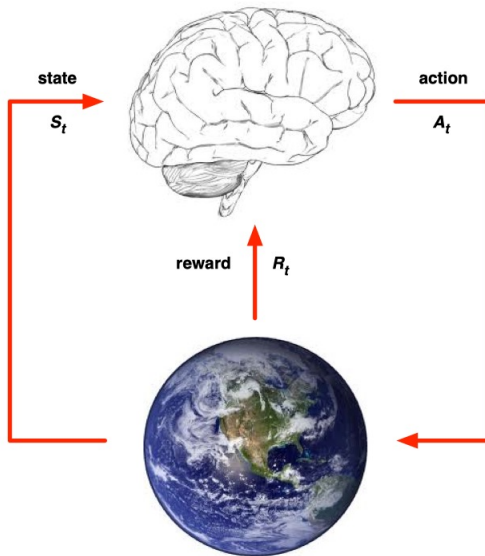


# Reinforcement Learning in Portfolio Management

Jie Ma

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# Framework of Reinforcement Learning



# How a Robo-advisor Works?

- Environment/State:
  - Stock prices
  - Portfolio
  - Other factor: major indexes, interest rate, macro factor, ...
- Action  
Hold or switch portfolio in some policies
- Reward  
Present value of future return - portfolio switch cost

# Introduction of Report

States:

$$\text{Prices} : S^k = (S_1^k, \dots, S_L^k)$$

$$\text{Portfolio} : P^k = (P_0^k, P_1^k, \dots, P_L^k)$$

$$\text{State}^k = (S^{k-N}, S^{k-N+1}, \dots, S^{k-1}, S^k, P^{k-1})$$

Rewards

$$R^k = R_{P^k_* S^{k+1} - P^k_* S^k} - \text{switch\_cost}_{P_{k-1} P_k}$$

Policy

*Deep Neural Networks*

# Improvement

- ① State: Add more information into state and add cash/riskless asset into portfolio
- ② Rewards: Improve Reward function from return to return/risk
- ③ Frequency: Improve the price frequency means improving the sensitivity of agent
- ④ Policy: More freedom?

# Build Environment with Gym

## Logic of backtest system

```
initialize()  
while t in time.index:  
    pre_trading()  
    strategy_sigal()  
    strategy_order()  
    after_trading()
```

Github:

*[https : //github.com/marsMa/rl\\_in\\_portfolio\\_management](https://github.com/marsMa/rl_in_portfolio_management)*