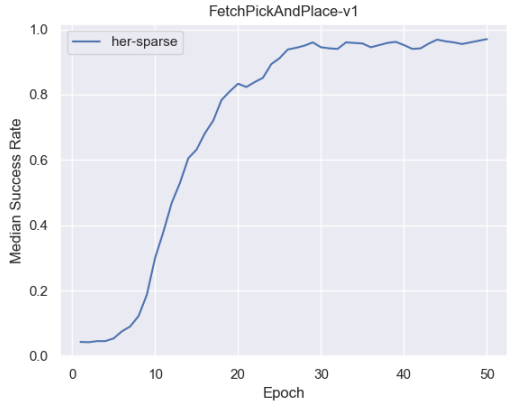


Benchmarks


FetchReach-v1
Median Success Rate
Epoch
her-sparse

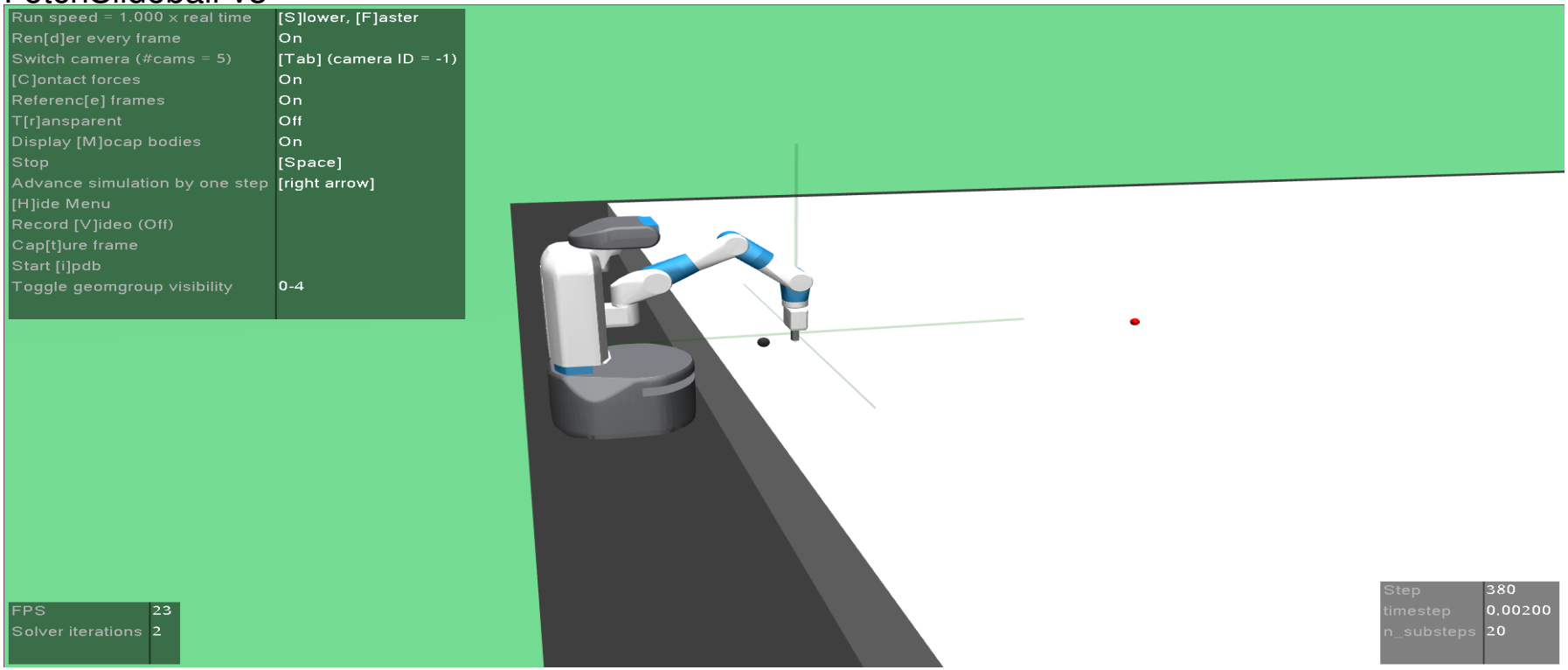

FetchPush-v1
Median Success Rate
Epoch
her-sparse


FetchSlide-v1
Median Success Rate
Epoch
her-sparse


FetchPickAndPlace-v1
Median Success Rate
Epoch
her-sparse

FetchSlideball

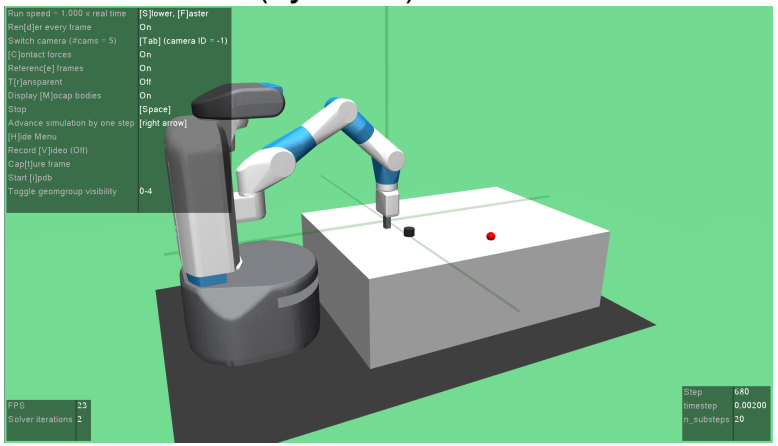
FetchSlideball-v3



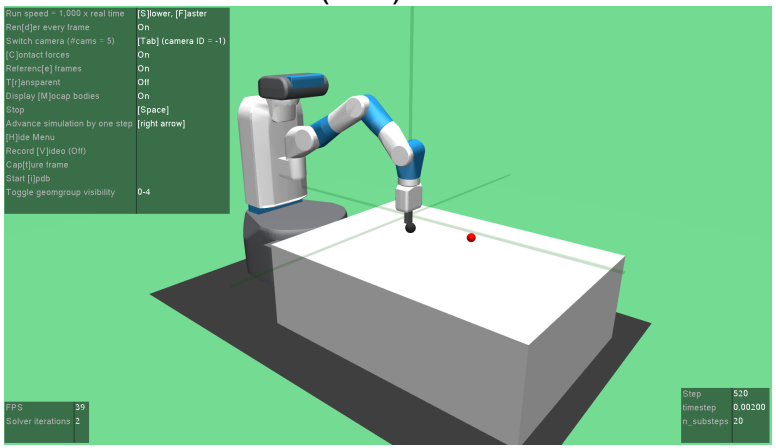
FetchSlideball Version 1

Same as FetchSlide-v1, but with a ball

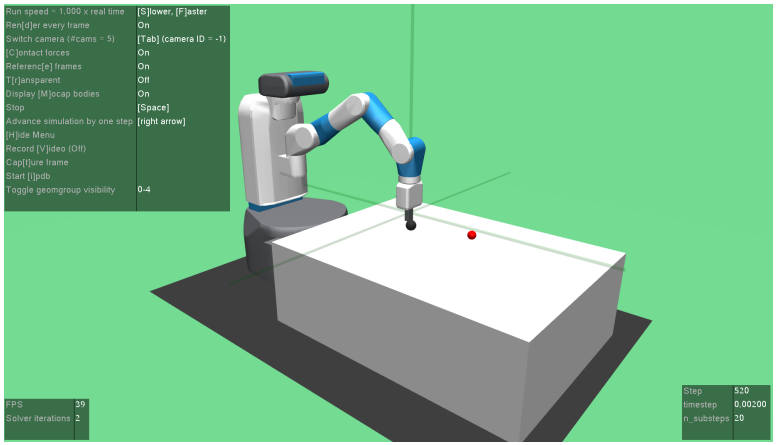
FetchSlide-v1 (cylinder)

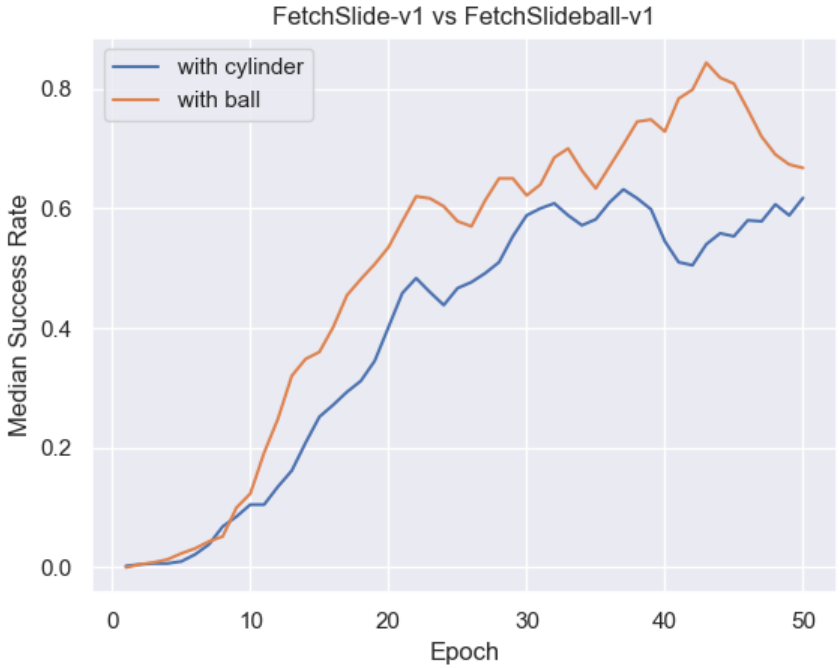


FetchSlideball-v1 (ball)



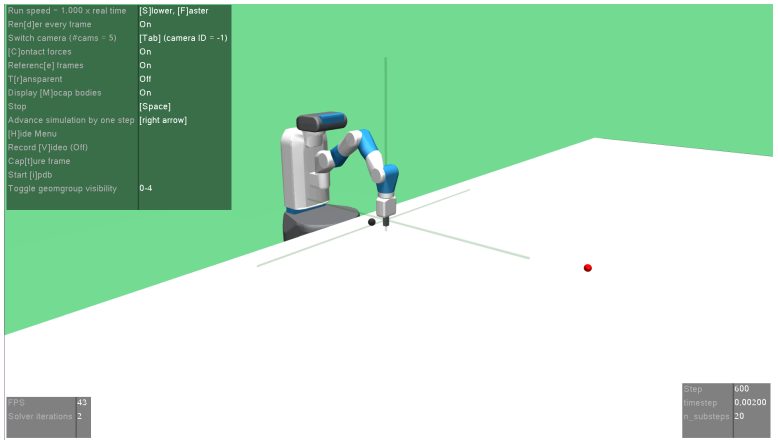
FetchSlideball Version 1

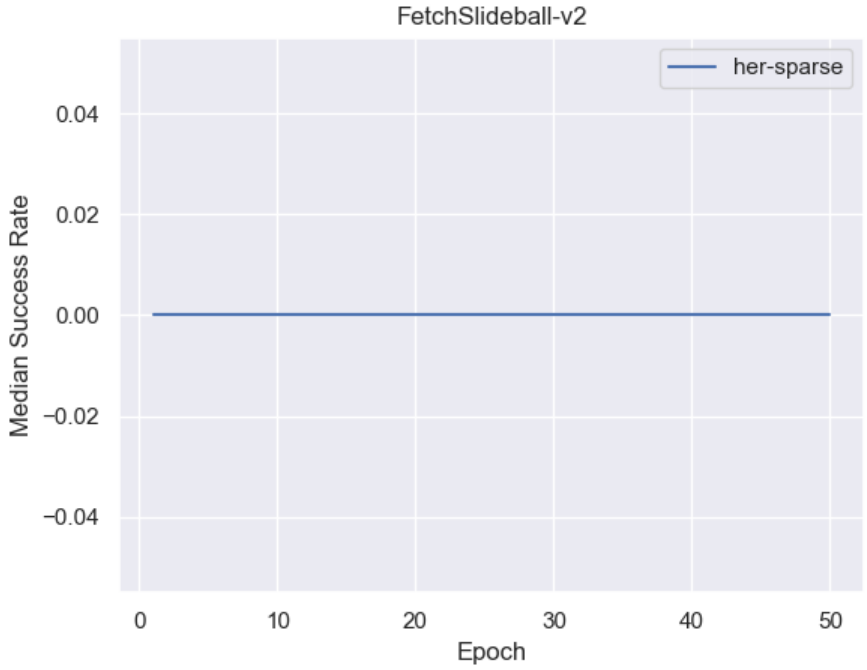




FetchSlideball Version 2

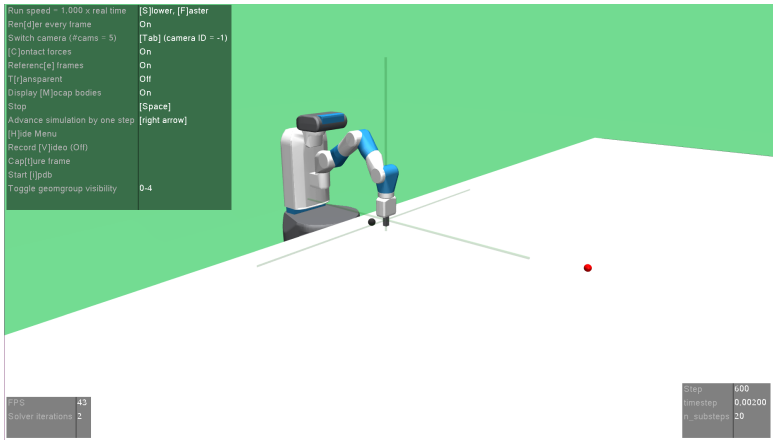
Doubled the goal distance

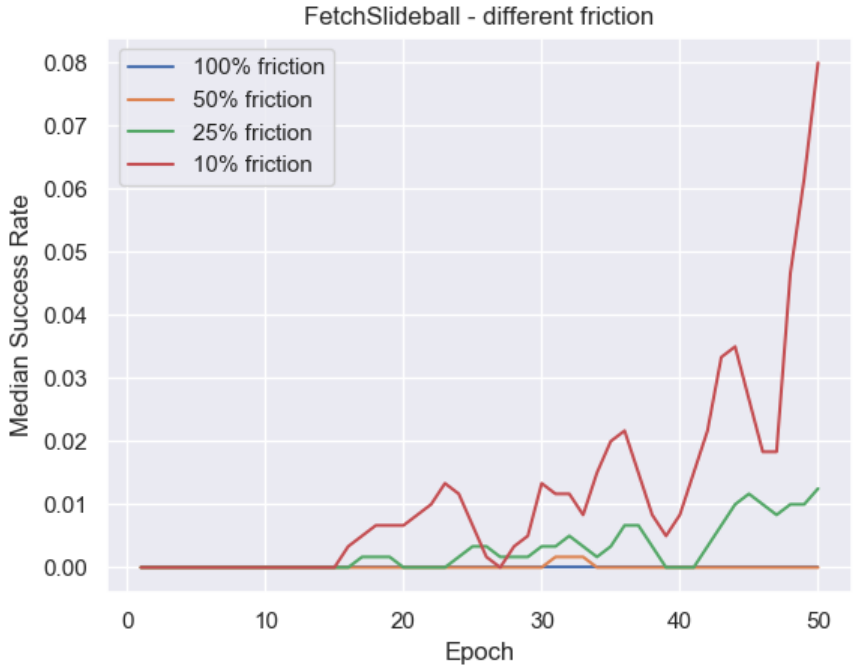




Problem: Arm not strong enough too push it far enough -> decrease friction

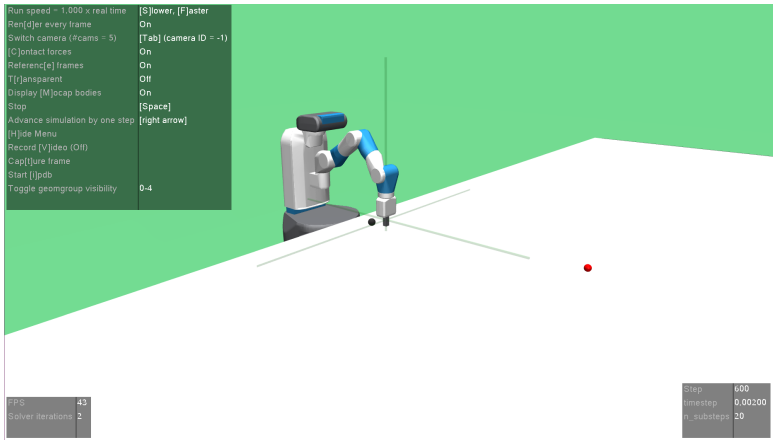
FetchSlideball with lower friction



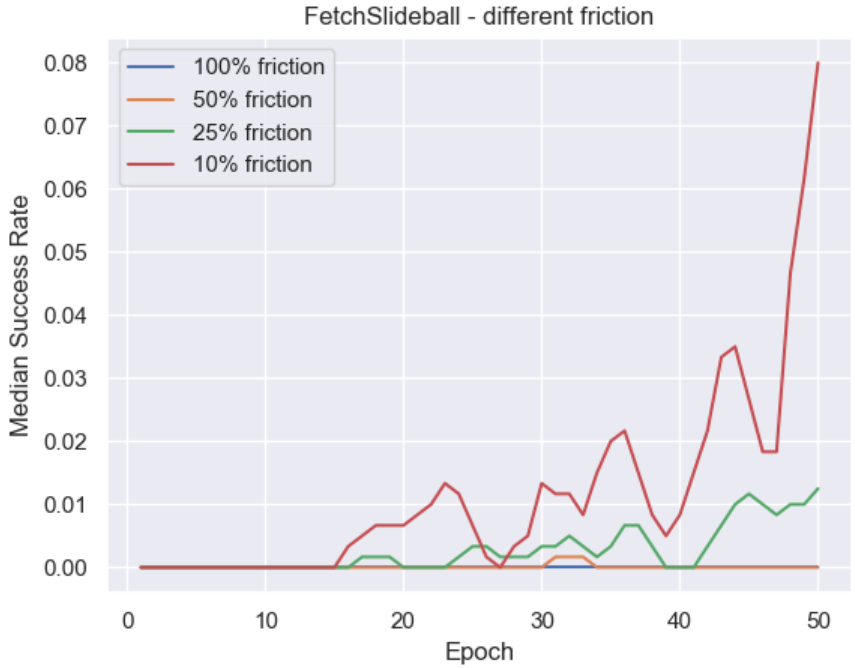


-> learns direction but can’t control distance

FetchSlideball with lower friction - **Slideball-v3 Video**

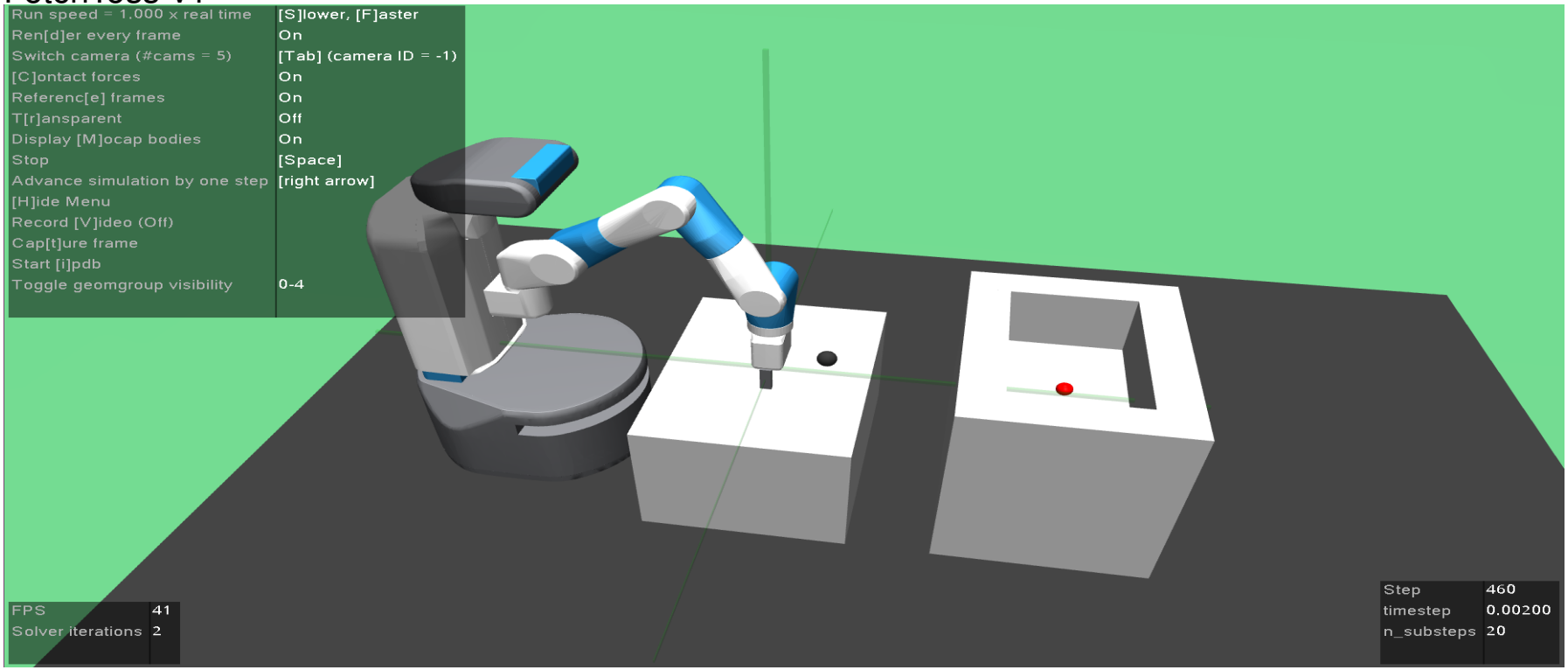


-> learns direction but can’t control distance



FetchToss

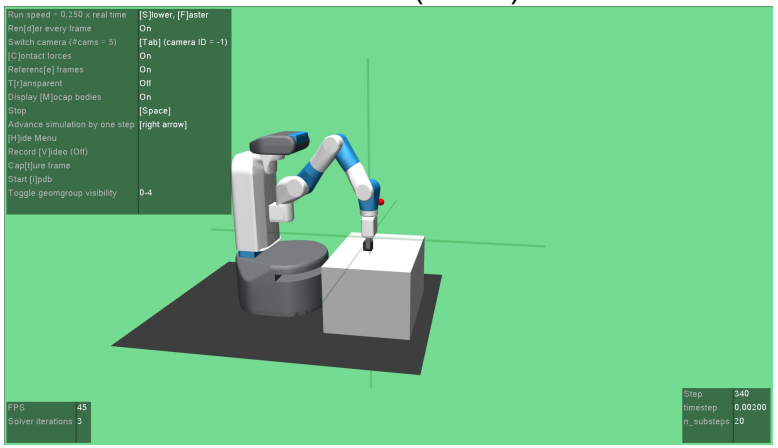
FetchToss-v1



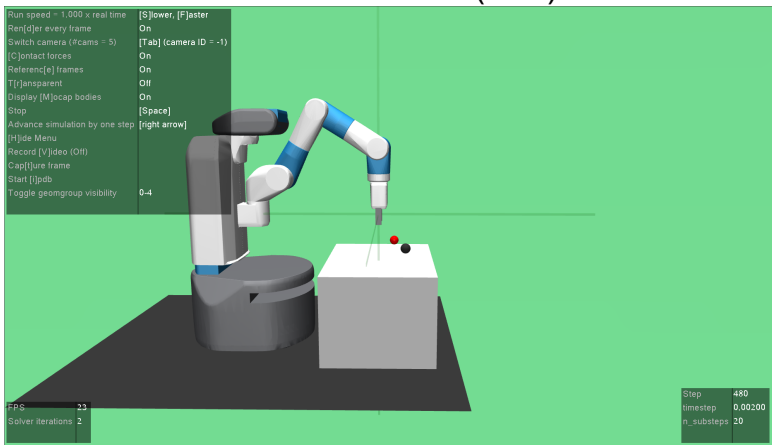
FetchPickAndPlaceball-v1

Same as FetchPickAndPlace-v1, but with a ball

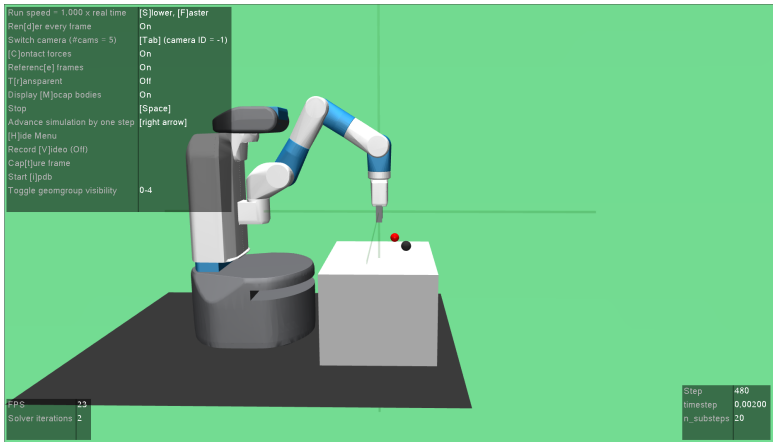
FetchPickAndPlace-v1 (cube)

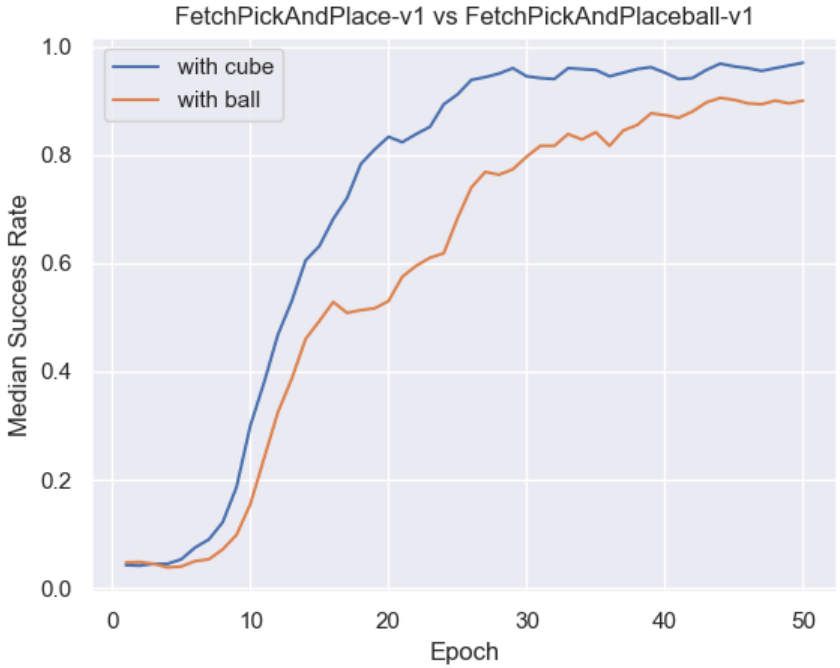


FetchPickAndPlaceball-v1 (ball)



FetchPickAndPlaceball-v1

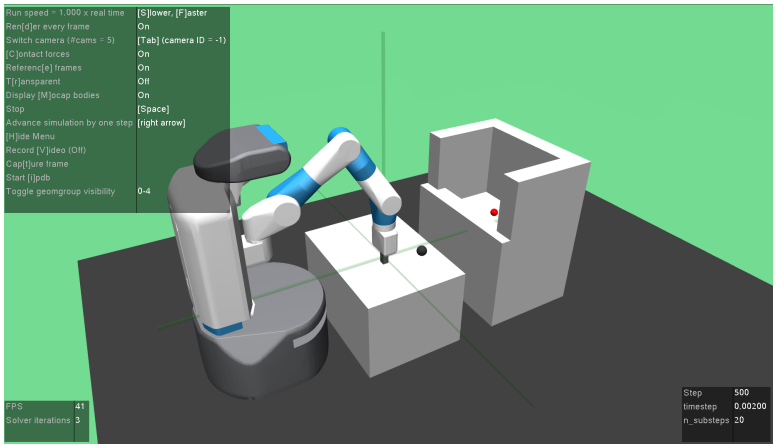


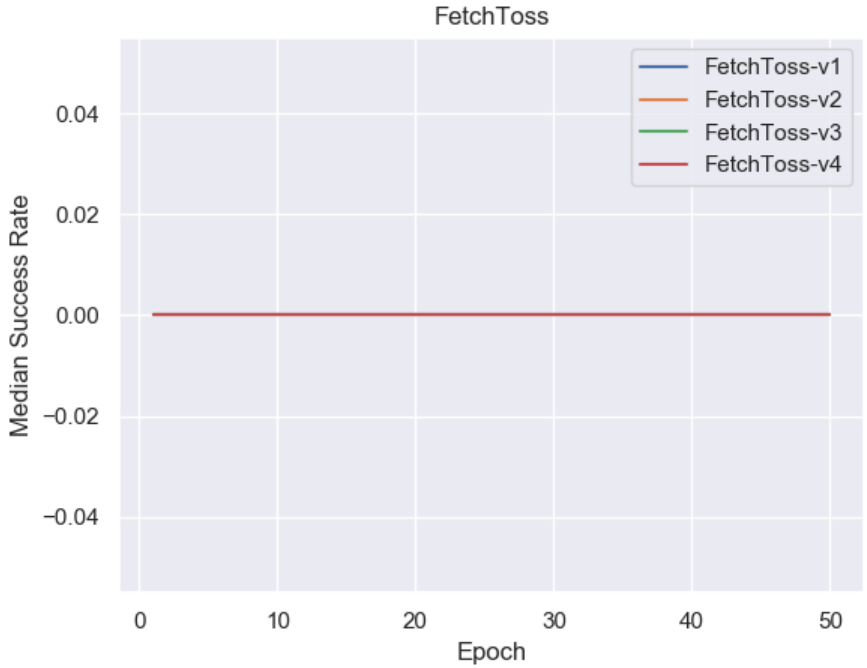


FetchToss Version 1-4

Goal is only in the box

Changes from v1 to v4: Better box, friction added, double steps/episode, 1% weight

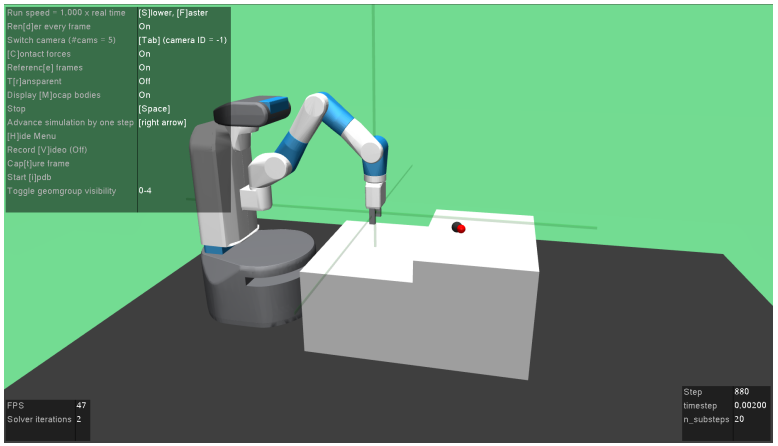




-> Fail: because the goal is **only** in the box

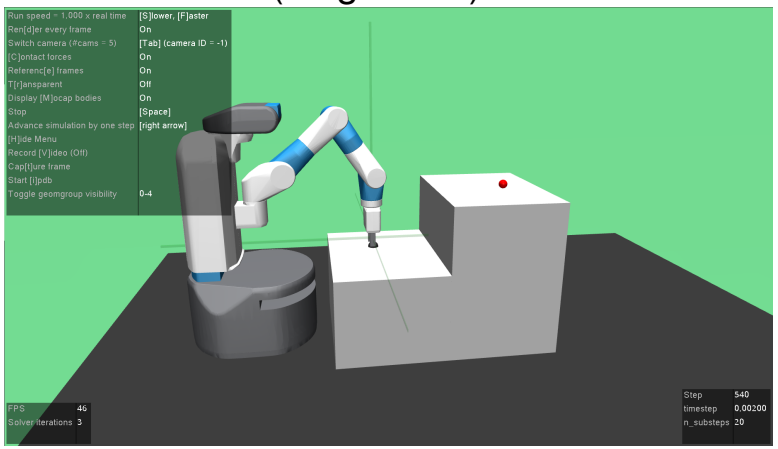
FetchToss Version 5

no friction, 1% weight
(25% Toss, 75% FetchPickAndPlace)



FetchToss with different height

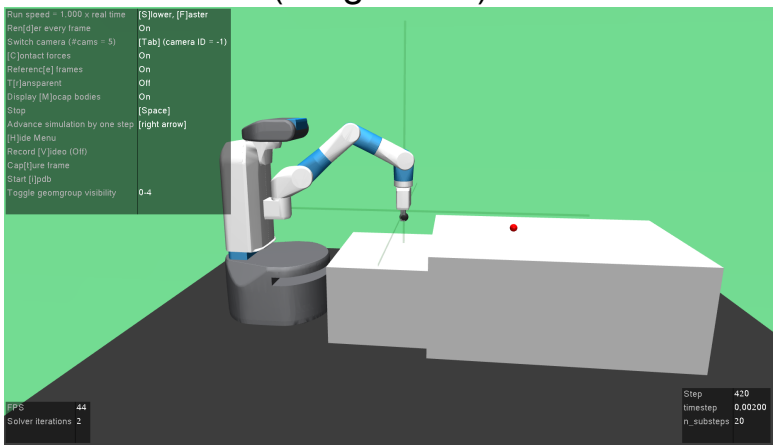
FetchToss-v13 (height: 0.7)

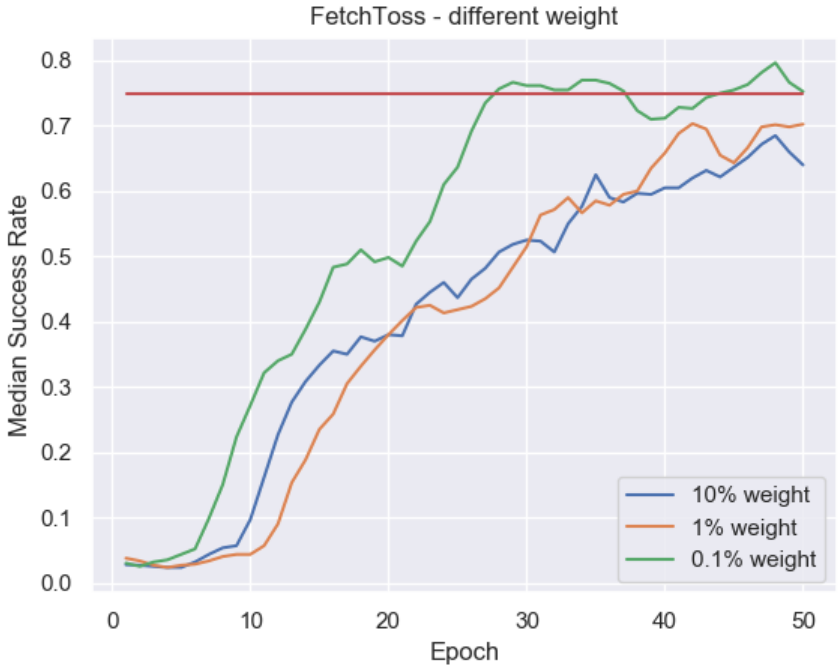


FetchToss with different weight

goal distance is longer

FetchToss-v10 (weight: 1%)





Conclusion and Future Work

- Tossing in general works
- Struggle to toss up and long distances

Ideas for Future Works:

- Try different parameters
- Different gripper (more human-like hand)
- Obstacles between robotic arm and goal
- Different Objects (paper plane)

Presentation Sources

https://blog.goodaudience.com/what-is-inverse-reinforcement-learning-e333228af146

https://pixabay.com/de/photos/basketball-net-ergebnis-felge-2099656/

https://pixabay.com/de/photos/golf-golfball-loch-golfplatz-pokal-1284012/

https://en.wikipedia.org/wiki/Paper_Toss/