

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

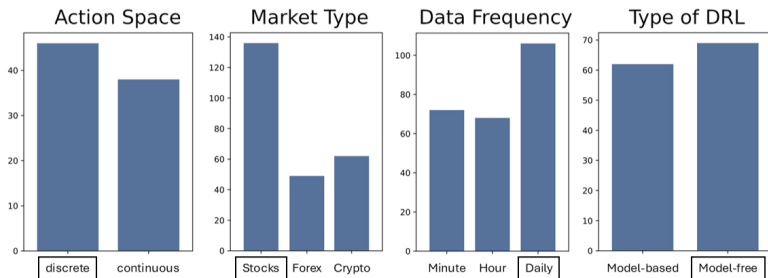
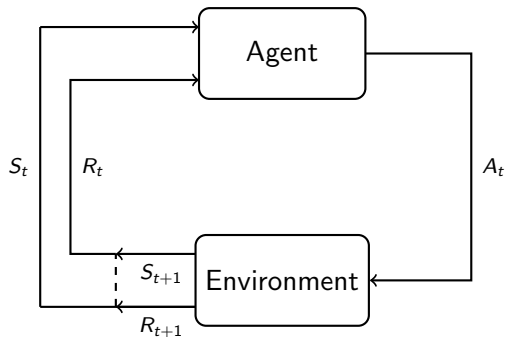


Figure 1: Existing literature on using Deep Reinforcement Learning in Trading. Minimally dapted from Millea (2021) for better readability.

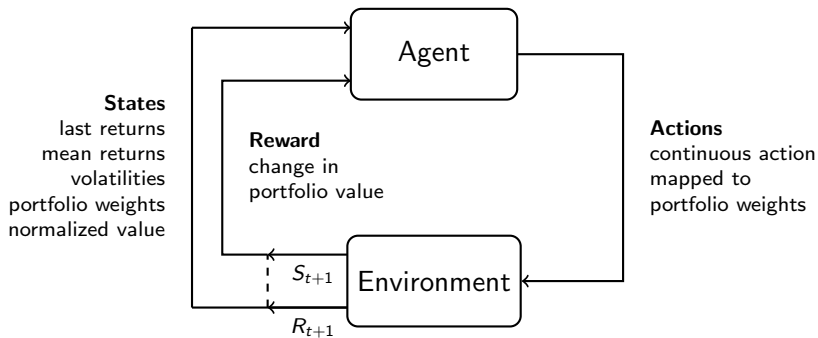
Wide variety of models, in particular:

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

Environment Diagram: General Case



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

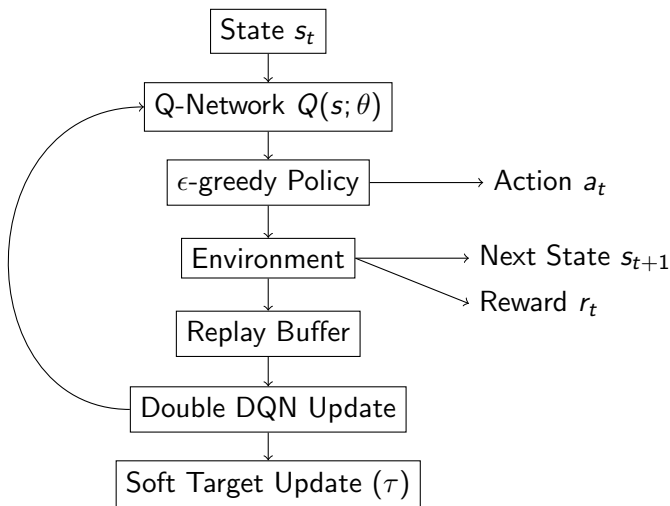
- ▶ **'AA'**: Alcoa Corporation (*aluminum producer*)
- ▶ **'ABT'**: Abbott Laboratories (*healthcare*)
- ▶ **'KGC'**: Kinross Gold Corporation (*gold mining*)
- ▶ **'KO'**: Coca-Cola Company (*beverage production*)

Choice of Assets: by sector

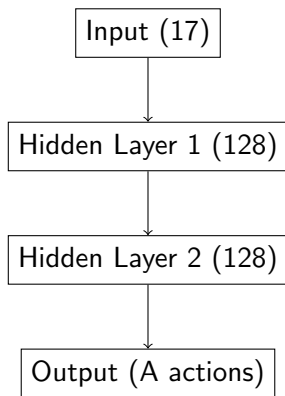
For each of the four biggest sectors on yahoo finance, choose stock with highest market-capitalization:

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

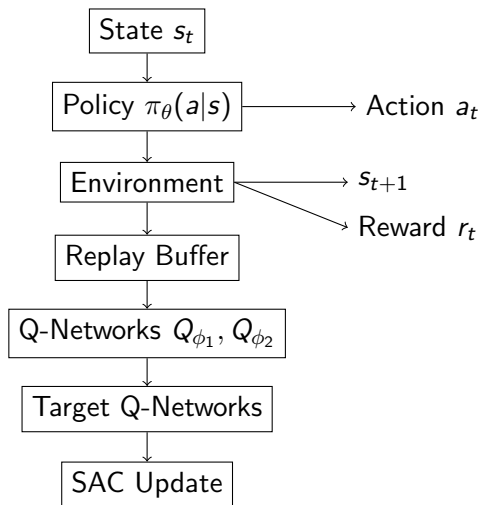
DDQN (see also Gao et al. (2020))



DDQN Model Architecture

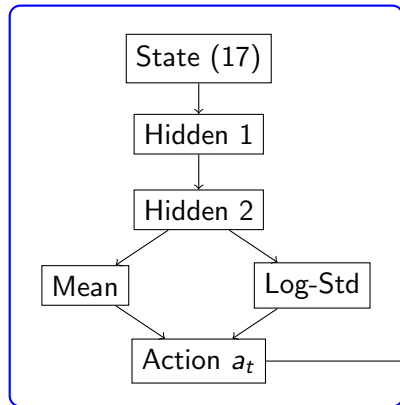


SAC Workflow

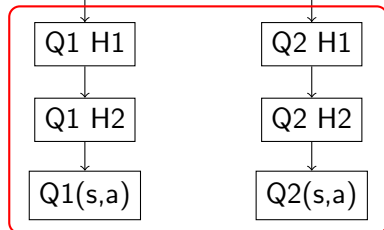


SAC Model Architecture

Actor (Policy)



State + Action



Critics (Twin Q-Networks)

Evaluation: Main results

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
- ▶ **Rewards:** transaction costs, risk penalties
- ▶ **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.