Module 3 - Limit Order Book

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Order Types

A trading exchange may supports a variety of order types to cater for different execution needs and degree of sophistication:

- Market order
- Limit order
- Stop-loss order
- Take-profit order
- Non-display orders (iceberg, hidden, peg etc.)
- Auction orders
- Execution algorithms - TWAP, VWAP, Iceberg

Central Limit Order Book

- Market makers provide liquidity by limit orders
  - Bids: Limit orders to buy at lower prices
  - Offers: Limit orders to sell at higher prices (aka ask prices)
- Takers consume liquidity by market orders (or aggressive limit):
  - “Lift offers”: Buy at higher ask prices
  - “Hit bids”: Sell at lower bid prices

Bids			Offers	
Bid Size	**Bid Price**	1.5	**Ask Price**	**Ask Size**
100	20.00		21.50	110
150	19.00		22.00	200
160	18.00		23.00	300

Characteristics of a Limit Order Book

In a continuous markets, where buyers and sellers continuously submits limit and market orders to the LOB to execute their trades, a book snapshot displays the following characteristics:

- Bids side (buy limits orders) is arranged in decreasing price order
- Asks side (sell limits orders) is arranged in increasing price order
- Top-of-book refers to highest bid and lowest offer, the delta is known as “bid/ask spread”
- Each price level shows a different size, changing with time
- The size may only reflects a subset of orders present in the LOB, some are hidden
- There is a fixed increment on price and size changes
- A common matching algorithm between buy and sell orders is based on price-time priority

Price and Size Ticks

- Price tick (or tick size) is the minimum price increment on the limit order book.
- Limit orders are positioned on a price grid to form a book, where the distance between two consecutive prices on the grid is at least one tick size.
- A common way to measure cost of trading is to look at the bid-ask spread; this is one cost of trading when trader makes a quick round of buy and sell transactions without delay.
- The amount of securities available to buy and sell at each price level also varies, and is an aggregate of all limit orders' sizes at that price level
- An exchange will specify a minimum trading unit/size for each security
- When trader submits an order to the exchange, the order price and size must be a multiple of price and size ticks as per product specification.

Adverse Selection Effect

- Liquidity providers place their limit orders at a specific price with the promise to trade at that price.
- These limit prices are exposed to changes in the value of an asset, where the information is only known to some informed traders.
- Informed traders can execute a market order to buy at offer immediately if he knows that the true value is higher than offer price. The larger the size of market order, the more information is included.
- For example, an informed trader may have private information not yet available to the market. Or a liquidity provider is not be able to process public information quick enough to update his price, so his limit order get picked off by a faster trader.
- Given every limit order is firmed and cannot be contingent on the size of market orders, limit orders at the top of the book are more exposed to adverse selection
- Hence limit order book has non-zero bid-ask spread even for very small orders to compensate for the adverse selection risk.

Market Impact

When a large market order is executed, multiple levels of limit prices are consumed instantaneously, leaving behind a gap at top-of-book (i.e a wide bid/ask spread) and an immediate price shift:

- Price impact is the correlation between trades and subsequent price change i.e. how bids and offers react to this trade, and trades that follow
- How long does the bid/ask spread take to revert normal value? If the spread stays wide for a long period, it is a sign of liquidity crisis.
- Does the price revert to its previous level or there is a permanent price shift?
- Market impact is another source of transaction costs, as slippage will be higher for subsequent trades during the impact time window
- From taker's perspective, market impact is the risk of moving the market because his action may result in a permanent change to price level (which will increase his overall execution price if he has more orders to fill)

Classroom exercises: week_03

- Classes and objects
- Order book model
- Hashing algorithm and signature
- Your first API order