

# CMPE362 Homework 2

## Stock Trading Using DSP Techniques

### Overview

In this homework, you will assume the role of a quant developer tasked with designing a simple stock trading algorithm. You will use **MATLAB** to analyze historical stock price data and implement **Digital Signal Processing (DSP)** techniques to extract meaningful trends. These trends will then inform a basic trading strategy.

You are provided with daily stock price data (use VWAP column) for four Indian banks, covering the period from **January 1, 2000 to April 30, 2021**. The data is provided in four separate CSV files.

Note that you are allowed to pre-process this data to be better imported into MATLAB environment if you choose (as long as you do not alter the values).

### Part 1: Signal Processing for Trend Extraction (60 Points)

Your goal in this part is to use signal processing tools to uncover underlying patterns in the stock data.

#### 1.1 Simple Moving Average (FIR Filter) – 18 Points

- Implement a **Simple Moving Average (SMA)** filter.
- Choose and justify a window size (e.g., 10, 20, or 50 days).
- Apply the filter to each of the four stock series.
- Plot the SMA with the original data (see Report section).
- Comment on delays and smoothing effects.

#### 1.2 Exponential Moving Average (IIR Filter) – 18 Points

- Implement an **Exponential Moving Average (EMA)** filter.
- Choose and justify a smoothing factor ( $\alpha$ ).
- Compare responsiveness to the SMA.
- Plot and analyze outputs.

#### 1.3 Your Suggested Method – 24 Points

Propose and implement a method of your choice. It must belong to DSP or quantitative finance, and it should help uncover trends or trading signals. Some suggestions:

- Frequency-based methods (e.g., STFT, wavelets)

- Band-pass filters for volatility detection
- MACD, RSI, or Kalman filters
- FIR/IIR designs with dynamic windows
- Energy or zero-crossing analysis

You must explain the method and:

- Discuss your reasoning if you designed it.
- If it's a known method, explain why it's suitable.
- Plot the output of your method for the last 1000 days of each stock.

## Part 2: Trading Strategy Design (20 Points)

Using the information obtained from Part 1, develop a basic **algorithmic trading strategy**.

### Instructions

- Apply your strategy to the **last 600 days** of data for each stock.
- Start with **10,000 currency units**.
- You may **buy/sell fractional shares**.
- Simulate day-by-day decisions with **no lookahead**.

### Output

- A text file logging actions, e.g.,  
  
Day 1: BUY 500 currency of Stock A  
Day 3: SELL 250 currency of Stock A

- A report of your **final net worth**.
- Commentary on strategy logic and performance.

*Note:* Profitability is not required (you will not be graded based on the performance of your strategy). What matters is a clear, data-driven strategy using outputs from Part 1.

## Report Guidelines (20 Points)

Prepare a comprehensive report including the following:

## Part 1.1 & 1.2 – Moving Averages

For each stock:

- Create one plot showing:
  - Original stock price – Blue
  - Simple Moving Average – Red
  - Exponential Moving Average – Green
- Use the last **1000 days** only.
- Include brief discussion on:
  - Differences between SMA and EMA
  - Observed delays, smoothing, or trends

## Part 1.3 – Your Method

- Describe and explain your chosen method.
- Include rationale (designed or literature-based).
- Provide visualizations (last 1000 days for all banks).

## Part 2 – Trading Strategy

- Describe your trading logic in plain English or pseudocode.
- Explain how Part 1 outputs are used to make decisions.
- Optional: include diagrams or flowcharts.
- Comment on performance:
  - Was it profitable?
  - What worked well?
  - What could be improved?

## Submission Checklist

- MATLAB code for calculations, plotting, strategy (well-commented). You can submit multiple .m files.
- Trading log text file
- Final report (PDF)

## Bonus Ideas (Optional)

For the curious, consider the following. Note that those who apply these **will not** be subjected to extra points.

- Adding a risk management system
- Comparing strategies to a baseline (e.g., buy-and-hold). For example: How much profit does "just buying equally from 4 banks at the beginning of 600 days and selling at the end of 600 days" generate? Were you able to do better?
- Performing inter-stock correlation analysis