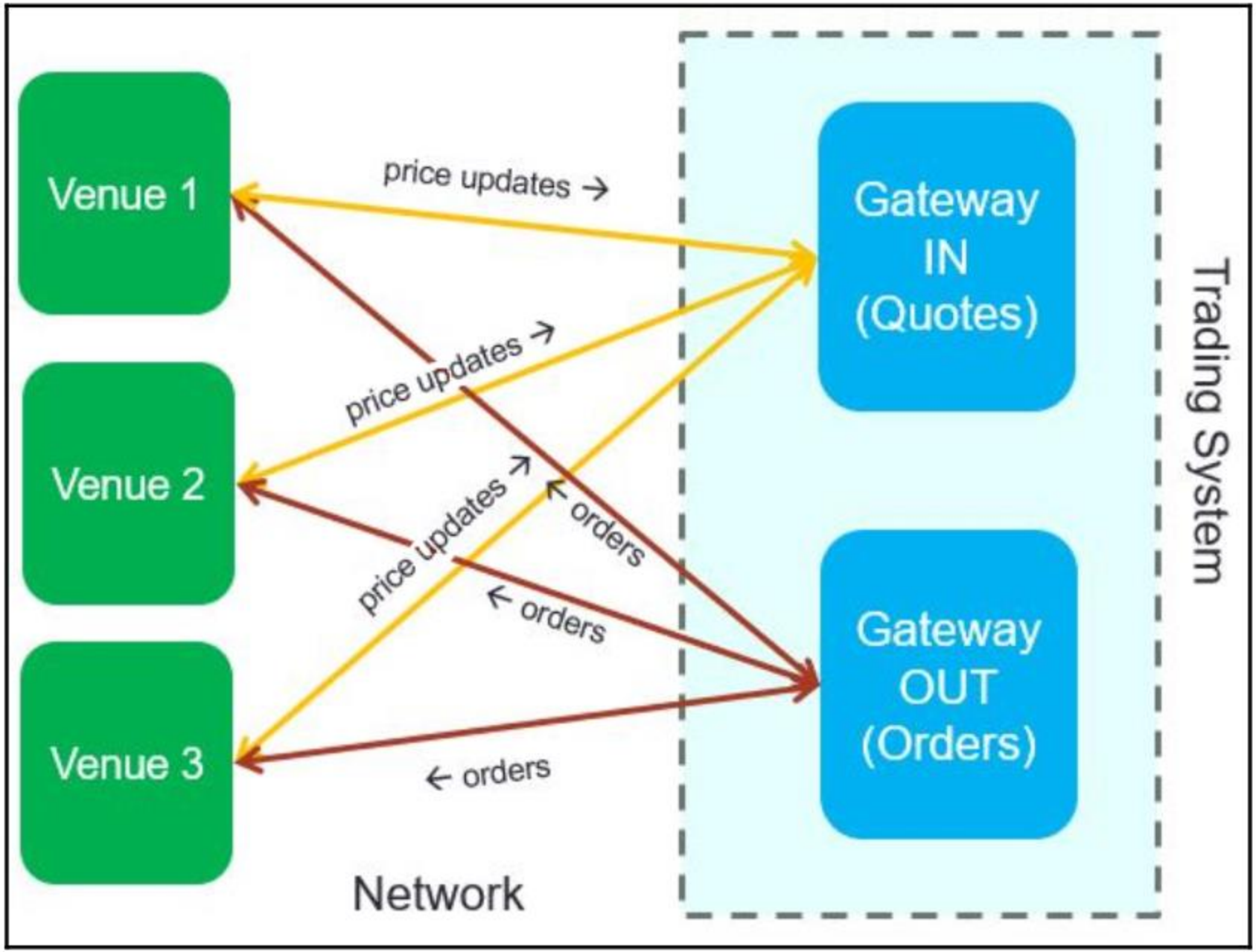
# Trading Systems

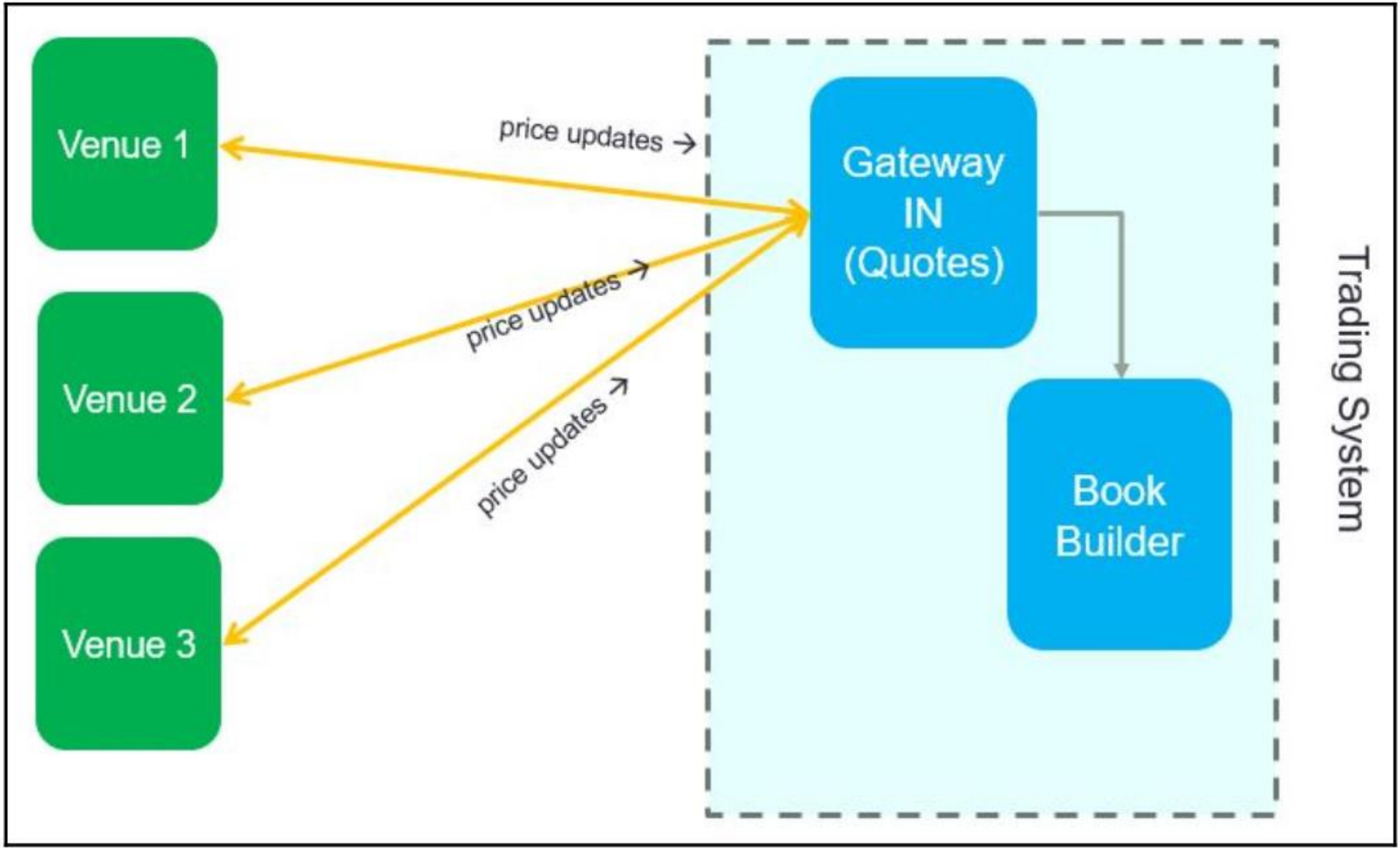
# Understanding the trading system

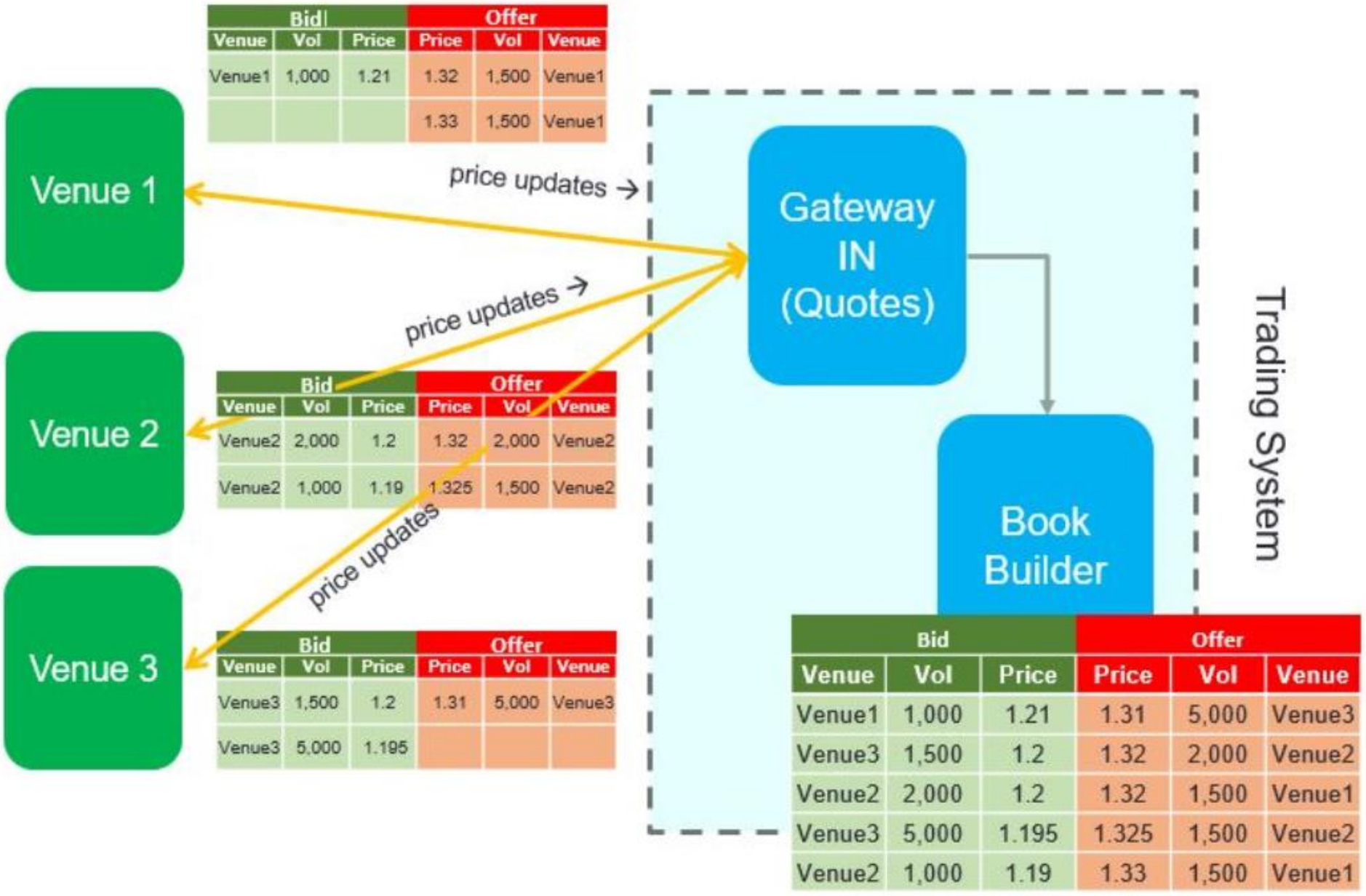
- Asset class
- Trading strategy type
  - High frequency
  - Long term
- The number of users (the number of trading strategies)

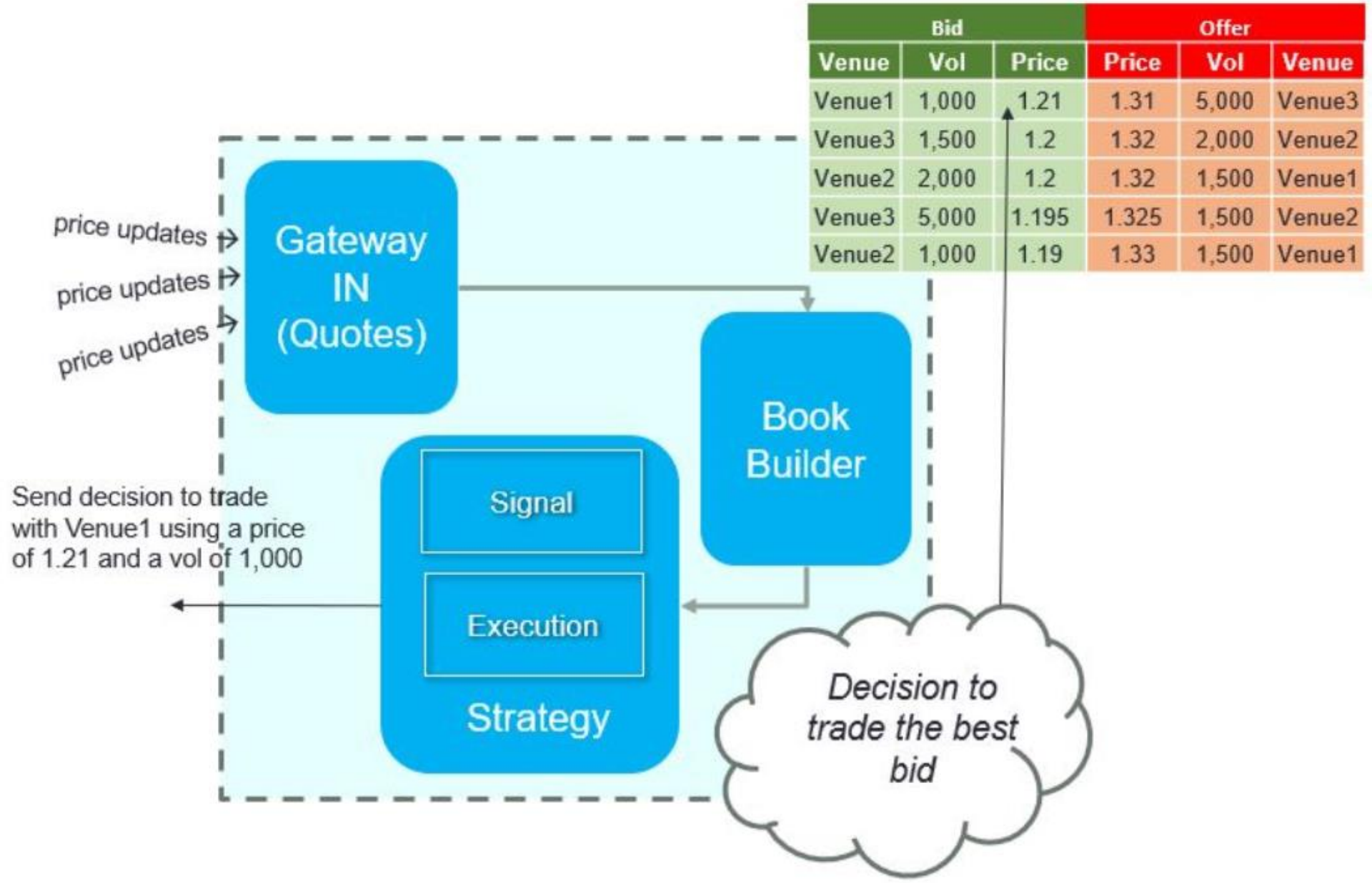
# Gateways

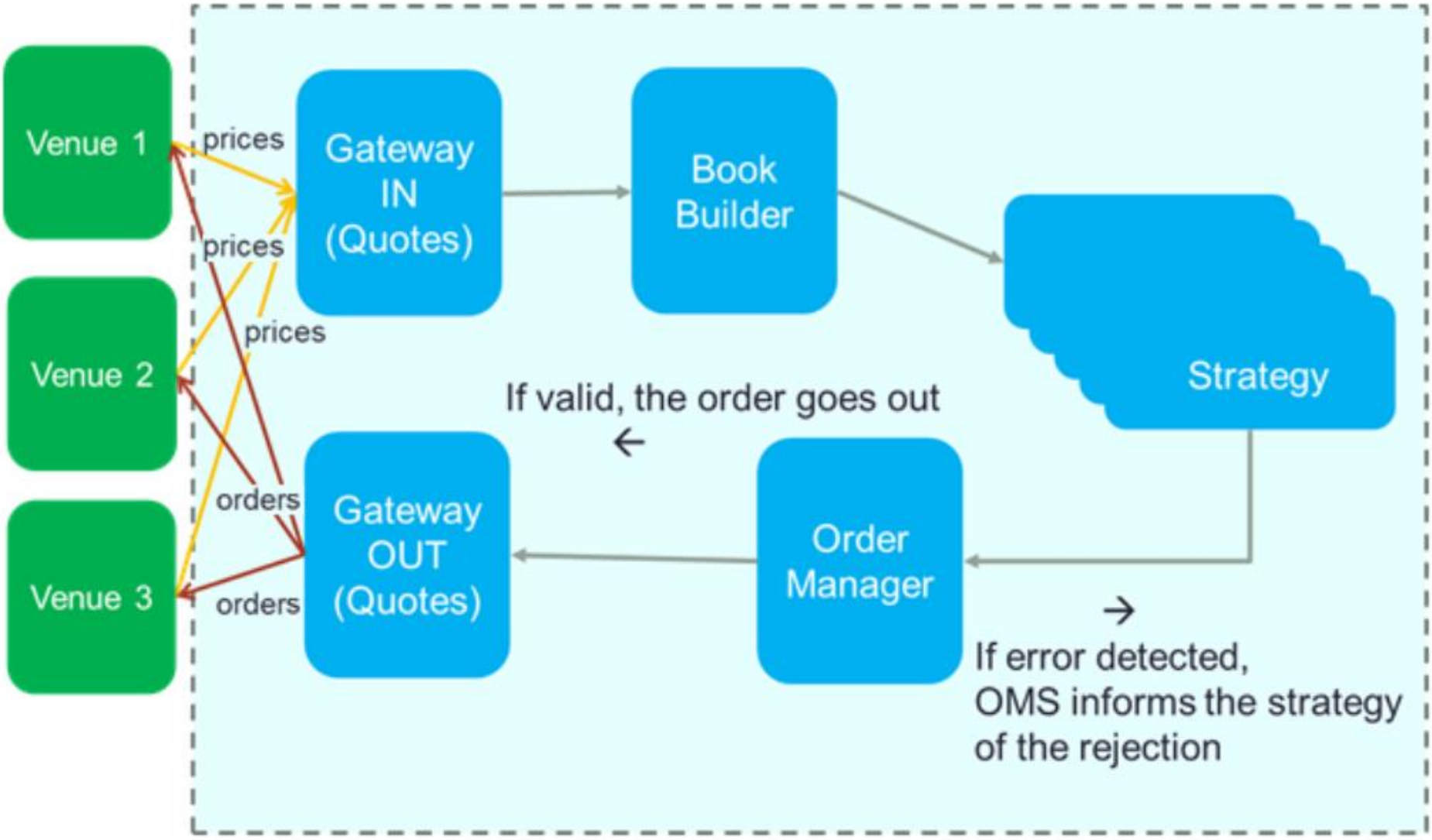
- The task of this component is to get the book for a given instrument from an exchange to the trading system. This component will be linked to the network and it will get connected to exchanges receiving and sending streams to communicate with it.

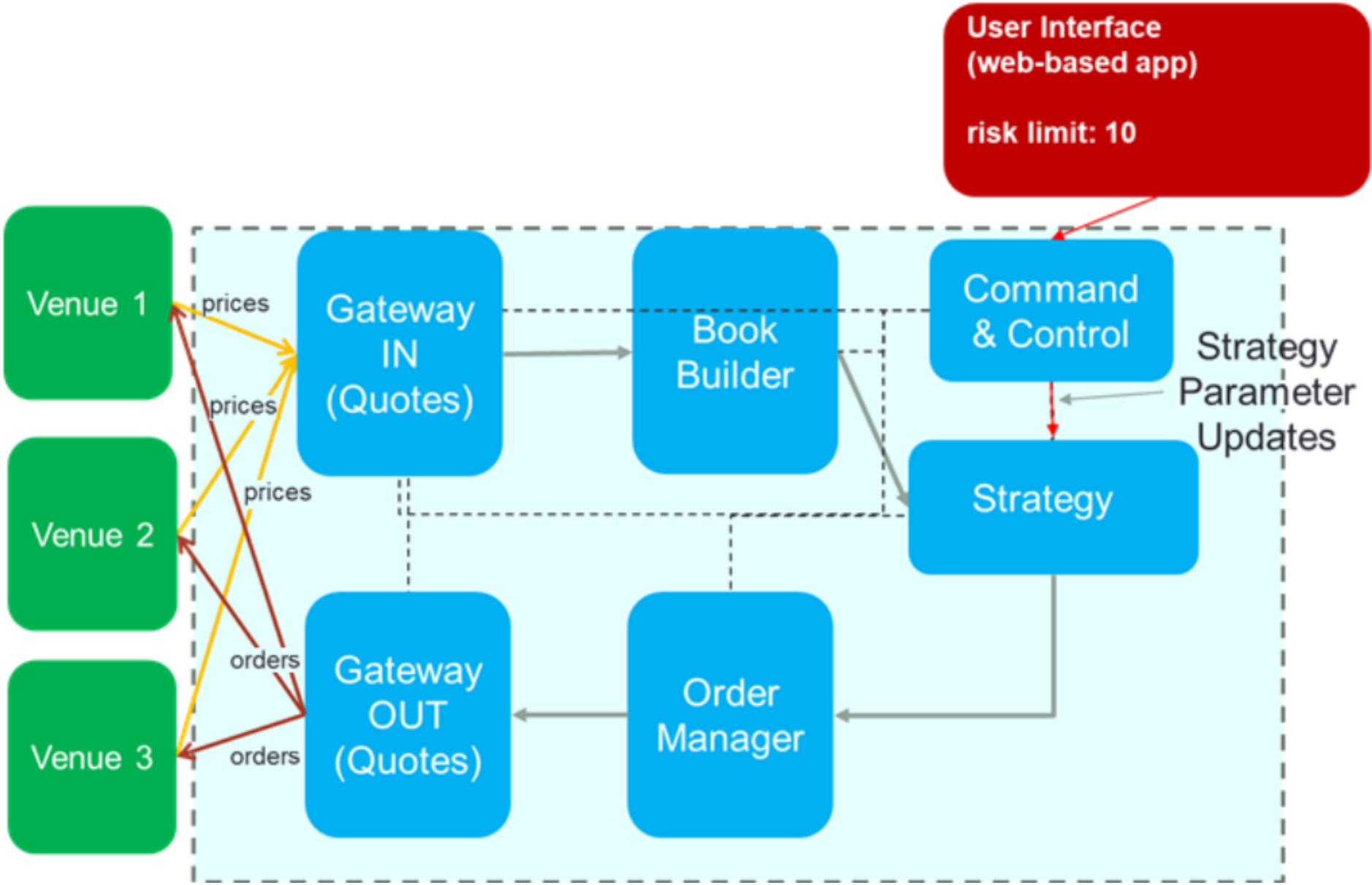

Venue 1
Venue 2
Venue 3
price updates →
price updates →
price updates →
← orders
← orders
← orders
Gateway IN (Quotes)
Gateway OUT (Orders)
Trading System
Network


Venue 1
Venue 2
Venue 3
price updates
price updates
price updates
Gateway
IN
(Quotes)
Book
Builder
Trading System

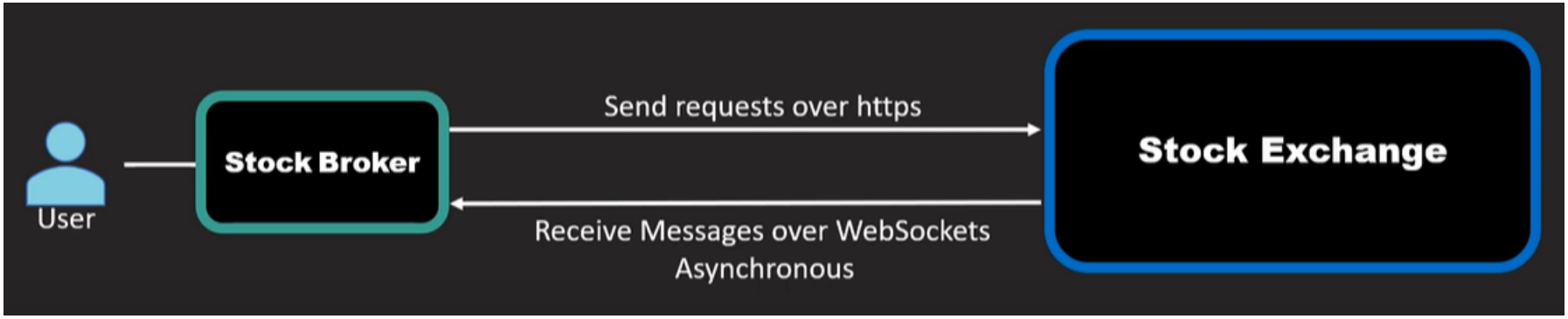

Bid
Offer
Venue
Vol
Price
Price
Vol
Venue
Venue1 1,000 1.21 1.32 1,500 Venue1
1.33 1,500 Venue1
Venue 1
price updates →
Gateway IN (Quotes)
Trading System
price updates →
Venue 2
Bid
Offer
Venue Vol Price Price Vol Venue
Venue2 2,000 1.2 1.32 2,000 Venue2
Venue2 1,000 1.19 1.325 1,500 Venue2
Book Builder
price updates
Venue 3
Bid
Offer
Venue Vol Price Price Vol Venue
Venue3 1,500 1.2 1.31 5,000 Venue3
Venue3 5,000 1.195
Bid
Offer
Venue Vol Price Price Vol Venue
Venue1 1,000 1.21 1.31 5,000 Venue3
Venue3 1,500 1.2 1.32 2,000 Venue2
Venue2 2,000 1.2 1.32 1,500 Venue1
Venue3 5,000 1.195 1.325 1,500 Venue2
Venue2 1,000 1.19 1.33 1,500 Venue1


Bid
Offer
Venue Vol Price Price Vol Venue
Venue1 1,000 1.21 1.31 5,000 Venue3
Venue3 1,500 1.2 1.32 2,000 Venue2
Venue2 2,000 1.2 1.32 1,500 Venue1
Venue3 5,000 1.195 1.325 1,500 Venue2
Venue2 1,000 1.19 1.33 1,500 Venue1
price updates
price updates
price updates
Gateway IN (Quotes)
Book Builder
Signal
Execution
Strategy
Send decision to trade with Venue1 using a price of 1.21 and a vol of 1,000
Decision to trade the best bid


Venue 1
Venue 2
Venue 3
prices
prices
prices
Gateway IN (Quotes)
Book Builder
Strategy
If valid, the order goes out
orders
orders
Gateway OUT (Quotes)
Order Manager
If error detected, OMS informs the strategy of the rejection


User Interface
(web-based app)
risk limit: 10
Venue 1
Venue 2
Venue 3
prices
prices
prices
orders
orders
Gateway
IN
(Quotes)
Book
Builder
Command
& Control
Strategy
Parameter
Updates
Strategy
Gateway
OUT
(Quotes)
Order
Manager

- CA2 task
  - Possibility of building and trading application
  - Or any module


User
Stock Broker
Send requests over https
Receive Messages over WebSockets
Asynchronous
Stock Exchange

Incoming Message for a BUY Order


```
{
        "id": “OD932A16",
        "type": "BUY",
        "brokerId": "BR319A19",
        "stock": "AMZN",
        "qty": 5,
        "price": 100
}
```

- Successful at algorithmic trading
  - understanding risk management and using good risk management practices
- Bad risk management practices can turn any good algorithmic trading strategy into a nonprofitable one.
- How to quantitatively measure and compare these risks?

# Risk and risk factors

- Risks
  - that cause money loss
  - that cause illegal/forbidden behavior in markets that cause regulatory actions

# Risk of trading losses

- we want to trade to make money, but we always run through the risk of losing money against other market participants
- Zero-sum game
  - amount that's lost by the losing participants is the amount that's gained by the winning participants

# High precision trading

- **Field Programmable Gate Arrays (FPGAs)**

As a market maker, IMC provides liquidity to buyers and sellers of financial instruments. This requires us to price every instrument we trade and to react to the market accordingly. Valuation is a view on what the price of an asset should be, which is handled by our traders and our automated pricing algorithms. When a counterpart wants to buy or sell an asset on a trading venue, our role is to always be there and offer, or bid, a fair price for the asset. FPGAs enable us to perform this key function in the most efficient way possible.

https://careers.imc.com/us/en/blogarticle/how-are-fpgas-used-in-trading

# Regulation violation risks

- Algorithmic trading strategies are not violating any regulatory rules

**Citigroup Fined €12.9M for Algorithmic Trading Violations in Germany**

Thursday, 20/06/2024 | 15:08 GMT+5.5 by Damian Chmiel

- According to BaFin, Citigroup failed to maintain proper systems and risk controls.
- It led to a market disruption caused by erroneously transmitted orders.

Retail FX citigroup


https://www.financemagnates.com/forex/citigroup-fined-129m-for-algorithmic-trading-violations-in-germany/

# Spoofing

- A bonafide order is one that is entered with the intent of trading
- Spoofing orders are entered into the market with the intent of misleading other market participants


[Northern District of Illinois | High-Frequency Trader Sentenced to Three Years in Prison for Disrupting Futures Market in First Federal Prosecution of "Spoofing" | United States Department of Justice]

https://groww.in/blog/sebi-new-rule-to-discourage-spoofing-by-traders

# Software implementation risk

- Computer software is designed, developed, and tested by humans who are error-prone and sometimes, these errors creep into trading systems and algorithmic trading strategies.
- Software implementation bugs are often the most overlooked source of risk in algorithmic trading.
- While operation risk and market risk are extremely important, software implementation bugs have the potential to cause millions of dollars in losses, and there have been many cases of firms going bankrupt due to software implementation bugs within minutes.

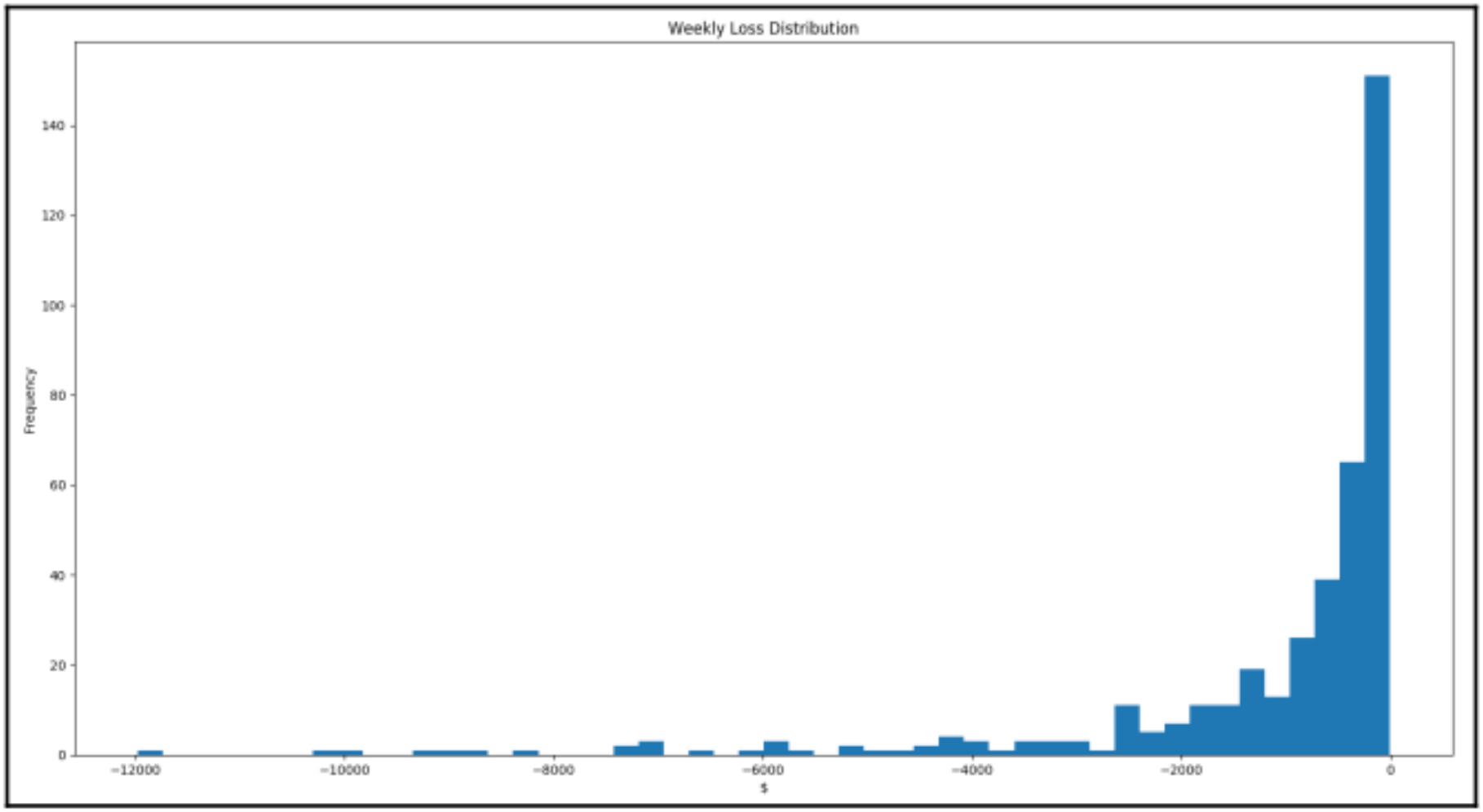
# Trading Desk, or TradeOps or DevOps

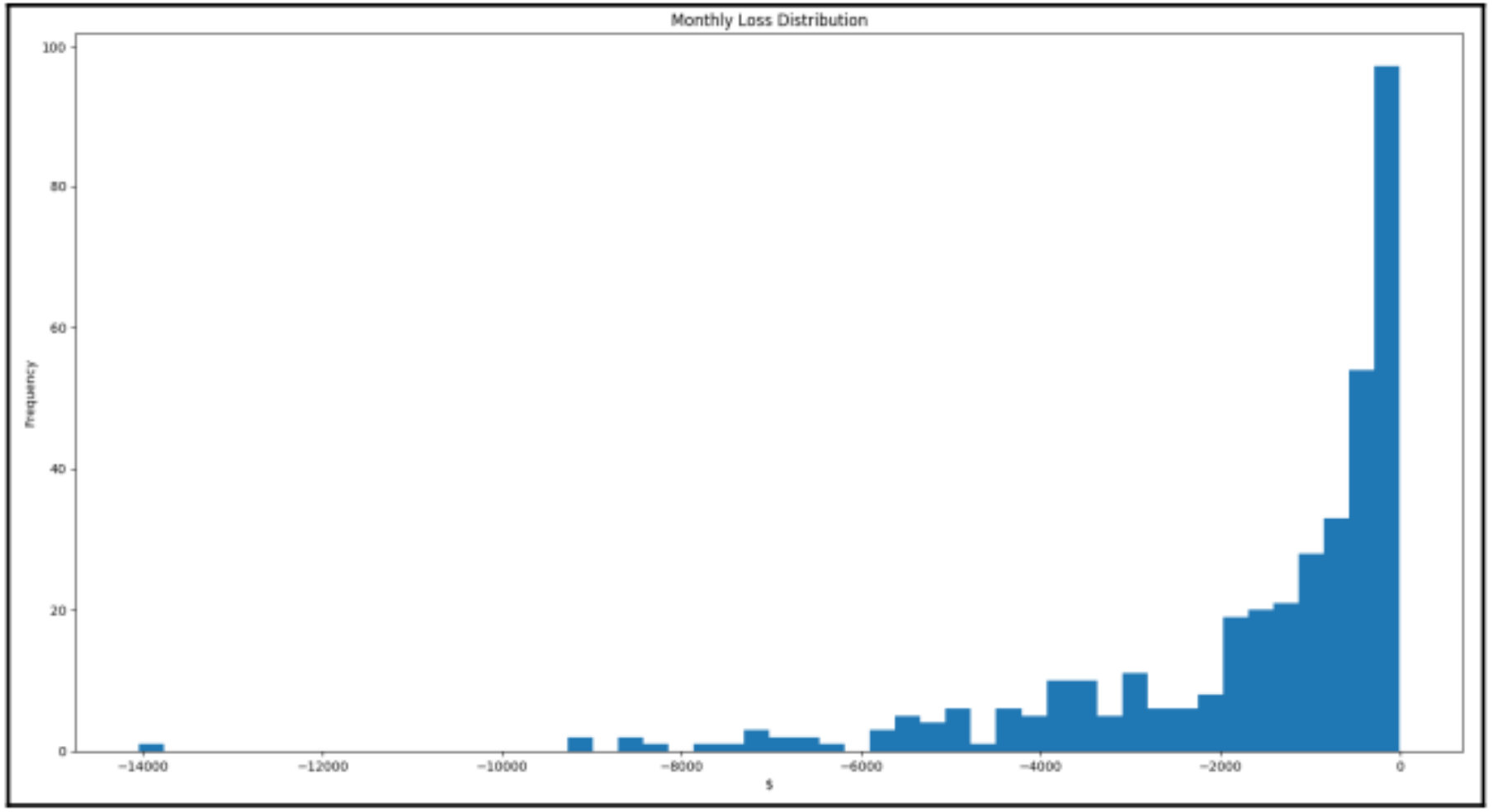
- **Staff** whose only job is to keep an eye on the automated algorithmic trading strategies that are deployed to live markets

# Quantifying the risk

- Stop loss
- This limit is the maximum amount of money a strategy is allowed to lose, that is, the minimum PnL allowed

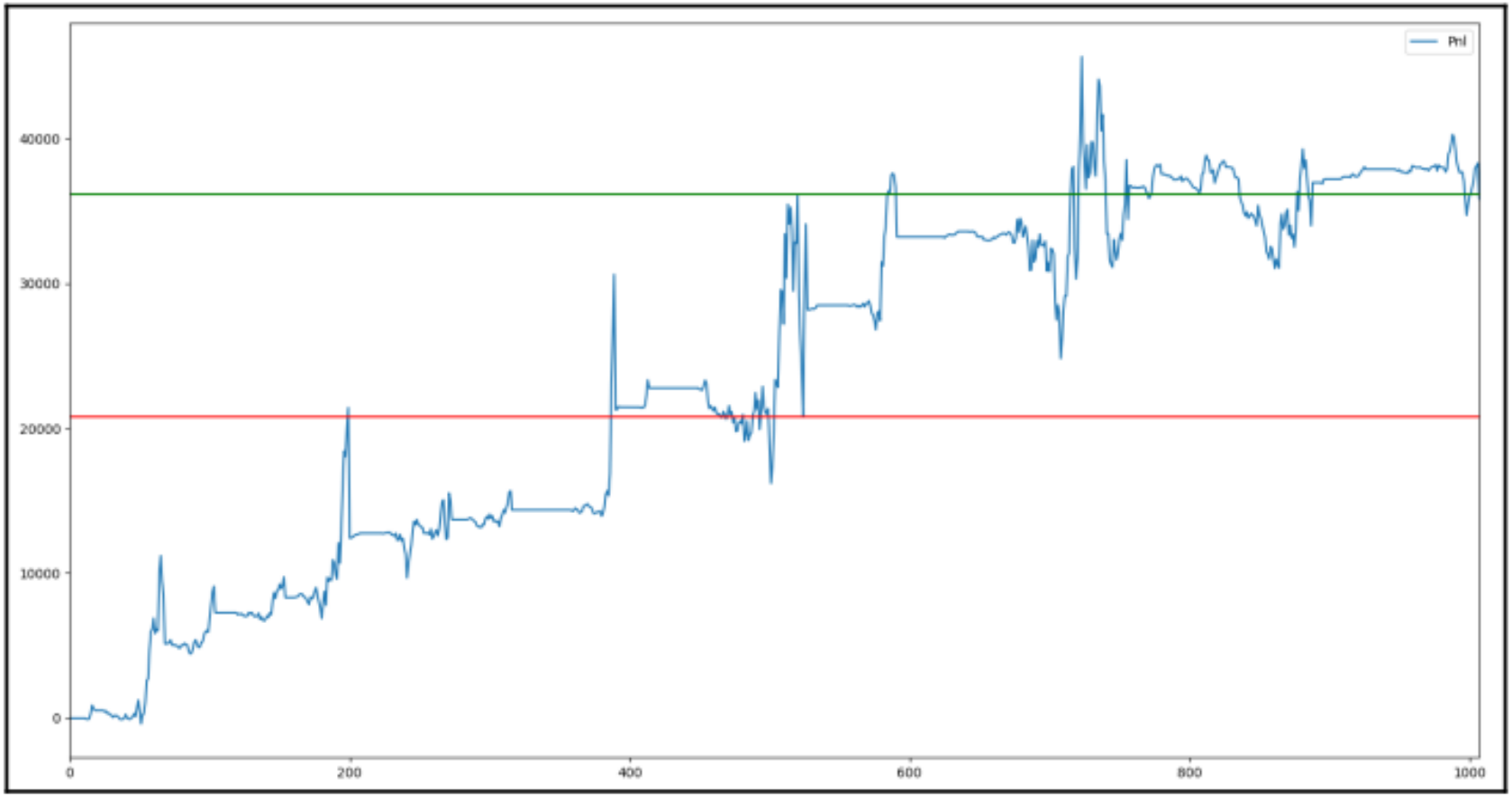
- https://onlinelibrary.wiley.com/doi/epdf/10.1155/2019/3582516
- https://link.springer.com/chapter/10.1007/978-3-031-39777-6_72


Weekly Loss Distribution
Frequency
0
20
40
60
80
100
120
140
−12000
−10000
−8000
−6000
−4000
−2000
0
$


Monthly Loss Distribution
Frequency
$
100
80
60
40
20
0
−14000
−12000
−10000
−8000
−6000
−4000
−2000
0

# Quantifying the risk

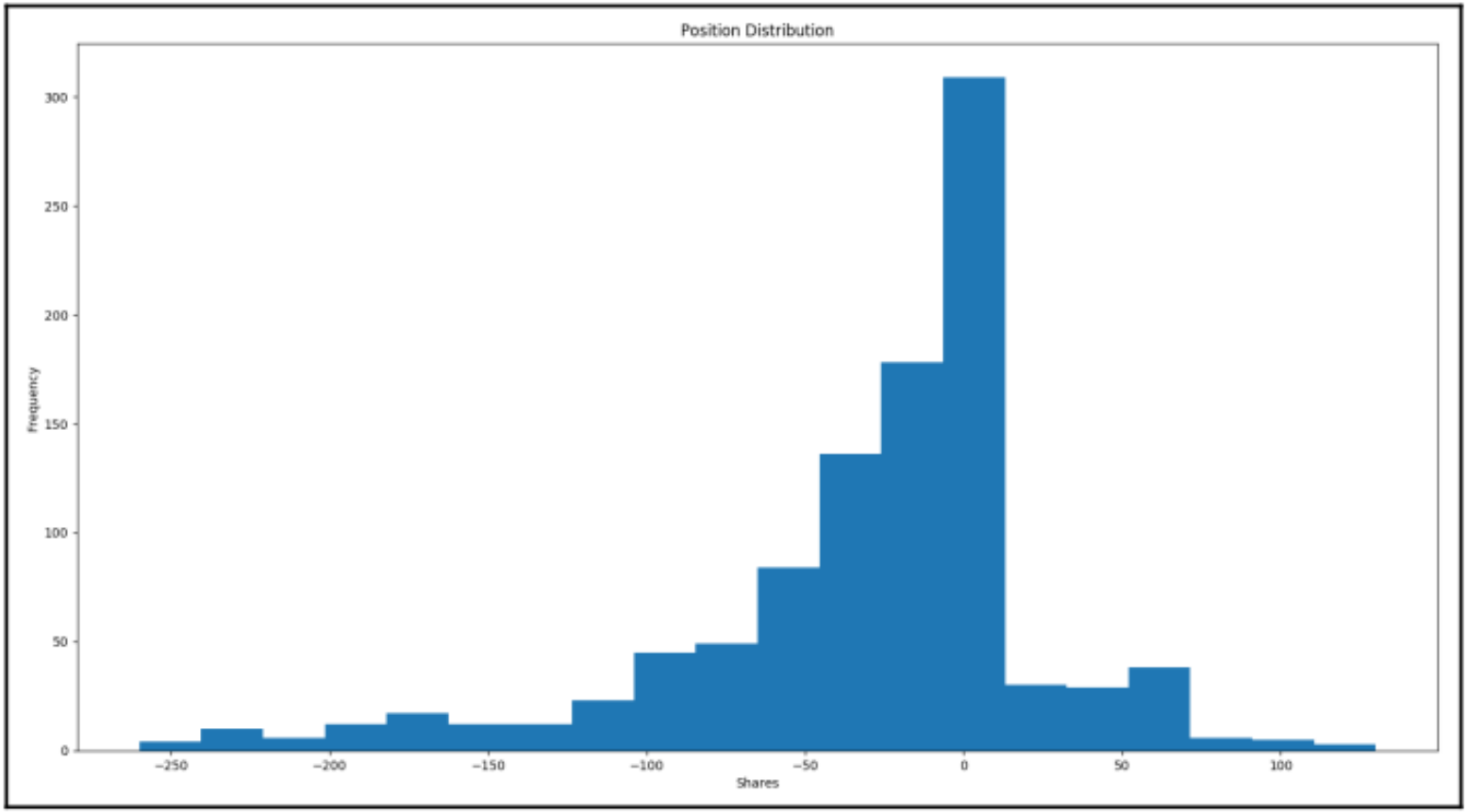
- Max drawdown is also a PnL metric, but this measures the maximum loss that a strategy can take over a series of days


Pnl
40000
30000
20000
10000
0
0
200
400
600
800
1000

# Quantifying the risk

- **Position limits**
- Position limits are also quite straightforward and intuitive to understand. It is simply the
- maximum position, long or short, that the strategy should have at any point in its trading
- lifetime.

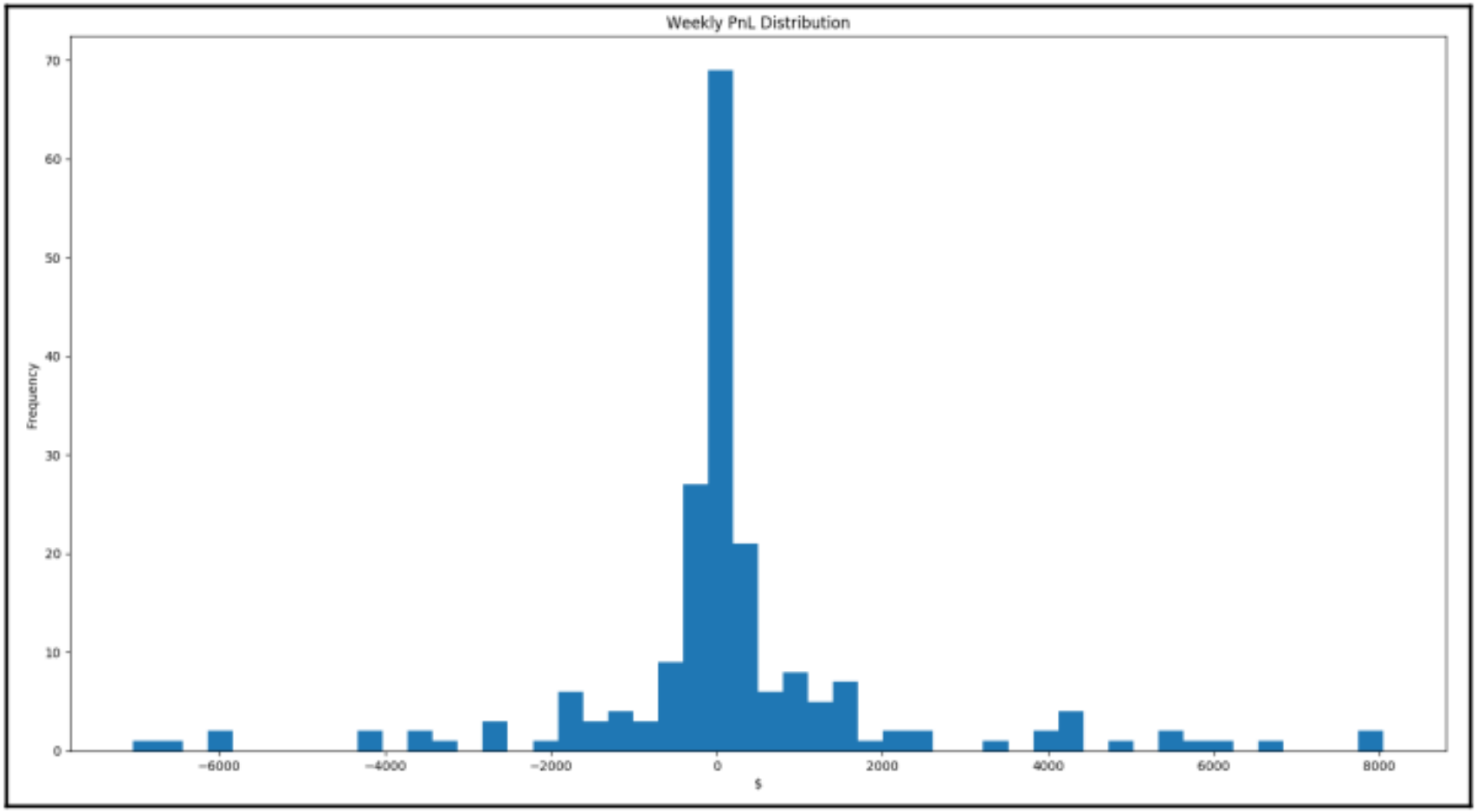
- If it gets into position levels exceeding 250, we should be careful that the trading strategy is still performing as expected



# Variance of PnLs

- We can see that the weekly PnLs are close to being normally distributed around a mean of $0, which intuitively makes sense.
- The distribution is right skewed, which yields the positive cumulative PnLs for this trading strategy.
- There are some very large profits and losses for some weeks, but they are very rare, which is also within the expectations of what the distribution should look like.

- Weekly PnL Standard Deviation: 1995.1834727008127



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- CA-2
- Suggested problem statement
- Making a risk management algorithm