Welcome to:

Hands-on RL with Ray's RLlib

A beginner's tutorial for working with environments, models, and algorithms

Setup: conda create -n rllib python=3.8; conda activate rllib; pip install ray[rllib]==1.4; pip install [tensorflow|torch]; pip install jupyter-labs;
git clone https://github.com/sven1977/rllib_tutorials; cd rllib_tutorials; jupyter-lab

Who am I?

Sven Mika - ML Engineer Anyscale Inc.

https://linkedin.com/in/sven-mika
sven@anyscale.com

- Late 90s: Biochemistry (undergrad)
- Early-mid 2000s: Bioinformatics & NLP (PhD)
  “Why are you using NNs? SVMs are so much better and robust!”
- 2010s: Wall Street (Quant. Dev./Data Scientist)
- 2015+: Contributor to other OSS RL libraries (TensorForce, RLgraph, Surreal); Self-taught RL: Books, papers, online courses.
- 2019+: Anyscale Inc. (lead-dev RLlib)

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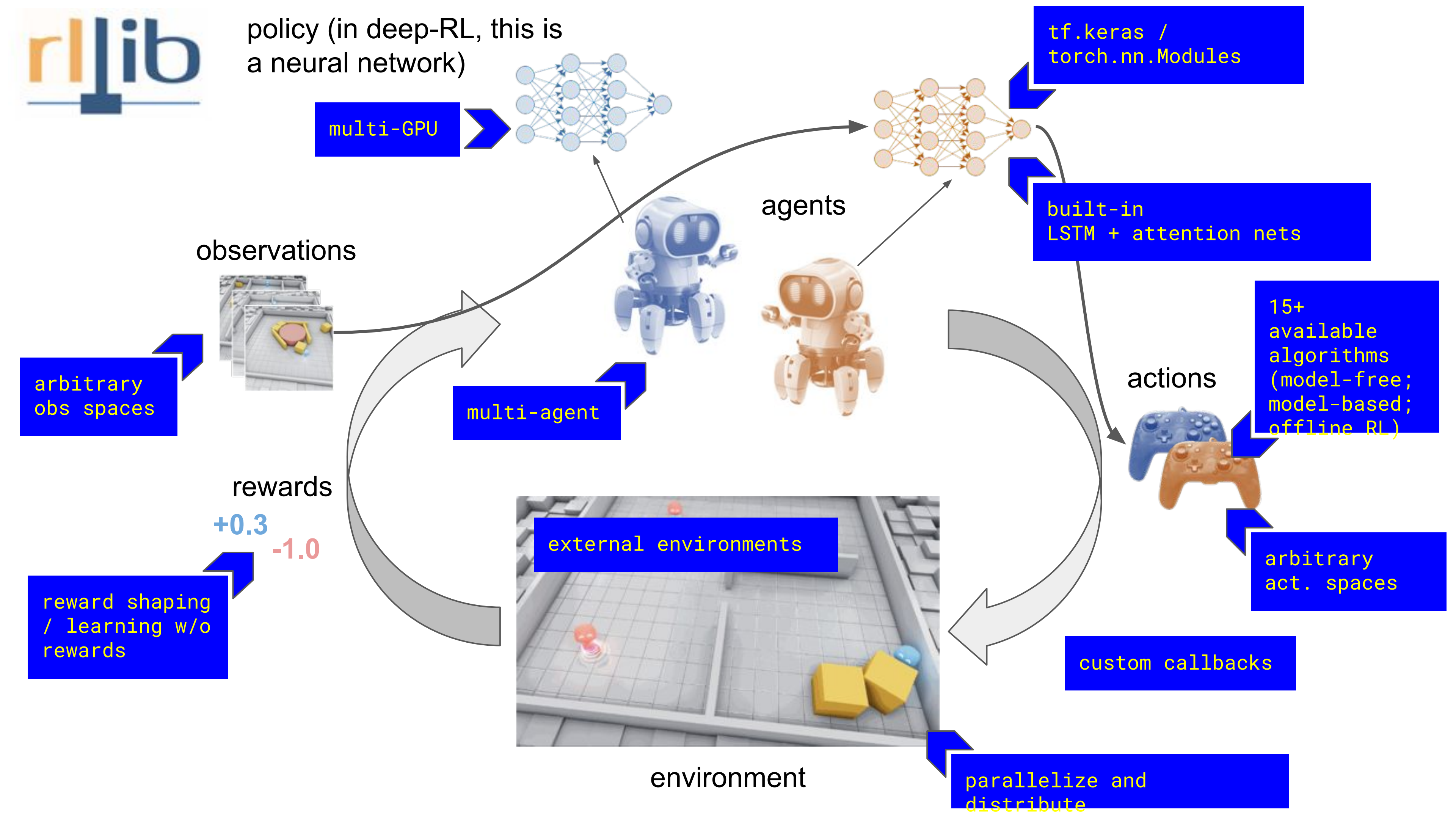

rllib
policy (in deep-RL, this is a neural network)
multi-GPU
tf.keras / torch.nn.Modules
built-in LSTM + attention nets
agents
observations
arbitrary obs spaces
multi-agent
15+ available algorithms (model-free; model-based; offline RL)
actions
arbitrary act. spaces
rewards
+0.3
-1.0
reward shaping / learning w/o rewards
external environments
custom callbacks
environment
parallelize and distribute

Key differences: RL vs Supervised Learning

- Data collection loop is essential part of the RL algorithm, especially in the distributed setting.

- RL is forced to use unstable (bootstrapped) loss functions due to missing labels (rewards cannot cover absence of SL-style labels).

$$\mathbb{E}_{(s,a,r,s')}\left[\frac{1}{2}\left(\underbrace{R(s,a,s') + \gamma \max_{a'} Q(s',a';\theta)}_{\text{“labels” (bootstrapped using reward AND network output)}} - \underbrace{Q(s,a;\theta)}_{\text{predictions (actual network output)}}\right)^2\right]$$

- Exploration vs exploitation. An (online) RL algo can try new things in the environment.

- By default, RL tries to optimize over a time axis.

Overview of RLlib's Industry Users

GM
GENERAL MOTORS
WILD LIFE
Microsoft
pathmind
UBISOFT
amazon web services
THIRD WAVE AUTOMATION
TWO SIGMA
QUANTUMBLACK
A MCKINSEY COMPANY
ERICSSON
RIOT GAMES
DOW
REPSOL
InstaDeep™
REWE
Besser leben.

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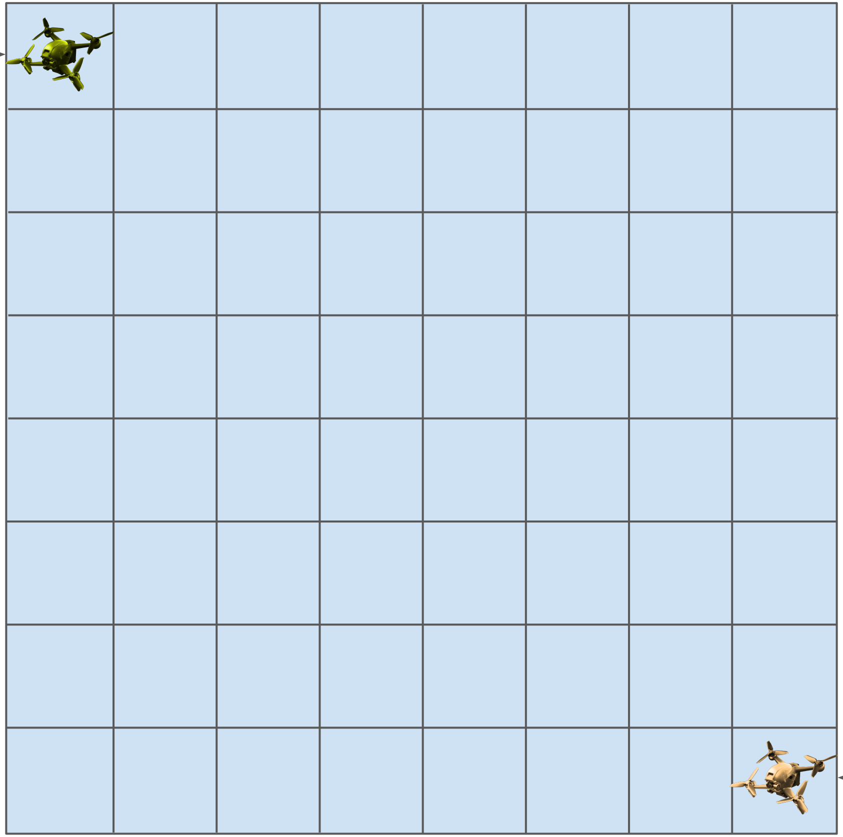
Many Great Reasons for Using RLlib

- RLlib is based on Ray, so it benefits from all its improvements on **performance** and **scalability**.
- RLlib is backed by Anyscale, the fast-growing, well-funded company behind Ray, offering strong **OSS support**.
- RLlib is extremely **flexible**, allowing you to **customize every aspect** of the RL cycle and workflows.
- RLlib is good at solving **real-world** problems, supporting **offline RL**, **multi-agent** setups, **external simulators**, and more.

Our Environment - The “MultiAgentArena” 😶

agent 1



agent 2

action space: Discrete(4)
0 - up
1 - right
2 - down
3 - left

rewards:

agent1 (“cover as much ground as possible”):

- +1 if new field
- -1 if colliding with agent 2
- -0.5 otherwise

agent2 (“defend: bump into agent1 as often as possible”):

- +1 if colliding with agent 1
- -0.1 otherwise

observation space:
MultiDiscrete([64, 64])

pos. agent 1

pos. agent 2

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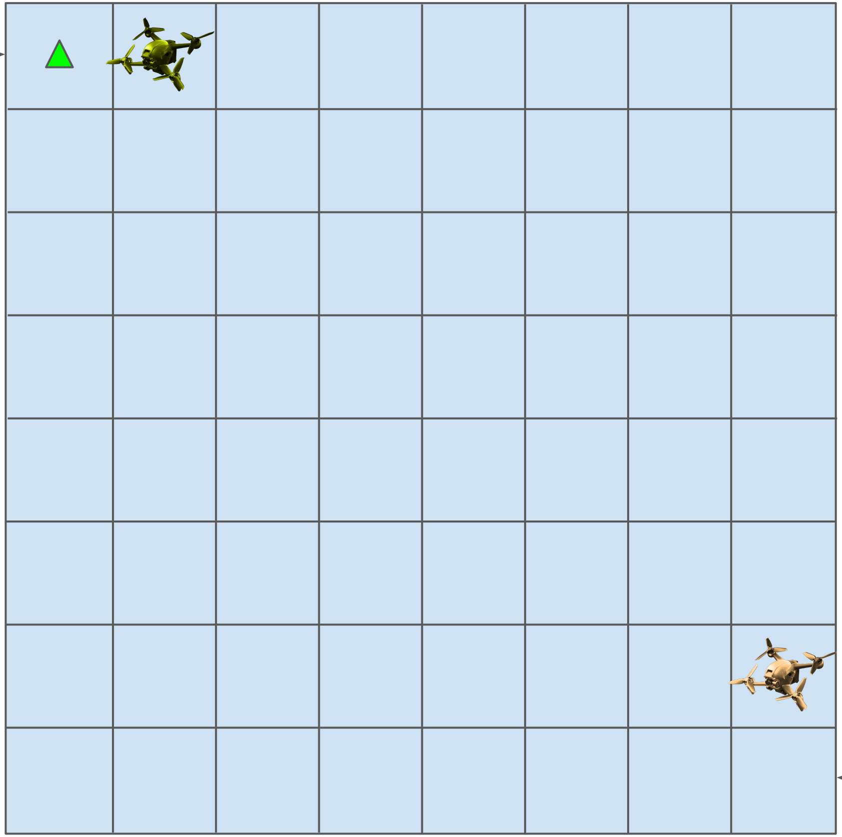
agent 1



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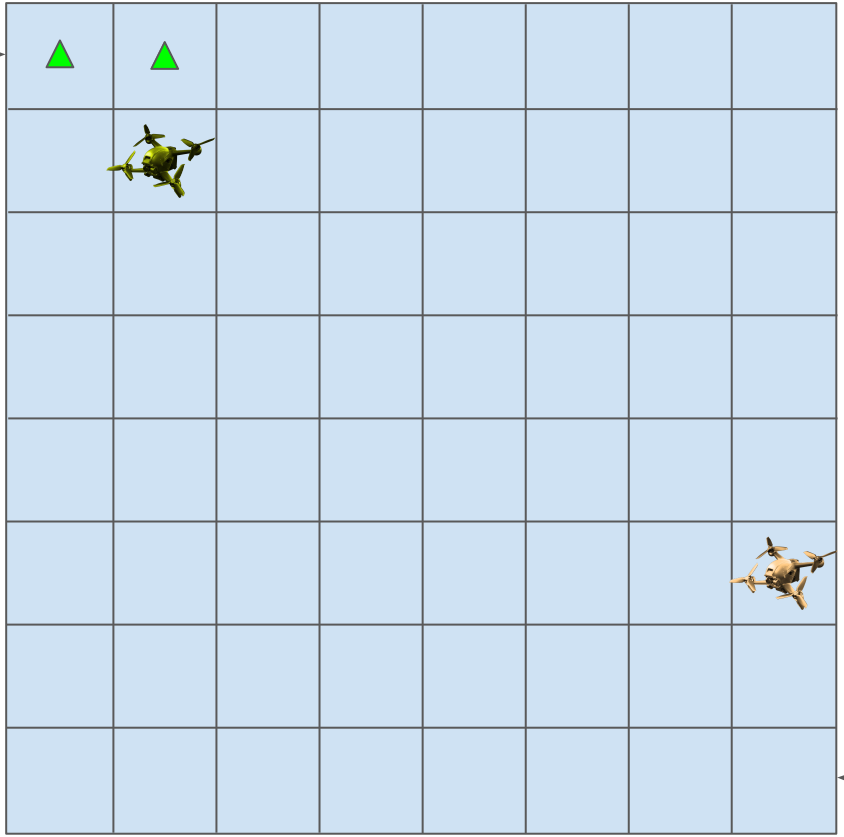

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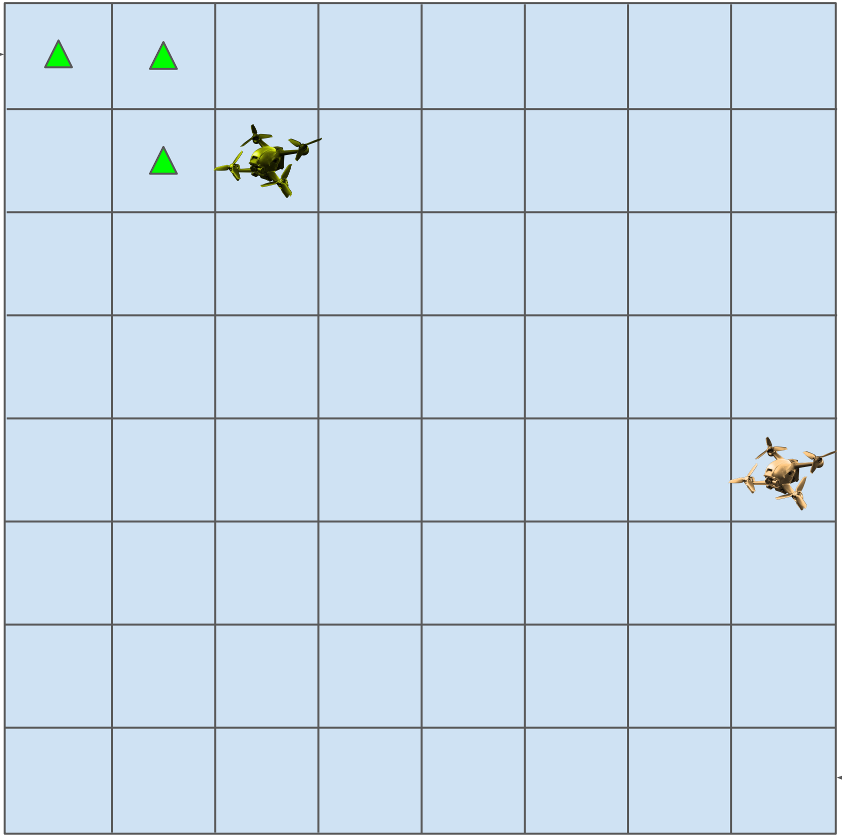

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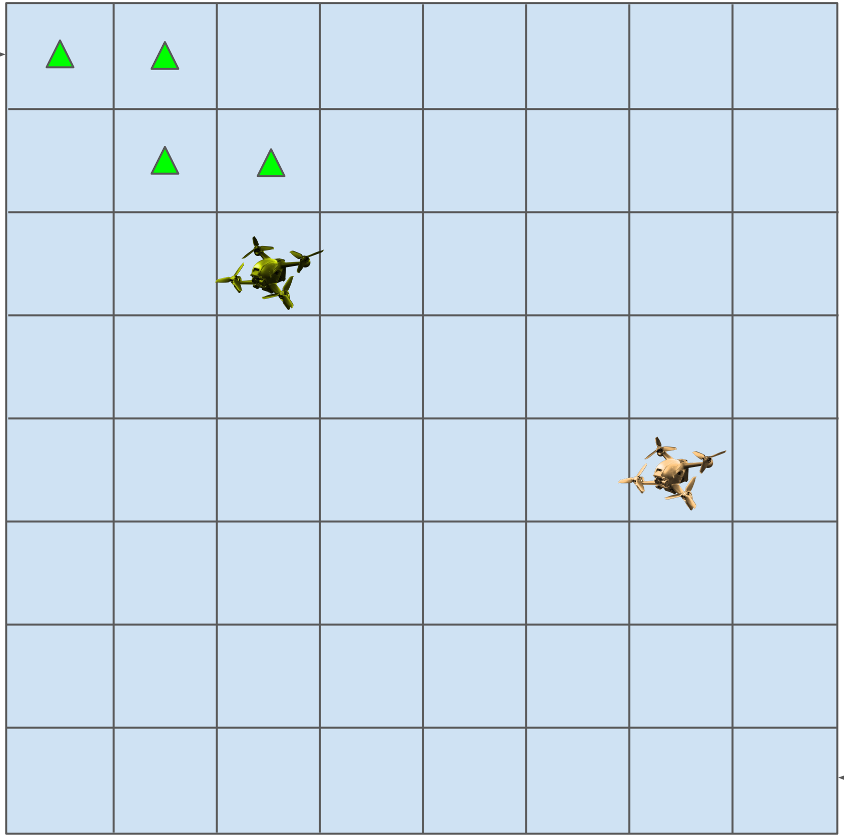

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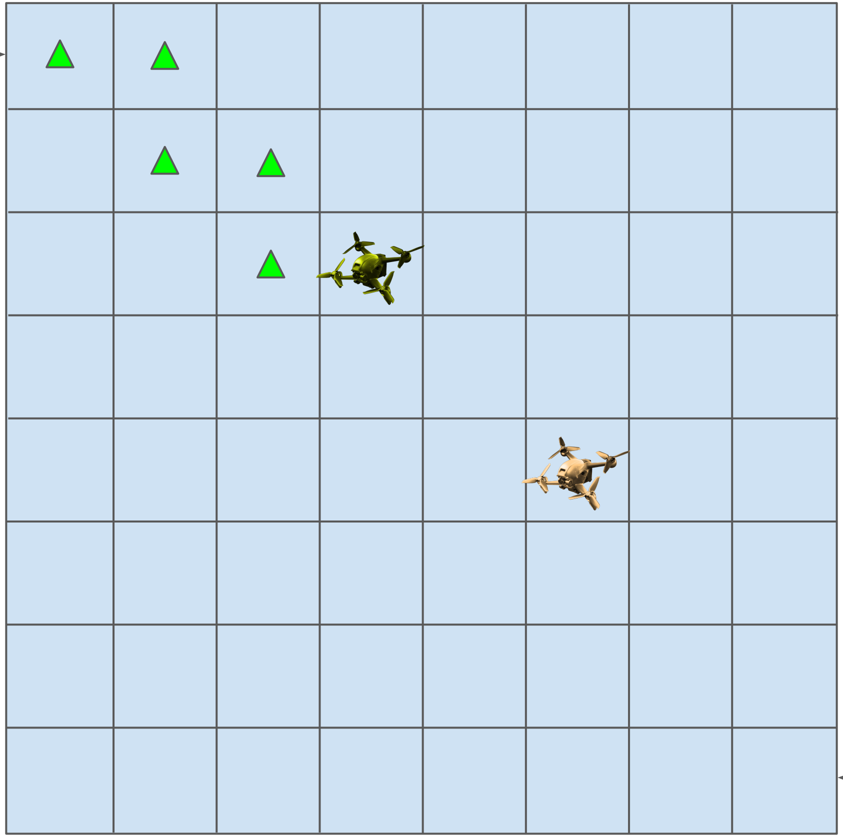

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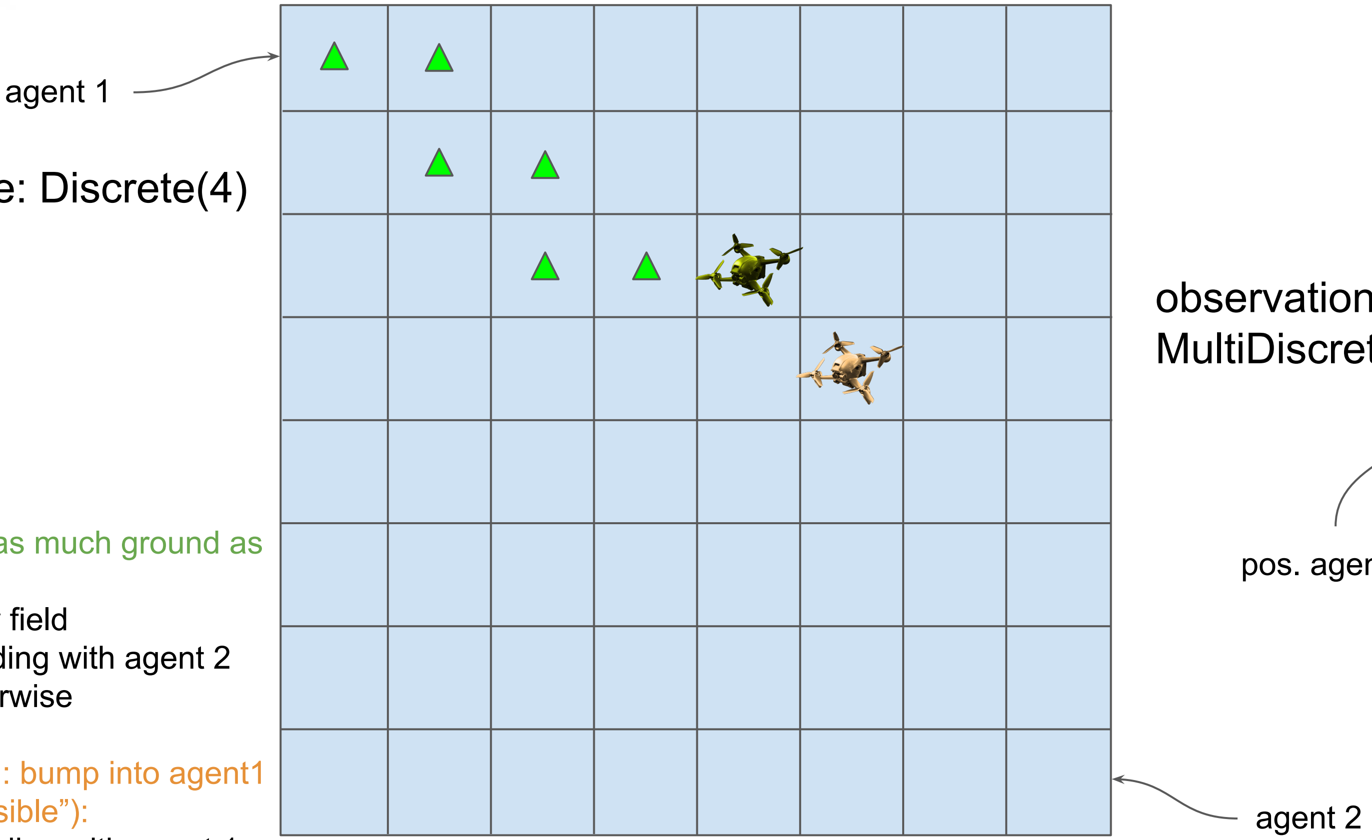

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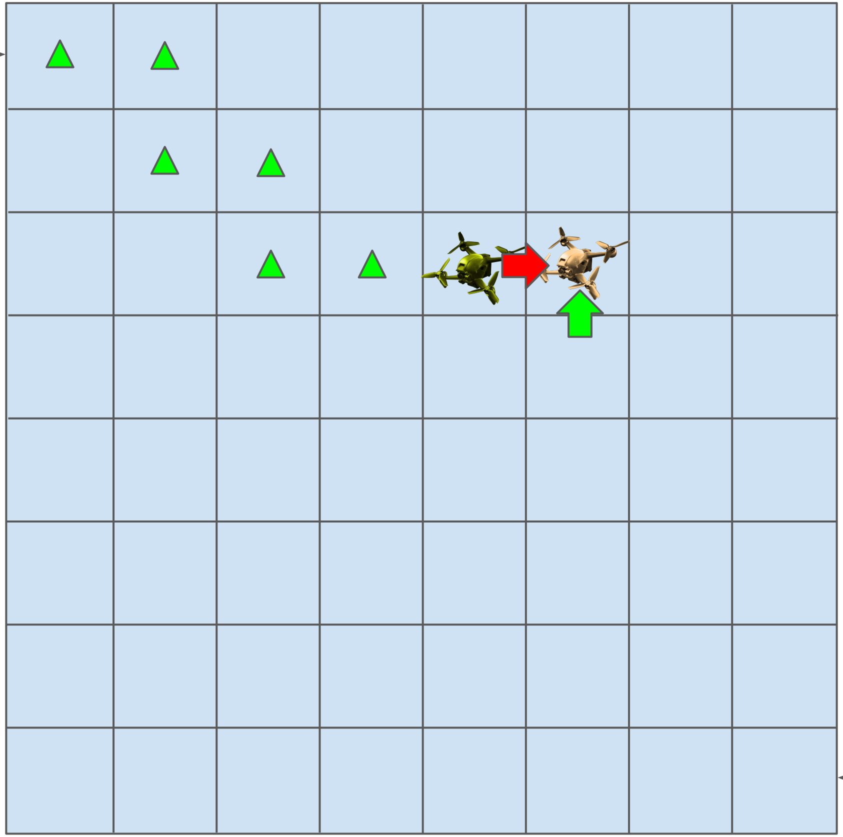

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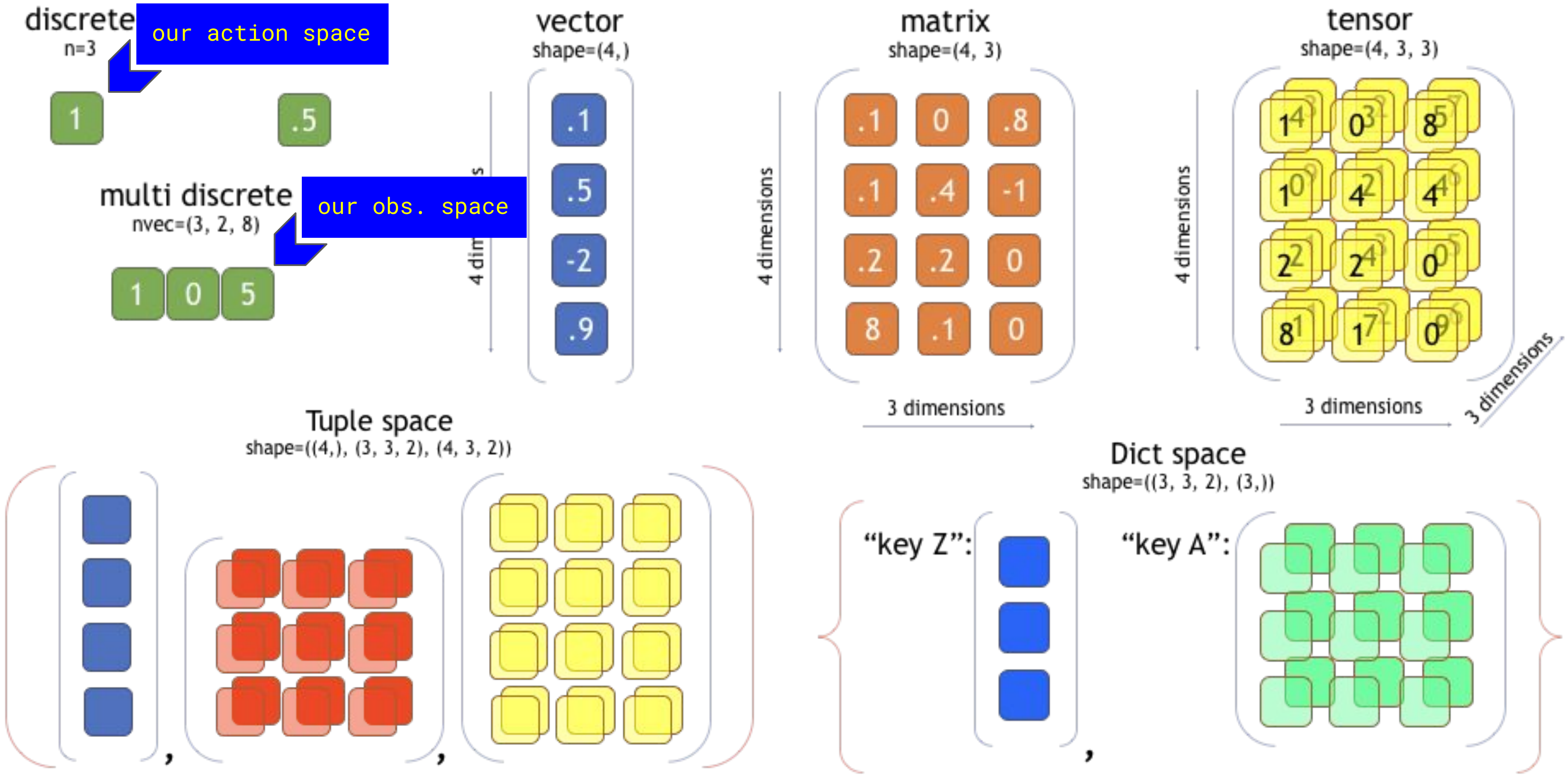
What’s a Space?



Algo Overview

Algorithm	Frameworks	Discrete Actions	Continuous Actions	Multi-Agent	Model Support	Multi-GPU
A2C, A3C	tf + torch	Yes +parametric	Yes	Yes	+RNN, +LSTM auto-wrapping, +Attention, +autoreg	A2C: tf + torch
ARS	tf + torch	Yes	Yes	No		No
BC	tf + torch	Yes +parametric	Yes	Yes	+RNN	torch
CQL	torch	No	Yes	No	+RNN, +LSTM auto-wrapping, +autoreg	torch
ES	tf + torch	Yes	Yes	No		No

Model Support	Multi-GPU
	torch
	torch
+RNN	torch
	tf + torch
	torch
+RNN, +LSTM auto-wrapping, +Attention, +autoreg	tf + torch
	torch
+RNN	torch
	torch
+RNN, +LSTM auto-wrapping, +Attention, +autoreg	tf + torch
+RNN, +LSTM auto-wrapping, +Attention, +autoreg	tf + torch
+RNN, +LSTM auto-wrapping, +autoreg	torch
	torch
	torch
	No
	No

Algorithm	Frameworks	Discrete Actions	Continuous Actions	Multi-Agent	Model Support	Multi-GPU
DQN, Rainbow	tf + torch	Yes +parametric	No	Yes		tf + torch
APEX-DQN	tf + torch	Yes +parametric	No	Yes		torch
IMPALA	tf + torch	Yes +parametric	Yes	Yes	+RNN, +LSTM auto-wrapping, +Attention, +autoreg	tf + torch
MAML	tf + torch	No	Yes	No		torch
MARWIL	tf + torch	Yes +parametric	Yes	Yes	+RNN	torch
MBMPO	torch	No	Yes	No		torch
PG	tf + torch	Yes +parametric	Yes	Yes	+RNN, +LSTM auto-wrapping, +Attention, +autoreg	tf + torch
PPO, APPO	tf + torch	Yes +parametric	Yes	Yes	+RNN, +LSTM auto-wrapping, +Attention, +autoreg	tf + torch
R2D2	tf + torch	Yes +parametric	No	Yes	+RNN, +LSTM auto-wrapping, +autoreg	torch
SAC	tf + torch	Yes	Yes	Yes		torch

Continuous Actions	Multi-Agent	Model Support
No	Yes	+RNN
Partial	Yes	

Shared Critic Methods — Depends on bootstrapped algorithm

Exploration-based plug-ins (can be combined with any algo)

Algorithm	Frameworks	Discrete Actions	Continuous Actions	Multi-Agent	Model Support
Curiosity	tf + torch	Yes +parametric	No	Yes	+RNN

https://docs.ray.io/en/master/rllib-algorithms.html#available-algorithms-overview

A Closer Look at RLlib