ECE280 - Lab 2: Introduction to Simulink

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ECE 280
I have adhered to the Duke Community Standard in completing this assignment.

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Abstract

This is my write up for my song composition in matlab.

Contents

1 Objectives

This lab exercise aims to introduce participants to Simulink, covering how to launch, navigate, and use its basic functionalities. I will learn to create and connect blocks, handle data transfer with MATLAB, and print models. I hope to enhance skills in generating signals, performing mathematical operations, building systems, and data visualization and saving. The practical component involves constructing and simulating a simple system to examine stock price data, reinforcing the theoretical concepts with hands-on experience in modeling and simulation.

2 Results

2.1 Exercises 1-3

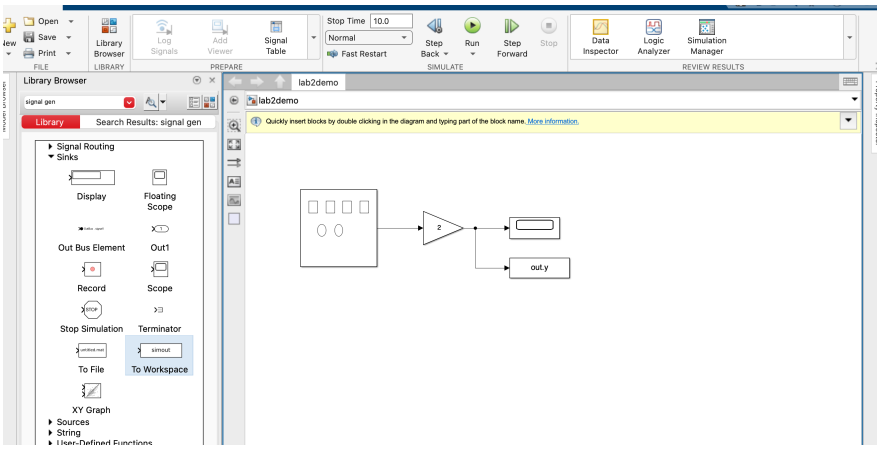

Figure 1: Simulink Model for Exercises 1 - 3

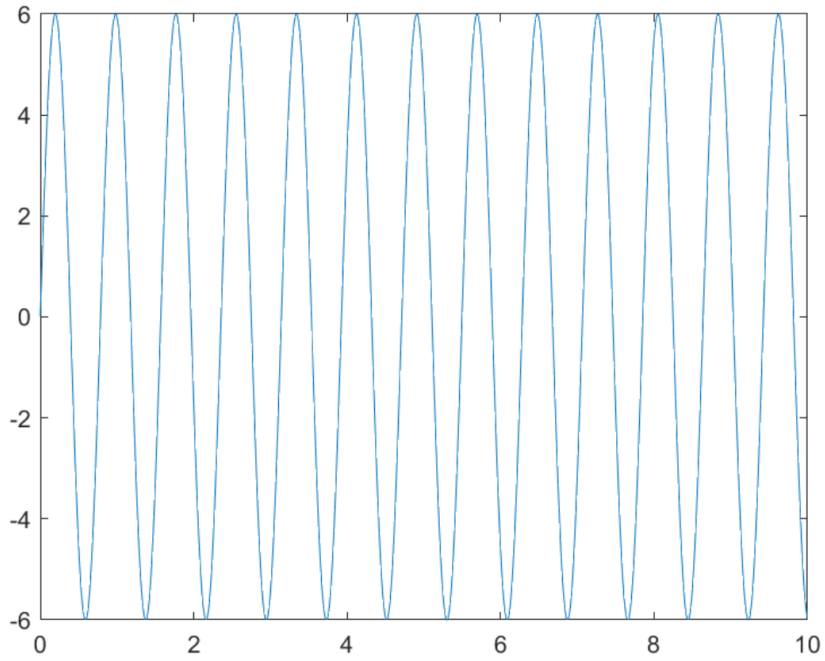

Figure 2: High Step From MatLab Plot

2.2 Exercise 4

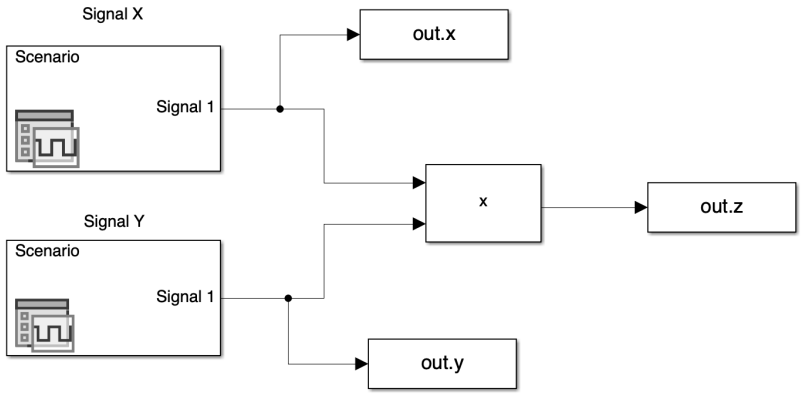

Figure 3: Simulink Model for Exercise 4

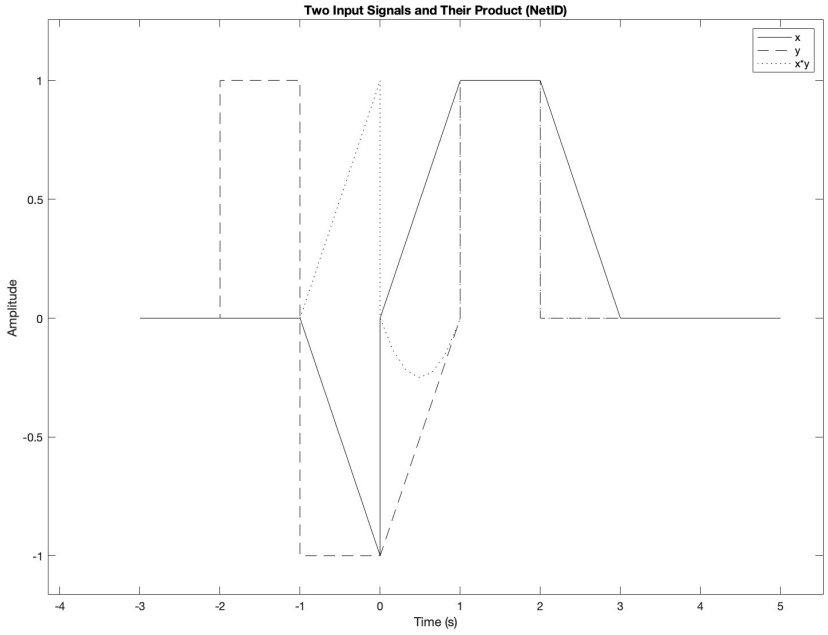

Figure 4: Plot for Exercise 4

2.3 Exercise 5

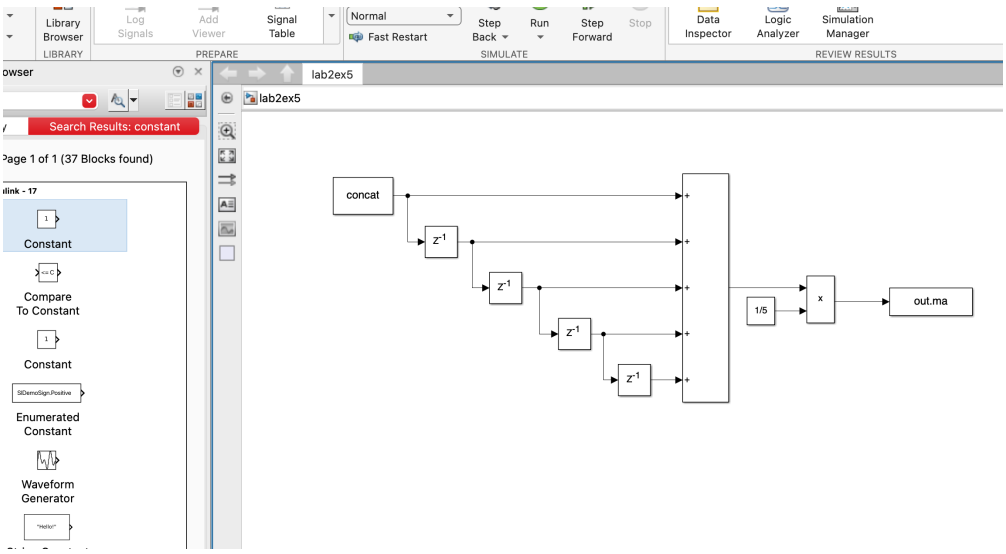

Figure 5: Simulink Model for Exercise 5

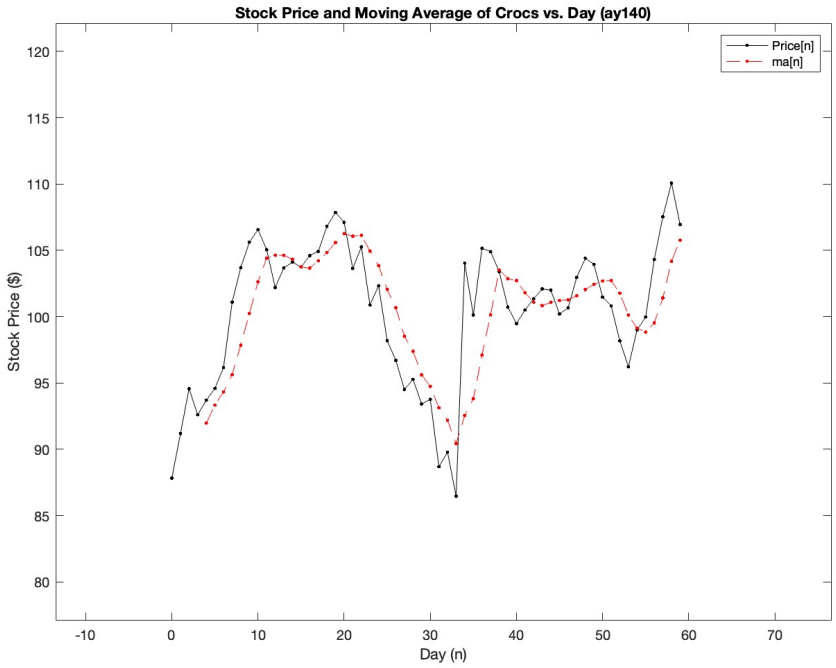

Figure 6: Plot for Exercise 5

3 Discussion

1. Why did the plot command for StockPrices in Exercise 5, part 4. use only part of ma and not all of ma?

   This is because this allows the 5-day moving average to be plotted (which is the average of the current day and the previous four days). The graph starts at the 5th day and goes until the last (60th) element - therefore not all of ma is needed.

2. What is the length of the output (ma) vector?

   Output vector is length 56.

3. What do you observe about the length of the output (ma) relative to the length of the input (StockPrices)?

   The first 4 data points do not have enough preceding data to calculate a 5-day average, and therefore do not have a valid output. Therefore the ouput only contains data points for which valid outputs are possible (of which there are 56).

4. What do you observe about the values of the output (ma) relative to the input (StockPrices)? Comment both on the initial values of ma and on the overall pattern in the

output relative to the input. (You will probably want to look at the first and last several data points in each array.) Explain these results in terms of the system that you implemented.

The original data begins from day 0, but due to the application of a moving average, the output values only start from day 5. In contrast to the StockPrices input, which shows pronounced daily price fluctuations, the output exhibits a smoother trend. This smoothness arises because the output values are derived from the preceding input values, ensuring a consistent progression from one point to the next. Consequently, while the input data may present abrupt changes in stock prices, the output more clearly illustrates the stock's overall trend over time.

5. Is the system Memoryless?

   The output of the system relies on past values of the input (4 previous data points), meaning the system has memory.

6. Is the system Causal?

   The output of the system only relies on past and present values of the input, making the system causal.

7. Is the system Stable?

   Because the range of the inputs is bound and the output is determined by averaging five of the bounded inputs at a time, the output of the system is bounded and therefore, the system is stable.

8. Is the system Time Invariant?

   The system is time invariant because shifting the inputs would lead to the outputs being similarly shifted (as it is due to the system being a moving average).

9. Is the system Linear?

   System is linear because the only sub operations used are delay and add which are linear, and combined in a linear manner.

4 Conclusions

In this lab, I gained hands-on experience with Simulink by employing block diagrams to simulate systems using signals and real-world data, enhancing my understanding of system outputs. We utilized blocks from the Simulink Library, including the Signal Generator for sinusoidal inputs, Gain for amplifying signals, and To Workspace for exporting data to MATLAB, facilitating the analysis and visualization of system behavior. Additionally, by integrating Add and Delay blocks, we developed a system to compute a 60-day moving average of stock prices, resulting in smoother, more interpretable data.

5 Extension

Disscussion of another real-world application of the moving average filter. What kind of data could be analyzed and why is this filter appropriate? How would you choose the length?

One of the ways in which a moving average filter can be applied in the real-world is for weather forecasting, which involves smoothing out short-term fluctuations and highlighting longer-term trends or cycles in weather data. This technique is particularly useful in meteorology for several reasons, including the prediction of temperatures, rainfall, and other atmospheric variables over time.

Forecasters use moving average filters to analyze temperature data over specific periods, such as 7-day predictions. By smoothing out daily temperature variations, meteorologists can better understand the underlying trends, such as warming or cooling patterns, which are very important for seasonal forecasting.

Similar techniques can be used for rainfall and AQI (air quality index) predictions. For example with AQI moving averages can also be applied to to monitor and forecast air pollution levels. This helps in identifying trends in air quality improvement or deterioration over time, aiding in public health advisories.

Below I've attached a diagram of me applying a moving average using a python script on some rainfall data - showing the power of using moving averages to predict future events given they are somewhat stable.

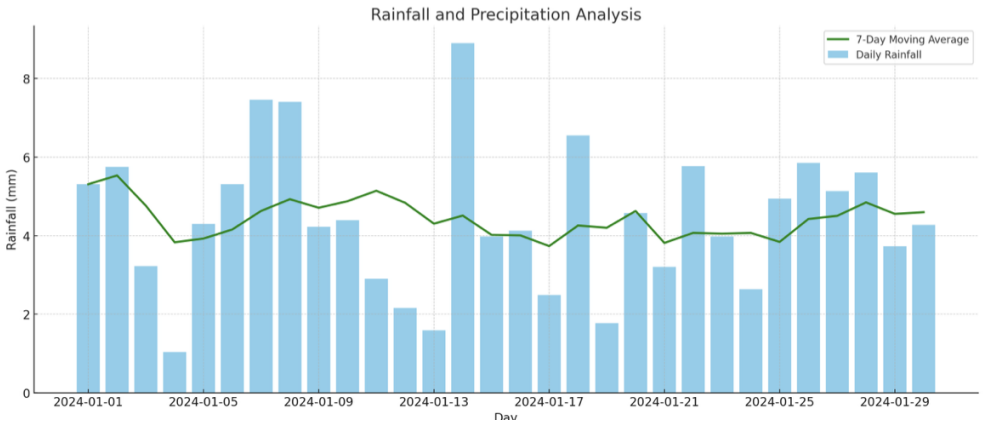

Figure 7: Rainfall Moving Average Graph

Duke Honor Code

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Date: February 23rd 2024