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Assignment Goal:
As part of this project we are comparing Market Taking, Opportunistic Market Making Mid & Side
approaches for order execution. We want to find out for which approach would work better economically for the Market Taker. We have to figure out which approach works best economically and also for what values of stop loss and wait time would help us in achieving that.

Data:
We have been given two different data sets. First dataset is the Tick data which contains the bid values, ask values and the time for that value. Another dataset is orders dataset which contains various information about that

Execution Approaches:
1. Market Taking
2. Opportunistic Market Making mid
3. Opportunistic Market Making side

Market Taking(MT):
In this approach the order is executed the instance it is received or whenever the next tick data is available. The market taker executes the order at same instance it is received and does not have any constraints. Hence, he will always bear the half of the bid offer spread. We are calculating the same as part of our approach. The full results can be seen in the Annexure of this report.

Opportunistic Market Making Mid:
As part of this approach we want to reduce our losses which we might occur if we execute it immediately. Here our desired execution price is the middle of the Bid Ask price and we will wait until the market moves in our favour. The criteria of waiting are the stop loss and the time to execution limit. The full results can be seen in the Annexure of this report.

Opportunistic Market Making Side:
As part of this approach we want to reduce our losses which we might occur if we execute it immediately. Here our desired execution price is the mid - Ask price or bid price - mid price depending on the type of order and we wait till the market moves in our favour. The criteria of waiting are the stop loss and the time to execution limit. The full results can be seen in the Annexure of this report.
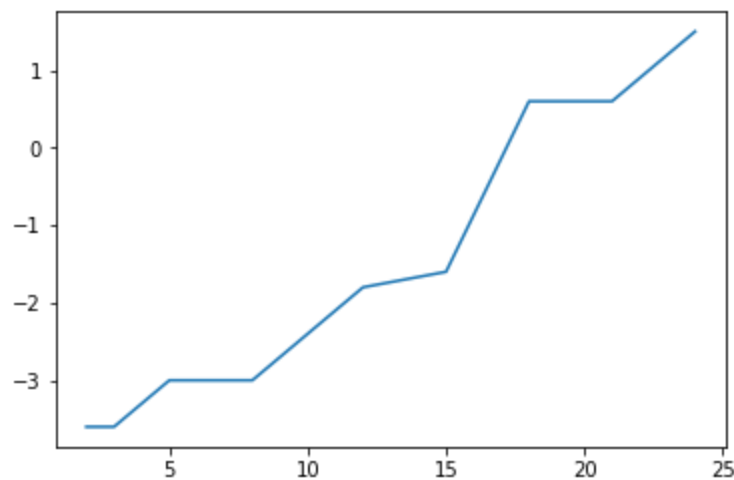
Analysis:

1) Recapitulating table captures all the three approaches. We have used the value of stop loss as 0.01% and max time to execute as 10 sec for the OMM mid and OMM side. We found the 10 seconds is the ideal time as after this time the number of times the stop loss was triggered was too high.
2) We have also calculated graphs for different values of tte for a specific stop loss.
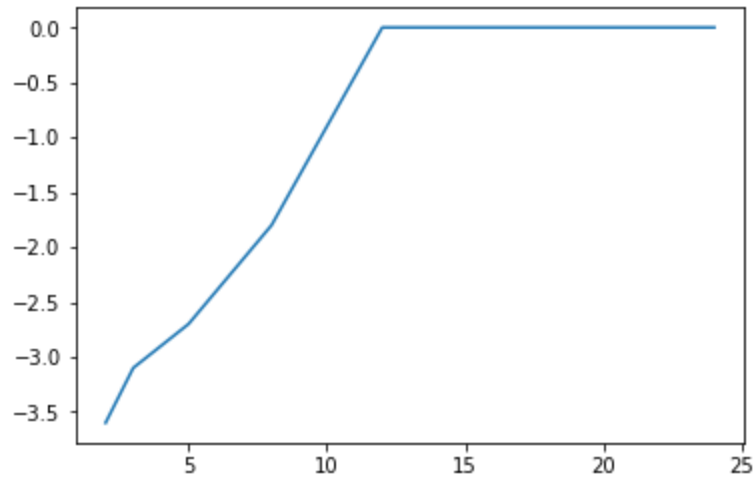
Recapitulating table

	Approach	Average PNL	Median PNL	Min PNL	Max PNL	Avg TTE(seconds)	Median TTE(seconds)	Total number of SL triggered	Total numbers of times order executed on max TTE
0	Market Taking	-4.76	-4	-52	-0	NaN	NaN	NaN	NaN
1	OMM Mid	-5.14	0	-75.95	13.95	7.37	8.81	14	34
2	OMM Side	-5.13	-2.7	-67.2	14.7	7.6	10.04	34	34

Below are the graphs which compares median PNL for the different stop loss values

1) Median stop loss variation with respect to the max tte for OMM Side.
    a) X-axis is max tte in seconds
    b) Y-axis is median PNL

2) Median stop loss variation with respect to the max tte for OMM Mid
   a) X-axis is max tte in seconds
   b) Y-axis is median PNL

Annexure

1) **Market Taking Approach**: Here we are presenting the few records we captured for this approach. Please look into the Jupyter notebook for full table.

	trade_id	buy/sell	notional	price	datetime	instrument	alpha	MT_PnL
2	107638	-1	310000	1.35453	2018-01-08 07:38:48	GBP/USD	SOM	-1.55
3	107649	-1	310000	1.35371	2018-01-08 08:10:55	GBP/USD	SOM	-7.75
4	107654	-1	320000	1.35394	2018-01-08 08:19:10	GBP/USD	SOM	-6.40
5	107664	-1	200000	1.35405	2018-01-08 08:23:16	GBP/USD	SOM	-3.00
6	107670	-1	490000	1.35423	2018-01-08 08:34:40	GBP/USD	SOM	-4.90
7	107726	1	200000	1.35716	2018-01-08 11:25:13	GBP/USD	SOM	-3.00
8	107733	1	310000	1.35693	2018-01-08 11:42:08	GBP/USD	SOM	-7.75
9	107737	1	310000	1.35676	2018-01-08 12:15:34	GBP/USD	SOM	-6.20
10	107738	1	310000	1.35677	2018-01-08 12:15:35	GBP/USD	SOM	-6.20
11	107739	1	320000	1.35645	2018-01-08 12:20:20	GBP/USD	SOM	-4.80

2) **OMM Side:** Here we are presenting the few records we captured for this approach. Please look into the Jupyter notebook for full table.

	trade_id	buy/sell	notional	price	datetime	instrument	alpha	MT_PnL	omm_mid_pnl	mid_tte_val	mid_tte	mid_stoploss	omm_side_pnl	side_tte_val	side_stoploss	side_tte
2	107638	-1	310000	1.35	2018-01-08 07:38:48	GBP/USD	SOM	-1.55	4.65	2.41	NaN	NaN	4.65	2.41	NaN	NaN
3	107649	-1	310000	1.35	2018-01-08 08:10:55	GBP/USD	SOM	-7.75	1.55	0.80	NaN	NaN	7.75	6.08	NaN	NaN
4	107654	-1	320000	1.35	2018-01-08 08:19:10	GBP/USD	SOM	-6.40	-35.20	10.11	True	NaN	-38.40	6.76	True	NaN
5	107664	-1	200000	1.35	2018-01-08 08:23:16	GBP/USD	SOM	-3.00	-3.00	13.75	True	NaN	-3.00	13.75	NaN	True
6	107670	-1	490000	1.35	2018-01-08 08:34:40	GBP/USD	SOM	-4.90	0.00	0.82	NaN	NaN	4.90	0.88	NaN	NaN
7	107726	1	200000	1.36	2018-01-08 11:25:13	GBP/USD	SOM	-3.00	-11.00	10.39	True	NaN	-11.00	10.39	NaN	True
8	107733	1	310000	1.36	2018-01-08 11:42:08	GBP/USD	SOM	-7.75	-29.45	10.87	True	NaN	-29.45	10.87	NaN	True
9	107737	1	310000	1.36	2018-01-08 12:15:34	GBP/USD	SOM	-6.20	3.10	4.26	NaN	NaN	6.20	4.32	NaN	NaN
10	107738	1	310000	1.36	2018-01-08 12:15:35	GBP/USD	SOM	-6.20	3.10	3.26	NaN	NaN	6.20	3.32	NaN	NaN

3) **OMM mid:** Here we are presenting the few records we captured for this approach. Please look into the Jupyter notebook for full table.

	trade_id	buy/sell	notional	price	datetime	instrument	alpha	MT_PnL	omm_mid_pnl	mid_tte_val	mid_tte	mid_stoploss
2	107638	-1	310000	1.35	2018-01-08 07:38:48	GBP/USD	SOM	-1.55	4.65	2.41	NaN	NaN
3	107649	-1	310000	1.35	2018-01-08 08:10:55	GBP/USD	SOM	-7.75	1.55	0.80	NaN	NaN
4	107654	-1	320000	1.35	2018-01-08 08:19:10	GBP/USD	SOM	-6.40	-35.20	10.11	True	NaN
5	107664	-1	200000	1.35	2018-01-08 08:23:16	GBP/USD	SOM	-3.00	-3.00	13.75	True	NaN
6	107670	-1	490000	1.35	2018-01-08 08:34:40	GBP/USD	SOM	-4.90	0.00	0.82	NaN	NaN
7	107726	1	200000	1.36	2018-01-08 11:25:13	GBP/USD	SOM	-3.00	-11.00	10.39	True	NaN
8	107733	1	310000	1.36	2018-01-08 11:42:08	GBP/USD	SOM	-7.75	-29.45	10.87	True	NaN
9	107737	1	310000	1.36	2018-01-08 12:15:34	GBP/USD	SOM	-6.20	3.10	4.26	NaN	NaN
10	107738	1	310000	1.36	2018-01-08 12:15:35	GBP/USD	SOM	-6.20	3.10	3.26	NaN	NaN
11	107739	1	320000	1.36	2018-01-08 12:20:20	GBP/USD	SOM	-4.80	1.60	0.70	NaN	NaN
12	107742	1	200000	1.36	2018-01-08 12:26:08	GBP/USD	SOM	-3.00	1.00	1.81	NaN	NaN
13	107784	1	240000	1.36	2018-01-08 15:41:56	GBP/USD	MAR	-3.60	-6.00	10.14	True	NaN
14	107785	1	240000	1.36	2018-01-08 15:41:57	GBP/USD	MAR	-3.60	-6.00	10.54	True	NaN
15	107831	-1	490000	1.36	2018-01-08 20:03:48	GBP/USD	SOM	-12.25	7.35	3.48	NaN	NaN
16	107835	-1	310000	1.36	2018-01-08 20:06:50	GBP/USD	SOM	-7.75	-7.75	10.78	True	NaN
17	107844	-1	180000	1.36	2018-01-08 21:02:49	GBP/USD	DIS	-2.70	0.90	13.37	True	NaN
18	107846	-1	310000	1.36	2018-01-08 21:07:40	GBP/USD	SOM	-4.65	-20.15	12.06	True	NaN
19	107847	-1	320000	1.36	2018-01-08 21:18:26	GBP/USD	SOM	-6.40	-3.20	11.07	True	NaN
20	107848	-1	200000	1.36	2018-01-08 21:21:09	GBP/USD	SOM	-4.00	-4.00	20.19	True	NaN
21	107849	-1	200000	1.36	2018-01-08 21:21:10	GBP/USD	SOM	-4.00	-4.00	19.19	True	NaN
22	107851	-1	490000	1.36	2018-01-08 21:33:50	GBP/USD	SOM	-9.80	-4.90	10.04	True	NaN
23	107853	-1	310000	1.36	2018-01-08 21:37:19	GBP/USD	SOM	-7.75	1.55	1.37	NaN	NaN