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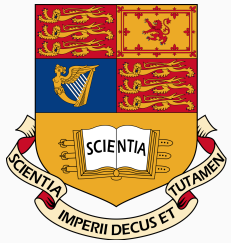

Reinforcement Learning for Portfolio Management

Final Year Project

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Portfolio Management

Given a finite universe of instruments Ω, where:

$$\Omega = \{\omega_1, \omega_2, ..., \omega_M\}, \quad |\Omega| = M < \infty$$

Allocate **portfolio vector $\mathbf{w}_t$**, such that:

$$\mathbf{w}_t = \max_{\mathbf{w}^*} \mathbf{Y}_{t+1} \mathbf{w}_t^* \tag{1}$$

where:

- $\mathbf{w}_t \in R^M$
- $\mathbf{Y}_t$: **price tensor** at time t
- $\sum_{i=1}^{M} |w_t^{(i)}| = 1^*$

*Allowing long and short positions.

Reinforcement Learning

Markov Decision Process

Frame Portfolio Allocation problem as a Markov Decision Process with Infinite State Space.

Reward

- (+) Cumulative Returns
- (−) Transaction Costs

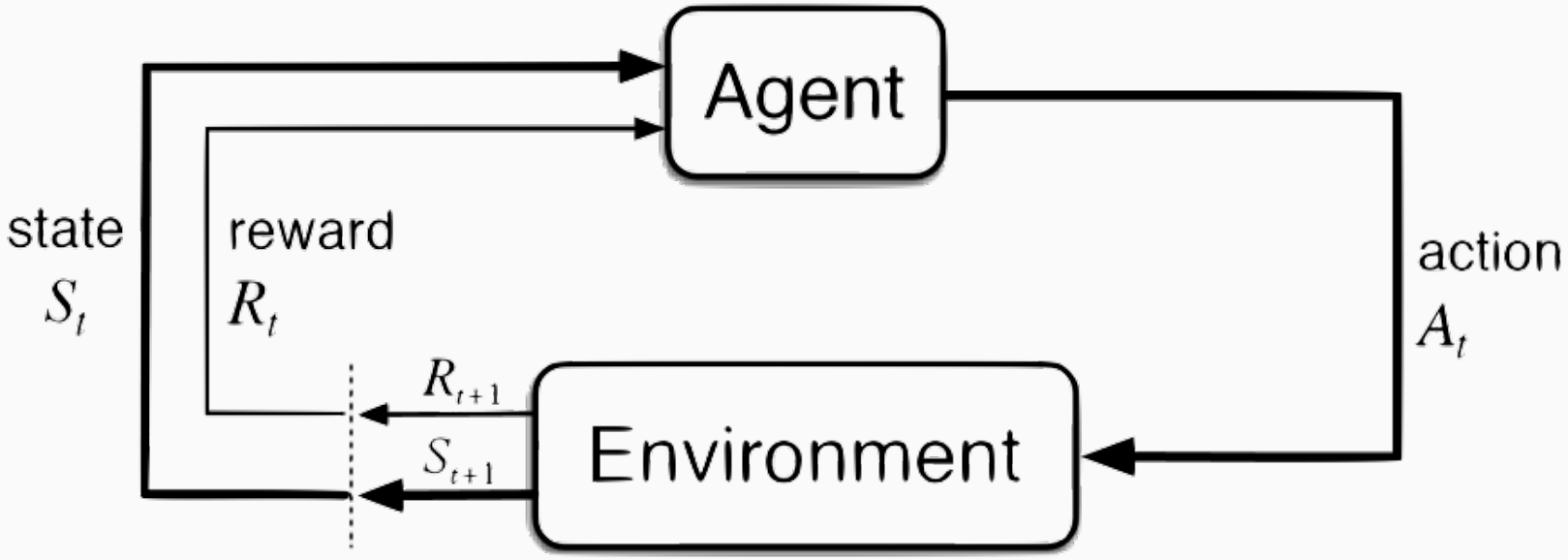
State

- Portfolio vector $\mathbf{w}_t$
- History of rewards

Actions

Portfolio vector rebalance, respecting equation (1).

Abstract



Fusion

Q-Learning

Approximate mapping function $\mathcal{Q}$, such that:

$$\mathcal{Q} : \mathcal{S} \rightarrow \mathcal{A} \tag{2}$$

Deep Reinforcement Learning

Implement **Double Deep Q-Network** (DDQN), based on both feedforward and recurrent architectures.

Simulation

Toy datasets, starting from sum of noisy sinusoids.

Transfer Learning

1. Generate data, using **Generative Models**, such GANs.
2. Retrain last **Fully Connected** layers of the network.

Questions?

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