Performance Improvement of Algorithmic Trading Strategies Using Deep Learning

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1. Trading Algorithms
What are Algorithmic Trading Strategies

An algorithm creates a rough schedule of trades such as “when”, “how many shares” and “at what price” to buy or sell, and follow the schedule until all of its order quantity are traded.

Whenever there is a change in the market, the algorithm checks if the current situation fits the requirements to trigger executions.

Fig1. A typical case of algorithmic trading
AI and Deep Learning

Expert System

If Condition “A” Then Do Action “α”
If Condition “B” Then Do Action “β”
If Condition “C” Then Do Action “γ”

Copies how human “experts” would behave depending on specific condition

Existing Trading Algorithms

Machine Learning

**Basic**
- Perceptron
- Support Vector Machine (SVM)
- Auto Encoders (AE)
- Recurrent Neural Network (RNN)
- Hidden Markov Model (HMM)
- Reinforced Learning (RL)

**Advanced**
- Deep Learning
  - Deep Belief Network (DBN)
  - Deep Convolutional Neural Network (CNN)
  - DNN-HMM
  - Deep RL
  - DNN-RNN

**Fig2. Deep Learning on Trading Algorithms**
2. Our study of stock price prediction
What we predict

Predict the case when price of stock will have a significant change

- +0.5% and above
- from -0.5% to +0.5%
- less than -0.5%

Threshold 0.5%

Fig 3. Three Classifications of Stock Price Range at a Future Time
**Dataset**

**Input Data**

- **Marketdata of Topix Core 30 constituents**
  - Recent 20 OHLC** + Volume
    - Minutely time series OHLCV*** (5 values)
    - 5-Minutely OHLCV (5 values)
    - Hourly OHLCV (5 values)
    - Daily OHLCV (5 values)
    - Weekly OHLCV (5 values)

- **Marketdata of Nikkei 225 futures**
  - 100 most-recent order book data
    - Price and quantity of ask1 to ask8 (2 x 8 values)
    - Price and quantity of bid1 to bid 8 (2 x 8 values)

- **100 most-recent trade data**
  - Exec price from base price in %
  - Exec quantity vs, previous day total traded volume in %

**Label (Answer)**

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**Fig 4. Structure of Input Data Used for Our Prediction**
Type of Deep Learning Algorithm We Used

Fig 5. Structure of Deep Belief Network
Our Application

Throwing away the idea of creating one omnipotent AI

- DBN1 is specifically trained to answer at 9 am predicting 10 am whether it’s in range between $\pm 0.3\%$ from current price or higher than that or lower than that.

- DBN2 is specifically trained to answer at 1 pm predicting 1:30 pm whether it’s in range between $\pm 0.15\%$ from current price or higher than that or lower than that.

Create many different DBNs for each specific conditions.
(Current Time, Threshold and Prediction Time Spread)

Fig 6. Create and Train Different DBN at Different Condition
Expected improvement of algorithmic trading strategy performance is 1 bps
3. Our business application
MAGI Platform Overview

What’s in MAGI

1. Choice of AI
   Provides common deep learning models such as DBN, RNN(LSTM), RNN(RBM), DNN-HMM.

2. Heterogeneous Data Sources
   Heterogeneous data sources are ready for training such as Historical Data (Stock, FX, Commodities), Financial Statements, News, and more...

3. Easy to Train
   Data preprocessing tasks and training tasks are schedules and run on multiple servers and on GPUs without programming!

Ever evolving R&D platform to generate the best deep learning model which is specifically designed for market prediction!
Production Hardware of MAGI

Fig 8. Servers and Network

- Spec
  - 224TFlops (NVIDIA Tesla M40 x 32)
  - Low latency Infiniband 56Gbs network
  - Distributed Computing
  - Direct Memory Access
  - Parallel File System + Raid50

Task Scheduler

Calculation Servers

Infiniband Switch
Fig 9. System flow of MAGI
Thank you for Listening !