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Automated Trading System - A Survey

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Abstract - *Automated trading systems have been proved to be very helpful to traders and investors. The idea of developing such a money making system is very old and the work on the same ground has started in late 90's. Being a fond of the capabilities of Artificial Intelligence, in Computer Science, we thought we could bring the finance domain and AI fields together to construct a very effective tool which will make the common man's life in the field of stock trading much easier by assisting him in his investment in the share market also giving profitable returns.*

To bring the system into reality, we've gone through lot of research papers under the domain of automated trading systems. This paper is an attempt to segregate the respective research papers under two fundamental criteria – Functional domain and Technical domain.

Trade execution, market analysis, trade strategies, candlesticks, market indicators, discernment, Risk management etcetera are some of the terms we learnt from functional literature reviews whereas, Algorithmic trading, Artificial Neural Networks, Fuzzy logic, classification and clustering, etc. were the terms related to technical domain. At the ending section of this paper, the influence of usage of HPC technology in the field of stock market prediction has been discussed.

Key Words: **Artificial Neural Networks, Fuzzy logic, Machine Learning, Data Mining, Bid and offer price, HPC.**

1. INTRODUCTION

Automated Trading is one of the very popular areas in the world of stock market. Since the work to build such type of intelligent systems within its domain has started way long back, it has retained its interest in human mind for further development due to its economic cause and support it provides to its respective users. A constructive system that provides guidance to its users by capturing real time data from the stock market environment to form profitable financial decisions by building user's portfolio and analyzing trends, which have a primary importance. Our hypothetical system includes decision making expertise, which mainly contains buying, selling or holding the stock dataset/value at that instantaneous time. It works on highly relative environment. To overcome the limitations of the current systems, we propose better solutions that consider the latest trends like Chart analysis, Fuzzy logic, Decision Support System, Data Mining and Social Media Trends. We are incorporating experience building capabilities within the system that enables the hypothetical system to calculate results based on machine learning, which helps the system to learn and generate new knowledge through the historical data, thus limiting loses and raising the chances of gain.

Though Automated Trading Systems have proved their importance to the traders and investors, most of the existing systems implemented with statistical or neural network approaches are incapable of giving accurate advice because they cannot capture the off-market information for which most of it is non-numeric. In this we tried to cover every aspect of stock market from input to final decision that is output. [1]

1.1 Hybrid Automated Trading System [1]

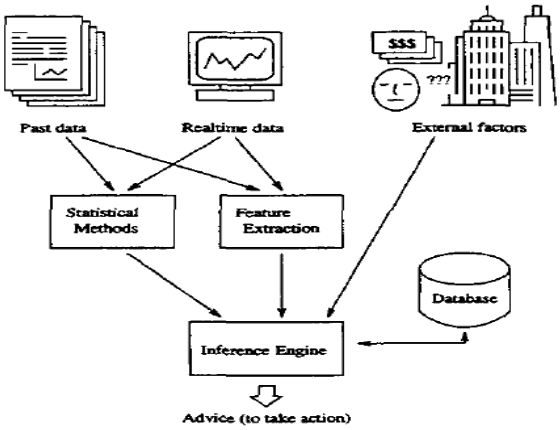

Figure 1. The overview of Hybrid Automated Trading System [1]

The above diagram describes the basic structure of an automated trading system. We can visualize this diagram in three classes –

1) Input layer (Blocks include Past data, Real-time data and External factors)

2) Processing layer (Statistical Methods and Feature Extraction, Inference Engine and Database) and

3) Output layer (User Advice).

Input layer components provide numeric as well as non-numeric data to the processing layer which is then analyzed and a decision is generated and provided as an output. Past data is the data which is generated in the stock market in past few years (it may be company specific or in general) and in numeric form describing price of the share. Real-time data is the current data of the market which has major driving effect on the system's decision. External factors include newsletters, social media which has direct or indirect impact on the market.

Statistical methods are the trading algorithms and rules which have to be applied in the trading process. Feature extraction is prominent and yet challenging part of the system which has the capability of extracting the useful data from the input layer and presenting it to the inference engine.

Database is the repository of data. It stores the features extracted from the extraction module as well as the decisions generated by the system. It is connected in a two-way approach it means data can be queried whenever required as well as can be deposited. Finally, the decision is advised to the end user.

1.2 Modified Hybrid Automated Trading System

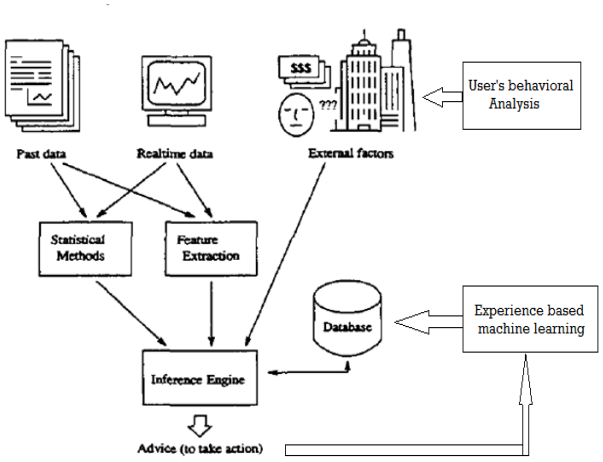

Figure 2. The overview of Hybrid Automated Trading System with proposed add-ons

Two additions from our side –

I. **User's behavioral analysis –**Our proposed system is intended to monitor the users' behavioral patterns that are actually using it. The system will monitor each and every action of its user and it will rate him/her accordingly based on the expertise. Accordingly his/her strategy will be considered seriously by the system.

II. **Experience based machine learning –** System will build the experience logs of the decisions and their impacts. E.g. If system follows certain path of decisions and suddenly it committed a loss, this pattern is considered to be as an experience. And when a similar situation will happen in the market again, the system will look for the same in the experience base and it will plan the course of actions accordingly to eliminate the loss. [1]

2. Trade execution [2]

Now, we will discuss few functional domain terminologies that are used in the area of stock trading and then we will move on to the technical side of the system. Dealers generally execute their orders through a shared centralized order book that lists the buy and sell orders for a specific security ranked by price and order arrival time (generally on a first-in, first-out basis). This centralized order-driven trading system

continuously tries to match buy and sell orders that is what we called Trading System.

3. Electronic Trading [2]

Broadly, electronic trading is any method of exchanging securities, stocks, bonds, foreign exchange and derivatives (options, futures, and so on). Within electronic trading, specialized programs bring together buyers and sellers through electronic media to create an exchange (such as Nasdaq). Order management systems facilitate and manage order execution, generally connecting to one or more electronic exchanges. Automated trading systems usually refer to trade execution programs that automatically submit trades to an exchange. The distinguishing feature of algorithmic (referred to by some people as systematic) trading systems is the sophistication of their analysis and decision making. Broadly, these systems are deployed for highly liquid markets and high-frequency trading, such as equities, futures, derivatives, bonds (US Treasuries), and foreign exchange (currencies). The essential characteristic of a highly liquid market is that there are ready and willing buyers and sellers at all times.

4. Automated Trading Components

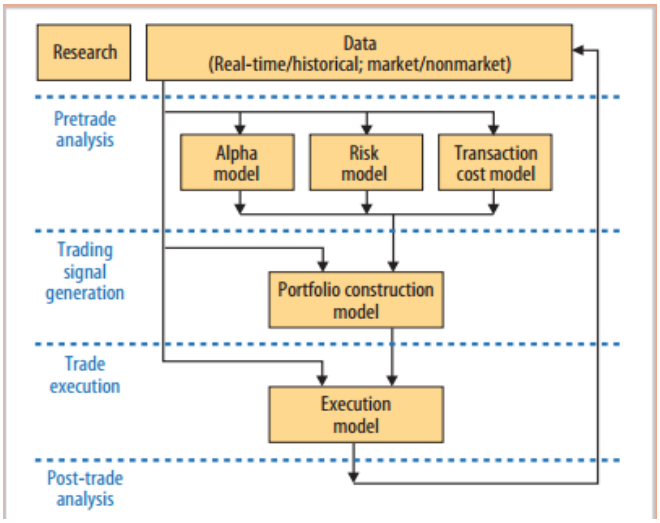

Figure 3. Steps at which the algorithmic trading system components occur [2]

Figure above, shows the major components of an algorithmic trading system and the steps at which they occur. Pretrade analysis includes three mathematical models:

- The alpha model predicts the future behavior of the financial instruments to trade.
- The risk model evaluates the levels of exposure/risk associated with the financial instruments.
- The transaction cost model calculates the (potential) costs associated with trading the financial instruments.

Trading signal generation consists of the portfolio construction model. This model takes as its inputs the results of the alpha, risk, and transaction cost models and decides what portfolio of financial instruments should be owned going forward and in what quantities. At trade execution, the execution model executes the trades, making several decisions with constraints on (actual) transaction costs and trading duration. The most general decision is the trading strategy followed by the venue and order type.

5. Fuzzy Decision Trees [3]

The primary issue with stock prediction is that prices tend to contain a lot of noise. This makes accurate modeling difficult without overtraining the prediction system. An alternative to this is to design a trading system that directly outputs buy and sell signal. A simple approach presented in uses fuzzy logic to derive trading signals from technical indicators. In, a neuro-fuzzy system is employed to generate buy and sell signals for trading. Support vector machines have also been demonstrated in classifying trading signals.

6. Short-term Stock Trading [3]

Stock trading systems vary not only in terms of strategy but also the duration between transactions. Long term strategies such as the well-known buy-and-hold trading system make use of large trends in the market to derive earnings. However, such a system is heavily dependent on the present market conditions.

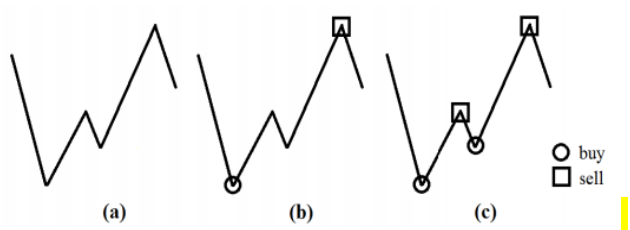

Figure 4. Buying zones and selling zones [3]

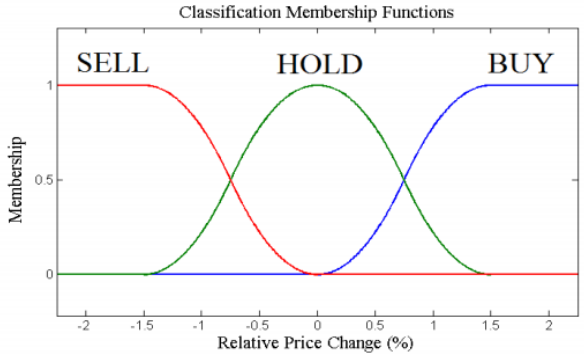

Figure 5. Classification of trading actions [3]

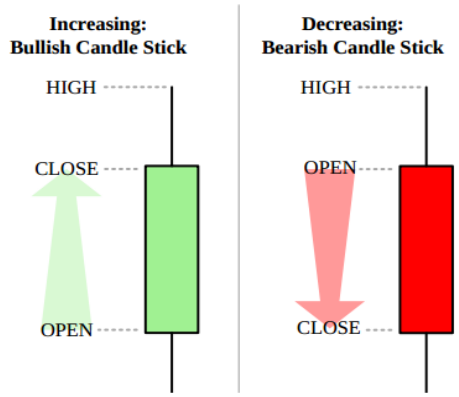

Figure 6. Representation of a candlestick [4]

The boxed area represents the body of the candlestick. White or hollow candlesticks indicate a higher close relative to the open. Black or filled candlesticks show a lower close.

7. Important Indicators in Stock Market [4] [5]

In this section, some important stock market indicators have been discussed that have significant influence in building strategies. The values of these indicators are taken into consideration in technical analysis of a stock by traders. Therefore these indicators can be coded and be used by the automated system while employing rule-based decision making strategy. Patterns retrieved from Data Mining is an another set of inputs to the decision making algorithm which sets the weight for a particular input depending upon its influence of the price movement.

1) **Relative Strength Index (RSI):** *RSI* is an indicator that measures the speed and change of price movements.

2) **Moving Average:** Moving averages smooth the price to form a trend indicator. They do not predict the direction of price, but define the direction late. It is useful for eliminating noise in raw data, producing an overview of trends.

3) **Exponential Moving Average:** Exponential moving averages reduce the lag by applying more weight to recent prices.

4) **Moving Average Convergence/Divergence (MACD):** *MACD* is a specific example of an oscillator in price and is mainly used on the closing prices of an asset to detect price trends, showing the relationship between two moving averages.

5) **Average Directional Movement Index (ADX):** The Average Directional Movement Index (ADX) indicator describes when a market is trending or not trending, that is, the strength of a trend.

6) **Aroon Indicator:** A technical indicator used for identifying trends in an underlying security and the likelihood that the trends will reverse. *Aroonup*, which measures the strength of the uptrend, and the other line, is called *Aroondown*, which measures the downtrend. *AroonUP – AroonDown.*

7) **Bollinger Bands:** Bollinger Bands are volatility bands placed above and below a moving average. Volatility is based on the standard deviation, which changes as volatility increases and decreases. The bands automatically widen when volatility increases and narrow when volatility decreases.

8) **Commodity Channel Index (CCI):** The Commodity Channel Index (CCI) is a versatile indicator that can be used to identify a new trend or warn of extreme conditions.

9) **Chande Momentum Oscillator (CMO):** It is created by calculating the difference between the sum of all recent gains and the sum of all recent losses and then dividing the result by the sum of all price movement over the period.

10) **Rate of Change (ROC):** The Rate-of-Change (ROC) indicator, which is also referred to as simply Momentum, is a pure momentum oscillator that measures the percent change in price from one period to the next.

8. Basic rules of placing order in stock market

1) If 20 days of moving average > 50 days of moving average the **buy** the share **(Bullish line)**
2) If 20 days of moving average < 50 days of moving average the **sell** the share **(Bullish line)**

9. Impact of Social Media Trends on Stock Markets Trends [8] [9]

This study examines ways in which consumer engagement on social media such as micro blogs, blogs, videos, and message boards can be used to predict the performance of individual stocks. There are two major approaches to this study – In first type, rather than studying social media messages about specifics stocks, messages about the underlying brand themselves can be captured in order to cast a wider net for harvesting public opinions about a firm. Second, instead of collecting information about firms in disparate industries, gathering data on all firms in a specific industry, permit us to account for competitor effects in the analysis. Results show that while public perception of a firm is important for predicting stock performance, public perception of a firm's competitors can often have an even greater predictive power.

10. Existing Systems [10]

Fully Automatic	Semi Automatic
TradeStation	AmiBroker
Interactive Brokers	Tradedecision
WealthLab	

11. Dataset characteristics [11] [12]

Basic attributes of data:

1) Date of trade
2) Open price
3) High price
4) Low price
5) Number of shares of the company
6) Total turnover (in INR)
7) Deliverable quantity
8) Spread High-Low
9) Spread close-open

12. Stock prediction and High Performance Computing [6] [7] [13]

High Performance Computing (HPC) is the use of parallel processing for running advanced application programs efficiently, reliably and quickly. [10] The term especially used for the computers performing supercomputing at the speed of operations measured in teraflops. As the stock market undoubtedly performance intensive application, HPC has a great scope in this field. Stock market system has to deal with humongous data which is generated within seconds, performing analytical operations for prediction on the same may become cumbersome. Most speedy processor and RAM in the world will also rest at a particular limit when it comes to performance. Thus technology world is now shifting gears to cluster computing and GPU (Graphics Processing Unit) programming in order to achieve a great hike in performance mainly with respect to speed.

In the field of Automated Stock Trading, HPC technology can be used to process big data, evaluate complex and time consuming database queries and enforcing parallelism. Performance sensitive tasks such as generating quick reports, data analysis and summarization can be shifted on the GPU instead of CPU to leverage the speed of processing and ended up improving performance. The proposed system is targeted to be developed in Java language whereas to incorporate HPC capabilities, the GPU centric code must be written in CUDA (Compute Unified Device Architecture) language based on C, originated by NVDIA Corporation especially for NVDIA GPUs. To bridge the gap between Java and CUDA, a third party middleware library comes for the rescue which JCUDA. This API library interprets the Java code into the CUDA native code and hence eliminating the necessity of Java programmer to swim into the ocean of CUDA.

Another approach in HPC is distributed databases and parallel processing. In Automated Trading Systems, this scheme can be employed while fetching thousand of records in parallel manner on different database nodes to avoid speed lag issues. Second scheme to improve the performance of database systems is to implement In Memory Database IMDB (also called as Main Memory Database MMDB). In this technique, database objects like tables, are operated on the main memory i.e. RAM instead of performing I/O operations on secondary storage i.e. Hard Disk. As the main memory is any time faster than the secondary storage, this approach gains a significant benefit over the conventional DBMS when it comes to speed of database operations.

13. CONCLUSIONS

Stock market is considered to be one of the popular sources of investment where you can get the returns in bucks in less time. However it is subjected to be titled under risky investment due to its highly fluctuating and unpredictable in nature. Common investors invest their money in stock market but at the same time they get so anxious with a thought of losing money. Automated Trading System is an attempt to make investor's life easier made by researchers working a way long back.

However, today's algorithmic trading systems lack in many aspects while serving their purpose. Now a day, a lot of sophistication and innovation has enriched the field of Computer Science, it has become possible to develop a system which can fulfill the market needs. We being researchers in Computer Science field, found a scope in the challenging field of Automated Trading System. To construct our idea and to figure out the where the current systems flawed, we had to have conduct a rigorous literature survey.

In this survey paper, at first we have mentioned basic building blocks of every automated trading system. Then we proposed our model with some improvements to give the system a personalized touch. In next sections, we discussed about some functional terms related to the market. Later we focused about the aspects such as candlesticks, decision making process in the trading which are the core components of proposed system. Later, we have emphasized some indicators of stock market which have to be programmatically implemented as a part of inference engine. In the last section of this paper, we stated how the integration of HPC technology in Automated Trading System will leverage the performance at a peak thereby bringing accuracy and speed in the operations. We also mentioned basic attributes in our database that we have considered for our research.

This paper is an attempt to gather the basic and advanced techniques to stock price prediction that are invented so far. This paper also talks about the ins and outs of the automated trading world which will definitely help the enthusiasts working on the similar ground.

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