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ARTIFICIAL NEURAL NETWORK IN PREDICTING PRICE MOVEMENTS IN STOCK MARKET – A LITERATURE SURVEY

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Abstract: Predicting stock market using data mining has enabled investors to discover better price for their stocks. Enter artificial intelligence; we have a system, which atomizes this prediction. A great task cut short for the investment bankers alike. Since the availability of data has become easy at present with high frequency, prediction through neural network is considered more accurate. This is greatly assisted by the advancement in algorithms in machine learning models. Accuracy level has improved and prediction has improved the return generated by the traders in stock market alike. The present study keeping this is in focus collected research papers published in Artificial Neural Network (ANN) and analysed the outcomes during the last ten years. The study find that most commonly used algorithm at present are Support Vector Machine (SVM), Regression, Multi-Layer Preceptors (MLP), Random Forest (RF), Decision Tree (DT), Feed Forward Propagation (FFP), Feed Backward Propagation (FBP), self-organizing map (SOM) and more. Of all these, SVM and Hybrid Algorithm are gaining importance amongst the researchers due its capability in predicting with more accuracy than before.

Keywords: Data Mining, Artificial Intelligence (AI), Artificial Neural Network (ANN), Supervised and Unsupervised Learning, Support Vector Machines, Hybrid Algorithm.

1. INTRODUCTION

Data is a value of an attribute. When accepting the value to the attribute, it leads to increase the size of data. Huge collection of data companies to form database. In data mining, the attributes are manipulated to perform a particular task successfully. Data mining deals with the structure of data, representation of data, identification of data, segregation of data, pre-processing of data, transformation of data and manipulation of data. Today we are made available with a huge amount of data; a data that mixed which does not convey any meaning to the user or to the viewers. The data mining tools are used to convert the available data into a meaningful form. With the help of the data mining, forecasting is possible in most cases with the maximum possible occurrence.

Data structure is a subject, which helps the user to understand the storing and retrieving process of data into and fro from the storage medium. The common method in which most of the systems are same, either stack (LIFO) or queue (FIFO). When compare to LIFO, FIFO is very easy and quick in both the function (storing and accessing).

Support Vector Regression (SVR) uses the same logic as the Support Vector Machine (SVM) for classification, with a few minor differences. In regression, a margin of tolerance is set in approximation to the SVM which would have given from the problem. The output is a real number it becomes very difficult to predict the information, which has infinite outcomes. In fact, it is also a very difficult; the algorithm is more complicated therefore to be taken in consideration. The main concept is the same to minimize error, in individualizing the hyper plane which maximizes the margin.

Support Vector Machine (SVM) is a supervised machine learning algorithm, which can be used for both classification and regression task. However, it is

commonly used in classification problems. Marking each data item as a point in n-dimensional space with the value, of each feature is the value of a particular coordinate. We perform classification by finding the hyper-plane that differentiates the two classes very well. Support vectors are simply the co-ordinates of individual observation. Support vector machine is a frontier which best separates the two classes.

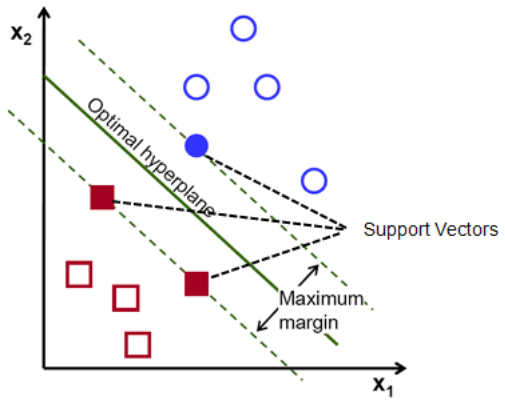

Figure 1: Support Vector Model

The genetic algorithm allows a population composed of many individuals or chromosomes to evolve under predefined selection rules to a state that maximizes the fitness. A string in its turn, consists of a number of genes, which may take some number of values called alleles. The genetic algorithm terms for genes and alleles are features and values. Associated with each string is a fitness value, which determines the goodness of a string. The fitness value is determined by a fitness function. Three operators lead to good results in a genetic algorithm.

1. *Reproduction*: It is a process in which strings are copied onto the next generation. Strings with a higher fitness value have more chance of making it to the next generation.
2. *Crossover*: A part of one string is combined with a part of another string. The good parts of one part of one string with the good parts of another string, yielding an even better string after the operation.
3. *Mutation*: A randomly selected gene in a string takes a new value. The aim of this operator is to introduce new genetic material into the population or at least prevent the loss of it. In mutation, a gene can get a value that did not occur in the population before, or that has been lost due to reproduction.

A hybrid algorithm is an algorithm that combines two or more other algorithms that solve the same problem, either choosing one (depending on the data) or switching between them over the course of the algorithm.

A decision tree is a type of supervised learning algorithm (having a pre-defined target variable) that is mostly used in classification problems. It works for both categorical and continuous input and output variables. In this technique, we split the population or sample into two or more homogeneous sets (or sub-populations) based on most significant splitter/ differentiator in input variables. It is a collection of decision trees whose predictions are combined to make the overall prediction for the forest. A decision tree forest is similar to a Tree Boost model in the sense that a large number of trees are grown. Tree Boost generates a series of trees with the output of one tree going into the next tree in the series. In contrast, a decision tree forest grows a number of independent trees in parallel, and they do not interact until after all of them have been built. It produces high accuracy.

Regression and correlation can be used to evaluate the strength of a relationship between two variables. Regression is used to predict future values based on past values by fitting a set of points to a curve. Correlation is used to examine the degree to which the values for two variables behave similarly.

Self-Organizing Map (SOM) is an NN approach that uses competitive unsupervised learning. Learning is based on the concept that the behaviour of a node should impact only those nodes and arcs near it. Weights are initially assigned randomly and adjusted during the learning process to produce better results. During this learning process, hidden patterns in the data are uncovered and the weights are adjusted.

Multilayer preceptor is one of the most commonly used neural networks. In terms of mapping, the MLP is believed to be capable of approximating arbitrary functions. Two important characteristics of

the multilayer preceptor are its nonlinear processing elements which have a nonlinearity that must be smooth and their massive interconnectivity of any element of a given layer feeds all the elements of the next layer.

2. STOCK MARKET

Wealth creation through stock market for traders and speculators are their bread and butter for their day-to-day life. For them predicting the movements in prices of equity shares traded in the secondary market is vital. Nevertheless, most of the traders do not have the mathematical or statistical knowledge to do this. Hence, they mostly relay on computers and analysts. Due to technological advancement in computer estimation of various aspects have become easy now. In the stock market, we find the use of Artificial Intelligence (AI) is huge. This is due to its capacity in giving accurate price movements beforehand to the analysts.

The two phases that are regular in the stock market is the bullishness and bearishness, which ensures profits for both 'long' and 'short' traders. Therefore, for them, every price increase or decrease gives enough room for making profits. From the early days of 'out-cry' trading system to the present online trading has only one role that is to discover the best price for the equity shares. Now in the online trading platform, these traders and speculators are facilitated with the advanced version of 'High-frequency' trading and 'Algorithm Trading'. This makes their job much easier. This improvement in trading is based on ANN platform.

3. OBJECTIVE OF THE STUDY

This paper tries to survey the literature available on neural networks that has been used in predicting stock market. The important objective is to bring out the viability and uses of Artificial Neural Network (ANN) in forecasting the movements of price and indexes in a stock market. In addition, we wanted to understand how this is studied in different periods and in different countries. The purpose is to build evidences of improvement in ANN along the years and how far it is effective in getting an accurate output. Even though ANN a tool in Artificial Intelligence (AI) had evolved during early 1990's, through the following years, it has been improved by researchers. Whether this led to commercial viability is one aspect, which this study wanted to find out.

4. METHODOLOGY

As this research is based on literature review, a more simple descriptive design is adopted to pronounce the important findings. We collected 45 research papers and used 43 of these in our survey. This survey covered ten years research from 2007 to 2016 and classified them as supervised and unsupervised algorithm learning under which, we categorized the developments and improvements in Artificial Neural Network (ANN).

We arranged the type of statistics and other ratios adopted by the authors in separate table format. To understand the extend of usage and number of usage, we added up all the necessary information to find gross total of methods adopted. After summarizing these databases, we interpreted each table, which brings out the developments that took place between these ten years.

5. DISCUSSION

We report our analysis of the literature survey in six tables. Use of statistical and time series tools to extract the needed variables by the authors is presented in Table 1. Here, the first column represents the different time series tools used and from column 2 to column 11 represents the numbers of times these tools have appeared during the sample period of 10 years from 2007 to 2016. The last column is the sum total of each category of time series tools. The last row presents the total number of tools used in each year. We find the usage pattern is very less in initial years of the sample period and this gradually increases in the following years, but with a sudden drop in 2011, after it peaks again. In 2015, a maximum of 74 frequent appearances is observed. That is, researchers around the world have utilized time series tools more frequently to improve the accuracy level in their results. Analysis of the literature survey is reported in six tables. Mean Absolute Percentage Error (MAPE) appears to be most

sought after statistical tool by the authors. Correlation, variance, Root Mean Square Error (RMSE) and regression in this order respectively follow this. We observed use of GARCH and EGARCH, tool to find volatility clustering is very less.

Table 1
Basic Indicator

Indicators	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*SUM*
ARIMA	1	1	3	1	0	2	2	1	6	2	19
MAPE	1	2	4	3	1	4	4	4	13	6	42
P/E	1	1	3	1	0	3	2	1	3	3	18
ARCH	0	0	2	0	0	0	0	0	0	1	3
CORRE-LATION	1	2	4	3	1	4	2	4	13	6	40
EGARCH	0	0	2	0	0	0	0	0	0	1	3
GARCH	0	0	2	0	0	0	0	0	0	1	3
RE-GREESI-ON	1	2	4	2	1	3	4	2	13	6	38
RSME	1	2	4	3	1	4	4	4	13	5	41
VARIAN	1	2	4	3	1	4	4	4	13	6	42
Grand Total	7	12	32	16	5	24	22	20	74	37	249

Graphical representation of the tabulated results are shown in Figure 2. Here the X-axis represents the time series tool and Y-axis shows the number of articles in each year.

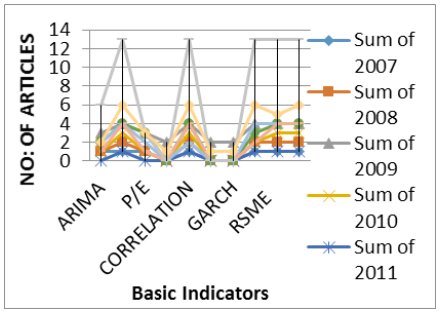

Figure 2: Basic Indicators Vs Articles

The next analysis is organized in table 2. This presents the feed forward neural network algorithms (FFNNA) used by the authors of the research articles. This also covers the usage pattern during the sample study period. Regression (REGR) finds the maximum usage in FFNNA followed by Recurrent Connections (RCC) and Learning Vector Quantization (LVQ). Research papers published in 2015, carried most number of FFNNA followed by 2012, 2013 and 2009. Interesting feature of this particular the analysis is that in 2014, we found no utilization of FFNNA in the

Table 2
Supervised Learning Feedback Nets

Supervised Feed Backward	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Total*
RCC	0	0	1	1	1	1	0	0	3	0	7
BAYE	0	0	0	0	0	0	1	0	0	1	2
BM	0	0	1	0	0	2	0	0	1	0	4
BPTT	0	0	1	0	1	1	0	0	1	0	4
LVQ	1	0	1	0	1	1	1	0	2	0	7
MFT	0	0	1	0	0	1	0	0	1	0	3
REGR	1	1	0	2	0	0	4	0	8	3	19
RTRL	0	0	1	0	1	1	0	0	1	0	4
Total	2	1	6	3	4	7	6	0	17	4	50

The table reveals that Bayes theorem is the least used algorithm. The results in the table is represented in graphical format as found in Figure 3.

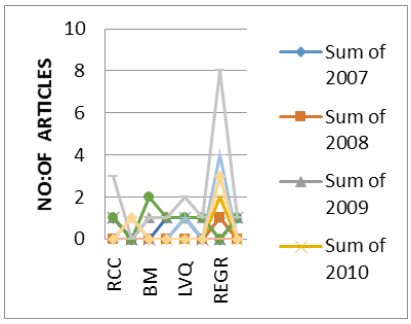

Figure 3: Supervised Feed Backward

The Figure 3 shows the line chart representing the usage pattern of FFNN algorithms. Types of algorithms are represented in X-axis and number of appearances in Y-axis. We see that REGR is high. That is usage of Ordinary Least Square (OLS) regression is very high amongst the authors.

We present the supervised learning feed forward neural network algorithm in Table 3. This table presents the details of the algorithm used by the researchers during the sample period. We observe

in 2015, the authors had used more frequently the algorithms, also in 2009, we see seventeen such usages and in 2012, they had used thirteen times. When we see the sum total across the table, we find that Multi Layer Perceptron (MLP) was the most adopted technique in supervised learning feed forward NN, a sum of twenty-eight times.

Table 3
Supervised Learning Feed Forward Neural Network only

Supervised Feed Forward	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Total*
ADA/ MADA	1	2	3	1	1	2	1	0	1	0	12
ARTMAP	0	0	2	0	0	2	0	0	1	0	5
BP	0	2	4	1	1	1	1	2	10	0	22
CASCR	0	0	2	0	0	3	0	0	2	2	9
CM	0	0	2	0	0	2	0	0	1	0	5
DIS-TRBUT	0	0	0	0	0	1	0	1	0	0	2
MLP	1	2	4	2	1	2	4	2	9	1	28
Total	2	6	17	4	3	13	6	5	24	3	83

Back Propagation (BP) comes next with twenty-two such adoption and it is followed by Adaline/Madaline (ADA/MADA) with 12 adoptions. Distribution is the least used algorithm with two utilization. In 2015, BP and MLP are widely used by the authors. We can say that usage of these two algorithms gained importance in 2015 in improving accuracy of predictions.

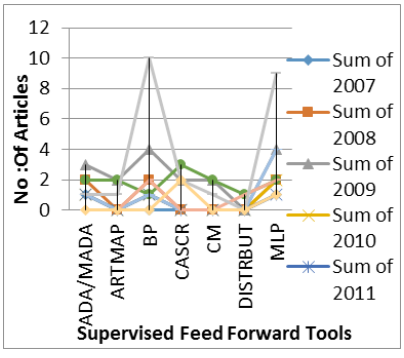

Figure 4: Supervised Feed Forward

We also used graphical representation as seen in Figure 4 in showing the algorithm usage. As can be observed, BP and MLP find the maximum usage.

The next observation is algorithm used in unsupervised learning feedback mode. This is presented in Table 4, where we see the columns display the algorithm and the first column shows the year as per the sample period.

Table 4
Unsupervised Learning Feedback Net

Unsupervised Feed Backward	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Total*
ART1	0	0	2	0	0	2	0	0	1	1	6
RT2/ ART3	0	0	2	0	0	2	0	0	2	1	7
DH	0	0	2	0	1	2	0	0	1	0	6
f CH	0	0	2	0	1	2	0	0	1	1	7
BAM	0	0	2	0	1	2	0	0	1	0	6
TAM	0	0	2	0	1	2	0	0	1	0	6
ABAM	0	0	2	0	0	2	0	0	1	0	5
SOM	0	0	3	0	0	2	0	1	1	0	7
TPM	0	0	2	0	1	2	0	0	1	0	6
COM	0	0	2	0	1	2	0	0	1	0	6
TOTAL	0	0	21	0	6	20	0	1	11	3	62

We find that this unsupervised learning feed backward neural network finds more useful in 2009, 2012, and 2015 in that order, as the number of usages in finding more frequent in these three years. However, these were never used in articles that published in 2008, 2010, and 2013. In addition, we also find that authors of these research articles used all these algorithms in the years where their articles were published.

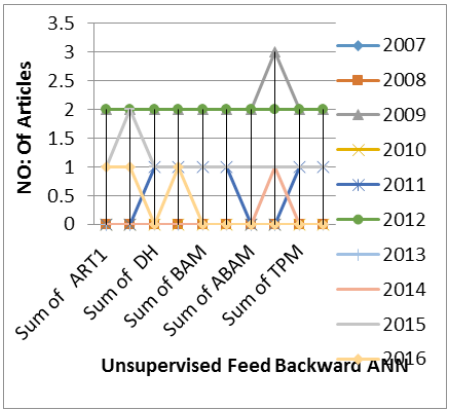

Figure 5: Unsupervised Feed Backward

The results from the table are represented in Figure 5.

In Table 5, we show the Advanced Artificial Neural Network (ANN) tools used by the authors in the sample period. The first column shows the type of ANN used and the rest of the columns displays appearance of ANN tools in each sample year. Except in 2008 and 2010, adoption of advanced ANN tools is frequent in all the sample years. In 2015 alone, we see a maximum number of uses for these tools, a total of 50 appearances. We find this intriguing, since in the sample periods till 2014, usage of these ANN is limited even though there is a greater awareness. The studies surveyed in 2015 did show that this improved the accuracy of prediction.

Table 5
Advanced ANN tools

Advance Ann Tools	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Sum*
LM	0	0	2	0	1	2	0	0	3	0	8
DR	0	0	2	0	0	2	0	0	2	0	6
CPN	0	0	2	0	0	2	0	0	3	0	7
SVR	0	0	3	0	0	2	2	1	8	2	18
DT	0	0	3	0	0	2	1	2	4	1	13
SVM	0	0	3	0	0	3	2	1	9	2	20
GA	0	0	4	0	0	2	1	1	7	2	17
HYB	0	0	1	0	0	1	2	2	8	1	15
PART	1	0	1	0	0	1	1	1	3	0	8
RTF	0	0	2	0	0	0	1	0	3	0	6
Grand Total	1	0	23	0	1	17	10	8	50	8	118

ANN tools like Support Vector Regression (SVR), Decision Tree (DT), Support Vector Machines (SVM), Genetic Algorithm (GA) and Hybrid Algorithm (HYB) found a maximum number of applicability in the research papers. This shows that researchers around the world find the recent developments in Artificial Intelligence (AI) models more effective than the earlier version of ANN algorithms. The results also are shown in Figure 6.

6. FINDINGS

Here, we summarize the important findings from our survey of the literature available in Artificial Neural Network (ANN). During the sample period between

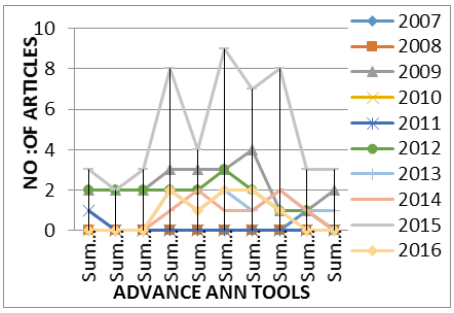

Figure 6: Advance ANN Tools

2007 and 2016, we find a trace of improvement in algorithm design used in predicting stock price movements. In the early part of the sample period, i.e., between 2007 and 2012, older version of the ANN found to be prevalent among the researchers. However, it witnessed a change after this period, and we observed that entry of new algorithmic tools. Classifications, Prediction, Time series analysis using regression are the main four tasks of the predictive method. These are found in the basic model building in all the papers surveyed.

Most of the researchers had used time series forecasting method to predict the price movements. From basic regression model to Generalized Auto Regressive Conditional Heteroscedasticity (GARCH) found to be used along with Artificial Neural Network process. Most research articles came out the results that ANN is found to be more accurate than time series models.

Improvements in ANN like Support Vector Regression, Support Vector Machines, Genetic Algorithm, Random Forest Tree and Hybrid Algorithm did improve the accuracy level as per the findings observed in the research papers.

7. CONCLUSION

An analyst job of predicting the price movements has become easy nowadays due to advancement in Artificial Intelligence (AI). Though Artificial Neural Network (ANN) forms the base for learning and predicting the outcomes, only the improvements in AI have made the much-needed difference. The present study attempted to survey these developments along the research that has taken during the past decades. The study proved it worthwhile as it brought out few interesting findings.

Most of the studies taken as the sample used high-frequency data for prediction. One thing to be added here is almost all the countries across the world support the researchers with high-frequency data. This has made the job easier as feeding the neural for testing with high-frequency data gives insightful lessons to AI, which in turn gives a very good outcome. This is observed in most papers, use of Hybrid Algorithm (HYB) is one such example. This particular tool has an accuracy level, which never was in the earlier cases. Hence, the study concludes that the development in AI does not stop here, and it is to improve in the coming days (not years- as the gap between next development nowadays is shortened day by day), which definitely will improve predictive capability.

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