*Journal of Advances and Scholarly Researches in Allied Education*
*Vol. XV, Issue No. 5, July-2018, ISSN 2230-7540*

# Comparative Analysis of Various Machine Learning Techniques based on Performance Metric used in Business Forecasting

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***Abstract – Once in the past authority judgment is the primary decision for business forecasting. It is a dull and slanted to error process. Continuously the interest is moved from authority conclusion to unadulterated genuine based forecasting models. Any business association uses bits of knowledge to characterize fitting game plans and plans. Bits of knowledge are in like manner supportive in forecasting purpose. As quantifiable speculations end up being more erratic, it is difficult to do estimations. In like manner authentic methodologies can't be insightful, nor can the rationale of framework be retained. For whatever period of time that there are no different features in the data set and relationship among the factors are immediate it is clear and alluring to use true based forecasting model. In any case, if the hidden relationship among the factors is unidentified or not immediate, machine learning based procedures are favored better. So the eagerness of making forecasting model has been moved from quantifiable field to computer field. Machine learning gives us computerized techniques for data examination. In this paper we discussed about machine learning techniques used in business forecasting and studied their performance in predicting Foreign Exchange rate.***

***Keywords: Machine Learning Techniques, Business Forecasting, Foreign Exchange rate.***

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## INTRODUCTION

The machine learning is an activity to enable computer to learn from the data to make data driven decisions. The machine learning algorithm is employed to learn the data to build the decision model. Then, the decision models are used to make decision. In this paper we are utilizing computer as a problem solving apparatus using various machine learning techniques which incorporates a straightforward correlation with how machine learning is better that human learning. Some imperative techniques viz. Simple Moving Average, Exponential Moving Average, Naïve Bayesian Regression, K Nearest Neighbor, and Artificial Neural Network are discussed in this paper. At the end a comparative analysis of these algorithms showing their utilization in forecasting using performance measurements like mean gauge error, mean total error, mean outright rate error, mean square error, entirety square error, etc. is done in this paper.

## COMPUTER AS A PROBLEM SOLVING TOOL

Attempting to utilize machines to tackle scientific problems can be followed to the mid seventeenth century. Wilhelm Schickhard, Blaise Pascal and Gottfried Leibnitz were among mathematician who structured and set in motion adding machines that were equipped for option, subtraction, duplication and division. Computers were concocted to register i.e. to take care of complex scientific problems. The computer is for the most part a problem solving apparatus. When it is appropriately given a legitimate program, the computer ends up self-operational, that is, it needs no human obstruction amid preparing. Starting from the Latin, by the mid seventeenth century the word computer implied a man who comprehends conditions. The computer stayed aligned with human action until about the center of the twentieth century when it ends up connected to a programmable electronic gadget that can store recover and process data. Presently multi day computers are utilized all over the place. With computers we can ascertain, process data,

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take care of problems, speak with one another and make craftsmanship.

## LEARNING

Learning is a noteworthy trademark of human intellectual competence and the fundamental way to get information. Different meanings of learning consolidate:

(i) According to Random House Dictionary, "The adjustment of conduct through work on, preparing or encounters is called learning".

(ii) In the expressions of Harvard Business School therapist Chris Argyris, Learning is "discovery and revision of blunder" where a mistake signifies "any confound between our expectations and what really occurs."

(iii) "To secure information or expertise in by study, guidance or encounters".

(iv) "Learning is a long lasting procedure of changing data and encounters into learning, aptitudes, conduct and state of mind".

(v) According to Skinner, "Learning can be characterized as changes in the conduct of a living being that are the aftereffect of regularities in the earth of that living being

### LEARNING BASED PROGRAMMING

Learning based programming (LBP) is a programming worldview that expands traditional programming language by enabling developer to compose programs in which a portion of the factors are not expressly characterized in the program. Rather these factors can be named by the software engineer that may utilize language build to characterize them as trainable segments. The objective of LBP is to build up the programming worldview and language that can bolster machine learning focused system.

In LBP we build up a programming model that backings constructing expansive scale system in which a few segments can't be expressly characterized by a software engineer. Particularly a LBP program expands conventional programming in the accompanying way:

(i) Allowing the software engineer to name deliberations over space components and data source characterized verifiably in watched data.

(ii) Allowing the software engineer to communicate with named deliberations.

(iii) Supporting consistent consolidation of trainable segments into the program.

(iv) Provide a level of induction over trainable parts to help consolidating source and choices in way that regard area's limitation

(v) A gathering process that transforms a data subordinate abnormal state program into an express program, when data is watched.

## MACHINE LEARNING

The most dynamic research region inside man-made reasoning is the field of machine learning, which includes the investigation and advancement of computational models of learning forms. As on date, a ton of fascinating work has been done in the zone of applying machine learning calculations. Machine learning is the rudimentary method to make the computer scholarly. R. Shank, renowned identity from the territory of man-made consciousness has stated: "If a computer can't learn, it won't be called smart." The principle goal of research here is to construct computer projects or programming fit for enhancing the execution with training and of procuring information all alone. The point of machine learning is to get the new information or the expertise, arrange the information structure, which can make dynamic enhancement of its own execution. Machine learning is a critical piece of man-made brainpower. Learning and knowledge are firmly connected to one another.

## BUSINESS FORECASTING

Business forecasting is the way toward concentrate verifiable execution to use the information picked up to conjecture future business conditions with the goal that business arrangements are surrounded in like manner to accomplish objectives. Ongoing advances in processing and improvements in innovation have encouraged the normal accumulation and capacity of business data that can be utilized to help business related choices. As of late no business work developed as quickly as the forecasting capacity. Business forecasting is preliminary intended to help basic leadership and arranging in an association. It offers capacity to individuals to distinguish pivotal parameters and factors which can be controlled ahead of time so results in future are administration oriented. In straightforward words business forecasting is a procedure used to appraise or foresee future examples utilizing business data. Forecasting in the present business world is ending up progressively critical as firms center around expanding consumer loyalty while lessening the expense of giving items and administrations.

## OBJECTIVE OF THE STUDY

1. To justify that the machine learning techniques does more accurate business

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forecasting as compared to traditional statistical approaches.

2. To evaluate the prediction capability of various machine learning algorithms applied on the business forecasting datasets.

3. To provide a framework for the implementation and appropriate use of various machine learning techniques in business forecasting.

## RESEARCH METHODOLOGY

Research Methodology is the deliberate, hypothetical examination of the procedures connected to a field of study. It is a systematic method to determine a problem. It is a study of concentrate how research is to be completed. Fundamentally, the activities by which researchers do their work of portraying, clarifying and anticipating marvels are called research strategy. It is additionally characterized as the investigation of techniques by which learning is picked up. It will likely give the work plan of research. In this section the primary objective is to ponder and break down some key machine learning models and measurable methodologies utilized for forecasting reason. Some imperative techniques that are considered in this investigation are Simple Moving Average, Exponential Moving Average, Naïve Bayesian Regression, K Nearest Neighbor, and Artificial Neural Network. These strategies are widely concentrated and after that a computer program is proposed for every procedure. The subtle elements of every technique is as under

**Forecasting through Simple Moving Average:**

It is a kind of scientific convolution. It is a Simple short-run forecasting instruments dependent on some fundamental example to the data. A moving normal can be ascertained to smooth the first arrangement, or to get a conjecture. Just put Moving Averages are a math figuring that midpoints out a progression of numeric qualities. A moving normal arrangement can be computed for whenever arrangement. In back it is regularly connected to stock and subsidiary costs, rate returns and so forth. Moving midpoints are utilized to track the current pattern. Basic moving normal is absolutely a factual strategy utilized for forecasting reason. The moving normal for day and age k is the mean of the "k" most current perceptions. The steady number k is determined toward the begin. The lesser the number k, the more weight is given to current periods. The bigger the number k, the less weight is given to more present periods. Moving normal is additionally called "moving normal", "moving signify" or "running normal". A moving normal is generally utilized with time arrangement. Time arrangement is a gathering of data recorded over some stretch of time i.e. week after week, month to month, and quarterly. Noteworthy time arrangement data is utilized by the administration to settle on ongoing choices and plans, in light of long haul forecasting. The fundamental supposition of time arrangement data is that it accept past example to bear on into what's to come.

Straightforward moving normal is figured by taking the mean of a given arrangement of qualities. For occasions, to ascertain an essential 5-day moving normal we would include the end costs from the previous 5 days and afterward separate the outcome by 5. Scientifically, basic moving normal of request k is indicated by MA (k), is the estimation of k back to back perceptions and is ascertained by the accompanying recipe:

$$f_{t+1} = \frac{(y_t + y_{t-1} + y_{t-2} + \ldots + y_{t-k+1})}{k}$$

## EXPONENTIAL MOVING AVERAGE

It is a technique, brought about by Robert Macaulay in 1931 and created by Robert G. Dark colored amid World War II, for Extrapolative forecasting from time arrangement data. It is a sort of weighted moving normal. Exponential moving normal figures gauges by giving more weight to ongoing qualities than to prior qualities. This is a standout amongst the most habitually utilized techniques since usually simpler to ascertain than weighted moving normal and requires less data. The underlying estimation for the initial couple of gauges is more troublesome, however after that exponential smoothing requires less data and less calculation than straightforward moving normal. The data required for exponential smoothing incorporates the last time frame's figure esteem, the last time frame's esteem and the smoothing parameter alpha (α). Formally, the exponential smoothing condition is

$$F_{t+1} = \alpha y_t + (1-\alpha)F_t$$

$F_{t+1}$ = forecast for the next period.

= smoothing constant. Normally, choose between 0 and 1.

*y*t= observed value of series in period *t*.

Ft = old forecast for period *t*.

**Naive Bayesian Regression**

Bayesian classifier is a methodology for demonstrating probabilistic connection between the characteristic set and the class variable. Gullible Bayesian classifier depends on Bayes hypothesis, a factual guideline for joining earlier learning of the class with new proof accumulated from data. Let X

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signifies the quality set and Y de take note of the class variable. On the off chance that the class variable has a non-deterministic association with the traits, we can regard X and Y as irregular variable and catch their relationship likelihood utilizing P(Y|X). This is known as contingent likelihood or back likelihood for Y. Amid the preparation stage, we have to take in the back probabilities P(X|Y) for each blend of X and Y dependent on information assembled from the preparation data. By knowing these probabilities, a test record x' can be arranged by finding the class Y' that expands the back likelihood P(Y'|X').

A credulous Bayes classifier evaluates the class restrictive likelihood by expecting that the qualities are restrictively free, given the class name y. the restrictive autonomy suspicion can be formally expressed as pursue:

$$P(X|Y=y) = \prod_{i=1}^{d} P(Xi|Y = y)$$

where each attribute set X = {X1,X2,……, Xd} consists of d attributes.

### 3.5 K-Nearest Neighbor

Closest Neighbors have been utilized in factual estimation and pattern acknowledgment as of now in the start of 1970's. K-Nearest Neighbor (KNN) is a most straightforward machine learning strategy. KNN is adroitly straightforward, yet ready to take care of complex issues. In its essential frame a standout amongst the most basic machine learning techniques. The decision of KNN is persuaded by its effortlessness and adaptability to fuse diverse data types. The fundamental thought of KNN is to construct estimation in light of a settled number of perceptions, say k, which are nearest to the coveted yield. It is considered as an apathetic learning calculation since it doesn't manufacture a model or capacity beforehand, yet yields the nearest k records of the preparation data set that have the most astounding closeness to the test. KNN can be utilized both in discrete and consistent decision making known as order and relapse individually.

***Distance used in KNN***

The three famous distance functions used with KNN are

Euclidean Distance

$$\sqrt{\sum_{i=1}^{k}(x_i - y_i)^2}$$

Manhattan Distance:

$$\sum_{i=1}^{k} | xi - yi |$$

Minkowski Distance:

$$\sqrt{\sum_{i=1}^{k}(x_i - y_i)^q)^{1/q}}$$

In this research better outcomes are acquired when researcher utilize Euclidean Distance.

## ARTIFICIAL NEURAL NETWORK WITH BACK PROPAGATION

Introduction of Artificial Neural network has gigantically engaged the forecasting techniques of mind boggling framework since the most recent couple of decades. Neural Networks have seen a blast of enthusiasm in the course of the most recent couple of years and are as a rule effectively connected over an unprecedented scope of issue space. From a factual point of view neural networks are fascinating a result of their potential use in expectation and grouping issues. It is non-direct self versatile methodology. ANN like individuals gains from the data. They are especially utilized when the fundamental relationship is unknown. ANN can recognize and learn co-related patterns between input data set and comparing target esteem. Neural Network looks like the human mind in the accompanying two different ways.

1. It gets information through learning.

2. ANN's Knowledge is put away inside interneuron association qualities known as synaptic weights.

The way toward changing the weights is called learning or preparing. Contingent upon the weights, the calculation of the neuron will be unique. By modifying the weights of an artificial neuron, we can acquire the coveted output from the network. In the wake of preparing ANN can be utilized to foresee the result of new autonomous input data. ANN emulates the learning procedure of the human mind and can process issues including non straight and complex data regardless of whether the data are inspired and loud. In this manner neural network speaks to both straight and non straight relationship specifically from the data being demonstrated.

## RESULT AND DISCUSSION

At the point when researcher relatively investigates the consequences of algorithms by utilizing different business space data sets considered in this research, it is discovered that machine learning algorithms are more effective than conventional measurable pattern examination strategies for time arrangement data identified with business areas utilized for forecasting purpose.

Artificial Neural Network based forecasting model is proficient in every one of the data sets. It very well

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may be effectively dissected from the arranged information of performance criteria of these machine learning algorithms made with the assistance of redid programming created in this research. Graphical outcomes that are gotten by this product are likewise useful to discover best algorithm for forecasting purpose in quicker way i.e. just by looking wave diagram (fig3). The detail of key discoveries as for the research questions are condensed and general ends dependent on the discoveries of the examinations introduced. The accentuation is on the examination of forbidden consequences of different performance metric and graphical portrayals of watched and genuine estimation of focused variable. Every one of the values of performance measurements are registered through the unthinkable shape interface of the product intended for this research purpose. Following figure demonstrates the interface.

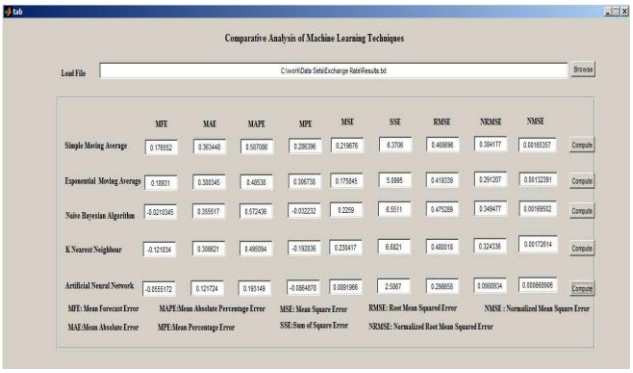


**Fig 1: Interface for the Experimental Setup showing comparative analysis of various forecasting techniques in terms of values of performance metrics (Exchange Rate Prediction Case)**

By utilizing this interface, client just loads the document that contains real estimation of target variable and guage estimation of that variable through thought about algorithm. There is a Browse catch to stack that record. Separate content boxes for every performance metric are installed for every algorithm. There is additionally a Compute catch for every algorithm. Client basic tap on that catch and the performance metric values are determined naturally by this interface for every algorithm. Table1 shows the examination of the performance metric for every datum set that are considered in this research.

### CASE 1: Foreign Exchange Rate Prediction Analysis

Following table shows values of performance measurements when data set has a place with foreign conversion scale is utilized for forecasting purpose

| PERFORMANCE METRIC → ALGORITHM ↓ | MFE | MAE | MAPE | MPE | MSE | SSE | RMSE | NRMSE | NMSE |
|---|---|---|---|---|---|---|---|---|---|
| Simple Moving Average | 0.176552 | 0.36344 | 0.587086 | 0.286396 | 0.219676 | 6.3706 | 0.468696 | 0.384177 | 0.0016535 |
| Exponential Moving Average | 0.18931 | 0.30034 | 0.48538 | 0.306738 | 0.175845 | 5.0995 | 0.419339 | 0.291207 | 0.0013239 |
| Naïve Bayesian Regression | -0.021034 | 0.35551 | 0.572436 | -0.032232 | 0.2259 | 6.5511 | 0.475289 | 0.349477 | 0.0016950 |
| K-Nearest Neighbour | -0.12103 | 0.30862 | 0.495094 | -0.192836 | 0.230417 | 6.6821 | 0.480018 | 0.324336 | 0.0017261 |
| Artificial Neural Network | -0.055517 | 0.12172 | 0.193149 | -0.086487 | 0.089196 | 2.5867 | 0.298658 | 0.098893 | 0.0006689 |

**Fig2: Showing values of various performance metrics for Foreign Exchange Rate Prediction in tabular format for various forecasting techniques**

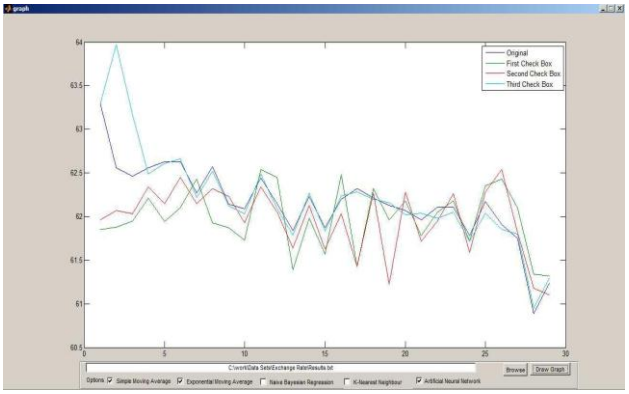


**Fig3: Showing comparative analysis of various forecasting techniques in terms of values of performance metrics in Graphical Wave Form (Exchange Rate Prediction Case)**

## COMPARATIVE ANALYSIS OF ALGORITHMS

While looking at the performance of algorithms utilized for forecasting purpose there are some performance measurements, for example, mean gauge error, mean total error, mean outright rate error, mean square error, entirety square error, etc. Smaller the values of these measurements better the performance of the forecasting algorithm.

## CONCLUSION

By investigating the consequences of calculations by utilizing different business area data sets considered in this research, it is discovered that machine learning calculations are more proficient than conventional factual pattern examination strategies for time arrangement data identified with business areas utilized for forecasting reason. Counterfeit Neural Network based forecasting model is effective in every one of the data sets. It tends to be effortlessly dissected from the organized data of execution criteria of these machine learning calculations made with the

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assistance of redid programming created in this research. Graphical outcomes that are gotten by this product are additionally useful to discover best calculation for forecasting reason in quicker way i.e. just by looking wave diagram.

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