Overview

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3 What is Reinforcement Learning?

4 Examples

- Learn to master 49 different Atari games from screens
- Excel human experts in 29 games
- Uses Deep Q-network receiving only the pixels and the game score as inputs
Click!

- AlphaGo achieved a 99.8% winning rate against other Go programs
- Defeated the human European Go champion by 5 games to 0
- Uses ‘value networks’ to evaluate board positions and ‘policy networks’ to select moves
AI that has managed to learn how to walk, run, jump, and climb without any prior guidance.
Dactyl is a system for manipulating objects using a Shadow Dexterous Hand.

- Trained entirely in simulation and transfers its knowledge to reality
- One of the first RL to be working in the real world
NeurIPS 2019 Will Host Minecraft Reinforcement Learning Competition

A group of AI experts from top US universities is organizing a sample-efficient reinforcement learning competition, MineRL, which will start on June 1,
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Supervised Learning

Data: \((x, y)\)

\(x\) is data; \(y\) is label

Goal: Learn a function to map

\(X \rightarrow y\)

\(y = f(x)\)

Examples: Classification, regression
decision trees, object detection, etc.
Data: \((x)\)
Just data, no labels

Goal: Learn some underlying hidden structure of the data

Examples: Clustering, dimensionality reduction, feature learning, anomaly detection, etc
Problems involving an agent interacting with an environment, which provides numeric reward signals.

**Goal:** Learn how to take actions in order to maximize reward

**Examples:** Learning tasks, navigation, etc
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Grid world
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Grid world

0 1 2 3

0 1 2 3

A grid world with a robot and an apple.
What is Reinforcement Learning?

Agent

Takes action $a (a \in A)$

Environment

State $s (s \in S)$
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What is Reinforcement Learning?

Reinforcement learning provides a formalism for behavior.
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Objective: Eat something tasty

State: Position of the instructor
Action: Give a paw
Reward: Food
Objective: Complete the game with the highest score

State: Raw pixel inputs of the game state
Action: Game controls e.g. Left, Right, Up, Down
Reward: Score increase/decrease at each time step
**Objective:** Win the game

**State:** Position of all pieces  
**Action:** Where to put the next piece down  
**Reward:** 1 if win at the end of the game, 0 otherwise
Objective: Manipulate physical objects with unprecedented dexterity

State: Coordinates of the fingertips and the images from cameras

Action: Changing the position of fingertips

Reward: Small reward for every simulated movement that brought the cube closer to the goal
**Objective:** Win the game

**State:** Current state of the game, positions of other agents

**Action:** Take one of the legal action, e.g. where to click and what to build

**Reward:** Points
The goal of reinforcement learning is to learn how to take actions in order to maximize the reward.

Reinforcement learning provides a formalism for behavior: we make decisions (action) and get consequences (new state, reward).

Now is a perfect time to start doing research in reinforcement learning!