Unity ML-Agents

Introduction of ML agents | Jihyun Oh 01
How I met Unity | Kyushik Min 02
ML Training Environment Requirements

Visual Complexity

Physical Complexity

Cognitive Complexity
The Unity Ecosystem
Making environments in Unity is not hard
Unity ML-Agents Workflow

Create Environment
Train Agents
Embed Agents
Unity ML-Agents Workflow

Create Environment

Train Agents

Embed Agents
Imitation Learning

Collect demonstrations from a teacher

Learn policy via imitation
INFO: unityagents: ('--curriculum': 'None',
'--docker-target-name': 'Empty',
'--help': False,
'--keep-checkpoints': '5',
'--lesson': '0',
'--load': False,
'--no-graphics': False,
'--run-id': 'MyRacer',
'--save-freq': '50000',
'--seed': '-1',
'--slow': True,
'--train': True,
'--worker-id': '0',
'--nenv': None)
INFO: unityagents: Start training by pressing the Play button in the Unity Editor.
INFO: unityagents: 'Academy' started successfully!

Unity Academy name: Academy
Number of Brains: 2
Number of External Brains: 1
Lesson number: 0
Reset Parameters:

Unity brain name: ExpertRacerBrain
Number of Visual Observations (per agent): 0
Vector Observation space type: continuous
Vector Observation space size (per agent): 20
Number of stacked Vector Observation: 3
Vector Action space type: continuous
Vector Action space size (per agent): 1
Vector Action descriptions:
Unity ML-Agents Workflow

Create Environment
Train Agents
Embed Agents
Embed Agents (Unity)

- Simply import a `.bytes` file (trained brain) into Unity project.
- Set corresponding brain component to “Internal” mode.
- Support for Mac, Windows, Linux, iOS, and Android.
Virtual Environments for Autonomous Vehicles Development
Why Virtual Environments?
Why Simulate?

Simulation can get autonomous systems ready for unforeseen scenarios and edge conditions in a fast and cost effective way.
Real World Simulation (80)

Assets designed to power real-world simulation.

- Road Signs Pack
  - Rating: 5 stars (0)
  - Price: $9

- Realistic Grass Vol. 1
  - Rating: 5 stars (0)
  - Price: $9.99

- Texture Creator
  - Rating: 4 stars (7)
  - Price: $5

- Landscape Auto Material
  - Rating: 5 stars (33)
  - Price: $99

- Civil Construction Pack - Roads, Highways...
  - Rating: 5 stars (9)
  - Price: $34.95

- Gaia
  - Rating: 5 stars (0)
  - Price: $67

- Car Water Spray Trails
  - Rating: 3 stars (1)
  - Price: $15

- Car Exhaust Effect
  - Rating: 4 stars (4)
  - Price: $5

- Urban Traffic System 2018.2
  - Rating: 5 stars (9)
Reinforcement Learning
Unity ML-Agents Toolkit (Beta)

The Unity Machine Learning Agents Toolkit (ML-Agents) is an open-source Unity plugin that enables games and simulations to serve as environments for training intelligent agents. Agents can be trained using reinforcement learning, imitation learning, neuroevolution, or other machine learning methods through a simple-to-use Python API. We also provide implementations (based on TensorFlow) of state-of-the-art algorithms to enable game developers and hobbyists to easily train intelligent agents for 2D, 3D and VR/AR games. These trained agents can be used for multiple purposes, including controlling NPC behavior (in a variety of settings such as multi-agent and adversarial), automated testing of game builds and evaluating different game design decisions pre-release. The ML-Agents toolkit is mutually beneficial for both game developers and AI researchers as it provides a central platform where advances in AI can be evaluated on Unity’s rich environments and then made accessible to the wider research and game developer communities.
SOSCON
Unity ML-Agents
How I met Unity

Hanyang University | Automotive Engineering | Kyushik Min
2018.10.17
Self Introduction

Kyushik Min

• Hanyang University MMC Lab. PhD candidate
• Operator of Reinforcement Learning Korea (Facebook)
• Machine Learning Camp Jeju 2017 Participant
• Modu Lab. Deep Learning Intensive Course
• Seminar Lecturer at Fast Campus
• Online Lecture Instructor of Programmers
Self Introduction

Self Driving Car

Driver Assistance System (DAS)

Vehicle Control
Self Introduction

Applying Deep Learning and RL to Self Driving Car

Machine Learning
Deep Learning
Reinforcement Learning (RL)

Applying Deep Learning and RL to Self Driving Car
How I Met Unity
How I met Unity

Breakout  Pong  Tetris  Wormy  Gridworld

https://github.com/Kyushik/DRL
How I met Unity

MACHINE LEARNING CAMP JEJU
2017
How I met Unity

Project Proposal

- Goal: Making Agent, which drives fast with minimum unnecessary lane change

Lane Keeping  Lane Change  Cruise Control

Proper choice of these functions can implement self driving car => Reinforcement Learning
How I met Unity

Project Proposal

Action selection of RL is unpredictable => Applying collision avoidance system
How I met Unity

Project Proposal

Add Vehicle Sensors!!

- DRL algorithms are already implemented!! (DQN, DDQN, PER, Dueling DQN)
- But there is no simulator, which satisfy these conditions!!
How I met Unity

Project Proposal

Making Simulator for the Project

- Making simulator without pygame
  - In the case of Pygame, it is hard to make 3D game
  - Sensor making or collision check are hard to implement
ML Camp Jeju 2017 Application Result: ACCEPT

MLCamp Jeju <mjcampjeju@mjcampjeju.com>

Dear, Kyushik Min

(If you have received a reject email from us, please discard it. You are ACCEPTED!)

We are very pleased to inform you that you have been selected as a participant of the ML Camp Jeju 2017 (http://github.com/TensorFlowKR/MLCampJeju) in Jeju, the most beautiful island in Korea. Congratulations!

This year, the competition was really strong: we received a total of 633 applications and only 20 were selected. The committee carefully reviewed every proposal, CV, and reference implementations, and made final decisions as a whole.

Once again, we really congratulate you for being selected as one of the 20 participants of this camp.

To complete the process to attend as a final participant, please carefully read and fill out the attached form and send us <mjcampjeju@googlegroups.com> back a signed photo copy ASAP (no later than May 15, 11:59PM AoE). If we do not receive the signed copy by May 15, 11:59PM AoE, we will CANCEL your acceptance.
How I met Unity
How I met Unity

Sensor configuration

Front Camera Coverage
Grayscale image is measured

Lidar Sensor Coverage
One ray is measured per 1°
Total 360 rays
How I met Unity

Sensor configuration

Vision

LIDAR

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How I met Unity

Actions

Keep current state

Acceleration

Deceleration

Lane change (Right)

Lane Change (Left)
How I met Unity

Project Overview

Front Camera

Sensor Data

DRL Algorithm

Vehicle Control

DAS
How I met Unity

Communication between Unity and python

Deep Learning Libraries
How I met Unity

Communication between Unity and python

Vehicle Simulator

DRL Algorithm

Camera Image
Sensor Data
Reward
Terminal
Socket
Action
How I met Unity

Communication between Unity and python
How I met Unity

Result

Before Training

After Training
How I met Unity

Communication between Unity and python

• There are lots of bugs in the implementation using Socket
  – Communication is disconnected after a certain length
  – It needs lots of coding for minor changes
  – Sync problem
  – There is a difference in speed between Unity and python code

• Trying to solve problems for about 1 to 2 months
  – Almost 70% of the problems were solved!!
  – I had a plan to upload it on Github
How I met Unity

Machine Learning Agents

2017.09.19
How I met Unity

ML-Agents Challenge I Winners
How I met Unity

Vehicle Environment Static Environment

Reward: 0.08571429

Kyushik Min
Student

SOSCON 2018
How I met Unity
How I met Unity

Vehicle Simulator + Unity ML-agents
### Speed

Average Speed / 5 Episodes of DRL algorithms

- **Input Configuration**
  - Camera Only: 71.0776
  - LIDAR Only: 71.3758
  - Multi-Input: 75.0212

### Lane Change

Average Lane Change / 5 Episodes of DRL algorithms

- **Input Configuration**
  - Camera Only: 35.2667
  - LIDAR Only: 38.0667
  - Multi-Input: **14.2667**

### Overtake

Average Overtake / 5 Episodes of DRL algorithms

- **Input Configuration**
  - Camera Only: 35.2667
  - LIDAR Only: 38.0667
  - Multi-Input: **44.8**

<table>
<thead>
<tr>
<th>Input Configuration</th>
<th>Average Speed (km/h)</th>
<th># of Average Lane Change</th>
<th># of Average Overtaking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera Only</td>
<td>71.0776</td>
<td>15</td>
<td>35.2667</td>
</tr>
<tr>
<td>LIDAR Only</td>
<td>71.3758</td>
<td><strong>14.2667</strong></td>
<td>38.0667</td>
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<tr>
<td>Multi-Input</td>
<td><strong>75.0212</strong></td>
<td>19.4</td>
<td><strong>44.8</strong></td>
</tr>
</tbody>
</table>
How I met Unity
How I met Unity

2018 IEEE Intelligent Vehicles Symposium (IV)
Changshu, Suzhou, China, June 26-30, 2018

Deep Q Learning Based High Level Driving Policy Determination

Kyushik Min, Hayoung Kim and Kunsoo Huh, Member, IEEE
How I met Unity
How I met Unity

Simulator Ver. 0.1

Simulator Ver. 1.3

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How I met Unity

https://github.com/MLJejuCamp2017/DRL_based_SelfDrivingCarControl
Unity ML-Agents
Unity ML-agents

Agony of those who study RL

Environment for verification
Unity ML-agents

Reinforcement Learning
Unity ML-agents

Taeyoung Kim

Hyunho Lee

InSpace

Intelligence in Space
Leverage the power of AI
Integrate powerful AI into your Unity games and applications with IBM Watson Unity SDK
Check it out
Unity ML-agents

Multi-agent

Imitation

Curriculum

SOSCON 2018
Unity ML-agents

democratizing game development

democratizing environment development for reinforcement learning
Conclusion
Conclusion

Making Environment for RL

- Difficulty in making the environment
- Unstable communication
- Low graphic
- Complex coding
- Implementation of physics model

Unity ML-agents solves the problems!
Conclusion

https://github.com/Kyushik/Unity_ML_Agent
Conclusion

Future Work

• Create various environments using Unity ML-agents
• Write papers and perform projects using Unity ML-agents
• Recruit team to study Unity ML-agents at Facebook page Reinforcement Learning Korea
  – Create environments for reinforcement learning
  – Make manual about ML-agents
• Seminar on Unity ML-agents at DeepLab Intensive Course in Modu Labs.
THANK YOU