Project Report

On

BLACK-BOX TRADING

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2nd year

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Contents:

Introduction:

Algorithmic trading (also called automated trading, black-box trading, or algo-trading) uses a computer program that follows a defined set of instructions (an algorithm) to place a trade. The trade, in theory, can generate profits at a speed and frequency that is impossible for a human trader.

The defined sets of instructions are based on timing, price, quantity, or any mathematical model. Apart from profit opportunities for the trader, algo-trading renders markets more liquid and trading more systematic by ruling out the impact of human emotions on trading activities.

Most algo-trading today is high-frequency trading (HFT), which attempts to capitalize on placing a large number of orders at rapid speeds across multiple markets and multiple decision parameters based on pre-programmed instructions.

Technical Requirements for Algorithmic Trading Implementing the algorithm using a computer program is the final component of algorithmic trading, accompanied by back-testing (trying out the algorithm on historical periods of past stock-market performance to see if using it would have been profitable). The challenge is to transform the identified strategy into an integrated computerized process that has access to a trading account for placing orders. The following are the requirements for algorithmic trading:

- Computer-programming knowledge to program the required trading strategy, hired programmers, or pre-made trading software.

- Network connectivity and access to trading platforms to place orders.

- Access to market data feeds that will be monitored by the algorithm for opportunities to place orders.

- The ability and infrastructure to back-test the system once it is built before it goes live on real markets.

- Available historical data for back-testing depending on the complexity of rules implemented in the algorithm.

Objective:

- Implementing the trading strategies as algorithms and analyzing their efficiencies on the basis of profitability.
- Suggesting some new algorithms or changes in the existing ones for improvement.

Algorithm Analysis:

MEAN-REVERSION Algorithm:

Pseudo Code:

```
For records in records ['Prev Close']):
    record_count += 1
    total_closing_price += record

    # Moving average is calculated for every 20 ticks(records)
    If record_count >= 20:
        moving_average = total_closing_price / 20
        avg.append ([records ['Date'][index], moving_average])

        # if moving average is greater than last tick, place a buy order
        If (1.02 * record < moving_average < 1.05 * record
                                            or moving_average < 0.8 * record) :
                Tag = 'buy'
```

```
Elif (.95 * record > moving_average > .9 * record
                                          or moving_average > 1.05 * record) :
        Tag = 'sell'

total_closing_price -= records ['Prev Close'][record_count - 20]
```

VWAP Algorithm:

Pseudo Code:

```
df ['20d'] = np.round (df ['Average Price'].rolling (window=20).mean ())
df ['5d'] = np.round (df ['Average Price'].rolling (window=5).mean ())

    While i < len (df):

        If (df['5d'][i] - df['20d'][i]) * (df['5d'][i - 1] - df['20d'][i - 1]) < 0:

            If df ['5d'][i] – df ['20d'][i] > 0:

                BAL -= df ['5d'][i]
                bought.append ([df ['Date'][i], df ['5d'][i]])

            Elif df ['5d'][i] - df ['20d'][i] < 0:  # and sbal > 0:

                 BAL += df ['5d'][i];
                 sold.append ([df ['Date'][i], df ['5d'][i]])

        i += 1
```

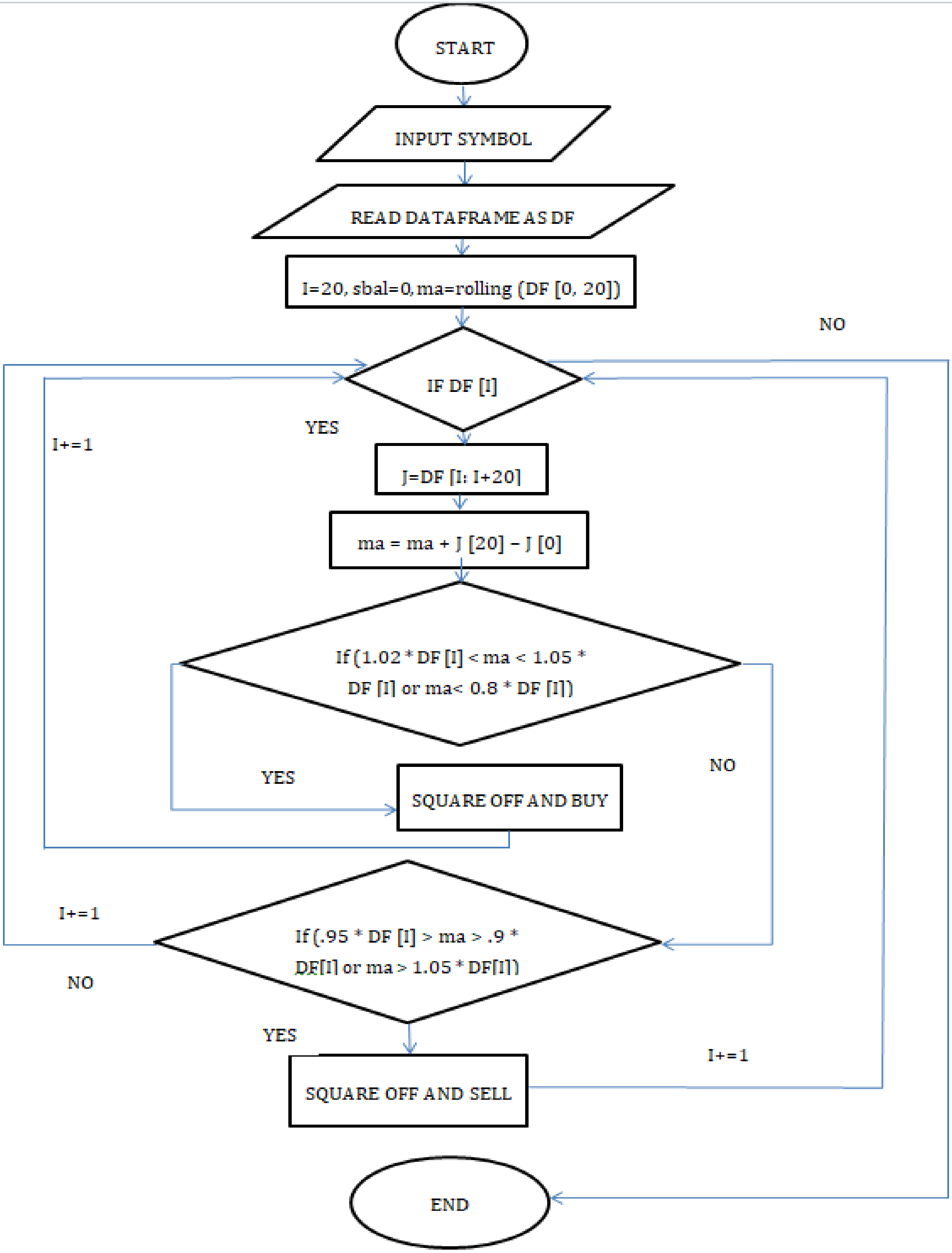
BID-ASK SPREAD Algorithm:

Pseudo Code:

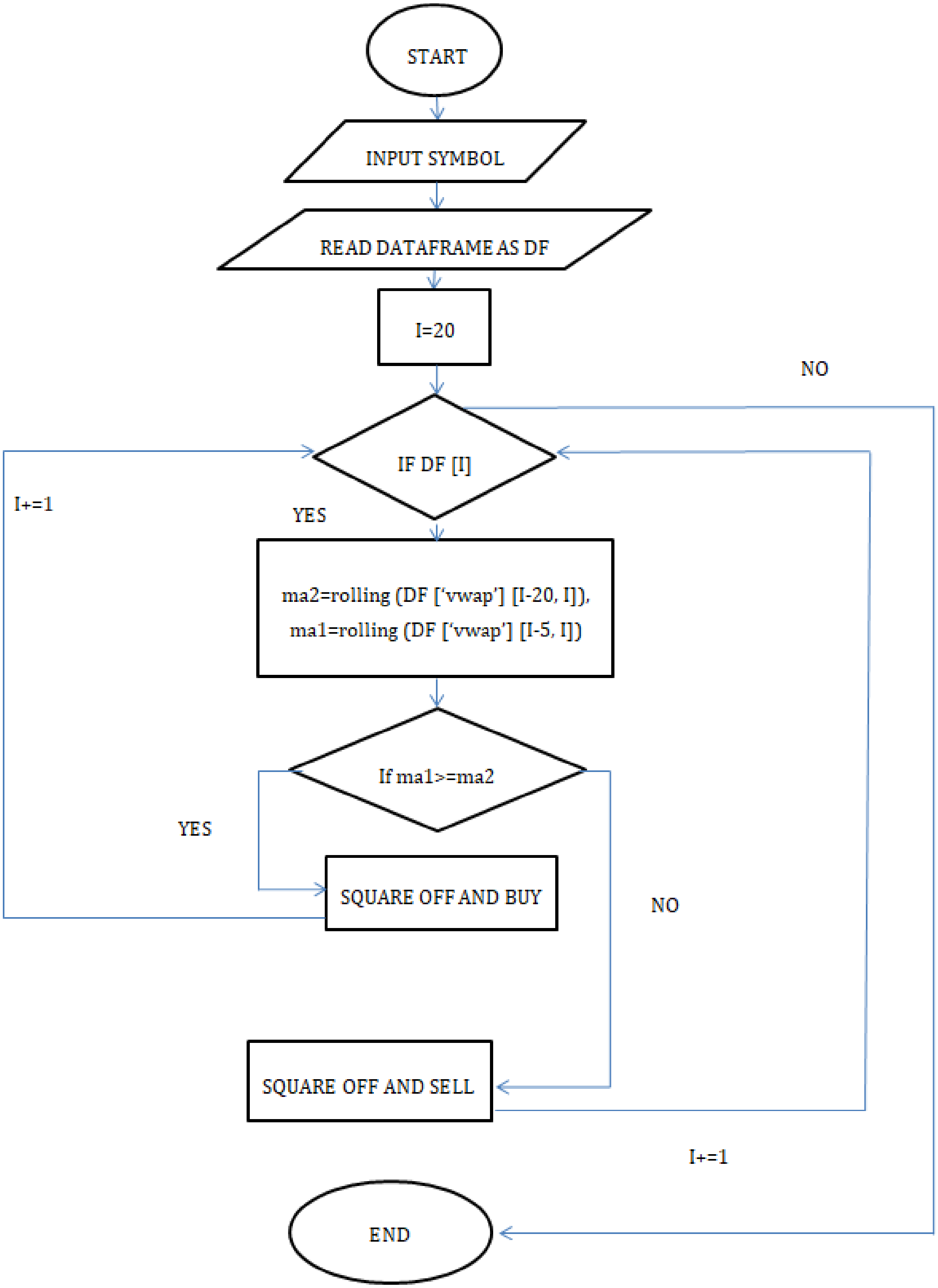
```
df ['20d'] = np.round (df ['Average Price'].rolling (window=20).mean ())
df ['5d'] = np.round (df ['Average Price'].rolling (window=5).mean ())

  While i < len (df):

    If (df['5d'][i] - df['20d'][i]) * (df['5d'][i - 1] - df['20d'][i - 1]) < 0:

      If df ['5d'][i] – df ['20d'][i] > 0:

        BAL -= df ['5d'][i]
        bought.append ([df ['Date'][i], df ['5d'][i]])

      Elif df ['5d'][i] - df ['20d'][i] < 0:  # and sbal > 0:

         BAL += df ['5d'][i];
         sold.append ([df ['Date'][i], df ['5d'][i]])

    i += 1
```

Algorithm Design:

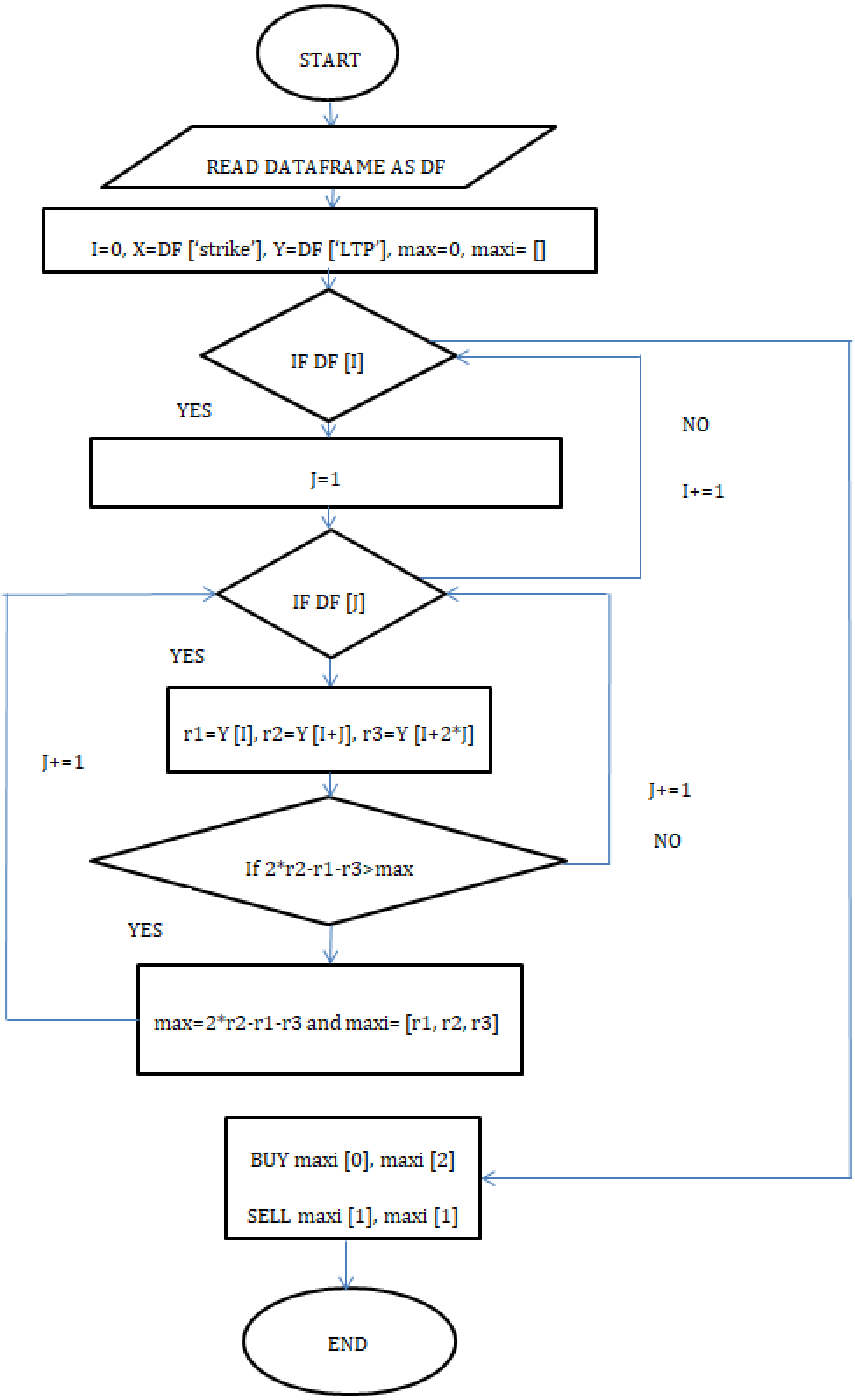
- **Mean-Reversion->**


START
INPUT SYMBOL
READ DATAFRAME AS DF
I=20, sbal=0, ma=rolling (DF [0, 20])
NO
IF DF [I]
YES
I+=1
J=DF [I: I+20]
ma = ma + J [20] – J [0]
If (1.02 * DF [I] < ma < 1.05 *
DF [I] or ma< 0.8 * DF [I])
YES
SQUARE OFF AND BUY
NO
I+=1
If (.95 * DF [I] > ma > .9 *
DF[I] or ma > 1.05 * DF[I])
NO
YES
I+=1
SQUARE OFF AND SELL
END

- **VWAP->**



- **BID-ASK Spread->**



Complexity Analysis:

1. MEAN REVERSION:

It is simply a single loop hence the time complexity = O (n)

Also space complexity = O (n)

Where, n is the number of days for which last traded price is recorded.

2. VWAP:

Volume weighted average price is calculated as:

Vwap=∑ (volume traded * last traded price)/∑ (volume traded)

Vwap is calculated in O (n) and stored separately before

Therefore, it is also simply a single loop and hence the O (n)

But space complexity = 2*n

i : e still = O (n)

Where, n is the number of days for which last traded price is recorded.

3. BID-ASK SPREAD:

It is of O (n^2) calculation is as follows:

$T = (n-2) + (n-5) + \_ \_ \_ \_ + (n-(n-1))$

Let T has x terms

⇨ $2 + 3*(x-1) = n-1$

⇨ $x = n/3$

$T= n. (n/3) - (2+5+\_ \_ \_ \_ +n-1)$

⇨ $T = n^2 /3 - (2*n/3 + 3 * (1 + 2 +\_ \_ \_ \_+ (n/3 - 1))$

⇨ $T = n^2 / 3 - (2*n/3 + (3*(n/3 – 1)*(n/3)) / 2)$

⇨ $T = n^2/3 - (n2 + n) / 6$

⇨ $T = (n^2 – n) / 6$

⇨ $T < n^2$

Therefore time complexity = O (n^2)

But space complexity = O (n)

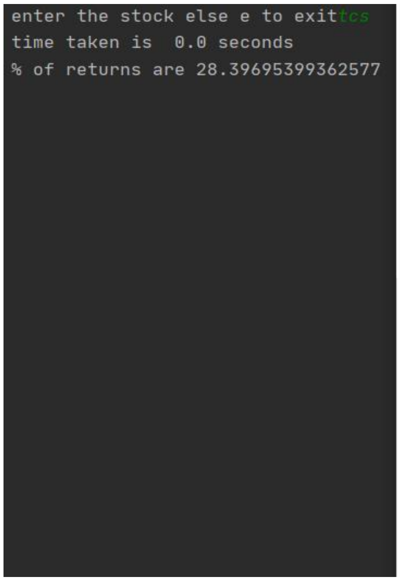
Where, n is the number of days for which last traded price is recorded

Implementation and Results:

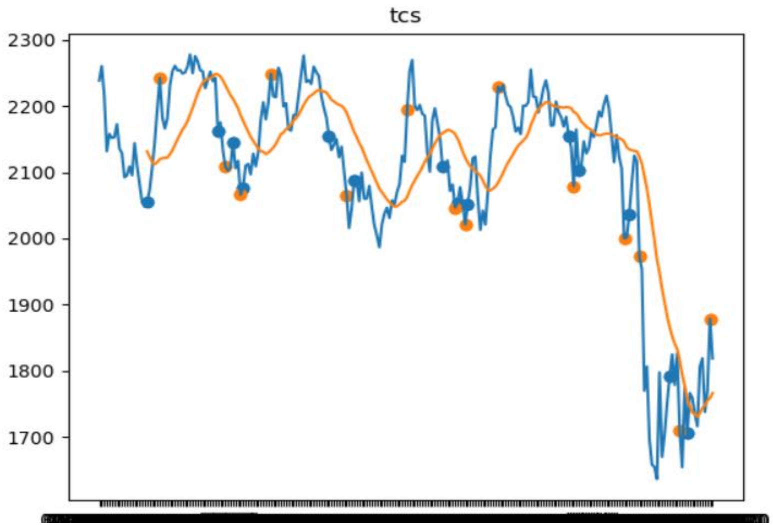
The algorithms are implemented on previous two year data

Of following shares before 14th may and then the conclusion is derived checkout (https://github.com/bhaskar1603/cs204/tree/master):

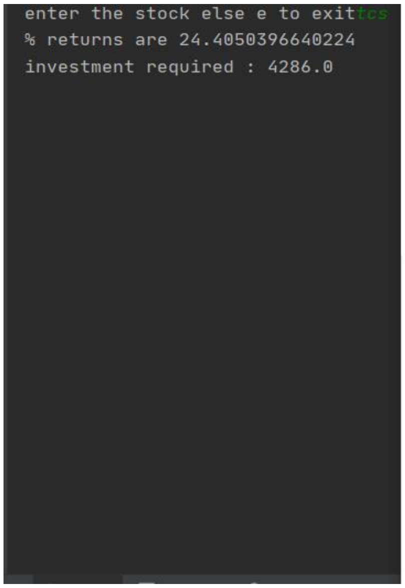
1. TCS
   A. Mean Reversion:



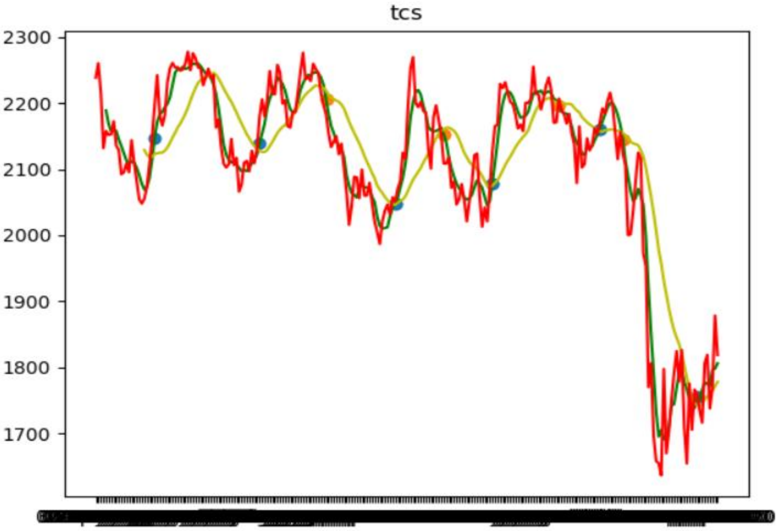
```
enter the stock else e to exittcs
time taken is  0.0 seconds
% of returns are 28.39695399362577
```



   B. VWAP:

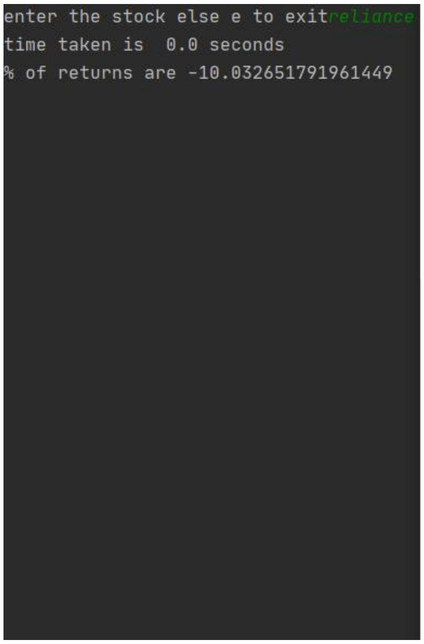


```
enter the stock else e to exittcs
% returns are 24.4050396640224
investment required : 4286.0
```

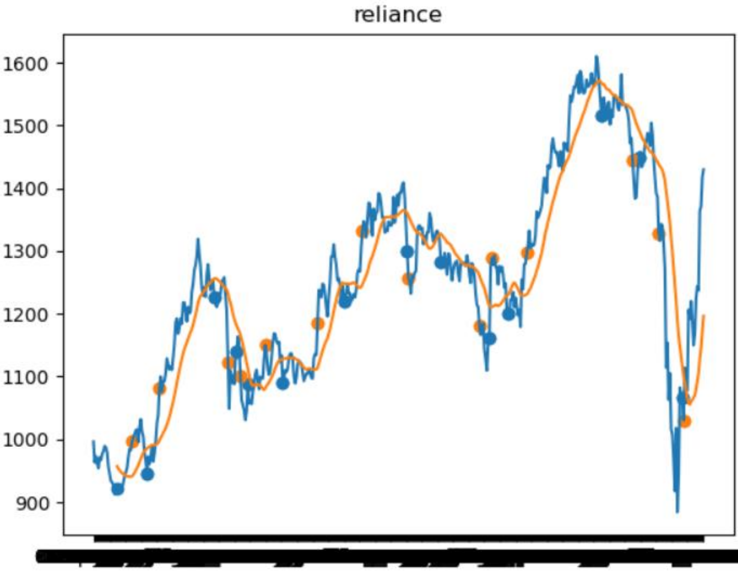


2. RELIANCE

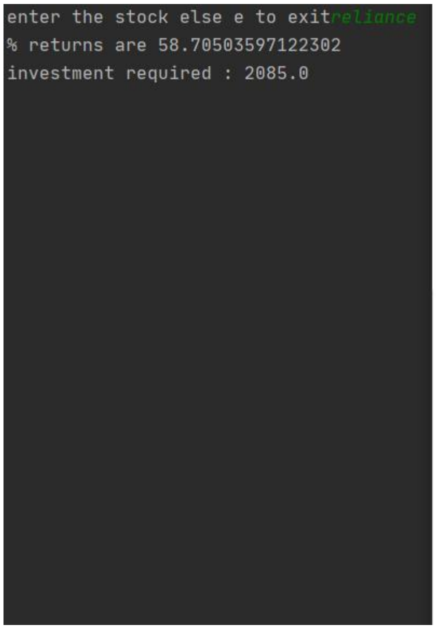
A. Mean Reversion:



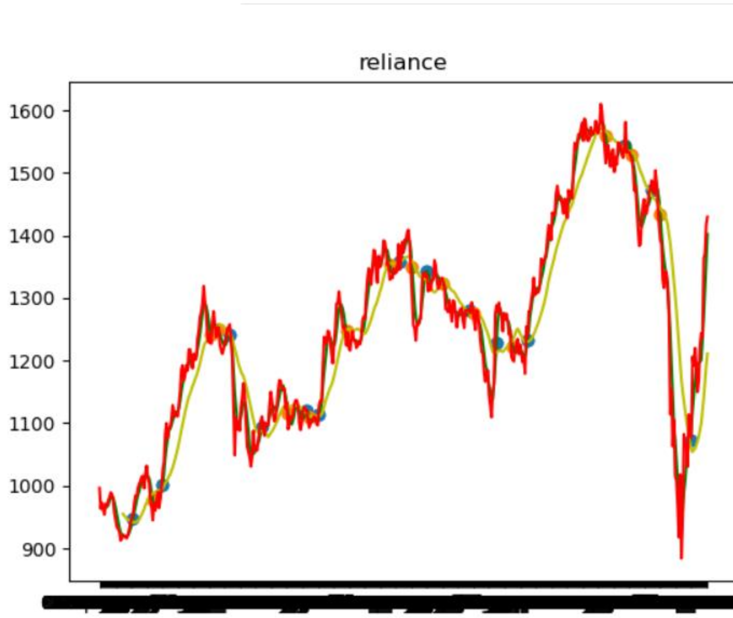
```
enter the stock else e to exitreliance
time taken is  0.0 seconds
% of returns are -10.032651791961449
```



B. VWAP:

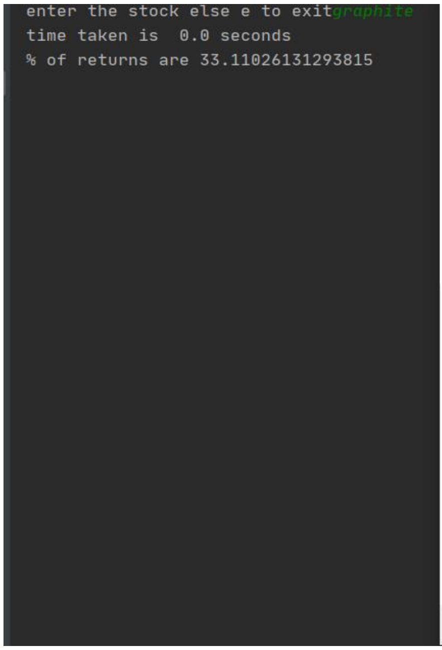


```
enter the stock else e to exitreliance
% returns are 58.70503597122302
investment required : 2085.0
```

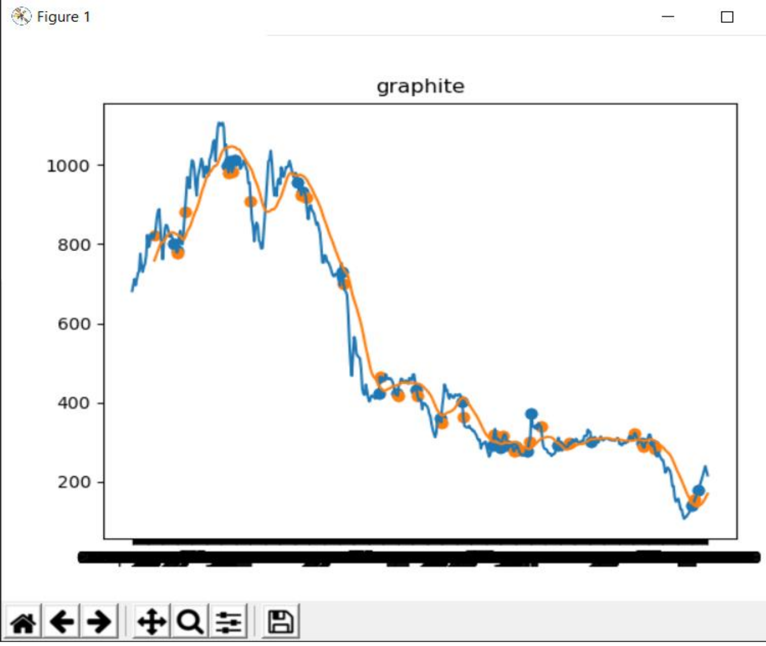


3. GRAPHITE

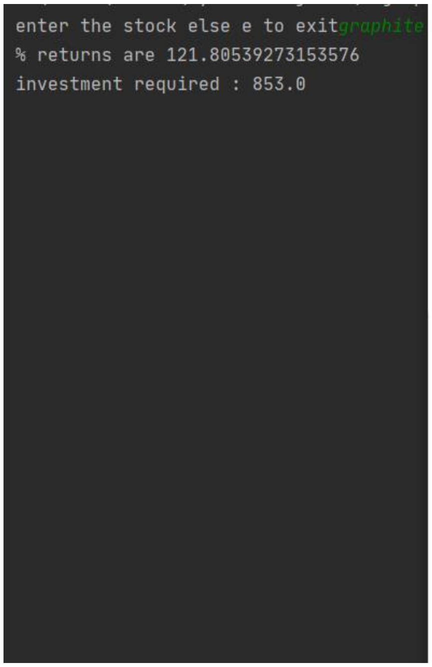
A. Mean Reversion:



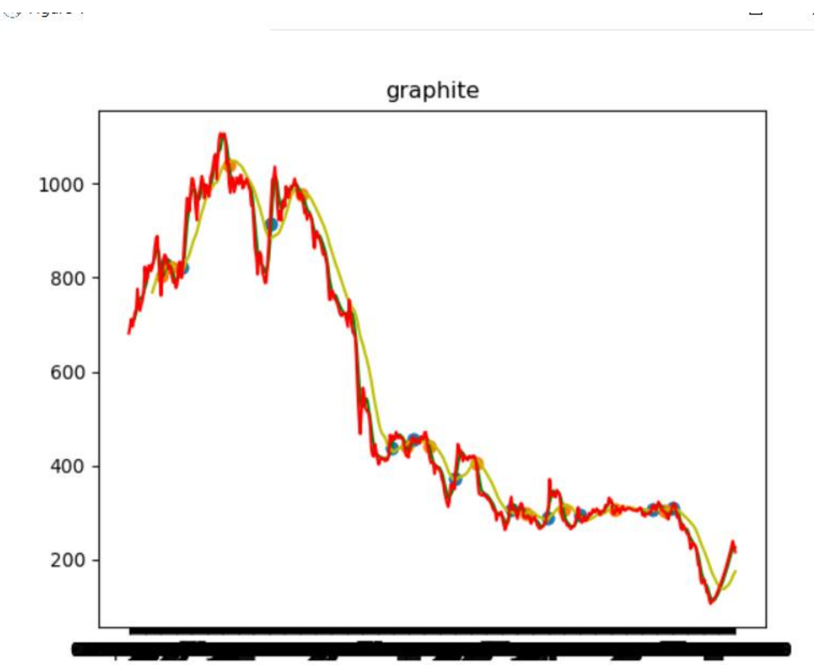
```
enter the stock else e to exitgraphite
time taken is  0.0 seconds
% of returns are 33.11026131293815
```



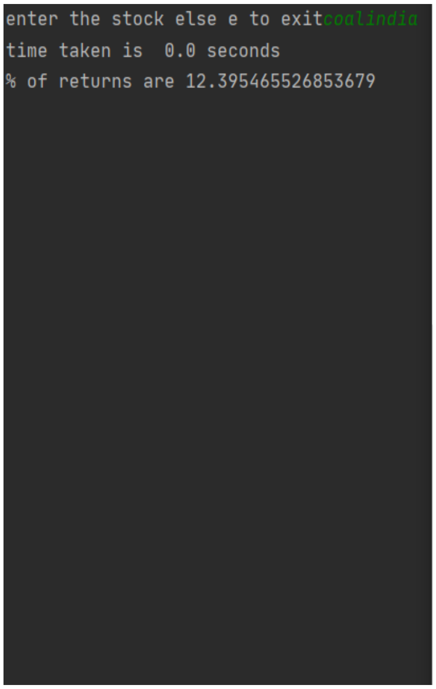
B. VWAP:



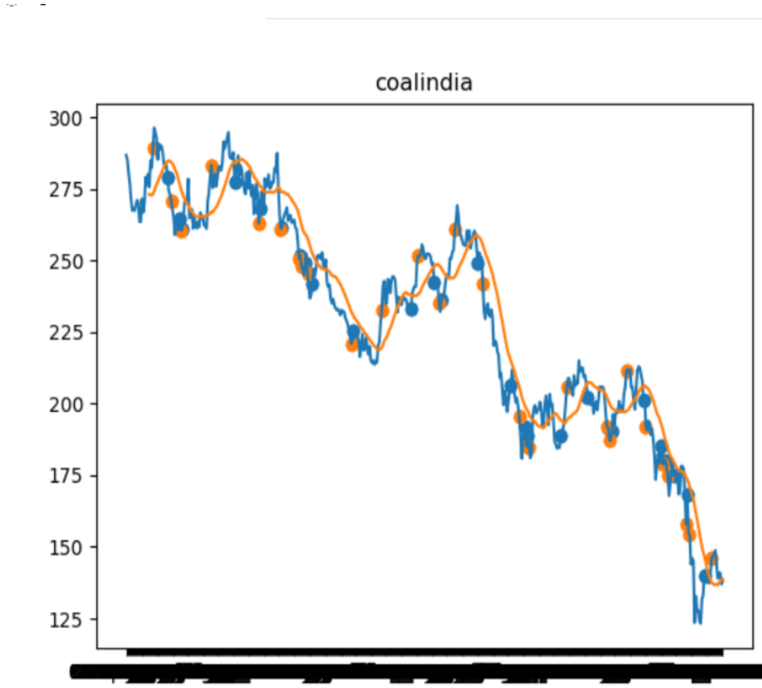
```
enter the stock else e to exitgraphite
% returns are 121.80539273153576
investment required : 853.0
```



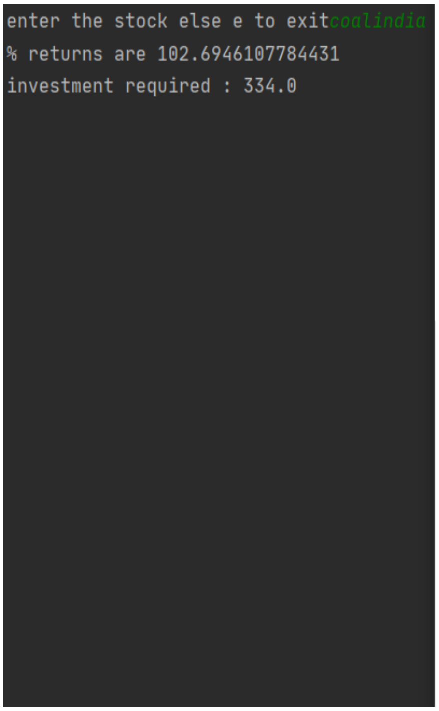
4. COALINDIA
    A. Mean Reversion:



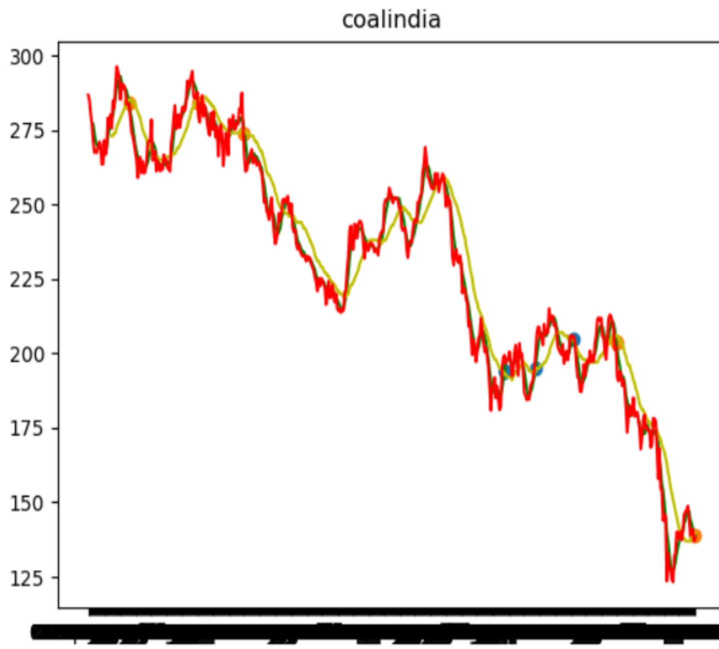
```
enter the stock else e to exitcoalindia
time taken is  0.0 seconds
% of returns are 12.395465526853679
```



    B. VWAP:

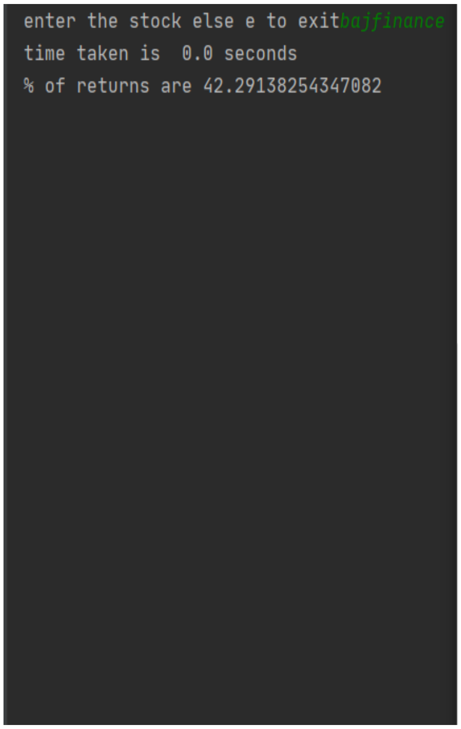


```
enter the stock else e to exitcoalindia
% returns are 102.6946107784431
investment required : 334.0
```

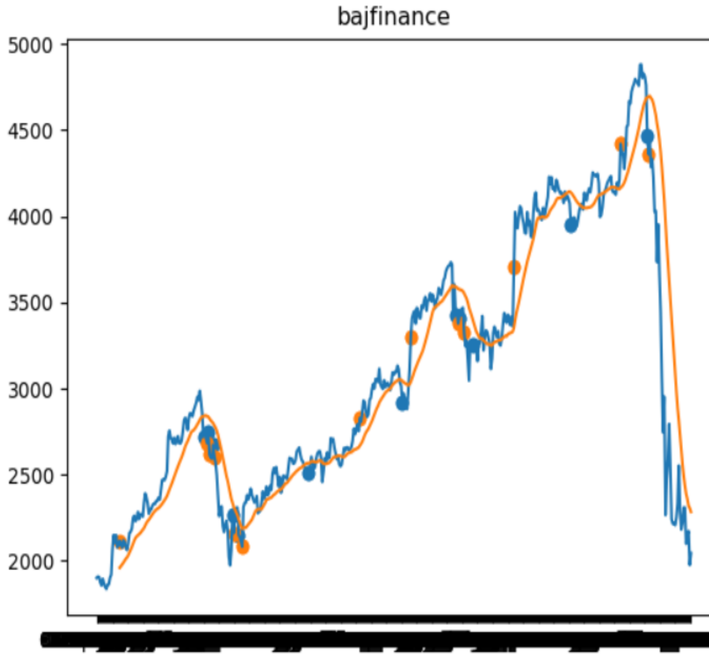


5. BAJFINANCE

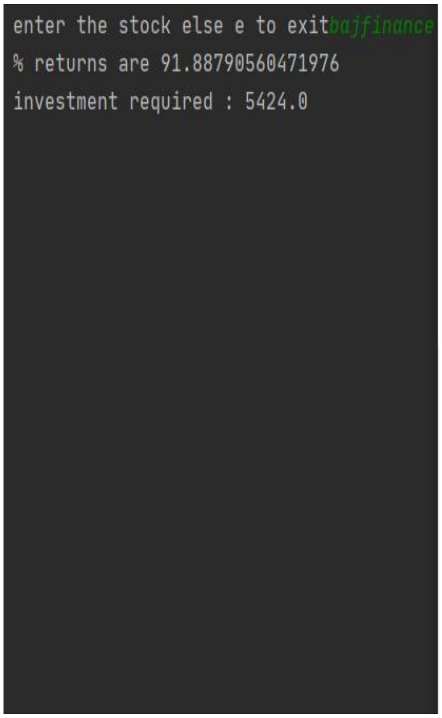
A. Mean Reversion:



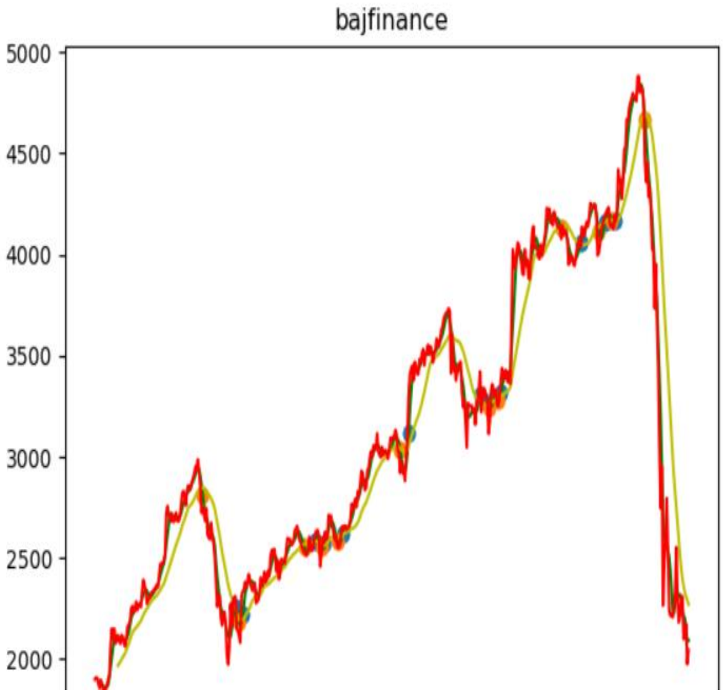
```
enter the stock else e to exitbajfinance
time taken is  0.0 seconds
% of returns are 42.29138254347082
```



B. VWAP:

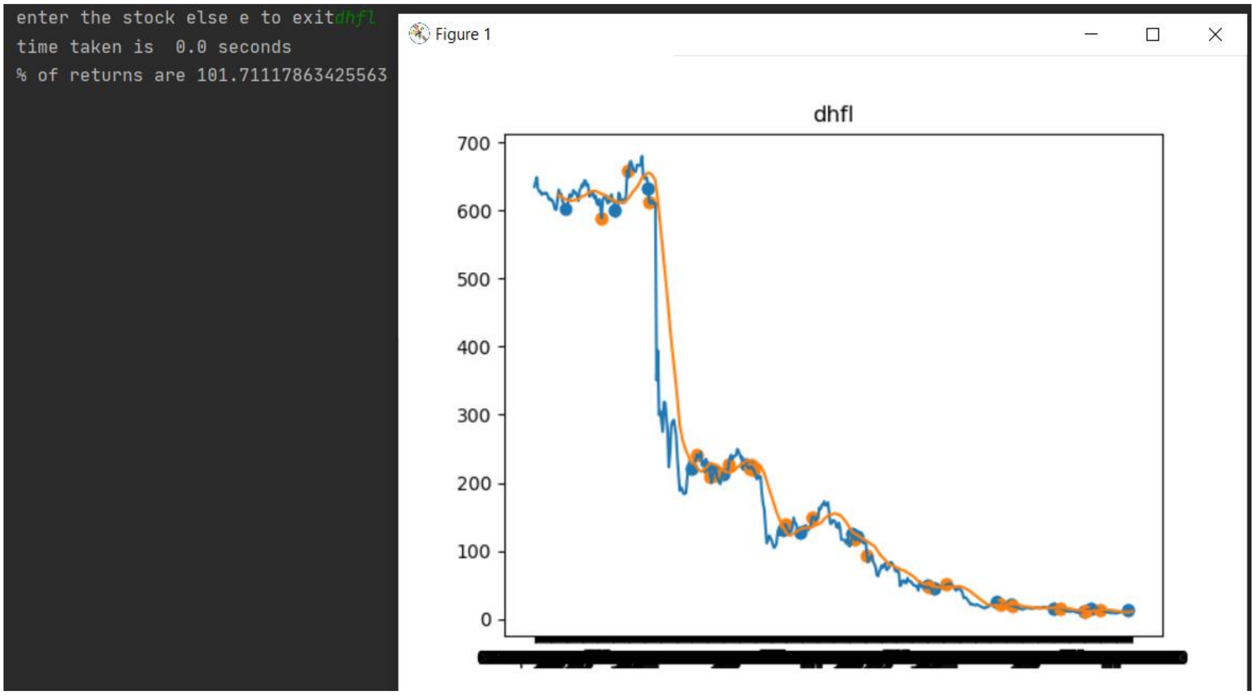


```
enter the stock else e to exitbajfinance
% returns are 91.88790560471976
investment required : 5424.0
```



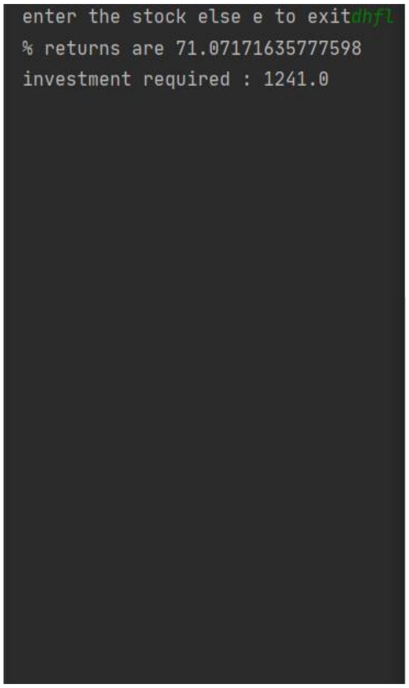
6. DHFL

A. Mean Reversion:

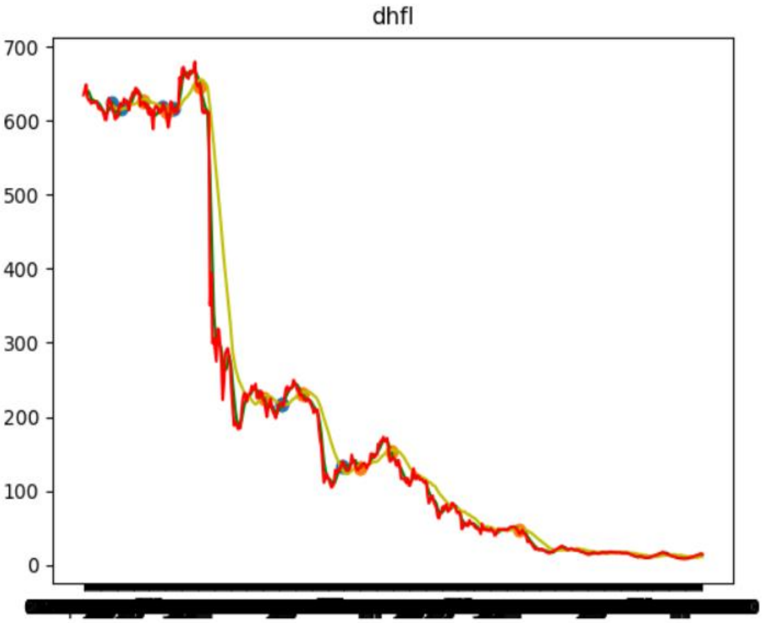


```
enter the stock else e to exitdhfl
time taken is  0.0 seconds
% of returns are 101.71117863425563
```

B. VWAP:

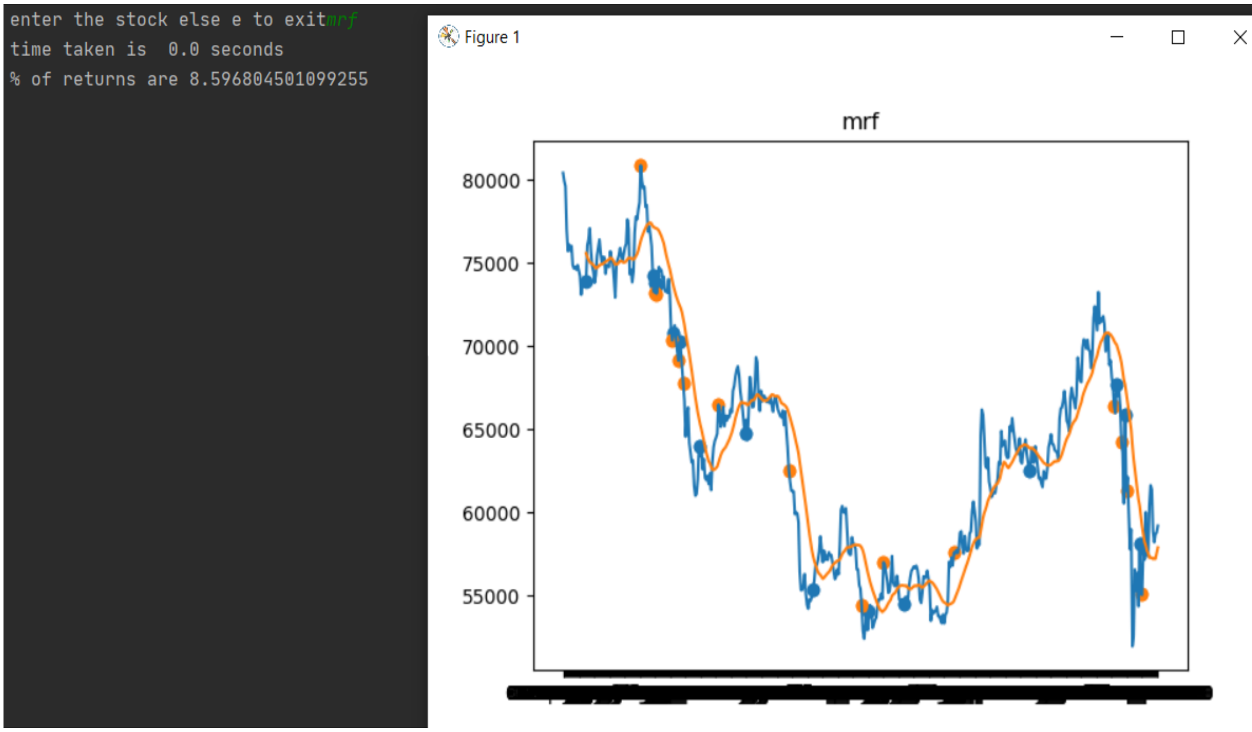


```
enter the stock else e to exitdhfl
% returns are 71.07171635777598
investment required : 1241.0
```



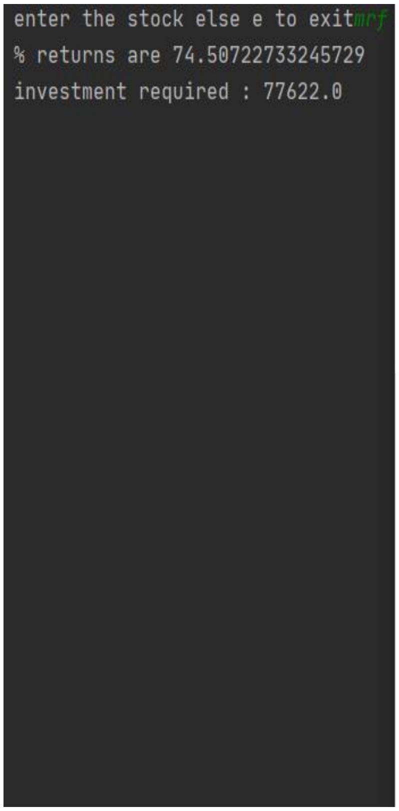
7. MRF

A. Mean Reversion:

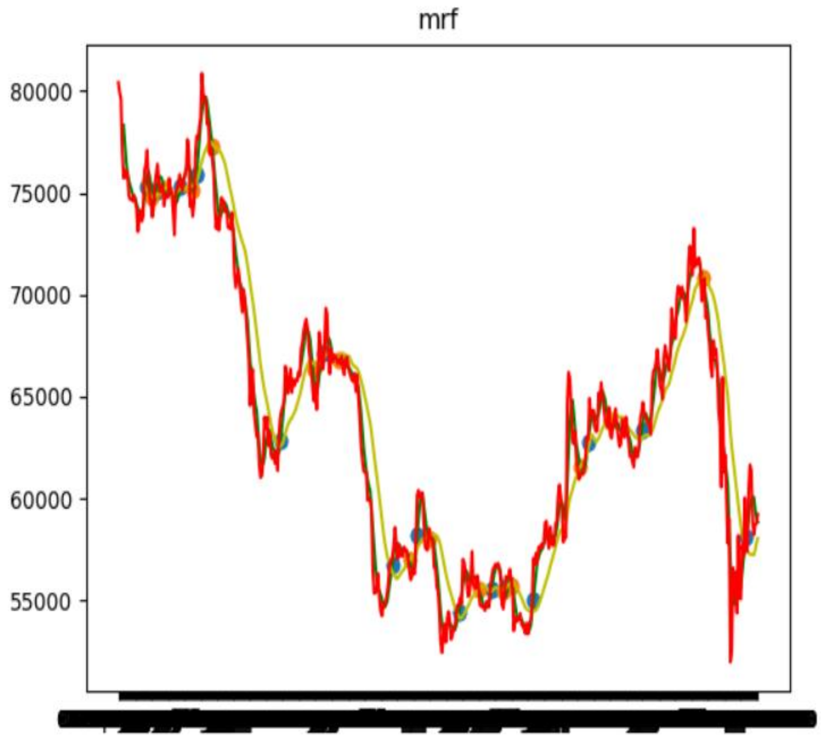


```
enter the stock else e to exitmrf
time taken is  0.0 seconds
% of returns are 8.596804501099255
```

B. VWAP:

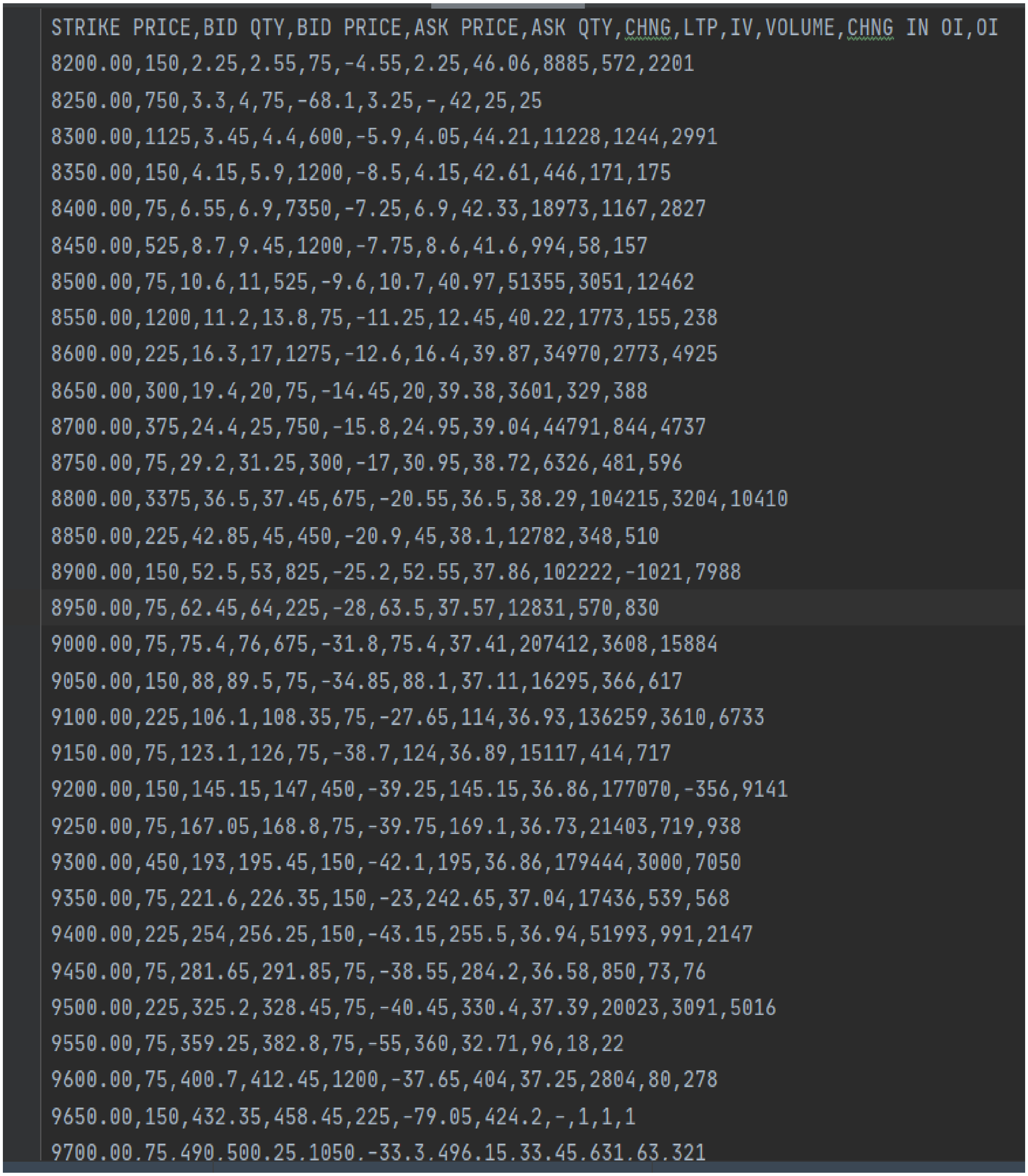


```
enter the stock else e to exitmrf
% returns are 74.50722733245729
investment required : 77622.0
```



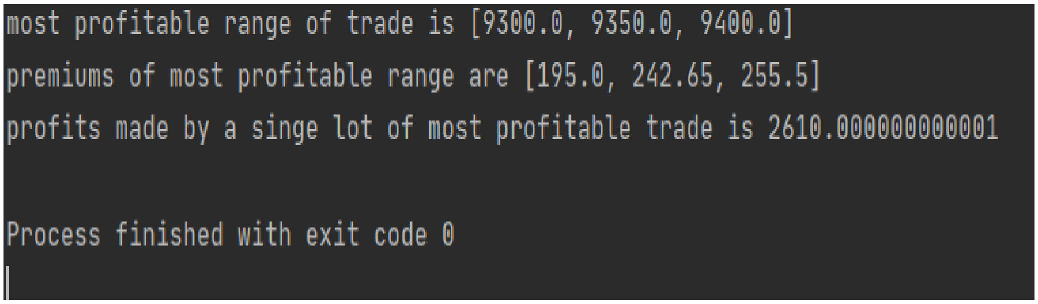
IMPLEMENTAION OF BID-ASK SPREAD WITH OPTION CHAIN

OF 11th may FOR 14th may EXPIRY FOR RISK-FREE TRADE:

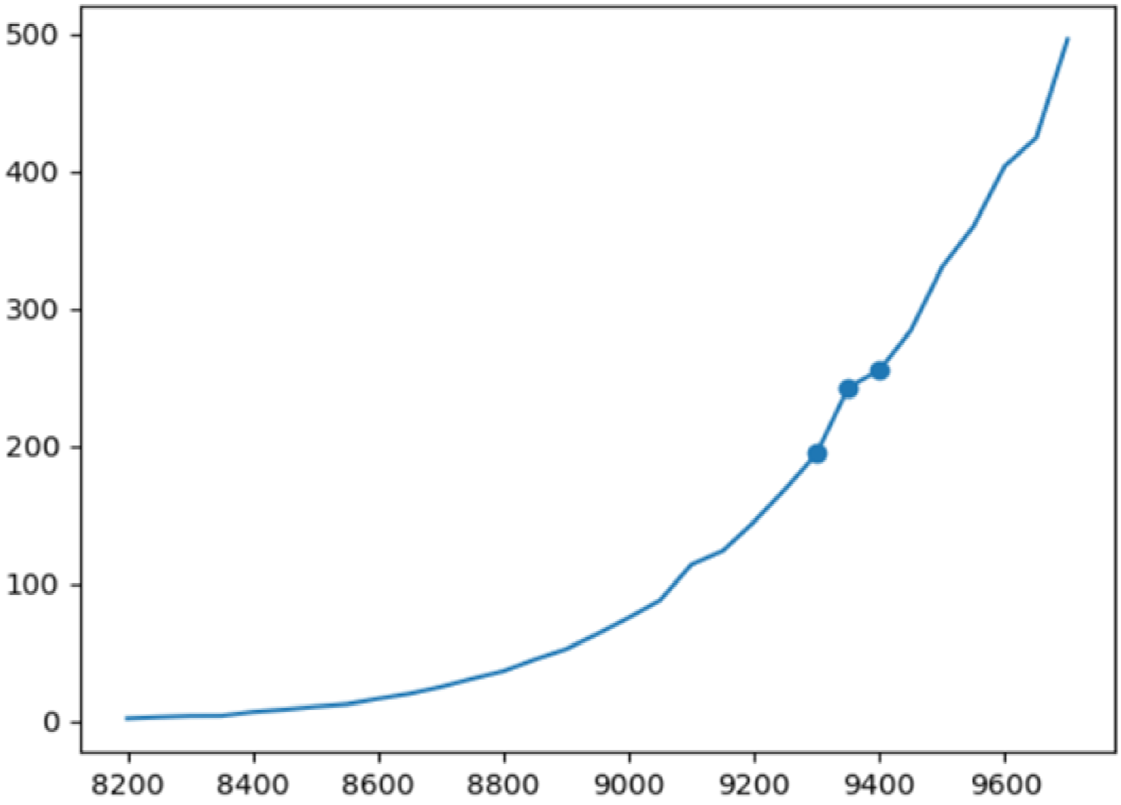


```
STRIKE PRICE,BID QTY,BID PRICE,ASK PRICE,ASK QTY,CHNG,LTP,IV,VOLUME,CHNG IN OI,OI
8200.00,150,2.25,2.55,75,-4.55,2.25,46.06,8885,572,2201
8250.00,750,3.3,4,75,-68.1,3.25,-,42,25,25
8300.00,1125,3.45,4.4,600,-5.9,4.05,44.21,11228,1244,2991
8350.00,150,4.15,5.9,1200,-8.5,4.15,42.61,446,171,175
8400.00,75,6.55,6.9,7350,-7.25,6.9,42.33,18973,1167,2827
8450.00,525,8.7,9.45,1200,-7.75,8.6,41.6,994,58,157
8500.00,75,10.6,11,525,-9.6,10.7,40.97,51355,3051,12462
8550.00,1200,11.2,13.8,75,-11.25,12.45,40.22,1773,155,238
8600.00,225,16.3,17,1275,-12.6,16.4,39.87,34970,2773,4925
8650.00,300,19.4,20,75,-14.45,20,39.38,3601,329,388
8700.00,375,24.4,25,750,-15.8,24.95,39.04,44791,844,4737
8750.00,75,29.2,31.25,300,-17,30.95,38.72,6326,481,596
8800.00,3375,36.5,37.45,675,-20.55,36.5,38.29,104215,3204,10410
8850.00,225,42.85,45,450,-20.9,45,38.1,12782,348,510
8900.00,150,52.5,53,825,-25.2,52.55,37.86,102222,-1021,7988
8950.00,75,62.45,64,225,-28,63.5,37.57,12831,570,830
9000.00,75,75.4,76,675,-31.8,75.4,37.41,207412,3608,15884
9050.00,150,88,89.5,75,-34.85,88.1,37.11,16295,366,617
9100.00,225,106.1,108.35,75,-27.65,114,36.93,136259,3610,6733
9150.00,75,123.1,126,75,-38.7,124,36.89,15117,414,717
9200.00,150,145.15,147,450,-39.25,145.15,36.86,177070,-356,9141
9250.00,75,167.05,168.8,75,-39.75,169.1,36.73,21403,719,938
9300.00,450,193,195.45,150,-42.1,195,36.86,179444,3000,7050
9350.00,75,221.6,226.35,150,-23,242.65,37.04,17436,539,568
9400.00,225,254,256.25,150,-43.15,255.5,36.94,51993,991,2147
9450.00,75,281.65,291.85,75,-38.55,284.2,36.58,850,73,76
9500.00,225,325.2,328.45,75,-40.45,330.4,37.39,20023,3091,5016
9550.00,75,359.25,382.8,75,-55,360,32.71,96,18,22
9600.00,75,400.7,412.45,1200,-37.65,404,37.25,2804,80,278
9650.00,150,432.35,458.45,225,-79.05,424.2,-,1,1,1
9700.00,75,490,500.25,1050,-33.3,496.15,33.45,631,63,321
```

Strike prices with their premium and maximum profit trade



```
most profitable range of trade is [9300.0, 9350.0, 9400.0]
premiums of most profitable range are [195.0, 242.65, 255.5]
profits made by a singe lot of most profitable trade is 2610.000000000001


Process finished with exit code 0
```



Conclusion and Future Work:

1. VWAP is a better strategy for blue-chip, stable and non-volatile stocks.
2. Mean-reversion is advantageous when some share shows unexpected results or is very much volatile.
3. By means of bid-ask spread we can find opportunities for risk-free trades with infinite returns in the option chain.
4. Black-box trading or Algo-trading is the future of trade. Today we have a lot of indicators and technical tools for trading and the field is still developing at a nice pace so in near future development of even more better algorithms and strategies is very much a possibility.

References:

https://www1.nseindia.com/

https://financialmodelingprep.com/developer/docs/

https://www.investopedia.com/