02_lobster_itch_data

September 29, 2021

1 Tick Data from LOBSTER

LOBSTER (Limit Order Book System - The Efficient Reconstructor) is an online limit order book data tool to provide easy-to-use, high-quality limit order book data.

Since 2013 LOBSTER acts as a data provider for the academic community, giving access to reconstructed limit order book data for the entire universe of NASDAQ traded stocks.

More recently, it has started to make the data available on a commercial basis.

1.1 Imports

[7]:
```
from pathlib import Path
import pandas as pd
import seaborn as sns
from datetime import datetime, timedelta
from itertools import chain
import matplotlib.pyplot as plt
import numpy as np
plt.style.use('fivethirtyeight')
%matplotlib inline
```

1.2 Load Orderbook Data

We will illustrate the functionality using a free sample.

Obtain data here: https://lobsterdata.com/info/DataSamples.php; this is the link to the 10-level file

The code assumes the file has been extracted into a `data` subfolder of the current directory.

[2]:
```
list(chain(*[('Ask Price {0},Ask Size {0},Bid Price {0},Bid Size {0}'.
↪format(i)).split(',') for i in range(10)]))
```

[2]:
```
['Ask Price 0',
 'Ask Size 0',
 'Bid Price 0',
 'Bid Size 0',
 'Ask Price 1',
 'Ask Size 1',
 'Bid Price 1',
 'Bid Size 1',
 'Ask Price 2',
 'Ask Size 2',
 'Bid Price 2',
 'Bid Size 2',
 'Ask Price 3',
 'Ask Size 3',
 'Bid Price 3',
 'Bid Size 3',
 'Ask Price 4',
 'Ask Size 4',
 'Bid Price 4',
 'Bid Size 4',
 'Ask Price 5',
 'Ask Size 5',
 'Bid Price 5',
 'Bid Size 5',
 'Ask Price 6',
 'Ask Size 6',
 'Bid Price 6',
 'Bid Size 6',
 'Ask Price 7',
 'Ask Size 7',
 'Bid Price 7',
 'Bid Size 7',
 'Ask Price 8',
 'Ask Size 8',
 'Bid Price 8',
 'Bid Size 8',
 'Ask Price 9',
 'Ask Size 9',
 'Bid Price 9',
 'Bid Size 9']
```

[4]:
```
price = list(chain(*[('Ask Price {0},Bid Price {0}'.format(i)).split(',') for i␣
 ↪in range(10)]))
size = list(chain(*[('Ask Size {0},Bid Size {0}'.format(i)).split(',') for i in␣
 ↪range(10)]))
cols = list(chain(*zip(price, size)))
```

[8]:
```
path = Path('data')
order_data = 'AMZN_2012-06-21_34200000_57600000_orderbook_10.csv'
orders = pd.read_csv(path / order_data, header=None, names=cols)
```

[9]:
```
orders.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 269748 entries, 0 to 269747
Data columns (total 40 columns):
Ask Price 0    269748 non-null int64
Ask Size 0     269748 non-null int64
Bid Price 0    269748 non-null int64
Bid Size 0     269748 non-null int64
Ask Price 1    269748 non-null int64
Ask Size 1     269748 non-null int64
Bid Price 1    269748 non-null int64
Bid Size 1     269748 non-null int64
Ask Price 2    269748 non-null int64
Ask Size 2     269748 non-null int64
Bid Price 2    269748 non-null int64
Bid Size 2     269748 non-null int64
Ask Price 3    269748 non-null int64
Ask Size 3     269748 non-null int64
Bid Price 3    269748 non-null int64
Bid Size 3     269748 non-null int64
Ask Price 4    269748 non-null int64
Ask Size 4     269748 non-null int64
Bid Price 4    269748 non-null int64
Bid Size 4     269748 non-null int64
Ask Price 5    269748 non-null int64
Ask Size 5     269748 non-null int64
Bid Price 5    269748 non-null int64
Bid Size 5     269748 non-null int64
Ask Price 6    269748 non-null int64
Ask Size 6     269748 non-null int64
Bid Price 6    269748 non-null int64
Bid Size 6     269748 non-null int64
Ask Price 7    269748 non-null int64
Ask Size 7     269748 non-null int64
Bid Price 7    269748 non-null int64
Bid Size 7     269748 non-null int64
Ask Price 8    269748 non-null int64
Ask Size 8     269748 non-null int64
Bid Price 8    269748 non-null int64
Bid Size 8     269748 non-null int64
Ask Price 9    269748 non-null int64
Ask Size 9     269748 non-null int64
Bid Price 9    269748 non-null int64
Bid Size 9     269748 non-null int64
dtypes: int64(40)
memory usage: 82.3 MB
```

[9]:
```
orders.head()
```

```
[9]:    Ask Price 0  Ask Size 0  Bid Price 0  Bid Size 0  Ask Price 1  Ask Size 1  \
     0      2239500         100      2231800         100      2239900         100
     1      2239500         100      2238100          21      2239900         100
     2      2239500         100      2238100          21      2239600          20
     3      2239500         100      2238100          21      2239600          20
     4      2239500         100      2238100          21      2239600          20

        Bid Price 1  Bid Size 1  Ask Price 2  Ask Size 2     …       Bid Price 7  \
     0      2230700         200      2240000         220     …           2202500
     1      2231800         100      2240000         220     …           2204000
     2      2231800         100      2239900         100     …           2204000
     3      2237500         100      2239900         100     …           2213000
     4      2237500         100      2239900         100     …           2213000

        Bid Size 7  Ask Price 8  Ask Size 8  Bid Price 8  Bid Size 8  Ask Price 9  \
     0        5000      2294300         100      2202000         100      2298000
     1         100      2294300         100      2202500        5000      2298000
     2         100      2267700         100      2202500        5000      2294300
     3        4000      2267700         100      2204000         100      2294300
     4        4000      2267700         100      2204000         100      2294300

        Ask Size 9  Bid Price 9  Bid Size 9
     0         100      2189700         100
     1         100      2202000         100
     2         100      2202000         100
     3         100      2202500        5000
     4         100      2202500        5000

     [5 rows x 40 columns]
```

1.2.1 Message Data

Message Type Codes:

```
1: Submission of a new limit order
2: Cancellation (Partial deletion
   of a limit order)
3: Deletion (Total deletion of a limit order)
4: Execution of a visible limit order
5: Execution of a hidden limit order
7: Trading halt indicator
   (Detailed information below)
```

```
[10]: types = {1: 'submission',
               2: 'cancellation',
               3: 'deletion',
               4: 'execution_visible',
               5: 'execution_hidden',
         7: 'trading_halt'}
```

[11]:
```
trading_date = '2012-06-21'
levels = 10
```

[12]:
```
message_data = 'AMZN_{}_34200000_57600000_message_{}.csv'.format(trading_date,␣
 ↪levels)
messages = pd.read_csv(path / message_data, header=None, names=['time', 'type',␣
 ↪'order_id', 'size', 'price', 'direction'])
messages.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 269748 entries, 0 to 269747
Data columns (total 6 columns):
time         269748 non-null float64
type         269748 non-null int64
order_id     269748 non-null int64
size         269748 non-null int64
price        269748 non-null int64
direction    269748 non-null int64
dtypes: float64(1), int64(5)
memory usage: 12.3 MB
```

[13]:
```
messages.head()
```

[13]:
```
           time  type  order_id  size    price  direction
0  34200.017460     5         0     1  2238200         -1
1  34200.189608     1  11885113    21  2238100          1
2  34200.189608     1   3911376    20  2239600         -1
3  34200.189608     1  11534792   100  2237500          1
4  34200.189608     1   1365373    13  2240000         -1
```

[14]:
```
messages.type.map(types).value_counts()
```

[14]:
```
submission           131954
deletion             123458
execution_visible      8974
cancellation           2917
execution_hidden       2445
Name: type, dtype: int64
```

[15]:
```
messages.time = pd.to_timedelta(messages.time, unit='s')
messages['trading_date'] = pd.to_datetime(trading_date)
messages.time = messages.trading_date.add(messages.time)
messages.drop('trading_date', axis=1, inplace=True)
messages.head()
```

```
[15]:                              time  type  order_id  size    price  direction
      0 2012-06-21 09:30:00.017459617     5         0     1  2238200         -1
      1 2012-06-21 09:30:00.189607670     1  11885113    21  2238100          1
      2 2012-06-21 09:30:00.189607670     1   3911376    20  2239600         -1
      3 2012-06-21 09:30:00.189607670     1  11534792   100  2237500          1
      4 2012-06-21 09:30:00.189607670     1   1365373    13  2240000         -1
```

```
[16]: data = pd.concat([messages, orders], axis=1)
      data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 269748 entries, 0 to 269747
Data columns (total 46 columns):
time           269748 non-null datetime64[ns]
type           269748 non-null int64
order_id       269748 non-null int64
size           269748 non-null int64
price          269748 non-null int64
direction      269748 non-null int64
Ask Price 0    269748 non-null int64
Ask Size 0     269748 non-null int64
Bid Price 0    269748 non-null int64
Bid Size 0     269748 non-null int64
Ask Price 1    269748 non-null int64
Ask Size 1     269748 non-null int64
Bid Price 1    269748 non-null int64
Bid Size 1     269748 non-null int64
Ask Price 2    269748 non-null int64
Ask Size 2     269748 non-null int64
Bid Price 2    269748 non-null int64
Bid Size 2     269748 non-null int64
Ask Price 3    269748 non-null int64
Ask Size 3     269748 non-null int64
Bid Price 3    269748 non-null int64
Bid Size 3     269748 non-null int64
Ask Price 4    269748 non-null int64
Ask Size 4     269748 non-null int64
Bid Price 4    269748 non-null int64
Bid Size 4     269748 non-null int64
Ask Price 5    269748 non-null int64
Ask Size 5     269748 non-null int64
Bid Price 5    269748 non-null int64
Bid Size 5     269748 non-null int64
Ask Price 6    269748 non-null int64
Ask Size 6     269748 non-null int64
Bid Price 6    269748 non-null int64
Bid Size 6     269748 non-null int64
```

```
Ask Price 7    269748 non-null int64
Ask Size 7     269748 non-null int64
Bid Price 7    269748 non-null int64
Bid Size 7     269748 non-null int64
Ask Price 8    269748 non-null int64
Ask Size 8     269748 non-null int64
Bid Price 8    269748 non-null int64
Bid Size 8     269748 non-null int64
Ask Price 9    269748 non-null int64
Ask Size 9     269748 non-null int64
Bid Price 9    269748 non-null int64
Bid Size 9     269748 non-null int64
dtypes: datetime64[ns](1), int64(45)
memory usage: 94.7 MB
```

[17]:
```
ex = data[data.type.isin([4, 5])]
```

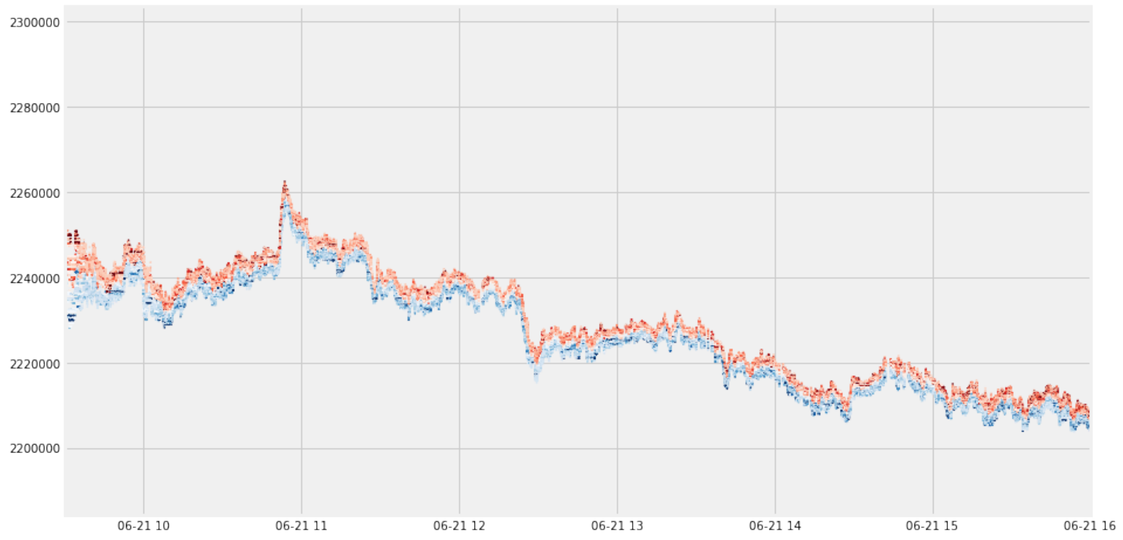
[18]:
```
ex.head()
```

[18]:
```
                             time  type  order_id  size    price  direction  \
0  2012-06-21 09:30:00.017459617     5         0     1  2238200         -1
32 2012-06-21 09:30:00.190226476     4  11885113    21  2238100          1
33 2012-06-21 09:30:00.190226476     4  11534792    26  2237500          1
37 2012-06-21 09:30:00.372779672     5         0   100  2238400         -1
38 2012-06-21 09:30:00.375671205     5         0   100  2238400         -1

    Ask Price 0  Ask Size 0  Bid Price 0  Bid Size 0     …     Bid Price 7  \
0       2239500         100      2231800         100     …         2202500
32      2239500         100      2237500         100     …         2230400
33      2239500         100      2237500          74     …         2230400
37      2239500         100      2237500          74     …         2226200
38      2239500         100      2237500          74     …         2226200

    Bid Size 7  Ask Price 8  Ask Size 8  Bid Price 8  Bid Size 8  Ask Price 9  \
0         5000      2294300         100      2202000         100      2298000
32         100      2244900         100      2230000          10      2245000
33         100      2244900         100      2230000          10      2245000
37         100      2244900         100      2213000        4000      2245000
38         100      2244900         100      2213000        4000      2245000

    Ask Size 9  Bid Price 9  Bid Size 9
0          100      2189700         100
32           5      2226200         100
33           5      2226200         100
37           5      2204000         100
38           5      2204000         100
```

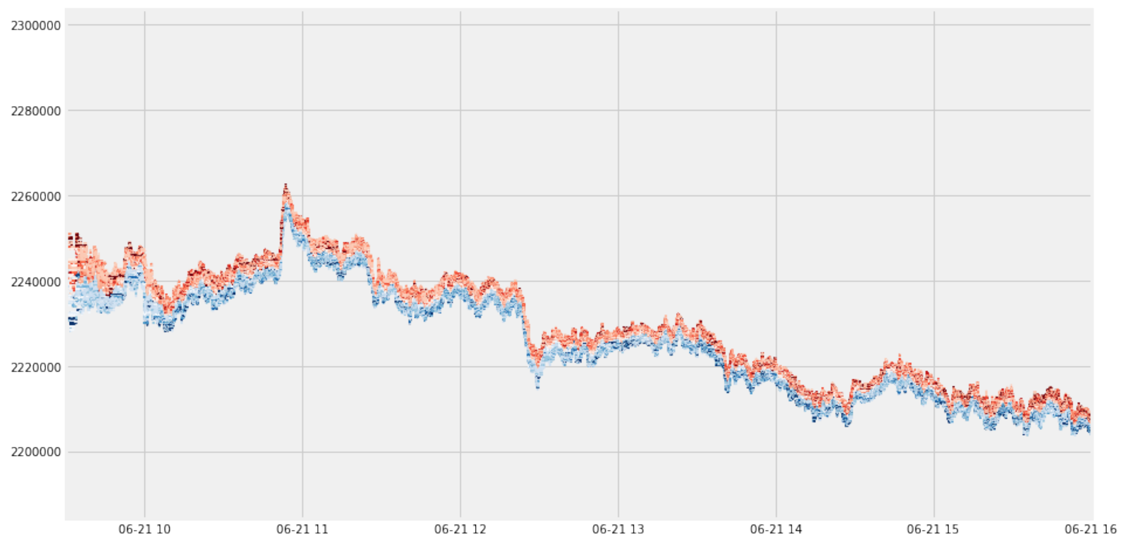
```
[5 rows x 46 columns]
```

```
[19]: cmaps = {'Bid': 'Blues','Ask': 'Reds'}
```

```
[20]: fig, ax=plt.subplots(figsize=(14, 8))
      time = ex['time'].dt.to_pydatetime()
      for i in range(10):
          for t in ['Bid', 'Ask']:
              y, c = ex['{} Price {}'.format(t, i)], ex['{} Size {}'.format(t, i)]
              ax.scatter(x=time, y=y, c=c, cmap=cmaps[t], s=1, vmin=1, vmax=c.
       ↪quantile(.95))
      ax.set_xlim(datetime(2012, 6, 21, 9, 30), datetime(2012, 6, 21, 16, 0));
```



```
[21]: fig, ax=plt.subplots(figsize=(14, 8))
      time = data['time'].dt.to_pydatetime()
      for i in range(10):
          for t in ['Bid', 'Ask']:
              y, c = data['{} Price {}'.format(t, i)], data['{} Size {}'.format(t, i)]
              ax.scatter(x=time, y=y, c=c, cmap=cmaps[t], s=1, vmin=1, vmax=c.
       ↪quantile(.95))
      ax.set_xlim(datetime(2012, 6, 21, 9, 30), datetime(2012, 6, 21, 16, 0));
```


2300000
2280000
2260000
2240000
2220000
2200000
06-21 10
06-21 11
06-21 12
06-21 13
06-21 14
06-21 15
06-21 16

```
[ ]:
```