

Cointegration Aware Pairs Trading with Reinforcement Learning Based Optimal Stopping

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Summary

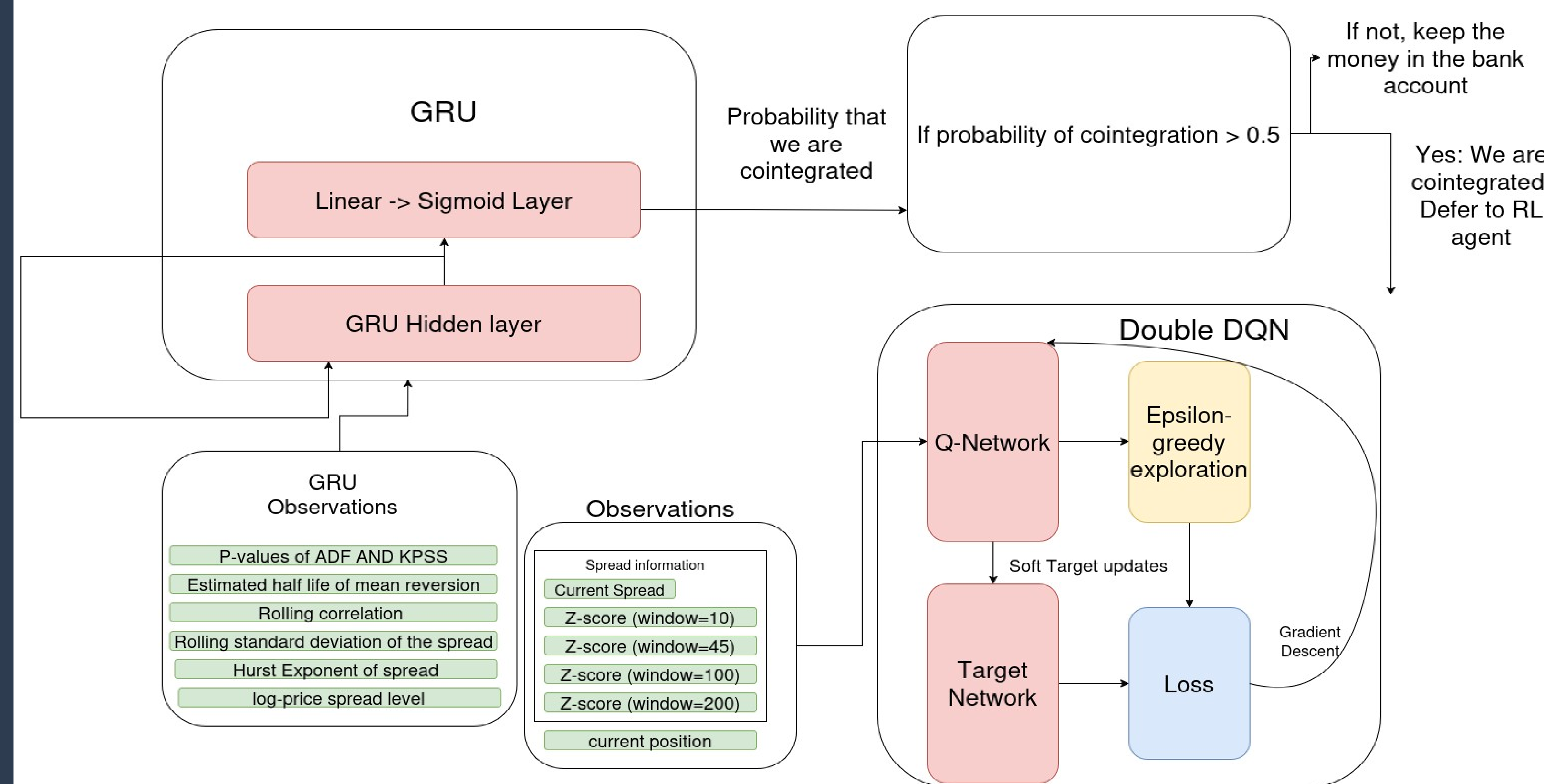
Pairs Trading is a trading strategy that exploits the tendency of some pairs of stocks to converge to the same price (e.g. Visa and Mastercard, Albert Heijn and Jumbo, etc.). We say that two stocks are **cointegrated** when they tend to converge in this way.

By entering into a simultaneous long and short position and the prices diverge (buying the cheap stock and selling the expensive one), and exiting when they converge again, the trader can earn a profit that is neutral to the overall market trends.

Reinforcement Learning can be used to implement a pairs trading strategy that outperforms fixed z-score thresholds (a common baseline strategy) [1,2]. However, the strategy can fail to make profit when the cointegration relationship breaks down.

We introduce a GRU (Gated Recurrent Unit) model to predict periods of cointegration. By only trading during periods of predicted cointegration, we found that the RL strategy can in some cases outperform the baseline, while trading less and therefore allowing the capital to be free for other purposes more often.

Methodology



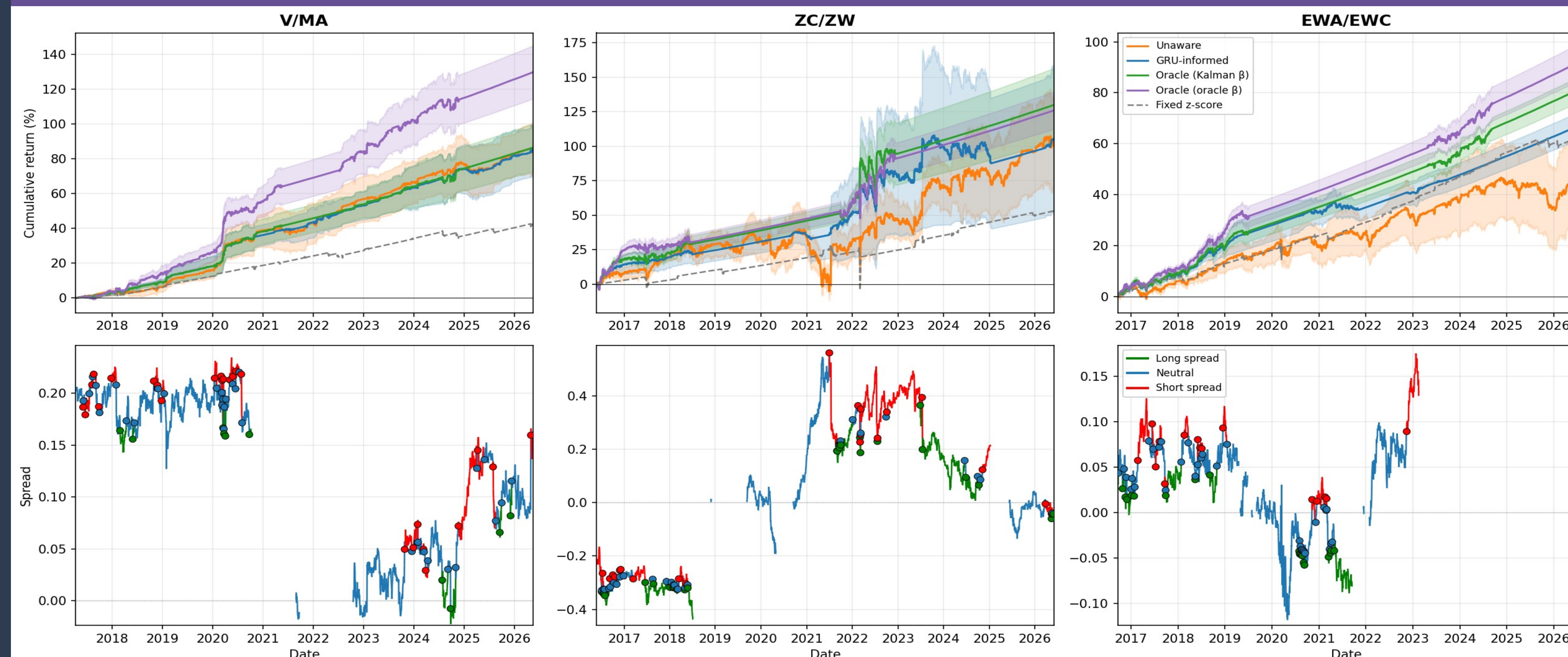
Results

Method	Ann. return
Fixed z-score (Baseline)	4.5%
Cointegration-unaware RL	6.0%
RL with cointegration estimation	6.5%
RL with perfect cointegration knowledge	8.3%

Discussion

- We found that limiting trades to periods of cointegration leads to a substantial improvement.
- We were able to capture some benefits of cointegration awareness by a GRU model predicting periods of cointegration, trained on labelled past data. More research is needed to find a more consistent predictor for cointegration.

Results



V/MA, ZC/ZW and EWA/EWC are 3 pairs of assets we tested on. Top row shows wealth curves of 5 strategies, bottom shows actions our main model (RL with cointegration estimation) takes on one particular seed, with the line being the spread between the assets.

References

- [1] Ning & Lee. Advanced statistical arbitrage with RL. Int. J. Financial Eng., 2025.
- [2] Kim, Taewook & Kim, Ha. (2019). Optimizing the Pairs-Trading Strategy Using Deep Reinforcement Learning with Trading and Stop-Loss Boundaries. Complexity. 2019. 1-20. 10.1155/2019/3582516.