A review of Traffic Flow Prediction Based on Machine Learning approaches

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Abstract— The traffic flow prediction has wide application in the city transportation and area management. In big cities, it is very difficult to manage traffic. But the prediction under consideration of some physical conditions of environment and weather is found more effective. In this study, we designed a traffic flow prediction system model to predict the traffic data with a time interval of 1 hour to 24 hours. The prediction algorithms have been used for research in the past, but there are not many platforms found on which traffic flow prediction has easy access to public users. The system is designed to overcome the problems associated with the historical and time series. Past Traffic data set was collected from an open-source and cleaned as per requirements. By using Machine learning algorithms, a system is designed, which takes the data from the roads using Vehicle detection sensors and stores into the database for future predictions. We also integrated the API of weather services to get weather data. This Traffic flow prediction Model is designed to use the existing two most popular machine learning prediction algorithms that are Artificial Neural Network (ANN) and Support Vector Machine (SVM).After experiments, results were compared with the actual data to check the accuracy of the algorithms. We found these two algorithms that are more helpful for our designed system. The artificial neural network helps for long time data prediction. Support Vector Machine (SVM) helps to predict in short term prediction scenarios. But a shorter time interval gives more accurate results. The traffic data is predicated on an hourly basis from 1 hour to 24 hours. Live stats of traffic on the road can also be obtained by this system, which is based on the vehicle detection sensors that are fetching data from the roads. The system compares the data of all roads and determines the most populated roads of the city.

Keywords — Artificial Intelligence, ANN (Artificial Neural Network), LSTM (Long short term memory), Machine Learning, SVM (Support Vector Machine)

1 INTRODUCTION

Traffic flow prediction has been discussed several times with different machine learning approaches. In this paper, we did a review of different researchers and the methodologies which have been used for prediction. Many algorithms show the excellent results on the given data sets. Those data sets have collected from different sources. To get accurate information about current and future traffic flow there are many applications such as vehicle navigation devices, congestion management, vehicle routing, and much more application have been introduced to guide the public on the road but the problem is to get real-time data on the spot and helps the users to plan their routs according to the situations on the road but the main problem to get information about traffic flow which are not well equipped with traffic sensors and many other factors that effect to get data such as accidents, public events, and bad weather conditions. Generally, there are two ways of traffic flow prediction, such as Short Term and Long Term Traffic Flow Prediction probably long term algorithms maybe cannot provide accurate prediction results because this mechanisms predict on hourly basis such as 12 hours or 24 hours data results, as well as short term mechanisms, provide more good results because they give results in terms of minutes such as a 5 to 15 minutes or 30 to 50 minutes so in this way, the short term time interval can give more accurate prediction values.so our model has been trained within a maximum time interval of 1 hour to give prediction results. To train this prediction model, we have gone through many researchers' contributions in this machine learning area, which have discussed in the literature review section. To meet all these problems, many researchers make a lot of effort by using different machine learning algorithms to predict traffic flow.

1.1 Purpose of Traffic Flow Prediction.

Most of the traffic data reports are actual time, but sometimes it is not so favorable because we use this report when we plan which route we should go. Assume that we are going to office in working hours and we at traffic information and select the best or shorter route to reach our destination but traffic congestion occurred .the issue is to get actual-time information about traffic comes whence to resolve this issue by using forecasting? It may be great, but what causes can affect traffic conditions? We need to analyze it. Many causes can affect traffic conditions. The present and ancient traffic condition can be considered to predict.these suggestions are very simple, if traffic is so heavy right now, also acceptable is that after ten or twenty minutes the traffic situation would be same ancient traffic situation, we have indicated the traffic situation on the same day and time, for instance, traffic condition on two Mondays remain same at 9 o'clock. Different weekdays and weekends may behave in different traffic situations, and maybe they can also affect traffic conditions. There have been a lot of joint efforts to enhance and mollify traffic situations; still, there are many chances of progress. Devoted traffic routing systemin coordination could be contributing to the reduction of traffic congestion and transport expenditures. With an increasing cost of gasoline, the demand for an efficient routing system to reduce traffic jams is very necessary.[1].In the past years, intelligent transportation systems(ITS) have made great achievements. Intelligent transportation systems help to in-

creases the ability of the road traffic system and fix all traffic issues by using new technologies. To achieve rising transportation ITS need to apply for useful transport infrastructure .one of the most significant demand of ITS is to would be able to predict the traffic truly there are three types of data in a traffic system that are ancient data, present data and short-term calculated data.[2]the capability to predict the transport values such as speed, travel time or flow, based on real-time data and historical data, collected by various vehicles detector sensors Prediction of traffic variables such as volume, speed, density, travel time, headways, etc. is important in traffic planning and design operations. Various methods are reported in the literature for prediction of traffic parameters such as time series analysis, real-time method, historical method, statistical methods, and machine learning, etc. It becomes essential to understand the working process behind each of these methods to know the limitations and advantages associated with them [3]. The traffic flow prediction has got a lot of care from transport management and crowded areas of the city management department with the usage of information technology.[4]the goal of traffic flow prediction is to deliver real-time transport data. Whatever to optimize, the traffic on the roads of city areas becomes complex and couldn't control very well, so such kind of systems are not sufficient for prediction .therefore, research on traffic flow prediction plays an important role in ITS Systems and Traffic Management Systems.

1.2 Problem statement

To overcome the problems associated with historical, and time series we have to develop a traffic flow prediction model by using machine learning approaches such that SVM and ANN by using these algorithms, we developed a UML based prediction system through these users can have interaction with the system and collect the information about current situation of traffic as well as also can check the traffic flow from 1 to next 24 hours of a days with the time interval of 1-hour data, this system shows the predicted data from 1 to next 24 hours. in this way they may know the weather effects and conditions of the roads that how much traffic will be on which road in the next 24 hours, they can also see accidentals records of number of vehicle's and how much chances can be occur for accidents on which road so our system may help them to make their planes that which route or road they should select to make their travel easy.

2 Related Work

A lot of work has been done in traffic flow prediction with different approaches and technologies. There are many scenarios that we have discussed in this paper with the related work of machine learning techniques.

2.1 Machine learning approaches

Someone has developed LSTM based prediction models by using machine learning approaches, which involve structure designing or network training designing and prediction and prediction implication. Another goal is to deal with prediction errors that may occur during the prediction process with deep learning methods. The discussed method has been applied to big data that has collected from the performance measurement system (PEMS).the experiments show that the LSTM model has many capabilities and good performance results as compared to shallow machine learning methods.

2.2 Artificial neural network (ANN) in traffic flow prediction.

Due to the random and nonlinear characteristics of traffic flow, it's troublesome to beat the limitations of constant models. Statistic machine learning ways became gradually standard Non-constant approach is that the most illustrious and presently employed in the analysis. Artificial neural networks (NN) are normally utilized for this downside, which may be regarded as the overall pattern of a machine learning system in traffic engineering. Smith and Demetsky developed a NN model that was compared with ancient prediction ways and their results counsel that the NN outperforms alternative models throughout peak conditions. Dougherty et al. studied the back-propagation neural network (BPNN) for the prediction of traffic flow, speed, and occupancy, and also the results show some promise. Since then, NN approaches have normally been used for traffic flow prognostication. Additionally, several hybrid NN models are planned to improve performance. Alternative statistic models have conjointly been studied, like -nearest neighbor (NN) models and support vector regression [11].

Felix Kunde Alexander Hartenstein et a.[12] Implement an approach of feeding device knowledge to an Artificial Neural Network (ANN), .but some Researchers implement ANN with completely different spatial associate degreed temporal holdups to seek out an optimum setup for a whole town. They need to be worked on a sensor network that's distributed across a whole town and got the simplest results once they are enclosed measurements from all sensors. Together with sequence data increased the prediction solely marginally. Once work with RNNs, it shall be best for statistical analysis as a result of their support to be told short and long sequences.[13]

2.3 Traffic congestion prediction

Another research has been organized to evaluate traffic flow by using neural networks and hybrids [14] of various techniques.[15].for example, the research conducted by vlahogianni et al.[16], traffic patterns had been identified by grouping them and traffic flow calculated by neural networks. Machine learning algorithms can predict short term transport blockage through connected traffic on the roads. This is inspired by

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multiple possible systems of these approaches for progressive prediction algorithms in the combined situation.[17].on other hand studies conducts two kinds of prediction models : (a) models that are not online are measured on historical information can be trained when important changes appear in the system as like changes and updating the whole framework, (b) online models measured by historical data and update the system by using usual transport condition achieved through v2v/v21 communication.[17].

2.4 Deep learning models prediction

Deep learning model is the most sufficient and stable because it can be used for significant abstraction deepest information of transport from several layers of data, in recent deep learning has been proved very successful in many fields such as images, audio, and ordinary language processing since the Hinton et al. time [5], researchers have been proved that deep learning models are many comparatives than the state-of-the-art models[2],[8],[7],[6]since the traffic blockage and traffic flow are nonlinear and deep learning models can get enough data without any previous information. Deep learning models have done a lot of research in traffic flow prediction, for example. Lv et al. developed a novel deep learning method for traffic flow prediction that uses a stacked auto-encoder method to study traffic flow components.[9]another studies have set traffic flow analysis examples that are purely based on several methods of deep learning approaches. And throughout multimodal deep learning methods are conferred to resolve the issues with traffic flow forecasting, which based on CNNGRU basic methods with supported mechanisms. The traffic flow forecasting becomes a difficult task because the components such as (traffic flow, travel time, speed,etc.) are always highly nonlinear and un-stationary, which can be affected by several mechanisms under different transport situations (such accidents, weather situation, rush hours,etc.).[10]

2.5 Deep Learning models based on machine learning approaches

Many studies prove that the LSTM model is more capable and has good workability, as compared to shallow machine learning prediction models. Machine-learning has many contributions in big data few of them can be summarized in below

1. Machine learning approaches big data prediction problems. Machine learning has been applied to image recognition, medical diagnosis securities analysis, and many other fields. It can depend on computational techniques to components learning and prediction in traffic flow big data theory can provide sample data sources for machine learning. With a huge collection of data samples, real-time traffic flow can be predicted.[18]

2. Learning which is based on machine learning is the first time applied to big data-driven traffic flow prediction. Before this approach, the shallow has done many experiments for short term traffic flow prediction. But the forecasting performance can vary due to reasons of the continuous undefined data sample. The stability and convergence of deep learning had supremacy. [18]

3. The LSTM network structure, which is based on deep learning, differs from deep learning models. RNN may be used to communicate the prior information to the present situation when information gapes increase than it maybe loses the capability to learn far-ranging data.
   LSTM can learn long-term depended on data as compare to RNN and LSTM neglect long-term
   Dependence issues through proper structure.it should be kept in mind that long-term learning is a natural behavior of LSTM .it's not a capability to pay at a special cost [18]

3 METHODOLOGIES

Many methods have been considered much time, but we use two existing methods in this paper for traffic flow prediction. The first one is a support vector machine (SVM), and the second is the artificial neural network (ANN).

3.1 Data set

Data collected in this paper are from the PEMS site for the implementations of machine learning methods to show outputs in this prediction system. Data collected from different numbers of VDS of the road. The data set have the number of vehicles passes from the road sensors as well as can also have types of vehicles after extracting the data from VDS and road sensors the unwanted data has been deleted by preprocessing the data aggregated from 1 to 24hours' time interval to calculate traffic flow prediction.

3.2 Support vector machine

The support vector machine has many methods and formulas which can be used to predict traffic data for the future. Traffic flow prediction is a nonlinear problem; it can be realized by using a support vector machine. And SVM works with the kernel functions to optimize the prediction result. Because kernel function may help SVM to transform the data. SVM is a supervised machine learning method, so it needs training data for this. It can work on any number of dimensions. When we input nonlinear data as a training sample so, with the help of this function, it can be transferred to high dimensions. In the following equation, those functions have been trying to fit for optimal results.

$$d=\omega\varphi(n)+\varepsilon \quad (1)$$

ω is for the weight vector;
n is input vector;
ε for the offset value.
For training, the following two values can be used for minimizing errors.
Where c is using for the only penalty $\sum \boldsymbol{iL}(\boldsymbol{y}-\boldsymbol{f}(\boldsymbol{x}))$is used to calculate errors terms;

$\mathbf{1/2\omega\hat{}2}$is a regular item;

L(d-f(x)) is need to present loss function, balance function, weight for training, and calculating errors.

ε used for loss function because its values can be affected support-vector.

In the following equation, slack values are included, ξ*.

so the collected problem can be converted into the following equations.

min12|ω|2+c∑i(ξi+ξ*i) (4) di-ω φ(x) - ε ≤ ε + ξi

The Lagrange multiplier terms used as xi and x*i are introduced, and the problem is transferred further into a simple optimization problem of the dual problem

$$max\sum(xi - x*i) - \theta\sum i(xi + x*i) - 12\sum i\sum j(xi - x*i)(xj - x*j)k(ni, nj) - (xi - x*i) = 0$$

So,

(0≤xi≤C,0≤x*i≤C)

So by computing all the above equation,

We have final prediction function

$d = \sum \boldsymbol{i}(\boldsymbol{xi} - x*\boldsymbol{i})\boldsymbol{k}(n\boldsymbol{i}, n\boldsymbol{j})$ + ε k (ni,nj) is the representation of the kernel function because its play k of role for SVM model for the prediction of our collected data,

So in this way, we transformed our problems and got the required result.

Further SVM algorithm has been trained with python through the dataset collected from PEMS by taking the time interval as one hour to predict data. Following is the representation of the SVM algorithm in "Fig-3.2."

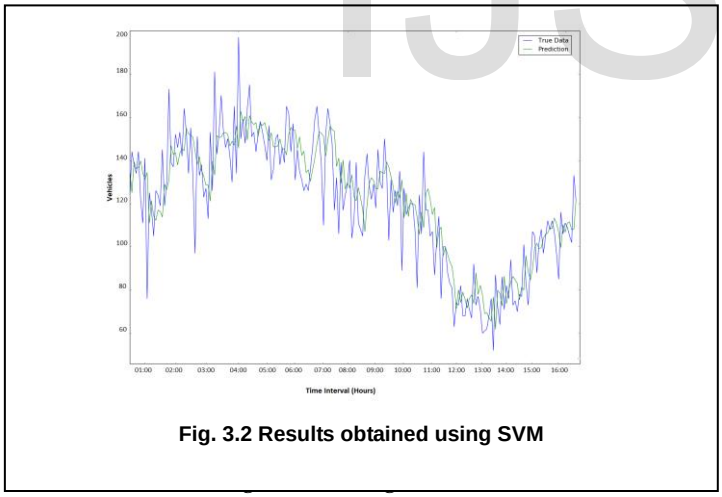

Fig. 3.2 Results obtained using SVM

the true data, which means original data collected from PEMS. And green lines show the predicted data that we have after applying the SVM algorithm on the existing data.

3.3 Artificial Neural Network

These models help for traffic flow prediction with the time interval of one hour of the day. ANN split the whole data of vehicles into two data sets. The first one is the train data set, and the second is the test data. Train the data set used to train the ANN model. For the example of the existing data set, get 10000 number of vehicles and 20% data occupied by a train set and test data set to have 80% data. The data set has been modified into a time-date format, so in this way, monthly weekly information has been omitted by time format, and weekly data has changed into days of the week from 1 to 7 days of the week. ANN model works in these three layers, namely the input layer, a hidden layer, and output layer when Ann has trained for one-hour prediction it takes three parameters for input layer such as days, hours, last known several vehicles. After processing of training data and test with ANN, we got a coefficient varied from 0.85 to 0.76 for test data and 0.99 for training data. The following "Fig 3.3(a)" shows the structure of the ANN model with those three layers.

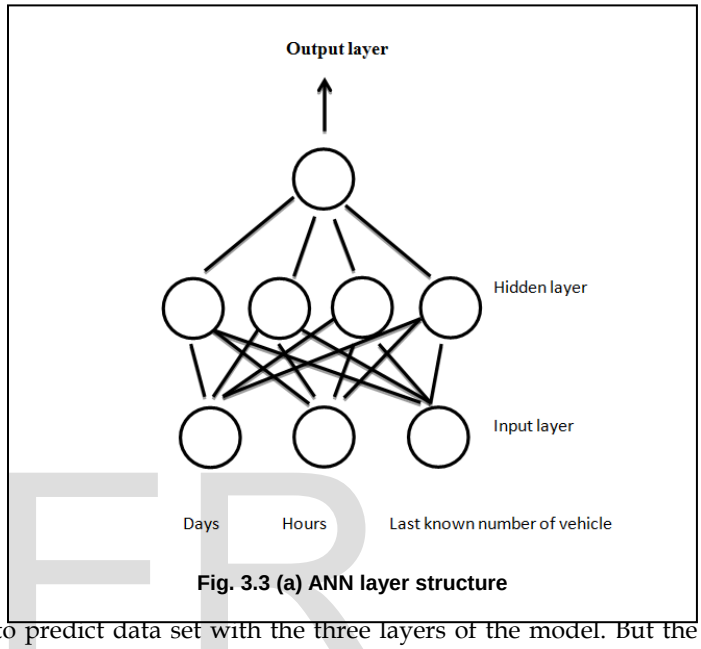

Fig. 3.3 (a) ANN layer structure

to predict data set with the three layers of the model. But the ANN algorithm has also trained with python on the collected data to give illustration graphically for traffic flow prediction with a time interval of one hour. In this way, a user may check traffic flow prediction by using the system.

The following graph shows output traffic flow prediction with ANN Algorithm."Fig 3.3(b)".

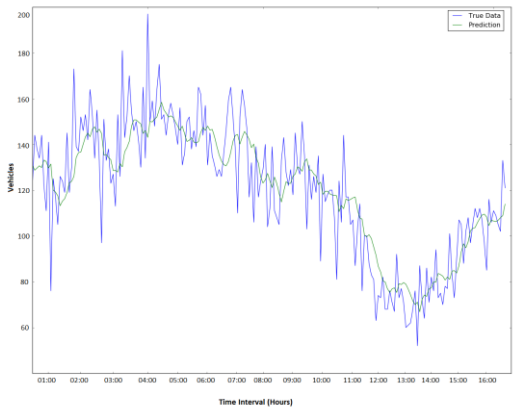

Fig. 3.3 (b) Results obtained using ANN

using the ANN model having two lines blue lines shows the true data, which means original data collected from PEMS. And green lines show the predicted data that we have after applying the ANN algorithm on the existing data.

4 CONCLUSION

In the system, it has been concluded that we develop the traffic flow prediction system by using a traffic flow prediction algorithm. By using two existing prediction algorithms, those are ANN and SVM. We try to utilize these models for our system to give the best prediction result on the developed system. The public can take many benefits by using this system because the users can know what the situation of traffic flow on the current situation is and they can also check what will be the flow of traffic on the right after one hour of the situation. This system also helps to check the weather conditions of the roads. As well user may also check about accident record that how many accidents occurred on which road so which would be safe for a future drive. In future, we can improve this system by making traffic congestion prediction, and many more factors that affect the management, as well as the flow of traffic, can be considered by using many other deep learning methods, as well as user, can use the system to find which route would be easiest to reach on destination. The system can suggest to the user according to their search.

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