歷史行情 & 策略回測說明

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歷史行情-Ticks

價格波動中，最小升降單位稱為tick，也可以稱為跳動點，代表價格往上或往下跳動時，最少會跳動多少，也可以稱為1個tick。

```
ts (int): timestamp
close (float): 成交價
volume (int): 成交量
bid_price (float): 委買價
bid_volume (int): 委買量
ask_price (float): 委賣價
ask_volume (int): 委賣量
tick_type (int): 內外盤別{1: 內盤, 2: 外盤, 0: 無法判定}
```

歷史行情-Ticks

1. 一次可以抓一天
2. 一天通常有好幾萬筆資料
3. 包含日盤及夜盤
4. 可以指定時段
5. 1年資料1GB左右(日盤)
6. 範例檔提供下載歷史Ticks參考

```python
import datetime
import pandas as pd
import os

days = 180

last_days = datetime.datetime.now() - datetime.timedelta(days=days)


ticks = api.ticks(
    contract=api.Contracts.Futures.TXF.TXFR1,
    date=last_days.strftime("%Y-%m-%d"),
    query_type=sj.constant.TicksQueryType.RangeTime,
    time_start="08:45:00",
    time_end="13:45:01"
)
print(last_days.strftime("%Y-%m-%d"))
df = pd.DataFrame({**ticks})
df.ts = pd.to_datetime(df.ts)
df = df.set_index('ts')
df.index.name = None
df_tick = df

for i in range(days-1):
    date = last_days + datetime.timedelta(days=i+1)
    print(date.strftime("%Y-%m-%d"))
    ticks = api.ticks(
        contract=api.Contracts.Futures.TXF.TXFR1,
        date=date.strftime("%Y-%m-%d")
    )
    if ticks['ts'] != []:
        df = pd.DataFrame({**ticks})
        df.ts = pd.to_datetime(df.ts)
        df = df.set_index('ts')
        df.index.name = None
        df_tick = pd.concat([df_tick, df], axis=0)

df_tick.to_csv('TXF_tick.csv')
```

歷史行情-KBar

代表一個時間單位的開盤價、收盤價、最高價和最低價。

```
ts (int): timestamp
Open (float): open price
High (float): the highest price
Low: (float): the lowest price
Close (float): close price
Volume (int): volume
```

歷史行情-KBar

1. 一次可以抓一天
2. 預設1分K
3. 一天通常有幾百筆資料
4. 包含日盤及夜盤
5. 2年資料8MB左右(日盤)
6. 範例檔提供下載歷史KBar參考

```python
import datetime
import pandas as pd
import os

days = 30

last_days = datetime.datetime.now() - datetime.timedelta(days=days)

kbars = api.kbars(
    contract=api.Contracts.Futures.TXF.TXFR1,
    start=last_days.strftime("%Y-%m-%d"),
    end=last_days.strftime("%Y-%m-%d"),
)

df = pd.DataFrame({**kbars})
df.ts = pd.to_datetime(df.ts)
df = df.set_index('ts')
df.index.name = None
df_1min = df

for i in range(days-1):
    date = last_days + datetime.timedelta(days=i+1)
    print(date.strftime("%Y-%m-%d"))
    kbars = api.kbars(
        contract=api.Contracts.Futures.TXF.TXFR1,
        start=date.strftime("%Y-%m-%d"),
        end=date.strftime("%Y-%m-%d"),
    )
    if kbars['ts'] != []:
        df = pd.DataFrame({**kbars})
        df.ts = pd.to_datetime(df.ts)
        df = df.set_index('ts')
        df.index.name = None
        df_1min = pd.concat([df_1min, df], axis=0)

df_1min = df_1min.between_time('08:45:00', '13:45:01')
df_1min = df_1min[['Open', 'High', 'Low', 'Close', 'Volume']]
df_1min.to_csv('TXF_1min.csv')
```

歷史行情-Ticks & KBar

資料歷史期間

	Start Date	**End Date**
Index	2020-03-02	Today
Stock	2020-03-02	Today
Futures	2020-03-22	Today

歷史行情-Ticks轉換KBar

許多技術指標計算需要用到最高價、最低價，但是Ticks是表示最小升降單位，只有包含成交價，該怎麼轉換成KBar(一段時間單位)？

```
ts (int): timestamp

close (float): 成交價

volume (int): 成交量

bid_price (float): 委買價

bid_volume (int): 委買量

ask_price (float): 委賣價

ask_volume (int): 委賣量

tick_type (int): 內外盤別{1: 內盤, 2: 外盤, 0: 無法判定}
```

歷史行情-Ticks轉換KBar

1. 使用Pandas(資料處理)，先將ts轉成pandas datetime object
2. resample_ohlc = df['close'].resample('30S').ohlc()
3. OHLC(Open-High-Low-Close)
4. 加入Volume
5. resample_volume = df['volume'].resample('30S').sum()
6. df_resample = pd.concat([resample_ohlc, resample_volume], axis=1)
7. 範例提供參考

歷史行情-KBar 1min轉5min

1. 使用Pandas(資料處理)，先將ts轉成pandas datetime object
2. resample_open = df['Open'].resample('5min').first()
3. resample_high = df['High'].resample('5min').max()
4. resample_low = df['Low'].resample('5min').min()
5. resample_close = df['Close'].resample('5min').last()
6. resample_volume = df['Volume'].resample('5Min').sum()
7. concat

backtesting.py

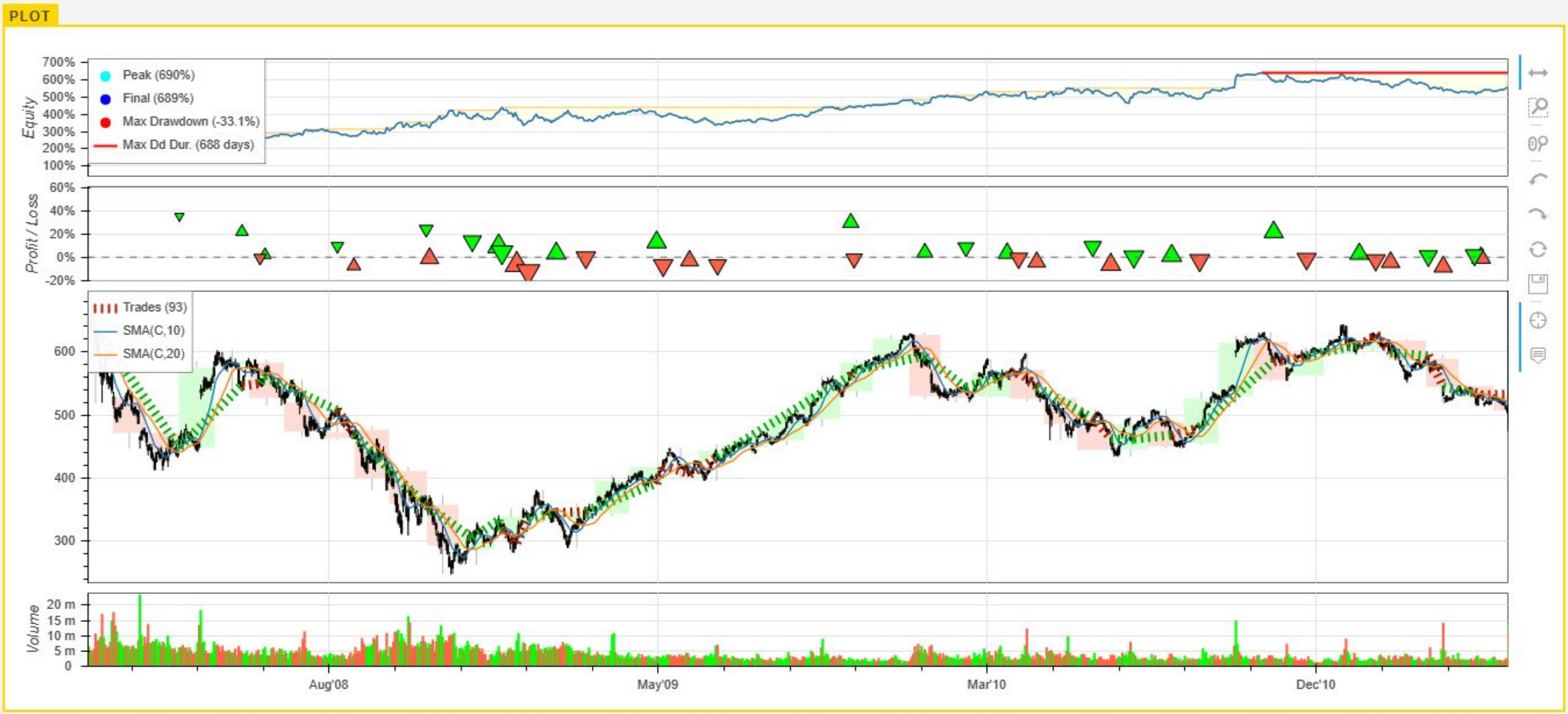
Backtesting.py是一個用Python編寫的框架，可以在**歷史數據上推斷交易策略的可行性**。儘管過去表現不代表未來結果，但在眾多市場條件下證明的策略，可能在未來也同樣可靠。Backtesting.py比Backtrader更為優秀，並且可與其他可用的選項相比，它**輕量級、快速、易用、直觀、互動式**，並且是可靠的。它有很好的文檔，包括一些教程。

SNIPPET

```python
from backtesting import Backtest, Strategy
from backtesting.lib import crossover

from backtesting.test import SMA, GOOG


class SmaCross(Strategy):
    n1 = 10
    n2 = 20

    def init(self):
        close = self.data.Close
        self.sma1 = self.I(SMA, close, self.n1)
        self.sma2 = self.I(SMA, close, self.n2)

    def next(self):
        if crossover(self.sma1, self.sma2):
            self.buy()
        elif crossover(self.sma2, self.sma1):
            self.sell()


bt = Backtest(GOOG, SmaCross,
              cash=10000, commission=.002,
              exclusive_orders=True)

output = bt.run()
bt.plot()
```

OUTPUT

```
Start                     2004-08-19 00:00:00
End                       2013-03-01 00:00:00
Duration                   3116 days 00:00:00
Exposure Time [%]                       94.27
Equity Final [$]                     68935.12
Equity Peak [$]                      68991.22
Return [%]                             589.35
Buy & Hold Return [%]                  703.46
Return (Ann.) [%]                       25.42
Volatility (Ann.) [%]                   38.43
Sharpe Ratio                             0.66
Sortino Ratio                            1.30
Calmar Ratio                             0.77
Max. Drawdown [%]                      -33.08
Avg. Drawdown [%]                       -5.58
Max. Drawdown Duration      688 days 00:00:00
Avg. Drawdown Duration       41 days 00:00:00
# Trades                                   93
Win Rate [%]                            53.76
Best Trade [%]                          57.12
Worst Trade [%]                        -16.63
Avg. Trade [%]                           1.96
Max. Trade Duration         121 days 00:00:00
Avg. Trade Duration          32 days 00:00:00
Profit Factor                            2.13
Expectancy [%]                           6.91
SQN                                      1.78
_strategy                 SmaCross(n1=10, n2=20)
```


PLOT
Peak (690%)
Final (689%)
Max Drawdown (-33.1%)
Max Dd Dur. (688 days)
Equity
Profit / Loss
Trades (93)
SMA(C,10)
SMA(C,20)
Volume
Aug'08
May'09
Mar'10
Dec'10

backtesting.py - Data

1. Backtesting ingests _all kinds of OHLC data_ (stocks, forex, futures, crypto, ...) as a pandas.
2. Besides these, your data frames can have additional columns which are accessible in your strategies in a similar manner.
3. DataFrame should ideally be indexed with a datetime index (convert it with pd.to_datetime()), otherwise a simple range index will do.

backtesting.py - Data

- 歷史資料用Ticks資料
  - 要先轉成OHLC，並且重新命名Column（第一字大寫）
  - df_resample = df_resample.rename(columns={"open": "Open", "high": "High", "low": "Low", "close": "Close", "volume": "Volume"})
- 歷史資料用Kbar資料
  - 可以直接使用

	Open	High	Low	Close	Volume
2021-03-15 08:45:00	16206.0	16219.0	16182.0	16185.0	2925.0
2021-03-15 08:50:00	16185.0	16185.0	16173.0	16175.0	1471.0
2021-03-15 08:55:00	16174.0	16192.0	16166.0	16183.0	1684.0
2021-03-15 09:00:00	16184.0	16208.0	16172.0	16175.0	3349.0
2021-03-15 09:05:00	16174.0	16231.0	16171.0	16231.0	4182.0

backtesting.py - Strategy(TA-Lib)

有了價量資料後，可以使用強大的 Python module — TA-Lib，在一兩秒的時間內快速計算多達 158 種的技術指標！指標的選擇眾多以外，還可以微調每個技術指標參數值的設定　　[安裝參考]

SMA - Simple Moving Average

```
real = SMA(close, timeperiod=30)
```

BBANDS - Bollinger Bands

```
upperband, middleband, lowerband =
BBANDS(close,timeperiod=5, nbdevup=2, nbdevdn=2, matype=0)
```

backtesting.py - Strategy (Example 1)

- **多單當沖策略**
- 台指期
- 5分K
- 日盤
- 樣本內：2022-09-05 ~ 2023-01-05（4個月）
- 樣本外：2023-01-05 ~ 2023-03-03（2個月）
- 手續費：百萬分之3（原百萬分之2加20元）

backtesting.py - Strategy (Example 1)

- 進場
  - SMA快 cross over SMA慢（黃金交叉）
- 出場
  - SMA快 cross under SMA慢（黃金交叉）
  - 當沖13:30平倉

backtesting.py - Strategy (Example 1)

- # Trades
  - 一個禮拜3~4次（半年96次以上）
- Win Rate [%] 勝率
  - 至少 > 30%
  - 最終策略通常 > 50%
- Profit Factor 獲利因子
  - 毛利/毛損，代表每損失1元的風險可以獲利多少
  - 要 > 1.7 左右

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   37.032367
Equity Final [$]                 100206.24282
Equity Peak [$]                  100277.58135
Return [%]                           0.206243
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    0.465166
Volatility (Ann.) [%]                1.014447
Sharpe Ratio                         0.458542
Sortino Ratio                          0.7208
Calmar Ratio                         0.583092
Max. Drawdown [%]                   -0.797758
Avg. Drawdown [%]                   -0.112189
Max. Drawdown Duration      119 days 23:40:00
Avg. Drawdown Duration       13 days 16:40:00
# Trades                                  125
Win Rate [%]                             41.6
Best Trade [%]                       2.144153
Worst Trade [%]                     -1.126648
Avg. Trade [%]                       0.010088
Max. Trade Duration           0 days 04:40:00
Avg. Trade Duration           0 days 01:41:00
Profit Factor                        1.078867
Expectancy [%]                       0.010952
SQN                                  0.310829
_strategy                            SmaCross
_equity_curve                             ...
_trades                         Size  Entry...
dtype: object
```

backtesting.py - Strategy (Example 1)

- SQN = 交易次數開根號 * 平均每筆損益 / 每筆損益的標準差
- SQN公式有什麼意義呢？

1. 期望獲利越高，SQN值越大。
2. 標準差越小，SQN值越大。(風險)
3. 交易次數(N)越多，SQN值越大。(穩定)

SQN	系統品質
<1.00	很爛(Probably very hard to trade)
<1.01-2.00	一般般(Average System)
<2.01-3.00	還不錯(Good System)
<3.01-5.00	很棒!(Excellent System)
<5.01-7.00	太神了!(Superb System)
<7.00<	這就是聖杯(Holy Grall System)

backtesting.py - Strategy (Example 1)

- 思考如何改進策略？
  - 改變進出場方式
  - 增加/改變停損停利方式
  - 觀察策略虧損大的區域
  - 加入其他指標輔助
  - 前一筆輸時休息n根
  - ……可以多嘗試不同方法

backtesting.py - Strategy (Example 1)

如果Vscode沒有出現圖，可以 [參考]

backtesting.py - Strategy (Example 1)

backtesting.py - Strategy (Example 1)

- 問題
  - 跳空缺口
    - 夜盤行情造成
- 解決
  - 開盤30分後再進場？

backtesting.py - Strategy (Example 1)

- 開盤30分後進場
    - SMA快 cross over SMA慢(黃金交叉)
- 出場
    - SMA快 cross under SMA慢(黃金交叉)
    - 當沖13:30平倉

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   22.040073
Equity Final [$]                  99472.66525
Equity Peak [$]                  100038.56155
Return [%]                          -0.527335
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                   -1.112242
Volatility (Ann.) [%]                0.597022
Sharpe Ratio                              0.0
Sortino Ratio                             0.0
Calmar Ratio                              0.0
Max. Drawdown [%]                   -0.645845
Avg. Drawdown [%]                   -0.327921
Max. Drawdown Duration      179 days 01:05:00
Avg. Drawdown Duration       89 days 12:40:00
# Trades                                   96
Win Rate [%]                        36.458333
Best Trade [%]                       0.808251
Worst Trade [%]                     -0.813807
Avg. Trade [%]                      -0.039967
Max. Trade Duration           0 days 03:40:00
Avg. Trade Duration           0 days 01:17:00
Profit Factor                        0.678689
Expectancy [%]                      -0.039563
SQN                                 -1.339134
_strategy                            SmaCross
_equity_curve                             ...
_trades                        Size  EntryB...
dtype: object
```

backtesting.py - Strategy (Example 1)

改進策略流程(重複以下步驟)

1. 將資料調整至樣本內(避免Overfit)
2. 決定最佳化參數區間、目標
3. 跑最佳化選出一組參數套用到策略中
4. 調回樣本外區間觀察績效
5. 改進策略表現不好的區域

backtesting.py - Strategy (Example 1)

決定最佳化參數區間、目標

```
stats = bt.optimize(n1=range(5, 30, 1),
                    n2=range(10, 70, 1),
                    maximize='Equity Final [$]',
                    constraint=lambda param: param.n1 < param.n2) # 快線週期<慢線
```

backtesting.py - Strategy (Example 1)

調回樣本外區間觀察績效

交易次數**變少** 96 -> 76

勝率**增加** 36% -> 53%

獲利因子**增加** 0.6 -> 1.8

SQN**增加** -1.3 -> 1.6

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                    20.13451
Equity Final [$]                  100636.3396
Equity Peak [$]                  100712.70267
Return [%]                            0.63634
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    1.442106
Volatility (Ann.) [%]                0.567049
Sharpe Ratio                         2.543175
Sortino Ratio                        5.813066
Calmar Ratio                         5.972703
Max. Drawdown [%]                   -0.241449
Avg. Drawdown [%]                   -0.032776
Max. Drawdown Duration       79 days 02:05:00
Avg. Drawdown Duration        3 days 18:13:00
# Trades                                   76
Win Rate [%]                        53.947368
Best Trade [%]                       1.609405
Worst Trade [%]                     -0.605476
Avg. Trade [%]                       0.060485
Max. Trade Duration           0 days 04:10:00
Avg. Trade Duration           0 days 01:30:00
Profit Factor                        1.838821
Expectancy [%]                       0.060938
SQN                                  1.695499
_strategy                            SmaCross
_equity_curve                             ...
_trades                        Size  EntryB...
dtype: object
```

backtesting.py - Strategy (Example 1)

- 改進策略表現不好的區域
- 交易次數**變少** 96 -> 76
  - 增加進場方式？

backtesting.py - Strategy (Example 1)

- 開盤30分後再進場
    - SMA快 cross over SMA慢（黃金交叉）
    - 當根K棒Close cross over SMA快
- 出場
    - SMA快 cross under SMA慢（黃金交叉）
    - 當沖13:30平倉

backtesting.py - Strategy (Example 1)

調回樣本外區間觀察績效

交易次數變多 76 -> 121

勝率減少 53% -> 51%

獲利因子減少 1.8 -> 1.4

SQN減少 1.6 -> 1.4

繼續修進場條件

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   27.434496
Equity Final [$]                 100621.79763
Equity Peak [$]                  100737.64496
Return [%]                           0.621798
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    1.343795
Volatility (Ann.) [%]                 0.67396
Sharpe Ratio                         1.993881
Sortino Ratio                        3.972788
Calmar Ratio                         5.339665
Max. Drawdown [%]                   -0.251663
Avg. Drawdown [%]                   -0.033593
Max. Drawdown Duration       41 days 21:30:00
Avg. Drawdown Duration        3 days 06:53:00
# Trades                                  121
Win Rate [%]                        51.239669
Best Trade [%]                       1.609405
Worst Trade [%]                     -0.615527
Avg. Trade [%]                        0.03604
Max. Trade Duration           0 days 04:20:00
Avg. Trade Duration           0 days 01:16:00
Profit Factor                        1.477587
Expectancy [%]                       0.036436
SQN                                  1.409023
_strategy                            SmaCross
_equity_curve                             ...
_trades                         Size  Entry...
dtype: object
```

backtesting.py - Strategy (Example 2)

- **多單當沖策略**
- 台指期
- 5分K
- 日盤
- 樣本內 : 2022-09-05 ~ 2023-01-05（4個月）
- 樣本外 : 2023-01-05 ~ 2023-03-03（2個月）
- 手續費 : 百萬分之3（原百萬分之2加20元）

$$\text{Wiliams }\%R = \frac{\text{Highest High} - \text{Close}}{\text{Highest High} - \text{Lowest Low}}$$

backtesting.py - Strategy (Example 2)

- 進場:
  - WR > 超買區
- 出場:
  - WR < -50（趨勢由多轉空）
  - 當沖13:30平倉
- SQN = 0.53

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   42.314698
Equity Final [$]                 100358.77027
Equity Peak [$]                  100625.10868
Return [%]                            0.35877
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    0.774336
Volatility (Ann.) [%]                1.001578
Sharpe Ratio                         0.773116
Sortino Ratio                        1.300069
Calmar Ratio                          1.13944
Max. Drawdown [%]                   -0.679576
Avg. Drawdown [%]                   -0.073093
Max. Drawdown Duration       64 days 00:20:00
Avg. Drawdown Duration        4 days 14:37:00
# Trades                                   79
Win Rate [%]                        50.632911
Best Trade [%]                        2.38123
Worst Trade [%]                     -1.215686
Avg. Trade [%]                       0.029831
Max. Trade Duration           0 days 04:40:00
Avg. Trade Duration           0 days 03:07:00
Profit Factor                        1.178706
Expectancy [%]                       0.031224
SQN                                  0.531716
_strategy                            SmaCross
_equity_curve                             ...
_trades                        Size  EntryB...
dtype: object
```

backtesting.py - Strategy (Example 2)

- 開盤15分後進場：
  - WR > 超買區
- 出場：
  - WR < -50（趨勢由多轉空）
  - 當沖13:30平倉
- SQN = 0.53 -> 0.89

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   40.128906
Equity Final [$]                 100547.21346
Equity Peak [$]                  100835.55253
Return [%]                           0.547213
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    1.182336
Volatility (Ann.) [%]                0.912659
Sharpe Ratio                         1.295485
Sortino Ratio                        2.350277
Calmar Ratio                         2.049483
Max. Drawdown [%]                   -0.576895
Avg. Drawdown [%]                   -0.059685
Max. Drawdown Duration       64 days 00:15:00
Avg. Drawdown Duration        4 days 04:03:00
# Trades                                   78
Win Rate [%]                        51.282051
Best Trade [%]                       2.108328
Worst Trade [%]                      -0.87637
Avg. Trade [%]                        0.04761
Max. Trade Duration           0 days 04:25:00
Avg. Trade Duration           0 days 02:59:00
Profit Factor                        1.317042
Expectancy [%]                       0.048772
SQN                                  0.893765
_strategy                            SmaCross
_equity_curve                             ...
_trades                      Size  EntryB...
dtype: object
```

backtesting.py - Strategy (Example 2)

- 開盤15分後進場:
  - WR 向上穿越 超買區
- 出場:
  - WR < -50(趨勢由多轉空)
  - 當沖13:30平倉
- SQN = 0.89 -> 1.3

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   18.130867
Equity Final [$]                  100456.0482
Equity Peak [$]                   100516.0482
Return [%]                           0.456048
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    0.984843
Volatility (Ann.) [%]                0.511304
Sharpe Ratio                          1.92614
Sortino Ratio                        3.182554
Calmar Ratio                         2.296039
Max. Drawdown [%]                   -0.428931
Avg. Drawdown [%]                   -0.041815
Max. Drawdown Duration       90 days 00:20:00
Avg. Drawdown Duration        5 days 11:41:00
# Trades                                   46
Win Rate [%]                        58.695652
Best Trade [%]                        0.79155
Worst Trade [%]                      -0.87637
Avg. Trade [%]                       0.061425
Max. Trade Duration           0 days 04:25:00
Avg. Trade Duration           0 days 02:16:00
Profit Factor                        1.588214
Expectancy [%]                       0.062052
SQN                                  1.342842
_strategy                            SmaCross
_equity_curve                             ...
_trades                       Size  EntryB...
dtype: object
```

backtesting.py - Strategy (Example 2)

- 開盤15分後進場:
  - WR 向上穿越 超買區
- 出場:
  - WR 向下穿越 超買區
  - 當沖13:30平倉
- SQN = 1.3 -> 1.6

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   14.501892
Equity Final [$]                 100492.35819
Equity Peak [$]                  100597.03156
Return [%]                           0.492358
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    1.063477
Volatility (Ann.) [%]                0.426522
Sharpe Ratio                         2.493371
Sortino Ratio                         5.31477
Calmar Ratio                         3.764324
Max. Drawdown [%]                   -0.282515
Avg. Drawdown [%]                   -0.032642
Max. Drawdown Duration       41 days 01:45:00
Avg. Drawdown Duration        4 days 18:08:00
# Trades                                   80
Win Rate [%]                             40.0
Best Trade [%]                       0.801321
Worst Trade [%]                     -0.499032
Avg. Trade [%]                       0.040152
Max. Trade Duration           0 days 04:25:00
Avg. Trade Duration           0 days 01:00:00
Profit Factor                        1.696511
Expectancy [%]                       0.040413
SQN                                  1.670555
_strategy                           SmaCross
_equity_curve                             ...
_trades                       Size  EntryB...
dtype: object
```

backtesting.py - Strategy (Example 2)

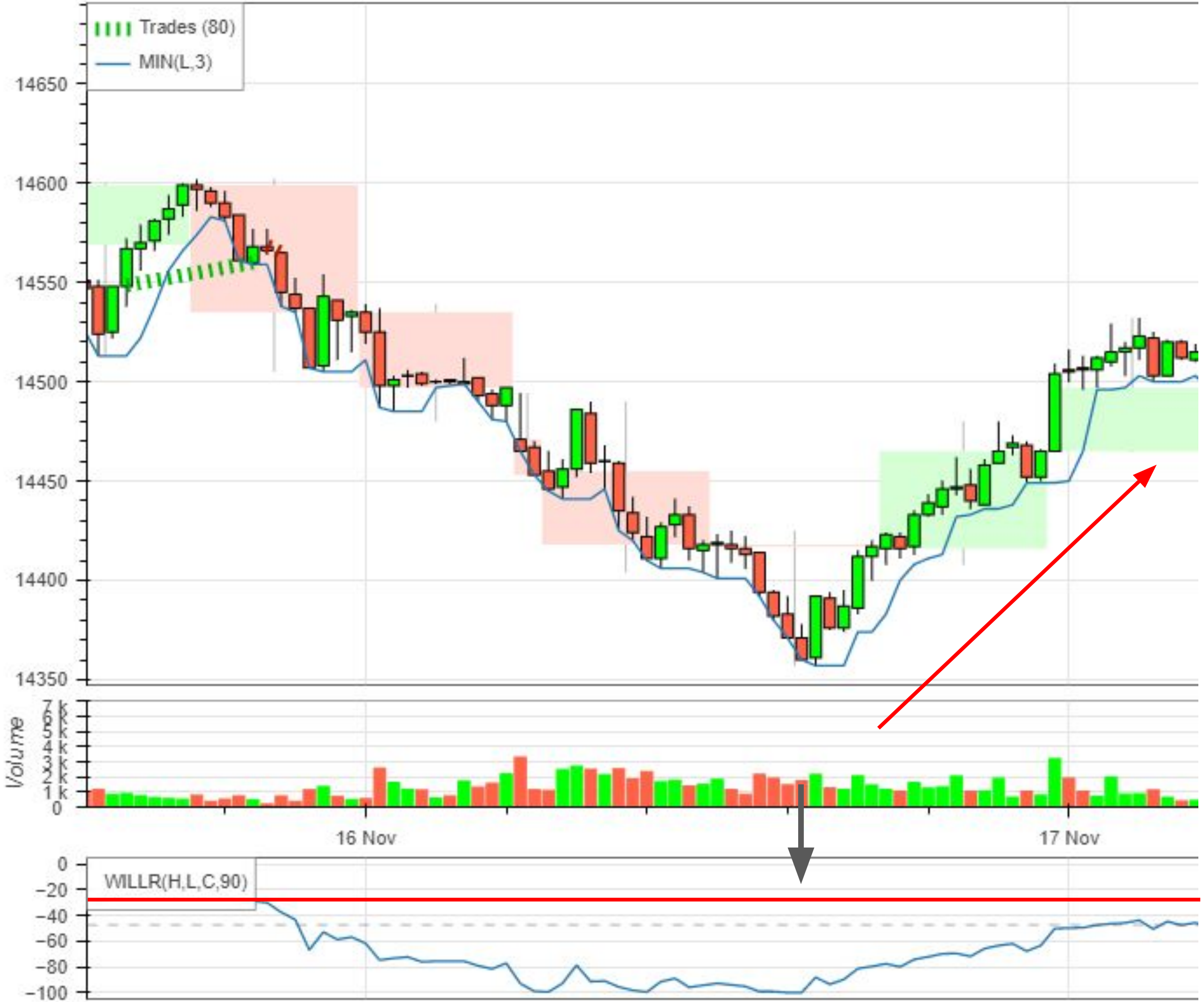
- 開盤15分後進場:
  - WR 向上穿越 超買區
- 出場:
  - 跌破3根低點停利停損
  - WR 向下穿越 超買區
  - 當沖13:30平倉
- SQN = 1.6 -> 2.0

Start	2022-09-05 08:50:00
End	2023-03-03 13:50:00
Duration	179 days 05:00:00
Exposure Time [%]	11.75564
Equity Final [$]	100562.35819
Equity Peak [$]	100665.03156
Return [%]	0.562358
Buy & Hold Return [%]	6.454471
Return (Ann.) [%]	1.215164
Volatility (Ann.) [%]	0.400546
Sharpe Ratio	3.033769
Sortino Ratio	8.024249
Calmar Ratio	6.005374
Max. Drawdown [%]	-0.202346
Avg. Drawdown [%]	-0.03215
Max. Drawdown Duration	28 days 21:05:00
Avg. Drawdown Duration	5 days 00:01:00
# Trades	80
Win Rate [%]	41.25
Best Trade [%]	0.823849
Worst Trade [%]	-0.279214
Avg. Trade [%]	0.047105
Max. Trade Duration	0 days 03:40:00
Avg. Trade Duration	0 days 00:48:00
Profit Factor	1.943096
Expectancy [%]	0.047336
SQN	2.010963
_strategy	SmaCross
_equity_curve	...
_trades	Size EntryB...
dtype: object	

backtesting.py - Strategy (Example 2)

- 開盤15分後進場:
  - WR 向上穿越 超買區
- 出場:
  - 百分比停損 0.1%
  - 跌破3根低點停利停損
  - WR 向下穿越 超買區
  - 當沖13:30平倉
- SQN = 2.0 -> 2.3

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   11.503433
Equity Final [$]                 100626.35819
Equity Peak [$]                  100738.03156
Return [%]                           0.626358
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    1.353956
Volatility (Ann.) [%]                0.390993
Sharpe Ratio                         3.462862
Sortino Ratio                       10.464056
Calmar Ratio                         8.495323
Max. Drawdown [%]                   -0.159377
Avg. Drawdown [%]                   -0.028722
Max. Drawdown Duration       28 days 21:05:00
Avg. Drawdown Duration        4 days 14:17:00
# Trades                                   80
Win Rate [%]                            41.25
Best Trade [%]                       0.823849
Worst Trade [%]                     -0.191865
Avg. Trade [%]                       0.053106
Max. Trade Duration           0 days 03:40:00
Avg. Trade Duration           0 days 00:47:00
Profit Factor                        2.206245
Expectancy [%]                       0.053323
SQN                                  2.304129
_strategy                            SmaCross
_equity_curve                             ...
_trades                        Size  EntryB...
dtype: object
```



Trades (80)
MIN(L,3)
14650
14600
14550
14500
14450
14400
14350
Volume
7 k
6 k
5 k
4 k
3 k
2 k
1 k
0
16 Nov
17 Nov
WILLR(H,L,C,90)
0
−20
−40
−60
−80
−100

WL = 90
OV = -30
L = 3

backtesting.py - Strategy (Example 3)

- 空單進場:
  - WR 向下穿越 超買區，且WR < -50
- 出場:
  - 多單進場
  - 百分比停利停損(1%、0.2%)
  - 當沖13:30平倉
- SQN = 2.5，交易次數1次

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   11.909766
Equity Final [$]                100712.89679
Equity Peak [$]                 100824.57016
Return [%]                           0.712897
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    1.541787
Volatility (Ann.) [%]                0.409707
Sharpe Ratio                         3.763144
Sortino Ratio                       11.919035
Calmar Ratio                         9.673863
Max. Drawdown [%]                   -0.159377
Avg. Drawdown [%]                    -0.02726
Max. Drawdown Duration       28 days 21:05:00
Avg. Drawdown Duration        4 days 02:27:00
# Trades                                   81
Win Rate [%]                        41.975309
Best Trade [%]                       0.823849
Worst Trade [%]                     -0.191865
Avg. Trade [%]                       0.059381
Max. Trade Duration           0 days 03:40:00
Avg. Trade Duration           0 days 00:48:00
Profit Factor                        2.365355
Expectancy [%]                       0.059611
SQN                                  2.519189
_strategy                            SmaCross
_equity_curve                             ...
_trades                       Size  EntryB...
dtype: object
```

backtesting.py - Strategy (Example 3)

- 空單進場:
    - WR 向下穿越 超買區，且WR < -50
    - WR 向下穿越 超賣區，且Close < SMA
- 出場:
    - 多單進場
    - 百分比停利停損(1%、0.2%)
    - 當沖13:30平倉
- SQN = 2.8，交易次數45次

```
Start                     2022-09-05 08:50:00
End                       2023-03-03 13:50:00
Duration                    179 days 05:00:00
Exposure Time [%]                   25.472888
Equity Final [$]                  101375.1431
Equity Peak [$]                  101467.28327
Return [%]                           1.375143
Buy & Hold Return [%]                6.454471
Return (Ann.) [%]                    2.985361
Volatility (Ann.) [%]                0.757881
Sharpe Ratio                         3.939092
Sortino Ratio                       10.086387
Calmar Ratio                        17.678885
Max. Drawdown [%]                   -0.168866
Avg. Drawdown [%]                   -0.034744
Max. Drawdown Duration       19 days 00:55:00
Avg. Drawdown Duration        2 days 09:29:00
# Trades                                  125
Win Rate [%]                             43.2
Best Trade [%]                       1.191563
Worst Trade [%]                     -0.414439
Avg. Trade [%]                       0.076976
Max. Trade Duration           0 days 04:25:00
Avg. Trade Duration           0 days 01:08:00
Profit Factor                        2.178683
Expectancy [%]                       0.077454
SQN                                  2.817253
_strategy                            SmaCross
_equity_curve                             ...
_trades                         Size  Entry...
dtype: object
```