Overview

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How do we build intelligent machines?
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Learn to make good sequences of decisions
Repeated Interactions with World

Learn to make good sequences of decisions
Learn to make **good** sequences of decisions
Learn to make good sequences of decisions
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- 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.
OpenAI - Dactyl

- 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

Click!
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.
Unsupervised Learning

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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What is Reinforcement Learning?

Environment
What is Reinforcement Learning?
What is Reinforcement Learning?

Agent

Environment

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

Grid world

- Grid with robot and apple
- Axes labeled 0, 1, 2, 3
What is Reinforcement Learning?

Agent

Takes action $a (a \in A)$

Environment

State $s (s \in S)$

Alina Vereshchaka (UB)
What is Reinforcement Learning?

Grid world
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!