

Homework 1

Instruction: Write a report including the screenshots of your code and backtesting performance, and briefly introduce your strategy.

Iteration 1: MACD + RSI in the Spot Market

Code:

<https://github.com/pointmekin/IntroToFintechAssignments-t11902203/blob/main/HW1/HW1.ipynb>

```
class Strategy(StrategyBase):
    def __init__(self):
        # strategy property
        self.subscribed_books = {}
        self.period = 60 * 60
        self.options = {}

        self.last_type = 'sell'
        self.fast_period = 12
        self.slow_period = 26
        self.signal_period = 10
        self.proportion = 0.9
        self.rsi_period = 10

    def on_order_state_change(self, order):
        pass

    # called every self.period
    def trade(self, candles):
        exchange, pair, base, quote = CA.get_exchange_pair()

        close_price_history = [candle['close'] for candle in
candles[exchange][pair]]
        high_price_history = [candle['high'] for candle in candles[exchange][pair]]
        low_price_history = [candle['low'] for candle in candles[exchange][pair]]

        # convert to chronological order for talib
        close_price_history.reverse()
        high_price_history.reverse()
        low_price_history.reverse()

        # convert np.array
        close_price_history = np.array(close_price_history)
        high_price_history = np.array(high_price_history)
        low_price_history = np.array(low_price_history)

        if len(close_price_history) < 2:
            return []

        # get macd from talib
        macd, macdsignal, macdhist = talib.MACD(close_price_history,
fastperiod=self.fast_period, slowperiod=self.slow_period,
signalperiod=self.signal_period)

        # curr_slow_macd = mac
        curr_macd = macdhist[-1]
```

```

prev_macd = macdhist[-2]

macd_now = macd[-1]
signal_now = macdsignal[-1]

# get the simple moving average of the RSI value in the the specified period
from talib
all_rsi = talib.SMA(talib.RSI(close_price_history, self.rsi_period),
self.rsi_period)

curr_rsi = all_rsi[-1]

# Check for overbought and oversold RSI signal in the past RSI period
min_past_rsi = min(all_rsi[-self.rsi_period:])
max_past_rsi = max(all_rsi[-self.rsi_period:])
past_rsi_greater_than_50 = all(i > 50 for i in all_rsi[-self.rsi_period:])
past_rsi_less_than_50 = all(i < 50 for i in all_rsi[-self.rsi_period:])

signal = 0
# MACD crosses the zero line from below - buy signal
# RSI falls into the oversold region
if (prev_macd < 0 and curr_macd > 0 and ((min_past_rsi <= 30) or
past_rsi_less_than_50)) :
    signal = 1

# MACD crosses the zero line from above - sell signal
# RSI rises into the overbought region
elif (prev_macd > 0 and curr_macd < 0 and ((max_past_rsi >= 70) or
past_rsi_greater_than_50)):
    signal = -1

# get available balance
base_balance = CA.get_balance(exchange, base)
quote_balance = CA.get_balance(exchange, quote)
available_base_amount = base_balance.available
available_quote_amount = quote_balance.available

# place buy order
if self.last_type == 'sell' and signal == 1:
    amount = np.around((available_quote_amount / close_price_history[-1]) *
self.proportion, 5)
    self.last_type = 'buy'
    CA.log("Buy " + str(amount) + " " + base)

    if (amount > 0):
        CA.buy(exchange, pair, amount, CA.OrderType.MARKET)
    else:
        CA.log("Not enough asset to buy")

# place sell order
elif self.last_type == 'buy' and signal == -1:
    self.last_type = 'sell'

    if (available_base_amount > 0):
        CA.log("Sell " + str(available_base_amount) + " " + base)
        CA.sell(exchange, pair, available_base_amount, CA.OrderType.MARKET)
    else:
        CA.log("Not enough asset to sell")

return

```

Backtest Performance



Strategy

What is the strategy?

I have taken Crypto-Arena's MACD strategy template and made additional adjustments by utilizing the RSI values and their moving average in addition to the MACD to identify buying and selling signals.

What's been updated?

Firstly, I have increased the period variable set in the Strategy class so that the closing price data will be pulled half as often, at 1 candlestick closing price record per hour.

Next, I experimented with the `fast_period` and `slow_period` to find a reasonable rate for the fast MACD and slow MACD lines for the 2 exponential moving averages, which I found to be the default to be the most fitting 12 and 26 respectively. However, I changed the signal period from 9 to 10 as I observed a slightly better performance from experimentation.

Next, I added the elements of RSI to the strategy. Using talib's RSI function, I collect the RSI values for the closing prices with the RSI period of 10 days, the same as the MACD signal period. Upon obtaining the RSI, I use talib's SMA function to find its simple moving average. I also checked for the individual RSI values in the past period to determine the buying and selling signal (explanation in the next part).

Finally, I edited the logic responsible for deciding whether the current tick should be a buy or a sell signal.

Justifications and Explanations for the Strategy

Initially, when the default MACD strategy is selected, the ROI backtested from August 1 to August 31 of 2022 using the default MACD strategy was negative.

While MACD is most helpful for determining the strength of the price movement rather than a trend direction, it is still respectable to help identify trading opportunities through the divergence signals it provides. The Moving average convergence divergence (MACD) tracks the moving averages of 2 different lengths, the shorter and the longer timeframe. Once the shorter timeframe MACD crosses the longer

timeframe MACD, the scenario indicates a change in the momentum of the asset price. Additionally, when MACD crosses the zero-line upwards from the bottom, it signals a buying opportunity.

I have decided to utilize the MACD as the first indicator to decide when a trade should be considered. Ta-lib library has provided the `macdhist` value from the MACD function. Whenever the histogram value crosses the zero line towards the positive side, I consider that moment a potential buying opportunity. Vice versa. When the histogram value crosses the zero line towards the negative value, I consider it a potential selling opportunity. However, the strategy is not yet complete as I planned to combine it with another useful indicator, the RSI.

Next, I add the RSI, an indicator that provides signals about the bullish and bearish price movement momentum. RSI works by measuring how quickly and by how much an asset's price changes to identify whether the asset is overbought or oversold. An overbought condition, traditionally an RSI reading above 70, indicates that the asset price may be overvalued and might see a change in momentum in a downward direction soon. An overbought condition means that the asset is overvalued beyond its intrinsic value and thus, a price correction (trend reversal downwards) is expected. On the contrary, the oversold condition traditionally marked by RSI falling below 30, suggests that the asset is oversold. This suggests that it is perhaps a good buying opportunity as the price may soon change the momentum towards the upside in the near short term because the asset is undervalued.

Moreover, once the RSI values are obtained, I put it into talib's SMA function to smooth out the RSI and find the moving average over a period of 10 days (the same as the MACD fast period) instead because individual RSI readings change quite drastically. By finding the moving average, I can better identify the overall trend of the RSI rather than using the actual RSI value itself.

Additionally, I thought using only the latest RSI value is a bit too stringent because the overbought or oversold signal may not happen exactly at the same time as the MACD's divergence signal. Also, only 6 trades were executed. Thus, I separate this into 2 scenarios

Scenario A: When the MACD signals a potential buying opportunity, I checked whether the minimum of the past 10 (RSI period) values of SMA RSI values were below 50, which means there was higher selling pressure than the buying pressure.

Scenario B: When the MACD signals a potential selling opportunity, I checked whether the maximum of the past 10 (RSI period) values of SMA RSI values were above 50, which means there was higher buying pressure than the selling pressure.

My final strategy is then as follow:

1. When the MACD suggests a buying opportunity
 - a. Check if the minimum SMA RSI of the past period is in the oversold zone or if Scenario A happened.
 - i. If any of the conditions are satisfied, buy the asset.
 - ii. Else, ignore the signal.
2. When the MACD suggests a selling opportunity
 - a. Check if the maximum SMA RSI of the past period is in the overbought zone or if Scenario B happened.
 - i. If any of the conditions are satisfied, sell the asset.
 - ii. Else, ignore the signal.

In my strategy, I used the RSI indicator to support the originally modified MACD strategy. I used the MACD divergence to check whether a trade is worth considering. Once the MACD suggests a buying signal, I check the latest RSI SMA to identify whether the asset is still in the oversold region because it suggests

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that the prices may go up soon as more people will start buying the asset. Only when both conditions happen at the same time, do I proceed to buy the asset. On the other end, if the MACD suggests a selling signal, I verify with the RSI to check whether the asset is overbought, then proceed to sell the asset when both conditions were met.

Together MACD identifies a potential signal, and the RSI is used to confirm whether the signal might lead to a change in the price movements trend soon and make trades accordingly. Both strategies are used to detect trend reversal signals, and by applying them together, the strategy can be more confident in the trade as the conditions of both strategies must be satisfied before executing a trade.

The Results

The strategy is then backtested from August 1 to August 31 of 2022 to evaluate the performance. The strategy shows a reasonable positive return over 1 month at an ROI of 14.87 and a Sharpe ratio of 6.27.

Iteration 2: MACD + RSI in the Spot Market (Revised)

Code

What's been updated?

Change from

```
past_rsi_greater_than_50 = all(i > 50 for i in all_rsi[-self.rsi_period:])
past_rsi_less_than_50 = all(i < 50 for i in all_rsi[-self.rsi_period:])

signal = 0
# MACD crosses the zero line from below - buy signal
# RSI falls into the oversold region
if (prev_macd < 0 and curr_macd > 0 and ((min_past_rsi <= 30) or
past_rsi_less_than_50)) :
    signal = 1

# MACD crosses the zero line from above - sell signal
# RSI rises into the overbought region
elif (prev_macd > 0 and curr_macd < 0 and ((max_past_rsi >= 70) or
past_rsi_greater_than_50)):
    signal = -1
```

To

```
signal = 0
# MACD crosses the zero line from below - buy signal
# RSI falls into the oversold region
if (prev_macd < 0 and curr_macd > 0 and ((min_past_rsi <= 30))):
    signal = 1

# MACD crosses the zero line from above - sell signal
# RSI rises into the overbought region
elif (prev_macd > 0 and curr_macd < 0 and ((max_past_rsi >= 70))):
    signal = -1
```



Strategy

What is the strategy?

Looking at the backtesting result, I have noticed that there were some trades that were not ideal as the buying price is higher than the selling price. To reduce this kind of potential loss, especially during the period that the ETH price is going down, I tried removing the condition where I checked if the past SMA RSI values were over or under 50, thus making the strategy more strict.

The Results

The strategy is then backtested from August 1 to August 31 of 2022 to evaluate the performance. The strategy shows an increase in the positive return over 1 month at an ROI of 17.76 and a Sharpe ratio of 5.55.

Iteration 3: MACD + RSI in the Futures Market

Code

<https://github.com/pointmekin/IntroToFintechAssignments-t11902203/blob/main/HW1/HW1.ipynb>

```
class Strategy(StrategyBase):
    def __init__(self):
        # strategy property
        self.subscribed_books = {}
        self.period = 60 * 60
        self.options = {}

        self.last_type = 'sell'
        self.fast_period = 12
        self.slow_period = 26
        self.signal_period = 10
        self.proportion = 0.9
        self.rsi_period = 10
```

```
def on_order_state_change(self, order):
    pass

# called every self.period
def trade(self, candles):
    exchange, pair, base, quote = CA.get_exchange_pair()

    close_price_history = [candle['close'] for candle in
candles[exchange][pair]]
    high_price_history = [candle['high'] for candle in candles[exchange][pair]]
    low_price_history = [candle['low'] for candle in candles[exchange][pair]]

    # convert to chronological order for talib
    close_price_history.reverse()
    high_price_history.reverse()
    low_price_history.reverse()

    # convert np.array
    close_price_history = np.array(close_price_history)
    high_price_history = np.array(high_price_history)
    low_price_history = np.array(low_price_history)

    if len(close_price_history) < 2:
        return []

    # get macd from talib
    macd, macdsignal, macdhist = talib.MACD(close_price_history,
fastperiod=self.fast_period, slowperiod=self.slow_period,
signalperiod=self.signal_period)

    curr_macd = macdhist[-1]
    prev_macd = macdhist[-2]

    macd_now = macd[-1]
    signal_now = macdsignal[-1]

    # get the simple moving average of the RSI value in the the specified period
from talib
    all_rsi = talib.SMA(talib.RSI(close_price_history, self.rsi_period),
self.rsi_period)

    # curr_rsi = all_rsi[-1]
    curr_rsi = all_rsi[-1]

    min_past_rsi = min(all_rsi[-self.rsi_period:])
    max_past_rsi =max(all_rsi[-self.rsi_period:])

    signal = 0
    # MACD crosses the zero line from below - buy signal
    # RSI falls into the oversold region
    if (prev_macd < 0 and curr_macd > 0 and min_past_rsi <= 30) :
        signal = 1

    # MACD crosses the zero line from above - sell signal
    # RSI rises into the overbought region
    elif (prev_macd > 0 and curr_macd < 0 and max_past_rsi >= 70):
        signal = -1

    # get available balance
    base_balance = CA.get_balance(exchange, base)
    quote_balance = CA.get_balance(exchange, quote)
    available_base_amount = base_balance.available
    available_quote_amount = quote_balance.available
```

```

# On buy signal
if self.last_type == 'sell' and signal == 1:
    amount = np.around((available_quote_amount / close_price_history[-1]) *
self.proportion, 5)
    self.last_type = 'buy'

# Close all short positions
short_position = CA.get_position(exchange, pair, CA.PositionSide.SHORT)
if short_position and short_position.available_size > 0:
    CA.log('Close all short positions for ' + base)
    CA.close_short(exchange, pair, short_position.available_size,
CA.OrderType.MARKET)

# Long the asset if available
if (amount > 0):
    # Long
    CA.log('Long ' + str(amount) + ' ' + base)
    CA.open_long(exchange, pair, amount, CA.OrderType.MARKET)

# On sell signal
elif self.last_type == 'buy' and signal == -1:
    amount = np.around((available_quote_amount / close_price_history[-1]) *
self.proportion, 5)
    self.last_type = 'sell'

# Close all long positions
long_position = CA.get_position(exchange, pair, CA.PositionSide.LONG)
if long_position and long_position.available_size > 0:
    CA.log('Close all long positions for ' + base)
    CA.close_long(exchange, pair, long_position.available_size,
CA.OrderType.MARKET)

# Short the asset if available
if (amount > 0):
    CA.log('Short ' + str(amount) + ' ' + base)
    CA.open_short(exchange, pair, amount, CA.OrderType.MARKET)

return

```

Backtest Performance



Strategy

What is the strategy?

Upon competing in the backtesting process of my first iteration of the strategy in the spot market, I noticed that in August of 2022, there are both upsides and downsides to the ETH price. As a result, I want to try to make profits both during the upward price movement and the downwards one.

What's been updated?

To do this, I moved to the USDⓈ-M Futures (Perp.) futures market. I further modify my code from buying and selling to opening long and short positions instead.

Using the same MACD and RSI simple moving average as the indicators, each time my strategy suggests a buying signal in the oversold region, I will close all my current short positions and open a long position at the market price if there are available asset remaining. Vice versa, each time the strategy suggests a selling signal in the overbought region, I will close all my long positions and open a short position at the market price.

Justifications and Explanations for the Strategy

In the futures market, I am now theoretically able to make profits regardless of whether the price of ETH is moving upward (through long positions) or downward (through short positions).

The Results

Finally, with the strategy applied in the futures market, I was able to obtain an ROI of 20.29, which is a 2.53% increase from applying the same strategy to the spot market.