Stock Prediction using Functional Link Artificial Neural Network (FLANN)

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ABSTRACT: Stock exchange that is, buying and selling of stock is considered to be an important factor in the economy sector. The Stockbrokers typically use time series or technical analysis in predicting the stock price. These techniques are based on trends and not the actual stock value. Therefore a method of prediction which takes into account the historical values of stock is desired. Neural Networks once again have become famous for prediction of stock. This is due to their ability to deal with non-linear data. The use of Artificial Neural Networks to for predicting the stock prices is proposed in this paper. The input features to the model sometimes can be non-related to the output. Hence, Functional Link Artificial Neural Networks is used here to increase the number of related features in the form of inputs. The data is taken from NSE and is converted into a suitable form for FLANN and then prediction is carried out using Multi-layer feed forward Perceptron model.

Keywords: MLP, ANN, FLANN, Stock Market

I. Introduction

Stock markets are institution where people buy and sell stocks with the help of stockbrokers. Stockbrokers guide them about when to sell or buy a new stock [1]. Due to the high risk, their investment is guided by prediction. They are under the influence of unique factors: input and output mapping (universal approximation),the practice of adapting in accordance with environment and start unreliable assumptions about the given physical circumstances that gives input data. Our model aims to provide promising results using densely interconnected simple computational entities. The neural networks provide good applications in the fields where data involves non-linear patterns[2], which the network has to learn. According to Wong [3], the fields of neural system applications in recent years are finance (25.4%) and production/operations (53.5%). Neural Networks are highly applicable in stock selection and prediction in the field of finance. Neural Network consists of input layer, hidden layers which have multiple neurons and an output layer. The inputs are the features on which the output depends. Functional Link Artificial Neural Networks allow us to increase the number of input features by applying a function on the current inputs. FLANN generally uses a single layer model for better computation speed [4].

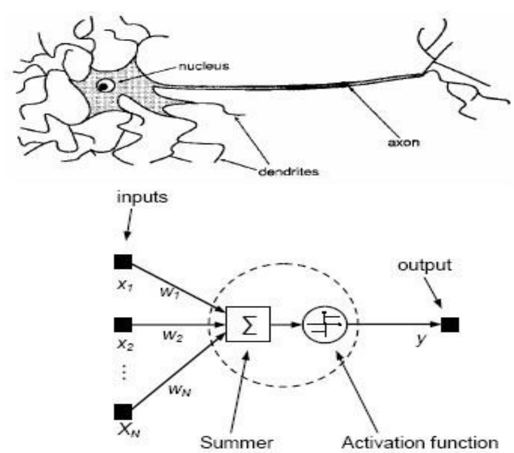

Figure 1: Human brain neuron v/s Artificial Neuron

II. Literature Review

For the last two decades, stock predicting has been an emerging field. Though many researchers have attempted at providing non-linear models for stock prediction, Artificial Neural Networks have been proved to be a more promising technique in acquiring the relationship among non-linear data. Siekmann et al. [5] uses fuzzy algorithm to break inputs into increasing, steady, and decrement trend variables. His implementation of network structure consisted of fuzzy logic between the first and second hidden layers. Kim [6] made use of a genetic algorithm for transforming continuous input values into discrete ones. The GA (genetic algorithm aimed at reducing the complexity. They used Neural Network modified by GA. Kim and Chun used refined PNN (probabilistic neural network)for predicting the index of stock market [7]. ANN has been used to diagnose diabetes [8]. There has been work in portfolio construction as well. Jovian Roman and Akhtar

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Jameel, have proposed in their paper a new methodology to enhance the designing of portfolio for investing in multiple stock markets [9]. To implement this, they used recurrent network and backpropagation algorithm. They used the accuracy of prediction of the neural network to create a determinant that is used to select the stock market among other markets. Bruce J. Vanstone, Gavin Finnie and Clarence Tan [10] in their study showed that stocks with a potential to rise significantly can be identified using Artificial Neural Networks (ANN). Dase R.K. and Pawar D.D. [11] in their research said that the World Predicting stock market index is a difficult task, but artificial neural network is having ability to predict stock index. Due to the availability of multiple hidden layers, the computation cost of most of the models is generally high. In order to reduce the computational cost and execution time, functional link artificial neural networks were proposed [12]. They increase the input by applying some function. According to this function, they are called, polynomial perceptron network (PPN), trigonometric based functional link artificial neural network (TFLANN), Legendre functional link artificial neural network (LeFLANN) .

3. Neural Networks

A neural network can be thought of as a parallel distributed processor that is made up of processing units. These units have the tendency to storing experimental knowledge and making sure it is available for use [13]. Neural networks are excellent in deriving meanings from imprecise and unpredictable data and are very remarkable in detecting trends and patterns that go undetermined by human beings or other computational methods. A well trained neural network, given information to analyse can be called an "expert" in that category of information it has been given to analyse. We are using a MLP (multiple layer perceptron) model in this paper.

3.1 Multiple Layer Perceptron

A MLP(multiple layer perceptron) is a structure that consists of a set of sensory units. They comprise of an input layer, multiple hidden layers (one or more) for computation purpose and an output layer that gives the result of computation[14] (shown in Figure 1). In the feed forward structure of the Multiple Layer Perceptron, a network consists of layers with nodes and these nodes are fully connected through the synaptic weights to the nodes in the previous layer. The input signal follows layer by layer propagation through forward direction.

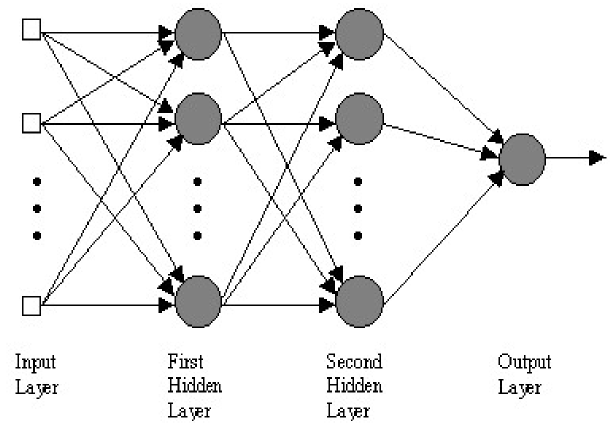


Figure 2: Artificial Neural Network with multiple layers.

The network structure is carried out in forward and backward phase. In forward phase, the effects of the pattern applied on the input phase propagate through network layer by layer. The actual true response of network system gives the set of outputs of output layer. The weights of the networks are all fixed during the forward phase. In the second phase (backward phase), the synaptic weights are adjusted while going in the backward direction. This is done according to known as Back Propagation algorithm [15] for error correction.

3.2 Functional Link Artificial Neural Network

The Multiple Layer Perceptron model that is trained with Back Propagation has a drawback. This network requires a large amount of computation cost, meaning the time taken to perform learning and predicting the output is high.

Functional Link Neural Network (FLNN) is proposed here. This approach is much easier and simpler to execute than multiple layer perceptron with back propagation. This is generally a single layer network structure that is there is only one hidden layer for computation. The nonlinearity is introduced when the input data is increased or enhanced with nonlinear functional expansion [16]. The benefit of the proposed network is that it requires less time and workload to perform the task than the multiple layer perceptron with backpropagation. It has been observed that with the proper choice of function to perform expansion, the output of this network can be better than multiple layer perceptron with back propagation. In Functional Link

Artificial Neural Networks, we increase the dimensionality of our input features by applying some function. The use of different functions gives different names to the FLANN model. Various functions used are Trigonometric, Chebysheb, Legendre and Lagurre polynomeials [17]. According to these functions, the models are termed as TFLANN, CFLANN, LeFLANN, LFLANN. If we have a feature x1, we can apply a functions like sin((pi)*x1) , cos((pi)*x1), sin(2*(pi)*x1) and cos(2*(pi)*x1) to generate multiple features from a single feature x1.

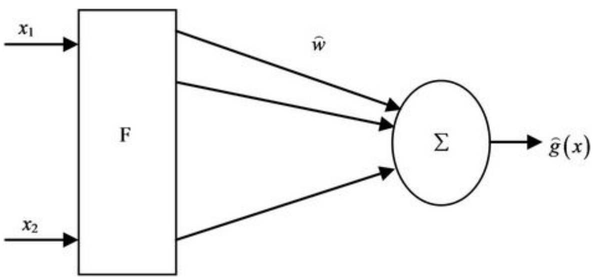


Figure 3: (Functional Link Artificial Neural Network. There are initially two features x1 and x2. After applying functional expansion (F), they are converted into more features.)

4. Methodology

4.1 Data

National Stock Exchange of India (NSE) is the most prestigious stock exchange of the country, started as the first stock electronic exchange in the country in 1992 Mumbai. The NSE Website has a database that contains historical data of stock index and other related data. NIFTY50 is the major stock index of NSE and it consists of 50 actively traded stocks from various sectors [18]. The NIFTY Auto Index which is used in this research reflects the bhaviour and performance of Automobile Sector. This index includes cars, motorcycles, heavy vehicles, auto ancillaries, tyres, etc. The Nifty Auto Index Comprises of the following companies: Apollo Tyres, Ashok Leyland, Bajaj Auto, Bosch, Hero Motocorp, Mahindra and Mahindra, Maruti Suzuki, MRF, Tata Motors and few other companies. The dataset contains the historical stock index for NIFTY Auto for one year. The values of Stock open, close, low, high and stocks traded are provided by NSE India Website.

4.2 Normalization

To speed up the process of prediction, we can make sure that our input values are roughly in the same range. This is helpful because if the data in present in a big range of values, the calculation of local minima takes a lot of time and may result in inaccurate value. When we use the input values that are in the same range, this process speed up and the local minimum can be found with much efficiency. In our research, the data is normalized by simply dividing the open values by the maximum open value and dividing the close values by the maximum close value.

4.3 FLANN Implementation

As we discussed earlier, Functional Link Artificial Neural Networks are useful in increasing the input dimension by increasing the related input data. FLANN generally uses a single hidden layer for computation. For this research, we first normalize the data and then increase the input features using Trigonometric FLANN.

open(normalized)	sin(open)	cos(open)	close(normalized)	NextDayOpen
0.70899514	0.651071394	0.759016495	0.702126948	0.709770872
0.709770872	0.651659992	0.75851121	0.705401749	0.710024661
0.710024661	0.651852472	0.758345801	0.716722522	0.719558503
0.719558503	0.659052688	0.752096772	0.709766557	0.704048651
0.704048651	0.647308978	0.762227713	0.697580472	0.696952139
0.696952139	0.641883566	0.766802118	0.688664407	0.691306534
0.691306534	0.637544298	0.7704137	0.664469124	0.670682596
0.670682596	0.621520876	0.783397601	0.676425734	0.682601097
0.682601097	0.630813436	0.775934539	0.706702108	0.712117222
0.712117222	0.653437929	0.756980101	0.693081803	0.694802117
0.694802117	0.640233442	0.768180408	0.69998518	0.708545024

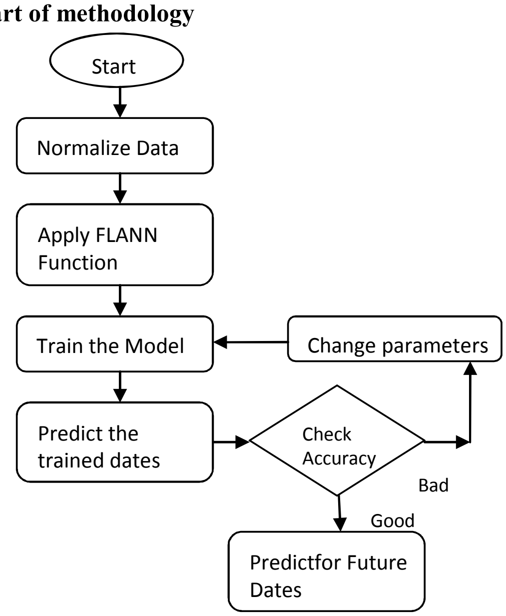
Figure 4: FLANN input features.

Our initial data consisted of Open and Close values of the stock index. To use the Trigonometric FLANN approach, we increased the number of input features by taking the sine and cosine of the stock open value. Now the first four columns will be used as the input and the last column “Next Day’s Open” will be used as the output.

4.4 Multiple Layer Perceptron (MLP) Implementation

A multiple layer perceptron takes multiple features as input, has multiple hidden layers and then represents the output in the form of a single layer. We have used a four layer network as 4, 4, 1. Four inputs, four total layers (two hidden layers) and one output. We have used LMS (Least Mean Square) as the learning method. The LMS algorithm was developed by Widrow and Hoff in 1960. It is a linear adaptive filtering algorithm that is used for solving prediction problems. In the perceptron learning algorithm, the training of perceptron is continued until the network can perform correct classification on the training set. But in the case of LMS, there is another termination criterion for the training of perceptron. So instead of using the previously known method, where the perceptron is trained until a solution is found, another method is to calculate the Mean Square Error (MSE) and continue to train the network while the value of MSE is greater than a preferred value. This is the basis for the LMS algorithm. We can set this value as small as 0.01. Learning rate is a value that defines the frequency of each iteration. If the learning rate in small, then there will be more iterations as we move from one point in our data to the other. If learning rate is set to a high value, we might miss the points in the data where the error was minimum.

4.5 Flowchart of methodology



4.6 Training

As the flowchart explains, the normalized data is changed by applying FLANN functions. The newly formed data set is used in our model. We have used 218 days data to train the model. After training, we predict the outputs for these 218 dates to check whether the model is training properly or not. The next step is to predict the Next Day Stock open price for the future dates. We will be predicting the stock values for the next 30 days. The outputs are calculated and compared with the original values using MS Excel. The Figures show the absolute error calculated in MS Excel.

The training data with its error is shown in the figure 5.

Actual	Experimental	Absolute Error
7411.25	7476.317823	0.87796
7413.9	7493.097521	1.06823
7513.45	7543.501706	0.399972
7351.5	7546.002608	2.645754
7277.4	7440.41684	2.240042
7218.45	7380.089106	2.239249
7003.1	7264.72863	3.735897
7127.55	7251.611281	1.740588
7435.75	7409.916329	0.347425
7254.95	7447.954946	2.660321

Figure 5: Actual v/s Experimental values using FLANN

The accuracy of the trained data can be seen in the form of a graph.

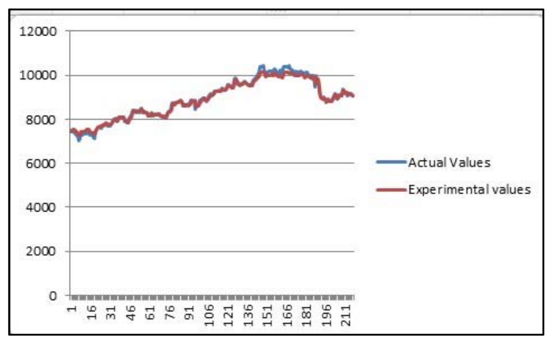


Figure 6: Plot of Actual v/s Experimental values using FLANN

The graph shows that for most of the values of dates, the actual and experimental values are close to each other. This training performance is compared to the training performance of a simple Multiple Layer Perceptron Model with 4 inputs (open, high, low, close), 4 hidden layers and one output (The next Day open value). The training process for Multiple Layer Perceptron Model is shown in the Figure 7 and Figure 8

Actual	Experimei	Absolute Error
7411.25	7640.539	3.093793
7413.9	7668.653	3.436153
7513.45	7820.143	4.081917
7351.5	7718.072	4.986362
7277.4	7587.024	4.254591
7218.45	7460.447	3.352474
7003.1	7059.812	0.809806
7127.55	7284.273	2.198833
7435.75	7718.15	3.797869
7254.95	7479.839	3.099794

Figure 7: Actual v/s Experimental values using MLP

The training result for MLP is shown in the form of a graph for better visualization.

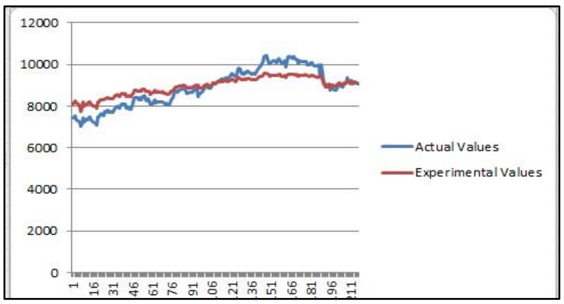


Figure 8: Plot of Actual v/s Experimental values for MLP

This graph shows that the prediction for the training data is not as accurate as we observed for the case when we used FLANN. Figure 5 and Figure 7 show that the absolute error while using MLP is significantly more than the absolute error while using FLANN.

4.7 Prediction

To perform the prediction for future dates, the data used contains the dates that were not used for training. These are the thirty dates following the last date of training data set. The prediction will be performed by MLP and then by FLANN. While using the FLANN model for prediction, the model is set for four inputs, one hidden layer and a single output. The output is obtained and then saved in a tabular form in MS Excel. The calculation of Absolute error is done in MS Excel. When using MLP model for prediction, the model is set for four inputs, two hidden layers and a single output. The output in both the cases is the next day stock open value. The output for MLP is obtained and stored in MS Excel and then the absolute error is calculated.

5. Result

The prediction process for the next thirty days is completed now and the outputs are stored in MS Excel. These outputs are compared with the expected values and hence absolute error is calculated.

Actual	Experimental FLANN	Absolute Error
9002.7	9045.797559	0.478718156
8917.7	8994.597887	0.86230628
8973.05	8965.846295	0.08028156
8864.7	8922.713065	0.654427839
9009.75	8941.807953	0.754094702
8969.15	9008.598419	0.439823385
9136.85	9055.240214	0.893193891
9169.95	9153.686615	0.177355222
9331.4	9259.652311	0.768884504
9336.6	9321.725969	0.15930886

Figure 9: Prediction using FLANN

The accuracy of the system can be seen in the form of a graph.

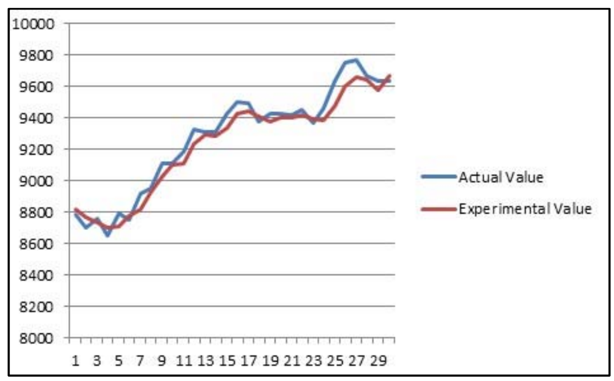


Figure 10: Plot of prediction using FLANN

It can be seen in the graph that the experimental value is close to the actual value for most of the data. The figure 10 also show that the prediction curve is similar to the actual curve, meaning the system was able to predict the stock trend for the next 30 days. This shows that the total error is significantly low.

The prediction is also performed using MLP and the results are shown.

Actual	Experimental MLP	Absolute Error
9002.7	9097.752684	1.055824198
8917.7	9083.859417	1.863254147
8973.05	9101.39865	1.430379342
8864.7	9045.930124	2.044402256
9009.75	9102.175123	1.025834507
8969.15	9096.356427	1.418266296
9136.85	9135.41653	0.015688873
9169.95	9137.201114	0.357132622
9331.4	9174.638384	1.679936723
9336.6	9167.460202	1.811578107

Figure 11: Prediction using MLP

It can be seen in the Figure 11 that the absolute error is more than compared to FLANN for almost every entry. The visual description of prediction using MLP can be seen in Figure 12

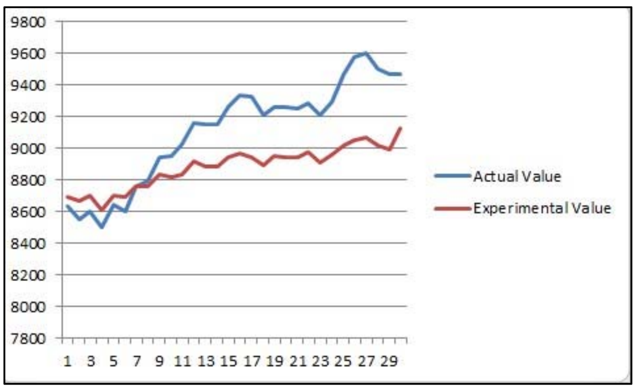


Figure 12: Plot of prediction using MLP

The table shows the errors for only ten values. When we look at the complete thirty values, we can see that the error in the case of MLP is significantly high. Hence, it can be seen that FLANN implementation is more accurate than Multiple Layer perceptron.

6. Conclusion

Stock prediction has always been a hot topic in the research field. People that are interested in buying or selling stocks usually hire a stock broker for an expert advice. The stock broker then uses an algorithm or study the market trend to predict what will be the value of a stock. Understanding the trend or the time series without the help of an algorithm is a difficult task. Artificial neural Networks have a great working ability in the area where the data is non-linear. A multiple layer perceptron model is the basic model which can have multiple hidden layers to perform operations. We have used MLP and Functional Link Artificial Neural Networks (FLANN). FLANN is a method by which we can increase the input dimensions by applying some function on the input data. We have successfully implemented both the techniques in this paper and then drawn the comparison between them. The standard MLP is a good option, but it takes more time to compute because of the multiple hidden layers. Using FLANN makes the system work faster because it is a single layer model with increased inputs. We can see in the results section that the Absolute Error for MLP is more than the absolute Error in FLANN for both the training as well as the prediction process. Hence the paper concludes that using FLANN with a basic one layer neural network can outperform the traditional Multiple Layer Perceptron model(MLP).

7. Future Scope

The prediction of stock has always been an interesting research. Stocks are a very important method of earning money as compared to other securities such as a government bond. Hence a lot of work is being done on predicting the future stock. We used two techniques of Artificial Neural Networks that are Multiple Layer Perceptron (MLP) and Functional Link Artificial Neural network. With improvements in the research, using more historical data, using a more powerful machine to compute data, using more functions to create the inputs, the FLANN approach can be further improved. Stock prediction will always have a scope in the future and hence these techniques will keep on evolving to make the prediction process more robust and accurate.

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