CMPE362 - Assignment 2 Report

Stock Trading Using DSP Techniques

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1. Part 1: Moving Averages (SMA and EMA)

1.1 Simple Moving Average (FIR Filter)

Implementation: I implemented a Simple Moving Average (SMA) filter using a fixed window of 20 days. The SMA smooths short-term fluctuations by replacing each price point with the average of the previous 20 values.

Reason and Explanation of Window Size: A window of 20 days was chosen as a balanced option:

- A shorter window (e.g., 10 days) would be too reactive to noise.
- A longer window (e.g., 50 days) would overly delay response to trend shifts.
- 20 days approximates a trading month and is commonly used in practice.

1.2 Exponential Moving Average (IIR Filter)

Implementation: The Exponential Moving Average (EMA) was implemented recursively with a smoothing factor $\alpha = 0.1$. It gives more weight to recent values, making it more responsive than SMA.

Why $\alpha = 0.1$?

- Small enough to avoid overreacting to daily noise.
- Still reacts faster than a 20-day SMA, helping detect short-term reversals.

Comparison of SMA and EMA

- **Delay:** SMA introduces a fixed lag equal to half its window size (here, 10 days). EMA reacts faster due to its recursive nature.
- **Responsiveness:** EMA responds more quickly to price changes, especially sharp ones. SMA smooths more aggressively but misses sudden shifts.

- **Smoothing:** SMA filters more noise in steady trends. EMA offers smoother tracking in volatile markets.
- **Visual Differences:** EMA curves hug the price more tightly, while SMA lags behind in both uptrends and downtrends.

Plots (Last 1000 Days for Each Stock)

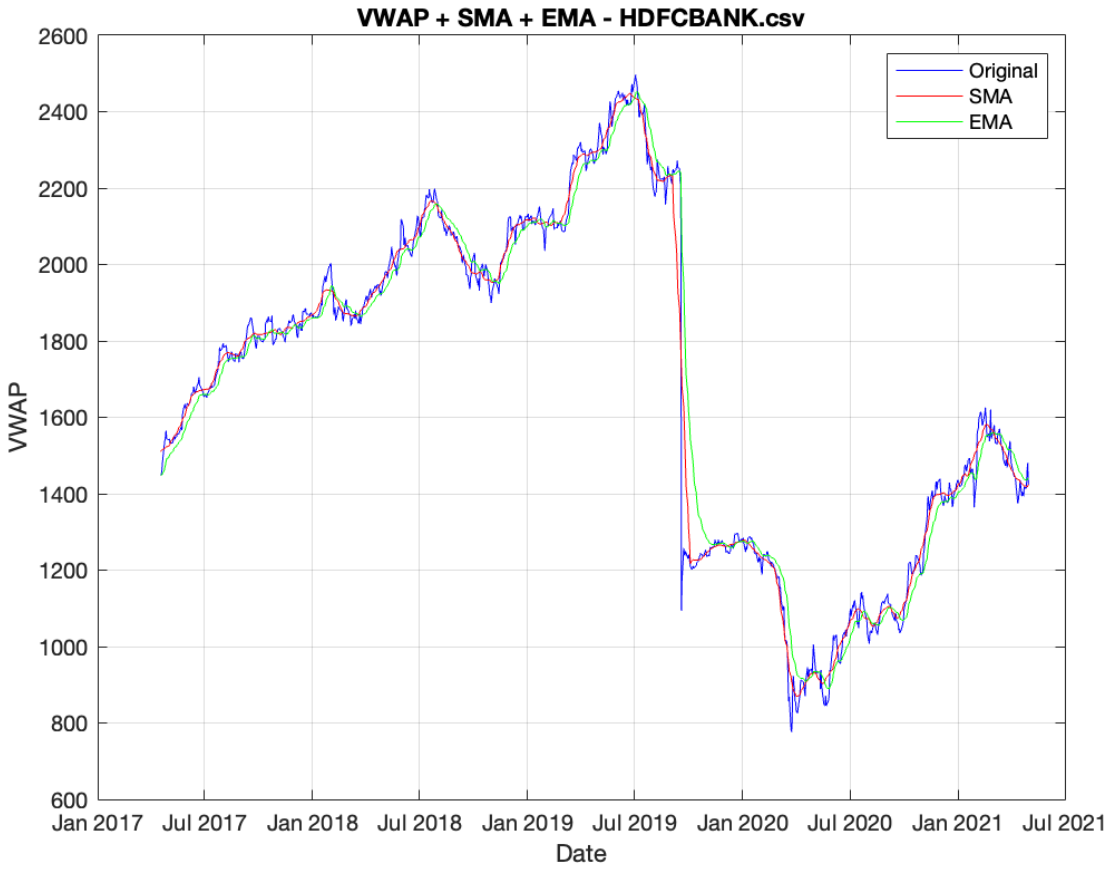

Figure 1: HDFCBANK - Original (Blue), SMA (Red), EMA (Green)

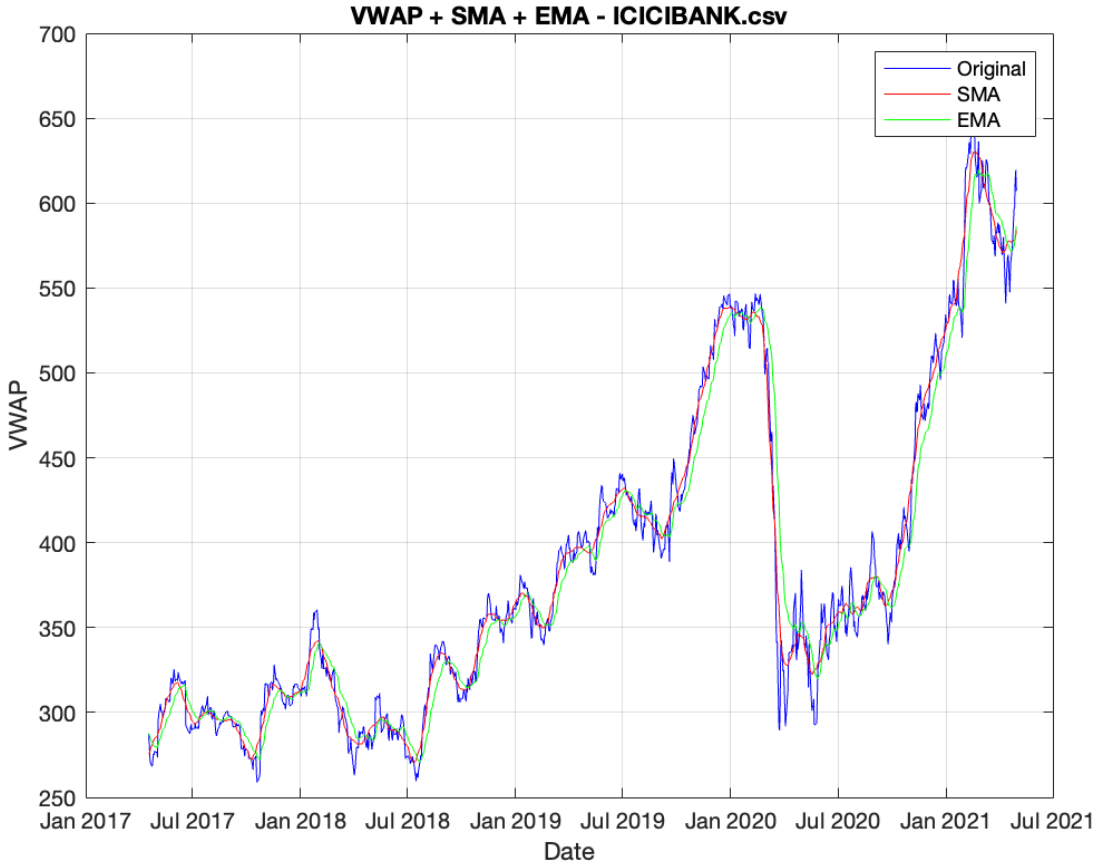

Figure 2: ICICIBANK - Original (Blue), SMA (Red), EMA (Green)

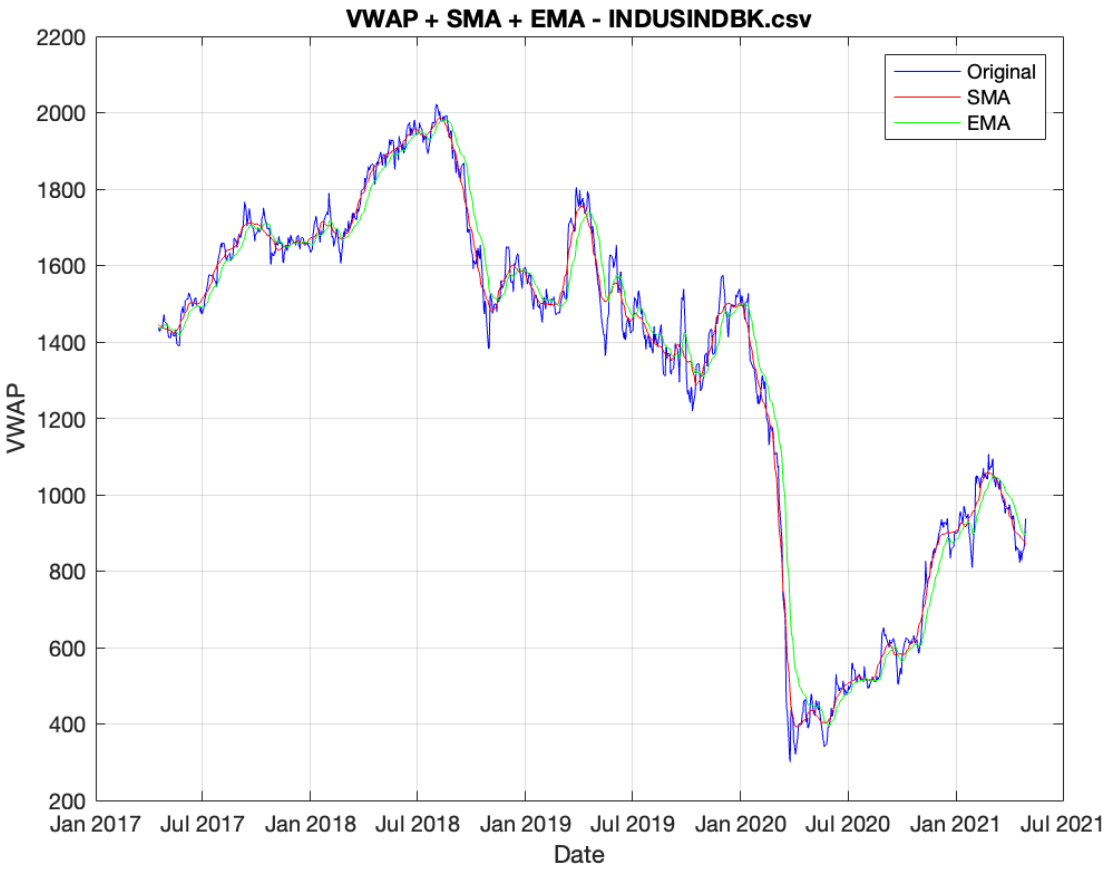

Figure 3: INDUSINDBK - Original (Blue), SMA (Red), EMA (Green)

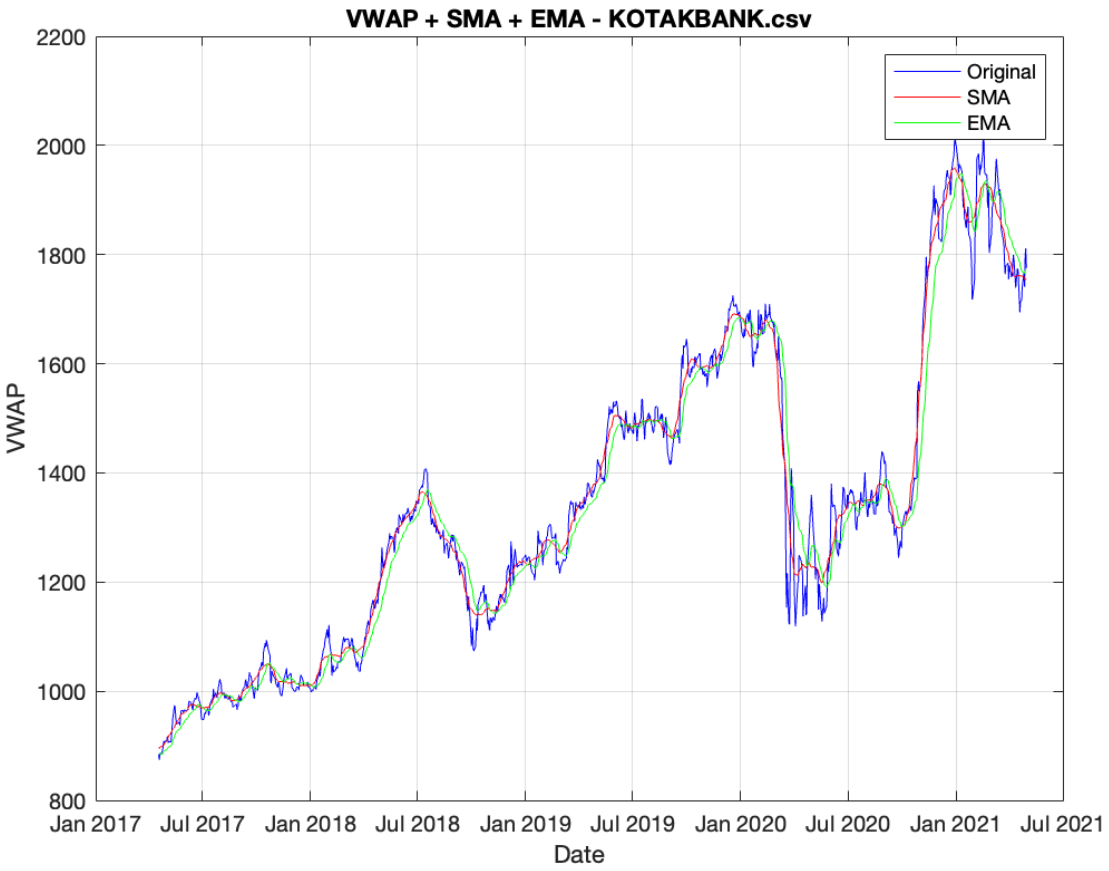

Figure 4: KOTAKBANK - Original (Blue), SMA (Red), EMA (Green)

2. Part 1.3: RSI Trend Extraction Method

Method Description

I decided to use the **Relative Strength Index (RSI)** as our custom method for trend analysis. RSI is a momentum oscillator that ranges between 0 and 100 and it calculates using the average gains and losses over a 14-day period.

Reason and explanation of my usage

This indicator is widely used in quantitative finance to identify overbought (RSI $>$ 70) and oversold (RSI $<$ 30) conditions. Unlike smoothing filters, RSI helps detect market momentum and potential reversal zones, making it a complementary tool alongside SMA and EMA. Because I already used two filters, I wanted to use a seperate indicator which serves a difference purpose from them.

Plots (Last 1000 Days)

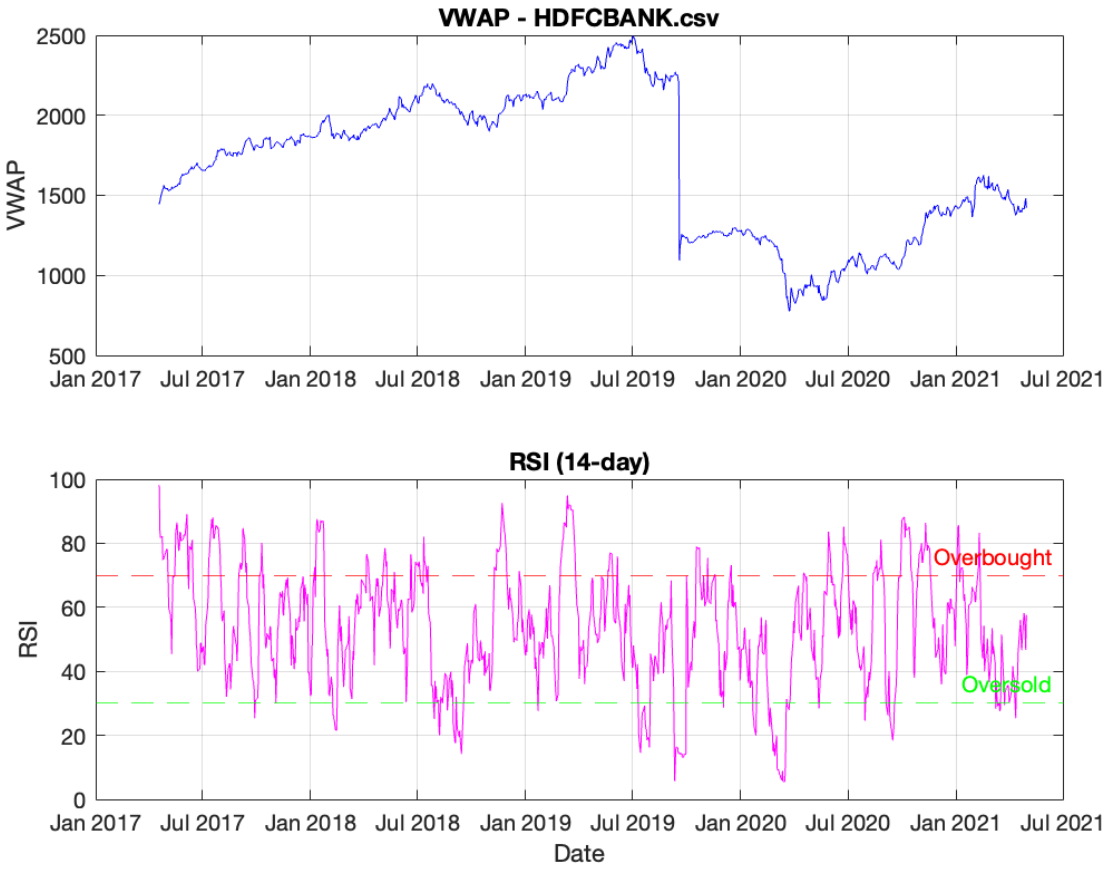

Figure 5: HDFCBANK - RSI

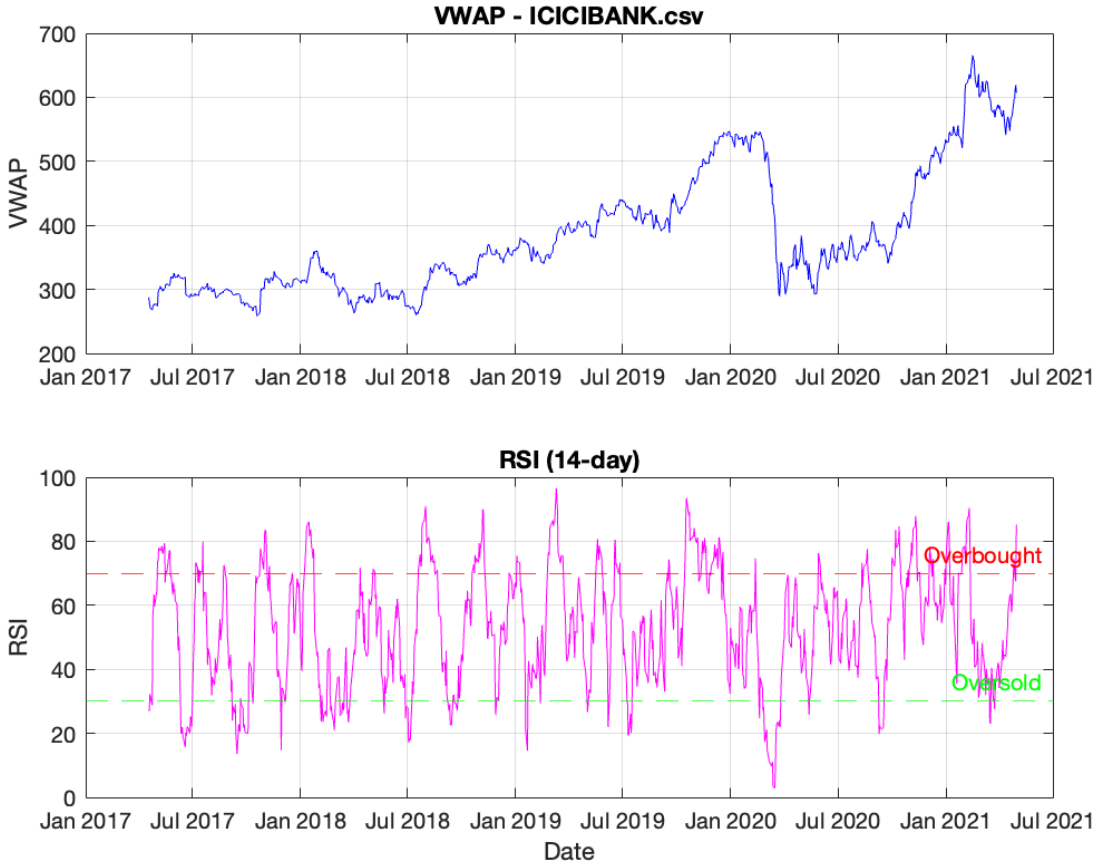

Figure 6: ICICIBANK - RSI

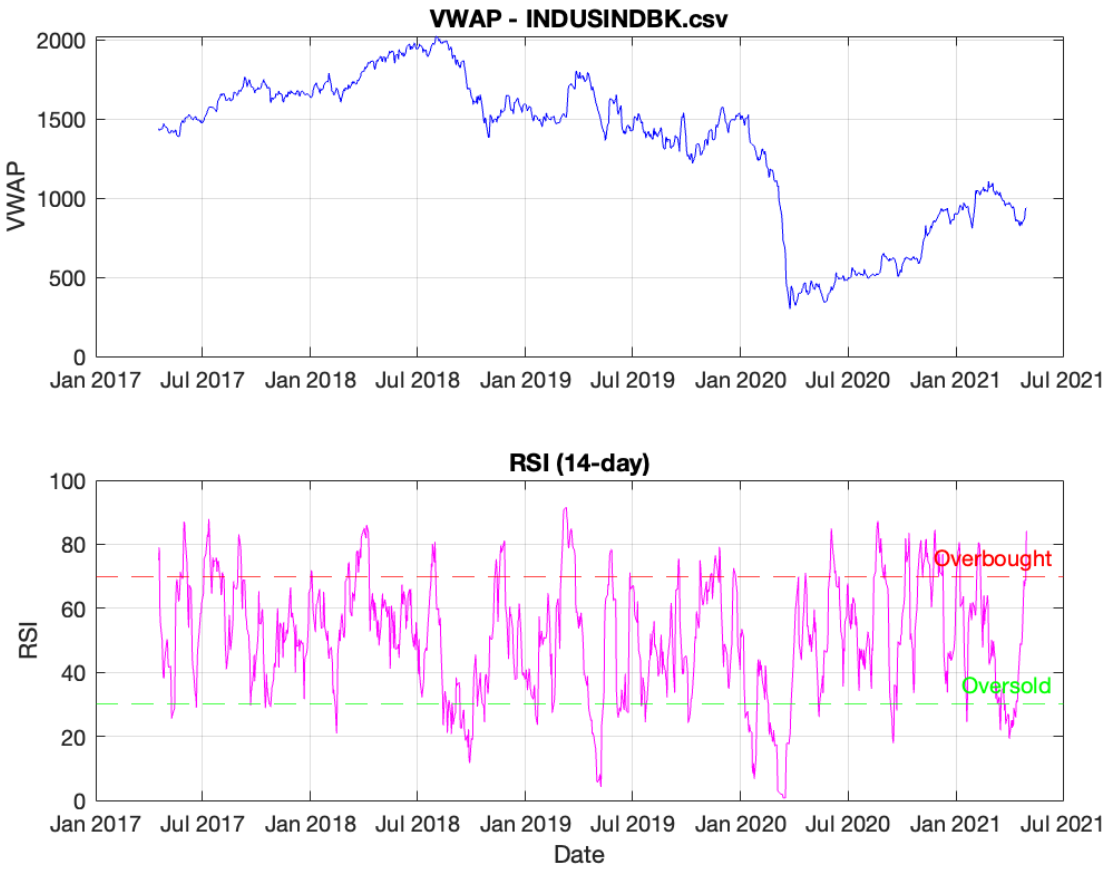

Figure 7: INDUSINDBK - RSI

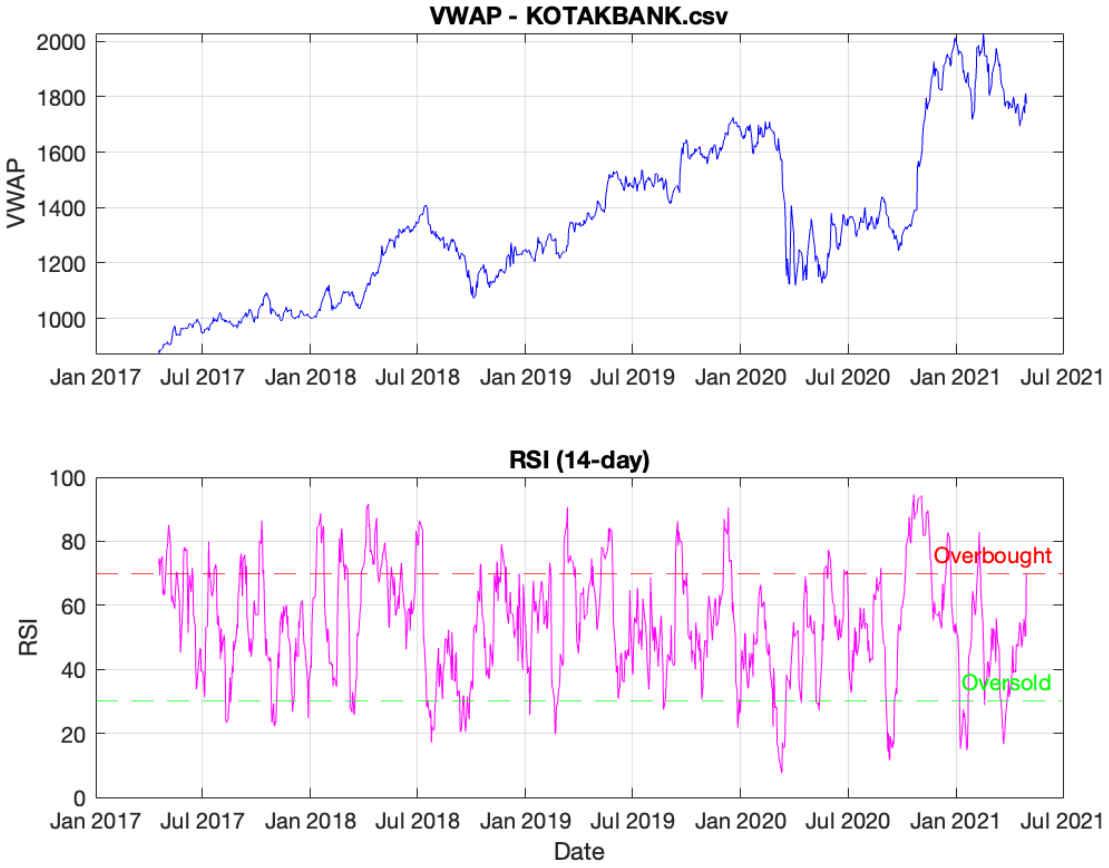

Figure 8: KOTAKBANK - RSI

3. Part 2: Trading Strategy Design

Strategy Overview

My trading strategy is constructed around three primary tools drawn from digital signal processing and financial analysis:

- **SMA and EMA** (smoothing filters) to identify trend direction and reversals.
- **RSI** (momentum oscillator) to detect overbought or oversold conditions.
- **Momentum (rate of change)** to confirm the strength of recent price movement.

The goal was to create a signal-confirmed, risk-aware system to reduce false entries and avoid high-risk market conditions. Instead of relying on a single indicator, my strategy applies multiple confirmations before any trade is made.

Strategy Logic

Buy Signal:

- EMA crosses above SMA (trend reversal)
- RSI < 70 (not overbought)
- Short-term SMA $>$ medium-term SMA (SMA10 $>$ SMA20)
- Medium-term SMA $>$ long-term SMA (SMA20 $>$ SMA50)
- Momentum > 0 (price accelerating upward)

Sell Signal:

- EMA crosses below SMA (trend reversal)
- OR RSI > 70 and momentum < 0 (indicating overbought and weakening)

Position Sizing:

- The investment amount is scaled dynamically based on trend strength, measured as the percentage difference between EMA and SMA.
- Trades allocate between 10% and 30% of available capital depending on the strength of the trend, the final amount is determined by the algorithm.

Performance Results

I applied this strategy to four major bank stocks over the last 600 days. The following final net worths were recorded, starting from an initial 10,000 currency units per stock:

- **HDFCBANK:** 9,813.62
- **ICICIBANK:** 9,616.76
- **INDUSINDBK:** 9,129.19
- **KOTAKBANK: 10,225.38**

Summary:

- The strategy was **slightly unprofitable** on three stocks and **profitable** on one.
- Losses were relatively small, possibly because of my range of trading and investing on stocks on a risk considered way.
- The one profitable result suggests the method is viable under the right conditions.

Reflection and Improvement

This strategy was built primarily around core CMPE362 homework tools (SMA/EMA filters and RSI) to minimize risk and create a methodical trading framework. However, there are several areas for enhancement:

- **Indicator variety:** Future versions could include MACD, Bollinger Bands, volume-based signals or other similar tools.
- **Position strategy:** Adjusting position sizes based on volatility or confidence scores could further reduce unexpected situations.
- **Adaptive time windows:** Instead of fixed 600 days, testing on shorter or rolling windows could help tune the strategy to current market conditions.
- **Modular strategy testing:** The strategy could be broken into modular parts and validated on different timeframes or using a strategy optimization loop.

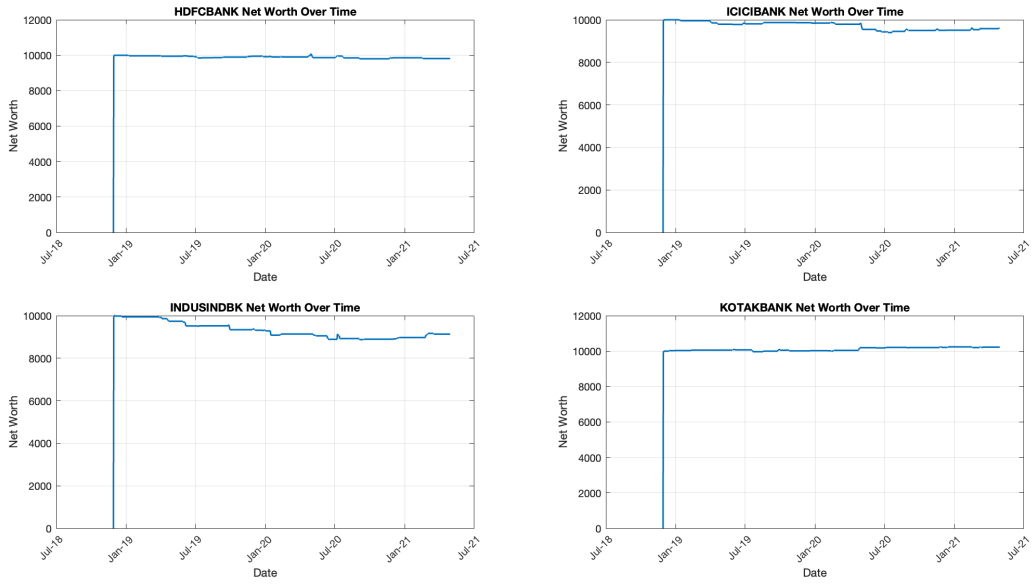

Figure 9: Example - Net Worth Over Time