NPC VOLLEYBALL

RL Methods Project in Unity

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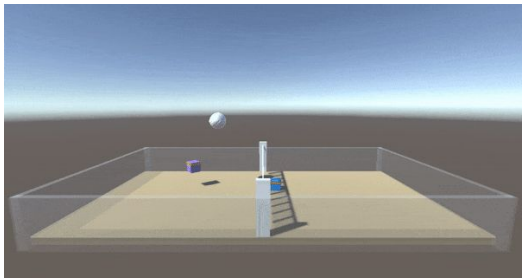

Sequential Decision Problem

Given position and velocity of the ball

Determine agent orientation and movement

Such That the ball goes over the net

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IN DEPTH

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WHY

- Low risk
- Methods-based 🔗
- First exposure to RL
- Within current skill set/computer specs

HOW

- Unity ML-Agents 🔗, C++
- Proximal Policy Optimization (PPO) by OpenAI 🔗
- PyTorch
- CoderOne Tutorial Guide 🔗

RL States

Observations

Agent:
- y-rotation
- x,y,z-velocity
- x,y,z-normalized vector to the ball

Ball:
- x,y,z-velocity

Move forward/back
Rotate clockwise/ccw
Move left/right
Jump
Add force

Actions

Reward

PPO: +1 if ball goes over the net

Self-Play:
- +1 to the winning team
- -1 to the losing team

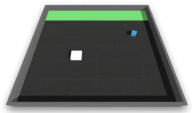
Steps

01

Set Up
Install proper versions of Python and Unity, clone the ML-Agents repo

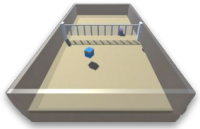
02

Practical Test
Load an example scene, train an example agent with the PPO algorithm



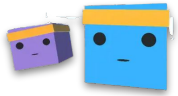
03

Create Environment
Clone Volleyball repo
Add physics, collisions…
Script env. behavior



04

Add Agents
Decisions, behavior, action
Set up observations
Set hyperparameters

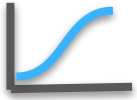


05

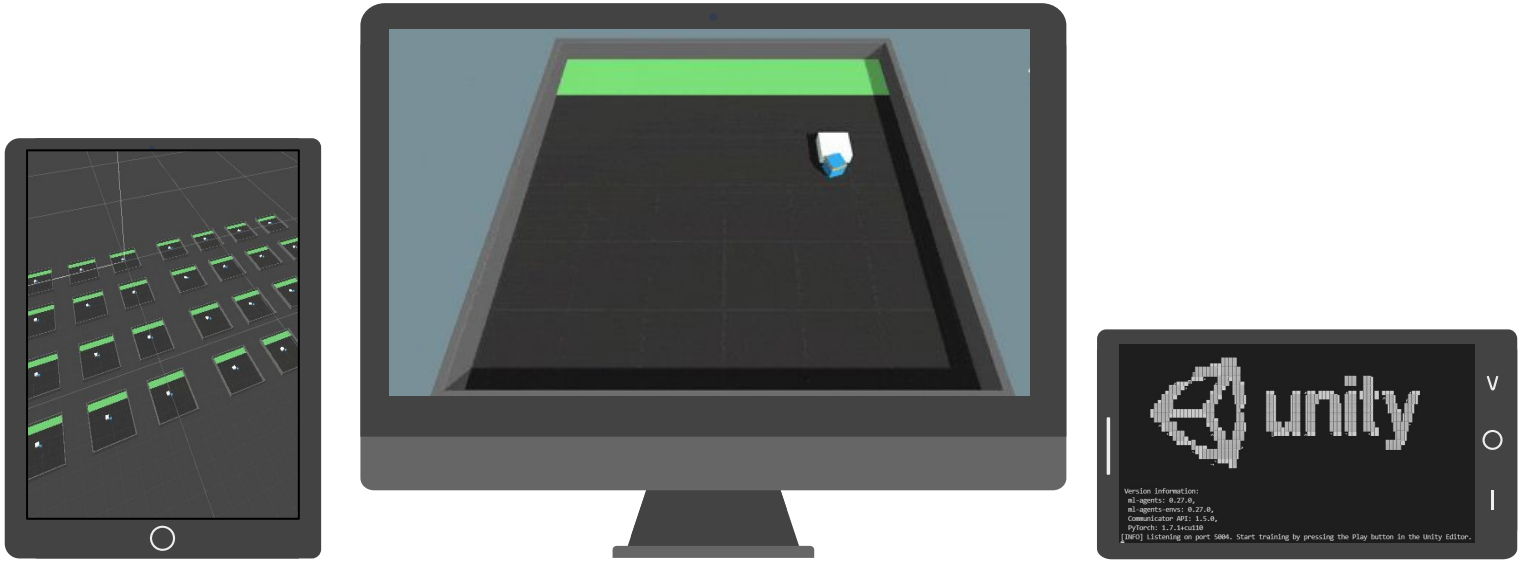
Train PPO
16 parallel environments
Simulate 20M steps
Gather results

06

Report Findings
Graph results
Revisit hypothesis
Give scientific observations

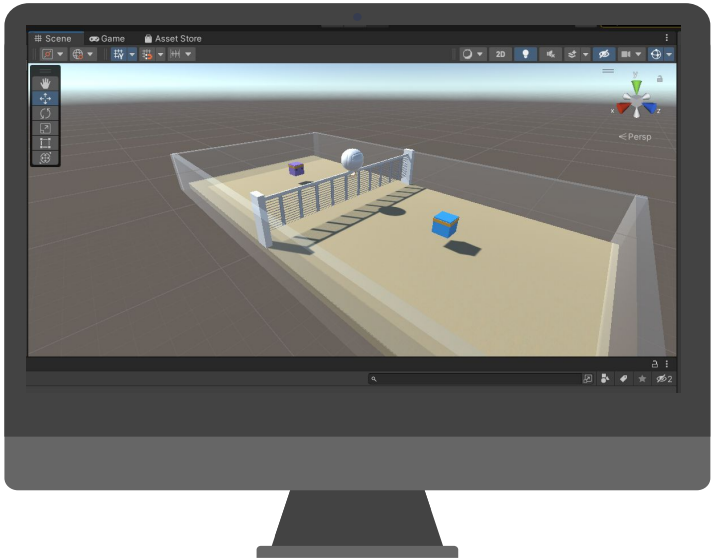


Steps 1, 2: Test Environment - PPO



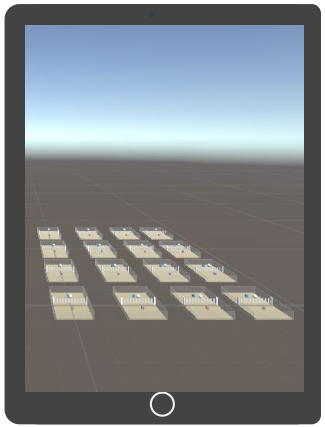
All software successfully integrated for this built-in ML-Agents example, proving that volleyball RL is feasible with this toolstack.

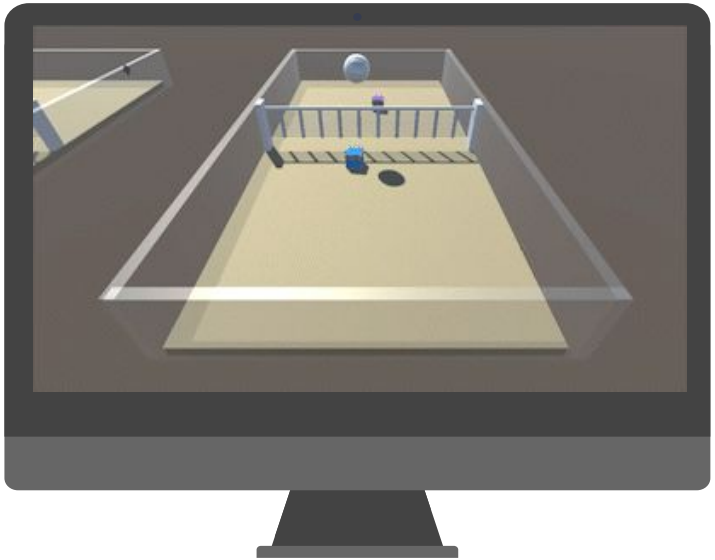
Step 3: Volleyball Environment Setup



Collisions and physics have been configured. The 3D models were imported.

Steps 4, 5: Add & Train Agents (PPO)





The agent was trained over 20M episodes. The learned behavior (hit ball over net) averages 15 seconds of continuous play. This lacks strategy or competition…

Step 6: PPO Results

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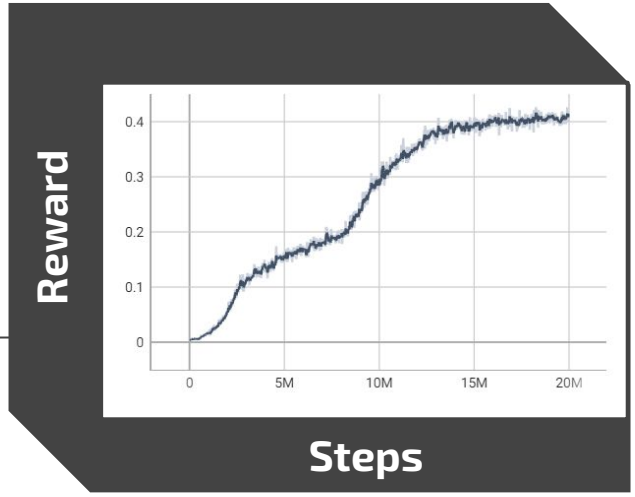
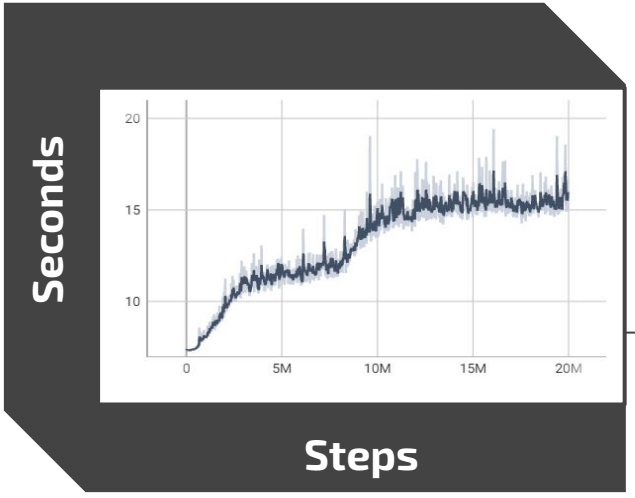
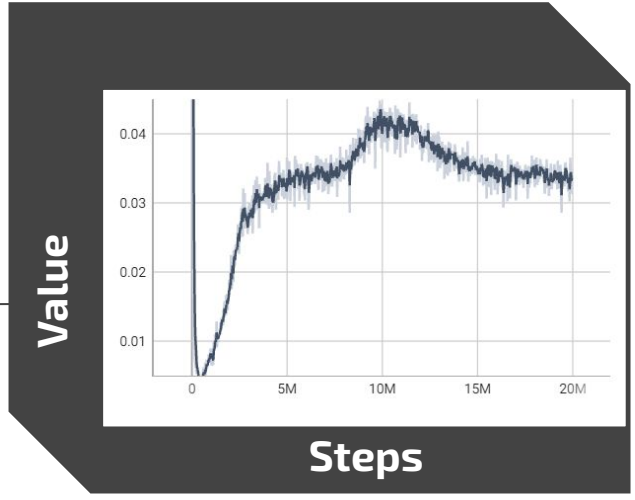
Cumulative Reward



Episode Length



Value Loss



Scientific Observations

Algorithm Synopsis

- monotonic improvement in the cumulative reward
- rapid learning from 1-3M steps and 7-13M steps
- highest sustained level of cumulative reward: 40% of theoretically optimal behavior

Why does the method not find the “perfect” player?

- It can only produce an agent that performs as well as its training is set up
- the agent may have gotten stuck in a suboptimal solution

Things I’d Change

- run PPO another 20M steps
- Optimize starting parameters
- Use another RL algorithm for comparison