Portfolio Rebalancing with Reinforcement Learning

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Goals

- Create an environment for automated portfolio rebalancing
- Compare different models' performance against benchmarks
- Develop rigorous evaluation techniques
- Explore extensions

Position of Project within Literature

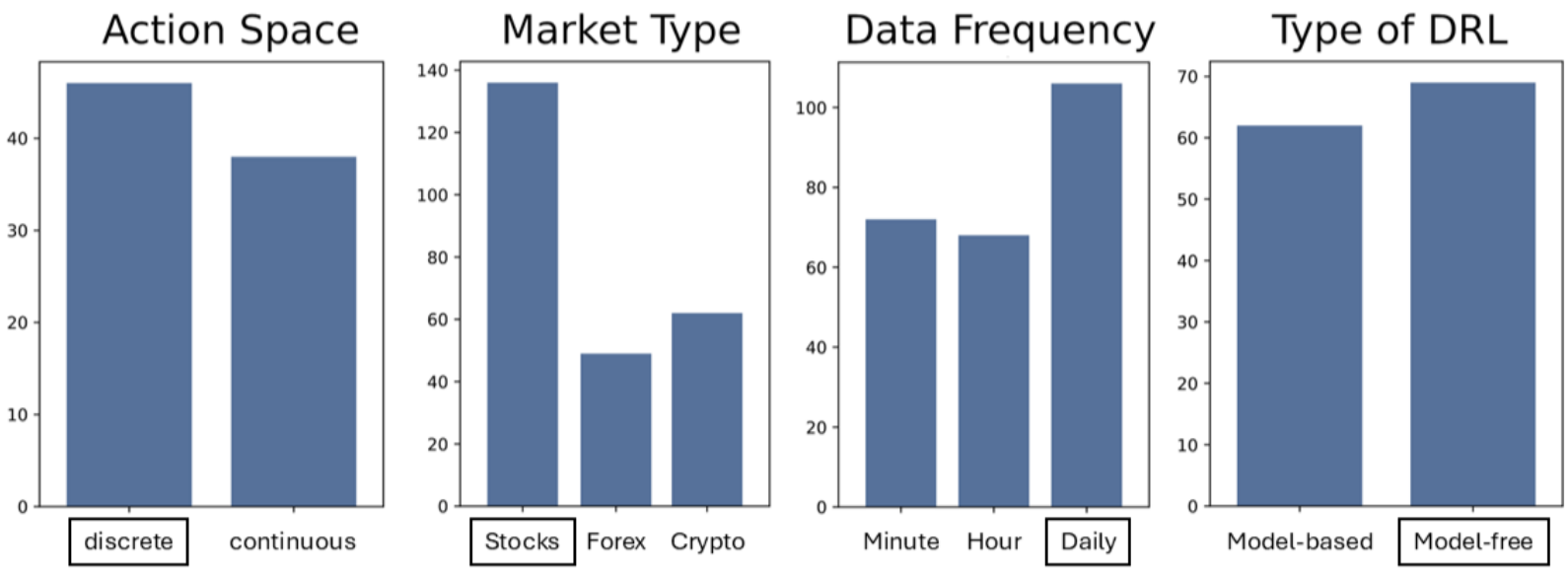
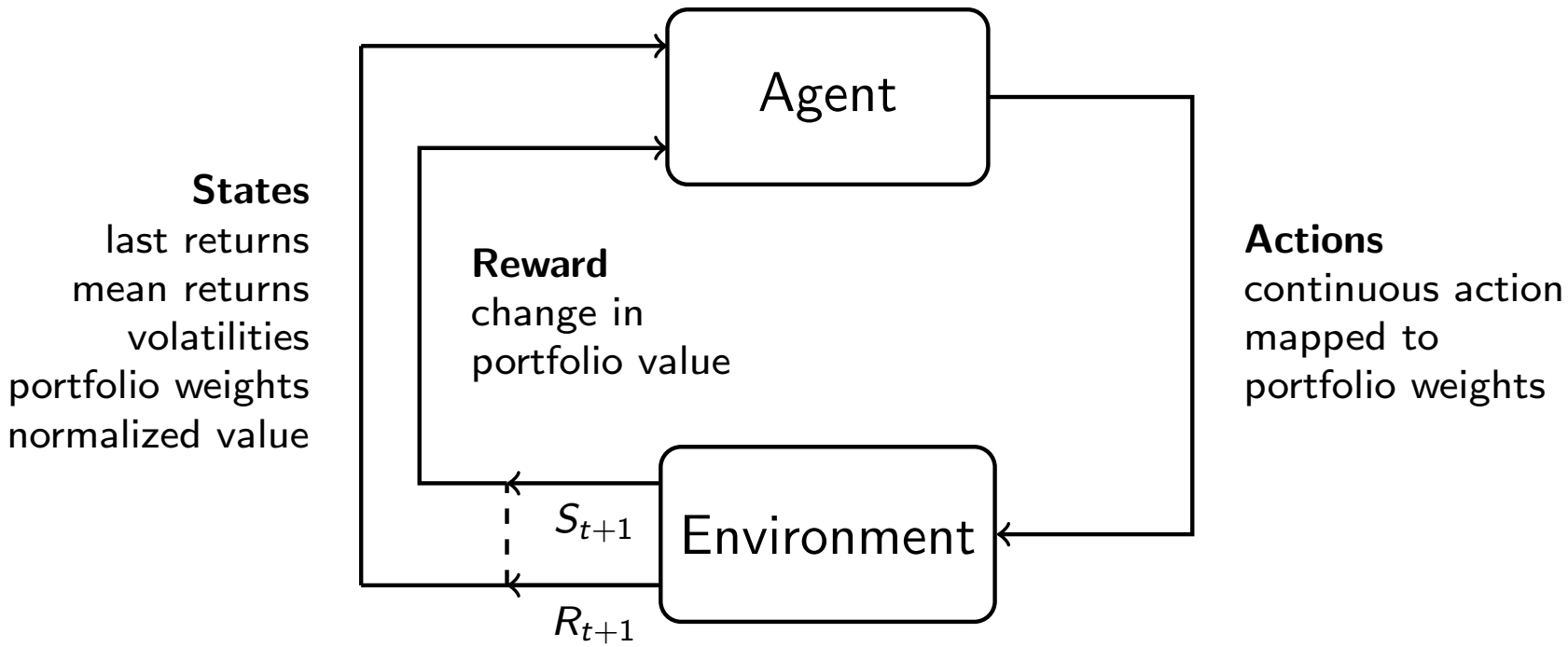


Figure 1: Existing literature on using Deep Reinforcement Learning in Trading. Minimally dapted from Millea (2021) for better readability.

Wide variety of models, in particular:

- **Double Deep Q-Network (DDQN):** Gao et al. (2020)
- **Soft Actor Critic (SAC):** Li et al. (2025)

Environment Diagram: Portfolio Rebalancing



Choice of Assets: Minimal Correlation

Following Lim et al. (2022):

1. Compute full correlation matrix between all assets in dataset
2. For each group of 4, compute mean pairwise correlation
3. Choose group with minimum mean correlation

- **'AA':** Alcoa Corporation (*aluminum producer*)
- **'ABT':** Abbott Laboratories (*healthcare*)
- **'KGC':** Kinross Gold Corporation (*gold mining*)
- **'KO':** Coca-Cola Company (*beverage production*)

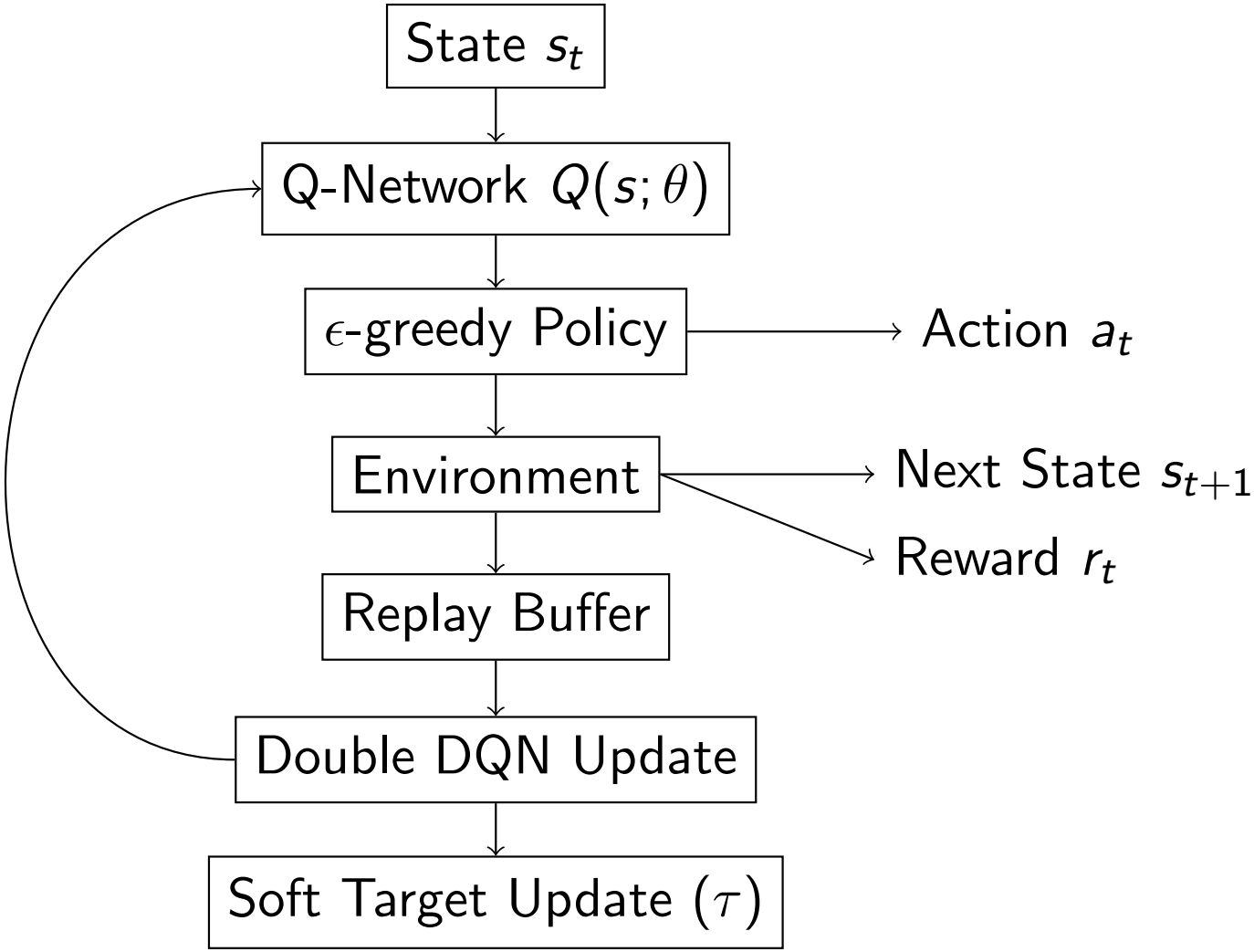
However: down-trending stocks always assigned 0 weight.

Choice of Assets: by sector

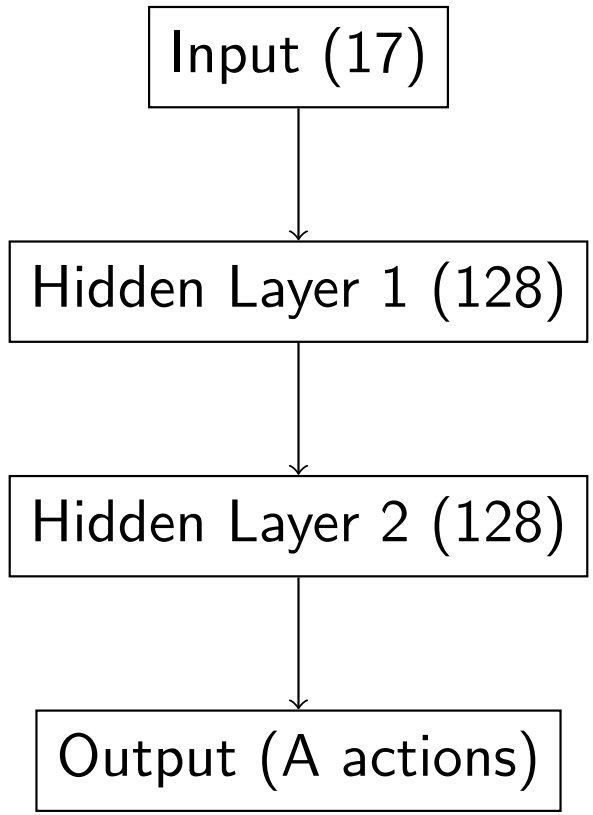
For each of the four biggest sectors on yahoo finance, choose stock with highest market-capitalization:

- **'NVDA'**: NVIDIA Corporation *(semiconductors)*
- **'LLY'**: Eli Lilly and Company *(healthcare)*
- **'JPM'**: JPMorgan Chase *(financial)*
- **'CAT'**: Caterpillar Inc. *(industrial machinery)*

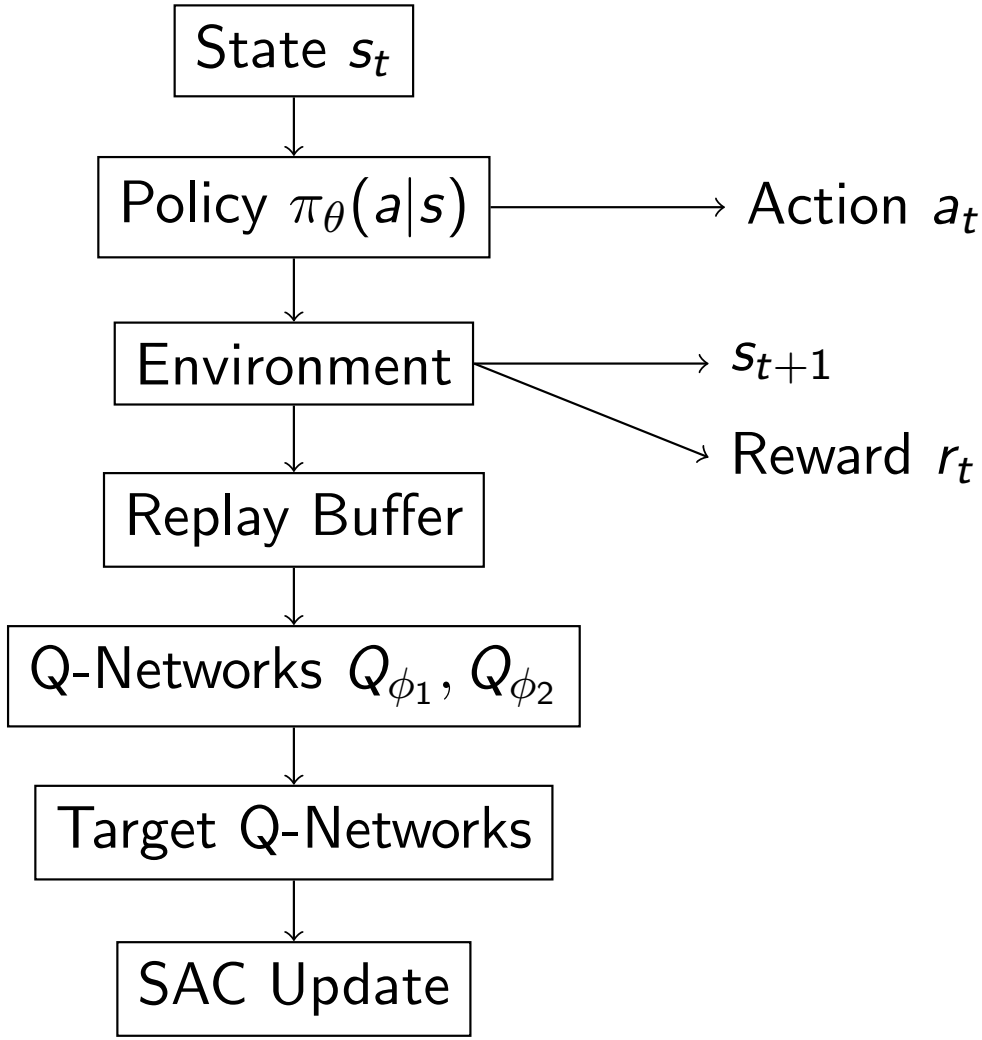
DDQN Workflow



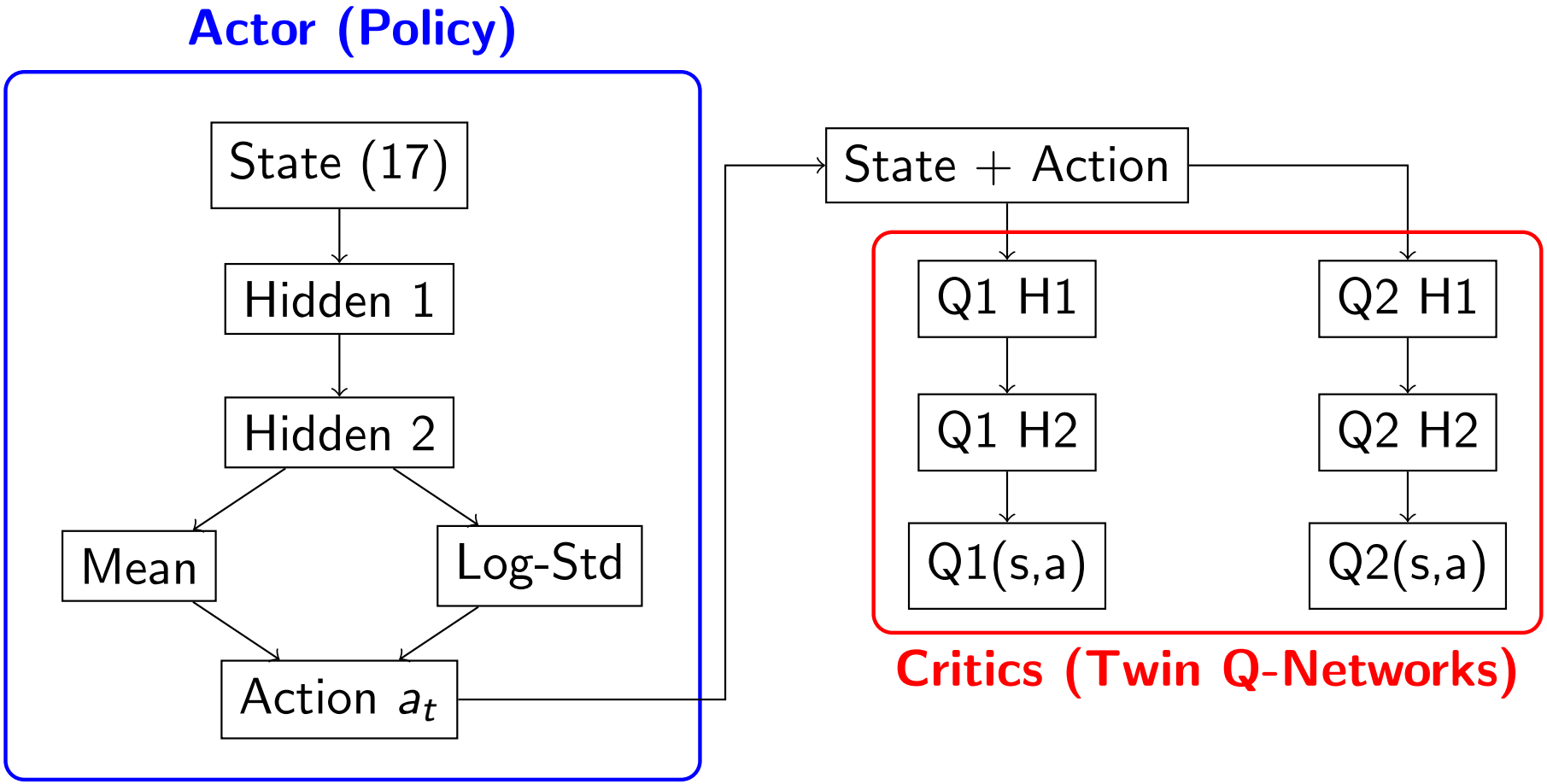
DDQN Model Architecture



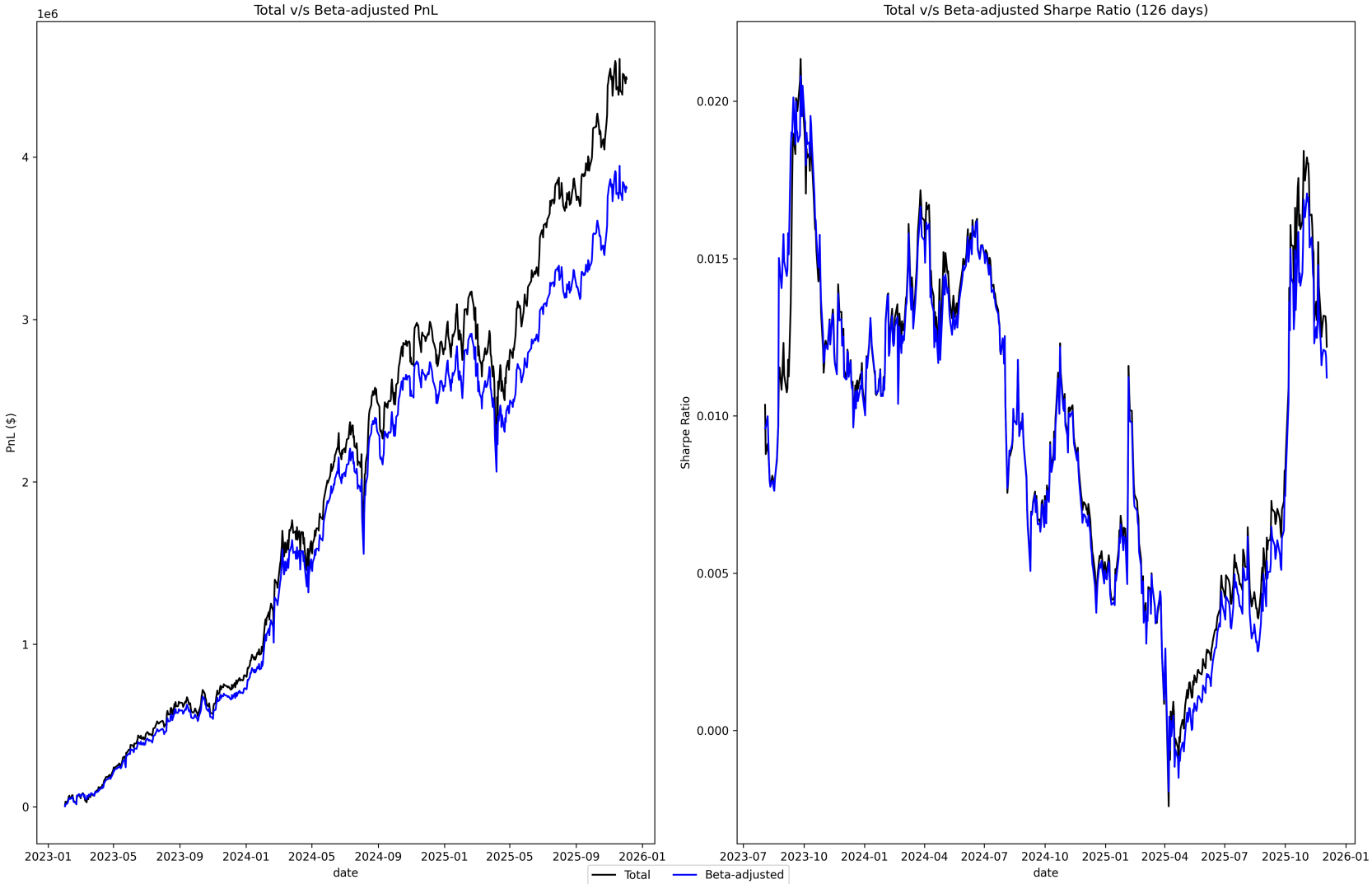
SAC Workflow



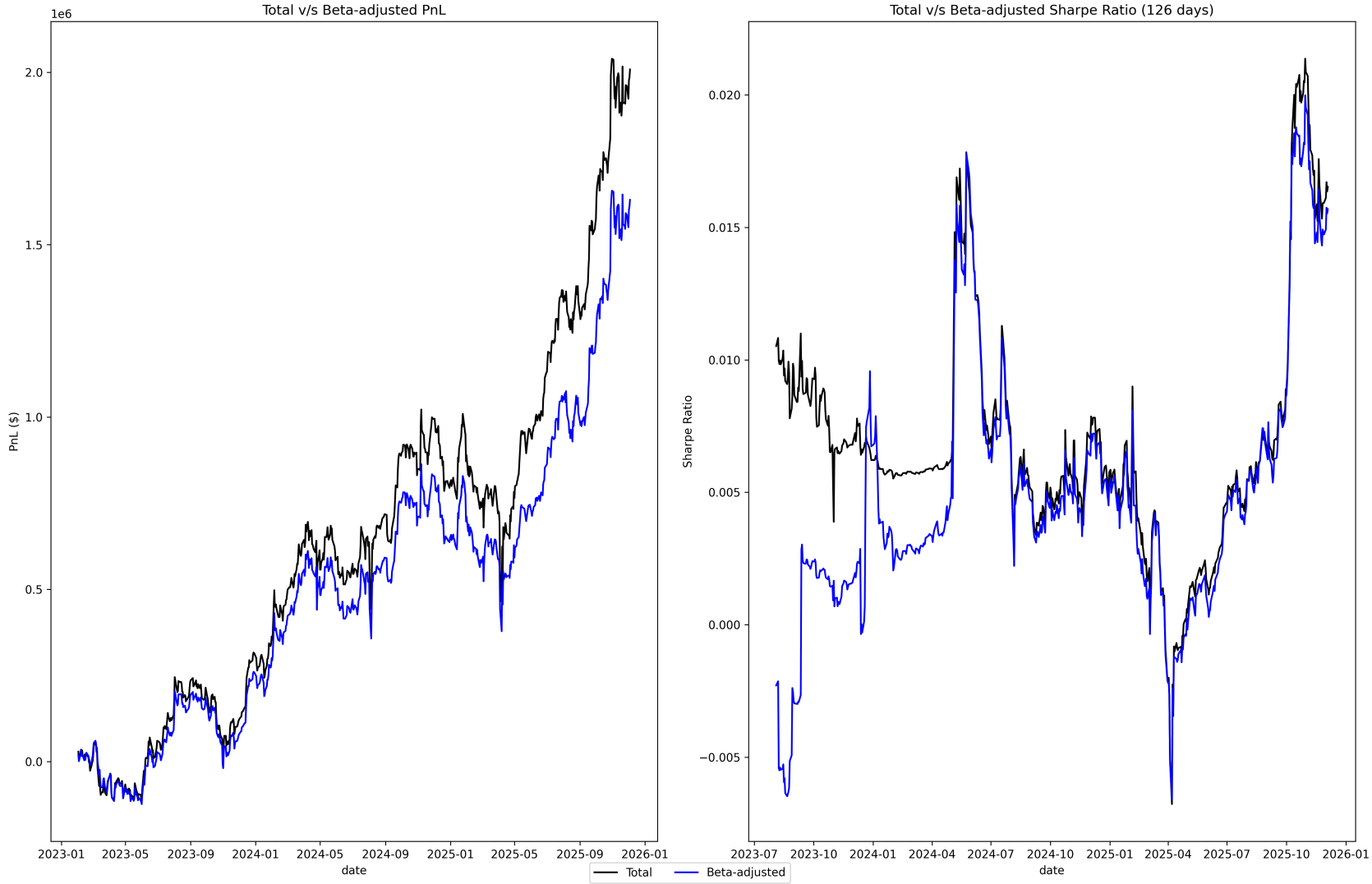
SAC Model Architecture



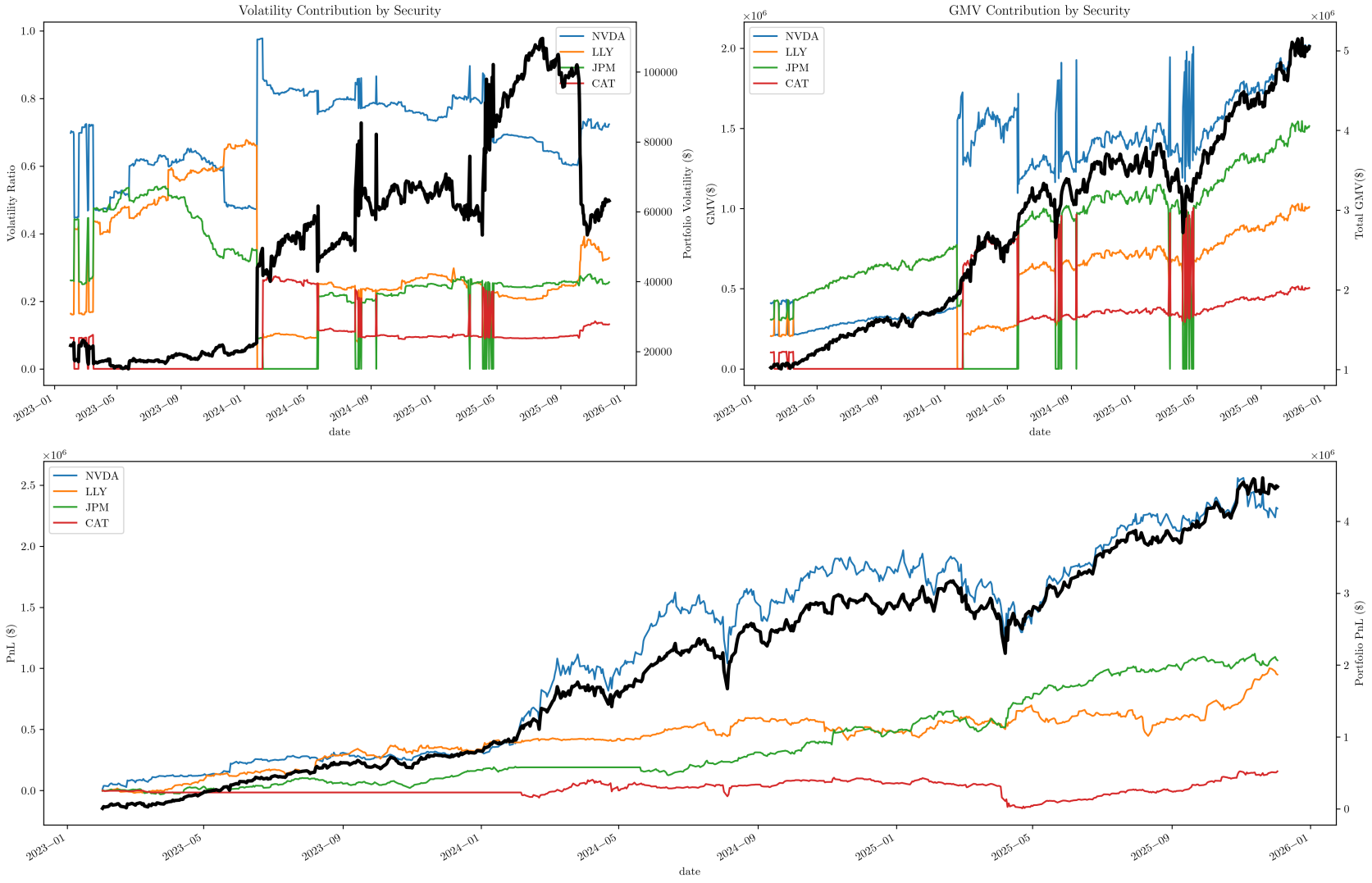
DDQN Evaluation: Topline Statistics and Market-Adjusted Results



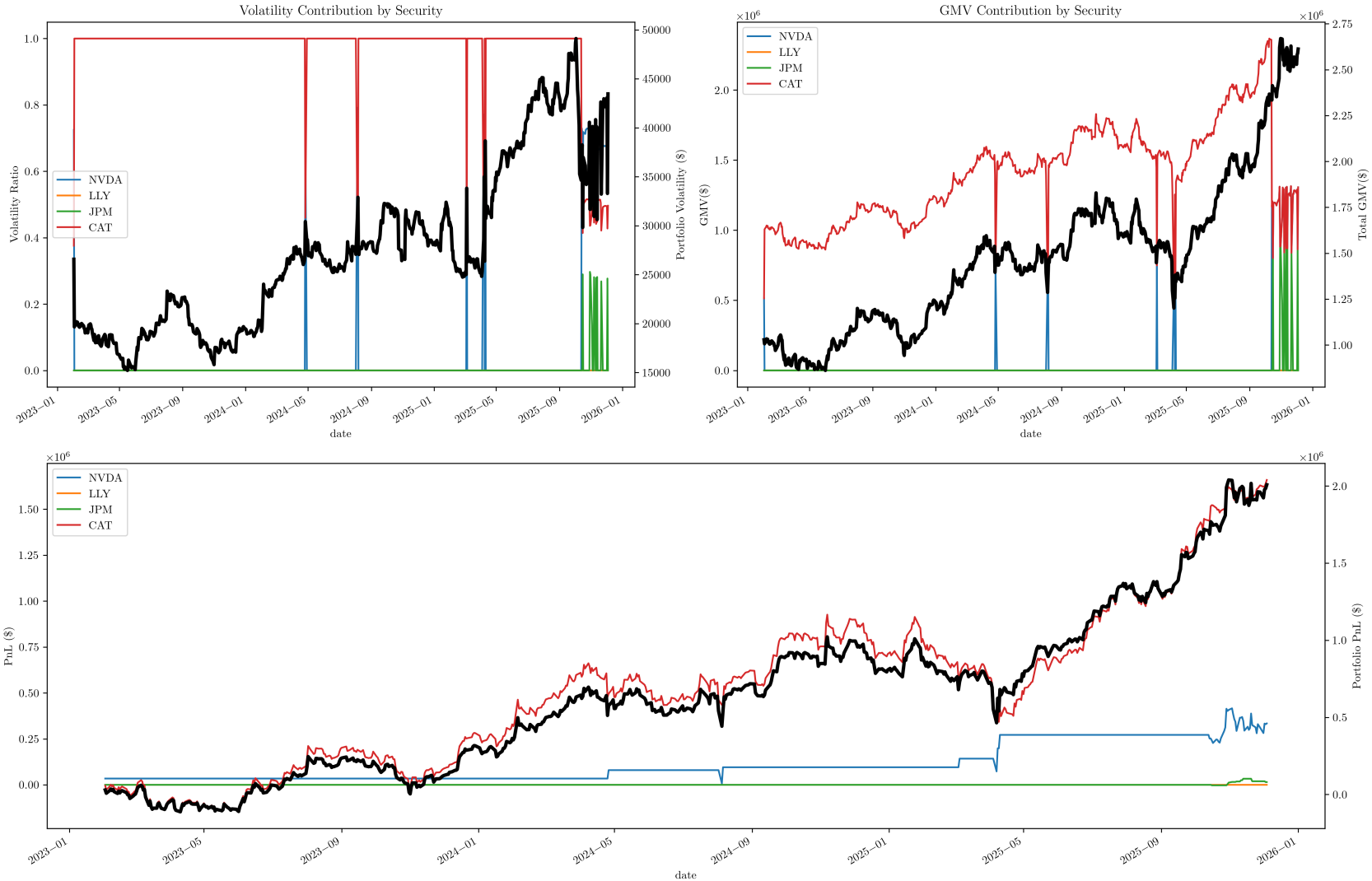
SAC Evaluation: Topline Statistics and Market-Adjusted Results



DDQN Evaluation: Per-Security Contribution



SAC Evaluation: Per-Security Contribution



Conclusion and Outlook

RL performs **profitably, but inconsistently**: inherent to the data, but also due to restrictions in approach

- **State space:** price predictions, technical indicators
- **Action space:** more granular weights, more/different assets
- **Model:** ensemble critics, attention-based networks

References

Gao, Z., Gao, Y., Hu, Y., Jiang, Z., and Su, J. (2020). Application of deep q-network in portfolio management.

Li, Y., Wu, Y., and Zhang, S. (2025). The exploratory multi-asset mean-variance portfolio selection using reinforcement learning.

Lim, Q. Y. E., Cao, Q., and Quek, C. (2022). Dynamic portfolio rebalancing through reinforcement learning. *Neural Computing and Applications*, 34:7125–7139.

Millea, A. (2021). Deep reinforcement learning for trading—a critical survey. *Data*, 6(11):119.