1.交易策略原理

可转债与其对应的正股在日内会有收益率的偏离效应，根据收益率偏离程度可构造策略的交易信号，在回测中定义diff为可转债收益率与正股收益率之差。当diff高于正向开仓阈值时，做空可转债，同时做多股票。diff低于反向开仓阈值时，做多可转债，做空股票。由于股票的T+1交易机制，回测中设定每日开仓平仓的交易次数上限为1。

选取的股债对如下：

可转债	股票
128081.SZ	002203.SZ
123046.SZ	300587.SZ
110061.SH	600674.SH
113642.SH	603185.SH

这几个可转债中的内嵌期权条款表明，他们都属于深度价内的看涨期权，故可用作delta对冲的工具。

1.1 diff计算方法

$$diff = \frac{bond\ close_t^{min}}{bond\ close_{-1}^{day}} - \frac{stock\ close_t^{min}}{stock\ close_{-1}^{day}} \tag{1-1}$$

1.2 diff取值不同时对仓位的操作

正向仓位

- short bond long stock

反向仓位

- long bond short stock

以$open\ threshold = 0.01$，$close\ threshold = 0.001$为例

$diff \in [0.01, \infty)$

- 此时若无仓位，正向开仓
- 此时若有正向仓位，继续持有
- 此时若有负向仓位，先平仓再正向开仓

$diff \in (0.001, 0.01)$

- 此时若无仓位，继续保持空仓
- 此时若正向仓位，继续持有
- 此时若有负向仓位，平仓

$diff \in [-0.001, 0.001]$

- 此时若无仓位，继续保持空仓

- 此时若有正向仓位，平仓
- 此时若有负向仓位，平仓

$diff \in (-0.01, -0.001)$

- 此时若无仓位，继续保持空仓
- 此时若有正向仓位，平仓
- 此时若有负向仓位，继续持有

$diff \in (-\infty, -0.01]$

- 此时若无仓位，反向开仓；
- 此时若有正向仓位，先平仓再反向开仓
- 此时若有反向仓位，继续持有

2.数据描述

回测中包含了4组股债对，回测区间自2021-12-13至2022-06-28

可转债	股票	转股价格
128081.SZ	002203.SZ	9.69 (2021-12-13->2022-06-28)
123046.SZ	300587.SZ	6.73 (2021-12-13->2022-03-22) 6.74 (2022-03-23->2022-06-28)
110061.SH	600674.SH	9.62 (2021-12-13->2022-06-28)
113642.SH	603185.SH	145.66 (2022-04-06->2022-06-01) 102.61 (2022-06-02->2022-06-28)

3.回测结果

通过单个股债对的回测检验，调试代码无误后，用网格搜索的方式，检验策略信号以及策略表现的稳定性，同时选出最优参数组。

回测中，

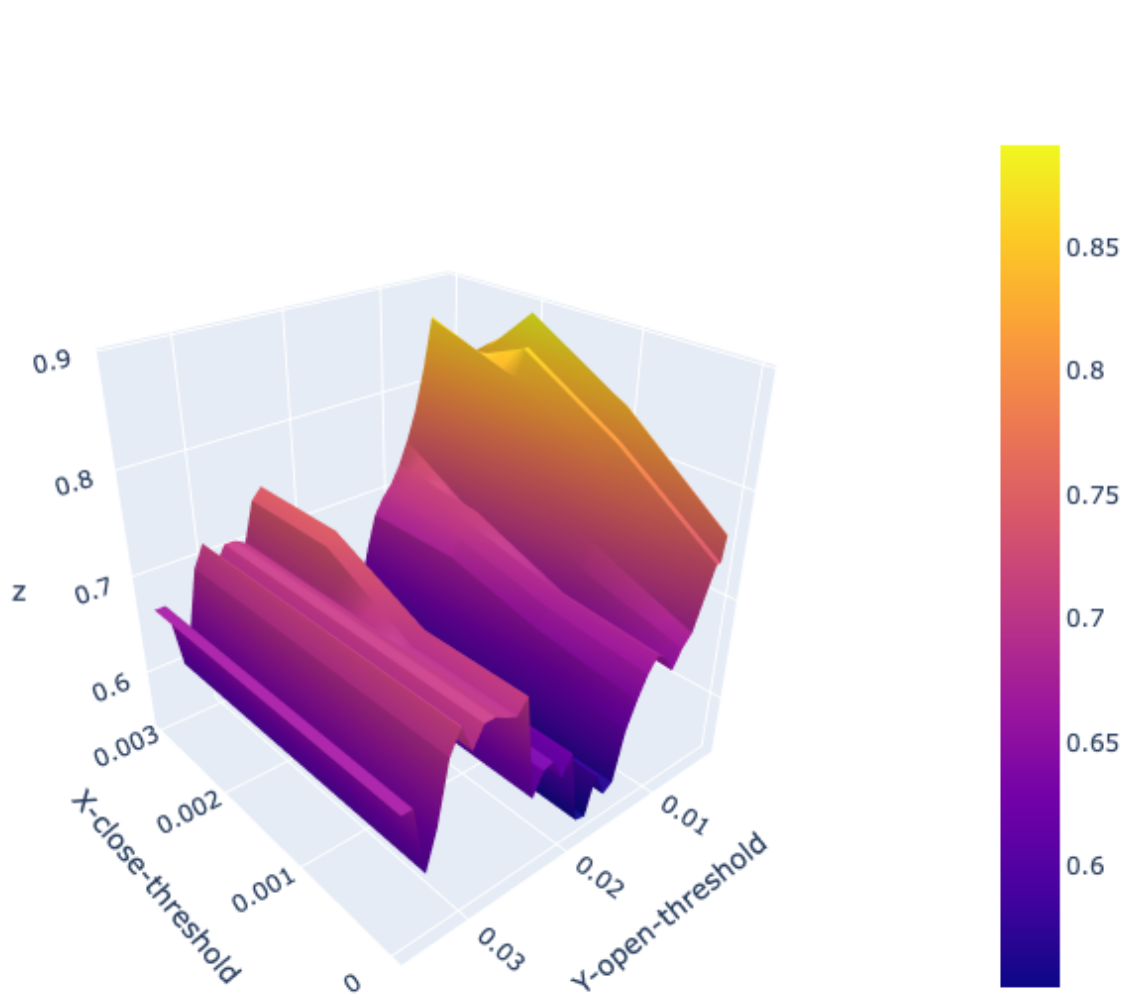
$$stock\ volume = \frac{bond\ close_{-1}^{day}}{stock\ close_{-1}^{day}} \tag{3-1}$$

3.1 参数网格搜索结果

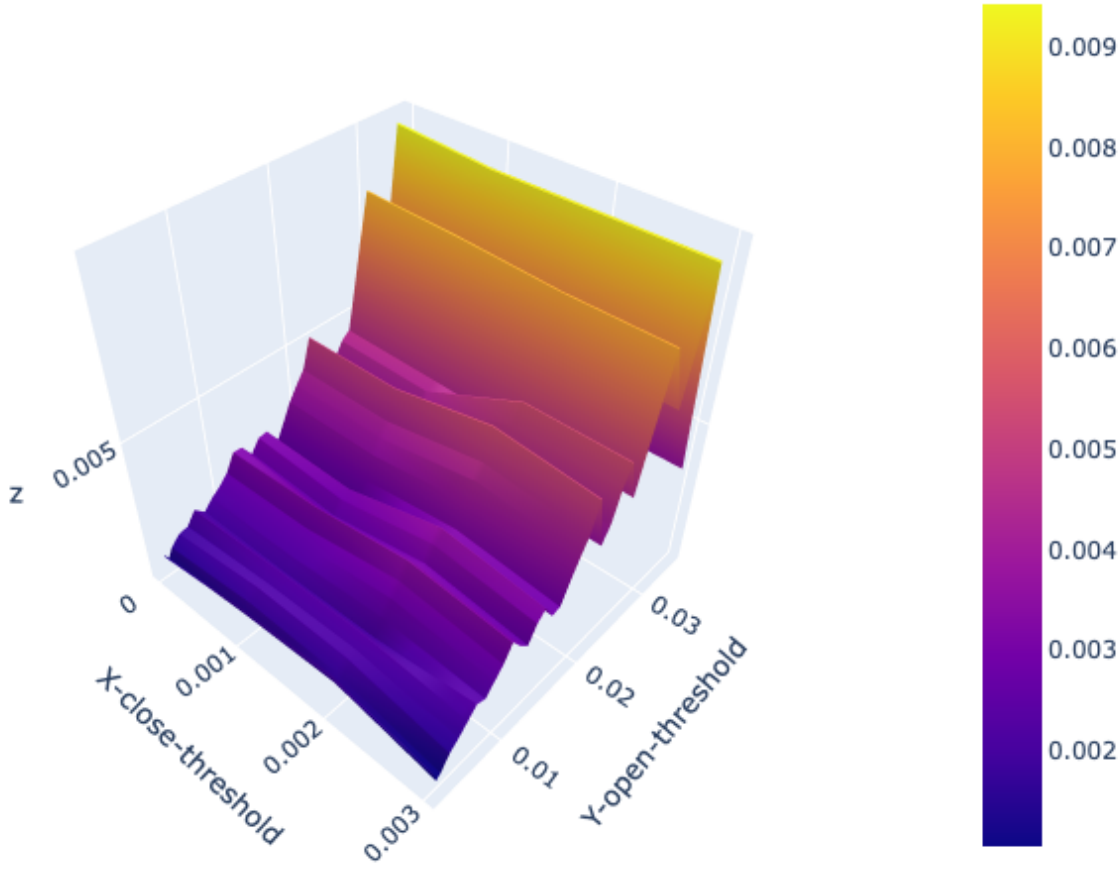
对各个股债对进行分组网格搜索，并将结果记录如下

3.1.1 【128081.SZ | 002203.SZ】

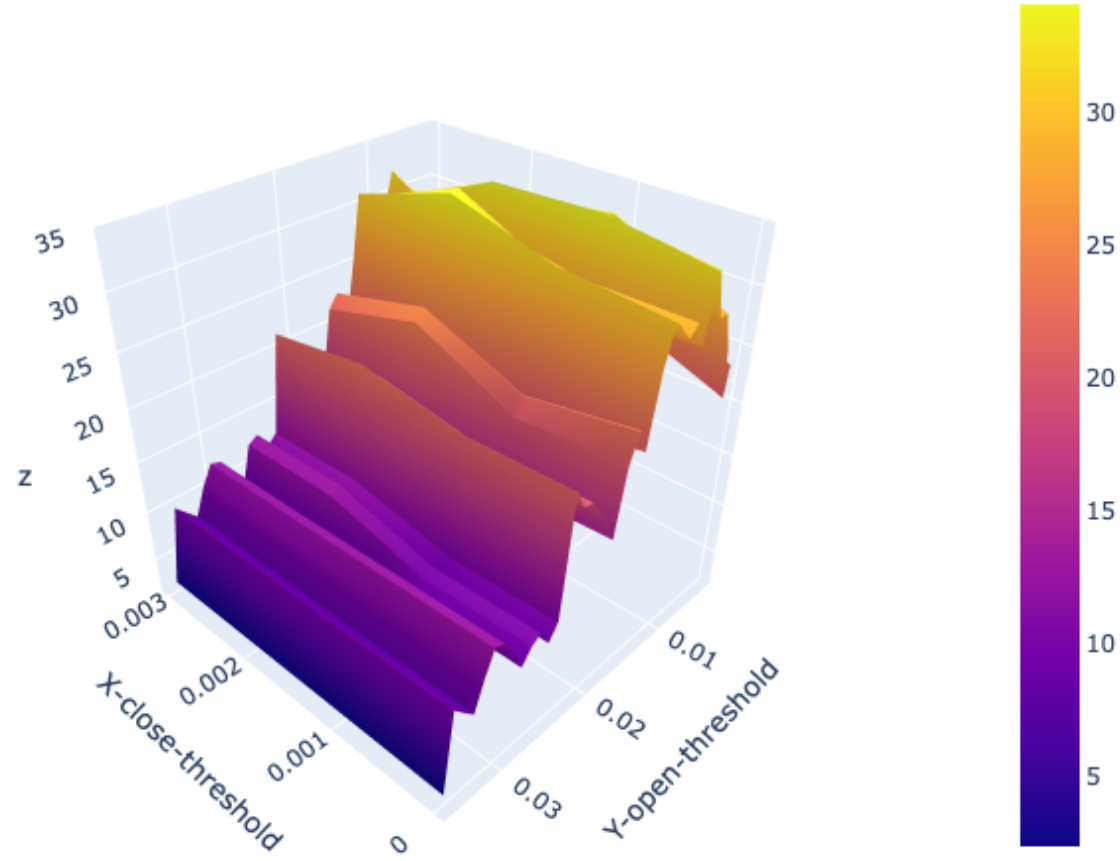
2021-12-13->2022-06-28

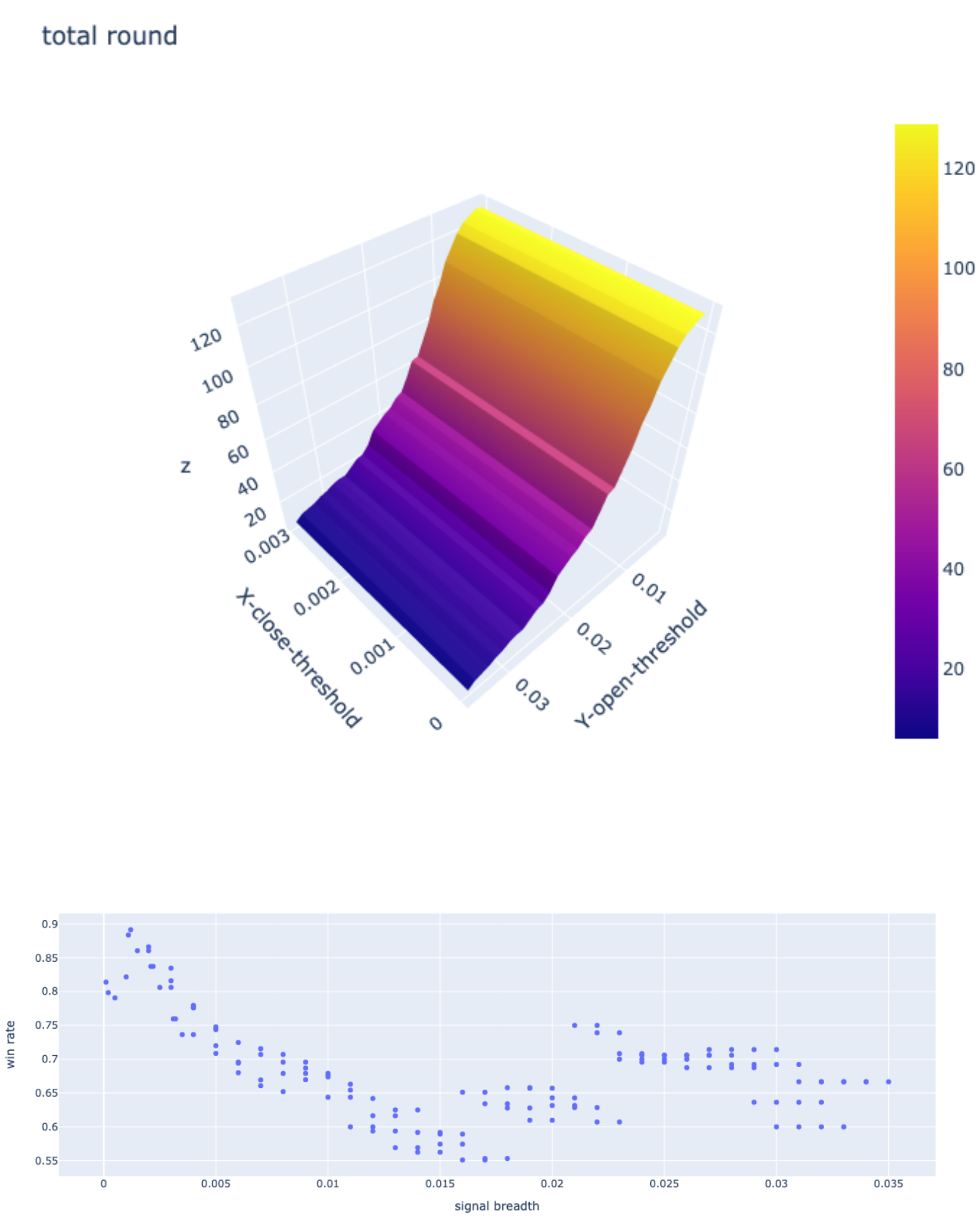


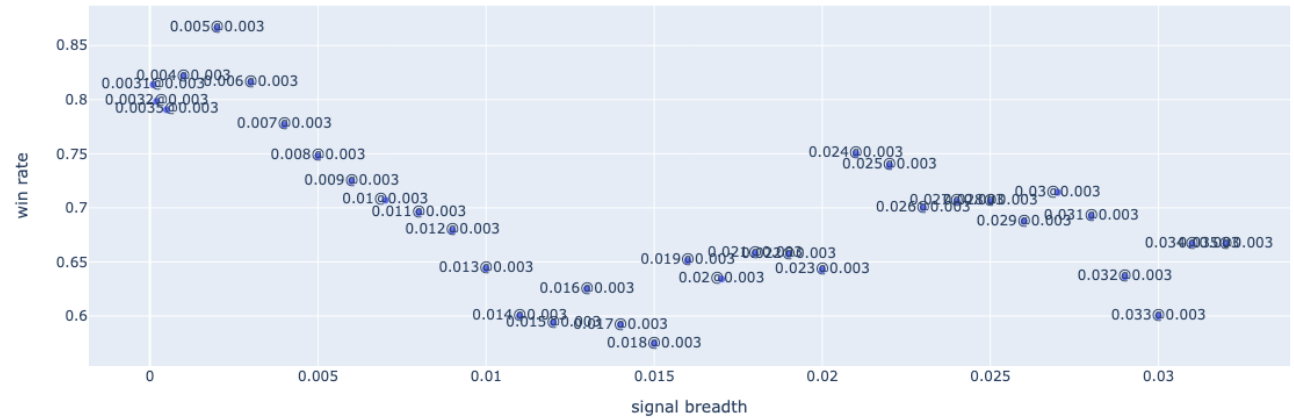
return per round

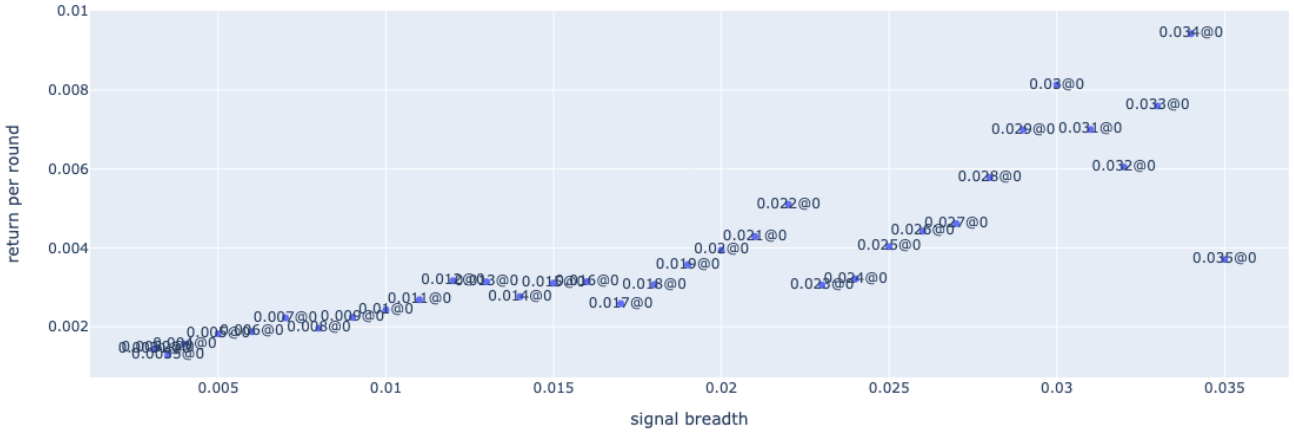


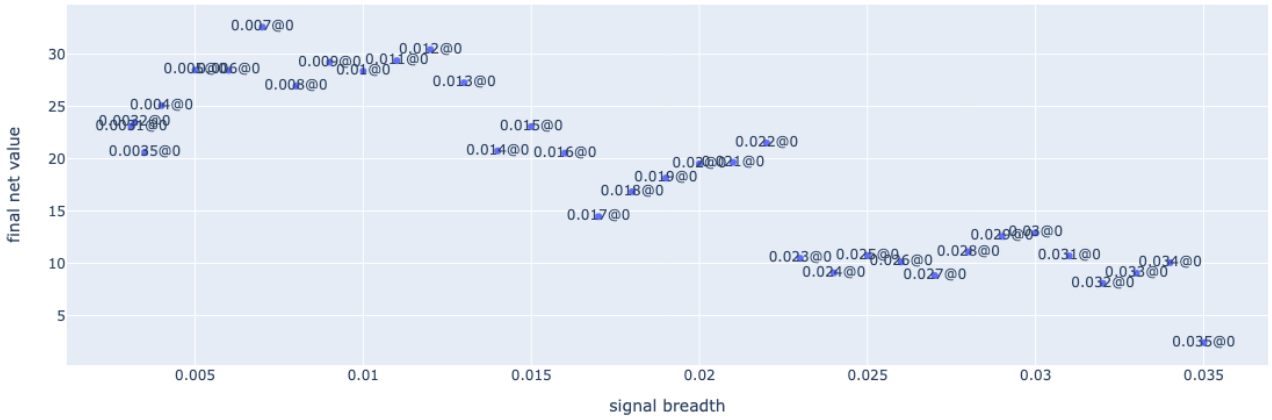
final net value




total round
Z
120
100
80
60
40
20
X-close-threshold
0.003
0.002
0.001
0
Y-open-threshold
0.01
0.02
0.03
120
100
80
60
40
20
win rate
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
signal breadth



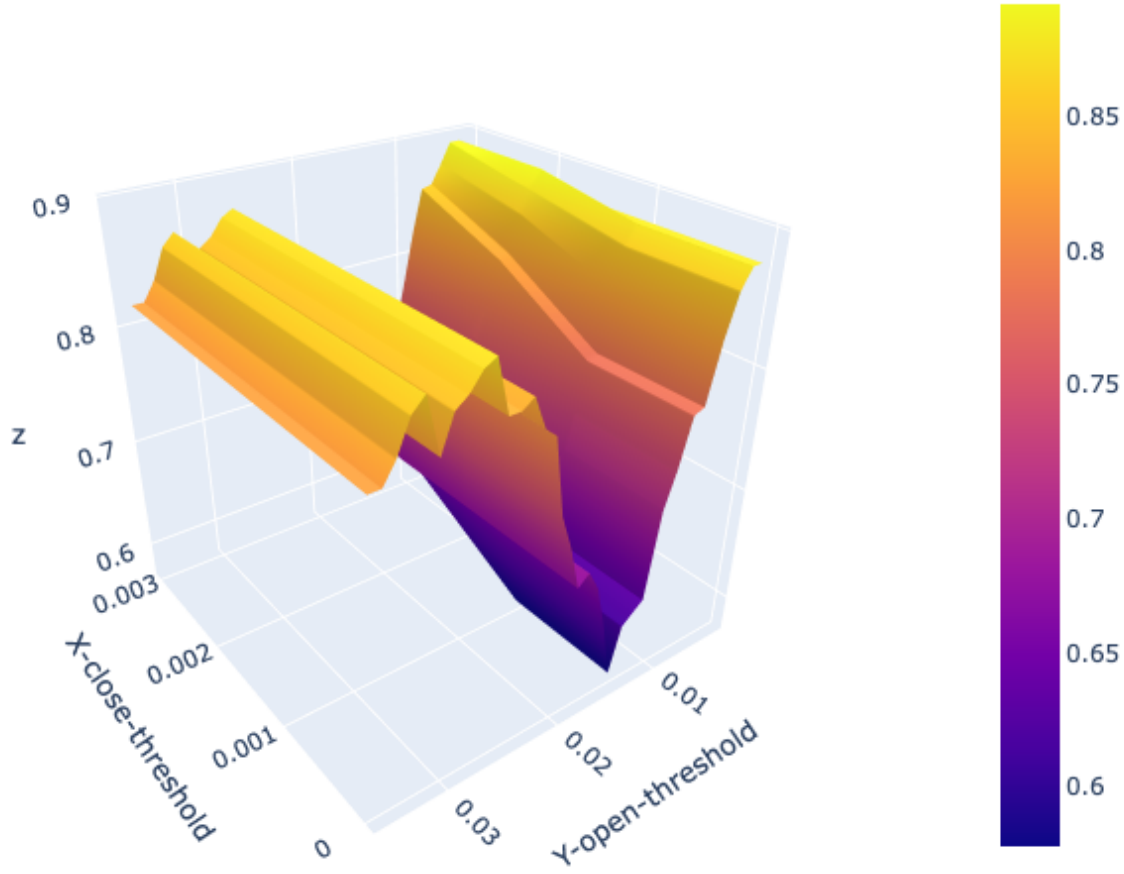




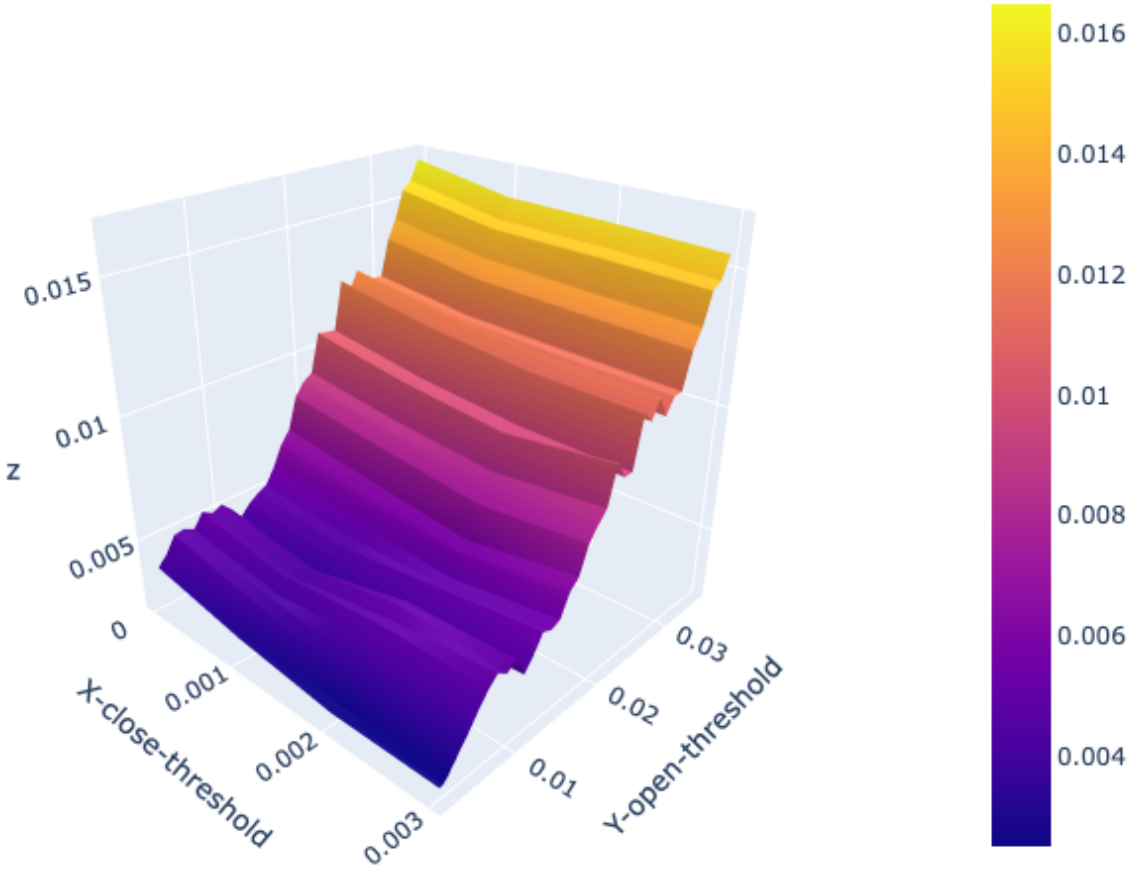
3.1.2 【123046.SZ | 300587.SZ】

2021-12-13->2022-03-22

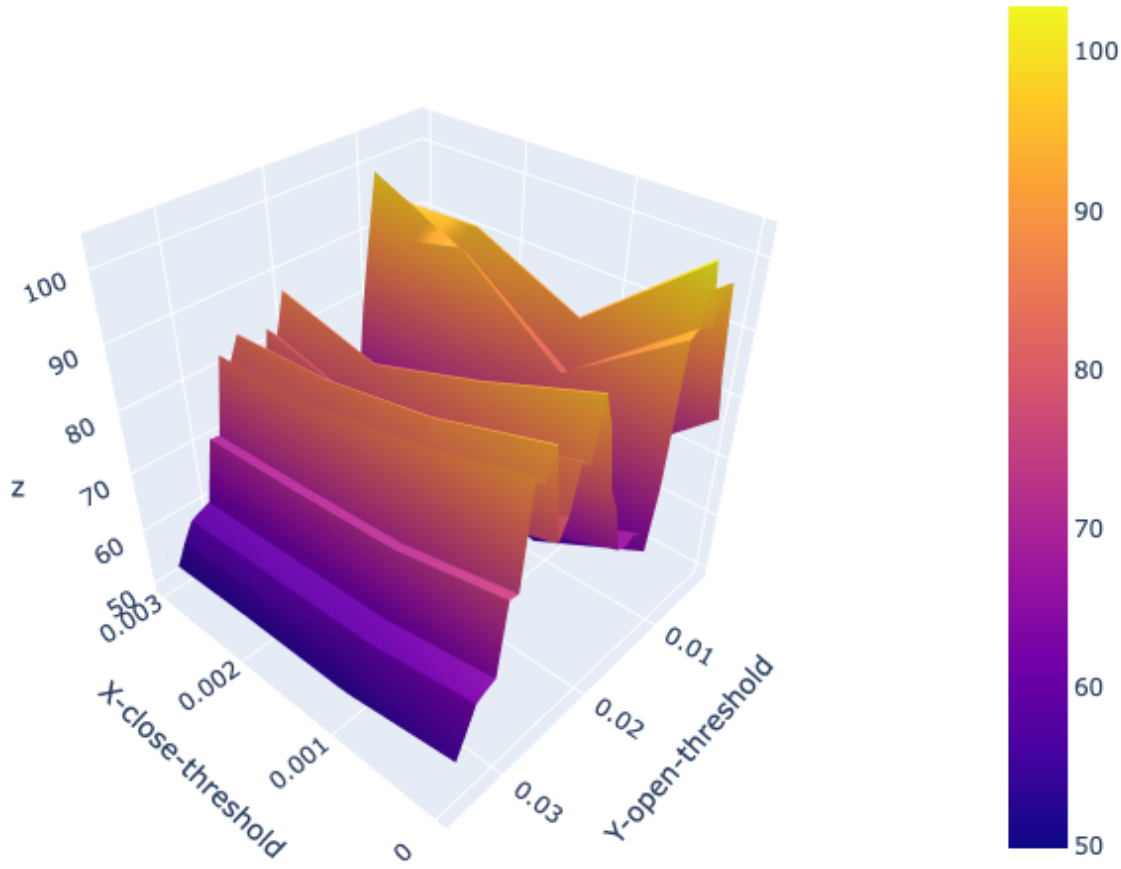
win rate

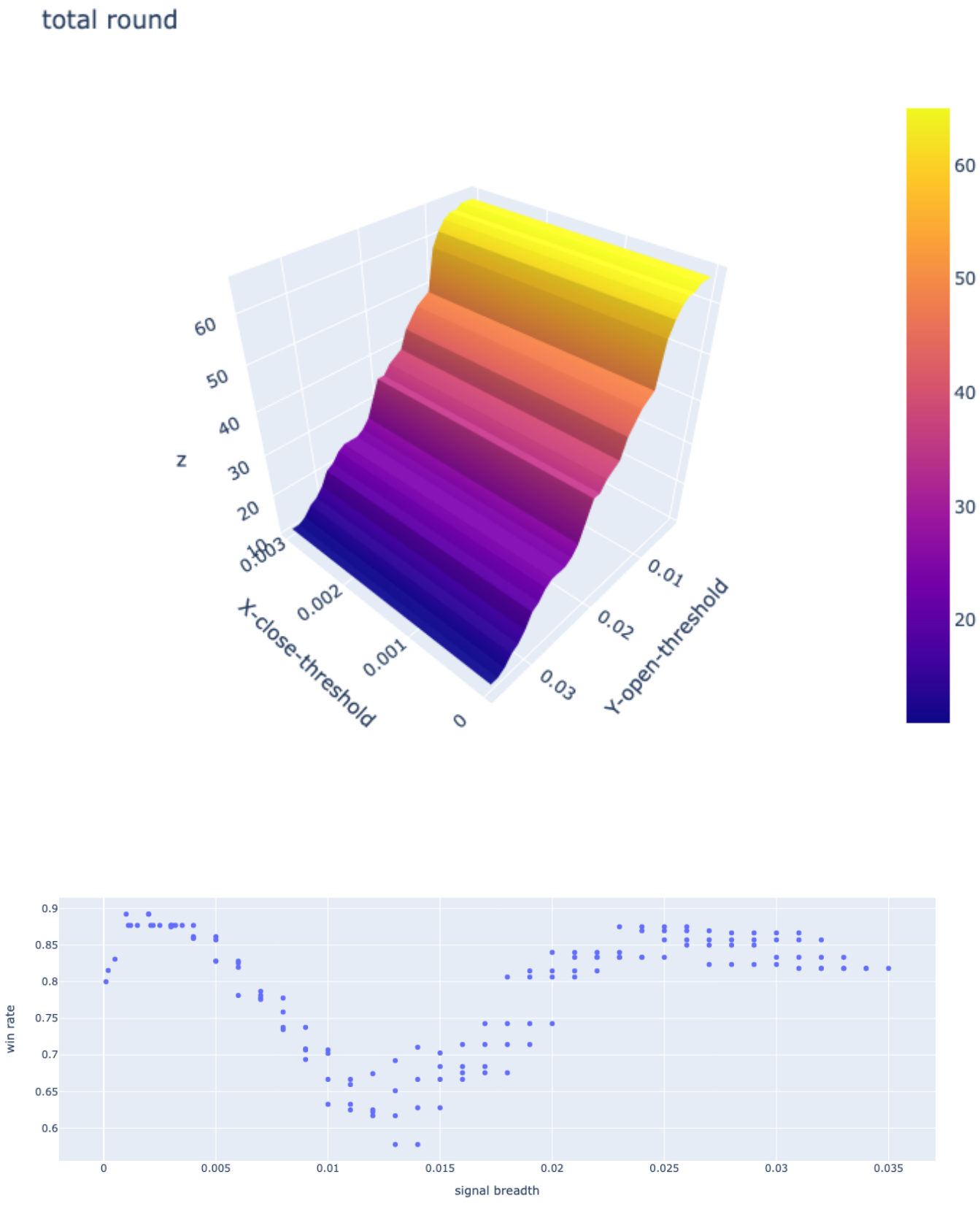

0.9
0.8
z
0.7
0.6
0.003
0.002
0.001
0
X-close-threshold
0.01
0.02
0.03
Y-open-threshold
0.85
0.8
0.75
0.7
0.65
0.6

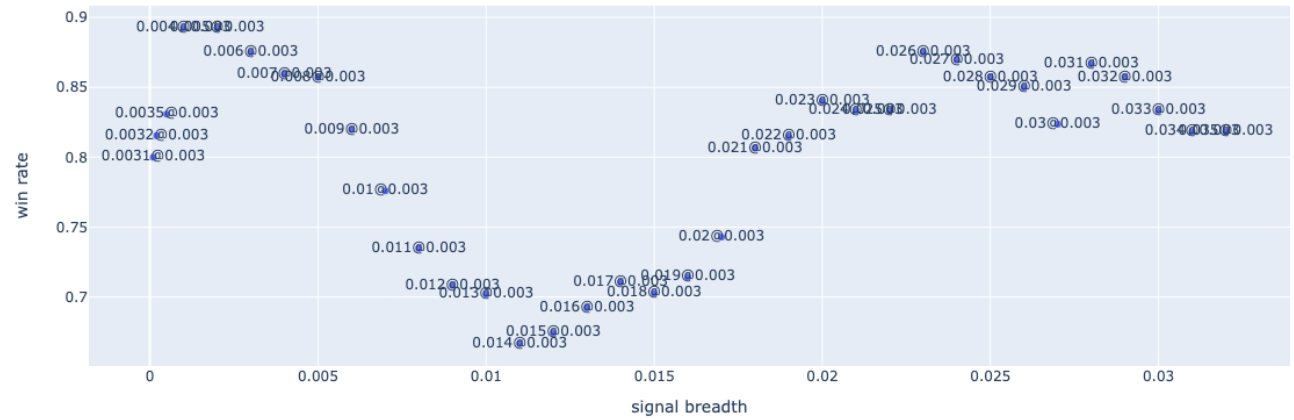
return per round

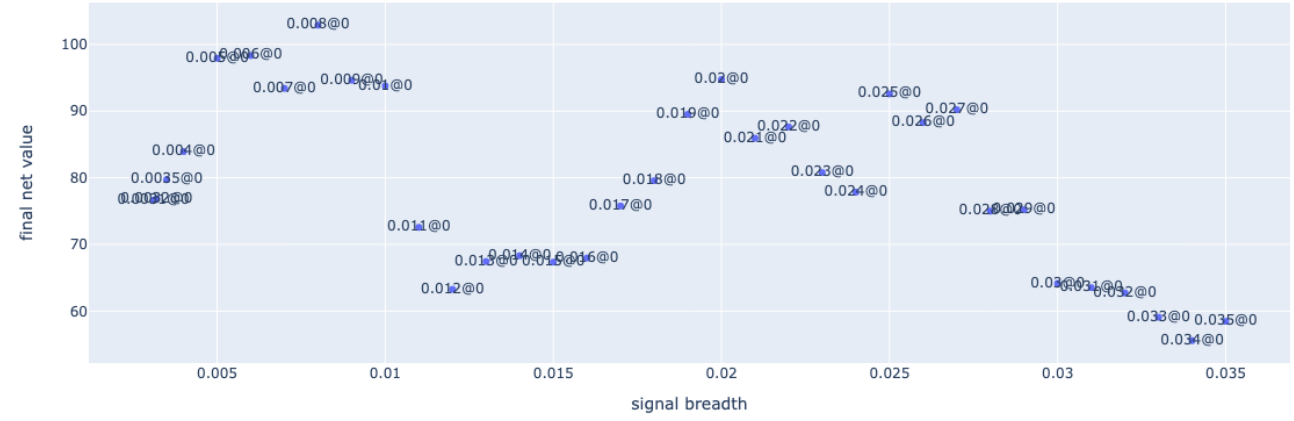


final net value



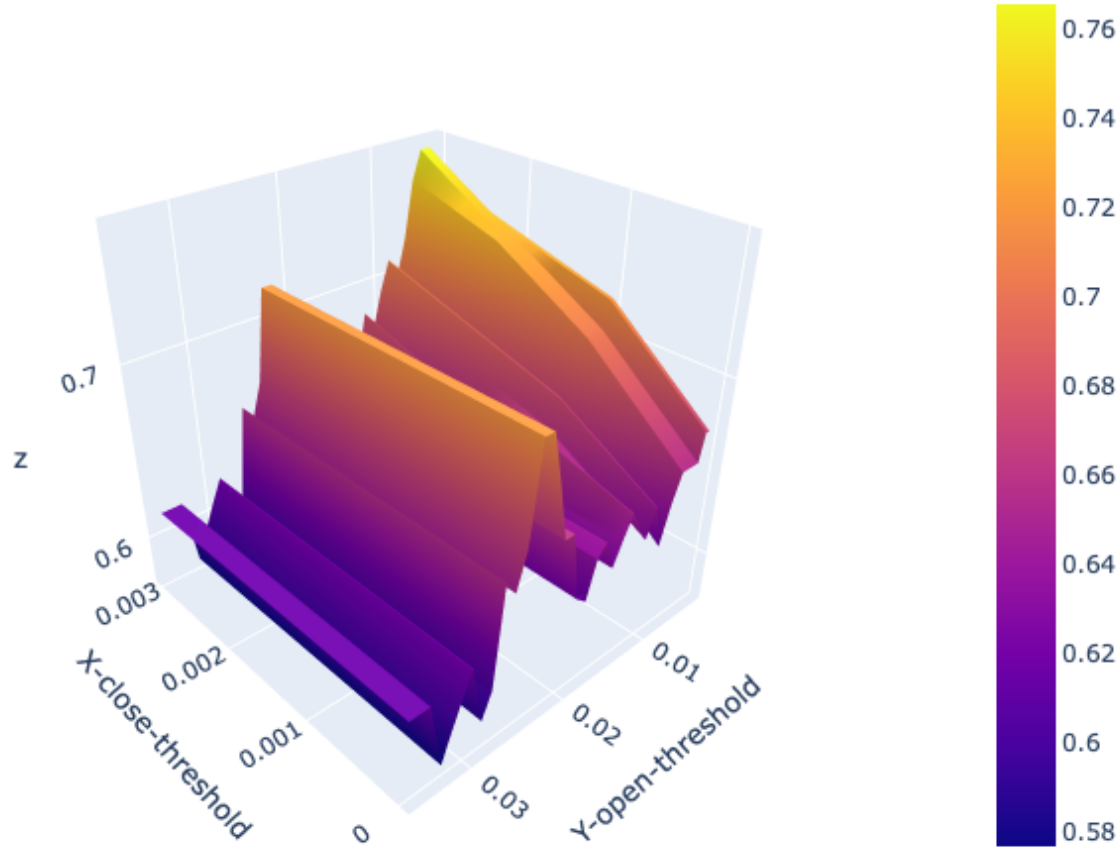

total round
z
60
50
40
30
20
10
0.003
0.002
0.001
0
X-close-threshold
0.01
0.02
0.03
Y-open-threshold
60
50
40
30
20
win rate
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
signal breadth



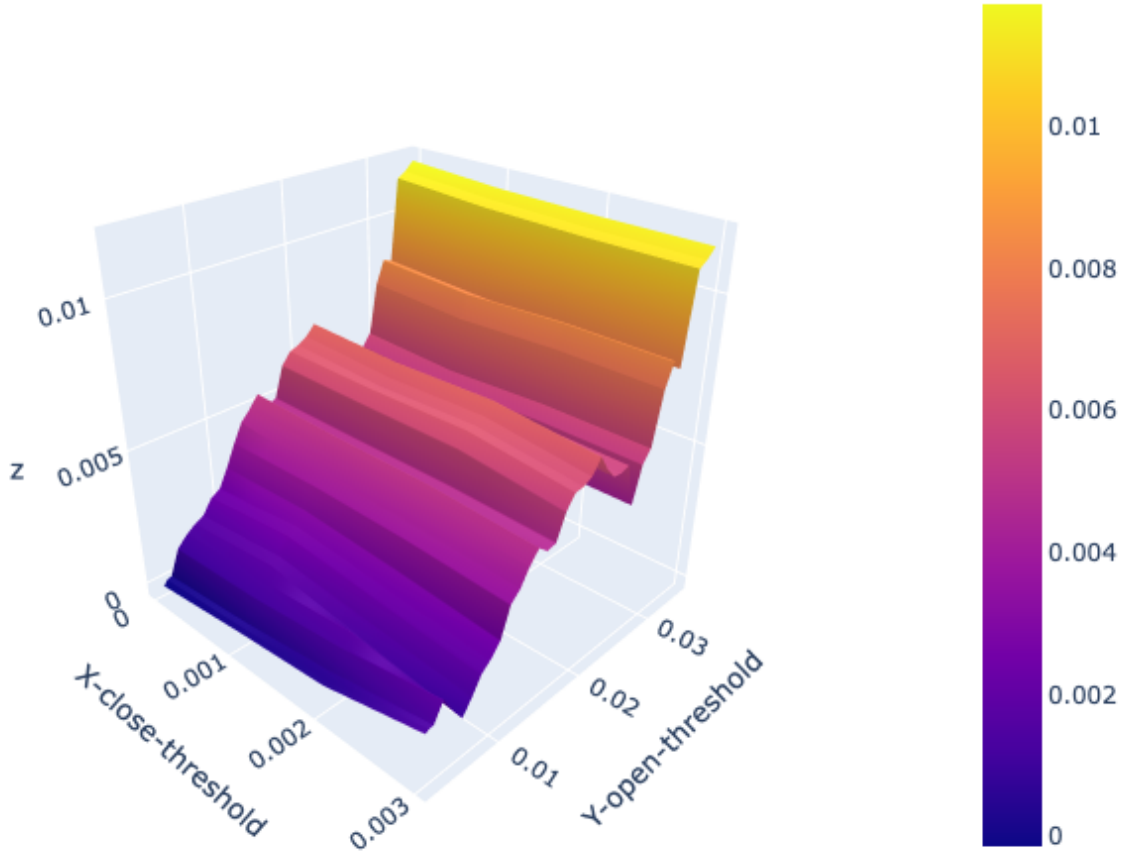


2022-03-23->2022-06-28

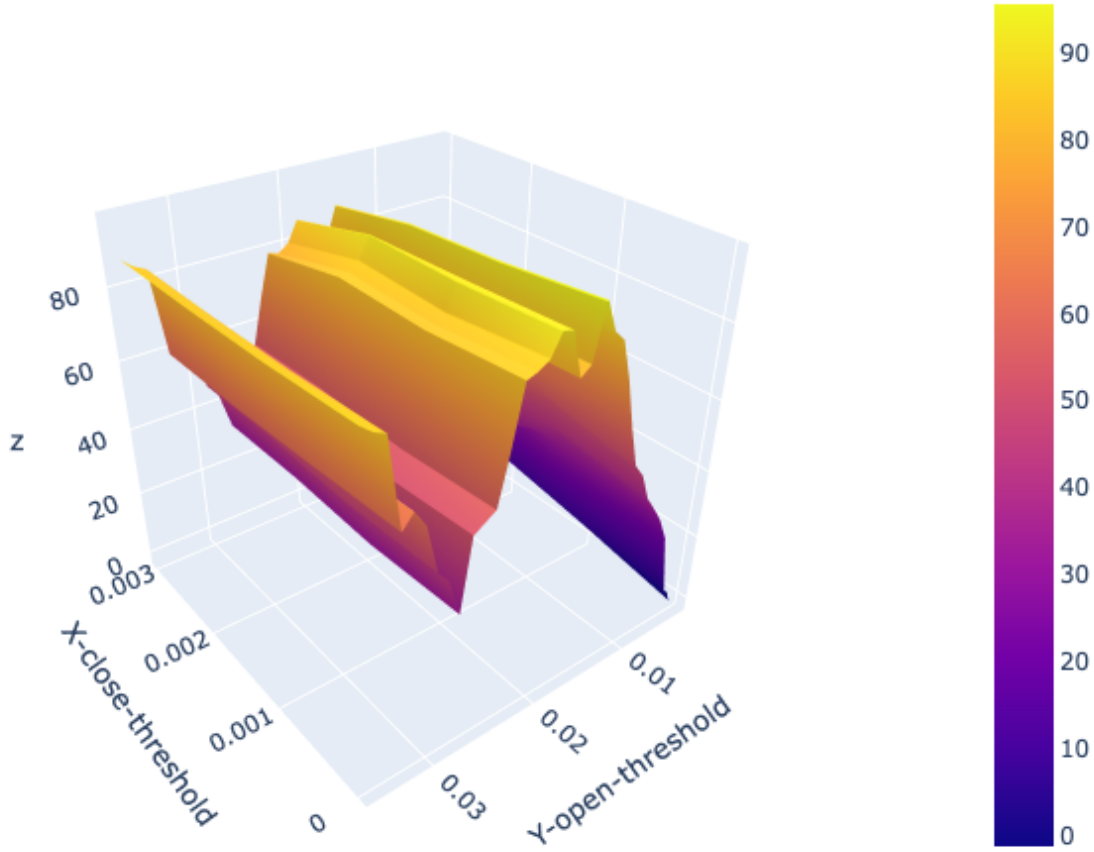
win rate

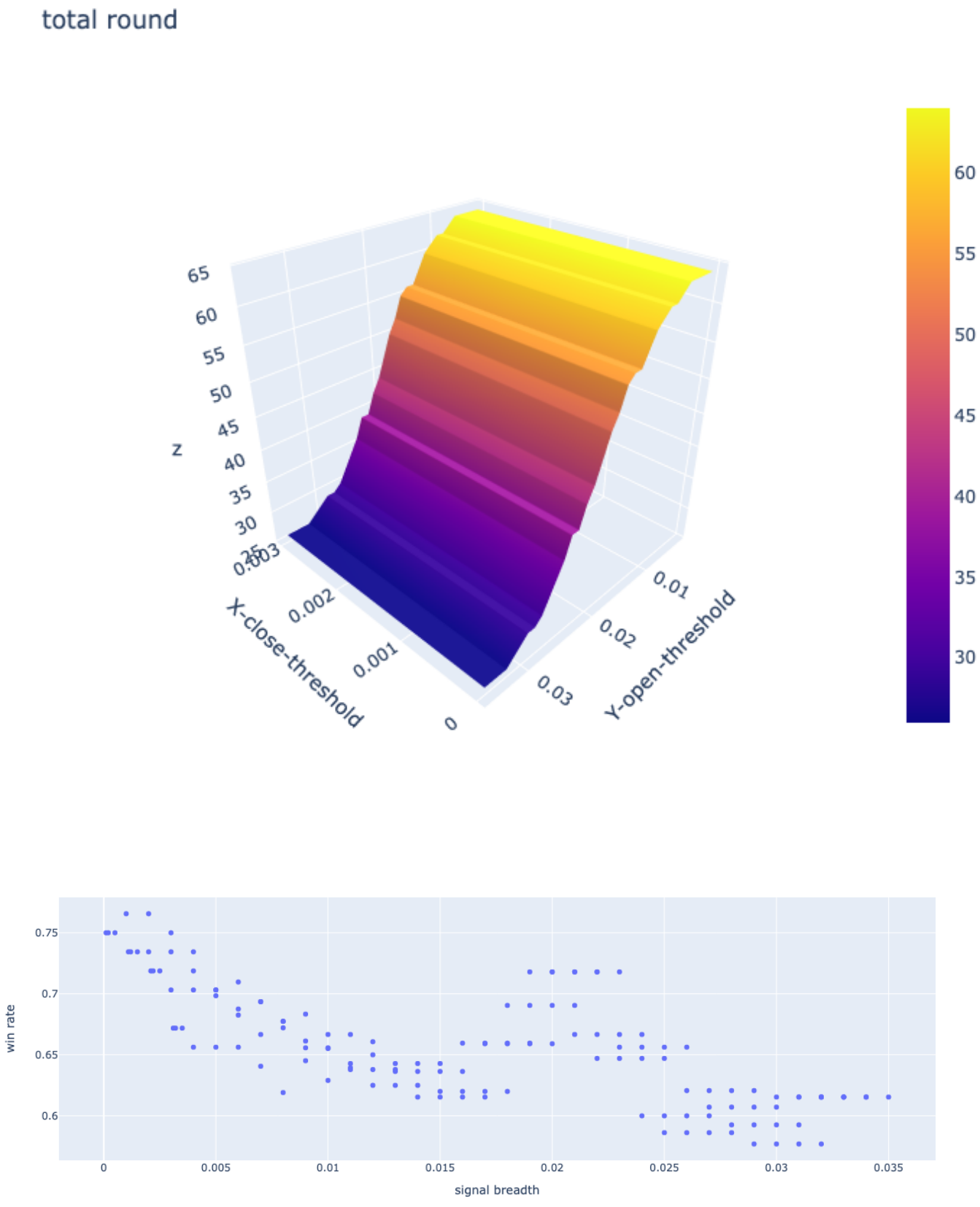

z
0.7
0.6
X-close-threshold
0.003
0.002
0.001
0
Y-open-threshold
0.01
0.02
0.03
0.76
0.74
0.72
0.7
0.68
0.66
0.64
0.62
0.6
0.58

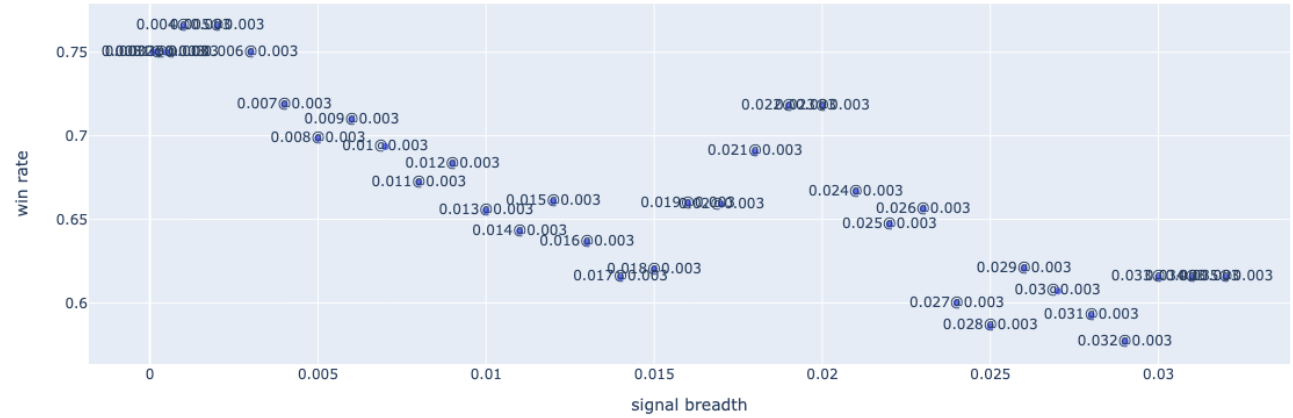
return per round

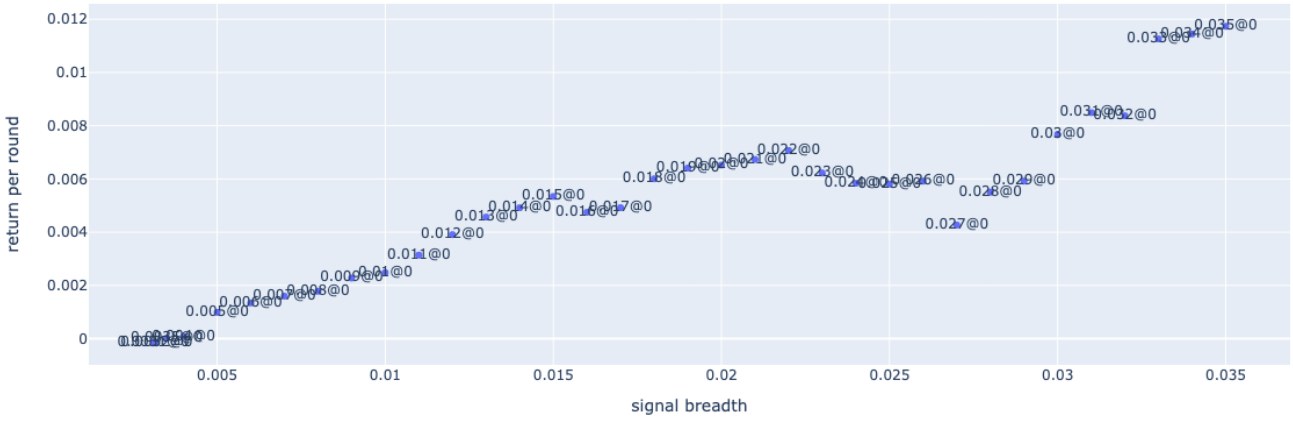


final net value




total round
z
65
60
55
50
45
40
35
30
25
X-close-threshold
0.003
0.002
0.001
0
Y-open-threshold
0.01
0.02
0.03
60
55
50
45
40
35
30
win rate
0.75
0.7
0.65
0.6
signal breadth
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035

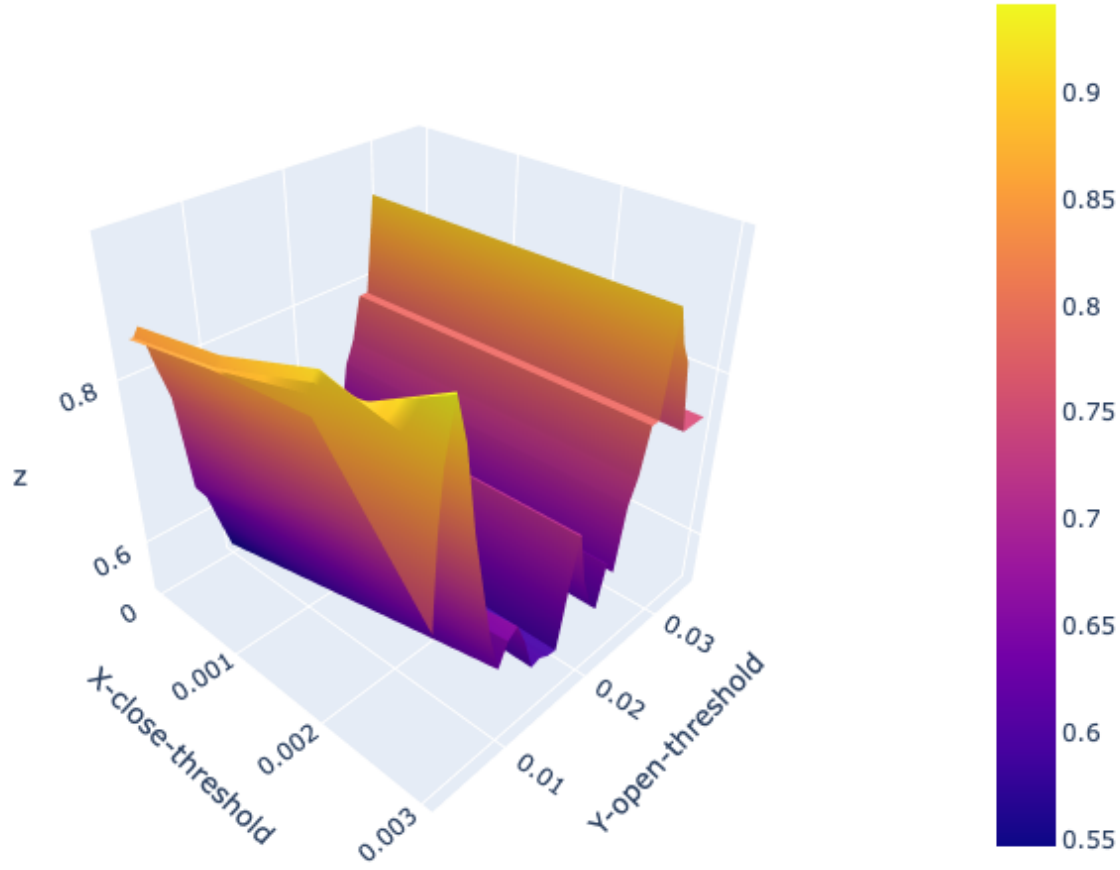




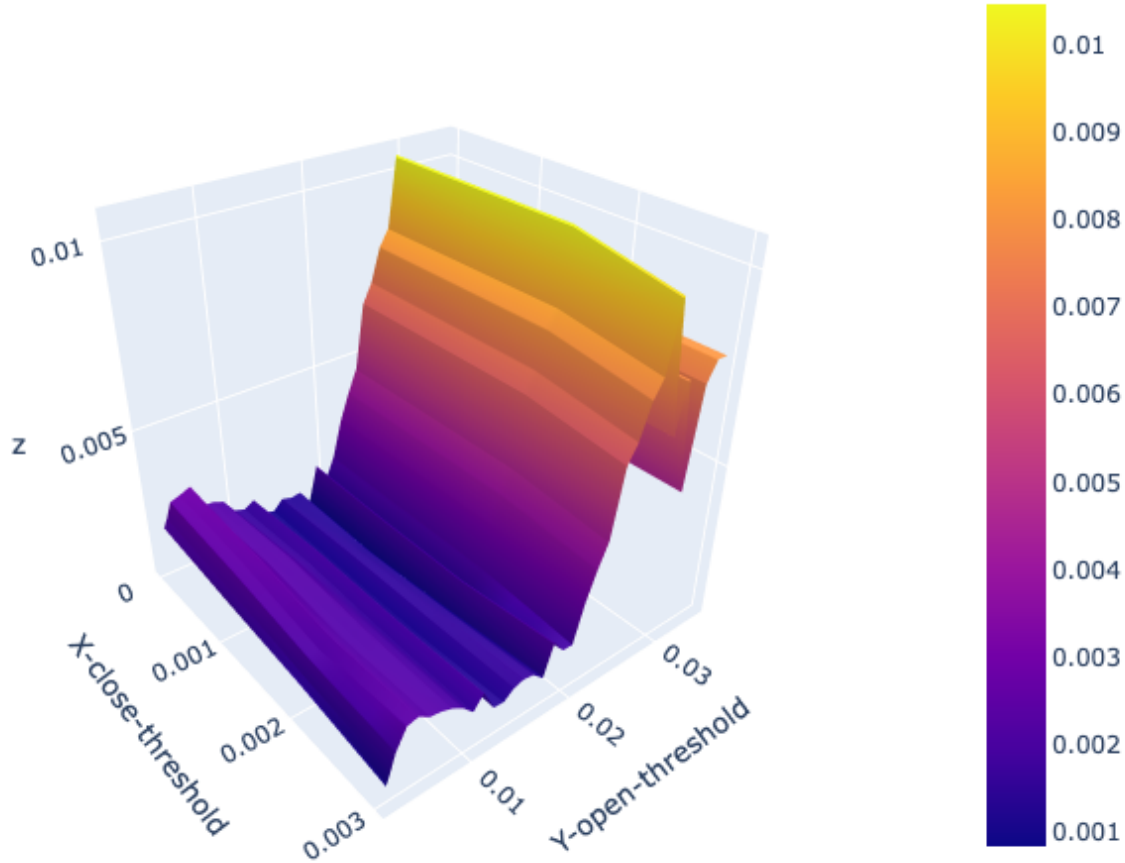
3.1.3 【110061.SH | 600674.SH】

2021-12-13->2022-06-28

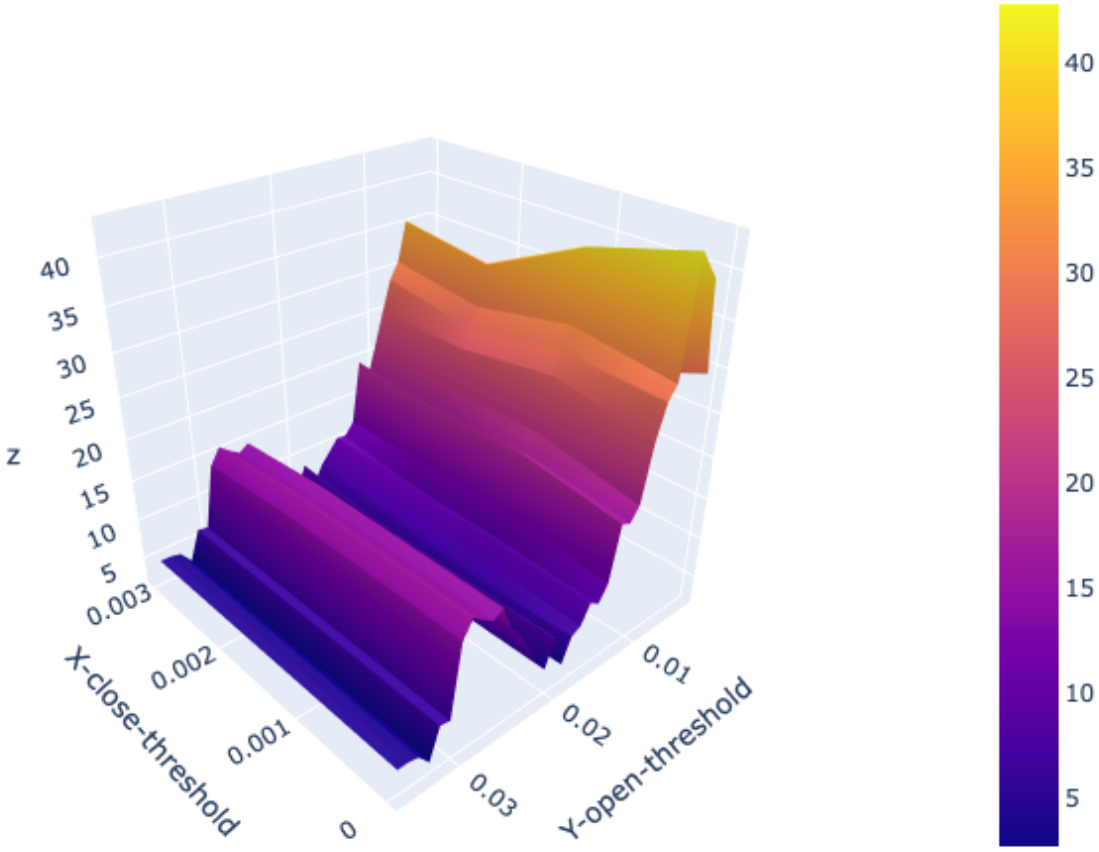
win rate

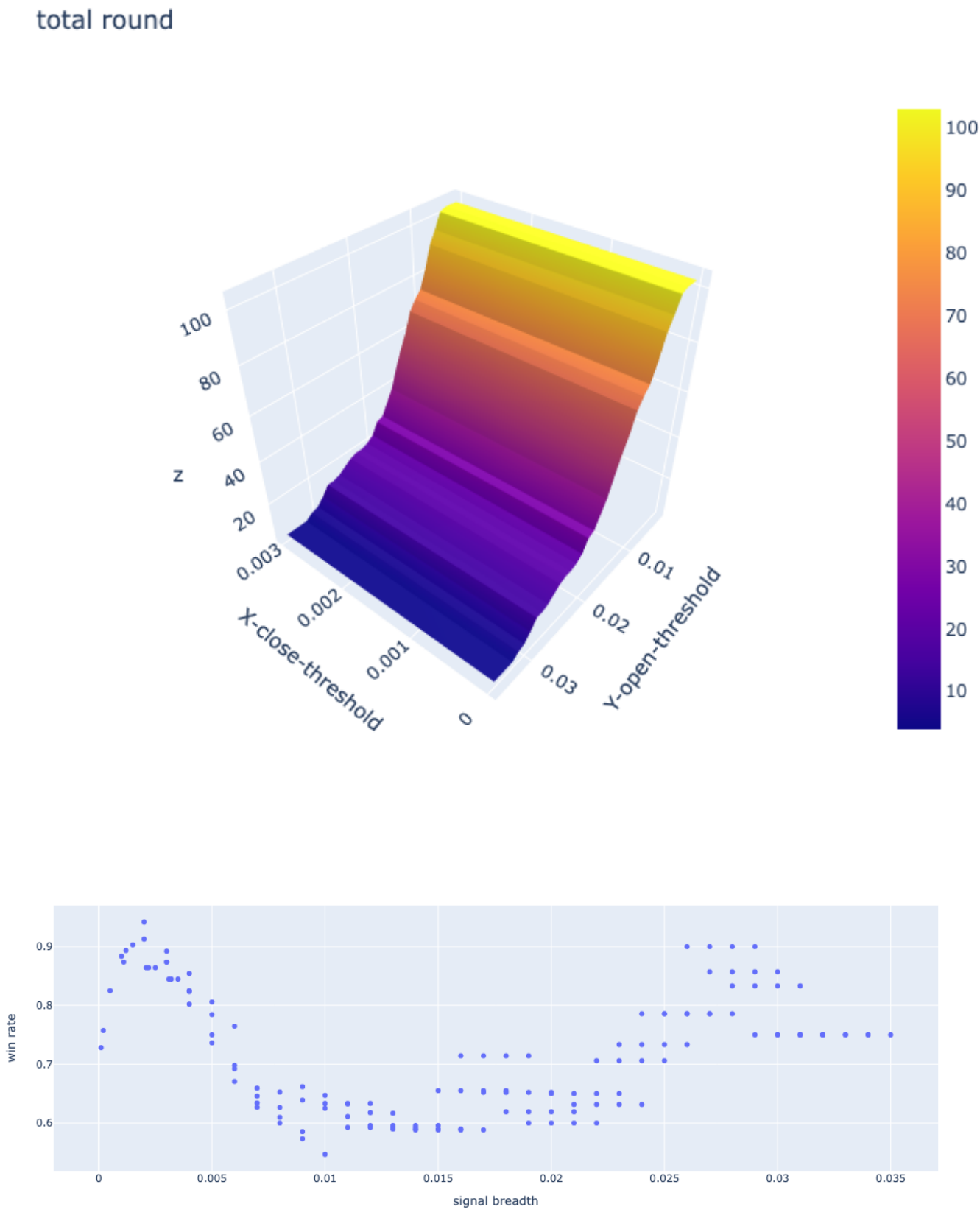

z
0.8
0.6
X-close-threshold
0
0.001
0.002
0.003
Y-open-threshold
0.01
0.02
0.03
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55

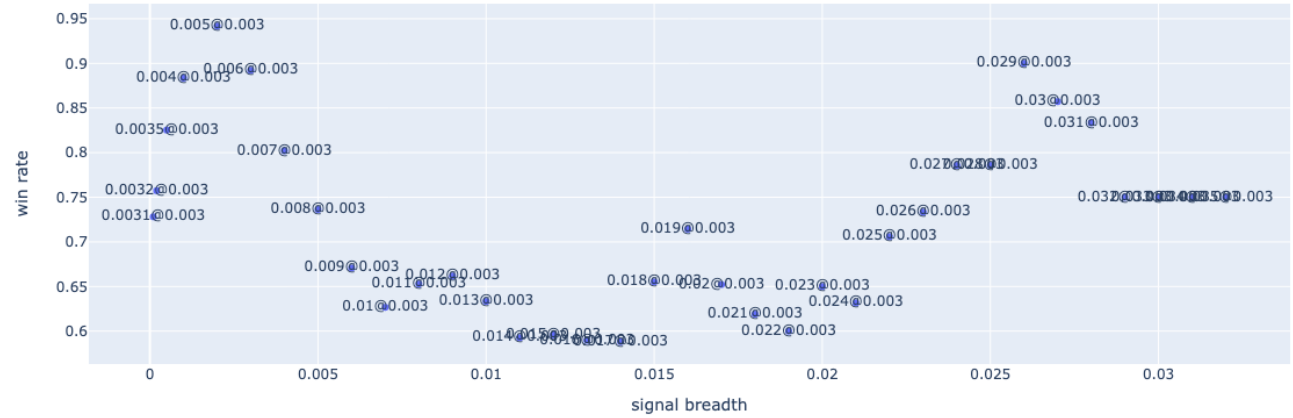
return per round

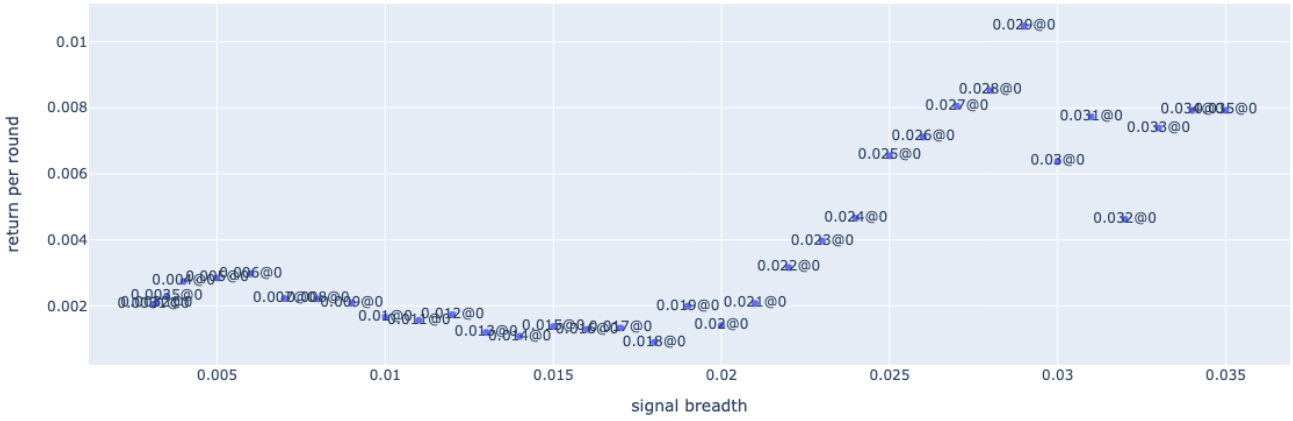


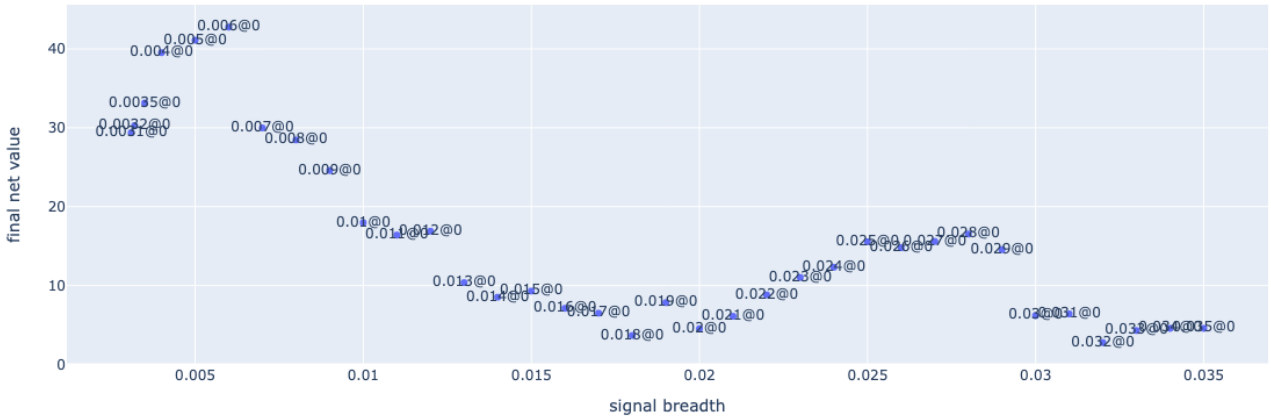
final net value




total round
z
100
80
60
40
20
X-close-threshold
0.003
0.002
0.001
0
Y-open-threshold
0.01
0.02
0.03
100
90
80
70
60
50
40
30
20
10
win rate
0.9
0.8
0.7
0.6
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
signal breadth



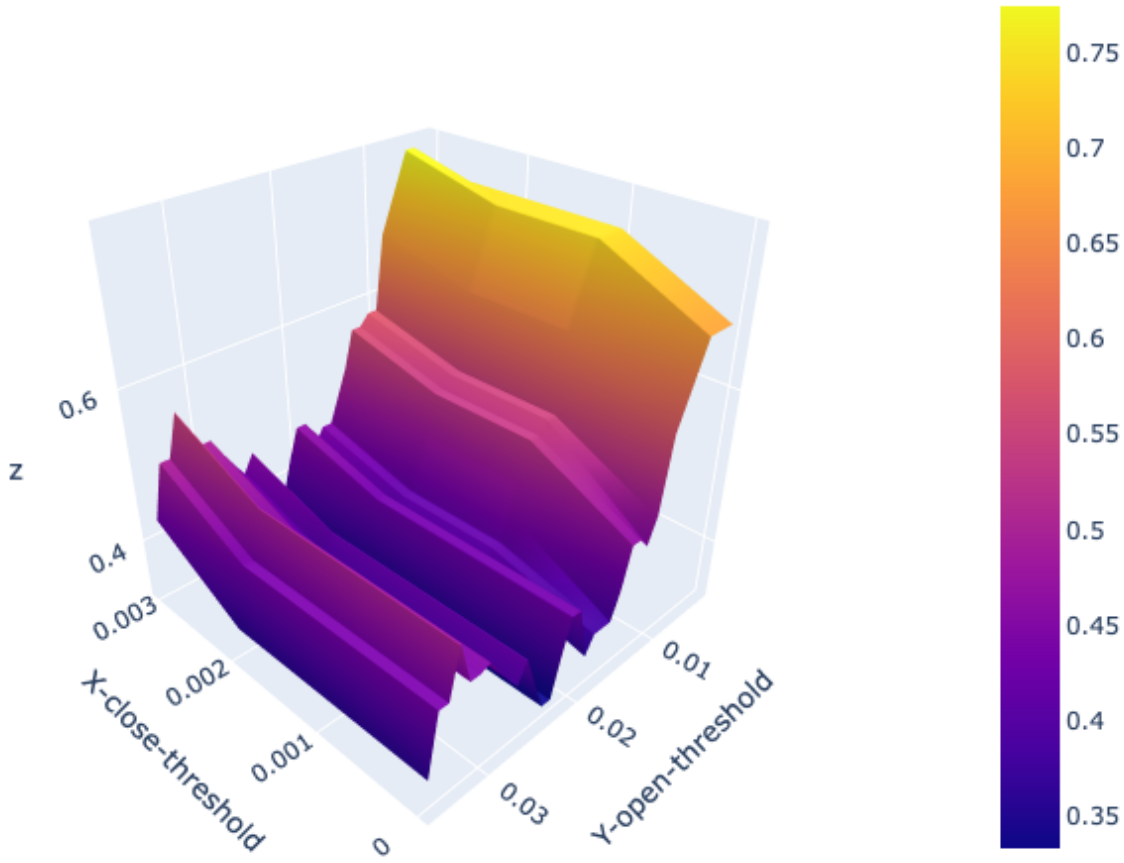




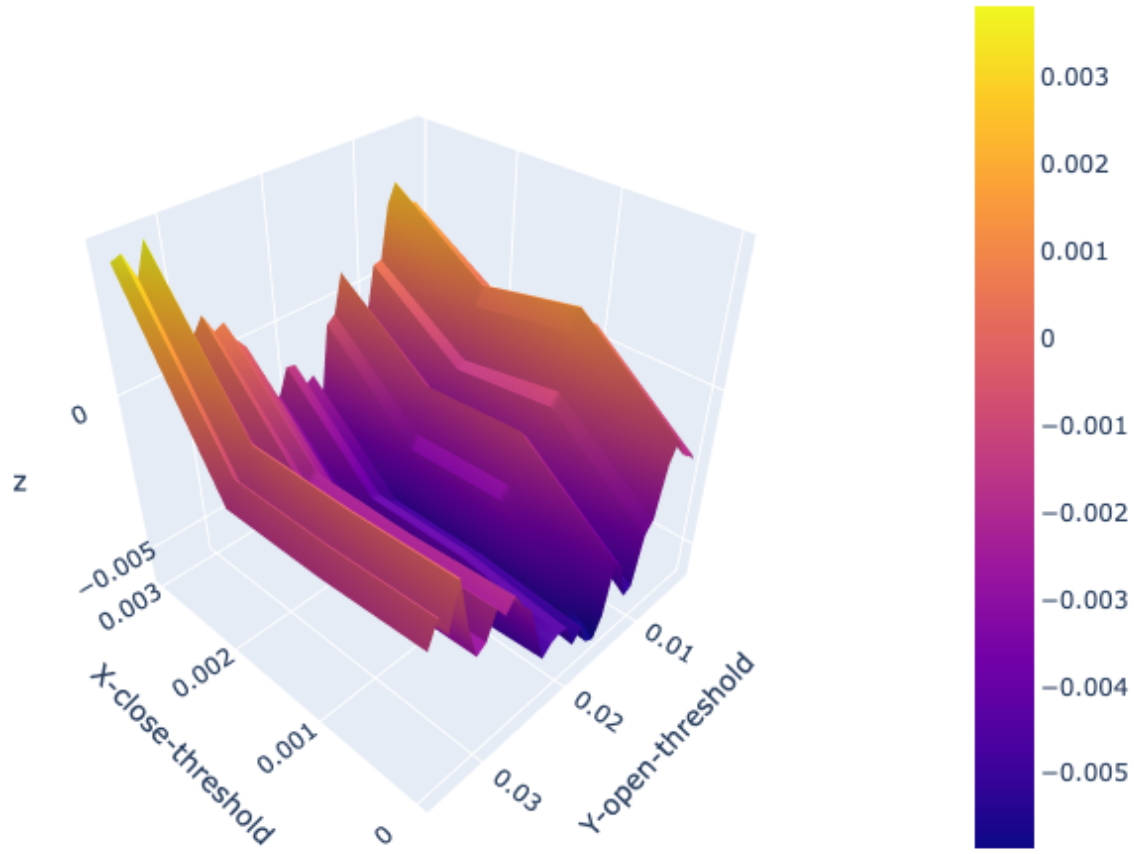
3.1.4 【113642.SH | 603185.SH】

2022-04-06->2022-06-01

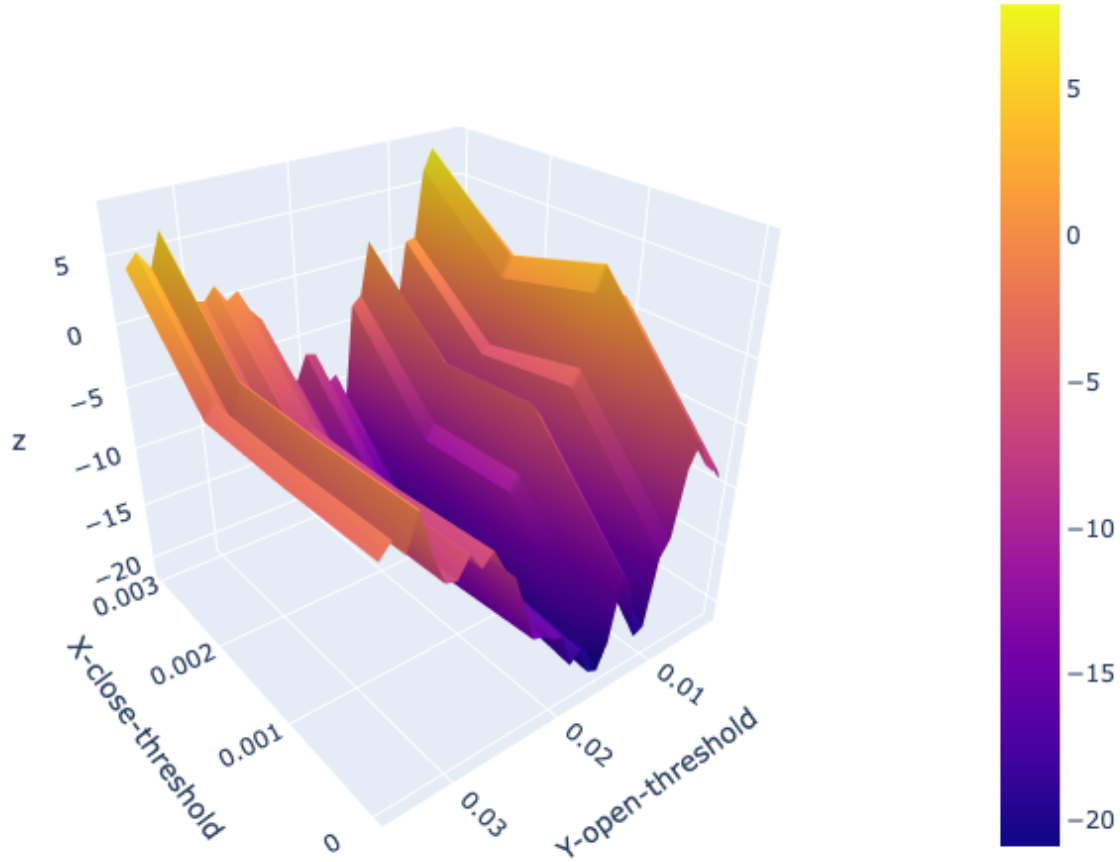
win rate


z
0.6
0.4
X-close-threshold
0.003
0.002
0.001
0
Y-open-threshold
0.01
0.02
0.03
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35

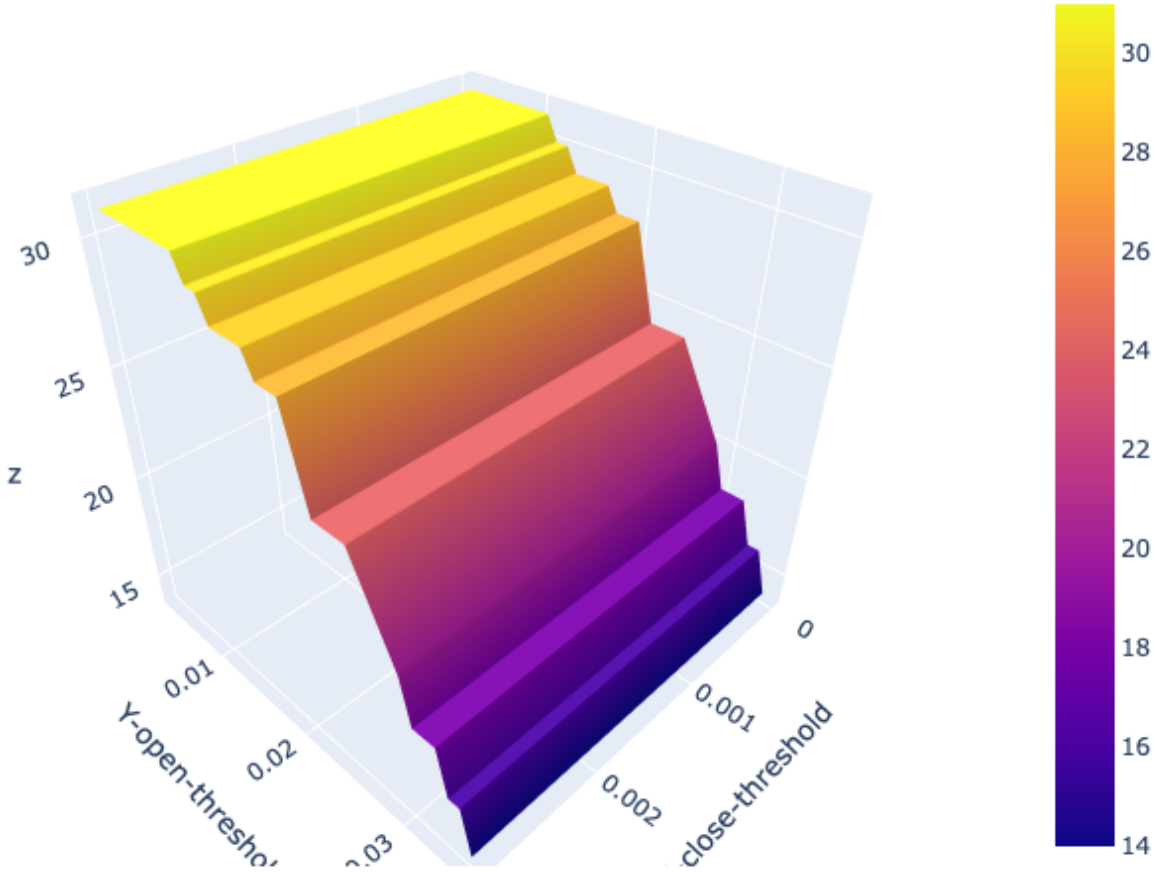
return per round

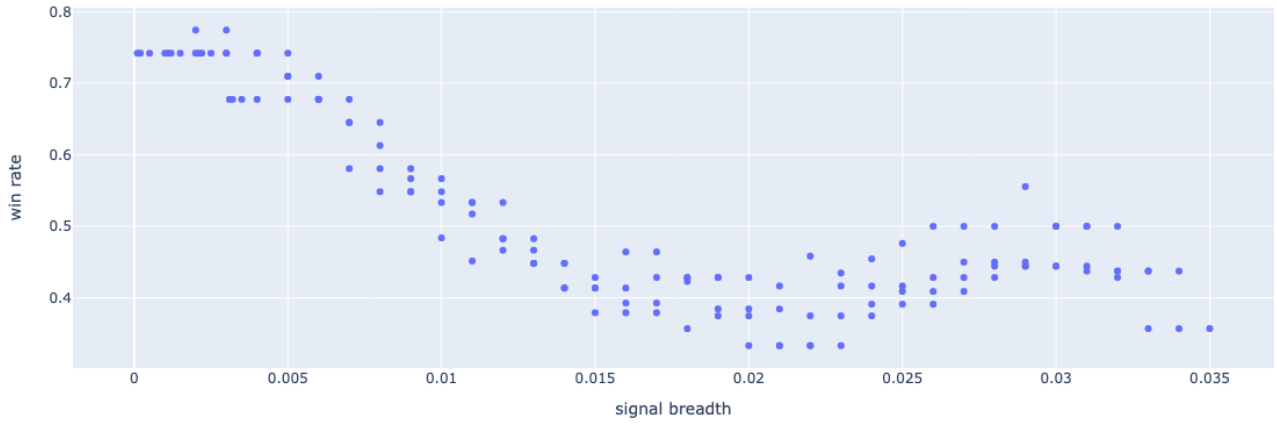


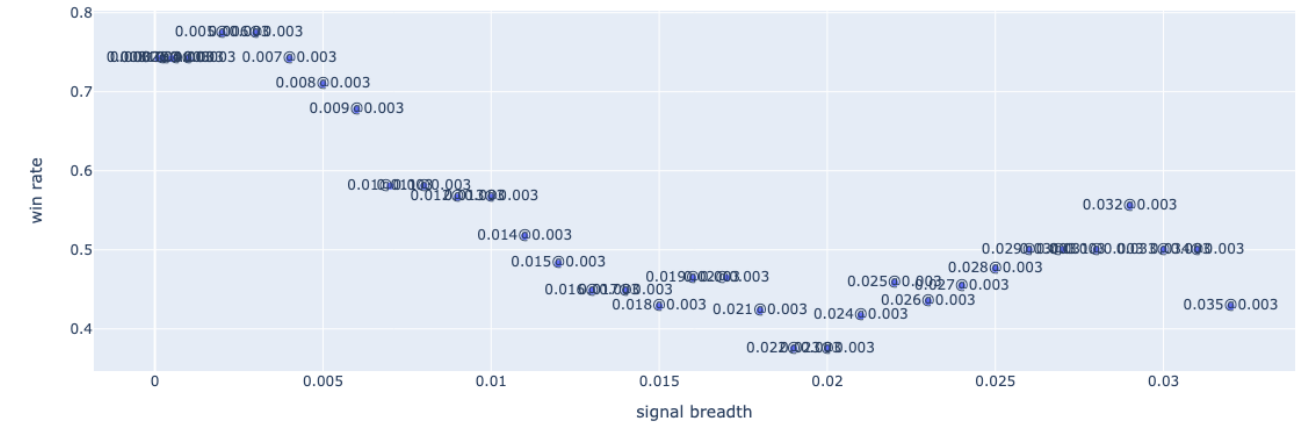
final net value

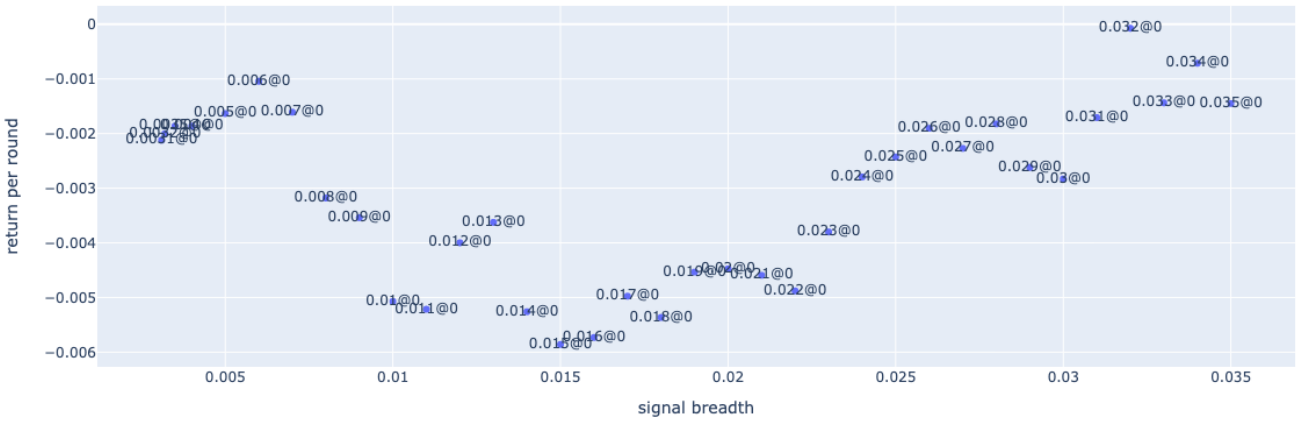


total round


z
30
25
20
15
Y-open-threshold
0.01
0.02
0.03
close-threshold
0
0.001
0.002
30
28
26
24
22
20
18
16
14

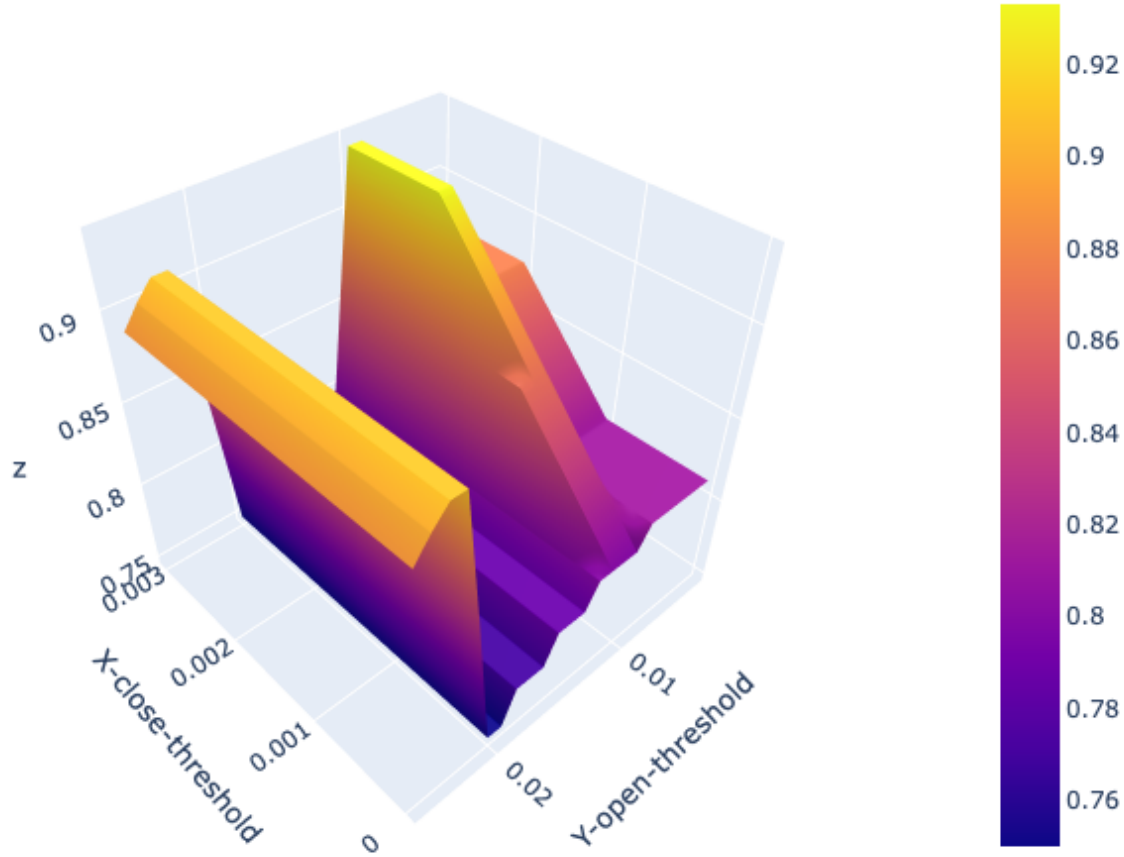

win rate
0.8
0.7
0.6
0.5
0.4
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
signal breadth



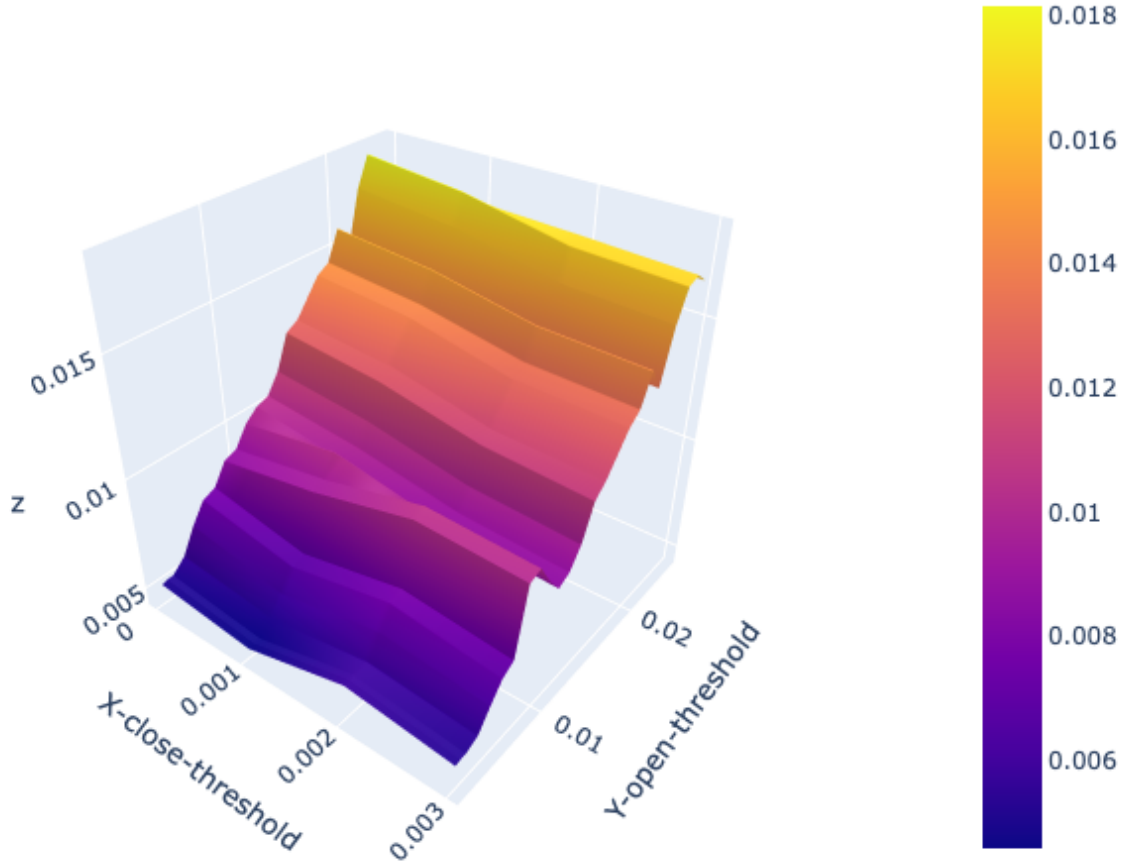


2022-06-02->2022-06-28

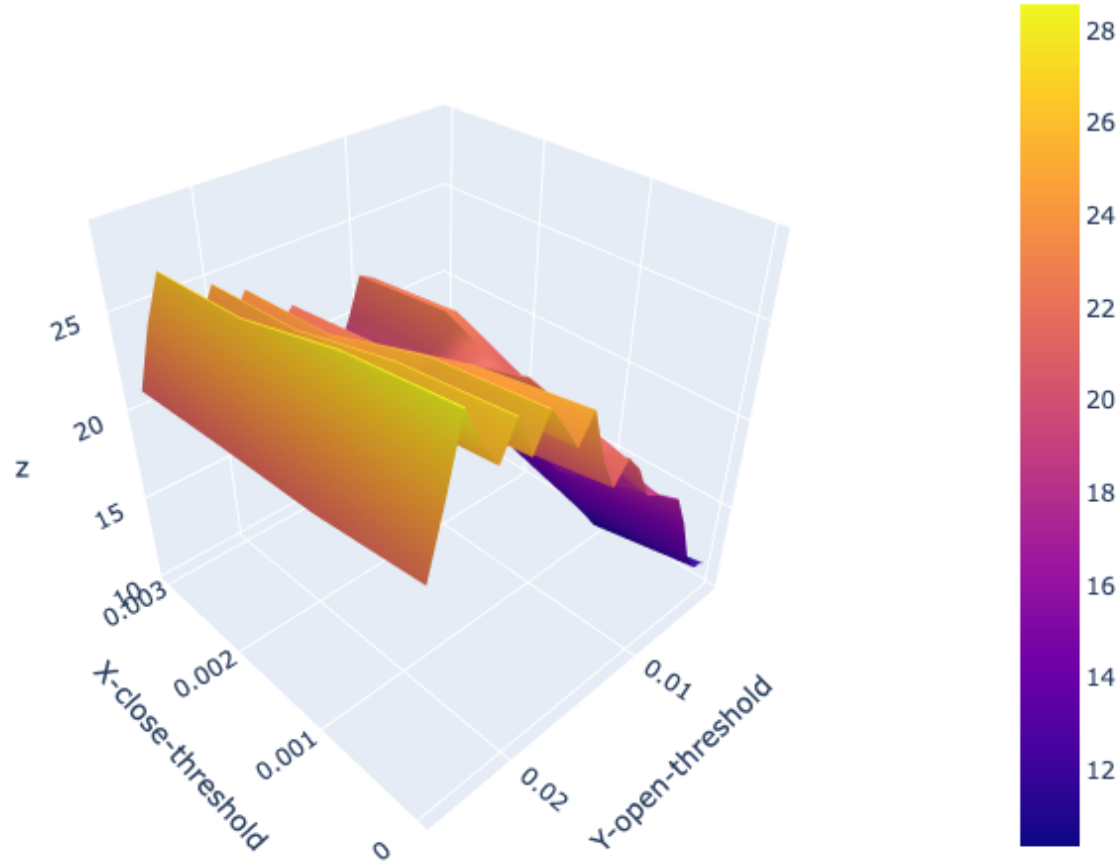
win rate

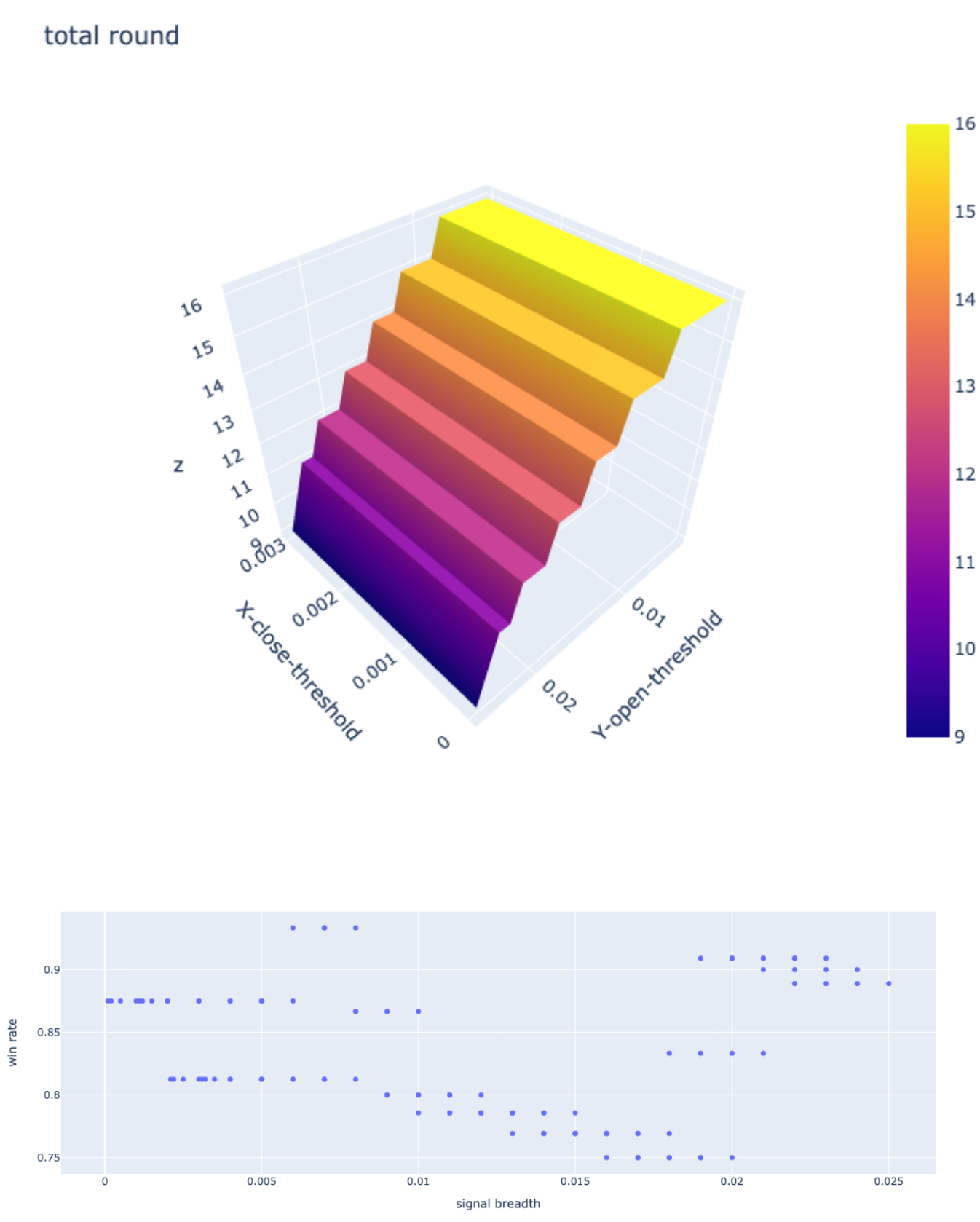

z
0.9
0.85
0.8
0.75
X-close-threshold
0.003
0.002
0.001
0
Y-open-threshold
0.01
0.02
0.92
0.9
0.88
0.86
0.84
0.82
0.8
0.78
0.76

return per round

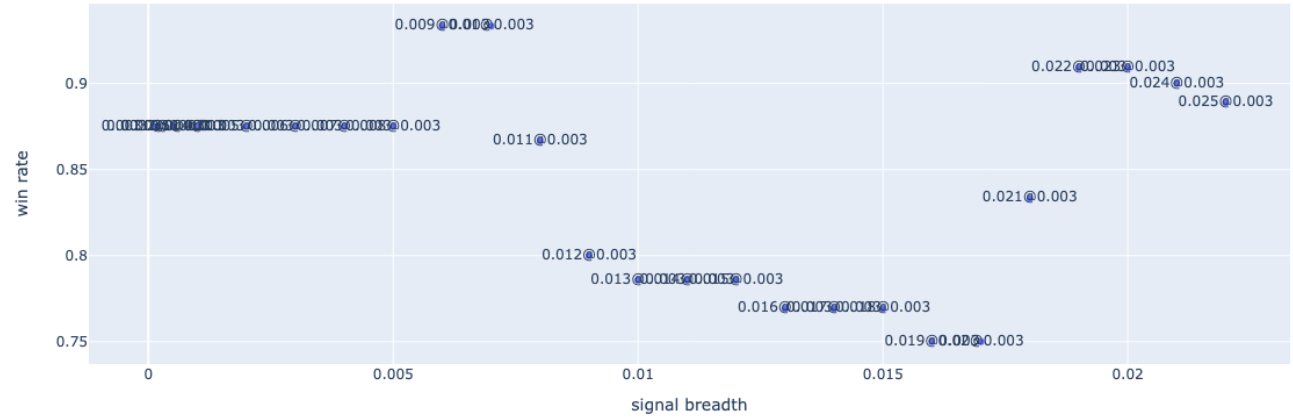


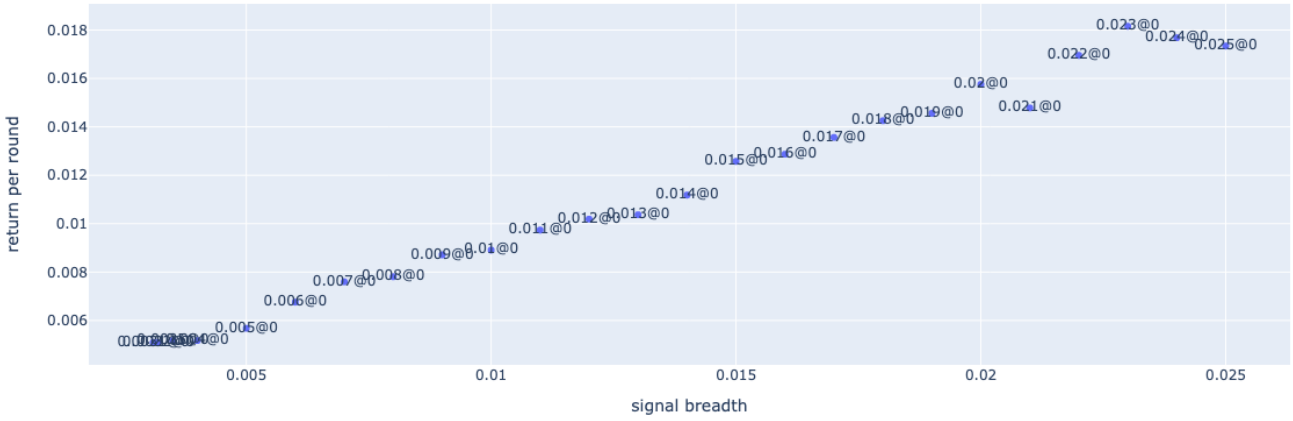
final net value




total round
z
X-close-threshold
Y-open-threshold
16
15
14
13
12
11
10
9
0.003
0.002
0.001
0
0.01
0.02

win rate
signal breadth
0.9
0.85
0.8
0.75
0
0.005
0.01
0.015
0.02
0.025





3.2 胜率稳定性分析

通过横坐标为信号宽度，纵坐标为胜率的二维散点图可以观察得出：在$[0, 0.3]$的区间内，胜率先随着信号宽度的增加会有明显的下降趋势，在信号宽度位于$[0.01, 0.02]$的区间内，各组股债对在不同时间段的胜率，都会达到其对应的最小值。在$[0.02, 0.03]$区间内，随着信号宽度的增加，胜率也随之上升。

分析第一段下降的原因为：

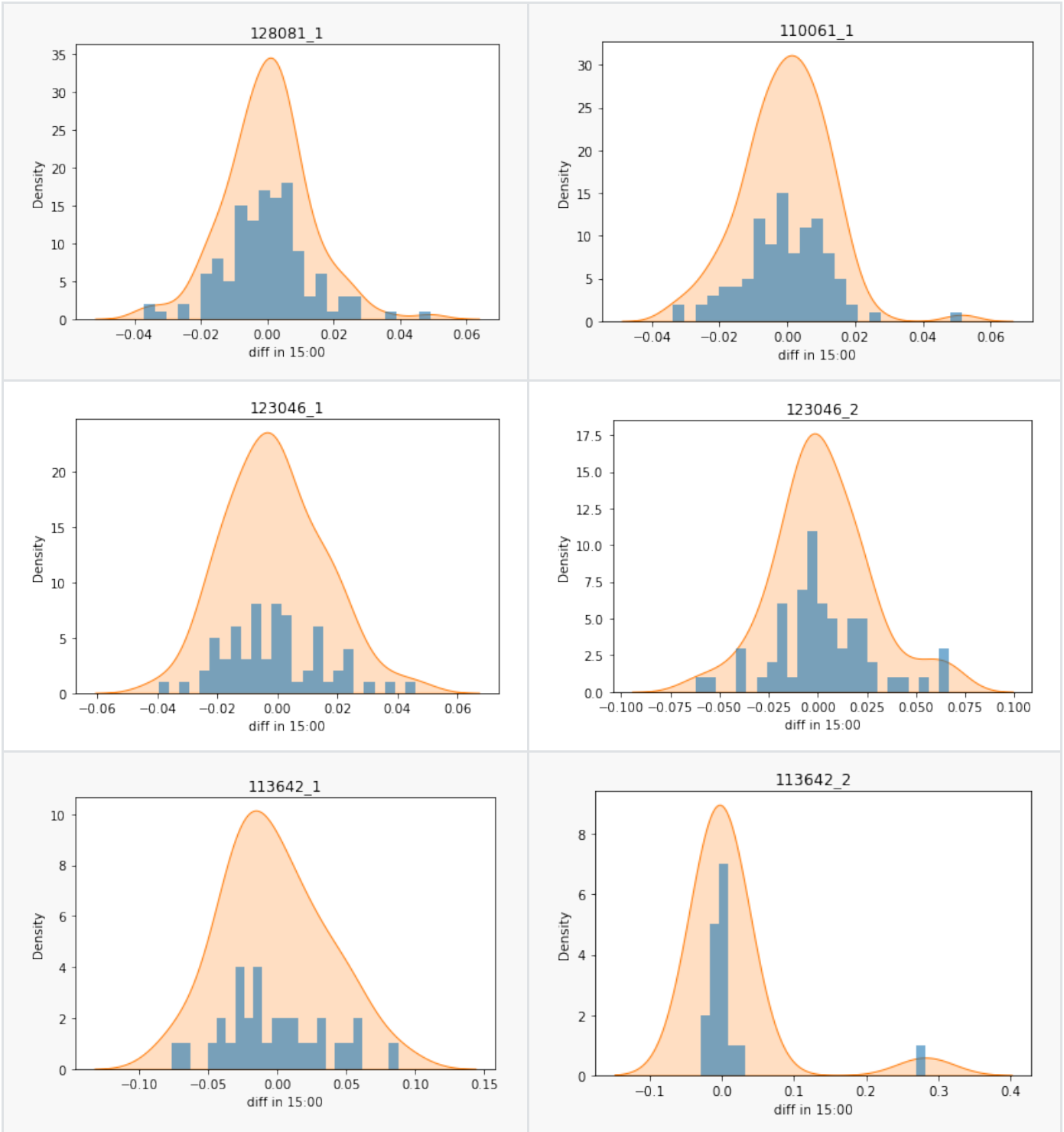
- 宽度越小，抓住的开仓平仓机会越多，按照信号进行操作并盈利的rounds占所有rounds中的绝大多数。故胜

率较高。

- 随着开仓阈值增加，平仓阈值不变，信号宽度也随之增加，此时若按信号操作，可以获得的单笔盈利更高。然而由于每日15:00收盘时强制平仓的操作，很多开仓阈值为0.012左右的rounds只进行了开仓操作，但是没有等到平仓信号的出现，就在收盘时平仓了。此时diff是否收敛到开仓时的diff之下（决定了该笔交易的盈亏）取决于当日行情。从回测统计的结果来看，这些按时间平仓的rounds大部分都发生了亏损。

胜率随信号宽度增加到达最小值后又上升的原因：

- 通过对回测期间15:00收盘时的diff分布图可得出，大部分交易日的收盘时刻diff都落在$[-0.02, 0.02]$区间内，随着开仓阈值提高到超过0.02之后，信号宽度虽然也在增大，但是收盘时强制平仓的rounds中，盈利的rounds数量占比提升了，使得整体胜率提升。



3.3 单笔回报率稳定性分析

通过横坐标为信号宽度，纵坐标为单笔回报率的二维散点图可以观察得出，大部分股债对（除【113642.SH 603185.SH】在2022-04-06->2022-06-01区间的回测结果外）在对应的回测区间内，单笔回报率都会随着信号宽度的增加而增加。这是因为信号宽度越大，diff从开仓到平仓时收敛的幅度越大，能抓住的套利机会就越多。

3.4 最优参数及对应的绩效指标

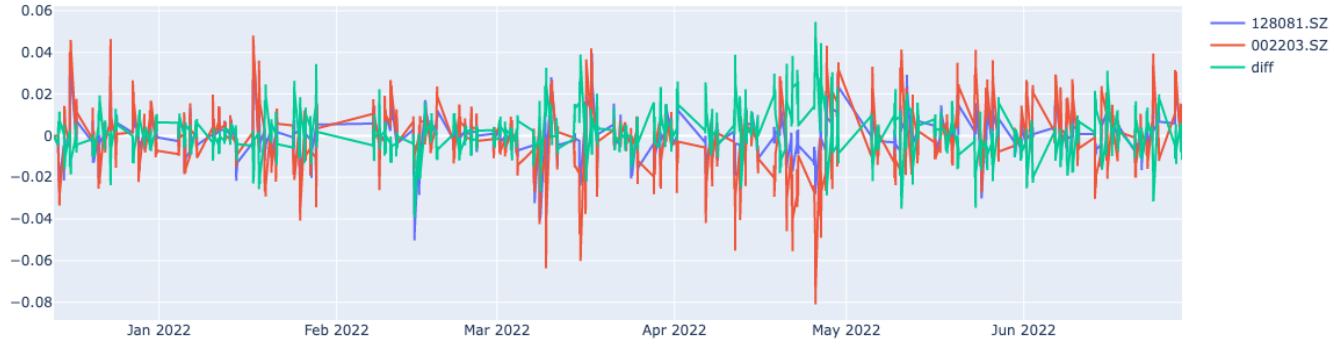
最优参数定义为：final net value最高的组对应的$(open_threshold, close_threshold)$

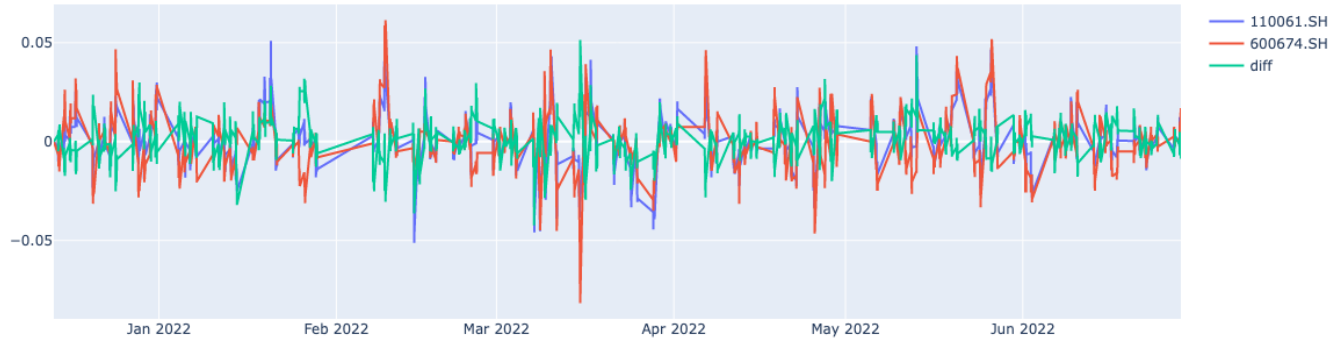
股债对	回测区间	最优参数	final net value	return per round	win rate	total rounds
110061.SH 600674.SH	2021-12-13->2022-06-28	0.006,0	42.760626	0.002973	0.764706	102
123046.SZ 300587.SZ	2021-12-13->2022-03-22	0.008,0	102.900400	0.005262	0.777778	63
123046.SZ 300587.SZ	2022-03-23->2022-06-28	0.015,0	95.664818	0.005342	0.642857	56.0
113642.SH 603185.SH	2022-04-06->2022-06-01	0.006,0.003	7.866114	0.002689	0.774194	31.0
113642.SH 603185.SH	2022-06-02->2022-06-28	0.023,0	28.572978	0.018156	0.909091	11.0
128081.SZ 002203.SZ	2021-12-13->2022-06-28	0.011,0.002	34.065072	0.003135	0.695652	92.0

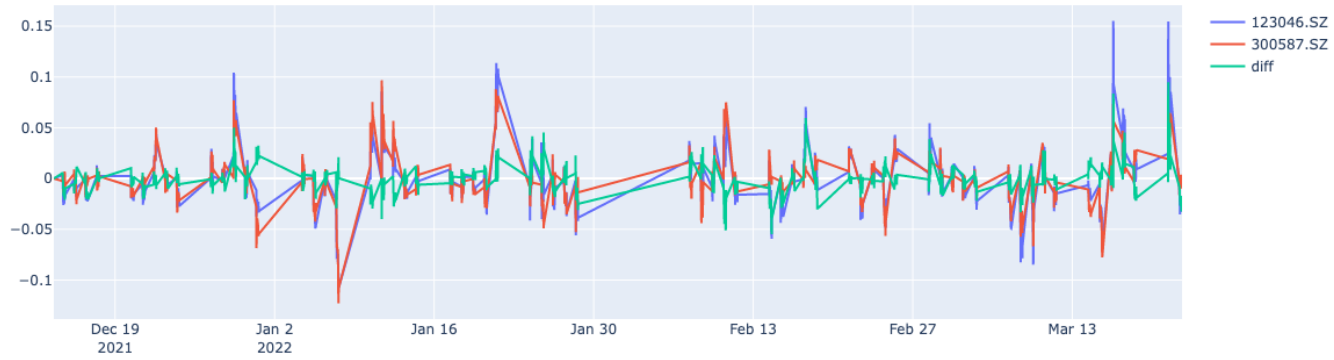
- 胜率（win rate）
- 每笔回报率(return per round)
- 交易来回数(rounds)

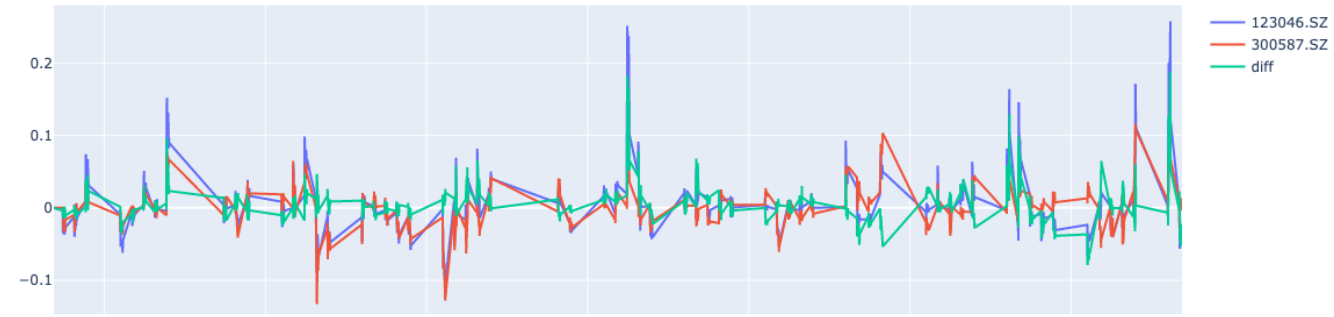
3.5 其他统计分析结果

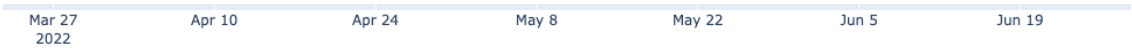
回测区间内的股债对diff信号走势

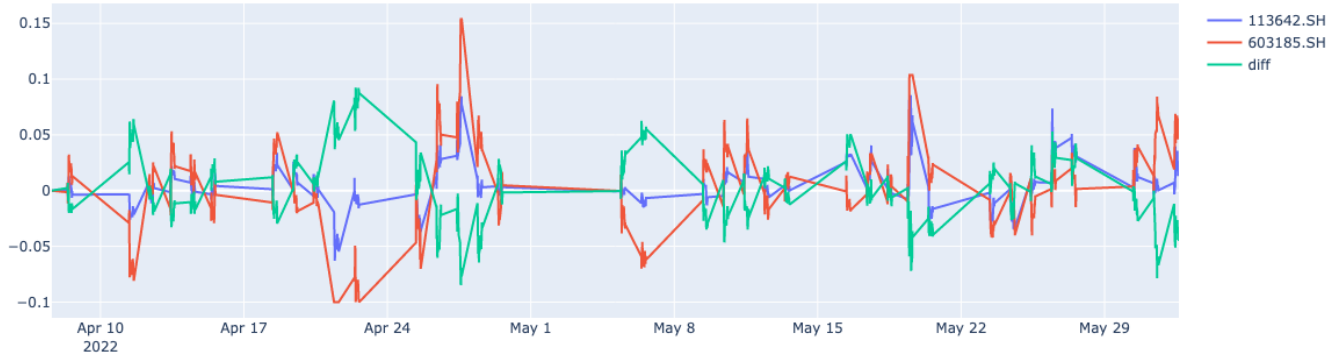

0.06
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
128081.SZ
002203.SZ
diff

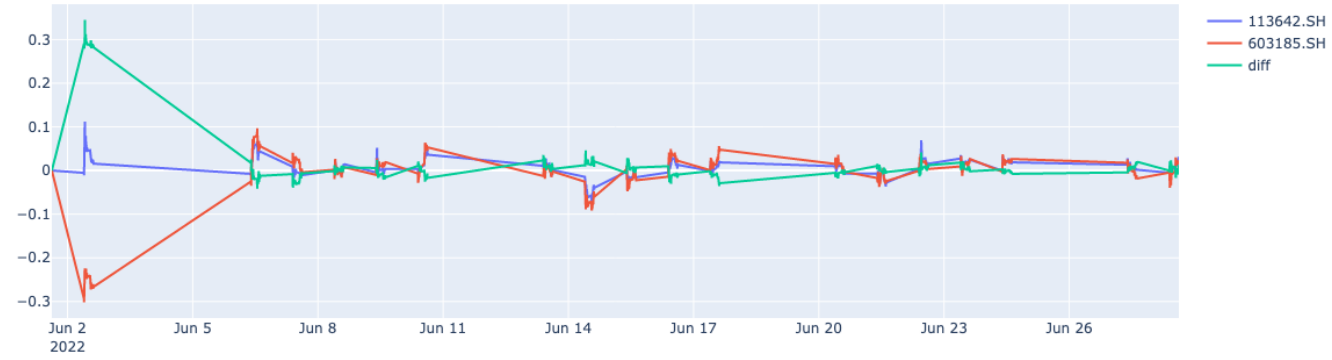

0.05
0
−0.05
Jan 2022
Feb 2022
Mar 2022
Apr 2022
May 2022
Jun 2022
110061.SH
600674.SH
diff


0.15
0.1
0.05
0
−0.05
−0.1
Dec 19
2021
Jan 2
2022
Jan 16
Jan 30
Feb 13
Feb 27
Mar 13
123046.SZ
300587.SZ
diff


0.2
0.1
0
−0.1
123046.SZ
300587.SZ
diff







4.策略改进方向

使用真实交易数据，回测模拟更接近实际交易的环境

滚动窗口优化，窗口大小用过去4周的数据