High Frequency Trading HW3 Report
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In this assignment, I applied 3 methods to order and test the execution result of these three methods respectively. After comparing those three methods, I find that method 2 and method 3 are similar to each other. Method 1 lose more but executed fast. In the following part, I will discuss each of the method in detail and give the result of each method. I will also present a comparation among those three methods and to see how PnL will change if we adjust Limit time and stop loss.

Part 1 Method & Algorithm

Method 1: Market Taking

For this method, we don't need to care about stop loss and limit execution time because we will execute immediately at the market price. We take all of the spread so our PnL should be half of the spread each time. The advantage in this case is that we can execute immediately and won't need to wait any other chances. The bad is that PnL is the largest.

Opportunistic Market Making
Method 2: OMMMid

For this method, we have to take time limit and stop loss into consideration. We would like to wait until the market moves to the midprice. However, market does not always move as we expected. Thus, it's necessary to set a stop loss line if the market goes away from our expected and we also need to set a time that how long we wait to execute. Definitely, if the market goes away, we will lose a lot in the trade. If the time went off, we don't know how much we are going to lose but it will be bigger than zero and smaller than stop loss line.

In our algorithm, we just pass time limit and stop loss to the function. Firstly, we compute the stop loss line, select the data from the order time to the end. Secondly, we initialize time and use while loop to find out when the order will be executed and at which price. Then we compare the time with limit time to see whether it's TTD and if not, we compare the price with stop loss line to see whether it hits the line. Finally, if the price didn't hit the stop loss line nor time limit, it should be traded in a normal way. For each order, we record the time and execution price and how it's executed.

Method 3: OMMSide

The algorithm and explanation are almost the same as method two. The only difference is that we wait for market move to bid price not the middle price. So, intuitively, it will have a better PnL and less possibility to be executed in normal way.

The results of the three method are shown as below.

	Side	M1 PnL	M2 PnL	Execution Time	method	M3 PnL	Execution Time	method
0	B	-0.00028	-0.00028	20	TTE	-0.00028	20	TTE

1	S	0.000285	-0.00029	20	TTE	-0.00029	20	TTE
2	B	-0.00028	-0.00028	20	TTE	-0.00028	20	TTE
3	S	0.000285	-0.00029	20	TTE	-0.00029	20	TTE
4	B	-0.00028	-0.00028	20	TTE	-0.00028	20	TTE
5	B	-0.00028	-0.00028	20	TTE	-0.00028	20	TTE
6	B	-0.00028	-0.00028	20	TTE	-0.00028	20	TTE
7	S	0.000285	-0.00025	20	TTE	-0.00025	20	TTE
8	S	0.000285	-0.00025	20	TTE	-0.00025	20	TTE
9	S	0.000285	-0.00039	20	TTE	-0.00039	20	TTE
10	S	0.000285	-0.00039	20	TTE	-0.00039	20	TTE
11	B	-0.00028	-0.00033	20	TTE	-0.00033	20	TTE
12	S	0.000285	-0.00039	20	TTE	-0.00039	20	TTE
13	S	0.000285	-0.00039	20	TTE	-0.00039	20	TTE
14	B	-0.00028	-0.00032	20	TTE	-0.00032	20	TTE
15	B	-0.00028	-0.00032	20	TTE	-0.00032	20	TTE
16	B	-2.5E-05	-2.5E-05	20	TTE	-2.5E-05	20	TTE
17	S	1.5E-05	-0.00023	20	TTE	-0.00023	20	TTE
18	B	-2E-05	2.22E-16	8	Normal	2E-05	9	Normal
19	S	2.5E-05	-0.00024	20	TTE	-0.00024	20	TTE
20	B	-2E-05	1E-05	6	Normal	3E-05	7	Normal
21	B	-2E-05	1E-05	5	Normal	3E-05	6	Normal
22	B	-2E-05	2.22E-16	4	Normal	2E-05	5	Normal
23	S	2E-05	-0.0002	20	TTE	-0.0002	20	TTE
24	S	2E-05	-0.00021	20	TTE	-0.00021	20	TTE
25	S	2E-05	-0.00019	20	TTE	-0.00019	20	TTE
26	S	2E-05	-0.00018	20	TTE	-0.00018	20	TTE
27	B	-1E-05	3E-05	1	Normal	3E-05	1	Normal
28	S	2E-05	-0.00012	20	TTE	-0.00012	20	TTE
29	S	1.5E-05	-0.0001	20	TTE	-0.0001	20	TTE
30	B	-2.5E-05	7.5E-05	7	Normal	7.5E-05	7	Normal
31	B	-2E-05	7E-05	6	Normal	7E-05	6	Normal
32	B	-2.5E-05	-0.00035	16	SL	-0.00035	16	SL
33	S	2.5E-05	6.5E-05	1	Normal	6.5E-05	1	Normal
34	B	-2.5E-05	-0.00035	12	SL	-0.00035	12	SL
35	B	-2.5E-05	-0.00035	10	SL	-0.00035	10	SL
36	B	-2.5E-05	-0.00035	8	SL	-0.00035	8	SL
37	B	-2.5E-05	-0.00035	6	SL	-0.00035	6	SL
38	B	-2.5E-05	-0.00035	4	SL	-0.00035	4	SL
39	B	-2.5E-05	-0.00035	2	SL	-0.00035	2	SL
40	B	-2.5E-05	-0.00049	1	SL	-0.00049	1	SL
41	B	-2.5E-05	-0.00076	1	SL	-0.00076	1	SL

42	B	-2.5E-05	-0.00088	1	SL	-0.00088	1	SL
43	B	-2.5E-05	-0.00119	1	SL	-0.00119	1	SL
44	B	-2.5E-05	-0.00112	1	SL	-0.00112	1	SL
45	B	-2.5E-05	-0.00101	1	SL	-0.00101	1	SL
46	B	-2.5E-05	-0.00087	1	SL	-0.00087	1	SL
47	S	2.5E-05	0.000805	1	Normal	0.000805	1	Normal
48	S	2.5E-05	0.000915	1	Normal	0.000915	1	Normal
49	S	2.5E-05	0.001135	1	Normal	0.001135	1	Normal
50	S	2.5E-05	0.001125	1	Normal	0.001125	1	Normal
51	S	2.5E-05	0.001025	1	Normal	0.001025	1	Normal
52	S	2.5E-05	0.000995	1	Normal	0.000995	1	Normal
53	S	2.5E-05	0.001115	1	Normal	0.001115	1	Normal
54	S	2.5E-05	0.001145	1	Normal	0.001145	1	Normal
55	B	-2.5E-05	-0.00028	20	TTE	-0.00028	20	TTE
56	S	2.5E-05	4.5E-05	1	Normal	4.5E-05	1	Normal
57	S	2.5E-05	5E-06	1	Normal	6.5E-05	2	Normal
58	B	-2.5E-05	-0.00028	20	TTE	-0.00028	20	TTE
59	B	-2.5E-05	-0.00037	19	SL	-0.00037	19	SL
60	B	-2.5E-05	-0.00037	17	SL	-0.00037	17	SL
61	B	-2.5E-05	-0.00037	15	SL	-0.00037	15	SL
62	B	-2.5E-05	-0.00037	13	SL	-0.00037	13	SL
63	B	-2.5E-05	-0.00037	11	SL	-0.00037	11	SL
64	B	-2.5E-05	-0.00037	10	SL	-0.00037	10	SL
65	B	-2.5E-05	-0.00037	9	SL	-0.00037	9	SL
66	S	2.5E-05	0.000235	1	Normal	0.000235	1	Normal
67	S	2.5E-05	0.000125	1	Normal	0.000125	1	Normal
68	S	2.5E-05	0.000335	1	Normal	0.000335	1	Normal
69	B	-2.5E-05	-0.00043	1	SL	-0.00043	1	SL
70	S	2.5E-05	0.000305	1	Normal	0.000305	1	Normal
71	B	-2.5E-05	5E-06	4	Normal	-0.00029	20	TTE
72	S	2.5E-05	5E-06	7	Normal	6.5E-05	11	Normal
73	S	1.5E-05	4.5E-05	3	Normal	4.5E-05	3	Normal
74	S	5E-06	5.5E-05	4	Normal	5.5E-05	4	Normal
75	S	2E-05	0.00013	4	Normal	0.00013	4	Normal
76	B	-1E-05	2E-05	1	Normal	2E-05	1	Normal
77	B	-2E-05	0	14	Normal	3E-05	16	Normal
78	B	-2E-05	2E-05	12	Normal	2E-05	12	Normal
79	B	-2E-05	2E-05	1	Normal	2E-05	1	Normal
80	B	-2E-05	2E-05	2	Normal	2E-05	2	Normal
81	B	-2E-05	1E-05	1	Normal	2E-05	2	Normal
82	B	-2E-05	1E-05	2	Normal	7E-05	15	Normal

| 83 | S | 2.5E-05 | 5E-06 | 3 | Normal | -9.5E-05 | 20 | TTE |
84	S	3E-05	-0.00013	20	TTE	-0.00013	20	TTE
85	S	2E-05	-0.00024	20	TTE	-0.00024	20	TTE
86	S	2E-05	-0.00022	20	TTE	-0.00022	20	TTE
87	S	2.5E-05	-0.00028	20	TTE	-0.00028	20	TTE
88	S	2E-05	-0.00032	20	SL	-0.00032	20	SL
89	S	2.5E-05	-0.00031	20	TTE	-0.00031	20	TTE

Part 2 Sensitivity Analysis

	Minimum PnL	Average PnL	Median PnL	PnL Volatility	Average Time	Median Time	Stop Loss Triggered Times	Time Limit Triggered Times
Mid Method	-0.001195	-0.000116	-0.000237	0.000453	10.333333	10.333333	23	32

	Minimum PnL	Average PnL	Median PnL	PnL Volatility	Average Time	Median Time	Stop Loss Triggered Times	Time Limit Triggered Times
Side Method	-0.001195	-0.000117	-0.000242	0.000454	10.977778	10.977778	23	34

From the result above, we can find that there are not too much difference between method 2 and method 3. But obviously, we can find that it's more difficult for method 3 to trade in a normal way. The average time is higher and there are more times that it hits the stop loss line. It seems that method 3 should have a higher PnL but since it triggered stop loss more times, the average PnL is lower.
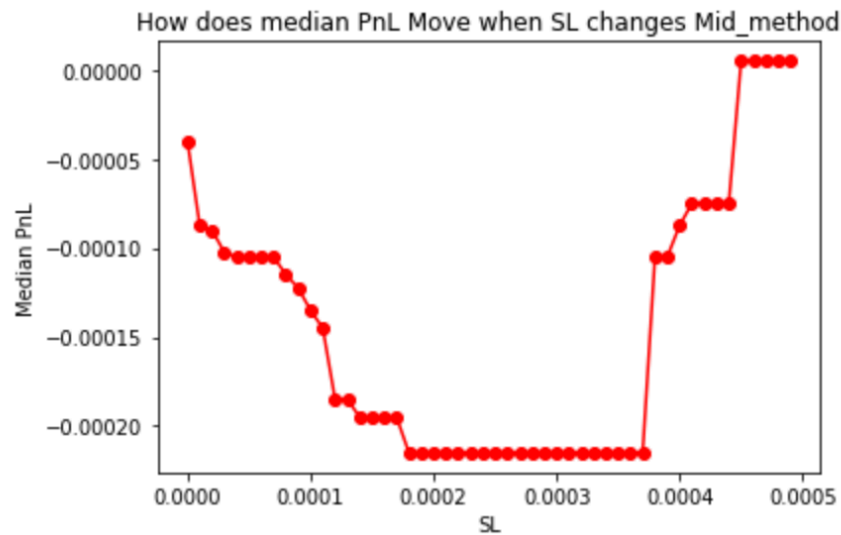
Here, we also consider volatility of the PnL, we dind that the volatility of the two methods are almost the same.
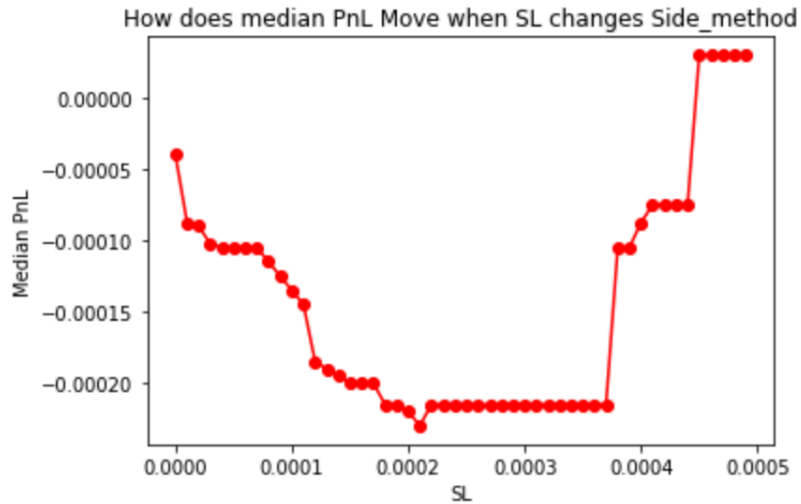
For method 2 and method 3, I plot graphs to show how PnL changes as time limit and stop loss change.

How does median PnL Move when TTE changes Side_Method
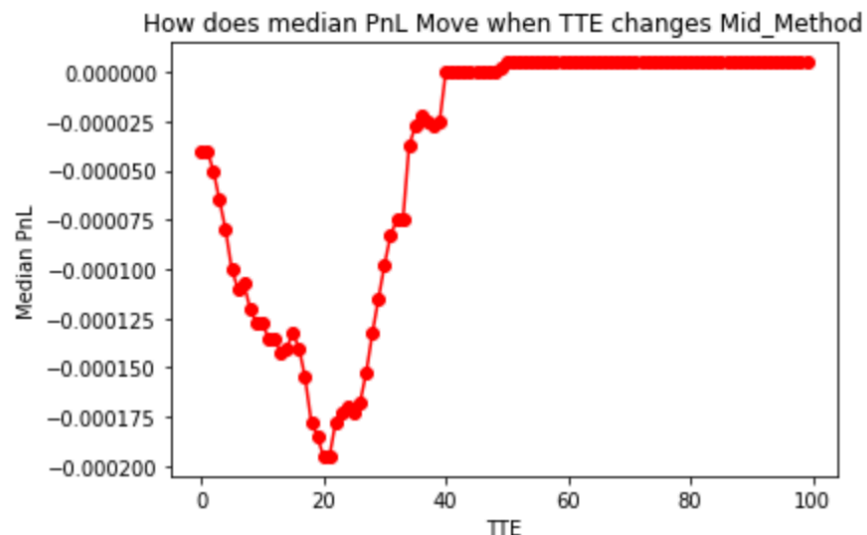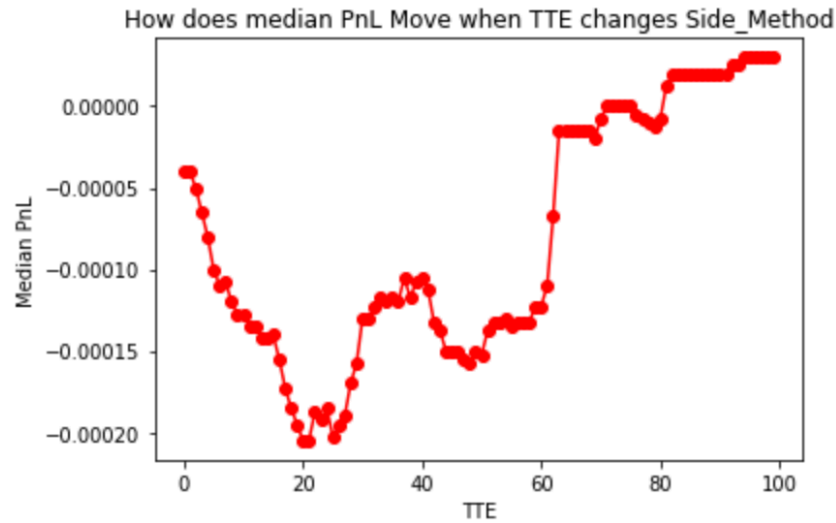
From the graph above, we can conclude that when we extend the TTE, the median PnL will eventually higher. This make sense because when we have a long TTE, market has more opportunity to hit the Midprice / Sideprice so that it could be traded in a normal way. It's not a monotone increasing because we need also take stop loss into consideration.

How does median PnL Move when SL changes Mid_method

How does median PnL Move when SL changes Side_method

From the above graph above, we can conclude that the median PnL will eventually increase if we enlarge the stop loss range. It also easily makes sense because it will have lower possibility to hit the stop loss line so the PnL won't be so low. Also, it's not a monotone increasing because we need to take TTE into consideration.