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Back Propagation: A Prediction Approach for Stock Market Based on Hidden Layer Identification

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ABSTRACT: Market inefficiencies tend to be localized in time and space with a limited potential volume of profits. It is all about trading rules. Stock market prediction is very difficult because it depend on known and unknown issues. One has to fit the market that handles orders in milliseconds.Nowadays Artificial Intelligence methods are very popular in forecasting the stock markets. The purpose of this paper is to identify the main benefits of back propagation in stock markets and also provide Back propagation implementation to emphasize the problems that can be important for added exploration.

KEYWORDS: Artificial Neural Network (ANN), Back Propagation(BP), neuron, demons, stock market,SMPBPM: Stock Market Prediction By Back Propagation Model[1],benefits.

I. INTRODUCTION

A. STOCK MARKET

The stock market is a complex system where shares of publicly-traded companies are issued, bought and sold. The stock market is a collection of millions of investors with diametrically opposing views. This is because when one investor sells a particular security, someone else must be willing to buy it. Since both investors cannot be correct, it is an adversarial system. In short, one investor will profit and the other will suffer loss. There are many factors that determine whether stock prices rise or fall. The various stock market areas are shown in the Fig 1. These include the media, the opinions of well-known investors, natural disasters, political and social unrest, risk, supply and demand, and the lack of or abundance of suitable alternatives. Let's assume stock prices have been rising for several years. Investors realize that a correction will come and stock prices will tumble.

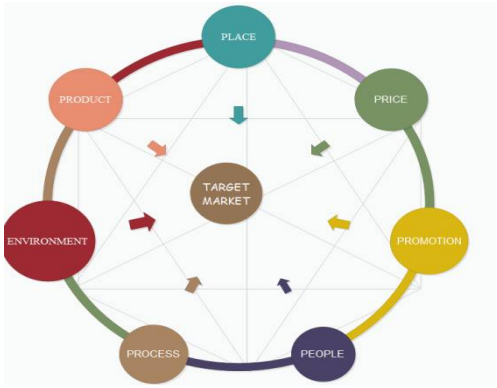

Fig. 1 Stock Market areas

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II. STOCK VALUATION

The actual price of a stock is determined by market activity. When making the decision to buy or sell, the investor will often compare a stock's actual price to its fair value. For example, if a stock is trading at $15 per share and its fair value is $25, it may be worth purchasing. Conversely, if it trades at $50 but its fair value is $40, the stock would be considered overvalued and the investor would be wise to avoid it. There are many ways to derive this figure. Among the various computerized method we choose Back propagation. In our previous paper we introduced a model SMPBPM: Stock Market Prediction by Back Propagation Model for stock market prediction.

III. BACK PROPAGATION

Numerous research and applications of Artificial Neural Network has shown best resultin solving business and financial problems. Artificial Neural Network is a nonlinear dynamic system which has the capability of very powerful supervised and self-learning techniques.Forecasting the stock market has been a major challenge for both investors and scholars. Statistical methods are not adequate to predict stock data because of nonlinear format. To overcome the problems faced computing concepts like Artificial intelligence techniques are accepted. In engineering and real time problems there are many research are done on the effectiveness of Back propagation. The back propagation algorithm with multilayer feed-forward method is shown in Fig 2. This is used to predict the stock. The back propagation algorithm uses multilayer feed-forward and gradient decent techniques to predict the stock.

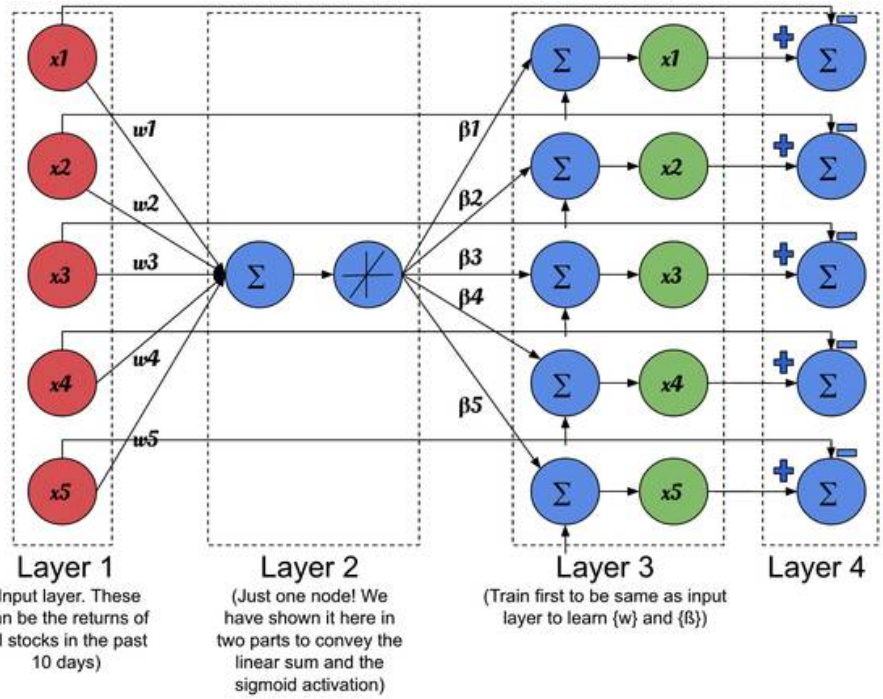

Fig. 2 Back Propagation Layer description

IV. NEED FOR BACK PROPAGATION ALGORITHM IN STOCK PREDICTION

Trajectory is taken exponential growthBack propagation algorithm has the powerful problem solving techniques. The need for computerized method is clearly described by Fig 3. The Human Decision Process is the most interesting .Inside every individual there is a logical and an emotional component. We may analyze a situation using our logical side but when it's time to act, we refer to our emotions .It was lead for training correct prediction. Back propagation

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with a multi-layer prediction is used to form right trajectory of prediction. It has the basic principle of selecting hidden layers with neurons. There is number of neurons in the hidden layer so it must be chosen carefully. The key idea is to identify the total neurons to be used in the hidden layer. Lesser neurons result in wrong estimation where as more neurons result in over estimation. The neuron selection is done by trial and error method.

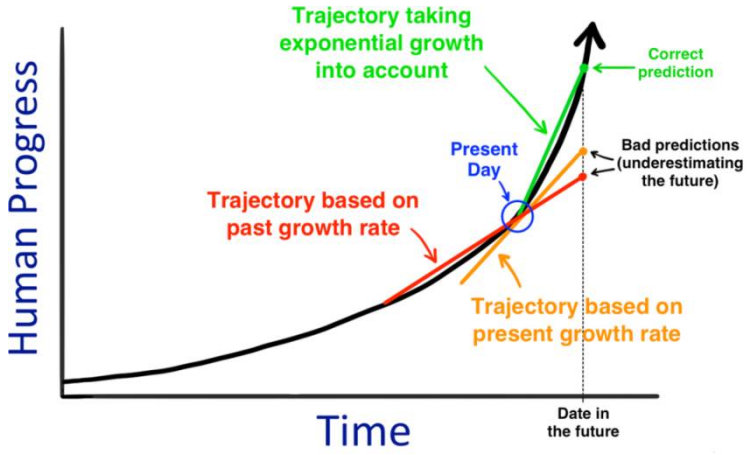

Fig. 3 Human Progress rate

V. NEURON SELECTION

Basically the neuron selection is done by using the following laws.

Law 1:

Number of neurons in hidden layer→ should be between the number of neurons in the input layer and the number of neurons in the output layer.

Law 2:

Number of neurons in hidden layer → should be (2/3 the number of neurons in the input layer) + (the number of neurons in the output layer).

Law 3:

Number of neurons in hidden layer → should be less twice the number of neurons in the input layer.

Many studies on stock market estimating done by Neural Network techniques have been performed by past 25 years (Nakamura, 1997; Aikan, 1999; Garliauskas, 1999; Shen, 2000; Chan, 2000; Hwarng, 2001; Thawornwong, 2005; Darwish, 2006; Distelfeld, 2007).

Back propagation is about understanding how changing the weights and biases in a network changes the cost function. Back propagation approach is about deep learning will sweep the trading world. This is described by Fig 3. To understand how the error is defined, imagine there is a demon in the neural network.

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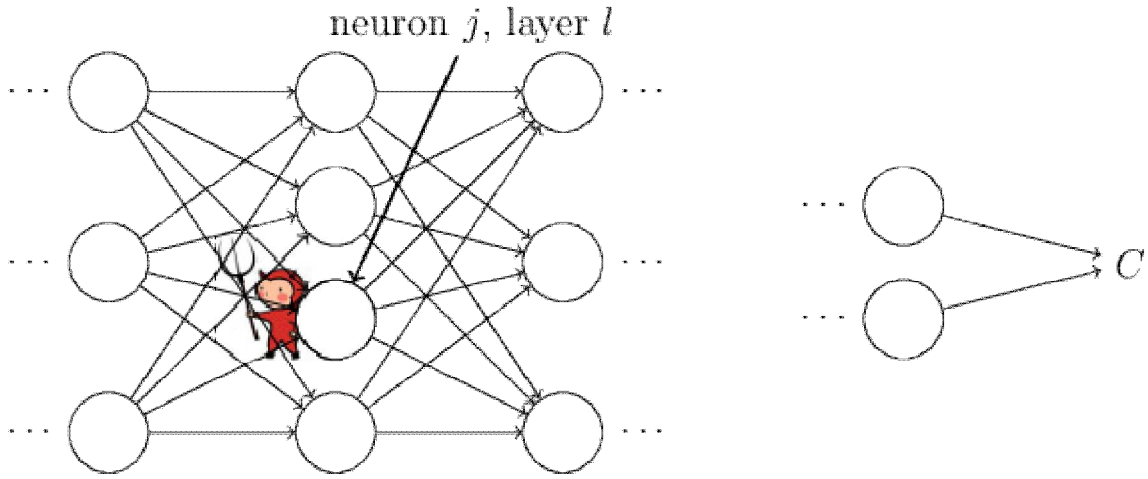

Fig. 4 Deep learning approach in Back propagation

The demon sits at the neuron j in layer 2. As the input to the neuron comes in, the demon messes with the neuron's operation. It adds a little change to the neuron's weighted input, so that instead of outputting, the neuron add some bias to the outputs. This change propagates through later layers in the network, finally causing the overall cost to change.

VI. IMPLEMENTATION OF SMPBPM: STOCK MARKET PREDICTION BY BACK PROPAGATION MODEL

A. FORMULAS OF BACK PROPAGATION

The following four formulas are used to find the sigmoid value (Fig 5). The four fundamental equations turn out to hold for any activation function, not just the standard sigmoid function. And so we can use these equations to design activation functions which have particular desired learning properties.

$$\delta^L = \nabla_a C \odot \sigma'(z^L)$$

$$\delta^l = ((w^{l+1})^T \delta^{l+1}) \odot \sigma'(z^l)$$

$$\frac{\partial C}{\partial b^l_j} = \delta^l_j$$

$$\frac{\partial C}{\partial w^l_{jk}} = a^{l-1}_k \delta^l_j$$

Fig. 5 The summarized equations of Back Propagation

B. THE BACK PROPAGATION ALGORITHM

The back propagation algorithm is described in Fig 6. Examining the algorithm one can see why it's called backpropagation. We compute the error vectors sigmoid backward, starting from the final layer. It may seem peculiar that we're going through the network backward.

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1. **Input** x**:** Set the corresponding activation a^1 for the input layer.

2. **Feedforward:** For each $l = 2, 3, \ldots, L$ compute $z^l = w^l a^{l-1} + b^l$ and $a^l = \sigma(z^l)$.

3. **Output error** δ^L**:** Compute the vector $\delta^L = \nabla_a C \odot \sigma'(z^L)$.

4. **Backpropagate the error:** For each $l = L-1, L-2, \ldots, 2$ compute $\delta^l = ((w^{l+1})^T \delta^{l+1}) \odot \sigma'(z^l)$.

5. **Output:** The gradient of the cost function is given by $\frac{\partial C}{\partial w^l_{jk}} = a^{l-1}_k \delta^l_j$ and $\frac{\partial C}{\partial b^l_j} = \delta^l_j$.

Fig. 6 Back Propagation Algorithm

The proof of backpropagation, the backward movement is a consequence of the fact that the cost is a function of outputs from the network. To understand how the cost varies with earlier weights and biases we need to repeatedly apply the chain rule, working backward through the layers to obtain usable expressions.

C. IMPLEMENTATION

To implement SMPBPM the previous three laws and above mentioned four back propagation formulas has been applied on three different architecture models depending on the number of neurons in the hidden layer.
The three models formed as follows:
ModelI:
N neurons in the input layer, (N-1)/2 neurons in the hidden layer and one neuron in the output layer. Fig 8(A)
ModelII:
N neurons in the input layer, 2/3(N+1) neurons in the hidden layer and one neuron in the output layer. Fig 8 (B)
ModelIII:
N neurons in the input layer, 2N-1 neurons in the hidden layer and one neuron in the output layer. Fig 8 (C)
For evaluating the performance of SMPBPM the previous different models, from financial time series raw dataset is considered. The sample result of test data is shown in the following graph (Fig 7).

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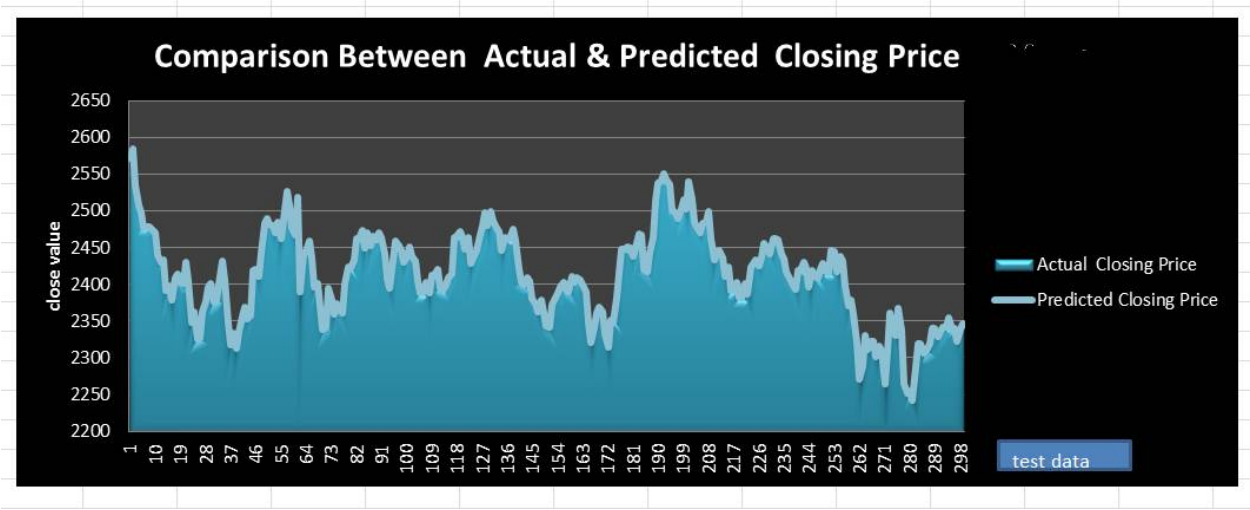

Fig. 7 Comparison between and actual & predicted closing price

The procedure mentioned has been applied in the sample to get the results illustrate in Fig 7. BP algorithm architecture consisting of five neurons is described in Fig 8.

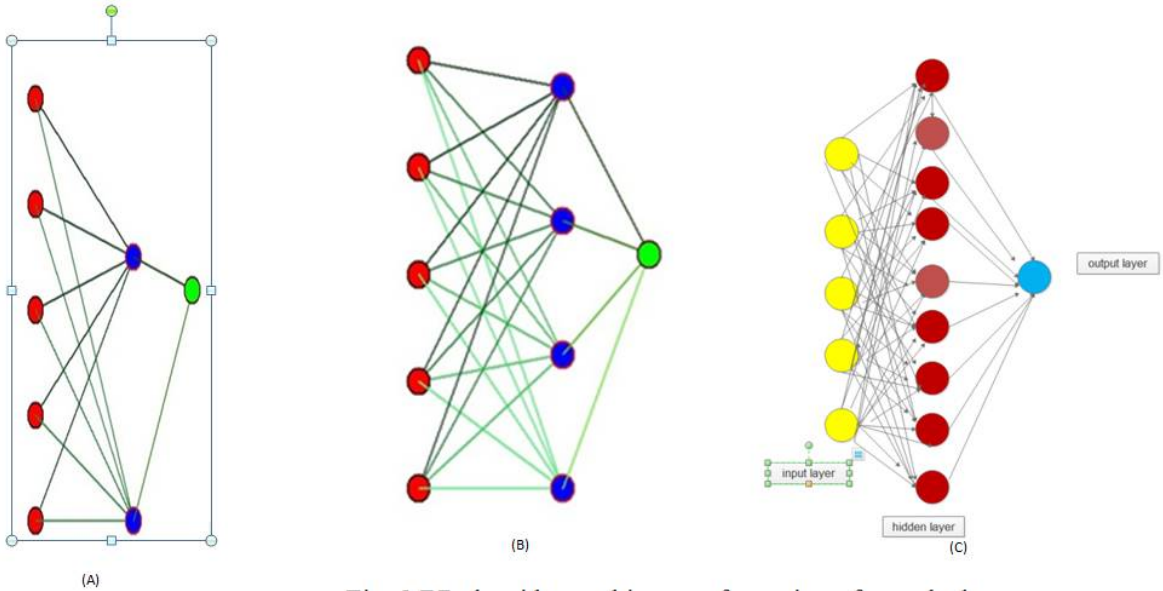

Fig. 8 BP algorithm architecture formation of sample data

Architecture (A) and (B) consisting of five neurons in the input layer, four neurons in the hidden layer and one neuron in the output layer has been used. Architecture (C) consisting of five the input layer, nine neurons in the hidden layer and one neuron in the output layer has been applied using the sample data.

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Table 1 Forecasting closing price

Criteria	Value(A)	Value(B)	Value (C)
X1	0.98	0.015120	0.32
X2	8.99	8.99	8.99
X3	0.52	0.42	0.48
X4	0.00002	0.0001	0.0002

The table 1 shows the total results forecasting closing price. The result shown in the table has fewer errors. It clearly shows that (A) that is lesser hidden layer (two) has under fit value and (C) the more hidden layer value (nine)has over fit value. The accurate bias value is calculated by (B) which has layer of 2/3(N+1) (four).

VII. CONCLUSION

Stock market forecasting plays a key role in investment. Therefore progress in automation of turnover on capital market. Forecasting share is a challenge of scientific environment. Back propagation in Artificial Neural Network(ANN) is more suitable traditional technique for stock prediction. The problem is in hidden layer selection. In this study we illustrate example to evaluate the performance of sample data .A three layer Back Propagation is used in this study. The experimental result shows using few or too many neurons in the hidden layer shows under and over fitting of stock. So for N neuron 2/3(N+1) is best accurate value.

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