You have 48 hours upon receving this coding test. You should pack your Python codes and answers in a zip file and submit it back via email.

1 Part I: Backtesting Platform.

First, you need to implement a simple quantitative investing backtest platform. For any quantitative investment strategy, we are interested to examine its historical performance by running it on the backtest system. The preferred coding language for the backtest platform is Python.

1.1 Data file description

- Factor.csv: a strategy that needs to be backtested.
- FMRTN1W.csv: weekly returns forward by 1-week - this is future returns that can be used directly.

1.2 Description of backtest

- We use equal weight investing for both initialization and weekly rotation
- Factor data gives you the score of each individual stocks. You can rank the stocks into 5 quantiles (20% per quantile).
- You want to buy the top 20% stocks (quantile 5), and short the bottom 20% stocks (quantile 1). Skip the stocks if the score is missing (NA)
- You have 1 dollar at the start. You want to invest equally, thus initially it is 0.01 dollar for each stock.
- When you need to reinvest stocks, i.e. sell (buy) K stocks to buy (sell), you reinvest also equally.
- You weekly returns is the difference of long position (stocks you buy) and short position (stocks you sell).

1.3 Result outputs

Your code should produce the results similar to \ToyBacktest folder.

- Coverage: This shows the number of stocks covered by the strategy (Factor data) in all quintile (meaning 20% fractile) portfolios, i.e. the number of stocks that have quant factors in each period. 12-month moving average is usually drawn to show smooth information.
- Annualized Returns: N weekly returns transfer to annualized returns by $r_{annual} = \left[\Pi_{i=1}^{N}(1+r_i)\right]^{\frac{52}{N}} - 1$.
- Annualized Volatility: Monthly standard deviation transfers to annualized volatility by $\sigma_{Annual} = \sqrt{12}\sigma_{month}$.
- Factor turnover: As we use equal weighted portfolio, every week you change K out of N stocks for the long position, the turnover is simply $\frac{K}{N} \times 100\%$. Similarly, every week you change L out of N stocks for the short position, the turnover is simply $\frac{L}{N} \times 100\%$. The actual turnover is $\frac{K+L}{N} \times 100\%$. It is clear that the maximum turnover is 200% for long-short strategy.
- Portfolio IR (Information Ratio): This is used to gauge the performance of active investing strategy versus corresponding passive benchmark (no information and no skill). It is defined as $IR = \frac{E[R_p - R_b]}{\sigma[R_p - R_b]}$. For long only strategy, the benchmark is usually the market indexes. For long-short strategy, the benchmark is simply $R_b = 0$.

- Portfolio Returns: This table gives simple returns (non-cumulative) of each portfolios.
- Quantile Returns: This shows monthly cumulative return of 5 portfolios.
- Serial Correlation: This is month-to-month factor score serial correlation. It measures how similar the factors are between adjacent months.
- Sortino Ratio: $S = \frac{E[R_p - R_b]}{DR}$, where $DR = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(min\left\{0, R_t - R_b\right\}\right)^2}$. Refer to Wiki but note our definition is a little different: https://en.wikipedia.org/wiki/Sortino_ratio.
- Spearson rank IC (information coefficient): For each month, you need to rank the factors and the actual realized returns by labeling the highest value should "1" and the lowest value "N" (N is the number of factors / actual realized returns), and then calculate the correlation of the two rank series. Ranking helps to mitigate outliers. For tied ranks, take the average rank (e.g. if there are two same largest number, each number has rank $\frac{1}{2}(1+2) = 1.5$).
- Time Series Spread: This is simply the time-series spread (difference) between the two extreme quantile portfolios $\Delta r_t = r_{1,t} - r_{5,t}$.
- Wealth Curve: This is the cumulative performance of the L-S strategy, i.e. $\Pi_{t=1}^{T}(1 + \Delta r_t)$.

2 Part II: Stock Market Data.

2.1 Stock market background

Momentum and Mean Reversion Momentum and mean reversion are common trading strategies. For the purposes of this Challenge, an asset that exhibits momentum is defined as an asset whose price returns are more likely to go up (down) on day t if the return went up (down) on day t-1. In other words, the stock exhibits a positive autocorrelation. Mean reversion is the opposite of momentum. Stocks are more likely to go up (down) on day t if that stock went down (up) on day t-1.

You are provided below with a simulated dataset of a series of stock returns. Data file is returns_20181228.csv. These returns have been generated with a predetermined average momentum during one period and a predetermined average mean reversion in another period. Please use this dataset to answer the questions below. In order to do so, you will need to clean the dataset. It comes with a number of flaws commonly seen in datasets we receive. In the interest of time, please feel free to drop any records that are problematic.

2.2 Questions to be answered

Following are the questions.

1. In what month did the returns shift from exhibiting mean reversion to exhibiting momentum, or from exhibiting momentum to exhibiting mean reversion? Before this month, stocks exhibit one pattern (on average), and after this month stock returns exhibit another (on average). Please submit your answer in the format mm-yyyy (ex: 01-2018).

2. During the time period when these stock returns had the momentum property, what was the average momentum? Please note this is a single number: the average across all stock returns in the time period.

3. During the time period when these stock returns exhibited mean reversion, what was the average mean reversion? Please note this is a single number: the average across all stock returns in the time period.

4. Why might the market shift from momentum being dominant to mean reversion being dominant (or the other way around)?

5. Why might trading momentum or mean reversion succeed as a strategy? Why might it fail?