Trading strategies based on fixed investment plan, market signals and price prediction using deep learning approach

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Introduction

- 2 Automatic Fixed Investment Plan
- Golden-cross and death-cross
- 4 Deep Learning model
- 5 Discussion and future work

Problem Background

Bitcoin vs Gold:





Figure: Gold and bitcoin coin on background of growth chart, Source: https://www.pexels.com/



Figure: The Bitcoin daily price, U.S. dollars per bitcoin. Source: NASDAQ, 09/11/2021



Figure: The Gold daily price, U.S. dollars per troy ounce. Source: London Bullion Market Association, 09/11/2021

In this workshop, we will run programs in HPC and Matlab to compare several trading strategies and their annualized return.

An automatic investment plan (AIP) is an investment program that allows investors to contribute money to an investment account at regular intervals.

In this project, we start with 500 for gold and 500 for bitcoin respectively.

Question 1:

Suppose we invest 500 evenly in 12 months, how much do we invest per month?

$$\frac{500}{12} = \$41.67\tag{1}$$

$$Return = N \times P \times (1 - \alpha) - 500$$
⁽²⁾

Where N is the number of shares you hold and P is the price of your financial investment and α is the transaction fee.

Therefore, we purchase \$41.67 on gold every 20 days and hold it until 09/9/2021. Similarly, We invest \$41.67 dollar on bitcoin every 30 days and hold it until 09/10/2021.

A generalized formula to calculate the annualized rate of return, which is exponential to take into account compound interest over time, is:

$$AP = ((P+G)/P)^{1/n} - 1$$
(3)

where

- P = principal, or initial investment
- G = gains or losses
- n = number of years
- AP = annualized performance rate

Here, the P is 500. The annualized rate of return of bitcoin is 65.05% for 12 months.

The annualized rate of return of gold is 10.1% for 12 months, which is closed to the average year return of S&P 500, 10.49%.

- **1** Log into HPC, type in command module load ifort, press enter.
- ② Then, type in command ifort Bitcoineven.f90, press enter.
- **③** Type in command ./a.out, press enter.

You will see the end value of our investment is \$6131.59 and annualized rate of return of bitcoin is 0.6504, which is 65.05%.

- Create a folder in desktop, right click, then selct new, then click 'Folder', you will see New folder in the screen. You may rename it (optional).
- Oownload all the files from BGSC session 6 and save them in the new folder you just created.
- Open Matlab, then click 'Open'(icon folder) on the left corner, then select 'Desktop' from the left window column, then click the folder you just created, then click 'Bitcoineven.m' file and click open, then click the green triangle button Run.

You will see a picture of the daily bitcoin price, the end value of our investment is \$6131.59 and annualized rate of return of bitcoin is 0.6504, which is 65.05%.

Question 2, which one is faster to show you the result? HPC or Matlab?

Let's go back to HPC and try it for gold.

- **1** Type in command ifort Goldeven.f90, press enter.
- **2** Type in command ./a.out, press enter.

You will see the end value of our investment is \$709.07.59 and annualized rate of return of bitcoin is 0.1061, which is 10.61%.

Next, we run the program for gold in Matlab, go to Matlab, click

'Open'(icon folder) on the left corner, then select 'Desktop' from the left window column, then click the folder you just created, then click 'Goldeven.m' file and click open, then click the green triangle button Run. You will see a picture of the daily gold price and total value of gold investment is \$709.07.59 and annualized rate of return of bitcoin is 0.1061, which is 10.61% as well.

which one is faster to show you the result? HPC or Matlab?

Moving average line has been used as a tool for judging conversion of a trend.

$$SMA = \frac{A_1 + A_2 + A_3 + A_4 + A_5 + \dots + A_n}{n}$$
(4)

where A_n is the price of the bitcoin or gold at a period of n, n is the number of total periods.

$$MA(s) = \frac{\sum p_n + p_{n-1} + p_{n-2} + p_{n-3} + \dots + p_{n-s+1}}{n_s}$$
(5)
$$MA(l) = \frac{\sum p_n + p_{n-1} + p_{n-2} + p_{n-3} + \dots + p_{n-l+1}}{n_l}$$
(6)

Where the MA(s) is short-term moving average and MA(I) is a long-term moving average.

Golden-cross

A golden cross is a chart pattern in which a relatively short-term moving average crosses above a long-term moving average. The golden cross is a bullish breakout pattern formed from a crossover involving a security's short-term moving average (such as the 50-day moving average) breaking above its long-term moving average (such as the 200-day moving average), which is also considered as the ''buy'' signal. 1. When a short term moving average line crosses over a long term one, from below, MA(s) > MA(I), while both lines are rising, this defines a golden cross, we buy at the golden cross point;



Figure: Golden cross, when 50-day moving average crosses over 200-day moving average from below

Trading strategy

Death-cross

On the other hand, the death cross is when a short-term moving average crosses under a long-term falling moving average, signing a reversion of the trend, which is a 'sell' signal.

2. When a short term moving average line crosses over a long term one, from above, MA(s) < MA(I), while both lines are falling, this defines a dead cross, we sell at the dead cross point;



Go back to BGSC, type in command ifort Bitcross.f90, press enter.
Type in command ./a.out, press enter.

You will see the end value of our investment is \$37388.69 and annualized rate of return of bitcoin is 1.3916, which is 139.16%.

Go to Matlab, then click 'Open'(icon folder) on the left corner, then select 'Bitcoincross.m' file, open it, then click the green triangle button Run.

You will see a picture of the following trading graph, which shows you the buying points, selling points, and a window for the rate of return, the end value of our investment is the same, \$37388.69 and annualized rate of return of bitcoin is 1.3916, which is 139.16% as well. Question 2, which one is faster to show you the result? HPC or Matlab?

Trading graph of Bit-coin based on SMA 5-day(short) and 20-day (long)



Figure: SMA 5-day(short) and 20-day (long) of bitcoin price from 09/16/2016 and 09/11/2021

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Next, we repeat the program for gold,

- **(**) Go back to BGSC, type in command ifort Goldcross.f90 , press enter.
- **2** Type in command ./a.out, press enter.

You will see the end value of our investment is \$582.99 and annualized rate of return of bitcoin is 0.0461, which is 4.61%.

Go to Matlab, then click 'Open'(icon folder) on the left corner, then select 'Goldtradecross.m' file, and open it, then click the green triangle button Run.

You will see a picture of the following trading graph, which shows you the buying points, selling points, and a window for the rate of return, the end value of our investment is the same, \$582.99 and annualized rate of return of bitcoin is 0.0461, which is 4.61%.

Trading graph of Gold based on SMA 5-day(short) and 20-day (long)



Figure: SMA 5-day(short) and 20-day (long) of gold price from 09/16/2016 and 09/11/2021

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In the same 'Goldtradecross.m' file, row 16, f=5, s=20, change that into f=50, s=200, which means 50-day for short and 200-day for long. Run the program again.

You will see a picture of a trading graph, which shows you the buying points, selling points, and a window for the rate of return, the end value of our investment is the same, \$672.57 and annualized rate of return of bitcoin is 0.1070, which is 10.70%.

In the 'Bitcoincross.m' file, row 16, f=5, s=20, change that into f=50, s=200, which means 50-day for short and 200-day for long. Run the program again.

You will see a picture of a trading graph, which shows you the buying points, selling points, and a window for the rate of return, the end value of our investment is the same, \$22174.0 and annualized rate of return of bitcoin is 0.397, which is 39.70%.

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Trading graph of Gold based on 50-day(short) and 200-day (long)



Figure: SMA 50-day(short) and 200-day (long) of gold price from 09/16/2016 and 09/11/2021

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Trading graph of Bit-coin based on SMA 50-day(short) and 200-day (long)



Figure: SMA 50-day(short) and 200-day (long) of bitcoin price from 09/16/2016 and 09/11/2021

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Annualized rate of return of gold from "golden-cross" and "death-cross" strategy

Table: Annualized rate of return of gold from ''golden-cross" and ''death-cross" strategy

	5-day(short); 20-day (long)	50-day(short); 200-day (long)
Annualized rate of return with 0.01% commission fee	4.38%	10.68%
Annualized rate of return without commission fee	4.61%	10.70%

Using 50-day (short), 200-day(long) period is slightly better than fixed investment plan, while the 5-day(short) and 20-day(long) period is not as good as the fixed investment plan. The transaction fee can be a factor that will affect the annualized performance rate if we choose a small window for the short and long moving average period.

Annualized rate of return of Bit-coin from 'golden-cross' and 'death-cross' strategy

Table: Annualized rate of return of Bit-coin from ''golden-cross" and ''death-cross" strategy

	5-day(short); 20-day (long)	50-day(short); 200-day (long)
Annualized rate of return with 0.02% commission fee	139.16%	39.7%
Annualized rate of return without commission fee	140.07%	39.74%

To verify the effectiveness our strategy, we also import the data set price of DOGEcoin history close price from 2017/11/9 to 2020/1/20 and ETH history close price from 2017/9/11 to 2022/2/20. The annualized rate of return of DOGEcoin is 67.6760% and the annualized rate of return of ETH is 434.4340%.

Deep Learning model

Deep learning is a machine learning technique that teaches computers to do what comes naturally to humans: learn by example. Different deep learning methods have been applied for the development of Bitcoin price prediction models, for example, deep recurrent convolution neural network, deep neural decision trees, and deep learning linear support vector machines.



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We trained a demo of 200 days and evaluate the accuracy by Mean Square Error Loss. After four times adjust, the prediction is considered "just right". In the end, we put our model to test the whole data set. We begin our trade from day 201 based on the price prediction from the previous 200 day's data, on day 201, we will add the 201-th day's data into the data set and predict the 202-th price and keep on.

Trading strategy based on deep learning

Trading strategy:

To buy

Compare the prediction value with the last 20-days average value. If we have cash and the prediction value is greater than or equal to 1.02 times the average of last 20-day's value, in other words, price increase 2%, we buy.

To sell

If we have bitcoin and the prediction value is less than or equal to 0.98 times the average of last 20-day and we have bitcoin, in other words, the price decreases 2%, we sell.

To hold

Otherwise, we hold.

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Run Fortran programs in HPC & Matlab

Once we receive the predicted date from deep learning model, we trade it based on our previous trading strategy. The deep learning model is run via python on Jupyter notebook.

Go to Matlab, then click 'Open' (icon folder) on the left corner, then select 'BitcoinDL.m' file, and open it, then click the green triangle button Run.

You will see a picture of the following trading graph, which shows you the buying points, selling points, and a window for the rate of return, the end value of our investment is the same, \$18884 and annualized rate of return of bitcoin is 1.2909, which is 129.09%.

Then, we compare it with our previous cross-point strategy, go to Matlab, click 'Open'(icon folder) on the left corner, then select 'BITCtradeforcomparison.m' file, and open it, then click the green triangle button Run.

You will see the end value of our investment is \$10332, and annualized rate of return of bitcoin is 0.9954, which is 99.54%.

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Bit-coin price prediction

The graph of bitcoin prediction value of next day and the actual market price is showing below in figure



Figure: Bitcoin actual market value and the predicted value from deep learning

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Trading graph of Bit-coin based on the deep learning model



Figure: Bitcoin actual market value and the predicted value from deep learning approach from 03/30/2017 and 09/11/2021

Table: Annualized rate of return of bitcoin trading based on short-term price prediction vs trading based on ''golden-cross" and ''death-cross" points from 03/30/2017 and 09/11/2021

	Trading based on deep learning approach	Trading based on crossing points
Annualized rate of return with 0.02% commission fee	128.18%	98.77%
Annualized rate of return without commission fee	129.09%	99.54%

From the table results, we can see that the the trading strategy based on the short-term learning approach beats the trading strategy based on the ''golden-cross" and ''death-cross" points. Here, the Annualized rate of return of the trading based on crossing points is less thanAnnualized rate of returne previous table's annualized rate of return since the starting trade point is 03/30/2017.

Here are our thoughts and suggestions for trading strategies:

- The slow-and-steady investment style produced by an automatic investment plan (AIP) is not a bad investment strategy in long term.
- Golen-cross and death cross:Using Golden-cross and Death-cross can easily get the cross point which is the relatively better time to made the transaction. Those who jump in too early before a new trend is confirmed are taking a higher risk, albeit for a potentially higher return.
- Deep learning: Deep learning Model can comparably perfectly predict the trend of price of the next day or longer by analyzing the historical data. Through the predicting, we can make the suitable decision either buying or selling or holding in time. The disadvantage of Deep learning is that the model adjusts cost lot of time.

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In the next step,

- We will use longer history data points to enhance the training data set.
- Optimize the window of learning.
- Develop an automatic effective trading strategy based on the short term price prediction using Deep Learning approach to maximize the total return.

- Upward Bound Program at UWEC.
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