Evaluating Algorithmic Trading strategies

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Introduction and Context

The stock market is one of the most complex systems studied in the modern world. Now more than ever, **algorithms** control the major movements of the stock market, from ultra high-frequency trading strategies to determining the best long term positions to hold over months or years.

In this experimental project, we wanted to take a look for ourselves at how some basic trading algorithms that use different heuristics perform on real-world historical data.

Summary of our contributions

We built a **backtesting framework** in Python to test our trading algorithms on historical data. We used the `yfinance` Python API to gather interday data over 5 years.
We then conducted research and concretely implemented the actual trading algorithms (see pink section for more detail).

Our code repository can be found here:

Our backtesting script runs the algorithms on **38 selected stocks**, recording their final net worth and various metric performances, as well as showing the net value over each data point.

Literature Review

A recent paper by Treleavan, Galas and Lachland, "Algorithmic Trading Review"[1] provided us with concise AT research, clearly defining key concepts such as execution algorithms, market microstructure and latency. Building on this, we explored specific trading strategies and referenced Investopedia and other reputable online resources.

Algorithms Tested

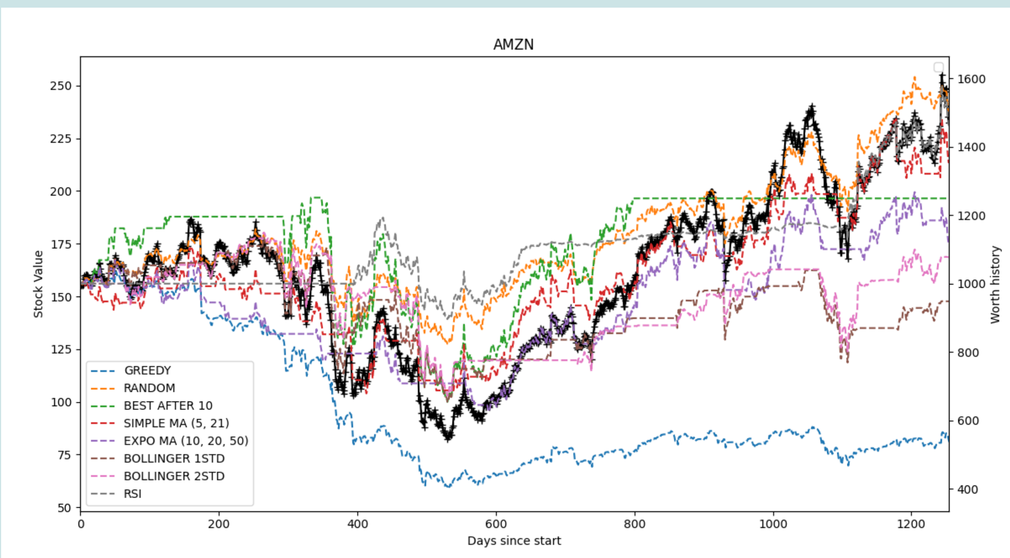
Our research led us to three different strategies that are used in the real world[2]:

- Mean Reversion, using Bollinger bands.
- Trend following, using exponential and simple moving averages.
- Momentum following, using RSI (Relative Strength Index).

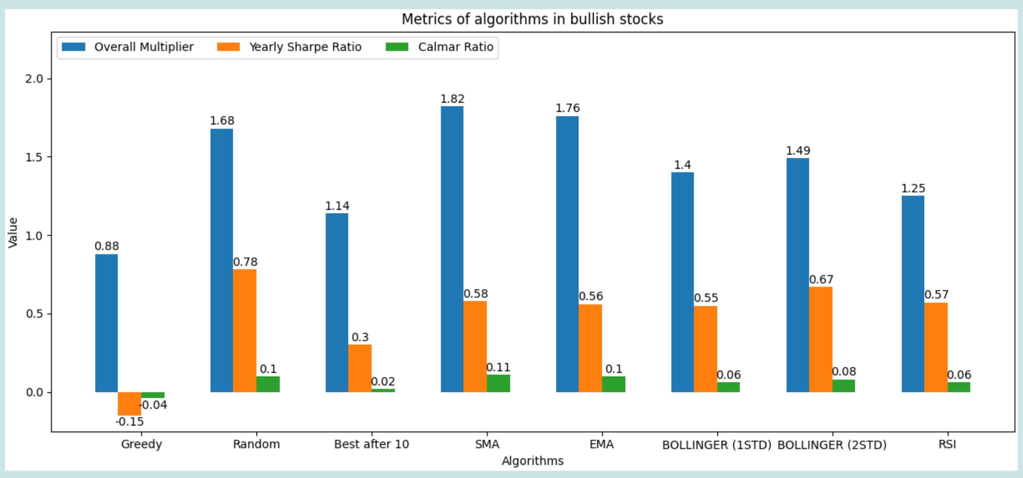
To compare against these algorithms, we built a handful of very basic "control" algorithms. This includes an algorithm that randomly decides to buy or sell at every step, and a greedy algorithm that only looked at the last price movement.
We also looked into a pre-trained **machine-learning** model using Proximal Policy Optimisation (PPO)[3], but unfortunately we had a few last-minute roadblocks getting this to work.

Graphs & Results

Bullish

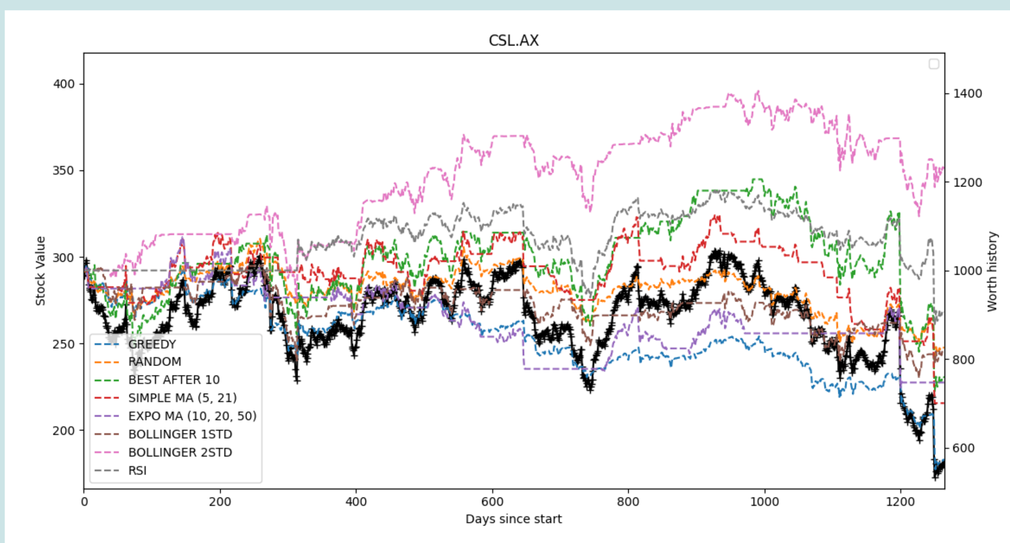


Sample performances of all algorithms on a bullish market (AMZN)

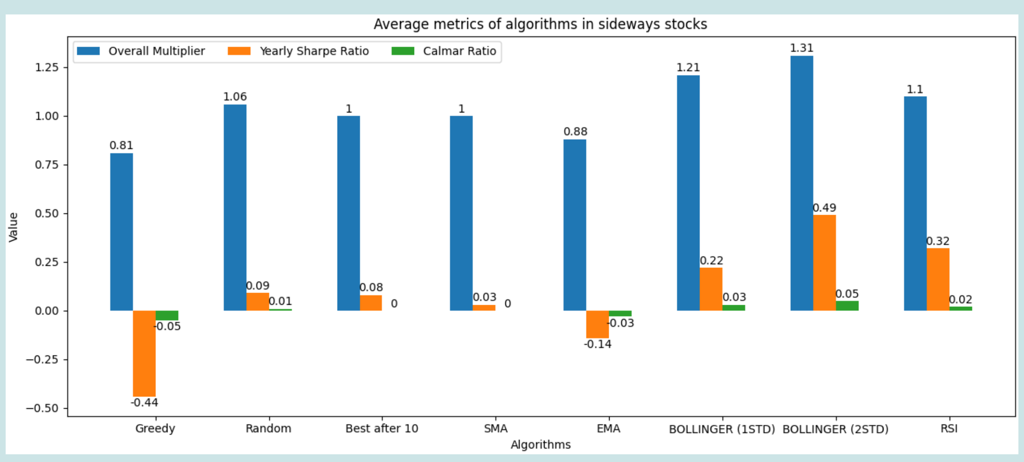


Moving average algorithms effective

Sideways

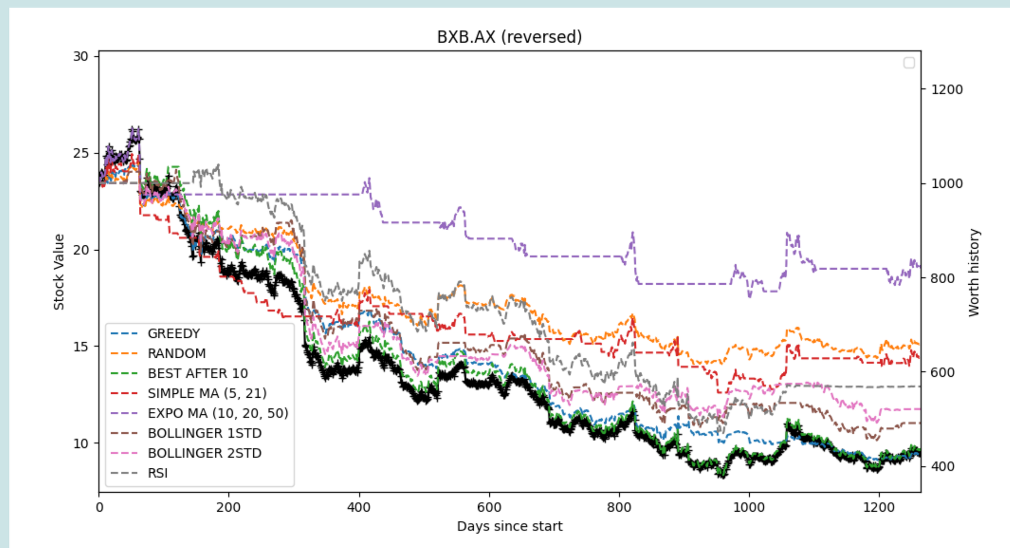


Sample performances of all algorithms on a sideways market (CSL.AX)

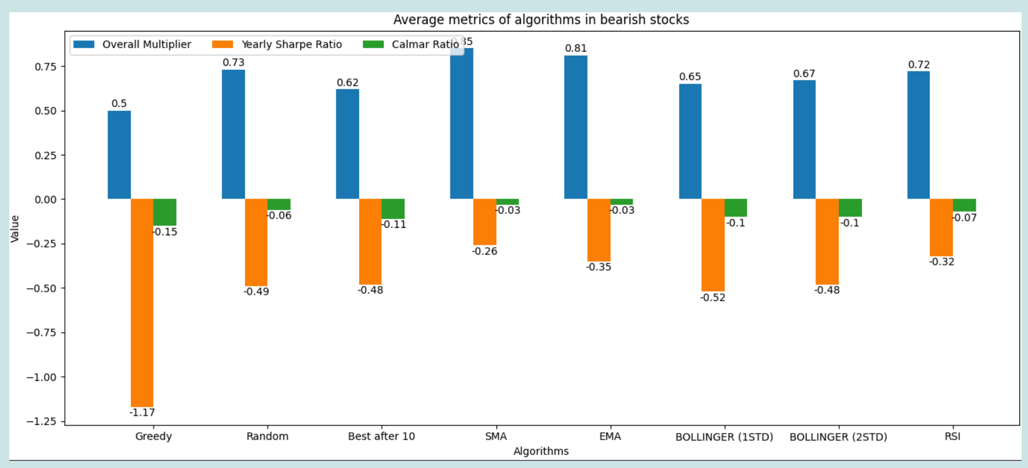


Mean reversal algorithms effective

Bearish



Sample performances of all algorithms on a bearish market (BXB.AX reversed)



All algorithms struggle in falling markets

Discussion & Analysis

As can be seen from the results, the performance of the tested algorithms are heavily based on the type of stock being tested against. Furthermore, they fail to significantly outdo the control algorithms, indicating that increases are due to a increase in market value in general, and not due to intelligent decisions on the algorithm's part. A notable exception are the mean reversion based algorithms, which seem to hold their own even in sideways markets. This could be related to these algorithms' time complexity of $\mathbf{O(m)}$ for window size $\mathbf{m}$, whereas the other algorithms tested were constant time, suggesting a time vs quality trade-off.

Conclusions

The algorithms we researched were able to beat the controls in specific markets. However, they were unable to well outperform *random* trading every time, nor could they prevent significant loss in bearish markets.

We found that objective trading algorithms need more elusive techniques such as machine learning to function well. Otherwise, external knowledge such as market conditions and multi-stock analysis are necessary to make informed decisions on trading.

References

1. Treleaven, P., Galas, M., & Lalchand, V. (2013). Algorithmic Trading Review. Communications of the ACM, 56, 76–85. `https://doi.org/10.1145/2500117`
2. Seth, S. (2025, August). Basics of Algorithmic Trading: Concepts and examples. Investopedia. `https://www.investopedia.com/articles/active-trading/101014/basics-algorithmic-trading-concepts-and-examples.asp`
3. Adilbai. (2025). Stock Trading RL Agent using PPO. `https://huggingface.co/Adilbai/stock-trading-rl-20250704-171446`