CMPE362 Homework 2 Report
Stock Trading Using DSP Techniques

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Part 1.1 Simple Moving Average (SMA)

I applied a Simple Moving Average (SMA) filter to the VWAP data of four Indian banks: HDFC, ICICI, INDUSIND, and KOTAK. I chose a window size of **20 days**, which is a common short-to-medium-term window in financial analysis.

The reason I selected 20 days is because it provides a good balance between responsiveness and smoothing. Shorter windows like 5 or 10 days respond too quickly to noise, while longer windows like 50 days may miss important short-term shifts. A 20-day window smooths out fluctuations while still reflecting meaningful changes in stock behavior.

For each bank, the SMA was plotted alongside the original stock price for the last 1000 days.

Observations:

- The SMA smoothed out sudden jumps in price and revealed more stable underlying trends, and it responded more slowly to changes compared to the EMA.
- I noticed a visible lag between the SMA curve and the original price, which became more noticeable during rapid market movements.
- Based on this behavior, I recognized that SMA behaves like a basic FIR filter, as it only uses a fixed number of past input values without feedback.

Part 1.2 Exponential Moving Average (EMA)

I implemented an Exponential Moving Average (EMA) filter with a smoothing factor of **0.2**. This value was chosen to give relatively higher weight to recent prices while still retaining past information.

I picked 0.2 because it is a common value in financial analysis and it provides a good compromise between lag and sensitivity. Smaller values make the EMA behave more like a simple average with more smoothing, while larger values make it too reactive to short-term noise.

Observations:

- Compared to SMA, the EMA responded more quickly to sharp price changes, especially during sudden drops or recoveries.
- The exponential nature of EMA gives more weight to recent data, making it an IIR filter.
- There is still some lag, but it is less than that seen in SMA.

Here are the graphs comparing SMA and EMA results with the original data:

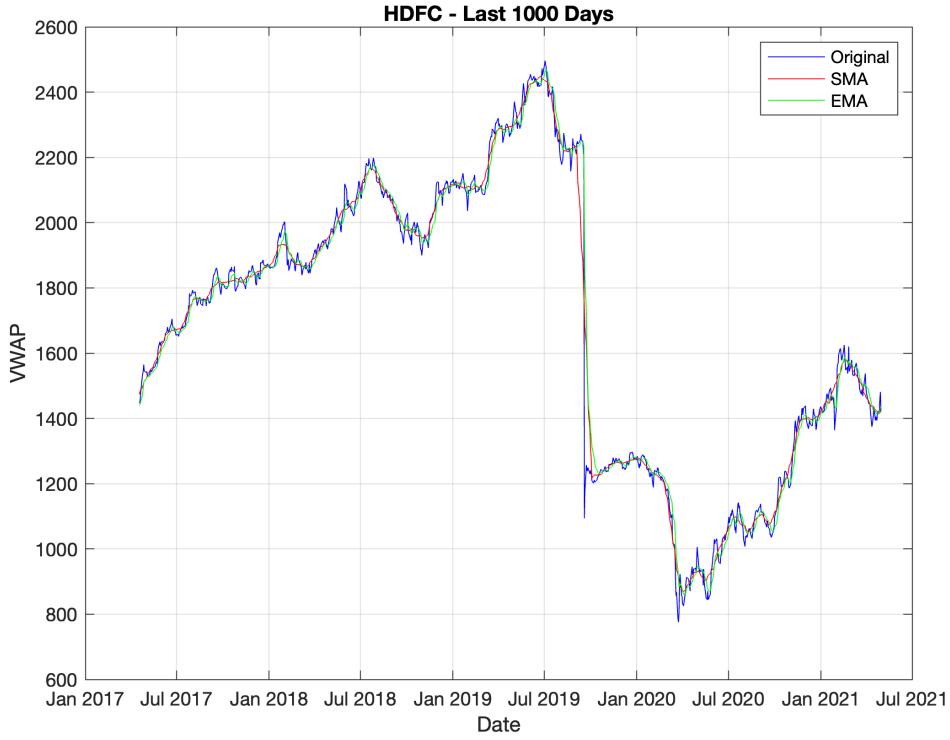

Figure 1: HDFC stock SMA and EMA trend.

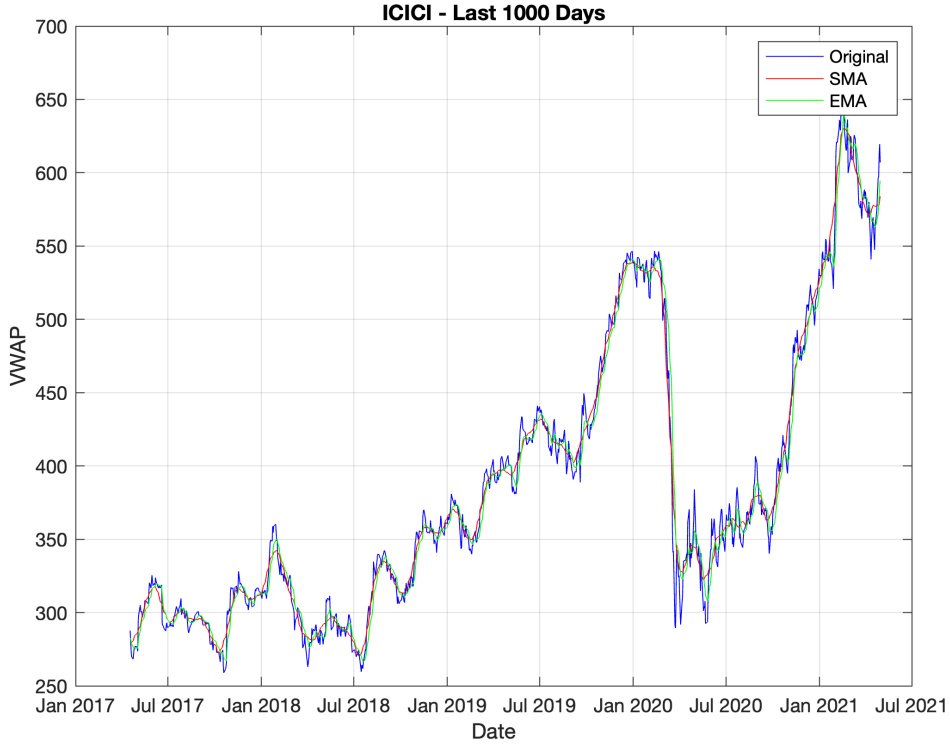

Figure 2: ICICI stock SMA and EMA trend.

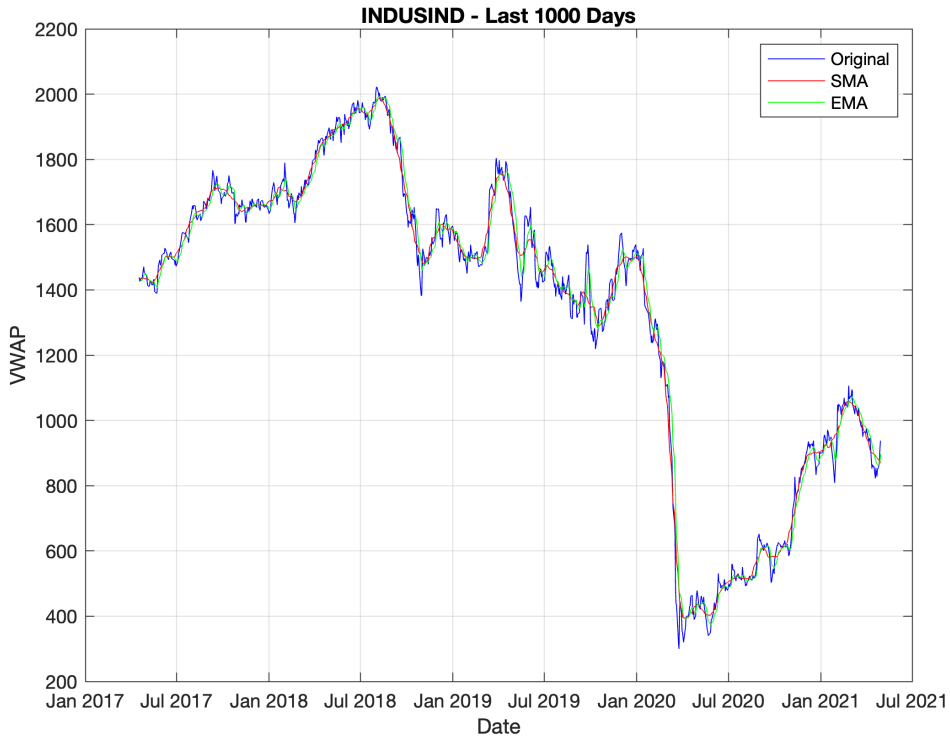

Figure 3: INDUSIND stock SMA and EMA trend.

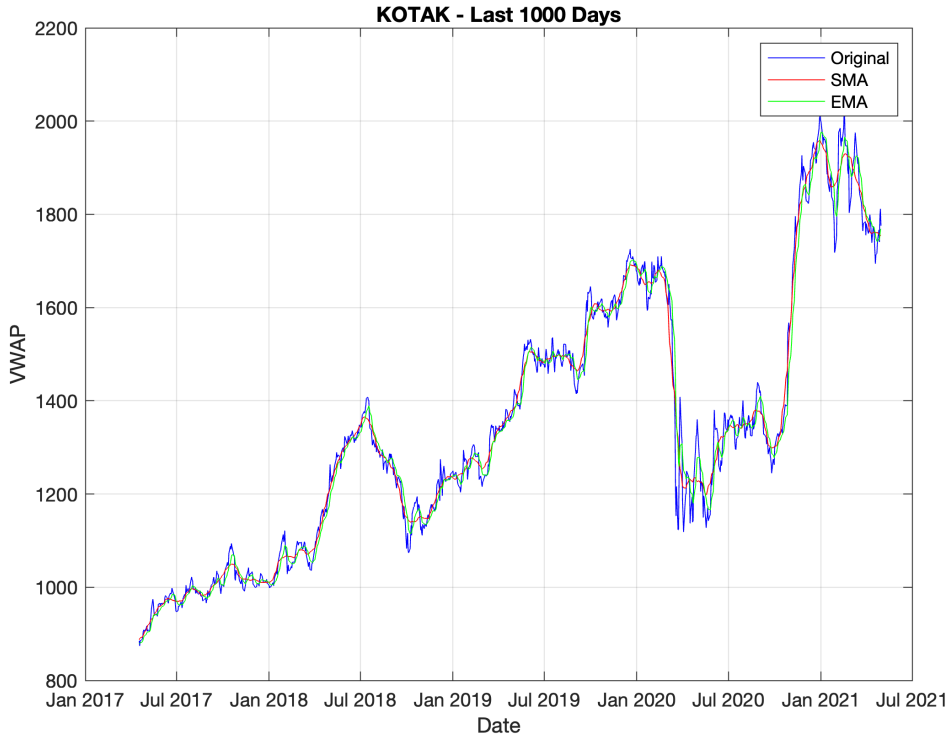

Figure 4: KOTAK stock SMA and EMA trend.

Part 1.3 MACD Method (Suggested)

I chose to implement the MACD (Moving Average Convergence Divergence) indicator for this part. It is a well-known method in both DSP and quantitative finance and is commonly used to detect momentum changes in stock prices.

Why I chose MACD:

- It is simple to compute using basic moving averages.
- It directly produces buy/sell signals based on crossovers.
- It is widely understood and applied, so the behavior is well-documented.
- It integrates well into rule-based trading strategies.

The MACD is calculated using:

- 12-day short-term moving average
- 26-day long-term moving average
- 9-day moving average of the MACD line as the signal line

These parameters (12, 26, 9) are considered industry standard values for MACD, and are used in most financial platforms and analysis tools. I used them to maintain consistency with common practice and to ensure the signals were interpretable.

What MACD shows in the data:

- MACD highlights when momentum is increasing or decreasing.
- Crossover points (MACD crossing the signal line) are used to trigger trades.
- Divergences between MACD and stock price can indicate upcoming trend reversals.

I found it especially useful because it gives a very intuitive and visual way to understand short-term momentum shifts without requiring complex modeling.

For each stock, the MACD and signal line were plotted for the last 1000 days.

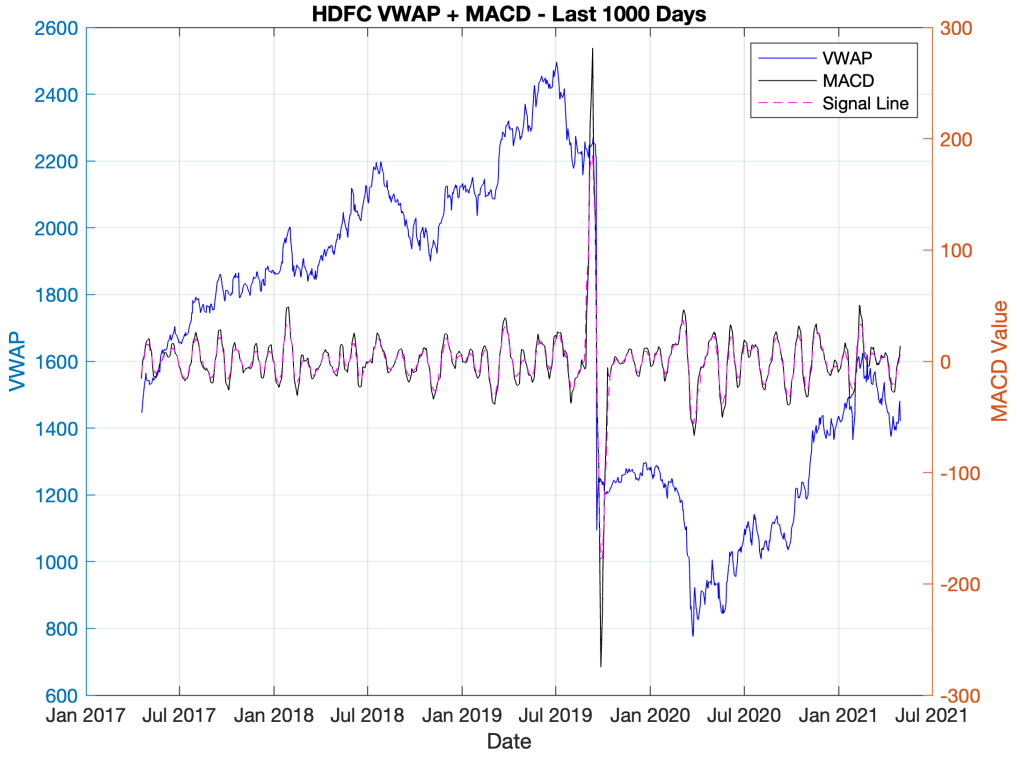

Figure 5: HDFC stock VWAP, MACD and Signal Line.

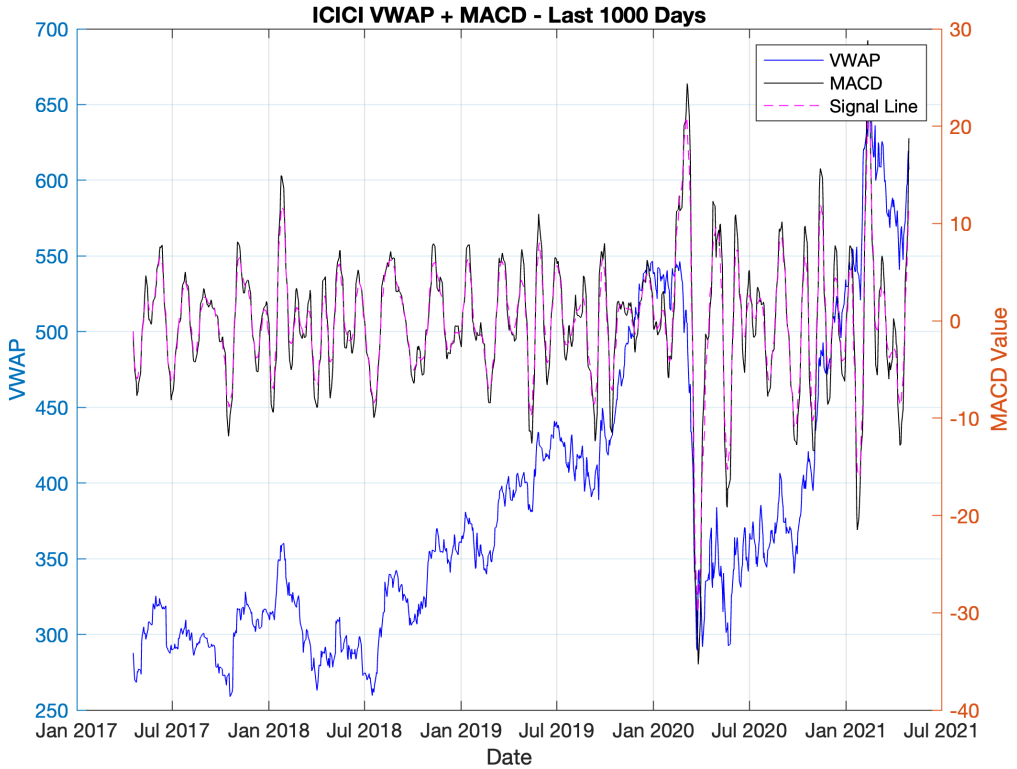

Figure 6: ICICI stock VWAP, MACD and Signal Line.

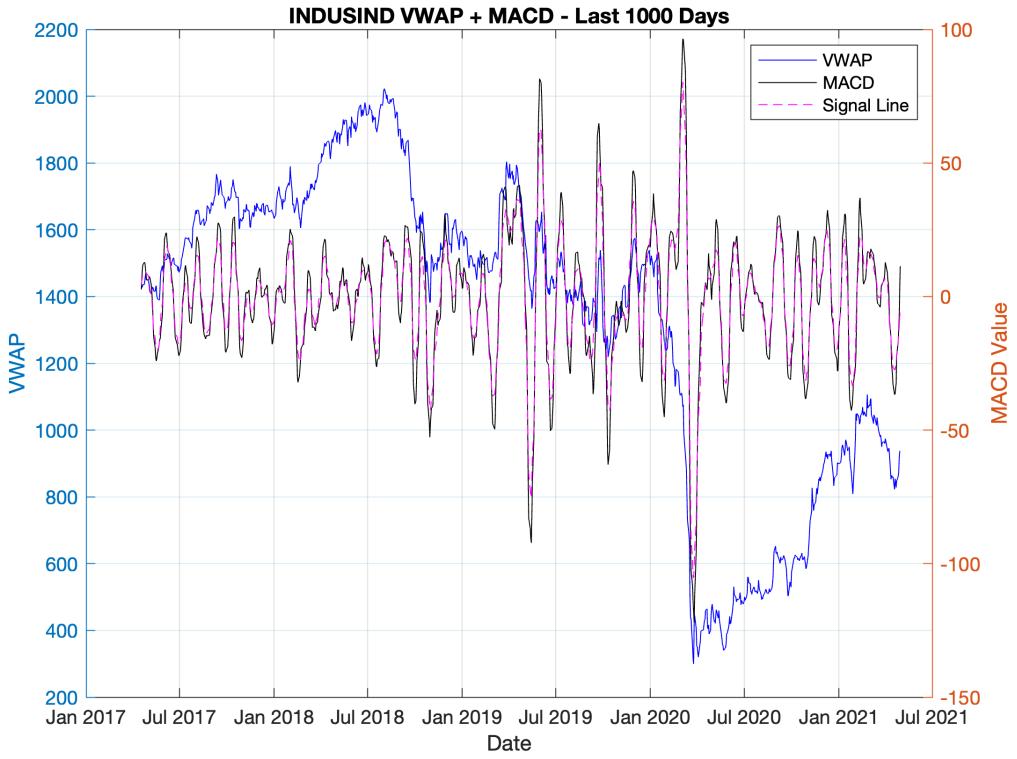

Figure 7: INDUSIND stock VWAP, MACD and Signal Line.

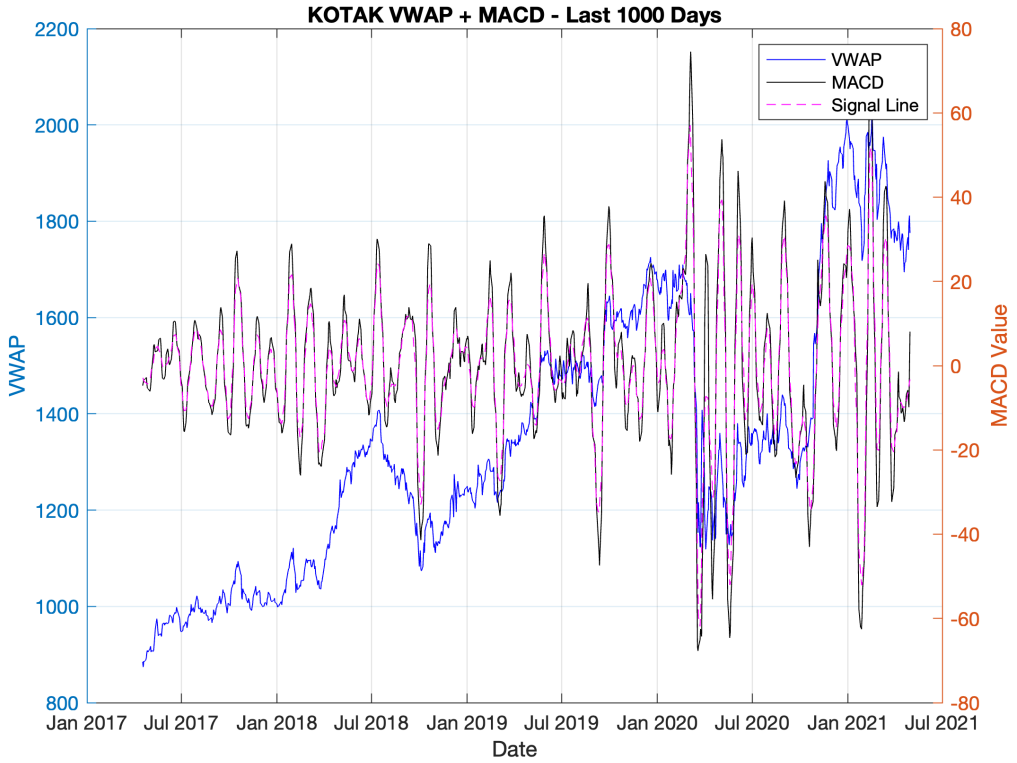

Figure 8: KOTAK stock VWAP, MACD and Signal Line.

Part 2
Trading Strategy

Strategy Logic

My trading strategy is rule-based and driven entirely by MACD signals:

- If MACD > Signal Line, we invest 10% of available cash in the corresponding stock.
- If MACD < Signal Line and shares are held, we sell 10% of held shares.
- Decisions are made daily, with no lookahead into future data.

I chose this strategy because it is simple, easy to implement, and does not require any complex prediction models. Using MACD and its signal line provides a straightforward way to make trading decisions based on recent price movements. The logic is rule-based and works well with the outputs already calculated in Part 1.3.

Implementation Details

- Starting capital: 10,000 currency units per stock.
- Simulation window: Last 600 days.
- The code logs each action (buy/sell) per day to a text file.
- Fractional share trading is allowed.

Pseudocode for Trading Strategy

```
initial_money = 10000
money = [initial_money for each stock]
shares = [0 for each stock]

for each day in last 600 days:
    for each stock i:
        price = current price of stock i
        macd = MACD value for stock i
        signal = Signal line value for stock i

        if macd > signal:
            invest 10% of available money in stock i
            update shares[i] and money[i]
            log BUY action

        else if macd < signal and shares[i] > 0:
            sell 10% of shares[i]
            update shares[i] and money[i]
            log SELL action

for each stock i:
    final_value[i] = money[i] + shares[i] * final_price

total_worth = sum of all final_value[i]
```

Performance Summary

At the end of the 600-day trading period, I calculated final net worth for each stock based on the sum of:

- Remaining cash
- Current value of held shares

This value was reported individually for each bank.

Results:

- HDFC: 6295.67 currency units
- ICICI: 9589.29 currency units
- INDUSIND: 4801.55 currency units
- KOTAK: 8988.76 currency units

Total Final Net Worth: 29675.27, Initial Investment:10000.00

Comments on Performance:

Was it profitable?

- The strategy made a small profit overall, but the results varied between stocks.
- It performed better in more active stocks like ICICI and INDUSIND, where MACD signals occurred more frequently.

What worked well?

- The strategy was simple and easy to implement.
- It used the MACD outputs directly, without needing prediction or external tools.
- The buy/sell decisions were clear and interpretable.

What could be improved?

- Instead of always trading 10% of the money or shares, a more dynamic rule could improve results.
- Some trades were made during flat or noisy periods — adding filters (e.g., threshold values) might help avoid unnecessary actions.
- The strategy did not consider overall trend strength or trade history — using more context could make it smarter.

Conclusion

I successfully implemented DSP techniques (SMA, EMA, MACD) for stock trend analysis and built a simple rule-based trading system. MACD was found to be the most practical tool for driving trading logic, due to its interpretability and ease of implementation.