assessment-notebook-group6

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0.1 Assessment Notebook_Group 6

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0.2 Install the Packages

[3]:

```
pip install --upgrade pip
```

```
Requirement already satisfied: pip in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (23.1.2)
Collecting pip
  Downloading pip-24.2-py3-none-any.whl (1.8 MB)
                           1.8/1.8 MB
422.0 kB/s eta 0:00:0000:0100:01
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 23.1.2
    Uninstalling pip-23.1.2:
      Successfully uninstalled pip-23.1.2
Successfully installed pip-24.2
Note: you may need to restart the kernel to use updated packages.
```

[4]:

```
pip install yfinance
```

```
Requirement already satisfied: yfinance in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (0.2.20)
Requirement already satisfied: pandas>=1.3.0 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (1.5.3)
Requirement already satisfied: numpy>=1.16.5 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (1.23.5)
Requirement already satisfied: requests>=2.26 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (2.28.1)
Requirement already satisfied: multitasking>=0.0.7 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (0.0.11)
Requirement already satisfied: lxml>=4.9.1 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (4.9.1)
Requirement already satisfied: appdirs>=1.4.4 in
```

```
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (1.4.4)
Requirement already satisfied: pytz>=2022.5 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (2022.7)
Requirement already satisfied: frozendict>=2.3.4 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (2.3.8)
Requirement already satisfied: cryptography>=3.3.2 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (39.0.1)
Requirement already satisfied: beautifulsoup4>=4.11.1 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (4.11.1)
Requirement already satisfied: html5lib>=1.1 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from yfinance) (1.1)
Requirement already satisfied: soupsieve>1.2 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
beautifulsoup4>=4.11.1->yfinance) (2.3.2.post1)
Requirement already satisfied: cffi>=1.12 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
cryptography>=3.3.2->yfinance) (1.15.1)
Requirement already satisfied: six>=1.9 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
html5lib>=1.1->yfinance) (1.16.0)
Requirement already satisfied: webencodings in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
html5lib>=1.1->yfinance) (0.5.1)
Requirement already satisfied: python-dateutil>=2.8.1 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
pandas>=1.3.0->yfinance) (2.8.2)
Requirement already satisfied: charset-normalizer<3,>=2 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
requests>=2.26->yfinance) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
requests>=2.26->yfinance) (3.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
requests>=2.26->yfinance) (1.26.14)
Requirement already satisfied: certifi>=2017.4.17 in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
requests>=2.26->yfinance) (2023.5.7)
Requirement already satisfied: pycparser in
/Users/xinruyu/anaconda3/lib/python3.10/site-packages (from
cffi>=1.12->cryptography>=3.3.2->yfinance) (2.21)
Note: you may need to restart the kernel to use updated packages.
```

[5]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import yfinance as yf
```

```
from pandas_datareader import data
```

0.3 Download Data

[6]:
```
# DOWNLOAD DATA

# only change the equity ticker strings if required
# don't change the variable name "tickers"
tickers = [ \
    'AAPL', # Apple
    'MSFT', # Microsoft
    'AMZN', # Amazon
    '^GSPC'] # S&P500 - Benchmark

# only change string values if required
# don't change the two variable names "start_date" and "end_date"
start_date = '2010-01-01'
end_date = '2023-06-14'

# download the time series of adj. close price
# for each of the tickers from Yahoo finance
# in case you receive an error go through this:
## https://stackoverflow.com/questions/74832296/
 ↪typeerror-string-indices-must-be-integers-when-getting-data-of-a-stock-from-y
price_data = {}

for ticker in tickers:
    price_data[ticker] = yf.download(ticker, start=start_date,␣
 ↪end=end_date)['Adj Close']

# create dataframe with one row per day and adj. close price for each of the␣
 ↪tickers
# and dataframe with price changes
df_prices = pd.concat([price_data[ticker].rename(ticker) for ticker in␣
 ↪tickers], axis=1)
prev = df_prices.to_numpy()
prev = prev / np.insert(prev[:-1,:], 0, np.ones(prev.shape[1]), 0)
prev[0] = np.ones(prev.shape[1])
df_price_changes = df_prices.copy(deep=True)
df_price_changes[:] = prev

# print dataframes
print(df_prices)
print(df_price_changes)
```

```
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
```

```
[*********************100%***********************]  1 of 1 completed
[*********************100%***********************]  1 of 1 completed
                  AAPL        MSFT        AMZN        ^GSPC
Date
2010-01-04    6.454505   23.347319    6.695000  1132.989990
2010-01-05    6.465663   23.354860    6.734500  1136.520020
2010-01-06    6.362819   23.211538    6.612500  1137.140015
2010-01-07    6.351057   22.970135    6.500000  1141.689941
2010-01-08    6.393281   23.128555    6.676000  1144.979980
…                  …           …          …           …
2023-06-07  176.676147  320.292603  121.230003  4267.520020
2023-06-08  179.408447  322.154694  124.250000  4293.930176
2023-06-09  179.795929  323.670105  123.430000  4298.859863
2023-06-12  182.607727  328.681763  126.570000  4338.930176
2023-06-13  182.130829  331.098511  126.660004  4369.009766

[3384 rows x 4 columns]
                AAPL      MSFT      AMZN     ^GSPC
Date
2010-01-04  1.000000  1.000000  1.000000  1.000000
2010-01-05  1.001729  1.000323  1.005900  1.003116
2010-01-06  0.984094  0.993863  0.981884  1.000546
2010-01-07  0.998151  0.989600  0.982987  1.004001
2010-01-08  1.006648  1.006897  1.027077  1.002882
…                …         …         …         …
2023-06-07  0.992244  0.969132  0.957507  0.996188
2023-06-08  1.015465  1.005814  1.024911  1.006189
2023-06-09  1.002160  1.004704  0.993400  1.001148
2023-06-12  1.015639  1.015484  1.025440  1.009321
2023-06-13  0.997388  1.007353  1.000711  1.006932

[3384 rows x 4 columns]
```

0.4 Define the Moving Average Function

[7]:

```python
# define the Moving average crossover
def moving_avg_crossover(prices, window_length):
# set the size of moving average series
    T = len(prices)
    moving_avg = np.zeros(T)
    moving_avg[:] = np.nan
# calculate the average by moving time period
    for n in range(window_length, T):
      moving_avg[n] = np.sum(prices[n-window_length:n]) / window_length
    return moving_avg
```

0.5 Define the Standard Deviation

[8]:

```
# calculate the standard deviation of moving average for Bollinger bands
def standard_deviation(prices, moving_avg_crossover):
    std= (((prices - moving_avg_crossover)**2)**0.5)
    return std
```

0.6 Define other necessary Functions

[9]:

```
# calculate the mean
def cal_mean(inputs):
    return np.sum(inputs) / len(inputs)

# calculate standard deviation
def cal_std(inputs):
    return np.sqrt(np.sum(np.square(inputs - cal_mean(inputs))) / len(inputs))

# calculate log returns
def log_return(inputs):
    return np.log(inputs).diff()

def calculate_excess_average(df):
    """
    Calculate the average daily return in excess of a risk-free rate
    """
    return df.mean()

def calculate_std_dev(df):
    """
    Calculate the standard deviation of daily returns using the formula you provided
    """
    avg = df.mean()
    var = sum(pow(x-avg,2) for x in df) / len(df)
    return np.sqrt(var)

def calculate_sharpe_ratio(df):
    """
    Calculate the Sharpe ratio for each strategy
    """
    # Calculate average excess return
    excess_average = calculate_excess_average(df)

    # Calculate standard deviation
    std_dev = df.apply(calculate_std_dev, axis=0)

    # Calculate Sharpe ratio
    sharpe_ratio = excess_average / std_dev

    return sharpe_ratio
```

0.7 1. Signal 0: Moving Average Crossover

[10]:

```
### SIGNAL 0

def signal_0(series):
    # Init
    signals = pd.DataFrame(index = series.index)
    signals['signal'] = 0.0

    # Compute simple moving average for short-term and long-term
    short_window = 20
    long_window = 100
    signals['short_ma'] = moving_avg_crossover(series, short_window)
    signals['long_ma'] = moving_avg_crossover(series, long_window)

    # Compute signals: buys and sells
    signals['buy']= np.where(signals['short_ma']> signals['long_ma'], 1.0, 0.0)
    signals['sell'] = np.where(signals['short_ma']< signals['long_ma'], -1.0,␣
 ↪signals['signal'])

    # modify the real signals in order to do not generate sell signals when␣
 ↪there were no buy signals before,
    # and in order to record the real buy, holding, sell signals
    # if previos signal is 0 and buy signal occurs in the current, buy the stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 0) &␣
 ↪(signals['buy'] == 1), 1, signals['signal'])
    # if previos signal is 0 and sell signal occurs in the current, do not sell␣
 ↪the stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 0) &␣
 ↪(signals['sell'] ==-1), 0,signals['signal'] )
    # if previos signal is buy and sell signal occurs in the current, sell the␣
 ↪stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 1) &␣
 ↪(signals['sell'] == -1), -1, signals['signal'])
    # if previos signal is 0 and buy signal occurs in the current, buy the stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 1) &␣
 ↪(signals['buy'] == 1), 1, signals['signal'])
    # if previos signal is sell and sell signal occurs in the current, return␣
 ↪zero, do not sell when there were no buy signal before
    signals['signal'] = np.where((signals['signal'].shift(1) == -1) &␣
 ↪(signals['sell'] == -1), 0, signals['signal'])
```

```
    # if previos signal is sell and buy signal occurs in the current, buy the␣
↪stock
    signals['signal'] = np.where((signals['signal'].shift(1) == -1) &␣
↪(signals['buy'] == 1), 1, signals['signal'])

    # compute the position_change in order to deliver it to portflio allocation
    signals['position_change'] = signals['signal'].diff()
    signals.loc[series.index[0], 'position_change'] = 0
    return signals
```

0.8 2. Signal 1: Bollinger Bands

```
[11]: def signal_1(series):
          # Initial Dataframe
          signals = pd.DataFrame(index = series.index)
          signals['signal'] = 0.0
          # calculate the middle line: moving average
          mid_window=20
          signals['mid_line'] = moving_avg_crossover(series, mid_window)
          # calculate the moving standard deviation
          signals['std'] = standard_deviation(series, signals['mid_line'])
          signals['moving_avg_std'] = moving_avg_crossover(signals['std'], mid_window)
          # calculate the upper band
          signals['upper_line'] = moving_avg_crossover(series,␣
      ↪mid_window)+(2*signals['moving_avg_std'])
          # calculate the lower band
          signals['lower_line'] = moving_avg_crossover(series,␣
      ↪mid_window)-(2*signals['moving_avg_std'])

          # Compute signals: buys and sells
          signals['buy'] = np.where(series < signals['lower_line'] , 1.0, 0.0)
          signals['sell'] = np.where(series > signals['upper_line'], - 1.0,␣
      ↪signals['signal'])

          # modify the real signals in order to do not generate sell signals when␣
      ↪there were no buy signals before,
          # and in order to record the real buy, holding, sell signals
          # if previos signal is 0 and buy signal occurs in the current, buy the stock
          signals['signal'] = np.where((signals['signal'].shift(1) == 0) &␣
      ↪(signals['buy'] == 1), 1, signals['signal'])
          # if previos signal is 0 and sell signal occurs in the current, do not sell␣
      ↪the stock
          signals['signal'] = np.where((signals['signal'].shift(1) == 0) &␣
      ↪(signals['sell'] ==-1), 0,signals['signal'] )
          # if previos signal is buy and sell signal occurs in the current, sell the␣
      ↪stock
```

```
    signals['signal'] = np.where((signals['signal'].shift(1) == 1) &␣
↪(signals['sell'] == -1), -1, signals['signal'])
    # if previos signal is 0 and buy signal occurs in the current, buy the stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 1) &␣
↪(signals['buy'] == 1), 1, signals['signal'])
    # if previos signal is sell and sell signal occurs in the current, return␣
↪zero, do not sell when there were no buy signal before
    signals['signal'] = np.where((signals['signal'].shift(1) == -1) &␣
↪(signals['sell'] == -1), 0, signals['signal'])
    # if previos signal is sell and buy signal occurs in the current, buy the␣
↪stock
    signals['signal'] = np.where((signals['signal'].shift(1) == -1) &␣
↪(signals['buy'] == 1), 1, signals['signal'])

    # compute the position_change in order to deliver it to portflio allocation
    signals['position_change'] = signals['signal'].diff()
    signals.loc[series.index[0], 'position_change'] = 0


    return signals
```

0.9 3. Signal 2: Relative Strength Index

[12]:

```
def signal_2(series):
    signals = pd.DataFrame(index = series.index)
    signals['signal'] = 0.0
    # Set the window period as 14 days
    window_period = 14
    signals['price']=series
    signals['prices_diff'] = series.diff()
    # calculate the gain and loss during the lookback period
    # for the gain history within the lookback period (0 if there is no gain,␣
↪and the magnitude of gain if there is gain)
    signals['up'] = np.where(signals['prices_diff'] > 0,␣
↪signals['prices_diff'], 0.0)
    # for the loss history within the lookback period (0 if there is no loss,␣
↪and the magnitude of loss if there is loss)
    signals['down'] = np.where(signals['prices_diff'] < 0, np.
↪abs(signals['prices_diff']), 0.0)
    # set the lookback period as 14 days, a half of 28 days also support the␣
↪results
    signals['avg_up'] = moving_avg_crossover(signals['up'], window_period)
    signals['avg_down'] = moving_avg_crossover(signals['down'], window_period)

    # Compute signals
    # calculate RS, and then RSI
    signals['RS'] =  signals['avg_up'] / signals['avg_down']
    signals['RSI'] = 100 - (100 / (1.0 + signals['RS']))
    # Generate signals

    signals['buy'] = np.where(signals['RSI'] < 30 , 1.0, 0.0)
    # derive position change directly from signal
    signals['sell'] = np.where(70 < signals['RSI'] , -1.0, signals['signal'])

    # modify the real signals in order to do not generate sell signals when␣
↪there were no buy signals before,
    # and in order to record the real buy, holding, sell signals
    # if previos signal is 0 and buy signal occurs in the current, buy the stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 0) &␣
↪(signals['buy'] == 1), 1, signals['signal'])
    # if previos signal is 0 and sell signal occurs in the current, do not sell␣
↪the stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 0) &␣
↪(signals['sell'] ==-1), 0,signals['signal'] )
    # if previos signal is buy and sell signal occurs in the current, sell the␣
↪stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 1) &␣
↪(signals['sell'] == -1), -1, signals['signal'])
    # if previos signal is 0 and buy signal occurs in the current, buy the stock
    signals['signal'] = np.where((signals['signal'].shift(1) == 1) &␣
↪(signals['buy'] == 1), 1, signals['signal'])
    # if previos signal is sell and sell signal occurs in the current, return␣
↪zero, do not sell when there were no buy signal before
    signals['signal'] = np.where((signals['signal'].shift(1) == -1) &␣
↪(signals['sell'] == -1), 0, signals['signal'])
    # if previos signal is sell and buy signal occurs in the current, buy the␣
↪stock
    signals['signal'] = np.where((signals['signal'].shift(1) == -1) &␣
↪(signals['buy'] == 1), 1, signals['signal'])

    # compute the position_change in order to deliver it to portflio allocation
    signals['position_change'] = signals['signal'].diff()
    signals.loc[series.index[0], 'position_change'] = 0
    return signals
```

0.10 Compute 3 signals together

[13]:
```
# Compute signals
signals = {}
# Moving average crossover for AAPL
signals[tickers[0]] = signal_0(df_prices[tickers[0]])
# Bollinger band for MSFT
```

```
signals[tickers[1]] = signal_1(df_prices[tickers[1]])
# RSI for AMZN
signals[tickers[2]] = signal_2(df_prices[tickers[2]])
df_position_open = pd.concat([
    signals[tickers[0]]['signal'].rename(tickers[0]),
    signals[tickers[1]]['signal'].rename(tickers[1]),
    signals[tickers[2]]['signal'].rename(tickers[2])], axis = 1)
df_position_changes = pd.concat([
    signals[tickers[0]]['position_change'].rename(tickers[0]),
    signals[tickers[1]]['position_change'].rename(tickers[1]),
    signals[tickers[2]]['position_change'].rename(tickers[2])], axis = 1)
```

0.11 Portfolio Allocation

[14]:

```
# ALLOCATE CAPITAL AND COMPUTE RESULTING POSITIONS
initial_cash = 1.0
capital_fraction_per_trade = 0.25

# DO NOT MODIFY THIS CELL BELOW THIS LINE
position = []

def open_trades(position, position_change):
    vec = np.maximum([position_change[ticker] for ticker in tickers[:-1]], [0])
    vec = position[-1] * (1 - np.power((1 - capital_fraction_per_trade), np.
 ↪sum(vec))) * vec / (1 if (np.nansum(vec) == 0.0) else np.nansum(vec))
    return np.append(vec + position[:-1], position[-1] - np.sum(vec))

def hold_trades(position, price_change):
    return np.concatenate((position[:-1] * price_change[:-1], [position[-1]]))

def close_trades(position, position_change):
    vec = np.concatenate((np.array([position_change[ticker] < 0.0 for ticker in␣
 ↪tickers[:-1]]), [False]))
    position[-1] = position[-1] + np.sum(position[vec])
    position[vec] = 0.0
    return position

is_first = True
for idx, position_change in df_position_changes.iterrows():
    if is_first:
        position.append(open_trades(np.concatenate((np.
 ↪zeros(len(df_position_changes.columns)), [initial_cash])), position_change))
        is_first = False
    else:
        hlpr_pos = hold_trades(position[-1], df_price_changes.loc[[idx]].
 ↪to_numpy()[0])
```

```
        hlpr_pos = close_trades(hlpr_pos, position_change)
        position.append(open_trades(hlpr_pos, position_change))

df_position = pd.DataFrame(position, index = df_prices.index, columns = tickers[:-1] + ['cash'])
```

0.12 Statistics Part

[15]:

```
# COMPUTE MEANINGFUL STATISTICS OF YOUR STRATEGY
# YOU ARE FREE TO CHOOSE MEASURES

# REMEMBER THAT YOU MAY NOT USE READY-TO-USE FUNCTIONS
# WHEN IN DOUBT - CODE A FUNCTION ON YOUR OWN!
# EXAMPLE: .mean() and .std() are ready-to-use, that's why they are implemented below

returns = df_position.sum(axis=1)
returns = (returns[1:].to_numpy() / returns[:-1].to_numpy()) - 1
mean_returns = np.sum(returns) / len(returns)
std_returns = np.sqrt(np.sum(np.square(returns - mean_returns)) / len(returns))
print('Annualized mean: ' + str(mean_returns * 250))
print('Annualized std:  ' + str(std_returns * np.sqrt(250)))
```

```
Annualized mean: 0.1245762482974658
Annualized std:  0.12773001644308574
```

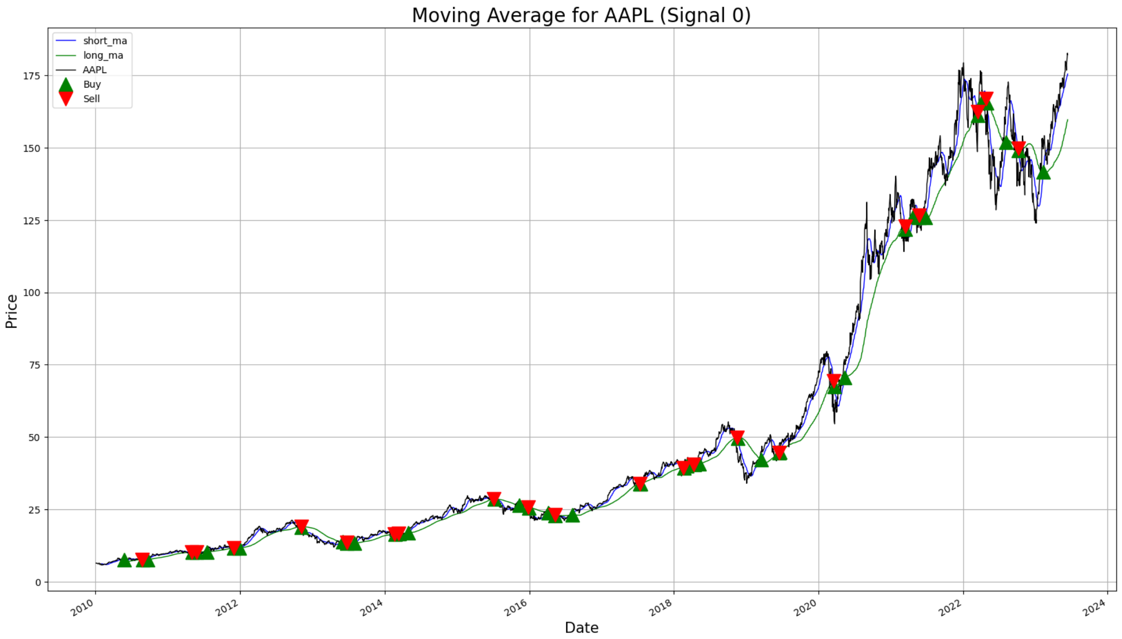
0.13 Plotting

0.13.1 1.Singnal 0: Moving Average

[16]:

```
# Select the APPL ticker for signal 0
appl_prices = df_prices['AAPL']
signals = signal_0(appl_prices)

# plotting
plt.figure(figsize=(20, 12))
signals['short_ma'].plot(color='blue', lw=1, label='short_ma')
signals['long_ma'].plot(color='green', lw=1, label='long_ma')
appl_prices.plot(color='black', lw=1, label='AAPL')

# Plot 'buy' signals
buy_signals = signals[signals['signal'].diff() == 1]
plt.plot(buy_signals.index.tolist(), buy_signals['short_ma'].to_numpy(), '^', markersize=15, color='g', label='Buy')

# Plot 'sell' signals
sell_signals = signals[signals['signal'] == -1]
```

```
plt.plot(sell_signals.index.tolist(), sell_signals['long_ma'].to_numpy(), 'v',␣
  ↪markersize=15, color='r', label='Sell')

plt.ylabel('Price', fontsize=15)
plt.xlabel('Date', fontsize=15)
plt.title('Moving Average for AAPL (Signal 0)', fontsize = 20)
plt.legend()
plt.grid()

plt.show()
```

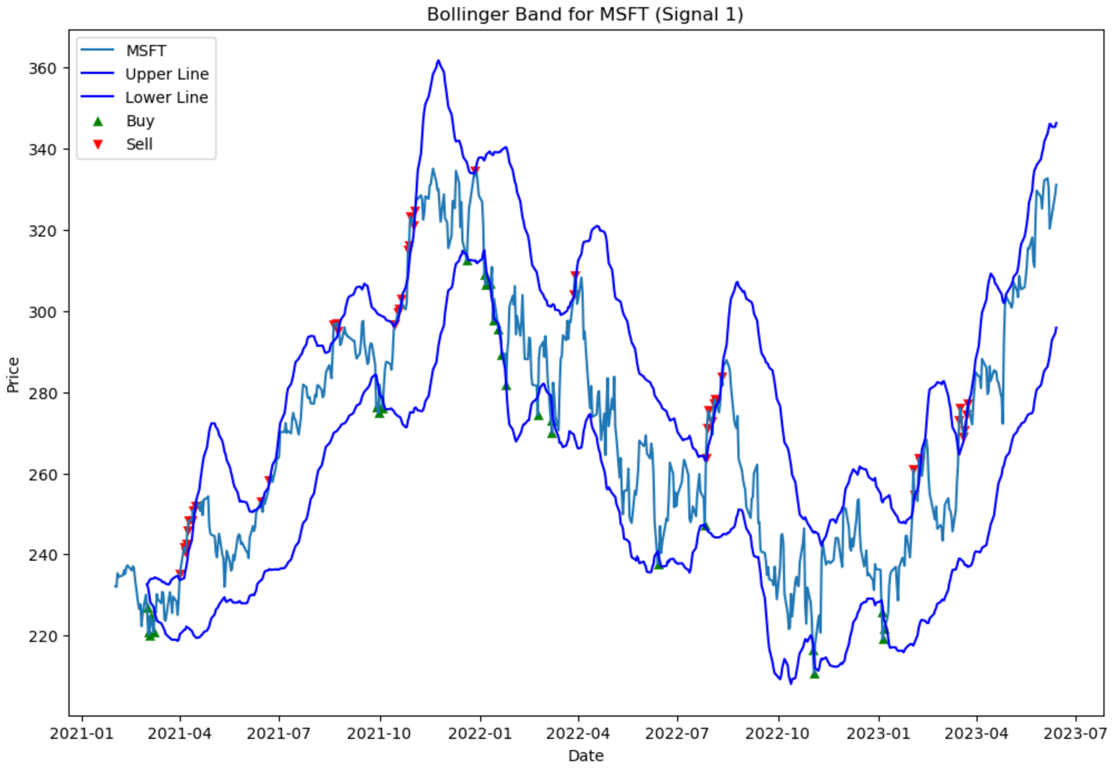


0.13.2 2.Singnal 1: Bollinger Bands

[17]:

```
# Select the MSFT ticker for Signal 1
msft_prices = df_prices['MSFT'].loc['2021-02-01':]

# Compute Signal 1 for MSFT
signals = signal_1(msft_prices)

# Plotting
fig, ax = plt.subplots(figsize=(12, 8))

# Plot the series
ax.plot(msft_prices.index, msft_prices, label='MSFT')

# Plot the upper and lower lines
```

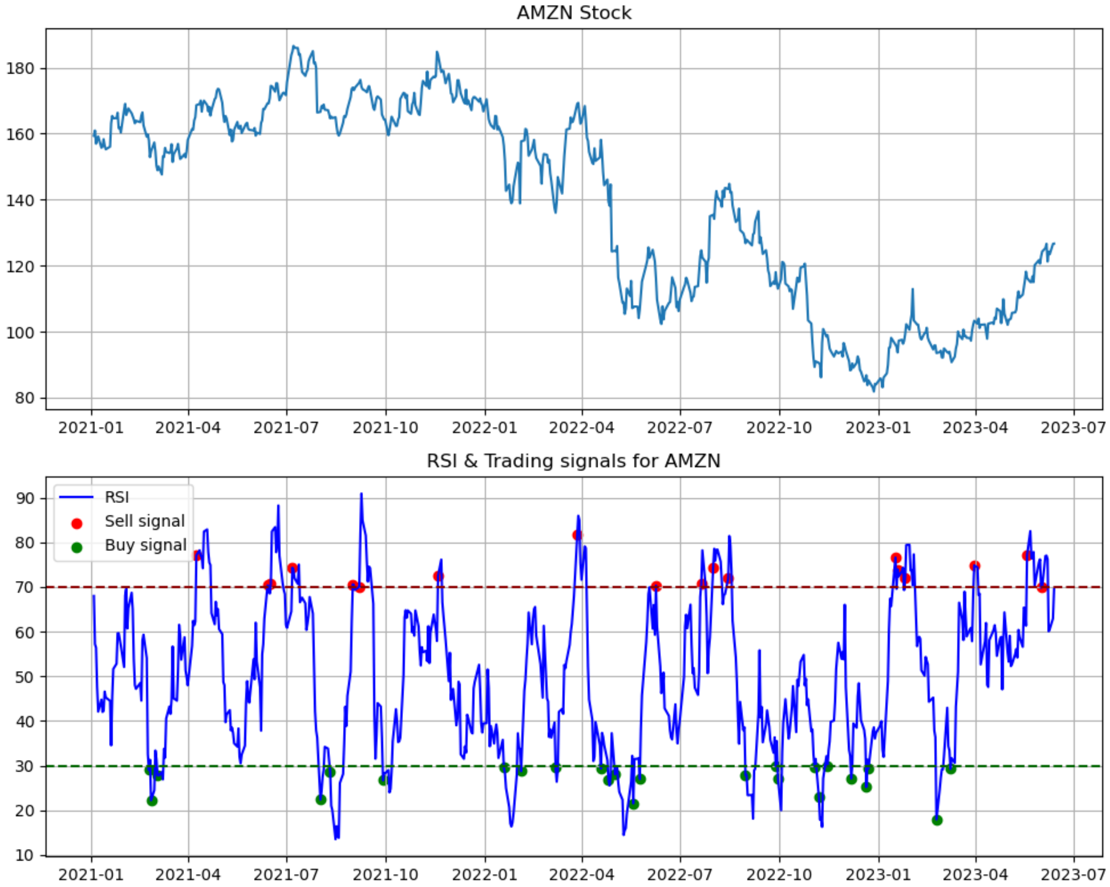
```
ax.plot(signals.index, signals['upper_line'], label='Upper Line', color='b')
ax.plot(signals.index, signals['lower_line'], label='Lower Line', color='b')

# Plot the buy signals
buy_signals = signals[signals['buy'] == 1]
ax.scatter(buy_signals.index, msft_prices.loc[buy_signals.index], color='g',␣
 ↪marker='^', label='Buy', linewidth=0.3)

# Plot the sell signals
sell_signals = signals[signals['sell'] == -1]
ax.scatter(sell_signals.index, msft_prices.loc[sell_signals.index], color='r',␣
 ↪marker='v', label='Sell', linewidth=0.3)

ax.set_xlabel('Date')
ax.set_ylabel('Price')
ax.set_title('Bollinger Band for MSFT (Signal 1)')
ax.legend()

plt.show()
```



0.13.3 3. Signal 2: RSI

[18]:

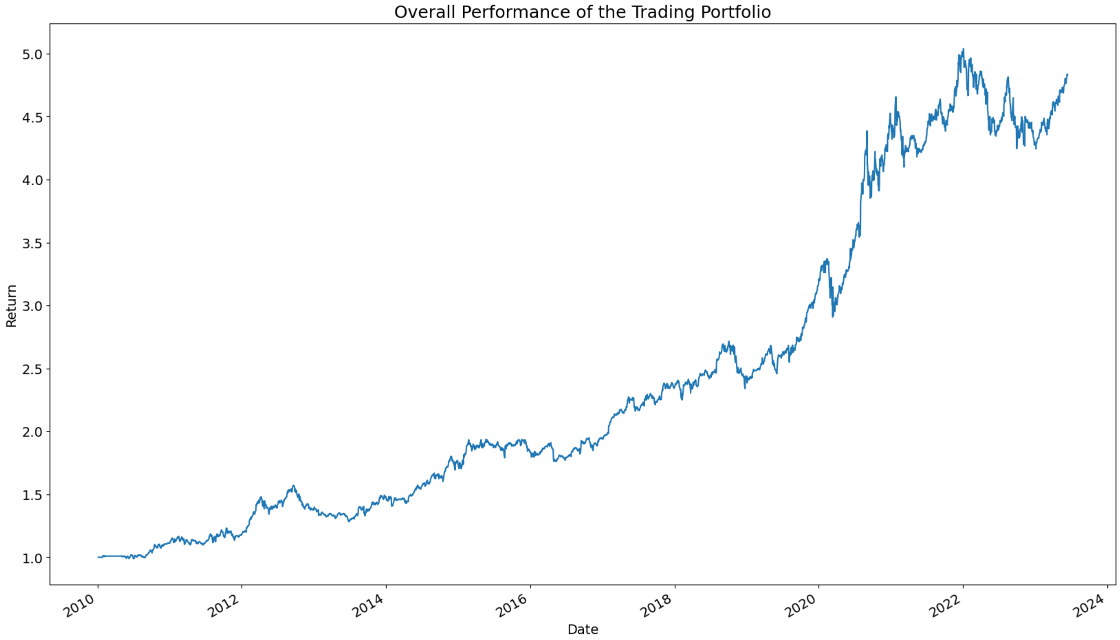
```
# Calculate the signals
amzn_signals = signal_2(df_prices['AMZN'])

# Start for the graphs
amzn_signals = amzn_signals.loc['2021-01-01':]

# Create 2 graphs (Stock and RSI)
fig, ax = plt.subplots(2, 1, figsize=(10,8))

# Showing stock prices
ax[0].plot(amzn_signals.index, amzn_signals['price'], label='Price')
ax[0].set_title('AMZN Stock')
ax[0].grid()

# Parameter for buy and sell signal
prev_rsi = amzn_signals['RSI'].shift(1)
buy = (amzn_signals['RSI'] < 30) & (prev_rsi >= 30)
sell = (amzn_signals['RSI'] > 70) & (prev_rsi <= 70)

# Showing RSI on second graph
ax[1].plot(amzn_signals.index, amzn_signals['RSI'], label='RSI', color='blue')

# Red marker for sell
ax[1].scatter(amzn_signals[sell].index, amzn_signals[sell]['RSI'], color='red', label='Sell signal')

# Green marker for buy
ax[1].scatter(amzn_signals[buy].index, amzn_signals[buy]['RSI'], color='green', label='Buy signal')

# Create barrier (30 and 70)
ax[1].axhline(30, color='darkgreen', linestyle='--')
ax[1].axhline(70, color='darkred', linestyle='--')

ax[1].set_title('RSI & Trading signals for AMZN')
ax[1].grid()

ax[1].legend(loc='upper left')

# Output
plt.tight_layout()
plt.show()
```



0.14 Portfolio

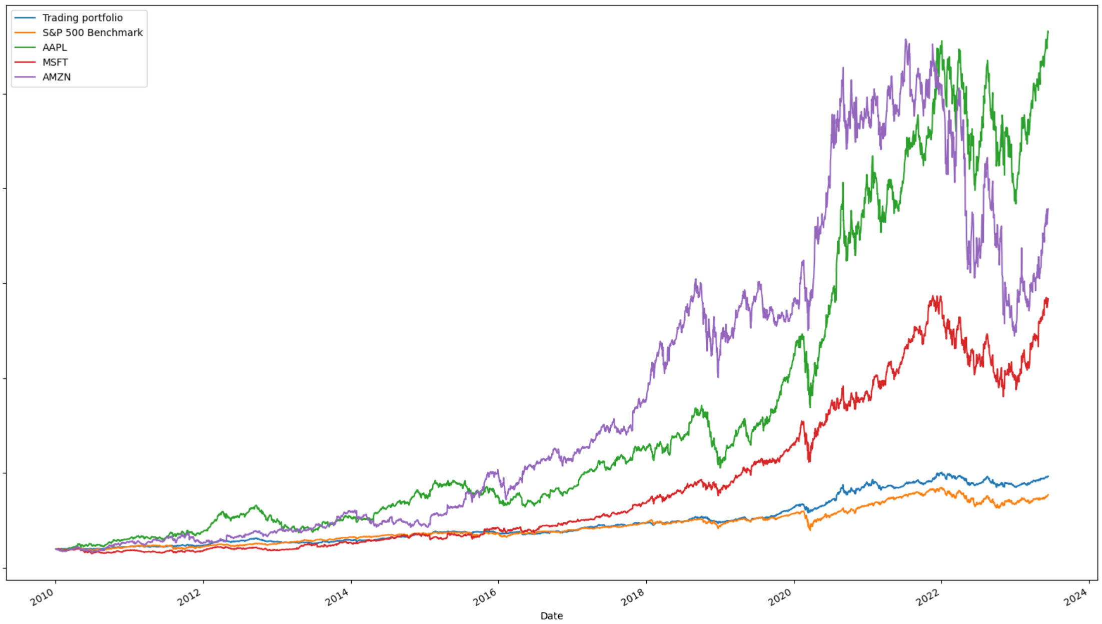
[19]:

```
# COMPUTE MEANINGFUL PLOTS OF YOUR STRATEGY AND LABEL IT IN AN UNDERSTANDABLE WAY
df_position.sum(axis=1).plot(figsize=(20,12))
plt.title("Overall Performance of the Trading Portfolio",fontsize= 18)
plt.xlabel("Date", fontsize = 14)
plt.xticks(fontsize=14)
plt.ylabel("Return", fontsize = 14)
plt.yticks(fontsize=14)
plt.show()
```



```
[20]: # Plotting the portfolio return against S&P 500 Index and the single stock␣
       ↪returns (based on the first day in the data set)

      # Take the stock prices and divide them by the first element in the time frame␣
       ↪to get the percentage return
      df_position.sum(axis=1).plot(label= 'Trading portfolio', linestyle= 'solid',␣
       ↪figsize = (20, 12))
      (df_prices['^GSPC']/(df_prices['^GSPC'][0])).plot(label= 'S&P 500 Benchmark',␣
       ↪linestyle= 'solid')
      (df_prices[tickers[0]]/(df_prices[tickers[0]][0])).plot(label= tickers[0],␣
       ↪linestyle= 'solid')
      (df_prices[tickers[1]]/(df_prices[tickers[1]][0])).plot(label= tickers[1],␣
       ↪linestyle = 'solid')
      (df_prices[tickers[2]]/(df_prices[tickers[2]][0])).plot(label= tickers[2],␣
       ↪linestyle = 'solid')
      plt.legend()
```

```
[20]: <matplotlib.legend.Legend at 0x7fe9e46e1960>
```



0.15 Performance Measurement - Sharpe Ratio

[21]:

```
#caculate the annual standard deviation
def calculate_annual_std(df, trading_days=252):
    std_data = {}
    for column in df:
        mean = df[column].mean()
        diff_squared = [(x - mean) ** 2 for x in df[column]]
        variance = sum(diff_squared) / len(df[column])
        std_dev = (variance ** 0.5) * (trading_days ** 0.5)  # annualizing std
        std_data[column] = std_dev
    return std_data

annual_std_dev = calculate_annual_std(df_price_changes)
print(annual_std_dev)
```

```
{'AAPL': 0.2851525859738212, 'MSFT': 0.2608400692874676, 'AMZN':
0.3314306101824793, '^GSPC': 0.17712612396160154}
```

[22]:

```
# download 5-year US treasury yield as the risk-free rate
risk_free_rate = yf.download('^FVX', start=start_date, end=end_date)['Adj␣
 ↪Close']
# convert to daily returns
risk_free_rate = log_return(risk_free_rate)#risk_free_rate.pct_change() + 1
# annualize the risk-free rate
annual_rf_rate = cal_mean(risk_free_rate)**250 - 1
```

```
print (risk_free_rate)
```

```
[*********************100%***********************]  1 of 1 completed
Date
2010-01-04         NaN
2010-01-05   -0.036088
2010-01-06    0.005847
2010-01-07    0.010439
2010-01-08   -0.013163
                ...
2023-06-07    0.016206
2023-06-08   -0.016206
2023-06-09    0.016461
2023-06-12   -0.000766
2023-06-13    0.026205
Name: Adj Close, Length: 3382, dtype: float64
```

[23]:

```
df_sharpe= df_position.resample('Y').mean()
df_sharpe['sum']= df_sharpe.sum(axis=1)
df_sharpe['return']=df_sharpe['sum']/df_sharpe['sum'].shift() -1

# adding the annual risk free rate
df_sharpe = pd.merge(df_sharpe, risk_free_rate, left_on= df_sharpe.index,␣
 ↪right_on = risk_free_rate.index)
df_sharpe.set_index ('key_0', inplace = True)

# creating data frame
df_position_sharpe = df_position.copy()
df_position_sharpe['sum']= df_position_sharpe.sum(axis=1)

# adding the year collumn
df_position_sharpe['year']=df_position_sharpe.index.year
df_sharpe['year']=df_sharpe.index.year

# copy index
df_position_sharpe['index']=df_position_sharpe.index

# Merge sharpe
df_position_sharpe = pd.merge(df_position_sharpe, df_sharpe[['year', 'sum']],␣
 ↪on ='year', how = 'left' )
# Resetting index
df_position_sharpe.set_index('index', inplace= True)

# calculating the std dev.
df_position_sharpe['std']= standard_deviation(df_position_sharpe['sum_x'],␣
 ↪df_position_sharpe['sum_y'])
```

```
# Resampeling
df_sharpe['std']=df_position_sharpe['std'].resample('Y').mean()

# calculating the sharp ratio
df_sharpe['Sharpe_ratio']= (df_sharpe['return']- (df_sharpe['Adj Close']/100))/
 ↪df_sharpe['std']

# renaming the columns
df_sharpe = df_sharpe.rename (columns = {"sum": "portfolio_value", 'return':␣
 ↪'return_per_year', 'Adj Close': 'risk_free_rate%'})

Sharpe_ratio = cal_mean(df_sharpe)

print(Sharpe_ratio)
```

```
AAPL                  0.991100
MSFT                  0.010317
AMZN                  0.019627
cash                  1.256236
portfolio_value       2.277279
return_per_year       0.147155
risk_free_rate%      -0.009617
year               2015.777778
std                   0.118212
Sharpe_ratio          1.614885
dtype: float64
```

[ ]:

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