Risk and transaction cost-awareness portfolio selection based on reinforcement learning

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MOTIVATION

1. The primary motivation for portfolio management is to optimize returns while managing risk.
2. Traditional portfolio management models may struggle to capture the complexity of the financial market in real-time.
3. There is a growing trend using deep reinforcement learning to make investment decisions and handling high dimensional data.

METHODS

1. Determined the asset allocation problem under portfolio constraints by considering the transaction cost and risk aversion in the portfolio selection problem.
2. Implemented Markov Decision process for portfolio trading. The objective reward function is denoted as:

$$r_t = \boldsymbol{p}_t^{\mathrm{T}} \boldsymbol{m}_t - \underbrace{\beta \sigma_t^2}_{\text{Risk cost}} - \underbrace{\xi \boldsymbol{p}_t^{\mathrm{T}} |\boldsymbol{k}_t|}_{\text{Transaction cost}}$$

3. TD3-based portfolio trading algorithm:

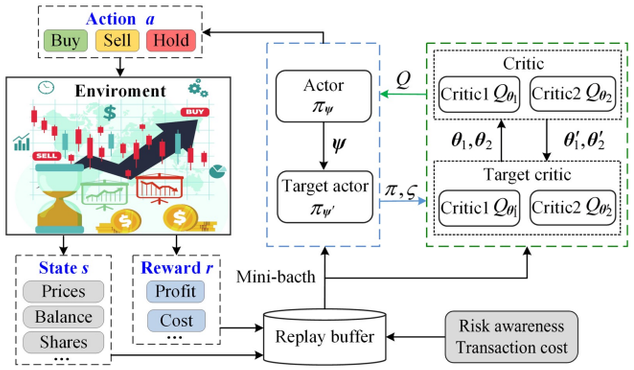

Fig. 1. The TD3-based portfolio trading framework

OBJECTIVES

- ❑ Propose a DRL-TD3-based risk and transaction cost-sensitive portfolio that combines advanced exploration strategies and dynamic policy updates.
- ❑ Maximize the expected returns of a portfolio over time at a given risk in high-dimensional state spaces.
- ❑ Develop trading strategies that can outperform traditional methods.

MAIN RESULTS

✓ Empirical results and analysis on DJIA stocks

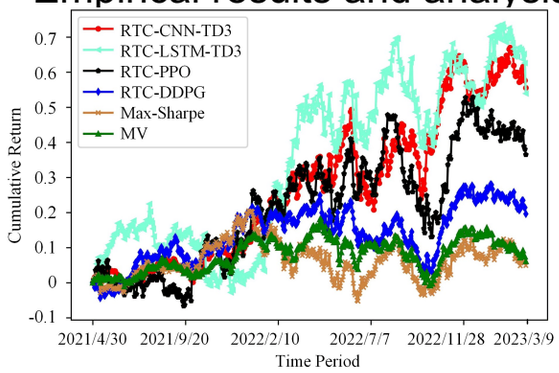

Fig. 2. Cumulative return performance comparisons using different portfolio trading strategies for a risk aversion coefficient β=0.005 and transaction cost rate ξ=0.05%.

Method	RTC-CNN-TD3	RTC-LSTM-TD3	RTC-CNN-DDPG	RTC-CNN-PPO	Max-Sharpe	MV
Annual Return (%)	26.91	26.20	10.18	18.28	2.62	3.25
Cumulative Return (%)	55.53	53.92	19.62	36.50	4.91	6.10
Annual Volatility (%)	22.01	29.02	17.28	28.08	19.97	13.42
Sharpe Ratio	1.19	0.95	0.65	0.74	0.23	0.31
Max Drawdown (%)	19.11	20.61	18.58	23.52	21.38	16.01
Calmar Ratio	1.41	1.27	0.55	0.78	0.12	0.20

Table 1. Performance measures of different portfolio methods when β=0.005 and ξ=0.05%.

✓ Empirical results for S&P100 index

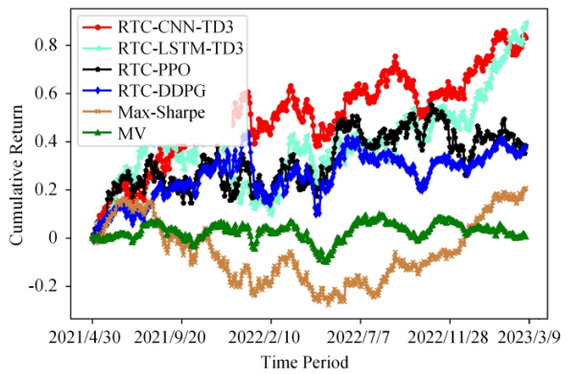

Fig. 3. Cumulative return performance comparisons using different portfolio trading strategies for a risk aversion coefficient β=0.005 and transaction cost rate ξ=0.05%

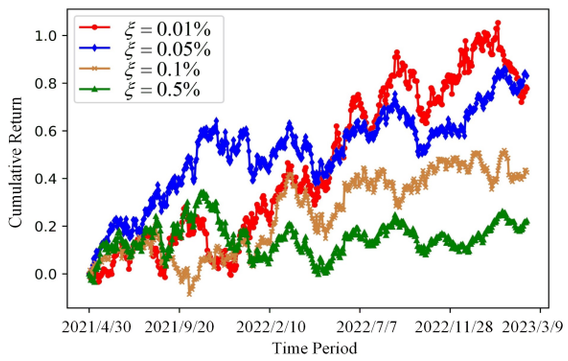

Fig. 4. Cumulative return performance of the RTC-CNN-TD3-based portfolio under different transaction cost rates ξ for a risk aversion coefficient β=0.005.

MAIN REFERENCES

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•Reference 2. Reference 3. Cui, T., Ding, S., Jin, H., & Zhang, Y. (2023). Portfolio constructions in cryptocurrency market: A CVaR-based deep reinforcement learning approach. *Economic Model, 119.*,
• Reference 3. Zeng, Y., & Klabjan, D. (2018). Portfolio optimization for American options. *Journal of Computational Finance, 22*(3), 37-64.