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Improving Forecasting Efficiency Using Machine Learning and IoT

Manisha Gaidhane[1*], Mona Mulchandani[2], Priyanka Dudhe[3]

[1,2,3]Dept. of Computer Science & Engineering, Jhulelal Institute of Technology, Nagpur, India

Corresponding Author: manisha.gaidhane8788@gmail.com

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***Abstract*—** Forecasting can be defined as prediction of what is going to happen in the future by analyzing the past and current available data. It can be done for power, weather, business, company management, economics, investors etc. Although it varies based on the area for which it is going to be applied. Forecasting has technical and business impacts. If it is not done properly, it can cause inefficient usage of resources. In traditional load forecasting, predicting future demands is a quite time consuming and sometimes it results in the incorrect output. To overcome these challenges, new generation technologies should be utilized such as internet of things, cloud computing, and machine learning. It can also help in improving existing established systems. The purpose of this study paper is to know, participation of new technologies in improving the efficiency of forecasting. Forecasting using machine-learning and IoT would really help to achieve high forecast accuracy. In machine learning forecasting, processors learn from mining loads of cloud data without human intervention to fulfill the demand. While doing this paper, by the manner of literature review, first, the trend of improvement, diversification and the new characteristics of the system will be evaluated. Then, the forecasting technology will be reviewed and analyzed from two different aspects, elementary analysis and application research. This review paper study will help to create a new system idea that would provide more accurate forecasting with reduction in time consumption.

***Keywords*—** Internet of Things, machine learning, cloud data, forecasting, load.

I. INTRODUCTION

Traditional forecasting techniques use historical data and time-series forecasting approaches that can only use few demand factors. On the other side, Machine Learning Forecasting combines big data, cloud computing, and learning algorithms to evaluate millions of data points using limitless amounts of fundamental factors at a time. Machine learning follows more data – better accuracy rule. So to yield better results use of cloud data will be the appropriate method. Accessing cloud data has become very easy and can be done via web APIs and web services [10]. In machine learning, contemporary forecasting technique is used. It uses extrapolative analytics and algorithms, like Neural Networks (NN), Recurrent Neural Networks (RNN), and Support Vector Machines (SVM) [8]. Neural Network (NN) is a good mathematical tool for mapping complicated relationships. Also, in recent years, artificial intelligence (AI) based techniques together with neural network (NN) is able to provide promising results [9]. IoT based forecasting collects data from the internet on demand and performs quick applied math and improvement strategies for efficient forecasting. Primarily, IoT based on-demand forecasting not only depends on particular systems properties but however it also additionally depends on web data, machine-to-machine connections, communications channels[2] and computation facilities. Internet of Things (IoT) is considered as an innovative technology that is expected to change our everyday lives. In the Internet of Things (IoT), '*things*' could be any device that contains the required computing energy, connectivity to the Internet and have the capacity to collect and transfer data over a network without any intervention. The embedded technology in the devices helps them to interact with internal states or the external environment. Use of cloud data makes the IoT based system more perfect. Nowadays, the Internet of things and some system are tightly coupled and coordinated to enhance efficiency and reliability, improve real-time decision, solve critical problems, and develop new services. Use of machine learning and IoT based forecasting will be helpful to improve forecasting efficiency

II. RELATED WORK

Here, we would like to present the previously existing systems and some methodologies that have been used for forecasting as well as information related to forecasting. In the past many forecasting systems are developed. Based on different areas where they are implemented, some are using traditional forecasting techniques and newly developed systems are using modern technologies. Systems with traditional forecasting have limitations to use data and datasets, so those systems will give that limited results as compared to systems with new technologies. Till the time many new algorithms and methods have been used for better

forecasting results but they fail to achieve better accuracy and provide results with high delay. They mostly work on STLF (Short Term Load Forecasting). To achieve best results machine learning based algorithms and methods could be helpful [11]. As well as use of more data will help to give better result and for getting the same, use of cloud and IoT based data will be the best source. To achieve more benefit out of forecasts, it is must to understand the finer details of the different types of forecasting methods to recognize what a particular forecasting method type can and cannot do, and know what forecast type is best suited to a particular need. Mainly, three types of forecasting and some set of forecasting methods used for deriving future forecasts.

i. Types of Forecasting

1) *Economic forecasts*: It addresses the trade cycle by predicting inflation rates, housing starts, cash suppliers, and other planning indicators.

2) *Technological forecasts*: It is more concerned about rates of technological progress, which may end with the birth of exciting new products, equipments and requirement of new plants.

3) *Demand forecasts*: These are the projections of demand for a company's goods or service. These forecasts are also called sales forecasts, drive a company's capacity, production, and management systems and serve as inputs to financial, personnel, and marketing tragedies.

ii. Methods used in Forecasting

1. Qualitative vs. quantitative methods
2. Average approach
3. Time series methods
4. Naive approach
5. Drift method
6. Seasonal naïve approach
7. Causal / econometric forecasting methods
8. Judgmental methods
9. Artificial intelligence methods

The objective of machine learning methods and traditional is the same. They both help to improve forecasting accuracy by minimizing loss function, typically the sum of squared errors. Their difference lies in how such a minimization is done with Machine Learning (ML) methods utilizing non-linear algorithms. ML methods are computationally more demanding than traditional ones, requiring greater dependence on computer science to be implemented [11]. Typically, Machine learning uses some models along with methods for better forecasting. Few are listed below.

iii. Models used in Machine Learning Forecasting[11]

1. Multi-Layer Perceptron (MLP)
2. Bayesian Neural Network (BNN)
3. Radial Basis Functions (RBF)
4. Generalized Regression Neural Networks (GRNN), also called Kernel Regression
5. K-Nearest Neighbor regression (KNN)
6. CART regression trees (CART)
7. Support Vector Regression (SVR), and
8. Gaussian Processes (GP)

iv. Existing System

Since the forecasting can be applied in several areas, for example, forecasting for power, weather, web-server load etc. The existing system we are referring is basically performing short term load forecasting [1]. Load forecasting (LF) (for power) would be estimating the future supply and demands of electric power for a region. It can possibly increase the efficiency and revenues for the electric generating and distribution firms. Load information would be collected from smart meters and stored as historical load data for calculations. Similarly, for weather forecasting, weather knowledge at a given geographical location together with temperature, humidity, wind speed, wind-direction, heat, sunlight, rain and so on with accuracy are collected from internet on-demand basis using the weather APIs. LF has been practically used in power systems for unit commitment, real-time dispatch, maintenance, optimization of power systems. It is developed by using neural Network (NN) and particle swarm optimization (PSO)[3]. LF in IoT explores a new dimension for on-demand online automatic load forecasting for the power system [1]. Load forecasting can be achieved in three forms 1) Short term load forecasting (STLF) 2) Medium term load forecasting, 3) Long term load forecasting [1]. Different statistical mathematics foretelling techniques are applied to short term load forecasting (STLF) and some methods including, time series [4], similar-day approach [5], regression methods [6], expert systems [7] etc. In general, these strategies are essentially linear models and therefore the load pattern is typically a nonlinear function of the external variables.

III. METHODOLOGY

In present scenario, the IoT based load forecasting does not give that much of accurate data and also it takes more time for load forecasting, so to avoid this we are going to use cloud data and machine learning for IoT based load forecasting so that load forecasting will be done more accurately without delay. Also the proposed system will be the dataset independent system thus it will perform forecasting for any type of dataset that is fed. It can be use for power load forecasting, weather forecasting, web server load forecasting and other places where data sets can be utilized for prediction.

The proposed methodology can be divided into following modules.

- Development of a system to collect online load datasets
- Removal of outlier data from those datasets
- Implementation of a hybrid load forecasting algorithm
- Performance evaluation of the algorithm with the existing ones optimization of the developed algorithm (if needed)

To develop dataset independent system for accurate forecasting, new algorithm will be using machine learning models and forecasting methods as per literature survey. This algorithm will help to get accurate forecasting result without delay.

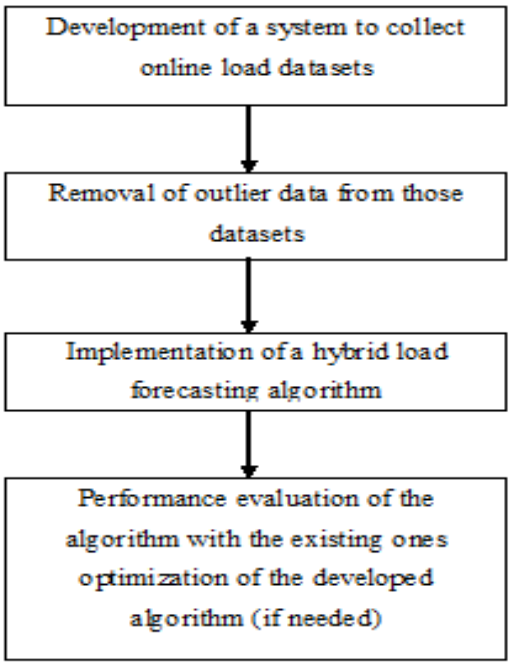

Figure 1. Project flow diagram

IV. Results and Discussion

In comparison of existing system we can expect improved system performance from proposed plan which will help in improving forecasting efficiency in terms of accuracy and lower output delay. In existing system, performance of forecasting is measure with the help of mean absolute performance error (MAPE). Using NN and NN-PSO models, average MAPE is found to be 2.043% and 2.0129% [1], hence using the simulated machine learning based classifier we would try to achieve better performance results than existing scenario. New system should be developed using new generation technologies and it should be able to do forecasting using huge data sets. The newly developed algorithm could be used by power generation companies for optimized usage of resources to avoid excessive power generation by utilization of real time data sets. It can also use in other fields for example,

1. Weather forecasting
2. Managing loads across servers based on the requests
3. Share market algorithm based trading
4. Sports strategies
5. Goods management in logistics
6. Managing cloud load in MNC
7. Balancing cloud load in military services

V. Conclusion and Future Scope

In this paper, we present the study for existing IoT based forecasting system which uses neural networks and particle swarm optimization tool for forecasting. Also some relative information about forecasting methods and machine learning models which are usually used in machine learning forecasting. After going through various existing systems we found that these systems are not giving more accuracy and loading speed in terms of output so, here we have given new system plan which will be developed by using machine learning algorithms to help in improving forecasting efficiency. It would be dataset independent, more accurate and with less delay than the existing one.

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Authors Profile

Miss Manisha Gaidhane pursed Bachelor of Engineering in Computer Engineering from Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur in 2011 and is currently a Master of Technology scholar from Rashtrasant Tukadoji Maharaj Nagpur University. Her main research work focuses on Machine Learning, Internet of things, cloud data based load forecasting.

