FinRL-Meta: Market Environments and Benchmarks for Data-Driven Financial Reinforcement Learning

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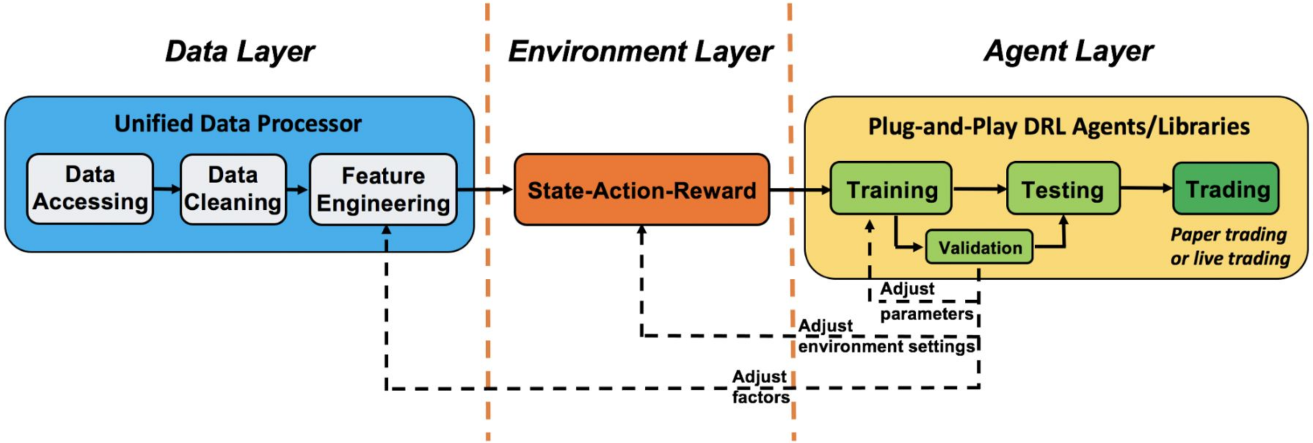
Overview

- **Finance** is a particularly difficult playground for **deep reinforcement learning (DRL)**.
- Open-source **FinRL-Meta** library:
  - Build hundreds of **market environments**.
  - **Benchmark** popular papers as stepping stones for users.
  - Tens of **demos** organized in a curriculum, with clean documentation.
- Features:
  - Layered structure
  - Extensibility.
  - “Training-testing-trading” pipeline.
  - Plug-and-play.

Layered Structure

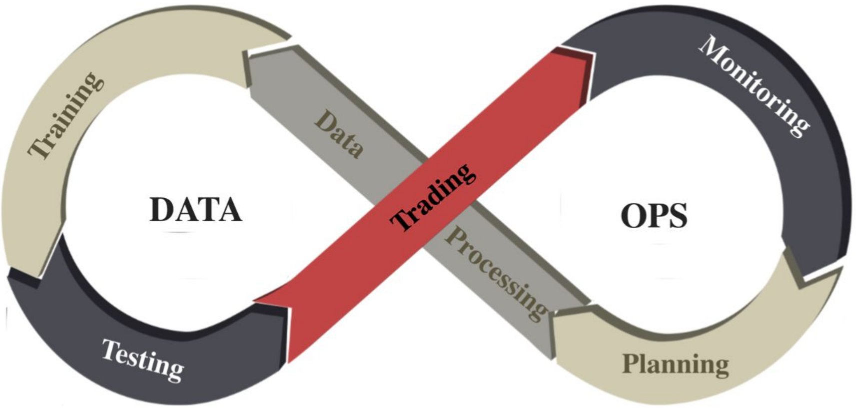
- Three layers: **data layer**, **environment layer**, and **agent layer**.
  - **Transparency**: layers interact through end-to-end interfaces
  - **Modularity**: easy extension of user-defined functions



DataOps Paradigm

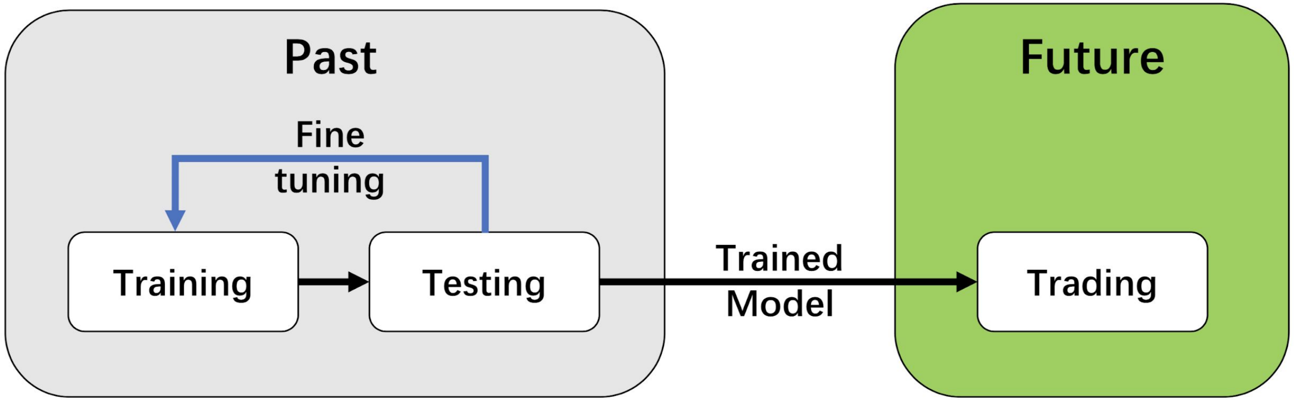
- **Automated data engineering** and **agile development**.
- Reduces the cycle time of data engineering and improves data quality.
- To deal with **financial big data**, we implement an **automatic pipeline**:
    a. Task planning
    b. Data processing
    c. Training-testing-trading
    d. Performance monitoring

We continuously produce dynamic market datasets.



Training-testing-trading Pipeline

- Training-testing-trading pipeline:
  - First, a DRL agent is **trained** in a training dataset and **fined-tuned** (adjusting hyperparameters) in a testing dataset.
  - Then, backtest the agent (on historical dataset), or deploy in a **paper/live trading** market.



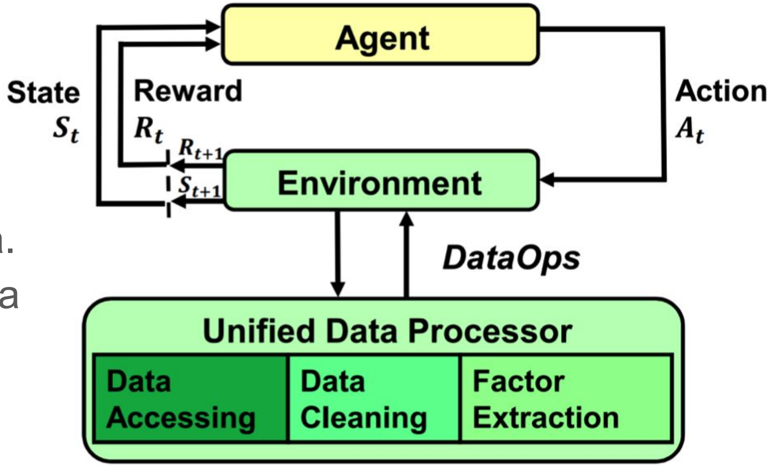
Plug-and-Play

- A DRL agent can be directly plugged in: training-testing-trading.
- Following DRL libraries are supported:
  - **ElegantRL**: Lightweight, efficient and stable DRL implementation using PyTorch.
  - **Stable-Baselines3**: Improved DRL algorithms based on OpenAI Baselines.
  - **RLlib**: An open-source DRL library that offers high scalability and unified APIs.

Data Layer

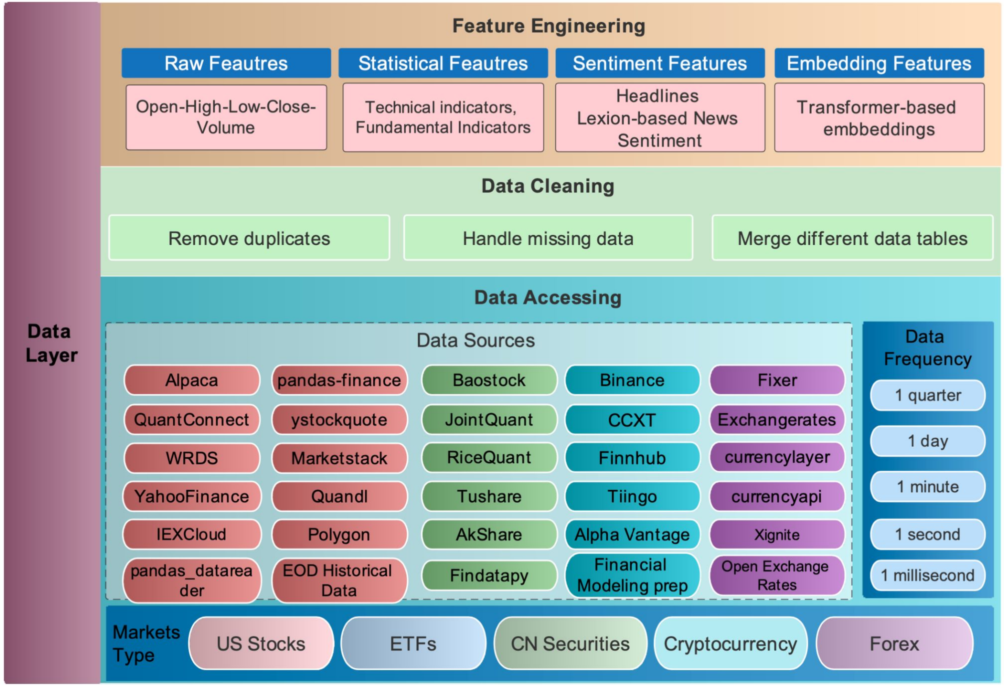
- **Data Accessing**:
  - Connect APIs of different platforms via unified interface.
  - Access data by specifying the start date, end date, stock list, time interval, and other parameters.
  - Support more than 30 data sources, e.g. stocks, cryptocurrencies, ETFs, forex, etc.

- **Data Cleaning**:
  - Raw data are unstructured: erroneous or missing data.
  - Automate the data cleaning process with a unified data processor.



Data Layer

- **Feature engineering:**
  a. Automatically calculate technical indicators, e.g., Stockstats, TA-lib
  b. Add user-defined features



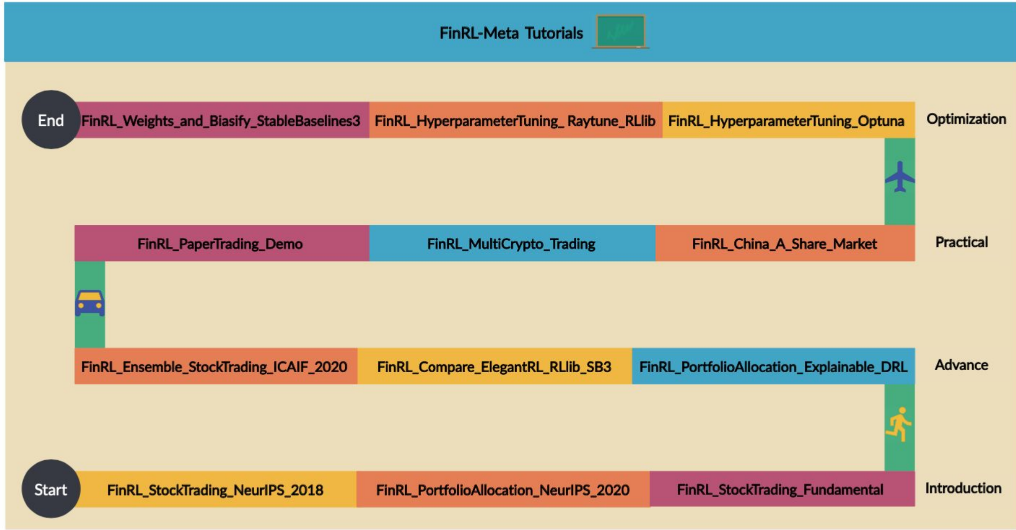
Environment Layer

- Incorporate **common market frictions** and **portfolio restrictions**.
  - Flexible account settings
  - Transaction cost
  - Risk-control for market crash

- **Multiprocessing training via vector environment**:
  - To utilize GPUs for multiprocessing training to accelerates the training process.
  - To achieve multiprocessing simulation of hundreds of market environments on large datasets.

Tutorials and Benchmarks

- For education, >100 Jupyter notebooks as **tutorials**:
  - Stock trading
  - Portfolio allocation
  - Cryptocurrency trading
  - MARL for liquidation strategy analysis
  - Ensemble strategy for stock trading
  - Paper trading demo
  - China A-share demo
  - Hyperparameter tuning
  - ……
- For demo, reproduce papers as **benchmarks**:
  - Stock trading task
  - Liquidation analysis
  - Explainable financial RL
  - Podracer on the cloud
  - Ensemble strategy



Conclusion

- Follow the DataOps paradigm and develop FinRL-Meta library
    - provide openly accessible dynamic financial datasets and reproducible benchmarks.

- Future work:
    - FinRL-Meta aims to build a universe of financial market environments.
    - To improve the performance for the large-scale markets, we are exploiting GPU-based massive parallel simulation such as Isaac Gym.
    - We believe that FinRL-Meta may help provide insights into complex market phenomena and offer guidance for financial regulations.

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idea

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