

Reinforcement Learning

Introduction

Reinforcement Learning (RL) is a type of machine learning where an agent learns how to behave in an environment by performing actions and receiving rewards or penalties. The goal is to learn a policy that maximizes cumulative reward over time.

Basic Concept of Reinforcement Learning

Unlike supervised learning, reinforcement learning does not use labeled input-output pairs. Instead, the agent learns through trial and error by interacting with the environment.

Agent → Action → Environment → Reward → Agent

Key Elements of Reinforcement Learning

- 1 **Agent:** The learner or decision-maker
- 2 **Environment:** The world the agent interacts with
- 3 **State:** Current situation of the agent
- 4 **Action:** What the agent can do
- 5 **Reward:** Feedback from the environment
- 6 **Policy:** Strategy used by the agent

How Reinforcement Learning Works

```
Initialize Agent
  ↓
Observe State
  ↓
Take Action
  ↓
Receive Reward
  ↓
Update Policy
  ↓
Repeat
```

Types of Reinforcement Learning

- 1 Positive Reinforcement
- 2 Negative Reinforcement

Common Reinforcement Learning Algorithms

- 1 Q-Learning
- 2 SARSA
- 3 Deep Q-Networks (DQN)
- 4 Policy Gradient Methods

Exploration vs Exploitation

Exploration means trying new actions to discover rewards, while exploitation means choosing actions that are known to give high rewards. Balancing both is critical in reinforcement learning.

Advantages

- 1 Learns optimal behavior automatically
- 2 No labeled data required
- 3 Effective in dynamic environments

Disadvantages

- 1 Requires large training time
- 2 High computational cost
- 3 Reward design is complex

Real-Life Examples

- 1 Game playing (Chess, Go)
- 2 Robotics control
- 3 Self-driving cars
- 4 Recommendation systems

Summary

Reinforcement learning enables agents to learn optimal behavior through interaction with the environment. It is powerful for decision-making problems but requires careful design and significant computation.