Crypto Trading System

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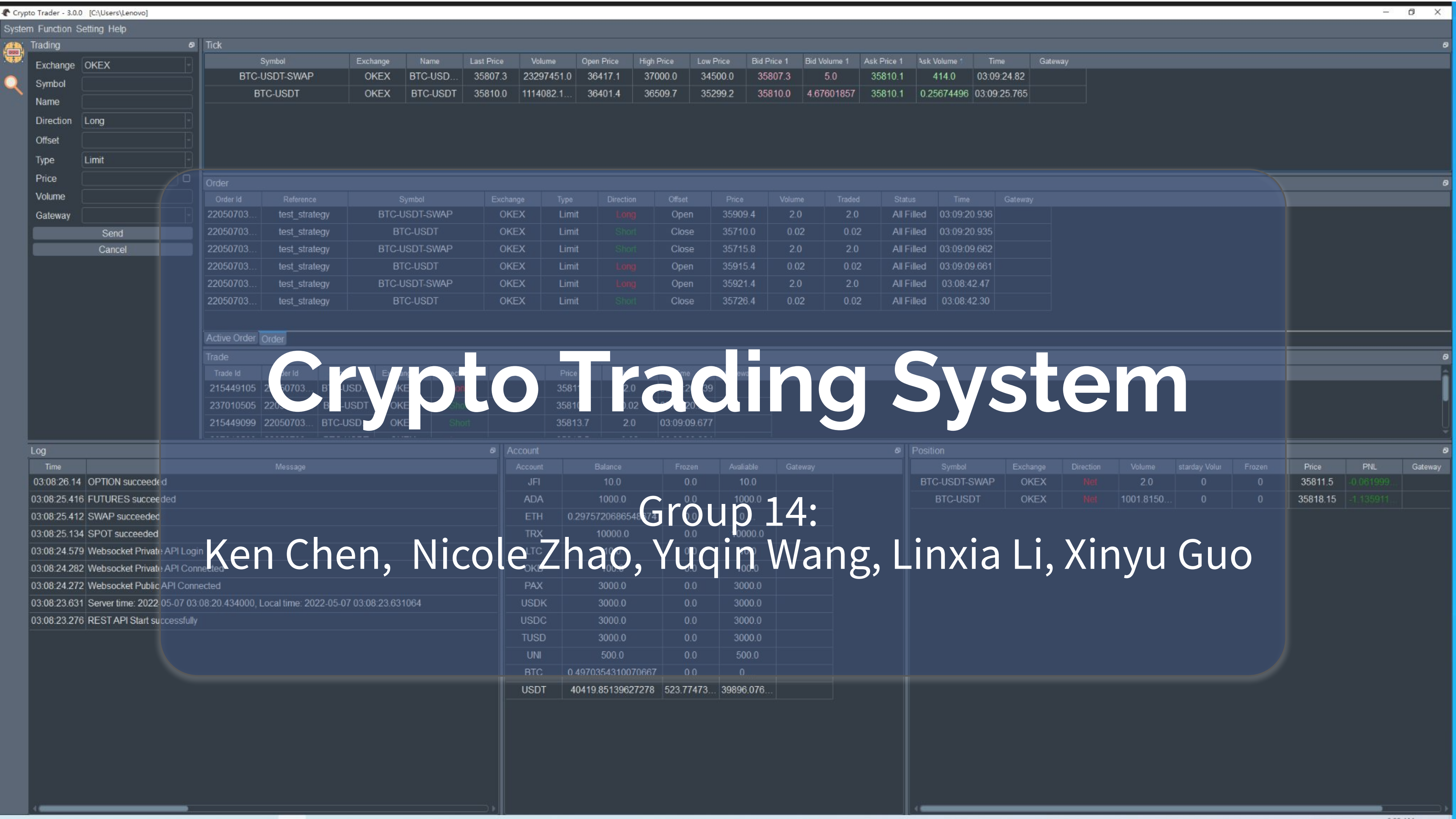

Crypto Trader - 3.0.0 [C:\Users\Lenovo]
System Function Setting Help

Trading

Exchange: OKEX
Symbol:
Name:
Direction: Long
Offset:
Type: Limit
Price:
Volume:
Gateway:

Tick

Symbol	Exchange	Name	Last Price	Volume	Open Price	High Price	Low Price	Bid Price 1	Bid Volume 1	Ask Price 1	Ask Volume 1	Time	Gateway
BTC-USDT-SWAP	OKEX	BTC-USD...	35807.3	23297451.0	36417.1	37000.0	34500.0	35807.3	5.0	35810.1	414.0	03:09:24.82	
BTC-USDT	OKEX	BTC-USDT	35810.0	1114082.1...	36401.4	36509.7	35299.2	35810.0	4.67601857	35810.1	0.25674496	03:09:25.765	

Order

Order Id	Reference	Symbol	Exchange	Type	Direction	Offset	Price	Volume	Traded	Status	Time	Gateway
22050703...	test_strategy	BTC-USDT-SWAP	OKEX	Limit	Long	Open	35909.4	2.0	2.0	All Filled	03:09:20.936	
22050703...	test_strategy	BTC-USDT	OKEX	Limit	Short	Close	35710.0	0.02	0.02	All Filled	03:09:20.935	
22050703...	test_strategy	BTC-USDT-SWAP	OKEX	Limit	Short	Close	35715.8	2.0	2.0	All Filled	03:09:09.662	
22050703...	test_strategy	BTC-USDT	OKEX	Limit	Long	Open	35915.4	0.02	0.02	All Filled	03:09:09.661	
22050703...	test_strategy	BTC-USDT-SWAP	OKEX	Limit	Long	Open	35921.4	2.0	2.0	All Filled	03:08:42.47	
22050703...	test_strategy	BTC-USDT	OKEX	Limit	Short	Close	35726.4	0.02	0.02	All Filled	03:08:42.30	

Trade

Trade Id	der Id		Exchang	ec		Price		me	ewa
215449105	2 50703...	BT USD...	OKE	on		3581	2.0	2 39	
237010505	220	B -USDT	OKE	Sho		3581	.02	20.	
215449099	22050703...	BTC-USD	OKE	Short		35813.7	2.0	03:09:09.677	

Log

```
Time          Message
03:08:26.14   OPTION succeeded
03:08:25.416  FUTURES succeeded
03:08:25.412  SWAP succeeded
03:08:25.134  SPOT succeeded
03:08:24.579  Websocket Private API Login
03:08:24.282  Websocket Private API Connected
03:08:24.272  Websocket Public API Connected
03:08:23.631  Server time: 2022-05-07 03:08:20.434000, Local time: 2022-05-07 03:08:23.631064
03:08:23.276  REST API Start successfully
```

Account

Account	Balance	Frozen	Avaliable	Gateway
JFI	10.0	0.0	10.0	
ADA	1000.0	0.0	1000.0	
ETH	0.29757206865486741	0.0	0...	
TRX	10000.0	0.0	10000.0	
LTC	10.0	0.0	10.0	
OKB	100.0	0.0	100.0	
PAX	3000.0	0.0	3000.0	
USDK	3000.0	0.0	3000.0	
USDC	3000.0	0.0	3000.0	
TUSD	3000.0	0.0	3000.0	
UNI	500.0	0.0	500.0	
BTC	0.4970354310070667	0.0	0	
USDT	40419.85139627278	523.77473...	39896.076...	

Position

Symbol	Exchange	Direction	Volume	starday Volu	Frozen	Price	PNL	Gateway
BTC-USDT-SWAP	OKEX	Net	2.0	0	0	35811.5	-0.061999...	
BTC-USDT	OKEX	Net	1001.8150...	0	0	35818.15	-1.135911...	

Crypto Market

There are 10+ liquid crypto exchanges (Binance, Coinbase, FTX, Huobi, OKX…) and hundreds of trading instruments . Cryptocurrency arbitrage strategies are based on low latency, which uses algorithmic trading to react to market events faster than the competition and increase profitability of trades.

Project Vision

We want to introduce a **real-time, low-latency** python-based trading system for **cryptocurrency arbitrage strategies**, including efficiently download historical data, record live data, train predictive model, and run model in real-time.

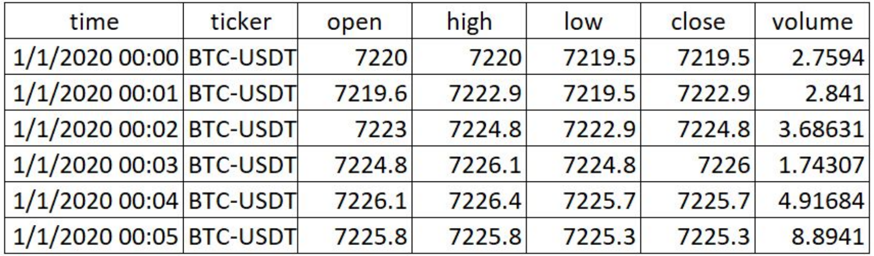
Project Achievements

- Build a crypto trading system that could be used to trade **arbitrage trading strategies** using Python.
- Connect to **OKX** crypto exchange based on REST/WebSocket API.
- Build functions such as data recording, signal/position calculation.
- Apply **predictive models** to trading strategies.
- Control the internal latency to the level of **7ms** (from receiving data to sending orders).
- Extra functions: strategy monitor UI, database management, risk management, order management

Data Collection

- **Minute bar data**

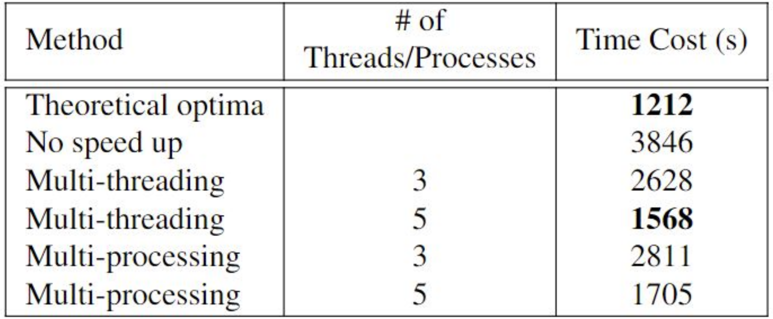
- BTC/BCH/ETH data 1/1/2020 - 4/22/2022, total 1,212,300 lines.
- Multi-threading with 5 threads improves the most with 1,568s.



time	ticker	open	high	low	close	volume
1/1/2020 00:00	BTC-USDT	7220	7220	7219.5	7219.5	2.7594
1/1/2020 00:01	BTC-USDT	7219.6	7222.9	7219.5	7222.9	2.841
1/1/2020 00:02	BTC-USDT	7223	7224.8	7222.9	7224.8	3.68631
1/1/2020 00:03	BTC-USDT	7224.8	7226.1	7224.8	7226	1.74307
1/1/2020 00:04	BTC-USDT	7226.1	7226.4	7225.7	7225.7	4.91684
1/1/2020 00:05	BTC-USDT	7225.8	7225.8	7225.3	7225.3	8.8941

- **Tick data**

- BTC/BCH/ETH's spot, futures and swap contract data 4/19/2022 - 4/22/2022, total 2,791,623 lines.
- An recorder function to register market data.
- Single thread implementation + SQLite database is used to store the live tick data.



Method	# of Threads/Processes	Time Cost (s)
Theoretical optima		**1212**
No speed up		3846
Multi-threading	3	2628
Multi-threading	5	**1568**
Multi-processing	3	2811
Multi-processing	5	1705

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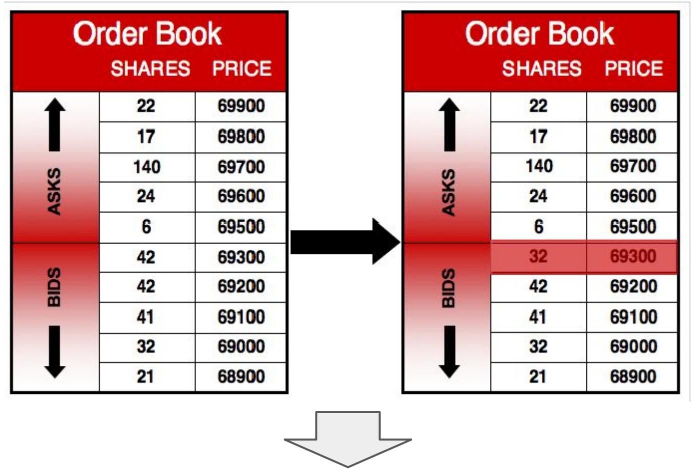
Features Selection

- **Order book:** buy and sell orders for a specific instrument organized by price level at a snapshot

$$Price\ Ratio = \frac{Mid\ Price(Spot)}{Mid\ Price(Swap)}$$

$$Order\ Imbalance\ Ratio = \frac{(bid\ volume - ask\ volume)}{(bid\ volume + ask\ volume)}$$

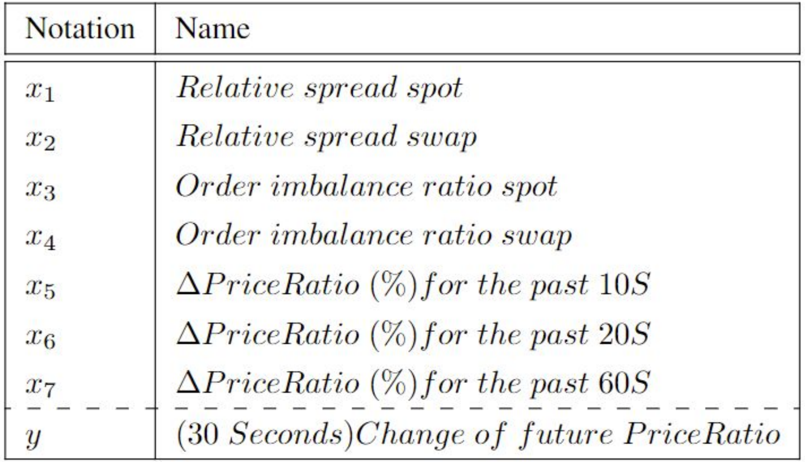


Order Book

SHARES	PRICE
22	69900
17	69800
140	69700
24	69600
6	69500
42	69300
42	69200
41	69100
32	69000
21	68900

Order Book

SHARES	PRICE
22	69900
17	69800
140	69700
24	69600
6	69500
32	69300
42	69200
41	69100
32	69000
21	68900



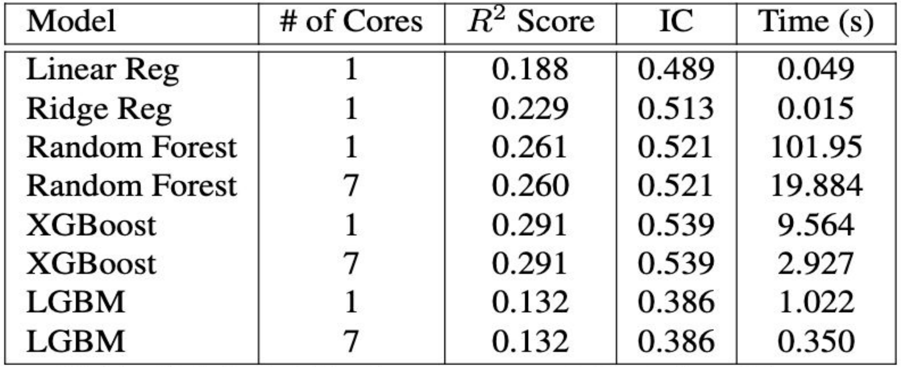
Notation	Name
x_1	$Relative\ spread\ spot$
x_2	$Relative\ spread\ swap$
x_3	$Order\ imbalance\ ratio\ spot$
x_4	$Order\ imbalance\ ratio\ swap$
x_5	$\Delta PriceRatio\ (\%) for\ the\ past\ 10S$
x_6	$\Delta PriceRatio\ (\%) for\ the\ past\ 20S$
x_7	$\Delta PriceRatio\ (\%) for\ the\ past\ 60S$
y	$(30\ Seconds) Change\ of\ future\ PriceRatio$

Model Training Result & Optimization

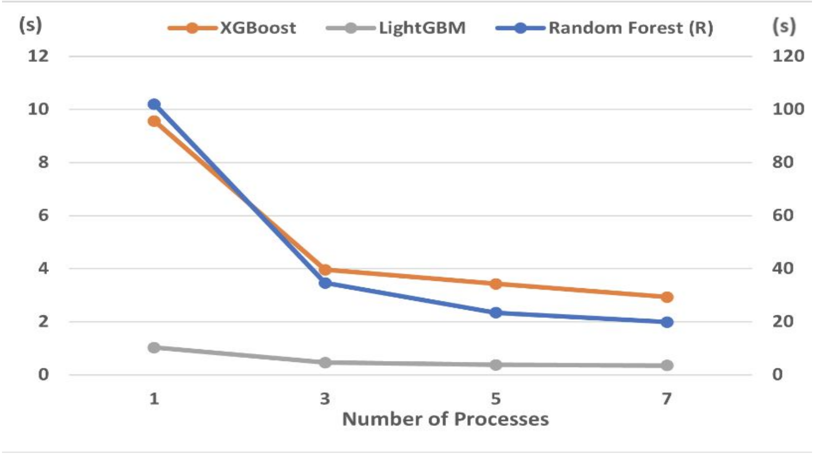
- **Evaluation**
  - R2: total price movements explained by model
  - IC: Information coefficient**,** shows how closely the analyst's financial forecasts match actual financial results; higher the better

- **Optimization Methods Implemented**
  - Multi-threading
  - Multi-processing

  From 1 core to 7 cores:
  - running speed of RF is increased by 413%
  - running speed of XGBoost is increased by 226%



Model	# of Cores	R^2 Score	IC	Time (s)
Linear Reg	1	0.188	0.489	0.049
Ridge Reg	1	0.229	0.513	0.015
Random Forest	1	0.261	0.521	101.95
Random Forest	7	0.260	0.521	19.884
XGBoost	1	0.291	0.539	9.564
XGBoost	7	0.291	0.539	2.927
LGBM	1	0.132	0.386	1.022
LGBM	7	0.132	0.386	0.350



Trading System

- **Build system**

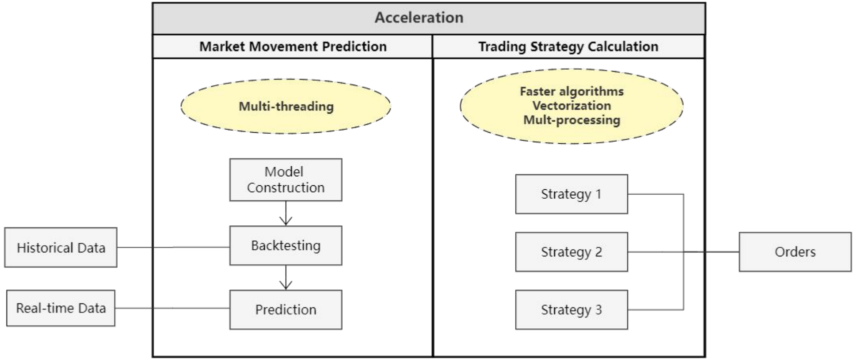
  We build our trading system based on VeighNa, a python-based open-sourced trading system used to trade Chinese futures market.

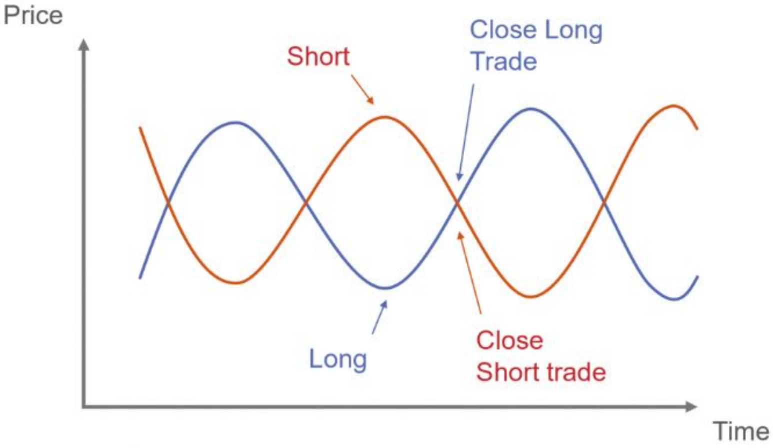
- **Add applications**

  We create our own applications including access to the OKX exchanges, data downloader, and trading strategy.

- **Load model**

  The predictive models are loaded in the trading system so we can predict the future price movements. Based on the prediction from the model (alpha), we can set a open limit parameter to decide when we will make the trades.





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Trading System Latency

- **Latency Evaluation: Tick-to-Trade**

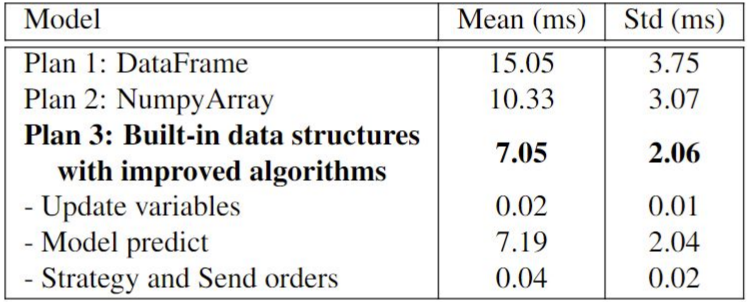
  Tick-to-Trade is the time interval between receiving a market tick data and processing the buy or sell order.

- **Implementation Plans**

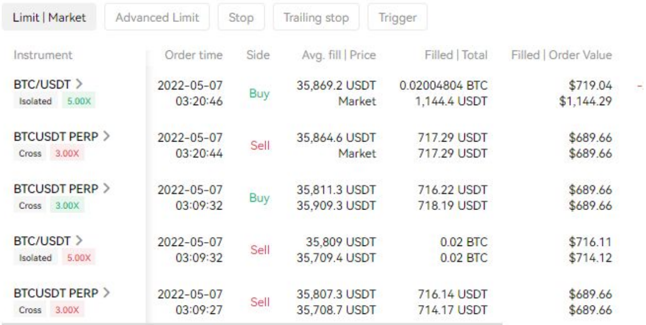
  (1) pandas DataFrame

  (2) NumPy array

  (3) Improved algorithms and built-in data structures including deque and hash-tables.

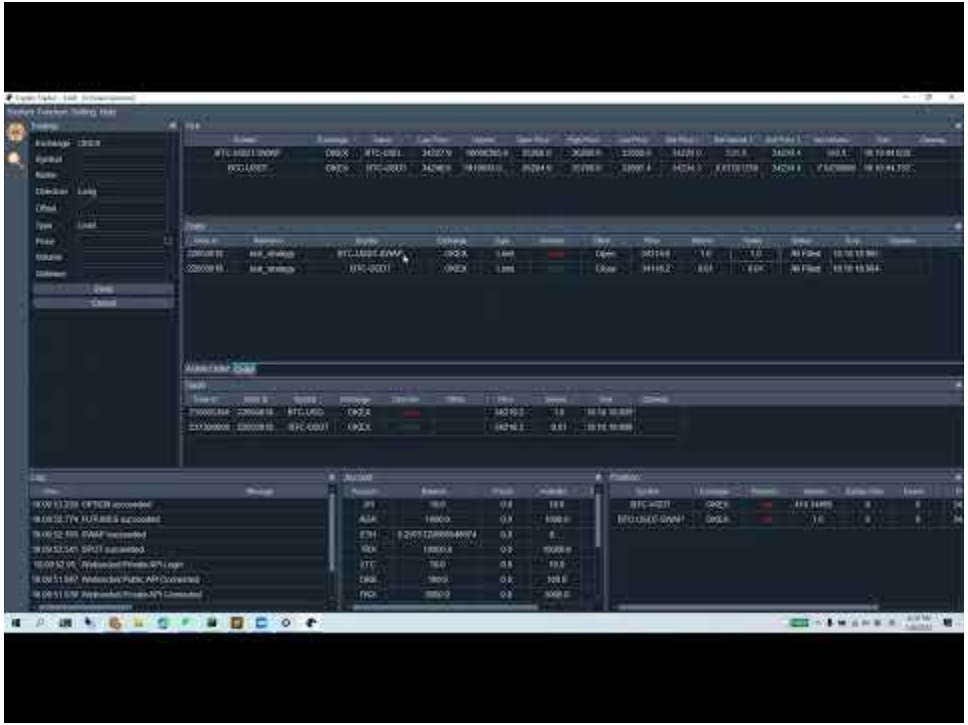


Model	Mean (ms)	Std (ms)
Plan 1: DataFrame	15.05	3.75
Plan 2: NumpyArray	10.33	3.07
Plan 3: Built-in data structures with improved algorithms	**7.05**	**2.06**
- Update variables	0.02	0.01
- Model predict	7.19	2.04
- Strategy and Send orders	0.04	0.02



Instrument	Order time	Side	Avg. fill | Price	Filled | Total	Filled | Order Value
BTC/USDT > Isolated 5.00X	2022-05-07 03:20:46	Buy	35,869.2 USDT Market	0.02004804 BTC 1,144.4 USDT	$719.04 $1,144.29
BTCUSDT PERP > Cross 3.00X	2022-05-07 03:20:44	Sell	35,864.6 USDT Market	717.29 USDT 717.29 USDT	$689.66 $689.66
BTCUSDT PERP > Cross 3.00X	2022-05-07 03:09:32	Buy	35,811.3 USDT 35,909.3 USDT	716.22 USDT 718.19 USDT	$689.66 $689.66
BTC/USDT > Isolated 5.00X	2022-05-07 03:09:32	Sell	35,809 USDT 35,709.4 USDT	0.02 BTC 0.02 BTC	$716.11 $714.12
BTCUSDT PERP > Cross 3.00X	2022-05-07 03:09:27	Sell	35,807.3 USDT 35,708.7 USDT	716.14 USDT 714.17 USDT	$689.66 $689.66

Trading System Demo



https://www.youtube.com/watch?v=MSD3RArbnnQ