**< Introduction to the Projects >**

There are two projects here. Please complete both projects.

Project 1 is designed to be a succinct demonstration of your software engineering excellence.

Project 2 is designed to allow us to examine how you approach data analysis, your thought process, initiatives, and interest on quantitative investment analysis. We are providing most of the framework code needed to do the analysis.

They are both important aspects for us to consider, but Project 1 will be given more weight in the evaluation. The reason is that we are looking for someone who shows up as an excellent software engineer from Day 1. But we plan to teach you all the necessary investment analysis knowledge you need to succeed in this role. One catch is there’s a lot to learn, so we need to know if you have the right mindset and interest.

Upload all work for both projects in a public GitHub repo. Please put each project in its own directory. Email the GitHub repo’s URL to the following people.

alexander\_salcedo@otpp.com, tunc\_utku@otpp.com, justen\_pinto@otpp.com

**< Project 1. Software Engineering >**

Create a software system that consists of 2 components below. The system must work when Server and Client are running on different computers.

We expect that you will be doing this in Python, and your code should be OS/platform agnostic, but we will be testing your code in Windows. If you prefer to do the project in a different language, that is ok as well. If parts of the instruction are not clear, make a reasonable assumption and move on.

Software 1: Trading Server

* The server is a long running process
* The data should be obtained from these two sources and stitched appropriately. From these two sources, you should be able to build a consistent intraday price series.

**< Source 1 >**

* + Alpha Vantage API: Realtime and historical US stock prices.
  + API documentation here
  + <https://www.alphavantage.co/documentation/>
  + Keep in mind that the free version of this API contains a max of 5 calls/min or 500 calls/day

**< Source 2 >**

* + Finhub API: <https://finnhub.io/>
  + API documentation here
  + <https://finnhub.io/docs/api>
  + We will be using this API to gather real time quotes, that will be the quote request on the documentation.
  + The t on the response is timestamp for the prices
* When the server starts, it connects to Source 1 and constructs a series of stock prices sampled at X-minute intervals, using all available historical data for the given tickers.
* The server then immediately computes a Boolean trading signal series for the entire price time series and does profit & loss calculation. Then this information should be saved in the format below.

E.g. (values not indicative of correct result)

datetime, ticker, price, signal, pnl

2022-04-25-11:00, AAPL, 421.04, -1, -0.02

2022-04-25-11:00, MSFT, 132.95, 1, 0.06

2022-04-25-11:05, AAPL, 421.09, -1, -0.05

2022-04-25-11:05, MSFT, 132.98, 1, 0.03

…

* For the trading signal and profit and loss calculation, use the formula given in the next section below. This is a very simple momentum trading strategy.
* The server must serve clients over network.
* The server is run from the command line with the following optional command line arguments
* --tickers
  + List of tickers to that the server is interested in
* --port XXXX
  + It specifies the network port for the server. If not specified, the default port is 8000.
* If necessary, feel free to add more arguments to the server

Software 2: Client

* The client can query the Server in multiple ways. The client is also a long running process that receives inputs interactively from the user and displays outputs.
* The client is run from the command line with one command line argument
  + –-server <ip>:<port>
* While the client is running, the user can enter the following commands.
* data YYYY-MM-DD-HH:MM  
  Client will query the server for latest price and signal available as of the time specified.

**>data 2022-01-27-13:34**

AAPL 162.45,1

MSFT 302.66,0

* delete TICKER
  + Instruct the server to delete a ticker from the server data set.
* add TICKER
  + Instruct the server to add a new ticker to the server data set
* report
  + Instruct the server to recreate report.csv with latest data, signal, pnl

**< Trading Signal Definition and Formula for calculating Profit & Loss for Project 1>**

1. Let **S** be the intraday price series for a given stock, as given by your server application
2. Create a new time series **S\_avg** that is the 24-hour rolling moving average of **S.**
3. Create a rolling series **Sigma(t)** for 24-hour price standard deviation based on the same rolling window as **S\_avg**

4a. Implement the following strategy:

**For all t**

**If S(t) > (S\_avg(t) + Sigma(t))**

**Define the position as**

**Pos(t+1) = +1 i.e., buy 1 stock at time t + 1 min**

**Else if S(t) < (S\_avg(t) - Sigma(t))**

**Pos(t+1) = -1 i.e., sell 1 stock at time t + 1 min**

**Else: do nothing**

**Pos(t+1) = Pos (t)**

5a. Calculate the Profit and Loss for the strategy: **PnL(t) = Pos(t-1) x [S(t) - S(t-1)]**

**< Project 2. Design and Analysis of Economic Indicator and Systematic Trading Signal >**

You have been given the following data for two countries, United States and Canada.

1. United States
   1. Two tradeable assets (in asset prices.csv)
      1. ES1 Index: Daily close price of S&P 500 Index Futures
      2. DXY Curncy: US Dollar Index. Please treat this as a tradeable foreign exchange rate. It represents value of 1 US Dollar. The higher the value, the stronger US Dollar is relative to other currencies.
   2. Four economic data \*
      1. US GDP growth rate (%)
      2. US Industrial Production
      3. US Home Sales
      4. US Unemployment Rate
2. Canada
   1. Two tradeable assets (in asset prices.csv)
      1. PT 1 Index: Daily close price of Toronto Stock Exchange Index Futures
      2. CADUSD Curncy: Tradeable foreign exchange rate. Represents value of 1 Canadian Dollar.
   2. Four economic data \*
      1. Canada GDP growth rate (%)
      2. Canada Industrial Production
      3. Canada Home Sales
      4. Canada Unemployment Rate

(\* For the economic data, the data include both actual value and expected value. The actual values are the values released by government on the date listed in the file. The expected values represent market-expected (forecasted) value known prior to the release of the actual value. The expected value is the average of forecasts published by multiple independent forecasters and disseminated among the market participants some time (e.g., a few days – a couple of weeks) before the release date.)

There are two parts to this project.

**Part 1. Using the economic data, propose and implement an economic indicator that will be indicative of the growth and/or health of the respective economy and could be used as a basis for some trading strategies.**

Please use the notebook given. It has all the code to load the data, and a sample indicator.

**Part 2.** **Create one or more trading signals using the indicator you created. Then, apply the trading signal to one or more tradeable assets to examine the profitability of your trading signal.**

Generally, the growth and health of the country’s economy translates to the strength of the country’s stock market and the country’s currency. Thus, it may be possible to use your indicator as a trading signal for the stock and currency market. You could either use the indicator as-is (in which case your trading signal will be identical to your economic indicator, this is the example given in the notebook) or transform the indicator in some way to make it more suitable for trading.

In the notebook given, we are proving the code you can use to apply your signal to the asset price data and calculate profit and loss of the trading signal.

Your trading signal can be anything from a time-series signal (the signal for the country tells you when to buys/sells one or more assets for that country, without regards to other country), or cross-sectional signal (a signal to buy/sell Canadian assets based on US economic indicator)

You don’t have to use all provided data to build this indicator and signal. You don’t have to use all past historical data. You don’t need to try to trade on all assets. We care primarily about your thought process, not the profitability of your trading signal. For example, your thought process could include how you chose your indicators, how you combined them together, etc. Please show all your analysis, investigative process, assumptions you made and the reasoning of choosing these indicators.

Expand the notebook given and provide some written commentary that shows your thought process. This is not an engineering project but an analytical and exploratory project, please treat it as such.

Here are some questions that are designed to help you think about this problem. To be clear, we are not asking you to answer these questions in your submission. But thinking about these questions could guide your mind in the exploratory process.

1. Should you use the actual value or the expected value in building your indicator? Why? How about both? Why or why not?
2. How will you choose which assets to trade?
3. Do some assets perform better than others using your indicator? Why?
4. If your signal worked, why?
5. If your signal didn’t work, why?
6. If you trade more than one asset, is the performance dominated by one asset? If so, why? Is there any way to deal with that?

We would like to emphasize that, in this project, candidates will not be evaluated on the profitability of the trading signals. We care about your aptitude for critical reasoning, thought process, interest, initiatives, and having the right mindset for the problem. So do not be concerned if your signals are not profitable.