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Traffic Projection for Intelligent Transportation System

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A B S T R A C T

Available prediction ways for traffic flow use few traffic prediction models and are still not satisfactory to handle real-world applications. This fact inspired us to work on the traffic flow forecast problem built on the traffic data and models. It is difficult to forecast the traffic flow accurately because the data available for the transportation system is very huge. In this job,, we planned to use machine learning algorithms, genetic, soft computing, and DL algorithms to analyse the big-data for the transportation system with much-reduced complexity. Also, Image Processing is involved in traffic signal recognition, which eventually helps for the right training of intelligent vehicles. This report aims to develop a tool for predicting accurate and timely traffic flow Information. The Traffic Environment involves everything that can affect the traffic flowing on the road, whether it's traffic flow, accidents, rallies, and repairing of roads that can cause a jam. If we have prior information which is very near approximate about all the above and many more daily life situations which can affect traffic then, a driver or rider can make an informed decision. Likely, it helps in the future of intelligent vehicles. In the current decades, traffic data have been generating exponentially, and we have moved towards the big data concepts transportation.

1. Introduction To Traffic Prediction

The increase in demand for transport services and facilities become more complex and larger with the increase in social and economic activities. This led to delays and huge congestion of arteries and city roads. Therefore, we can see too much research on control measures of traffic in transportation facilities. The traffic control system includes the study of traffic speed, volume and traffic density. Generally, these characteristics are considered as measures of performance of roads. The information about the temporal and spatial distribution of traffic is important factor requirement in almost all transport planning and design strategies. In a road network traffic control system, it is desired to predict the characteristics of future traffic to consider the appropriate control and management strategy. The establishment of a road traffic control system requires a means to acquire a temporal and spatial distribution of traffic.

In recent days, deep learning concepts have attracted many people including academicians and industrialists due to their ability to deal with classification difficulties, understanding of natural language, dimensionality reduction, detection of objects, motion modeling. Deep Learning uses multi-layer concepts of neural networks to mine the inherent properties in data from the lowest level to the highest level. They can identify huge volumes of structure in the data, which eventually helps us to visualize and make meaningful inferences from the information.

Motivation

- Traffic congestion leads to various problems like waste of important time, increased carbon emissions by vehicles, increased noise pollution.
- The main reason for traffic congestion is lack of coordination between the drivers, improper signal systems and uneven and uncontrolled speed of vehicles.
- There is a strict need for coordination between vehicles on the road which can be brought by using automated vehicles.
- Vehicles can be automated by making use of various speed sensors and image processing in them and control can be brought on traffic by using various machine learning algorithms.

1. Aim and Objective of the work

1.1 Aim

The aim of the project is to predict Traffic congestion by making use of Machine learning algorithms and alert the users so they can travel from an alternative way.

1.2 Objectives

- To make users aware of oncoming traffic.
- To make use of Machine learning algorithms for predicting traffic.
- To find optimal solutions for clearing traffic.
- To reduce carbon emissions produced by vehicles.

2. Survey on Traffic Flow Predicion Models

The transportation sector is one of the urban environment spheres that allows innovative smart city improvement on this could improve quality of life. World bank statistics published in 2017 that 64% of oil produced globally is consumed by transportation sectors. This sector also contributes in 27% of CO2 emissions worldwide. To improve this sector, there are various options which result in a better and efficient way of travel that allows usage of fuel is reduced and less CO2 emissions. One of the popular solutions is Intelligent Transportation System (ITS). ITS uses modern information, communication, computing, and control technologies in order to make a more efficient, reliable, and secure transportation system. This system guide user from their origin into their destination in the most efficient way. Most outdated static route guidance system relies on shortest path from initial location to destination without considering real-time information, but the advance of modern traffic sensor and communication system allows improvement of the guidance system to become dynamic by utilizing real-time traffic information.

There have been design schemes of dynamic route guidance which can provide drivers with optimal routes by using real-time traffic information, but this may result in the creation of new traffic congestion as drivers are conducted into the same route as the others. Qun proposed an optimization method of dynamic routing system with Particle Swarm Optimization to improve computation speed of route. This method was proven to be effective in improving computation time, but recently is rarely used. Another method to improve dynamic routing system is by predicting the traffic condition.

In predicting future traffic condition, more resources will be used as the results of more computation process. However, this method produces future traffic condition so computation can be done less intensely as non-prediction dynamic routing system whilst result in a similar traffic condition that can be used to guide travelers effectively. Predicted travel time information can support not only individual travelers but also commercial vehicle operators who seek appropriate travel routes.

Generally, in prediction of traffic condition, prediction method can be divided into two methods: short-term prediction and long-term prediction. Short-term prediction relies on recent or even real-time traffic condition data. Long-term prediction relies on daily base behavior data that usually can be related with weather or season.

Short-term prediction can be used to predict traffic condition in advance by using recent traffic condition, however this requires intense traffic data collection to just predict 5 or 15 minutes in advance. Some traffic condition such as morning rush hours in a congested city always show a similar traffic condition. Computing the same/similar situation daily that results in a repetitive pattern may looks like a wasteful computation. However, we can use this repetitive pattern for long-term prediction as a comparison for the short-term prediction model. Combining these two models may have result in a more refined and accurate traffic results.

3.Model Selections (LSTM and Bi-LSTM)

3.1 Long Short Term Memory Network (LSTM):

Theoretically, an RNN can handle such long-term dependency problems. One can carefully select parameters for solving the initial form of such problems. However, in practice, an RNN cannot successfully learn this information. Therefore, LSTM was developed for solving long-term dependency problems, and LSTM avoids long-term dependency problems through deliberate design. Long-term information memory is the default behavior of LSTM in practice, not the ability to obtain information at a low cost. All RNNs have a chained form with a repeating neural network module. In a standard RNN, this duplicate module has a straightforward structure, such as a tanh layer.

LSTM is also such a structure; however, the duplicate modules have a different structure. In contrast to the single neural network layer of a standard RNN, there are four layers here, which interact extraordinarily. A detailed description of the LSTM follows. The cell status (C t), a forgetting gate, an input gate, and an output gate included in each memory unit. These gate structures enable information to pass selectively to remove or add information to the cell state. The memory at time t is used to store important information. Similar to a notebook, it preserves the information that we have learned previously.

The content of the previous layer of the cell state is controlled according to the previous sequence of h t-1, and X t of the sequence is used as input to the sigmoid activation function to obtain the upper layer of the cell state content, which must be removed or retained. The input is in the form of a vector, and we hope that the value of the forgetting gate output is 0 or 1, namely, that each value in the vector is completely forgotten or ultimately remembered; thus, we use the sigmoid function as the activation function since the value of this function is close to 0 or 1 in many cases (the step function cannot be used as the activation function here because its gradient at all positions is 0). Other gates use the sigmoid function for the same reason. Therefore, although the activation function can be transformed into other neural networks, it is not recommended to transform the activation function of the LSTM. The forgotten threshold layer f t determines which information should be discarded from the cell state at the previous moment. In the following formulas, W f , b f , Wi , bi , Wo, and bo are the weights and offsets of each threshold layer, respectively, and σ represents the sigmoid activation function.

$f\_t = \sigma (W f \cdot [h\_t - 1, x\_t] + b f)$

The input of the current sequence position is processed, the information that must be updated is determined, and the cell status is updated. This process is divided into two parts: one part is to use the input gate that contains the sigmoid layer to decide which new information should be added to the cell state. Next, the selected new information must be converted into a form that can be added to the cell state. Hence, the other part is to use the tanh function to generate a new candidate vector. (LSTM's approach is to convert information into a form that can be added to the state of the cell and to use the results that were obtained in the first part to determine which new information will be added to the cell state.) The input threshold layer i_t determines the state of the unit that must be updated.

$i\_t = \sigma (Wi \cdot [h\_t - 1, x\_t] + bi)$

$C\_t = \tanh(WC \cdot [h\_t - 1, x\_t] + bC)$

With the forgetting gate and the input gate, we can update the cell state C t−1 to C t, where f t×C −1 denotes the information that has been selected for deletion and i_t×C_t' denotes the new information.

$C\_t = f\_t * C\_t - 1 + i\_t * C\_t$

C_t is obtained from the LSTM unit state, and C_t and C_t1 are comprehensively updated to C_t by using the input threshold and the forgetting threshold.

Finally, it is necessary to determine what to output based on the content that is saved by the cell state, namely, the content of the cell state that has been saved selectively. Similar to the two-part update of the input gate, the output gate also needs to use the sigmoid activation function to determine which portion of the content must be output. Then, the tanh activation function is used to process the content of the cell state (because each value of C t is determined via the above calculation) that is in the range of tanh −1∼1; content that is outside this range must be adjusted. The two parts are multiplied to yield the part that we want to output. The output threshold layer O_t will be filtered out based on the state of the unit.

$O\_t = \sigma (Wo \cdot [h\_t - 1, x\_t] + bo)$

$h\_t = O\_t * (C\_t)$

3.2 Bidirectional Long Short-Term Memory Network (BILSTM):

Sometimes, the prediction may need to be determined by several previous inputs and several subsequent inputs, which is more accurate. Therefore, a two-way cyclic neural network is proposed, and the network structure illustrated in Figure 4. The forward layer and the backward layer connected to the output layer, which contains six shared weights, namely, w1-w6. The six weights are reused at each time step and correspond to input to the forward and backward hidden layers (w1 and w3), information flow from the hidden layers to themselves (w2 and w5), and information flow from the forward and backward hidden layers to the output layer (w4 and w6). There is no information flow between the forward and backward hidden layers, which ensures that the expanded graph is acyclic.

In the forward layer, the forward calculation conducted from time 1 to time t, and the output of the forward hidden layer at each time is obtained and saved. In the backward layer, the calculation is reversed along time t to time 1, and the output of the backward hidden layer at each time is obtained and saved. Finally, at each moment, the final output is obtained by combining the results for the corresponding time of the forward layer and the backward layer. The mathematical expressions are as follows:

$h\_t = f (w1x\_t + w2h\_t - 1)$

$h\_t = f (w3x\_t + w5h\_t - 1)$

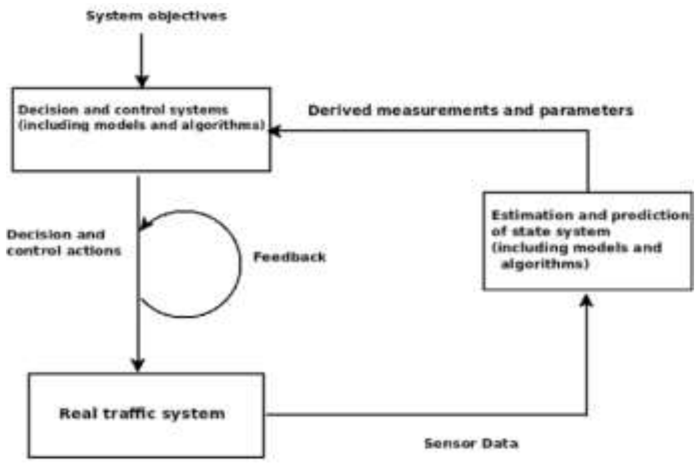

Fig. 1: Architecture of traffic prediction models

4.Benefits and Advantages

- **Planning**: Traffic predictions can help you plan for events like holidays, major sporting events, or concerts that may affect traffic flow. They can help you prepare for events during the daytime , such as maintenance services, work areas, or road stops.
- **Scheduling:** It will allow you to schedule your work crews in a more efficient way. This decreases the time they spend waiting around for equipment to arrive at job places or in holding areas before they start working on roads. It also helps them avoid sitting idle while waiting for road conditions to improvise;
- **Cost Management:** Traffic reports help you manage costs by providing better visibility into what it will cost to complete a project and when it'll be finished. This allows managers and contractors to make better-informed decisions about how much time and money should be allocated for each project step, resulting in lower overall prices due to lesser surprises along the way.
- **Improves Safety:** Traffic experts can predict how many people will be on the road at various times of day, which helps them plan for urgent responsiveness. For example, if there's a large sporting program in town, they can adjust the timing of the road lights to accommodate this size.
- **Reduces Fuel Consumption:** Traffic lights are timed to keep vehicles moving properly through intersections. This reduces fuel consumption by removing unnecessary braking and accelerating, which wastes energy;
- **Saves You Money:** By reducing congestion, traffic prediction can save companies money through improved productivity and decreased travel expenses. Traffic congestion also increases wear-and-tear on vehicles which adds up over time.

5.Disadvantages

- Accuracy of traffic prediction generally lags behind because of various reasons such as poor infrastructure, poorly designed cities, lack of traffic capturing devices and unpredicted congestion in cities or highways.
- To work effectively, there should be an intelligent system developed. But this system also requires credible and timely information to ensure that software can work securely and produce results within specified time.

6. Conclusion

Although deep learning and genetic algorithms are an important problem in data analysis, it has not been dealt with extensively by the ML community. The proposed algorithm gives higher accuracy than the existing algorithms also, it improves the complexity issues throughout the dataset. Also we have planned to integrate the web server and the application. Also the algorithms will be further improved to much higher accuracy. Random Forest outperforms several other methods in predicting traffic conditions. Random Forest can be used in both short-term and long-term prediction models. Combining short-term and long-term random forest prediction models may result in a better accuracy of traffic prediction.