TradeMaster Sandbox Whitepaper

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May 2023

1 Abstract

Implementing DRL agents to live trading markets suffers from the risk caused by the simulation-to-reality gap. To control the unseen risks, we made an evaluation sandbox that introduces diverse evaluation methods into the life cycle. The TradeMaster Sandbox evaluates QT algorithms in various paper-trading scenarios. At the end of the day, we want to conquer the sim-to-real gap for QT algorithms with the use of this sandbox.

2 Tools

2.1 Market Dynamics labeling

Market dynamics is a long study and not a well-established market feature. The market dynamics are formulated differently according to specific tasks, it can be a factor crafted manually or learned by a Hidden Markov Model (HMM). For our TradeMaster evaluation sandbox, we want to evaluate policy performance on specific market dynamics labeled automatically. We start with the most explainable formulation of market dynamics. What's more, we also understand that criteria vary with tasks and people, so we set several hyper-parameters to control the market dynamic labeling process.

Table 1: Hyper-parameters of market dynamics labeling

Name	Description
Dynamics number	Number of dynamics to label
Minimum length	Minimum length of each slice of the same dynamic
Cutoff frequency of the key indicator k	The cutoff frequency of the Butterworth filter
Cutoff frequency of percentage change of k	The cutoff frequency of the Butterworth filter
Dynamic interval	Interval used to label dynamic slices by slope

Algorithm 1 Market Dynamics Modeling

1. Calculate the percentage change (per tick) k_{pct} of the key indicator k
2. Apply low-pass Butterworth filters of cutoff frequency $Wn = Wn_{k_{pct}}$ to k_{pct} sequence and cutoff frequency $Wn = Wn_k$ to k sequence
3. Slice the filtered k sequence at the points in k_{pct} sequence where goes across zero.
4. Merge consecutive slices if the length is smaller than constraint l
5. Fit a linear regression model on each slice to get the slope
6. Label the dynamic of each slice of the original k sequence according to the interval that the slope of the corresponding filtered k sequence slice in I.

The data of different markets and tasks are heterogeneous and require hyper-parameters tuning, we provide detailed instructions in this document[1].

3 Usage

3.1 TradeMaster Library

All the evaluation tools are be integrated into the evaluation module of TradeMaster Library[2]. For now we only release the Market Dynamics Model, ongoing projects are listed in Section 4.

3.2 Website

In addition to the TradeMaster library, we also provide demos and sandbox api on our TradeMaster website[3]

4 On-going Projects and Future Plans

4.1 Market Feature Simulator

The market feature simulator uses a generative adversarial network to generate mid and low-frequency market features, for example, Open, High, Low, and Close. The generated data is controlled by given conditions, for example, market dynamics and stock tics. With this market feature simulator, we can evaluate our QT algorithms beyond historical data on specific market dynamics. This would be helpful to predict our algorithms' performance under extreme markets and avoid uncontrollable risks. Furthermore, the generated data can be used in the training phase for more robust live-market trading performance, this would enhance the generalization ability of our algorithms. Currently, we are able to generate mid and low-frequency market features with controlled market dynamics and stock ticks.

4.2 Limit Order Book Simulator

The Limit-Order-Book Simulator uses an agent-based model to simulate every activity traders take in the financial markets, including the limit order book and the trades. This simulator is an interactive paper-trading environment for RL-based QT agents to train and test in. Our simulation is a hybridization of traditional financial methods and data-driven machine learning methods. Beyond empirical agents, we incorporate learning agents in the simulator to reconstruct market behaviors based on historical data. Currently, the market simulator shows close-to-real market stylized facts. We are working on the reproduction of the market micro-structures such as the order book liquidity.

[1] https://github.com/TradeMaster-NTU/TradeMaster/blob/1.0.0/docs/source/tool/EvaluationSandbox_MDM.md
[2] https://github.com/TradeMaster-NTU/TradeMaster/tree/1.0.0/trademaster/evaluation
[3] Website: http://trademaster.ai/