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Embedding Neural Network in Knowledge Acquisition System

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***Abstract*—** In artificial neural networks, the knowledge stored as the strength of the interconnection weights is modified through a process called learning, using a learning algorithm. This algorithmic function, in conjunction with a learning rule, (i.e., back-propagation) is used to modify the weights in the network in an orderly fashion. In this proposed system a technique is used for extracting business knowledge from trained ANNs. It is organized into four sections that include acquisition of business data, knowledge extraction, representation by rules, and Controller for maintain the consistency of knowledge. The technique will use Back-propagation NN to predict stock prices and stock performance based on input of external variants such as government policies, quarterly export volumes etc. The application will also provide recommendations (or decisions) based on expected outcome, overall customer portfolio, and current market situation.

Key Words: neural network, knowledge acquisition, knowledge extraction, rules, back propagation algorithm.

I. INTRODUCTION

An artificial neural network is a computer program that can recognize patterns in a given collection of data and produce a model for that data. The working of neural networks is same as that of human brain. The network is composed of a large number of highly interconnected processing elements (neurons) working in parallel to solve a specific problem. Neural networks learn by example. They cannot be programmed to perform a specific task. It resembles the brain in two respects:

1) Knowledge is acquired by the network through a learning process (trial and error), and

2) Interneuron connection strengths known as synaptic weights are used to store the knowledge [2].

The knowledge embedded in a trained neural network is represented in terms of the activation functions, and the weights [1]. Several criteria can be used to classify the different methods for extracting knowledge from neural networks. Knowledge extraction from trained neural networks provides a way to explaining the functioning of a neural network. This is important for ANNs to gain a wider degree of acceptance.

A complex domain such as financial markets has many external parameters that affect the performance of various investment instruments such as stocks, bonds, and funds. An intelligent decision can be taken by manual thinking process teamed with intense experience built over a period of time and subjective factors such as personality, background, and motivation of decision maker etc. For a novice investor or a person seeking an objective decision in a short span of time without having to gather a lot of data manually, a computer system may come in handy.

This document describes the use of Neural Networks to analyze past and present data to come up with prediction of future outcomes in financial investment domain.

Financial market in National economies are strongly linked and heavily influenced of the performance of their Stock Markets. The characteristic that all Stock Markets have in common is the uncertainty, which is related with their short and long term future state. This feature is undesirable for the investor but when the Stock Market is selected as the investment tool, it is also unavoidable. We are trying to reduce this uncertainty. So, neural network suits better than other models in predicting the stock market returns.

A. Motivation

Existing systems predict stock performance by trying to classify stocks into the classes such as: stocks with either positive or negative returns and stocks that perform well, neutrally, or poorly. Such NN applications give valuable support to making investment decisions, but do not specify the amount of expected price and expected profit. Some systems try to predict stock prices for one or more days in advance, based on previous stock prices and on related financial ratios. However, there is a clear need for an application that provides a decision making platform based on expected gain and that can be understood by end customers who are financially not well versed. Like human information processing system, artificial neural system, or neural network, acquire, store, and utilize knowledge by learning. The knowledge is embedded in the networks that can be recalled in response to the presented information.

An important trend in the applications is combining two or more NN's into a single NN system, or incorporating other artificial intelligence methods into a NN system, such as expert systems, genetic algorithms, natural language processing. The number of Kohonen's, Hopfield's, and other algorithms is relatively small in the stock market NN applications.

This paper aims to provide a means of understanding and investigating the prediction of stock market using backpropagation neural network. Back propagation algorithm has the ability to predict with greater accuracy than other NN algorithms, no matter which data model was used. This paper demonstrates Knowledge acquisition and Back propagation

method for training the Neural Network in order to forecast the stock

B. Objectives & Scope

Knowledge acquisition is a frequent bottleneck in business intelligent systems, and knowledge extraction from trained artificial neural networks (ANNs) provides an excellent way for explaining the functioning of a business connectionist system [1]. Thus we would like to propose a system to acquire knowledge in the domain of business intelligent by applying the neural network technology.

Embedding neural network into the acquisition system will improve the throughput in this domain. In design and development of the said system building sub objectives are considered.

1. Classification of problem domain and design neural network model.
2. Knowledge acquisition system model using diagnosis.
3. Embedding neural network model into the knowledge acquisition system for the business application.
4. Test model for continuous approximation to achieve better performance.

II. LITERATURE REVIEW

A. Financial Domain Summary

If you calculate NPV, BCR, IRR, MCR, and payback, you have all the financial measures required both to compare your investment to other investments and also to sell your investment.

The NPV provides the means to select the best mutually exclusive alternative, while the BCR presents a gauge to rank your investment against others. The IRR, MCR, and payback provide other valuable information to help you measure your investment's performance.

NPV: The first tool we encounter is net present value, NPV. The net present value is the revenue or savings derived from an investment, less its cost. Future values are brought back to the present at a compound interest rate called the discount rate.

BCR: An important, but underutilized economic analysis tool is the benefit/cost ratio or profitability index. The benefit/cost ratio, B/C or BCR, is the present value of an investment's benefits divided by the present value of the initial cost.

The benefit/cost ratio shows, in an intuitive manner, how much discounted money an investment will yield. For example, a benefit/cost ratio of 1.50 describes a project that returns $1.50 in discounted money for each $1.00 invested.

IRR: Another widely used investment analysis tool is internal rate of return, IRR. The internal rate of return measures an investment's ability to repay capital. Internal rate of return gauges the internal merits of a project. It tells you the rate at which a project generates money. This rate is the compounded return rate, also called investment yield. Manual calculation of the IRR is difficult, but fortunately, Excel provides a built-in function.

Payback: Many investors use payback as an investment tool. Indicating the time it takes to recovery an investment, payback is easy to calculate, and it provides very useful information. Unfortunately, payback fails to fully account for the time value of money, because it excludes compounding.

B. Algorithm Summary - Neural Networks

- *What is Neural Network?*

A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. Mostly neural network is a collection of mathematical models that emulate some of the observed properties of biological nervous systems and draw on the analogies of adaptive biological learning. It is composed of a large number of highly interconnected processing elements that are analogous to neurons and are tied together with weighted connections that are analogous to synapses.

We will study the model of a neural network with the help of figure.1. The most common neural network model is the multilayer perceptron (MLP). It is composed of hierarchical layers of neurons arranged so that information flows from the input layer to the output layer of the network. The goal of this type of network is to create a model that correctly maps the input to the output using historical data so that the model can then be used to produce the output when the desired output is unknown.

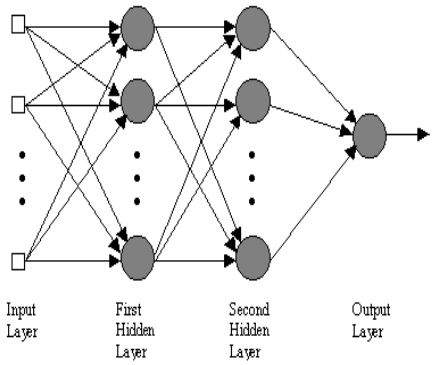

Figure1: Graphical representation of MLP

- *Resemblance with Brain*

The brain is principally composed of about 10 billion neurons; each connected to about 10,000 other neurons. Each neuron receives electrochemical inputs from other neurons at the dendrites. If the sum of these electrical inputs is sufficiently powerful to activate the neuron, it transmits an electrochemical signal along the axon, and passes this signal to the other neurons whose dendrites are attached at any of the axon terminals. These attached neurons may then fire. So, our entire brain is composed of these interconnected electro-chemical transmitting neurons. From a very large number of extremely simple processing units (each performing a weighted sum of its inputs, and then firing a binary signal if the total input exceeds a certain level) the brain manages to perform extremely complex tasks. This is the model on which artificial neural networks are based.

Neural network is a sequence of neuron layers. A neuron is a building block of a neural net. It is very loosely based on the brain's nerve cell. Neurons will receive inputs via weighted links from other neurons. This input will be processed according to the neurons *activation function*. Signals are then passed on to other neurons.

In a more practical way, neural networks are made up of interconnected processing elements called units which are equivalent to the brains counterpart, the neurons. Neural network can be considered as an artificial system that could perform "intelligent" tasks similar to those performed by the human brain. Neural networks resemble the human brain in the following ways:

1. A neural network acquires knowledge through learning.

2. A neural network's knowledge is stored within inter-neuron connection strengths known as synaptic weights.

3. Neural networks modify own topology just as neurons in the brain can die and new synaptic connections grow.

Graphically let us compare an artificial neuron and a neuron of a brain with the help of figures 2 and 3 given below:

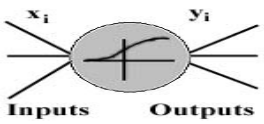

Figure2: Neuron of an artificial neural network

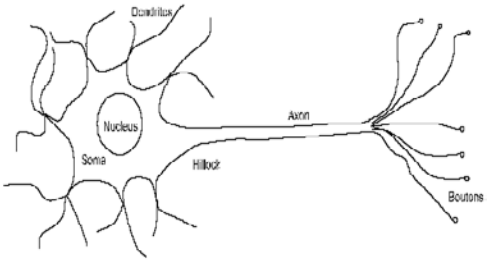

Figure3: Neuron of a brain

➢ *Basic Working of Neural Networks*

In artificial neural networks, the knowledge stored as the strength of the interconnection weights (a numeric parameter) is modified through a process called learning, using a learning algorithm. This algorithmic function, in conjunction with a learning rule, (i.e., back-propagation) is used to modify the weights in the network in an orderly fashion.

Artificial Neural Network (ANN) is the most commonly used technique in many predictions problems. ANN has developed for many years, and it has been confirmed to provide good performances on forecasting stock price [5], [6]. Artificial neural networks (the ones that run on a computer as opposed to a brain) can be thought of as a model which approximates a function of multiple continuous inputs and outputs as shown in Fig. 1.The network consists of a topology graph of neurons, each of which computes a function (called an activation function) of the inputs carried on the in-edges and sends the output on its out-edges. The
inputs and outputs are weighed by weights w_ij and shifted by bias factor specific to each neuron. For certain neural network topologies, any continuous function can be accurately approximated by some set of weights and biases. Therefore, we would like to have an algorithm which when given a function (f), learns a set of weights and biases which accurately approximate the function. The most common form of ANN in use for stock market prediction is the feed forward network utilizing the backward propagation of errors algorithm to update the network weights. These networks are commonly referred to as back propagation networks.

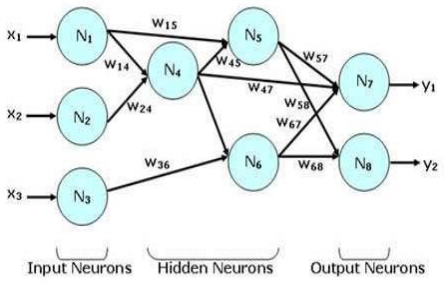

Figure4: Feed Forward Neural Network

Table1: Activation Function

Activation Functions	
Name	**Formula**
Identity	$A(x) = x$
Sigmoid	$A(x) = \frac{1}{1+e^{-x}}$
Tanh	$A(x) = \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}$
Step	$A(x) = \begin{matrix} -1 & if\ x < 0 \\ 1 & if\ x \geq 0 \end{matrix}$

➢ *Knowledge Acquisition*

Knowledge acquisition is the process of absorbing and storing new information in memory, the success of which is often gauged by how well the information can later be remembered (retrieved from memory). The process of storing and retrieving information depends heavily on the representation and organization of the information. Similarly, knowledge acquisition can be improved by considering the purpose and function of the desired information. The knowledge embedded in a trained neural network is represented in terms of the activation functions, and the weights [1]. Several criteria can be used to classify the different methods for extracting knowledge from neural networks. Knowledge extraction from trained neural networks provides a way to explaining the functioning of a neural network. This is important for ANNs to gain a wider degree of acceptance.

➢ *Backpropagation Algorithm*

Backpropagation is a supervised learning algorithm that applies to non-linear, multilayer, feedforward structure of nodes (networks). It works on minimizing the Mean Square Error, MSE, of the network. Basically, it requires no rules, no equations, and no conventional programming. It can be highly efficient for some large data sets via self-organizing, learning, and forgetting.

Backpropagation refers to the method for computing the gradient of the case-wise error function with respect to the weights for a feedforward network, a straightforward but elegant application of the chain rule of elementary calculus. A back propagation neural network learning methodology will be used to obtain the output. A subset of available daily stock return data will be used to construct the neural network. The network so constructed will be trained using the training data set. Training of a back propagation network involves obtaining optimal values for the learning rate, the momentum of learning, estimating the number of hidden layers and the number of nodes in each layer. The training of the network will be done using different combinations of learning algorithm and transfer functions. The overall error is tracked until a minima is obtained by altering the fore mentioned parameters. The net so obtained with minimum error is saved and this trained network can then be used in predicting future stock market returns. Accuracy of the performance of the neural network is compared against a traditional forecasting method.

➢ *Rule Extraction Process*

An ANN extracts information from a training series formed by input-output pairs, or simply input if unsupervised training is used. Based on the information obtained, it will be

able to offer output for input not previously seen during the learning process. Even if the provided answer is correct, the artificial neural network does not provide any information about why one particular solution has been chosen: it behaves like a "black box". In business, different rule-extraction techniques using ANN have been used and applied to multi-layer ANN, as they are easier to handle. Figure shows the rule extraction techniques. Once the ANNs have been designed and trained, the same training and test values may be used in order to generate a second data pattern which will be used to search for the rules that the ANN has acquired during the training process. The knowledge would include the information about the type of data used by the ANN, or the type of business problem trying to be solved. These ANNs have a limited capacity with regard to the knowledge that can be distributed among their connections.

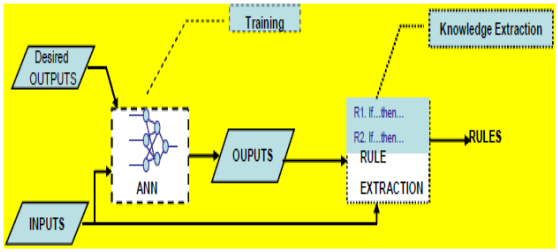

Figure5: Rule extraction process from trained ANN

C. Application Technology Summary

➢ *Servlet*

Java Servlet technology provides Web developers with a simple, consistent mechanism for extending the functionality of a Web server and for accessing existing business systems. A servlet can almost be thought of as an applet that runs on the server side--without a face. Java servlets make many Web applications possible. Servlets are the Java platform technology of choice for extending and enhancing Web servers. Servlets provide a component-based, platform-independent method for building Web-based applications, without the performance limitations of CG programs.

Servlets have access to the entire family of Java APIs, including the JDBC API to access enterprise databases. Servlets can also access a library of HTTP-specific calls and receive all the benefits of the mature Java language, including portability, performance, reusability, and crash protection.

➢ *JSPs*

Java Server Pages (JSP) technology provides a simplified, fast way to create dynamic web content. JSP technology enables rapid development of web-based applications that are server- and platform-independent.

JavaServer Pages (JSP) technology enables Web developers and designers to rapidly develop and easily maintain, information-rich, dynamic Web pages that leverage existing business systems. As part of the Java technology family, JSP technology enables rapid development of Web-based applications that are platform independent. JSP technology separates the user interface from content generation, enabling designers to change the overall page layout without altering the underlying dynamic content. The JSP specification is the product of industry-wide collaboration with industry leaders in the enterprise software and tools markets, led by Sun Microsystems. Sun has made the JSP specification freely available to the developer community, with the goal that every Web server and application server will support the JSP interface. JSP pages share the "Write Once, Run Anywhere" advantages of Java technology.

➢ *MySQL*

MySQL is the world's most popular open source database software, with over 100 million copies of its software downloaded or distributed throughout its history. With its superior speed, reliability, and ease of use, MySQL has become the preferred choice for Web, Web 2.0, SaaS, ISV, Telecom companies and forward-thinking corporate IT Managers because it eliminates the major problems associated with downtime, maintenance and administration for modern, online applications. Many of the world's largest and fastest-growing organizations use MySQL to save time and money powering their high-volume Web sites, critical business systems, and packaged software including industry leaders such as Yahoo!, Alcatel-Lucent, Google, Nokia, YouTube, Wikipedia, and Booking.com.

The flagship MySQL offering is MySQL Enterprise, a comprehensive set of production-tested software, proactive monitoring tools, and premium support services available in an affordable annual subscription. MySQL is a key part of LAMP (Linux, Apache, MySQL, PHP / Perl / Python), the fast-growing open source enterprise software stack. More and more companies are using LAMP as an alternative to expensive proprietary software stacks because of its lower cost and freedom from platform lock-in.

➢ *JFreechart*

JFreeChart is an open-source framework for the programming language Java, which allows the creation of complex charts in a simple way. JFreeChart also works with GNU Class path, a free software implementation of the standard class library for the Java programming language. Following chart types are supported:

- X-Y charts (line, spline and scatter)
- Pie charts
- Gantt charts
- Bar charts (horizontal and vertical, stacked and independent)
- Single valued (thermometer, compass, speedometer)

JFreeChart is a free 100% Java chart library that makes it easy for developers to display professional quality charts in their applications. JFreeChart's extensive feature set includes:

- a consistent and well-documented API, supporting a wide range of chart types;
- a flexible design that is easy to extend, and targets both server-side and client-side applications;
- support for many output types, including Swing components, image files (including PNG and JPEG), and vector graphics file formats (including PDF, EPS and SVG);
- JFreeChart is "open source" or, more specifically, free software. It is distributed under the terms of the GNU Lesser General Public License (LGPL), which permits use in proprietary applications.

III. PROPOSED SYSTEM: EMBEDDING NEURAL NETWORK IN KNOWLEDGE ACQUISITION SYSTEM.

Knowledge acquisition is a frequent bottleneck in business intelligent systems, and knowledge extraction from trained artificial neural networks (ANNs) provides an excellent way for explaining the functioning of a business connectionist

system [1]. Here we are considering important of ANNs to gain a wider degree of acceptance in problem domain applications function approximation & time series prediction. This typical application could be implemented into hybrid business intelligent systems.

In this proposed system a technique is used for extracting business knowledge from trained ANNs. It is organized into four sections that include acquisition of business data, knowledge extraction, representation by rules, and Controller for maintain the consistency of knowledge.

The technique will use Back-propagation NN to predict stock prices and stock performance based on input of external variants such as government policies, quarterly export volumes etc. The application will also provide recommendations (or decisions) based on expected outcome, overall customer portfolio, and current market situation.

PROPOSED HIGH-LEVEL ARCHITECTURE:

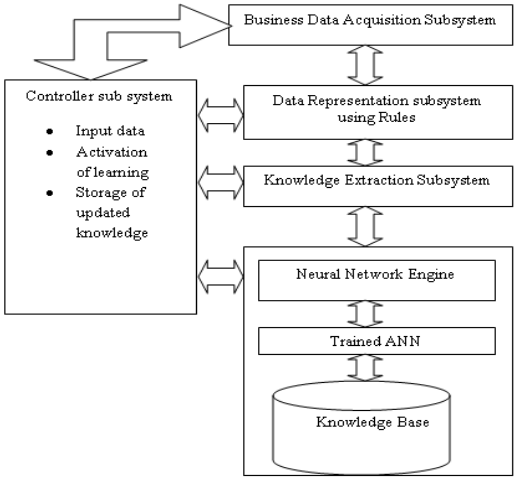

Figure6: Block Diagram of Proposed High-level Architecture

A. Working of sub-models

- *Business Data Acquisition Subsystem*

This system acquires the business related data from the knowledge base through controller subsystem. It takes data from user or controller subsystem and passed it to the next subsystem for further processing. Knowledge passing through control sub system in the form of prediction in future is given to this system for showing output. Neural networks which are trained in such a way that they provide an appealing solution to the problem of knowledge acquisition.

- *Controller Sub System*

It gives input data, rules & extracted data. it also provides the activation of learning, storage of updated knowledge that will help to maintain the consistency of data & updation of data.

- *Data Representation Subsystem using Rules*

This subsystem helps to formulate or represent data in the form of If-Else rules. These if-else rules are then extracted in the form of knowledge acquired by the system and passed to the knowledge extraction system for extracting and training purpose. System is created and manipulated for further prediction. Use machine learning to automate the process of knowledge acquisition.

- *Knowledge Extraction Subsystem*

An ANN extracts information from a training series formed by input-output pairs, or simply input if unsupervised training is used. Based on the information obtained, it will be able to offer output for input not previously seen during the learning process.

- *Neural Network Engine*

The NN engine helps to train the updated data from the subset of current data using backpropagation algorithm and then save the updated data to the knowledge base. Hence whenever you are inserting new updated data it will train the data from knowledge base using backpropagation to predict the value.

- *Trained ANN*

Using neural network engine current data is trained using backpropagation algorithm. Then the current data/knowledge is stored in the form of updated neural network. This module provide the trained artificial neural network, is passed to the storage knowledge base and from this to the controller sub system for retrieving purpose.

- *Knowledge Base*

This module is used to store the knowledge from trained neural network so that it can be used to train new data as per the user request. The knowledge would include the information about the type of data used by the ANN, or the type of business problem trying to be solved.

- *Machine Learning:*

Machine learning is the subfield of AI that studies the automated acquisition of domain-specific knowledge. All these methods use a set of samples to generate an approximation of the underling function that generated the data. Machine learning approach is appealing for artificial intelligence since it is based on the principle of learning from training and experience. The goal of these systems is to improve their performance as the result of experience. Connectionist models, such as ANNs, are well suited for machine learning where connection weights are adjusted to improve the performance of a network.

- *Activation functions*

The activation function acts as a squashing function, such that the output of a neuron in a neural network is between certain values (0 and 1, or -1 and 1). Each neuron has an activation function associated with it (often times all neurons have the same activation function). The steps for computing the output of a single neuron are as follows: (1) compute the weighted sum of inputs to the neuron (2) add the bias to the sum (3) feed the sum as an input to the activation function of the neuron. The output of the activation function is defined to be the output of the neuron.

- *Training a Neural Network*

Learning in a neural network is called training. Like training in athletics, training in a neural network requires a coach, someone that describes to the neural network what it should have produced as a response. From the difference between the desired response and the actual response, the error is determined and a portion of it is propagated backward through the network. At each neuron in the network the error is used to adjust the weights and threshold values of the neuron, so that the next time, the error in the network response will be less for the same inputs. This corrective procedure is called backpropagation and it is applied continuously and repetitively for each set of inputs and corresponding set of outputs produced in response to the inputs. Training a network involves presenting input patterns in a way so that the system minimizes its error and improves its performance. The training algorithm may vary depending on the network architecture.

B. Back propagation Neural Network

A back propagation neural network learning methodology will be used to obtain the output. A subset of available daily stock return data will be used to construct the neural network. The network so constructed will be trained using the training data set. Training of a back propagation network involves obtaining optimal values for the learning rate, the momentum of learning, estimating the number of hidden layers and the number of nodes in each layer... The net so obtained with minimum error is saved and this trained network can then be used in predicting future stock market returns. With backpropagation, the input data is repeatedly presented to the neural network. With each presentation the output of the neural network is compared to the desired output and an error is computed as shown in Fig. 2. This error is then fed back (backpropagated) to the neural network and used to adjust the weights such that the error decreases with each iteration and the neural model gets closer and closer to producing the desired output. This process is known as "training".

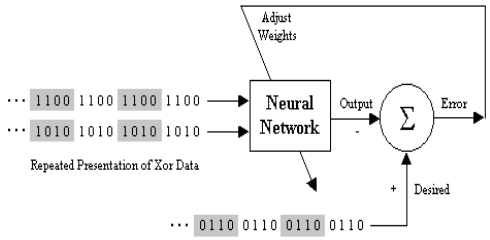

Figure7: Backpropagation learning using XOR data.

IV. FUTURE ENHANCEMENT

As we are developing neural network model for business application like stock prediction using knowledge acquisition techniques, this model/application can be enhanced to apply to many different types of instruments such as debt instruments, funds etc apart from stocks.

Currently, we plan to predict stocks on the basis of daily market data. The software can be enhanced to predict using weekly and monthly data as well.

We could provide prediction engines that use Hopfield's, Kohonen's NNs as well. The choice of engines used can be a part of setup or a user-preference.

We could provide attractive features such as the following:

- SMS/email notification of new Fund/Bond/IPO coming on the market that is suitable to an investor's portfolio
- Integration with existing portfolio management systems to exchange data
- Integration with demat accounts for quick investments

Further enhancements could be made to the technical robustness, scalability, usability, and commercial appeal of the application itself.

V.CONCLUSION

Here we are embedding neural network in knowledge acquisition system for business application like stock prediction. For this business application i.e. in stock prediction we are using back propagation neural network embedding in knowledge of business data and can be concluded that by providing an easy web-based user interface for decision making during investments, the following benefits can be achieved:

- Reduced hassle of data collection.
- Reduced delays in decision making due to lengthy analysis.
- More conscious decision due to multiple scenario-playing.
- Lesser dependence of third parties for decision making.
- Reporting of historic data and wealth gain over a period of time.
- No learning required for an informed decision!

The system can become an easily usable tool which can integrate with various other portals in future to give an end-to-end investment service to investors, right from shopping, analyzing, deciding, to investing and tracking.

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