

Home Assignment 3

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```
In [1]: import matplotlib.pyplot as plt

from main import main
from technical_strategies import (
    TechnicalStrategy,
    BuyHoldStrategy
)

INIT_INVESTMENT = 20000
```

Trading Initialization

The self-designed back testing framework has several assumptions:

- 1. Initial investment was 20k dollars
- 2. Commission was two-sided , either buy (pay more) or sell (get less), and ratio was 0.00025
- 3. Volume of each market order was 100 shares and could be executed immediately
- 4. Data was of daily frequency and was extracted directly from yahoo finance : yfinance api when running the code
- 5. Ticker I chose was Tesla: TSLA
- 6. The back-testing period was from 2010-06-30 to 2022-09-20 , which was the max I could extract from the api
- 7. Technical strategy I used was MACD : Gold Cross = long signal whereas Death Cross = short signal
- 8. If there was a buy and hold but no death cross signal triggered until the end (no sell), we would close our position at the end of the back-testing period
- 9. There was no consecutive buy or selling orders, aka. a buy order should always be followed by a sell order. Besides, a round-trip should always be buy-sell trip since I assumed no financing (short) selling was only allowed when there were position in hand

Instructions

Codes consists of several modules

- 1. technical_strategies.py : This includes the design of classes for Buy-and-Hold Strategies, Technical Strategies (MACD) etc.
- 2. back_testing.py : This includes the design of class for the BackTester.
- 3. main.py : This includes a main function which integrates strategy initialization, running and back testing.
- 4. utils.py : This includes some utilities for the calculation of performance indicators
- 5. log_trace.log : This a log file which records info for all orders (time, price, size, buy/sell etc.).

MACD Strategy

```
In [2]: df_macd, matrix_macd, idx_macd = main(
    investment=INIT_INVESTMENT,
    symbol="TSLA",
    log_path=None,
    strategy=TechnicalStrategy
) # , sr_macd
df_macd.set_index("Date", inplace=True)
```

```
In [3]: df_macd.head()
```

Out[3]:

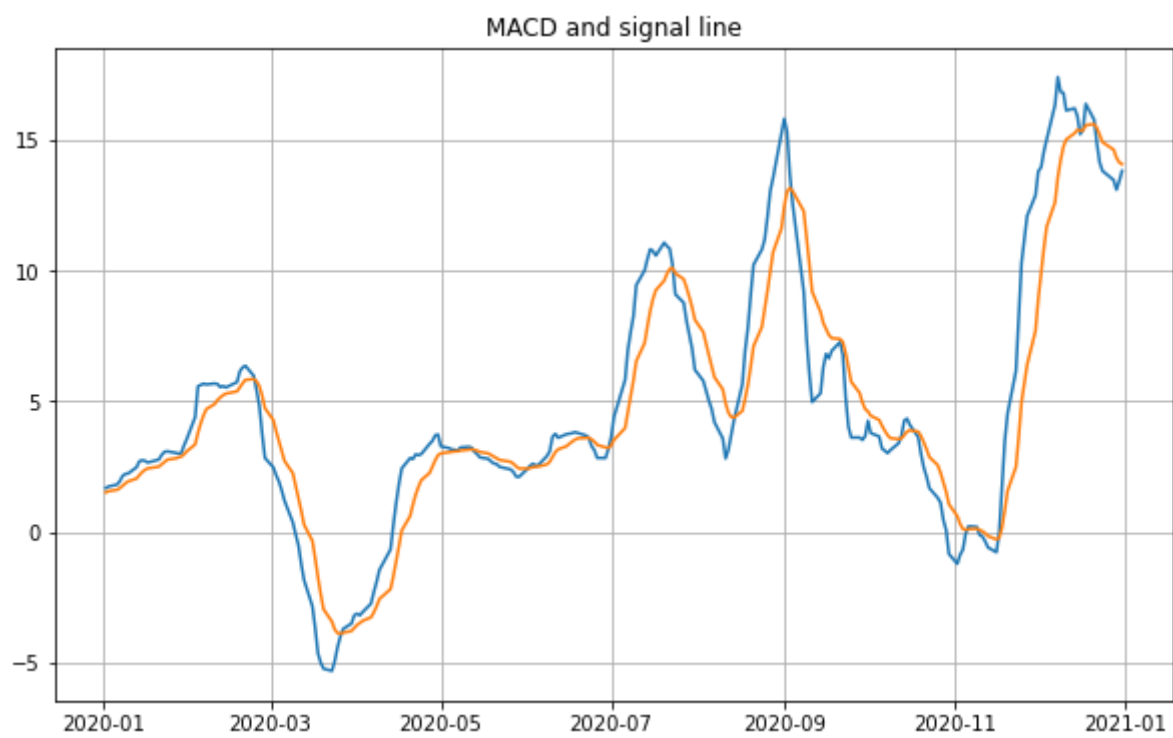
	Open	High	Low	Close	Volume	ema_12	ema_26	macd_line	signal_line
Date									
2010-06-29	1.266667	1.666667	1.169333	1.592667	281494500	1.592667	1.592667	0.000000	0.000000
2010-06-30	1.719333	2.028000	1.553333	1.588667	257806500	1.590500	1.590590	-0.000090	-0.000050
2010-07-01	1.666667	1.728000	1.351333	1.464000	123282000	1.541127	1.545107	-0.003980	-0.001661
2010-07-02	1.533333	1.540000	1.247333	1.280000	77097000	1.458700	1.470995	-0.012295	-0.005263
2010-07-06	1.333333	1.333333	1.055333	1.074000	103003500	1.354178	1.378930	-0.024752	-0.011061

Signal trigger mechnism of MACD

```
In [4]: plt.figure(figsize=(10, 6))

plt.title("MACD and signal line")
plt.plot(df_macd.loc["2020", "macd_line"], label="MACD")
plt.plot(df_macd.loc["2020", "signal_line"], label="signal")

plt.grid()
plt.show()
```



In [5]: `matrix_macd.tail()`

Out[5]:

	signal	position	close_price	cash	holdings	total	pnl	cum_return
2022-09-13	hold	100	292.130005	11131.740363	29213.000488	40344.740852	20344.740852	1.017237
2022-09-14	hold	100	302.609985	11131.740363	30260.998535	41392.738899	21392.738899	1.069637
2022-09-15	hold	100	303.750000	11131.740363	30375.000000	41506.740363	21506.740363	1.075337
2022-09-16	hold	100	303.350006	11131.740363	30335.000610	41466.740974	21466.740974	1.073337
2022-09-19	sell	0	309.070007	42031.014346	0.000000	42031.014346	22031.014346	1.101551

Performance of MACD Strategy on TSLA

In [6]:

```
plt.figure(figsize=(10, 6))

plt.title("NAV of MACD Strategy on TSLA")
plt.plot((1 + matrix_macd["pnl"].diff() / INIT_INVESTMENT).cumprod(), label="MACD")

plt.grid()
plt.show()
```



In [7]: `idx_macd`

Out[7]:

	annualized_return	annualized_volatility	total_return	annual_sharpe_ratio	maximum_drawdown	number_round_trip	z_score	p_value
0	0.090215	0.241771	1.101551	0.373141	-0.883167	123	0.368672	0.356186

From the results above including nav plot, we can conclude that the performance of MACD strategy performs well with an annual return at around 10%. The total return doubled at the end of the back testing period. With the highest nav nearly 4 times the initial investment. But the volatility is also very high: nearly 24% with the 88% max drawdown (almost in the year 2022)

There were only 123 round trip which means there are only 246 orders in total (sample size). This can to some extent explain why the p-value of back-testing return is not significant or robust.

Buy and Hold Strategy

In [8]: `df_bh, matrix_bh, idx_bh = main(`

```
investment=INIT_INVESTMENT,
symbol="TSLA",
log_path=None,
strategy=BuyHoldStrategy
)
```

In [9]: `matrix_bh.tail()`

Out[9]:

	signal	position	close_price	cash	holdings	total	pnl	cum_return
2022-09-13	hold	100	292.130005	19840.693485	29213.000488	49053.693973	29053.693973	1.452685
2022-09-14	hold	100	302.609985	19840.693485	30260.998535	50101.692020	30101.692020	1.505085
2022-09-15	hold	100	303.750000	19840.693485	30375.000000	50215.693485	30215.693485	1.510785
2022-09-16	hold	100	303.350006	19840.693485	30335.000610	50175.694095	30175.694095	1.508785
2022-09-19	sell	0	309.070007	50739.967467	0.000000	50739.967467	30739.967467	1.536998

In [10]: `plt.figure(figsize=(10, 6))`
`plt.title("NAV of Buy and Hold Strategy on TSLA")`
`plt.plot((1 + matrix_bh["pnl"].diff() / INIT_INVESTMENT).cumprod(), label="Buy and Hold")`
`plt.grid()`
`plt.show()`



In [11]: `idx_bh`

Out[11]:

	annualized_return	annualized_volatility	total_return	annual_sharpe_ratio	maximum_drawdown	number_round_trip	z_score	p_value
0	0.125877	0.338708	1.536998	0.371639	-1.002917	1	0.033108	0.486794

Since the MACD strategy shows a strong momentum, in order to check it out, I used Buy and Hold Strategy instead. The performance is stunning, with a total return of 153%, annual return of 12%. But there is also a lot of problems, the volatility is at a very high level, with annualized volatility at 33% and a 100% maximum draw down which means you may lose all of your money when you enter the market at some specific time. Besides, the p-value also tells us that this buy and hold strategy makes no sense but just gambling, (very small sample size / not enough trades). Though the performance using MACD is not as good as Buy and Hold, it can lower the volatility and add more robustness to the investment.

In []: