obAnalytics Guide

Philip Stubbings

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Contents

Overview

obAnalytics is an R package intended for visualisation and analysis of limit order data.

This guide is structured as an end-to-end walk-through and is intended to demonstrate the main features and functionality of the package.

Recommended environment settings

Due to the large number of columns in the example data, it is recommended to set the display width to make the most use of the display. It is also recommended to set *digits.secs=3* and *scipen=999* in order to display timestamps and fractions nicely. This can be achieved as follows:

```r
max.cols <- Sys.getenv("COLUMNS")
options(width=if(max.cols != "") max.cols else 80, scipen=999, digits.secs=3)
```

Loading data

The main focus of this package is reconstruction of a limit order book. The *processData* function will perform data processing based on a supplied CSV file, the format of which is defined in the *Expected csv schema* section.

The data processing consists of a number of stages:

1. Cleaning of duplicate and erroneous data.
2. Identification of sequential event relationships.
3. Inference of trade events via order-matching.
4. Inference of order types (limit vs market).
5. Construction of volume by price level series.
6. Construction of order book summary statistics.

Limit order events are related to one another by volume deltas (the change in volume for a limit order). To simulate a matching-engine, and thus determine directional trade data, volume deltas from both sides of the limit order book are ordered by time, yielding a sequence alignment problem, to which the the Needleman-Wunsch algorithm has been applied.

```
# load and process example csv data from the package inst/extdata directory.
csv.file <- system.file("extdata", "orders.csv.xz", package="obAnalytics")
lob.data <- processData(csv.file)
```

Expected csv schema

The CSV file is expected to contain 7 columns:

Table 1: Expected CSV schema.

Column name	Description
id	Numeric limit order unique identifier.
timestamp	Time in milliseconds when event received locally.
exchange.timestamp	Time in milliseconds when order first created on the exchange.
price	Price level of order event.
volume	Remaining order volume.
action	Event action describes the limit order lifecycle. One of: **created**, **modified**, **deleted**.
direction	Side of order book. On of: **bid** or **ask**.

Preprocessed example data

For illustrative purposes, the package contains a sample of preprocessed data. The data, taken from the Bitstamp (bitcoin) exchange on 2015-05-01, consists of 50,393 limit order events and 482 trades occuring from midnight up until ~5am.

The sample data, which has been previously processed by the *processData* function, may be attached to the environment with the *data()* function:

```
data(lob.data)
```

The *lob.data* object is a list containing four data.frames.

Table 2: lob.data summary.

data.frame	Summary
events	Limit order events.
trades	Inferred trades (executions).
depth	Order book price level depth through time.
depth.summary	Limit order book summary statistics.

The contents of which are briefly discussed in the following sections.

Events

The *events* data.frame contains the lifecycle of limit orders and makes up the core data of the obAnalytics package. Each row corresponds to a single limit order action, of which three types are possible.

Table 3: Possible limit order actions.

Event action	Meaning
created	The order is created with a specified amount of volume and a limit price.
changed	The order has been partially filled. On each modification, the remaining volume will decrease.
deleted	The order may be deleted at the request of the trader or, in the event that the order has been completely filled, deleted by the exchange. An order deleted by the exchange as a result of being filled will have 0 remaining volume at time of deletion.

In addition to the event *action* type, a row consists of a number of attributes relating to the lifecycle of a limit order.

Table 4: Limit order event attributes.

Attribute	Meaning
event.id	Event Id.
id	Limit Order Id.
timestamp	Local event timestamp (local time the event was observed).
exchange.timestamp	Exchange order creation time.
price	Limit order price level.
volume	Remaining limit order volume.
action	Event action: *created*, *changed*, *deleted*. (as described above).
direction	Order book side: *bid*, *ask*.
fill	For *changed* or *deleted* events, indicates the change in volume between this event and the last.
matching.event	Matching *event.id* if this event is part of a trade. NA otherwise.
type	Limit order type (see Event types below.)

Attribute	Meaning
aggressiveness.bps	The distance of the order from the edge of the book in Basis Points (BPS). If an order is placed exactly at the best bid/ask queue, this value will be 0. If placed behind the best bid/ask, the value will be negative. A positive value is indicative of a *innovative* order: The order was placed inside the bid/ask spread, which would result in the change to the market midprice.

An individual limit order (referenced by the *id* attribute) may be of six different types, all of which have been classified by onAnalytics.

Table 5: Order types.

Limit order type	Meaning
unknown	It was not possible to infer the order type given the available data.
flashed-limit	Order was created then subsequently deleted. 96% of example data. These types of orders are also referred to as *fleeting orders* in the literature.
resting-limit	Order was created and left in order book indefinitely until filled.
market-limit	Order was partially filled before landing in the order book at it's limit price. This may happen when the limit order crosses the book because, in the case of a bid order, it's price is >= the current best ask. However there is not enough volume between the current best ask and the order limit price to fill the order's volume completely.
market	Order was completely filled and did not come to rest in the order book. Similarly to a *market-limit*, the *market* order crosses the order book. However, it's volume is filled before reaching it's limit price. Both market-limit and market orders are referred to as *marketable* limit orders in the literature.
pacman	A limit-price modified *in situ* (exchange algorithmic order). The example data contains a number of these order types. They occur when a limit order's *price* attribute is *updated*. In the example data, this occurs from a special order type offered by the exchange which, in the case of a bid, will *peg* the limit price to the best ask once per second until the order has been filled.

The following table demonstrates a small snapshot (1 second) of event data. Some of the attributes have been omitted or renamed for readability.

```r
one.sec <- with(lob.data, {
  events[events$timestamp >= as.POSIXct("2015-05-01 04:55:10", tz="UTC") &
         events$timestamp <= as.POSIXct("2015-05-01 04:55:11", tz="UTC"),  ]
})
one.sec$volume <- one.sec$volume*10^-8
one.sec$fill <- one.sec$fill*10^-8
one.sec$aggressiveness.bps <- round(one.sec$aggressiveness.bps, 2)
one.sec <- one.sec[, c("event.id", "id", "price", "volume", "action",
    "direction", "fill", "matching.event", "type", "aggressiveness.bps")]
colnames(one.sec) <- c(c("event.id", "id", "price", "vol", "action", "dir",
    "fill", "match", "type", "agg"))
print(one.sec, row.names=F)
```

event.id	id	price	vol	action	dir	fill	match	type	agg
48258	65619043	235.84	0.000000	deleted	ask	1.6379919	49021	market-limit	NA
48443	65619136	235.98	0.000000	deleted	ask	0.2118824	49022	resting-limit	-6.36
48617	65619223	237.12	20.762160	deleted	ask	0.0000000	NA	flashed-limit	-47.03
48879	65619359	236.18	15.988592	deleted	ask	0.0000000	NA	flashed-limit	-7.20
48997	65619419	235.83	0.000000	deleted	ask	1.8498742	NA	unknown	NA
49001	65619421	236.01	15.435748	changed	ask	6.6832516	49023	resting-limit	NA
49020	65619430	236.05	8.533126	changed	bid	1.8498742	NA	market	NA
49021	65619430	236.05	6.895134	changed	bid	1.6379919	48258	market	NA
49022	65619430	236.05	6.683252	changed	bid	0.2118824	48443	market	NA
49023	65619430	236.05	0.000000	deleted	bid	6.6832516	49001	market	NA
49024	65619431	235.06	13.200000	created	bid	0.0000000	NA	resting-limit	-28.85
49027	65619432	236.03	13.200000	created	ask	0.0000000	NA	flashed-limit	-0.85
49029	65619433	233.71	8.665815	created	bid	0.0000000	NA	flashed-limit	-86.11
49030	65619433	233.71	8.665815	deleted	bid	0.0000000	NA	flashed-limit	-86.11
49031	65619434	236.94	22.749000	created	ask	0.0000000	NA	flashed-limit	-39.41

Trades

The package automatically infers execution/trade events from the provided limit order data.

The trades data.frame contains a log of all executions ordered by local timestamp.

In addition to the usual timestamp, price and volume information, each row also contains the trade direction (buyer or seller initiated) and maker/taker limit order ids.

The maker/taker event and limit order ids can be used to group trades into market impacts - An example of which will be demonstrated later in this guide.

```r
trades.ex <- tail(lob.data$trades, 10)
trades.ex$volume <- round(trades.ex$volume*10^-8, 2)
print(trades.ex, row.names=F)
```

timestamp	price	volume	direction	maker.event.id	taker.event.id	maker	taker
2015-05-01 04:59:27.503	235.73	0.01	buy	49630	49777	65619731	65619806
2015-05-01 04:59:27.532	235.79	0.02	buy	49672	49778	65619752	65619806
2015-05-01 04:59:41.568	235.77	0.02	buy	49802	49821	65619818	65619826
2015-05-01 04:59:55.877	235.77	0.02	buy	49803	49871	65619818	65619851
2015-05-01 04:59:59.217	235.77	0.38	buy	49804	49877	65619818	65619854
2015-05-01 05:00:08.361	235.77	0.12	sell	49878	49894	65619854	65619862
2015-05-01 05:00:08.395	235.58	0.21	sell	49406	49895	65619615	65619862
2015-05-01 05:00:08.424	235.01	0.07	sell	46221	49896	65618028	65619862
2015-05-01 05:00:10.108	235.79	0.02	buy	49816	49900	65619824	65619864
2015-05-01 05:03:13.566	235.45	0.05	sell	49992	50255	65619912	65620048

Each row, representing a single trade, consists of the following attributes:

Table 8: Trade data attributes.

Attribute	Meaning
timestamp	Local event timestamp.

Attribute	Meaning
price	Price at which the trade occurred.
volume	Amount of traded volume.
direction	The trade direction: *buy* or *sell*.
maker.event.id	Corresponding market making event id in *events* data.frame.
taker.event.id	Corresponding market taking event id in *events* data.frame.
maker	Id of the market making limit order in *events* data.frame.
taker	Id of the market taking limit order in *events* data.frame.

Depth

The depth data.frame describes the amount of available volume for all price levels in the limit order book through time. Each row corresponds to a limit order event, in which volume has been added or removed.

The data.frame represents a run-length-encoding of the cumulative sum of depth for all price levels and consists of the following attributes:

Table 9: Depth attributes.

Attribute	Meaning
timestamp	Time at which volume was added or removed.
price	Order book price level.
volume	Amount of remaining volume at this price level.
side	The side of the price level: bid or ask.

Depth summary

The depth.summary data.frame contains various summary statistics describing the state of the order book after every limit order event. The metrics are intended to quantify the shape of the order book through time.

Table 10: Order book summary metrics.

Attribute	Meaning
timestamp	Local timestamp corresponding to events.
best.bid.price	Best bid price.
best.bid.vol	Amount of volume available at the best bid.
bid.vol25:500bps	The amount of volume available for 20 25bps percentiles below the best bid.
best.ask.price	The best ask price.
best.ask.vol	Amount of volume available at the best ask.
ask.vol25:500bps	The amount of volume available for 20 25bps percentiles above the best ask.

Visualisation

The package provides a number of functions for the visualisation of limit order events and order book liquidity. The visualisations all make use of the ggplot2 plotting system.

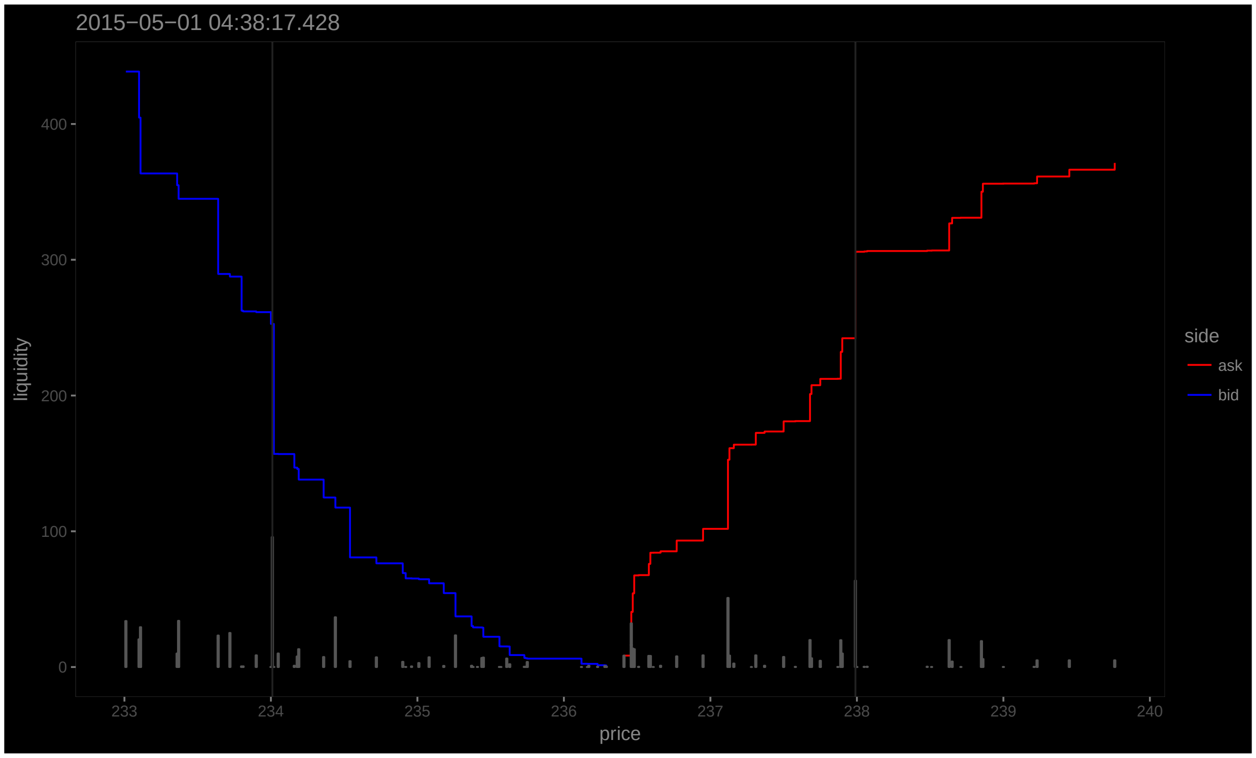
Order book shape

The purpose of the cumulative volume graph is to quickly identify the shape of the limit order book for the given point in time. The "shape" is defined as the cumulative volume available at each price level, starting at the best bid/ask.

Using this shape, it is possible to visually summarise order book imbalance and market depth.

```r
# get a limit order book for a specific point in time, limited to +- 150bps
# above/below best bid/ask price.
lob <- orderBook(lob.data$events,
    tp=as.POSIXct("2015-05-01 04:38:17.429", tz="UTC"), bps.range=150)

# visualise the order book liquidity.
plotCurrentDepth(lob, volume.scale=10^-8)
```



In the figure above, an order book has been reconstructed with the *orderBook* function for a specific point in time. The visualisation produced with the *plotCurrentDepth* function depicts a number of order book features. Firstly, the embedded bar chart at the bottom of the plot shows the amount of volume available at specific price levels ranging from the *bid* side on the left (blue) through to the *ask* side (red) on the right. Secondly, the blue and red lines show the *cumulative* volume of the bar chart for the bid and ask sides of the order book respectively. Finally, the two subtle vertical lines at price points $234 and $238 show the position of the top 1% largest limit orders.

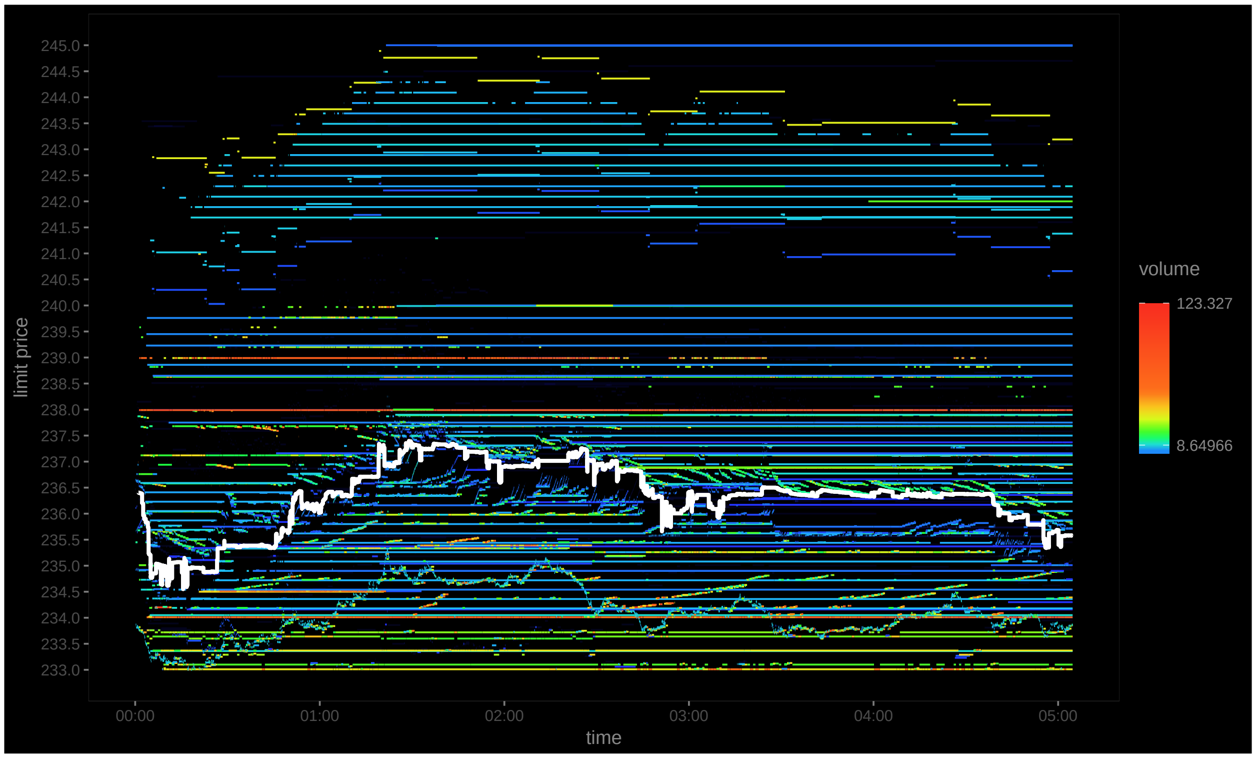
Price level volume

The available volume at each price level is colour coded according to the range of volume at all price levels. The colour coding follows the visible spectrum, such that larger amounts of volume appear "hotter" than smaller amounts, where cold = blue, hot = red.

Since the distribution of limit order size exponentially decays, it can be difficult to visually differentiate: most values will appear to be blue. The function provides price, volume and a colour bias range to overcome this.

Setting *col.bias* to 0 will colour code volume on the logarithmic scale, while setting *col.bias* < 1 will “squash” the spectrum. For example, a uniform *col.bias* of 1 will result in 1/3 blue, 1/3 green, and 1/3 red applied across all volume - most values will be blue. Setting the *col.bias* to 0.5 will result in 1/7 blue, 2/7 green, 4/7 red being applied such that there is greater differentiation amongst volume at smaller scales.

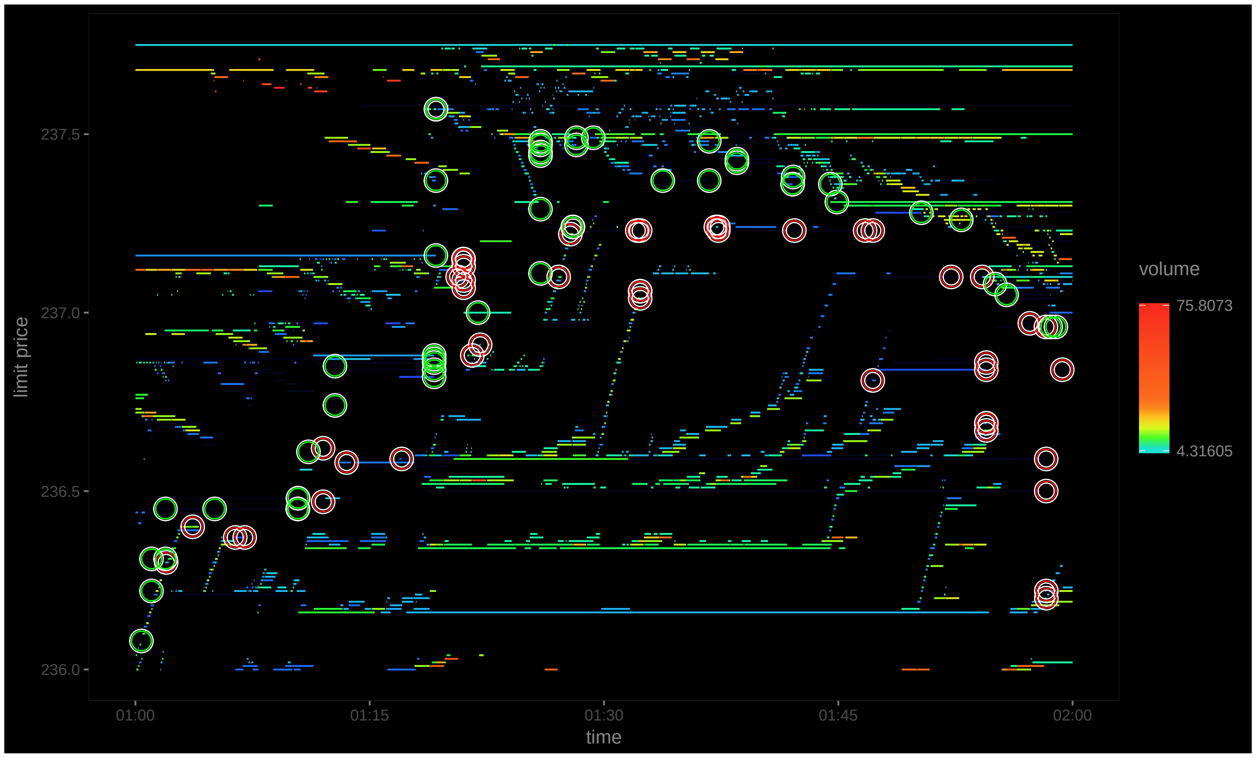
```r
# plot all lob.data price level volume between $233 and $245 and overlay the
# market midprice.
spread <- getSpread(lob.data$depth.summary)
plotPriceLevels(lob.data$depth, spread, price.from=233, price.to=245,
    volume.scale=10^-8, col.bias=0.25, show.mp=T)
```



The above plot shows all price levels between \$227 and \$245 for ~5 hours of price level data with the market midprice indicated in white. The volume has been scaled down from Satoshi to Bitcoin for legibility (1 Bitcoin = 10^8 Satoshi). Note the large sell/ask orders at \$238 and \$239 respectively.

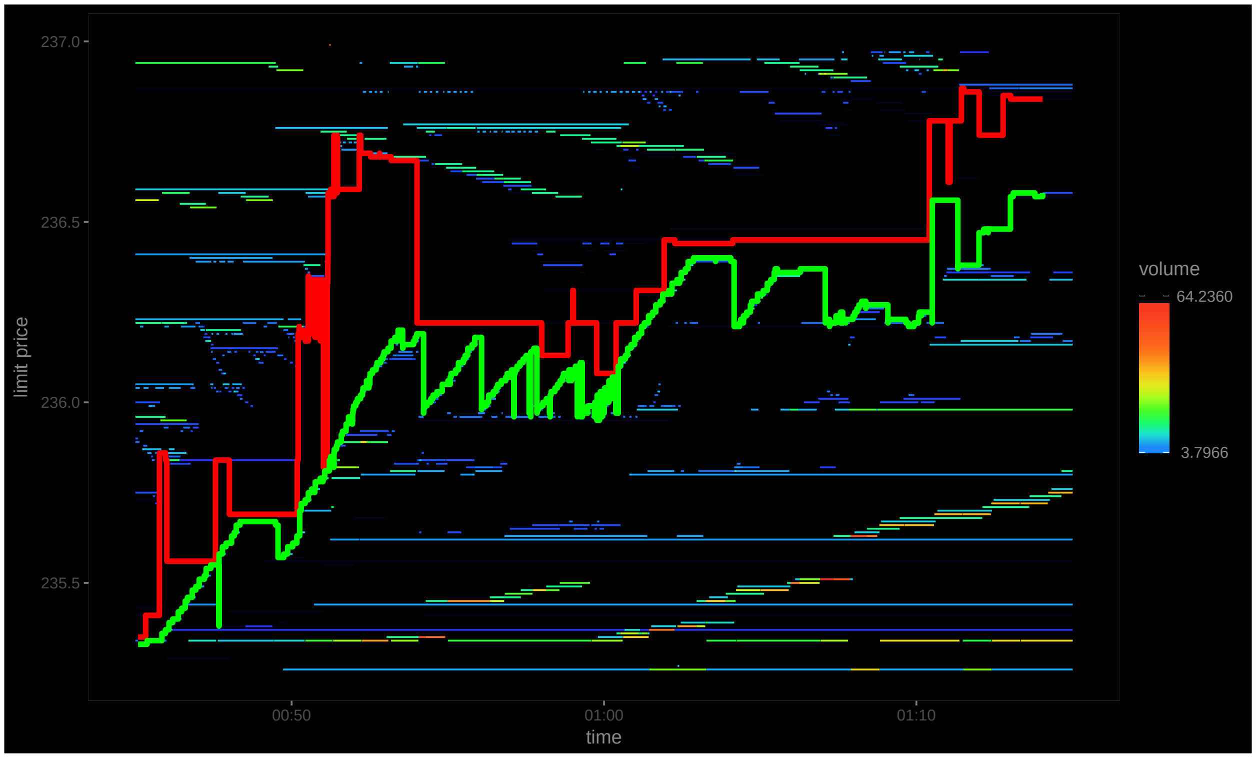
Zooming into the same price level data, between 1am and 2am and providing *trades* data to the plot will show trade executions. In the below plot which has been centred around the bid/ask spread, shows the points at which market *sell* (circular red) and *buy* (circular green) orders have been executed with respect to the order book price levels.

```r
# plot 1 hour of trades centred around the bid/ask spread.
plotPriceLevels(lob.data$depth, trades=lob.data$trades,
    price.from=236, price.to=237.75, volume.scale=10^-8, col.bias=0.2,
    start.time=as.POSIXct("2015-05-01 01:00:00.000", tz="UTC"),
    end.time=as.POSIXct("2015-05-01 02:00:00.000", tz="UTC"))
```



Zooming in further to a 30 minute window, it is possible to display the bid ask spread clearly. In the below plot, *show.mp* has been set to FALSE. This has the effect of displaying the actual spread (bid = green, ask = red) instead of the (bid+ask)/2 midprice.

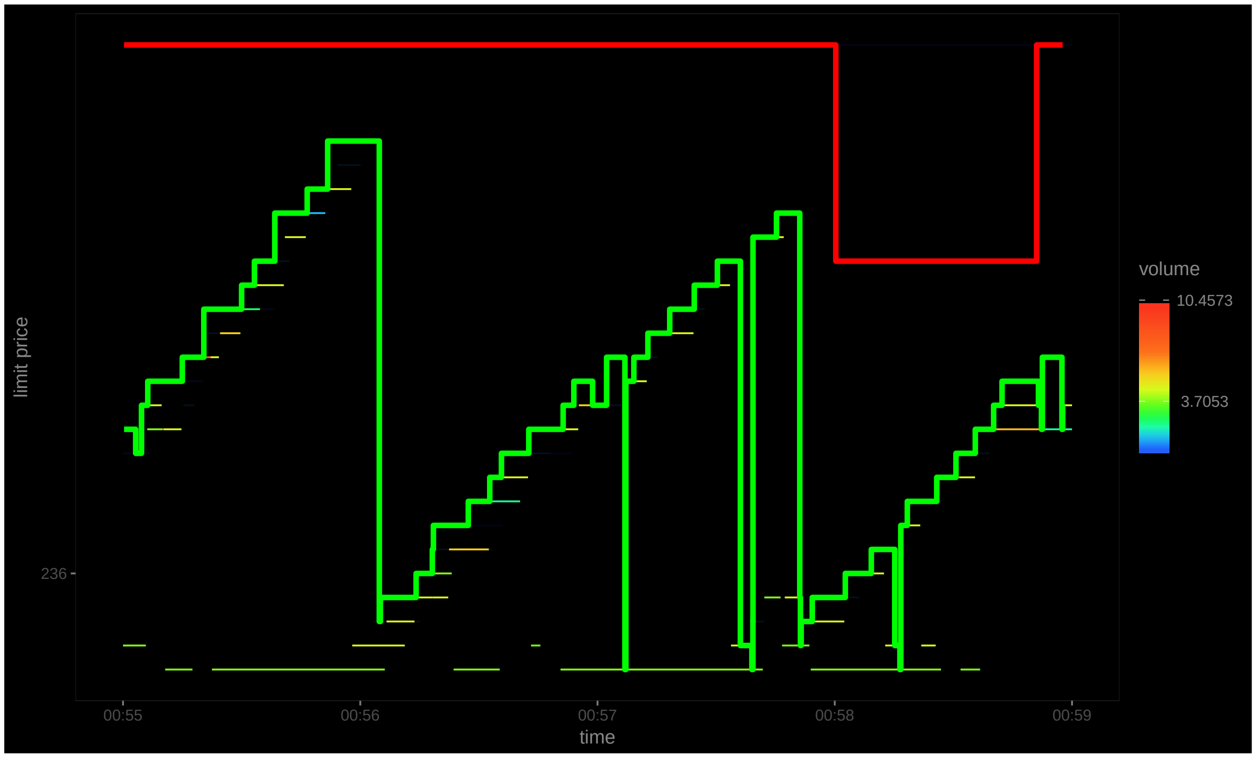
```
# zoom in to 30 minutes of bid/ask quotes.
plotPriceLevels(lob.data$depth, spread, price.from=235.25, price.to=237,
    start.time=as.POSIXct("2015-05-01 00:45:00.000", tz="UTC"),
    end.time=as.POSIXct("2015-05-01 01:15:00.000", tz="UTC"),
    volume.scale=10^-8, col.bias=0.5, show.mp=F)
```



Zooming in, still further, to ~4 minutes of data focussed around the spread, shows (in this example) the bid rising and then dropping, while, by comparison, the ask price remains static.

This is a common pattern: 2 or more algorithms are competing to be ahead of each other. They both wish to be at the best bid+1, resulting in a cyclic game of leapfrog until one of the competing algorithm withdraws, in which case the remaining algorithm "snaps" back to the next best bid (+1). This behavior results in a *sawtooth* pattern which has been characterised by some as market- manipulation. It is simply an emergent result of event driven limit order markets.

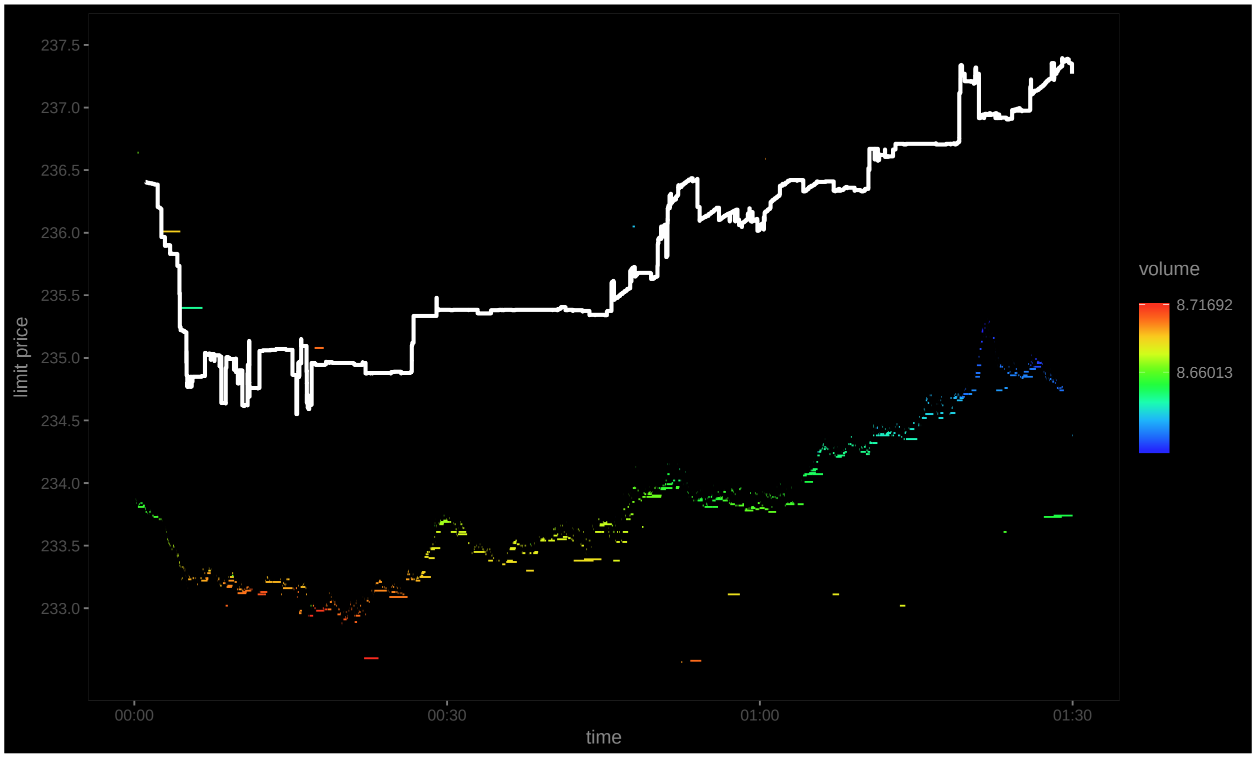
```
# zoom in to 4 minutes of bid/ask quotes.
plotPriceLevels(lob.data$depth, spread, price.from=235.90, price.to=236.25,
    start.time=as.POSIXct("2015-05-01 00:55:00.000", tz="UTC"),
    end.time=as.POSIXct("2015-05-01 00:59:00.000", tz="UTC"),
    volume.scale=10^-8, col.bias=0.5, show.mp=F)
```



By filtering the price or volume range it is possible to observe the behavior of individual market participants. This is perhaps one of the most useful and interesting features of this tool.

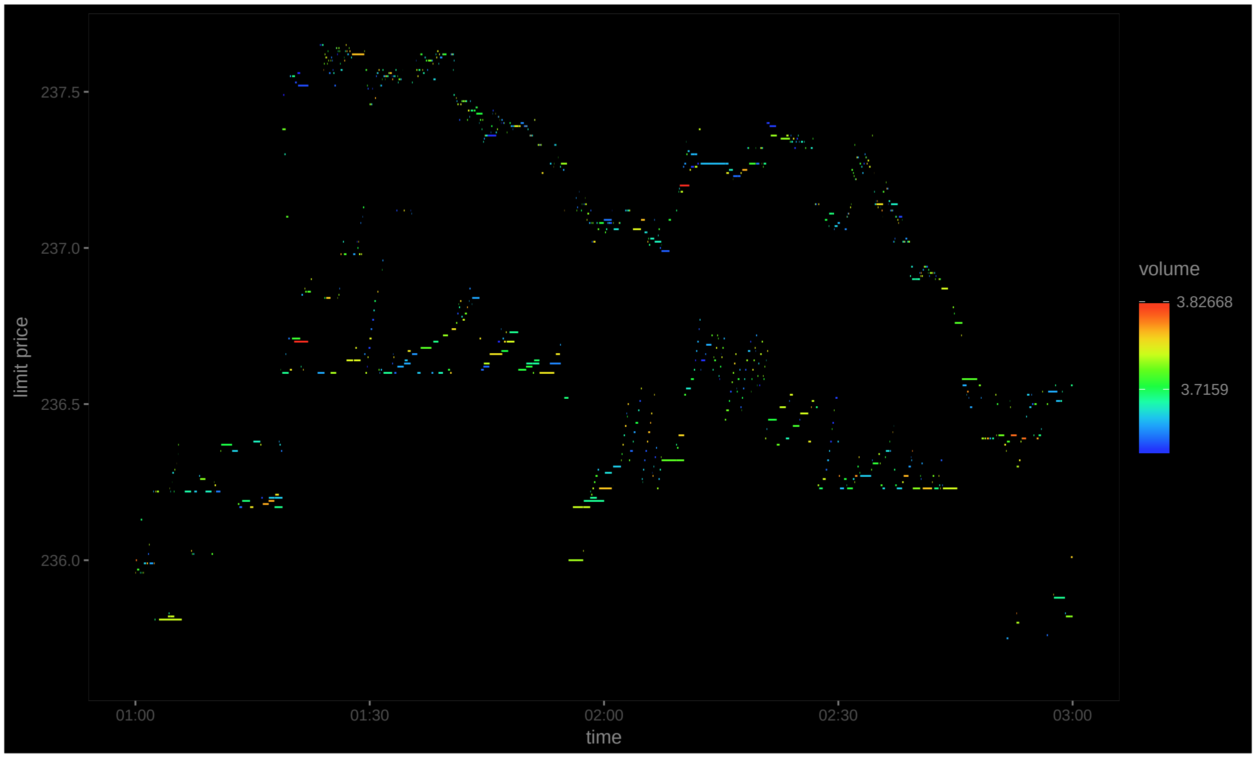
In the below plot, the displayed price level volume has been restricted between 8.59 an 8.72 bitcoin, resulting in obvious display of an individual algo. Here, the algo. is most likely seeking *value* by placing limit orders below the bid price waiting for a market impact in the hope of reversion by means of market resilience (the rate at which market makers fill a void after a market impact).

```r
plotPriceLevels(lob.data$depth, spread, price.from=232.5, price.to=237.5,
    volume.scale=10^-8, col.bias=1, show.mp=T,
    end.time=as.POSIXct("2015-05-01 01:30:00.000", tz="UTC"),
    volume.from=8.59, volume.to=8.72)
```



Using the same volume filtering approach, the next plot shows the behaviour of an individual *market maker* operating with a bid/ask spread limited between 3.63 and 3.83 bitcoin respectively. The rising bid prices at times are due to the event driven "leapfrog" phenomenon discussed previously.

```r
plotPriceLevels(lob.data$depth, price.from=235.65, price.to=237.65,
    volume.scale=10^-8, col.bias=1,
    start.time=as.POSIXct("2015-05-01 01:00:00.000", tz="UTC"),
    end.time=as.POSIXct("2015-05-01 03:00:00.000", tz="UTC"),
    volume.from=3.63, volume.to=3.83)
```



Liquidity

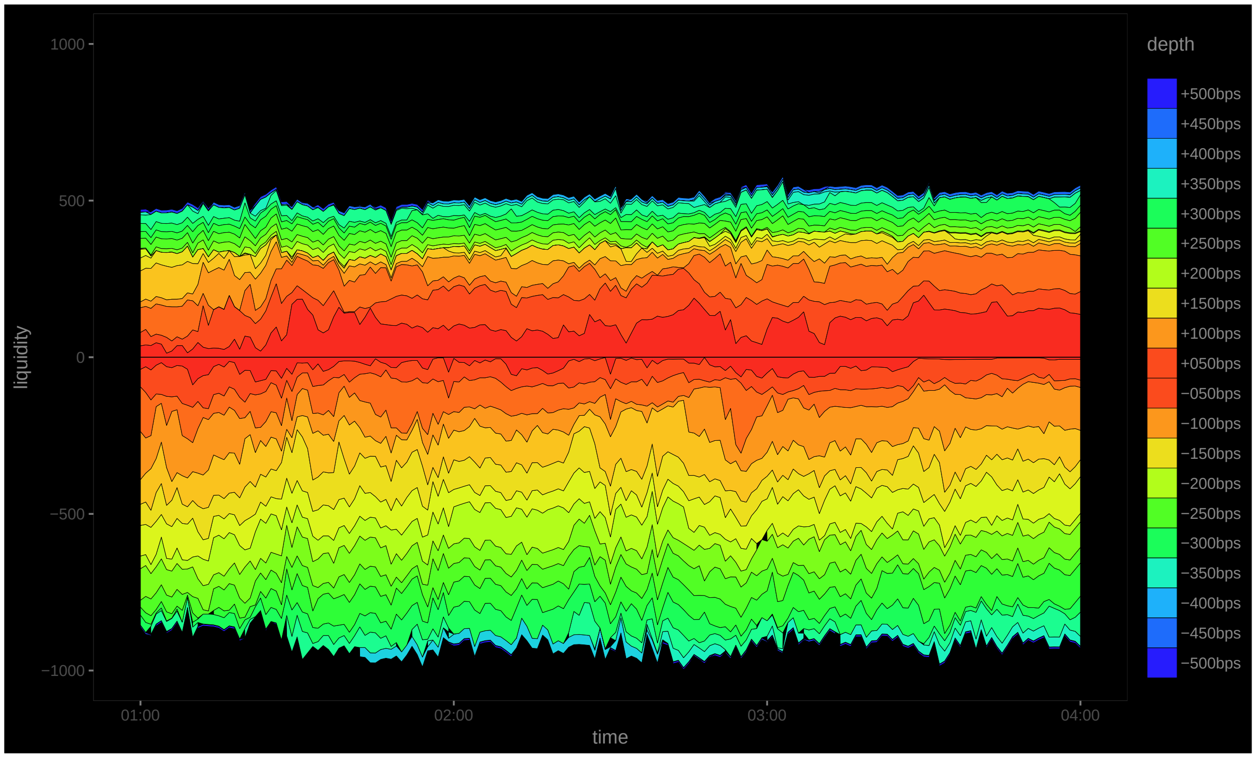
The *plotVolumePercentiles* function plots the available volume in 25bps increments on each side of the order book in the form of a stacked area graph.

The resulting graph is intended to display the market "quality" either side of the limit order book: The amount of volume available at increasing depths in the order book which would effect the VWAP (Volume Weighted Average Price) of a market order.

The example below favours buyers, since there is more volume available within 25 BPS of the best ask price in comparison to the thinner market -25 BPS below the best bid.

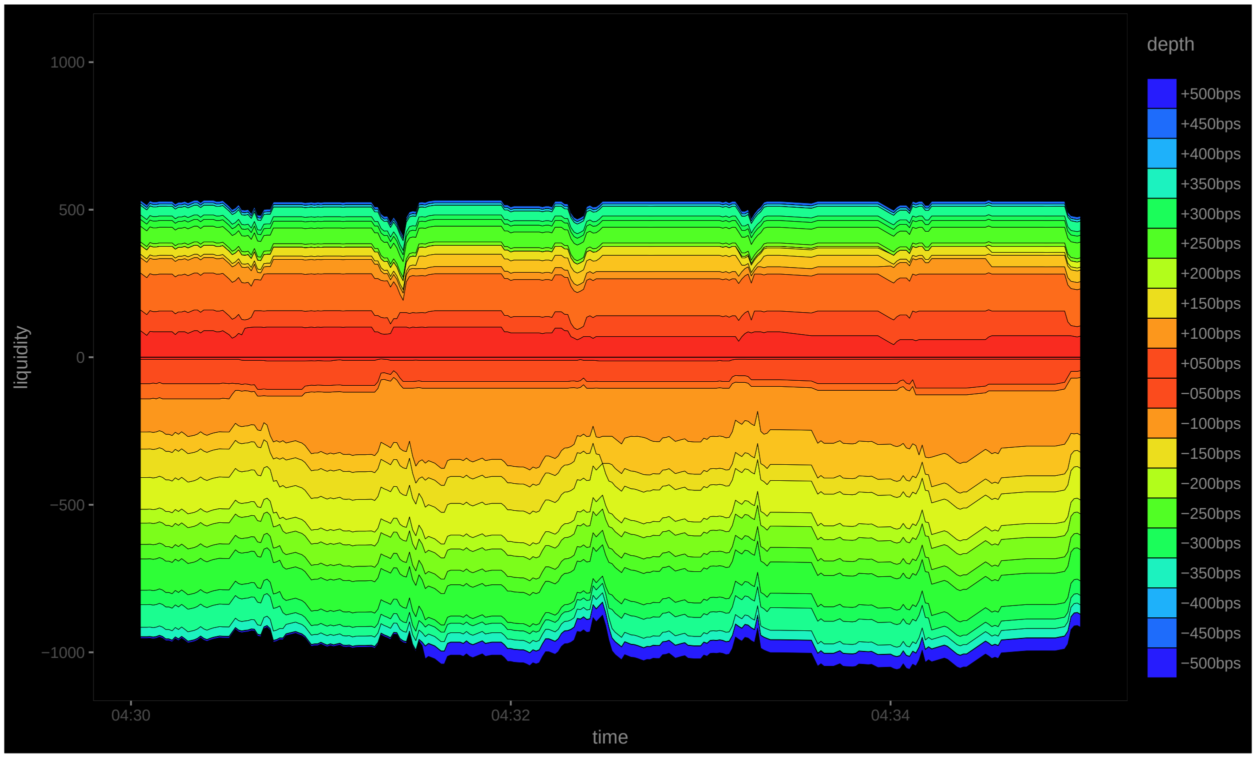
The top of the graph depicts the ask side of the book, whilst the bottom depicts the bid side. Percentiles and order book sides can be separated by an optional subtle line (*perc.line*) for improved legibility.

```
plotVolumePercentiles(lob.data$depth.summary, volume.scale=10^-8, perc.line=F,
    start.time=as.POSIXct("2015-05-01 01:00:00.000", tz="UTC"),
    end.time=as.POSIXct("2015-05-01 04:00:00.000", tz="UTC"))
```



Zooming in to a 5 minute window and enabling the percentile borders with (*perc.line=FALSE*), the amount of volume available at each 25 bps price level is exemplified.

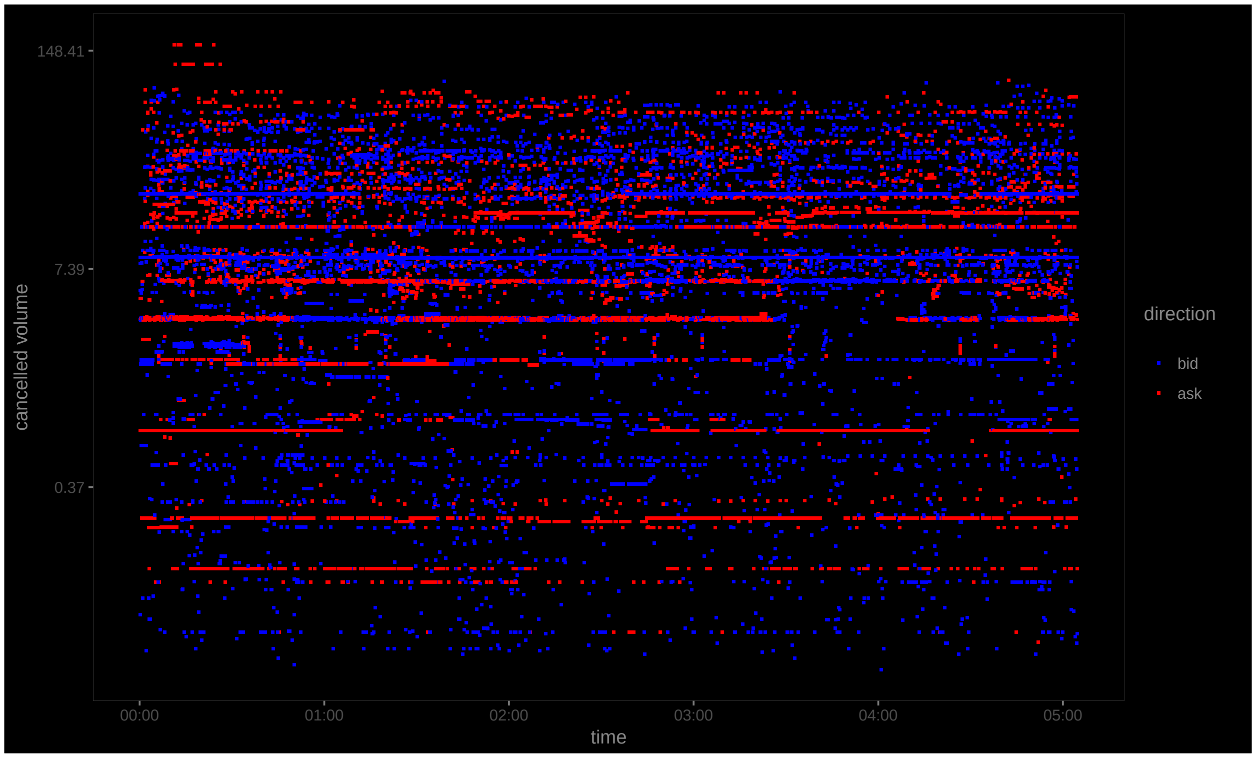
```
# visualise 5 minutes of order book liquidity.
# data will be aggregated to second-by-second resolution.
plotVolumePercentiles(lob.data$depth.summary,
    start.time=as.POSIXct("2015-05-01 04:30:00.000", tz="UTC"),
    end.time=as.POSIXct("2015-05-01 04:35:00.000", tz="UTC"),
    volume.scale=10^-8)
```



Order cancellations

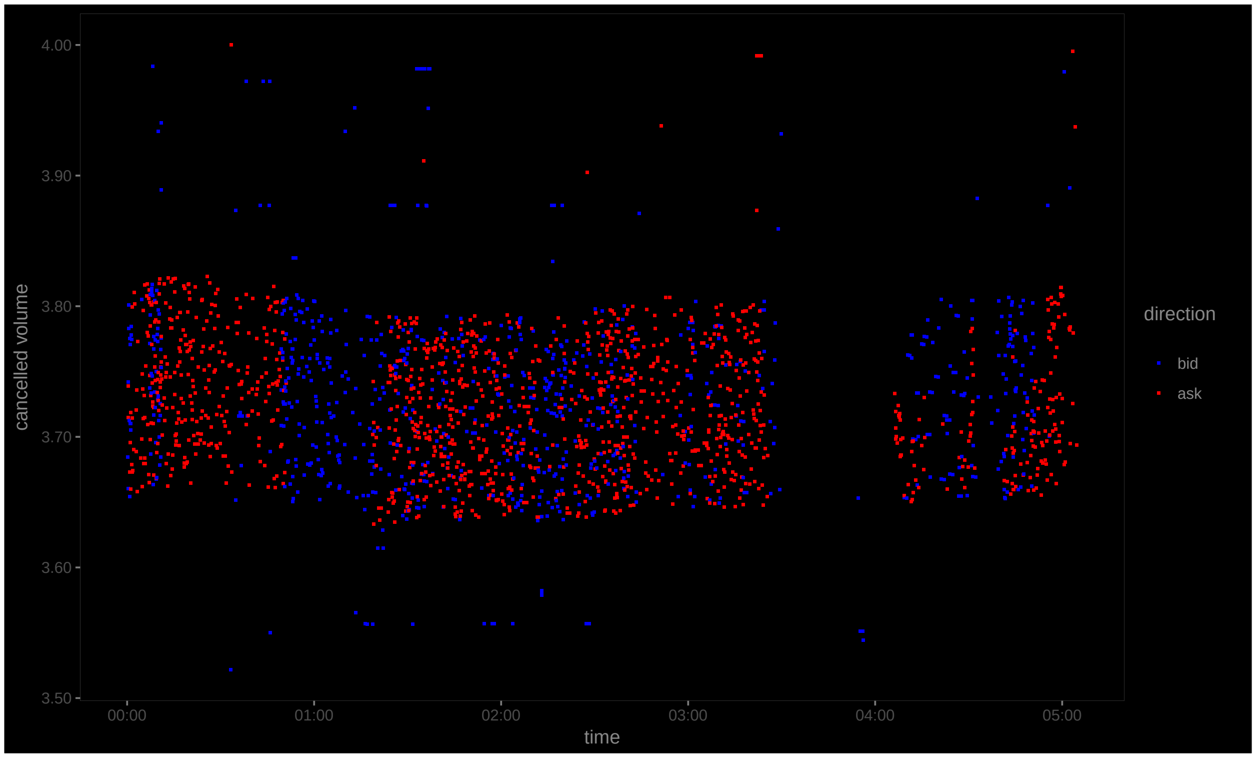
Visualising limit order cancellations can provide insights into order placement processes. The *plotVolumeMap()* function generates a visualisation of limit order cancellation events (excluding market and market limit orders).

```
plotVolumeMap(lob.data$events, volume.scale=10^-8, log.scale = T)
```



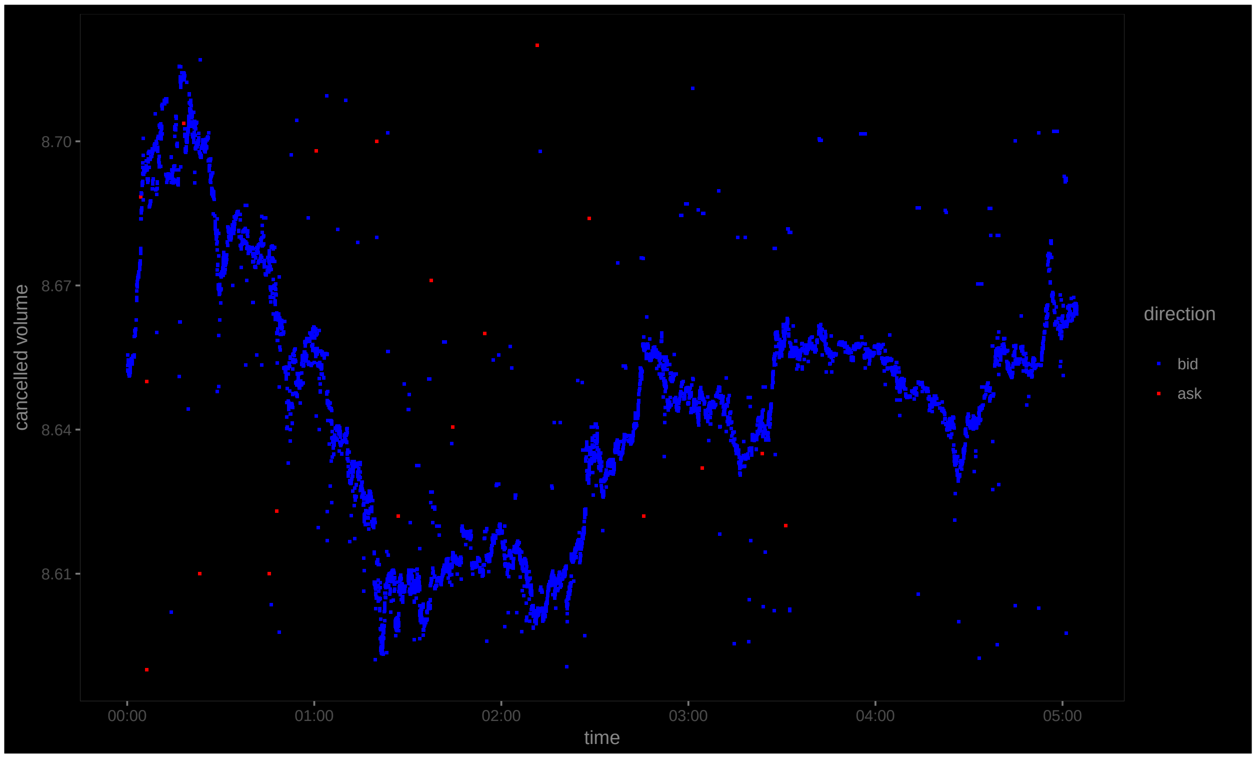
Interestingly, the order cancellation visualisation shows the systematic activity of individual market participants. By filtering the display of cancellation events within a volume range, it is possible to isolate what are most likely individual order placement strategies. The following graph shows an individual strategy cancelling orders within the [3.5, 4] volume range.

```
plotVolumeMap(lob.data$events, volume.scale=10^-8, volume.from=3.5, volume.to=4)
```



Restricting the volume between [8.59, 8.72] shows a strategy placing orders at a fixed price at a fixed distance below the market price.

```
plotVolumeMap(lob.data$events, volume.scale=10^-8, volume.from=8.59,
    volume.to=8.72)
```



Analysis

In addition to the visualisation functionality of the package, *obAnalytics* can also be used to study market event, trade and order book data.

Order book reconstruction

After loading and processing data, it is possible to reconstruct the limit order book for any given point in time. The next example shows the order book at a specific time (millisecond precision) limited to 10 price levels. The *liquidity* column shows the cumulative sum of volume from the best bid/ask up until each price level row.

```
tp <- as.POSIXct("2015-05-01 04:25:15.342", tz="UTC")
ob <- orderBook(lob.data$events, max.levels=10)
print(ob)
```

id	timestamp	liquidity	price	price	liquidity	timestamp	id
65619912	2015-05-01 05:03:13.566	0.16	235.45	235.71	3.91	2015-05-01 05:04:16.670	65620105
65620122	2015-05-01 05:04:26.395	1.10	235.12	235.71	7.70	2015-05-01 05:04:42.957	65620140
65620109	2015-05-01 05:04:18.993	2.03	235.10	235.72	7.91	2015-05-01 05:01:00.940	65619914
65618028	2015-05-01 05:00:08.424	4.57	235.01	235.80	21.11	2015-05-01 05:04:17.834	65620107
65619358	2015-05-01 04:54:21.109	4.67	234.95	235.81	34.31	2015-05-01 05:03:45.456	65620086
65598930	2015-05-01 00:39:56.799	4.80	234.92	235.84	50.29	2015-05-01 05:04:41.296	65620138
65620023	2015-05-01 05:02:33.711	5.88	234.74	235.85	73.11	2015-05-01 05:04:19.535	65620112
65620062	2015-05-01 05:03:28.263	16.86	234.73	235.87	79.90	2015-05-01 04:55:25.319	65619475
65619669	2015-05-01 04:57:31.676	23.99	234.72	235.90	79.94	2015-05-01 04:58:04.466	65619719
65597424	2015-05-01 00:23:05.230	28.36	234.54	236.05	86.75	2015-05-01 04:55:15.408	65619449

Market impacts

Using the *trades* and *events* data, it is possible to study market impact events.

All market impacts

The *tradeImpacts()* function groups individual trade events into market impact events. A market impact occurs when an order consumes 1 or more resting orders from the limit order book.

The following example shows the top 10 most aggressive sell impacts in terms of the *depth* removed from the order book in terms of BPS. The VWAP column indicates the volume weighted average price that the market *taker* received for their market order. In addition, the *hits* column shows the number of *hit* resting limit orders used to fulfil this market order.

```
impacts <- tradeImpacts(lob.data$trades)
impacts <- impacts[impacts$dir == "sell", ]
bps <- 10000 * (impacts$max.price - impacts$min.price) / impacts$max.price
types <- with(lob.data, events[match(impacts$id, events$id), ]$type)
impacts <- cbind(impacts, type=types, bps)
head(impacts[order(-impacts$bps), ], 10)
```

id	max.price	min.price	vwap	hits	vol	end.time	type	bps
65596324	235.09	234.20	234.33	8	37.13	2015-05-01 00:11:01.864	market	37.86
65619862	235.77	235.01	235.54	3	0.40	2015-05-01 05:00:08.424	market	32.23
65605893	236.96	236.20	236.27	5	8.61	2015-05-01 01:58:18.963	pacman	32.07
65619442	235.74	235.06	235.18	13	19.27	2015-05-01 04:55:13.891	market	28.85
65596235	235.22	234.55	234.85	2	0.25	2015-05-01 00:10:17.921	pacman	28.48
65608339	237.09	236.48	236.61	7	17.25	2015-05-01 02:26:54.539	market	25.73
65610618	236.27	235.75	235.77	6	31.21	2015-05-01 02:51:13.180	market-limit	22.01
65605081	237.23	236.81	237.06	2	0.05	2015-05-01 01:47:12.365	market	17.70
65596651	234.96	234.56	234.74	2	0.25	2015-05-01 00:15:10.098	market	17.02
65596775	234.57	234.19	234.35	5	29.53	2015-05-01 00:16:33.253	pacman	16.20

Individual impact

The main purpose of the package is to load limit order, quote and trade data for arbitrary analysis. It is possible, for example, to examine an individual market impact event. The following code shows the sequence of events as a single market (sell) order is filled.

The *maker.agg* column shows how far each limit order was above or below the best bid when it was placed. The *age* column, shows how long the order was resting in the order book before it was hit by this market order.

```r
impact <- with(lob.data, trades[trades$taker == 65596324,
    c("timestamp", "price", "volume", "maker")])
makers <- with(lob.data, events[match(impact$maker, events$id), ])
makers <- makers[makers$action == "created",
    c("id", "timestamp", "aggressiveness.bps")]
impact <- cbind(impact, maker=makers[match(impact$maker, makers$id),
    c("timestamp", "aggressiveness.bps")])
age <- impact$timestamp - impact$maker.timestamp
impact <-  cbind(impact[!is.na(age), c("timestamp", "price", "volume",
    "maker.aggressiveness.bps")], age[!is.na(age)])
colnames(impact) <- c("timestamp", "price", "volume", "maker.agg", "age")
impact$volume <- impact$volume*10^-8
print(impact)
```

timestamp	price	volume	maker.agg	age
2015-05-01 00:11:01.533	235.09	0.21	16.62	0.891 secs
2015-05-01 00:11:01.563	234.70	1.00	5.54	3.331 secs
2015-05-01 00:11:01.592	234.70	1.03	0.00	1.094 secs
2015-05-01 00:11:01.657	234.42	3.81	-11.93	1.321 secs
2015-05-01 00:11:01.720	234.37	9.02	-13.64	6.730 secs
2015-05-01 00:11:01.786	234.35	3.68	-14.49	6.128 secs
2015-05-01 00:11:01.864	234.20	16.38	-20.88	5.552 secs