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Intelligent model for Stock Market prediction

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ABSTRACT

Stock market prediction is a science more than an art, as it involves technical analysis, fundamental analysis and even some news analysis. Stock market prediction can help for wealth growing, enrich investment and detect potential financial crisis. The goal of stock market prediction is to anticipate potential movements in the optimum time to gain the best profit or avoid a major loss. So, the target is to reach an accurate result, with high confidence rate, on a real-time manner.

When it comes to stock market prediction, people are divided into two competing schools. Some count on fundamental analysis and others who use technical analysis. Fundamental analysis of a business involves analyzing its financial statements and health, management and competitive advantages, and competitors and markets. Technical analysis is a security analysis discipline to forecast the direction of the prices through the studyingthe past market data, specifically price and volume. In modern research, people tend to use“technological” analysis in resolving the stock market prediction problems. Technological analysis is based on using new technologies and computingresources to substitute old labor operated process. It can be an alternate for technical analysis, fundamental analysis or a hybrid of both.

On the path of technological analysis, research groups were divided into two major categories. A category used Artificial Neural Networks for the prediction process. The second category used Fuzzy Logic to resolve the relevant problems to stock market prediction. Some individuals tried to use hybrid techniques between both ANN and Fuzzy Logic. Recently, modern methodologies involve new approaches such as Markov Model and Genetic Programming.

In this thesis,a new prediction model is proposed that introduces anew learning technique of ANN, by incorporating KullbackLeibler Divergence from Digital Signal Processing in the learning process of the ANN. It optimizes the Multi Layer Perceptron prediction abilities, as described in this research. Also, this model is used in a multi-core based framework to reach a real-time prediction performance.The high level requirements that guided the formulationof the new model are (a) to

provide adequate prediction accuracy,(b) to support as many stock markets and securities as possible, (c) to offer reasonable confidence degree, (d) to provide real-time results and (e) provide all the above for normal users with regular machines. The challenge is to design and implement models that meet these complex requirements and balance the conflicts between them. The fundamental innovation in this work is formulating an efficient prediction model with high accuracy and confidence rates, and yet provides results in a real-time manner. The maximum performance was reached through the parallelization of Nprocesses on the multiple cores for a single machine, where N is the number of processes in our computation profile as described in chapter 4. Accuracy of the proposed model was confirmed through comparison with the most popular techniques results, with average difference of about 5-7%. Also, the proposed model provides high confidence rates up to 90%. On the other hand, the developed system exhibits acceptable speedupthat reaches3.78% on a quad core. Finally, the utilization of the computing cores was satisfactory for the considered test cases.

KEYWORDS

Stock Market Prediction,Candle Sticks Patterns,Technical Indicators,Multi-core Architecture,Concurrency,Artificial Neural Networks,Blind Source Separation.

LIST OF PUBLICATIONS

JOURNAL PUBLICATIONS

1-I. M. Hamed, A. S. Hussein and M. F. Tolba, "An Intelligent Model for Stock Market Prediction," *International Journal of Computational Intelligence Systems (IJCIS),* vol. 5, no. 4, pp. 639-652, 2012. Impact factor 1.47.

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CONFERENCE PUBLICATIONS

1-I. M. Hamed, A. S. Hussein and M. F. Tolba, "An Intelligent Model for Stock Market Prediction," in *The Seventh International Conference on Computer Engineering & Systems (ICCES2011)*, Cairo, 2011.

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LIST OF ABBREVIATIONS

1- Moving Average Convergence divergence (MACD).
2- Price/Earnings ratio (P/E).
3- Price/Earnings to Growth ration (PEG).
4- United States (US).
5- Artificial Intelligence (AI).
6- Artificial Neural Networks (ANN).
7- Multi-Layer Perceptron (MLP).
8- KullbackLeibler Divergence (KLD).
9- Radial Basis Function Neural Network (RBFNN).
10- Localized Generalization Error Model (L-GEM).
11- Adaptive Neuro Fuzzy Inference System (ANFIS).
12- Tokyo Stock Exchange Prices Indexes (TOPIX).
13- Field Programmable Gate Array (FPGA).
14- Personal Computer (PC).
15- Hang Send Index or Chinese Stock Index (HIS).
16- Dow Jones Index (DJI).
17- National Association of Securities Dealers Automated Quotations (NASDAQ).
18- NASDAQ Composite Index (IXIC).
19- Time Delay Neural Networks (TDNN).
20- BroydonFletcherGoldfarbShanno algorithm (BFGS).
21- Takagi-Sugeno-Kang model(TSK).
22- Back Propagation Neural Network (BPNN).
23- Multiple Regression Analysis (MRA).
24- Genetic Programming (GP).
25- Generalized Feed-Forward (GFF).
26- Mean Squared Error (MSE).
27- Mean Relative Percentage Error (MRPE).
28- General Growing and Pruning Radial Basis Function (GGAP-RBF).
29- Cyclic Self-Organizing Hierarchical Cerebella Model Arithmetic Controller (CSOHCMAC).
30- Cerebella Model Arithmetic Controller (CMAC).
31- Hierarchical Cerebella Model Arithmetic Controller (HCMAC).
32- Financial Information Grid (FinGrid).
33- Analysis Of Variance model (ANOVA).
34- Simple Moving Average (SMA).
35- Exponential Moving Average (EMA).
36- True Range (TR).
37- Average Directional Index (ADX).
38- Directional Indicator (DI).
39- Information retrieval (IR).
40- Relative Strength Index (RSI).
41- Independent Component Analysis (ICA).
42- Data Base (DB).
43- EFG Hermes Holding security (HRHO).
44- El Nasr Clothing - Textiles Co. security (KABO).
45- Egyptian Electrical Cables security (ELEC).
46- Microsoft Corporation security (MS).
47- United States Dollar (USD).

48- Off-Trading Session (OTS).
49- Average True Range Indicator (ATR).
50- Stochastic Oscillator indicator (SO).

CHAPTER 1. INTRODUCTION

1.01 MOTIVATION

Stock markets are very critical in our life, as they are the main vein of any economic system. In the past few decades, there has been a major growth in terms of stock market investments global wise. New markets have evolved to lead the world economy, such as China. And, other new growing markets are evolving, such as our Egyptian stock market. Obviously, stock markets now are capturing the focus of the people all over the world.

For the evolving markets, it's really important to understand the stock market system among all investors. This will lead to a more mature investment and then to a more mature market. For the mature markets, it's really important to maintain the quality of investment patterns and avoid possible crisis, as what happened in the year of 2010.

Surprisingly, many people now depend on the status of the stock market for their decision, even if such decision were not directly related to the current stock market status. All such decision needs to be taken across a huge amount of data, many unclear patterns, very tight time constraints and very high risk possibilities as shown in Figure 1.1. Therefore, there's an urgent need to fill the gap of stock market prediction and understandability.

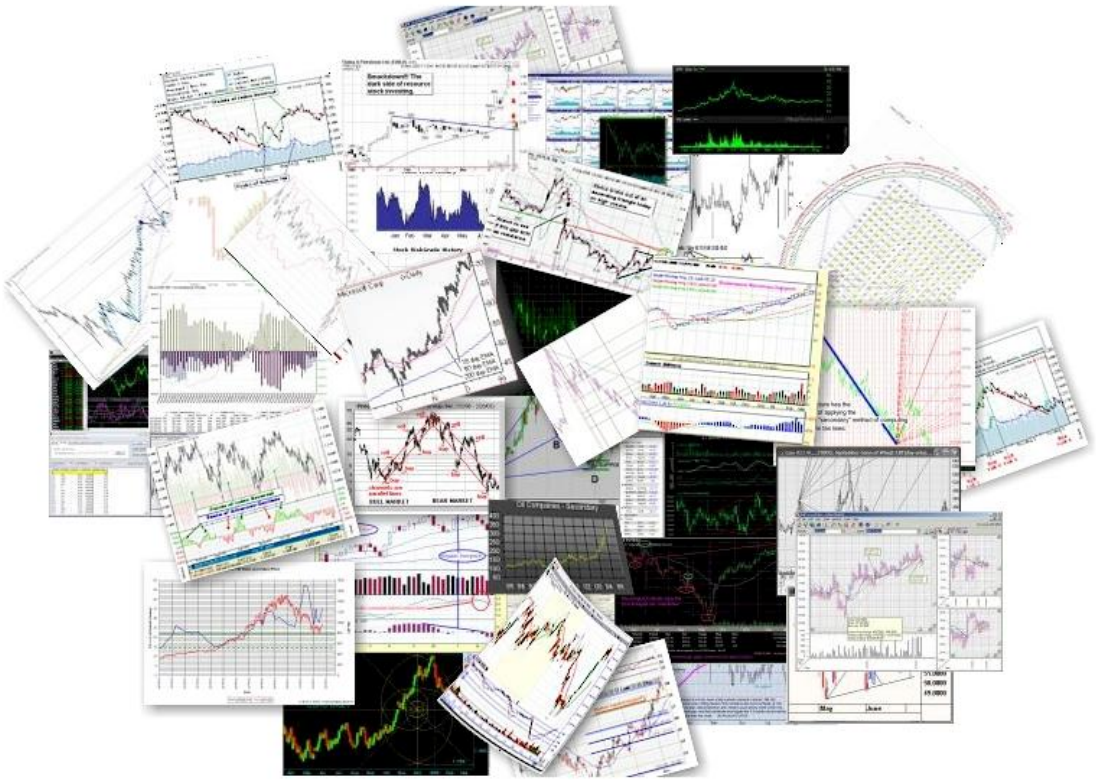

Figure 1.1 Complexity of stock market

Stock market is a supply and demand system. The more a certain stock demand increases the more its price raises, and vice versa. In the real world, stock market is not that simple. Since supply and demand are affected by many factors like rumors, sentimental factors, volatility and liquidity. Proportionally, these factors affect the behavior of the stock market price movement. These factors differ from market to another, sector to other, even from one security to another.

So, playing with fire and trading in stock market seems to be very similar, as they both are very risky and if got out of control, the results will be disastrous. Consequently, the need for stock market analysis started to evolve. Every decision under consideration needs to follow certain patterns,within the market,in order to have acceptable risk or at least,to be ready with the proper corrective actions, which are called in terms of the stock market “Re-entry” and “Stop loss”.

As a risk mitigation procedure, investors in stock market started to build different strategies to analyze the features of a given security,such as the volatility of the security, the trend of the price, etc. Those strategies wereevolved to form a new

kind of science or methodology, which are known as Technical Analysis, (statistical based), and Fundamental Analysis, (economical based).

In this research, we focused more on technical analysis, as we used a set of technical indicators to find some patterns and features.

In the following sections, we will go through the common techniques in stock market analysis to understand their nature. Then, we will give a brief on the candle sticks charting to elaborate the importance of adding it to our research.

1.01.1 TECHNICAL ANALYSIS

In finance, technical analysis is concerned with the forecasting of the direction of prices through the study of the past market data, specially price and volume, Kirkpatrick et al.[1]. Behavioral economics and quantitative analysis incorporate technical analysis, which being an aspect of active management stands in contradiction to much of modern portfolio theory. The effectiveness of both technical and fundamental analysis is disputed by efficient-market hypothesis, which states that stock market prices are essentially unpredictable, Lo et al.[2].

The principles of technical analysis are derived from hundreds of years of financial market data. Some aspects of the technical analysis began to appear in Joseph de la Vega's accounts of the Dutch markets in the 17th century. In Asia, technical analysis is said to be a method developed by Homma Munehisa during early 18th century, which evolved into the use of candlestick techniques, and is today a technical analysis charting tool [3]. In the 1920s and 1930s, Richard W. Schabacker published several books, which continued the work of Charles Dow and William Peter Hamilton in their books “Stock Market Theory” and “Practice and Technical Market Analysis”. In 1948,“Technical Analysis of Stock Trends” was published by Edwards et al. [4], which is widely considered to be one of the classical works of the discipline. It is exclusively concerned with trend analysis and chart patterns and remains in use to the present. To this point, early technical analysis was almost exclusively the analysis of charts, because there are no computers capable of doing such statistical analysis.