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Intelligent Transport Systems

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Abstract: Growing economic activities aand others are among the factors that make many cities busy places today especially in traffic systems. Road networks that seem to be spacious sometimes become completely congested so much so that traffic mobility looks standstill. This impacts negatively on traffic users resources in terms of time management, fuel and other resource. This paper discusses the background trend in traffic activities amid congestion environment and proposes an Intelligent Traffic System that uses Machine Learning technique of predictive classification and regression to help traffic users determine forehand on the congestion status of available roads or highways. This further suggests that if the road user tries to avoid congestion, then the congestion levels will minimize. For simplicity, the data that has been used for congestion has been from a csv file containing previous datasets of local roads or highways.
ITS – Intelligent Transport Systems; ML – Machine Learning; MHD – Modern Hardware Devices; SOSE – School of Specialized Excellence.

I. INTRODUCTION

Modern cities are places of numerous economic activity which is driven by transportation [1]. Free flow of transport is very essential to smooth running of economic activities in our cities [2]. Each passing day people, goods and services are moved from one place to another while their respective businesses are taking place. Time in every business activity is very important [3]. In most cities there is what they call peak times where roads and highways are filled with traffic which is almost immobile due to many reasons [4]. Planning in this kind of environment is not always easy as most of the times business players are found themselves right in the mid of the traffic congestion, stuck [5]. This becomes an impingement on the progress on a business and has possibility of costing high on the economy of such a business [6]. Assuming that this business activating is a periodical movement of people, goods and services; or it is an important event that takes place at a designated time of the year whose negative effect can remarkably drain the resources of a business. This then calls for proper planning which include numerical predictive analysis [7] which will help identify roads or highways that might be relatively not congested on a particular hour of day. This where ITS comes to play. This is a ML-based technology that automatically collects data over a period of times, builds a training dataset and makes predictions [8] [9]that helps in estimating the levels of congestion of roads and highways of a particular city and of a selected day peak hour. This paper discusses ways of predictive analyses which can be used in an ITS with an aim of assisting business players to plan cost-effectively on an important event where traffic congestion is the possible biggest risk. Transport users just find themselves within traffic jam and if such a situation were predicted and planned, it would perhaps be avoided. Therefore applying ML tools to predict non-congested roads and highway can help avoid it.

II. LITERATURE REVIEW

Many works that have been done previously did not specifically focus on the system that predicts non-congested roads and highways using ML techniques.

P. Martin-Martin et al. stated that his work presents the viability of the different ML techniques for their application in the problem of autonomous driving [10]. S. Suhas et al. in his review on Traffic Prediction for ITS focused much on aggregating previous on traffic prediction, highlighting marked changes in trends and provide research direction for future work [11]. A. Zeer et al. wrote in his work that aimed at conducting systematic analysis ITS and summarized their work into issues in ITS and techniques used to solve the issues [12]. Boukerche and Wang in their research stated that they were trying to build up a clear and thorough review of different ML models and analyze the advantages and disadvantages of these ML models [13].

Issam Damaj et al. focused on reviewing the recent literature of ML-driven ITS, in which MHDs were utilized, with a focus on performance indicators [14]. Another researcher Meng Lu et al. provided an overview of the history and the state of the art of C-ITS, analysed the challenges, defined C-ITS services, requirements and use cases, proposed generic a pan-European C-ITS architecture, investigated the next steps for C-ITS deployment, and discussed next steps for the C-ITS deployment [15].

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In his research K. Ashokkumar et al. presented a novel multi-layered vehicular data cloud platform by using cloud computing and IoT technologies with two innovative vehicular data cloud services, an intelligent parking cloud service and a vehicular data mining cloud service in the IoT environment and presented reviews [16]. In another research work by Mathew and Elizabeth, they evaluated intelligent transport system as a system of systems in the cyber-physical world. They also tried to identify the challenges and opportunities in SOSE research and ideas for attacking these challenges [17].
Studying through the works referred in this section clearly shows that great works have been done various researchers with various areas of focus which did not touch fully on assisting road and highway users with ITS that focuses on predicting non-congested route using ML technique.

III. RESEARCH METHODOLOGY

The data for the models for predictive algorithms were collected through Secondary data collection method, since much work on these has already been done by a number of researchers and authors [18].
There are basically top 5 predictive algorithms for implementing a system like the ITS [19]. These are

A. *Random Forest*

This comes from an aggregation of decision trees which are not related and use both regression and classification to classify huge amounts of data. In lieu of depending on one decision tree, it takes the prediction from each tree and based on the majority votes of predictions, it predicts the final output.

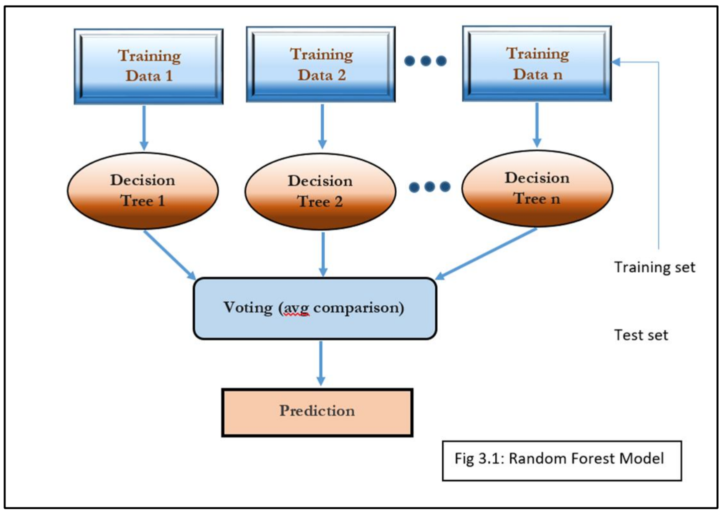

Fig 3.1: Random Forest Model

B. *Generalized Linear Model for two values*

This takes the General Linear Model comparison of the effects of multiple variables on continuous variables before drawing from an array of different distributions to get the best fitting model. It comprises of three models;

1) *Random Component:* This specifies the conditional distribution of the response variable, Y_i (for *i*th of *n* independently sampled observations), given the values of the explanatory variables in the model.
2) *Linear Predictor:* This is a linear function of regressors;

$$\eta_i = \alpha + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik}$$

Just like in the linear model, and in the logit and probit model [20]. The regressors X_{ij} are prespecified functions of the explanatory variables and may include quantitative explanatory variables, transformations of quantitative explanatory variables, polynomial regressors, dummy regressors, interactions, and others [21].

3) *Link Function*

This transforms the expectation the response variable,

$\mu_i \equiv E(Yi)$, to the linear predictor;

$$g(\mu_i) = \eta_i = \alpha + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_k X_{ik}$$

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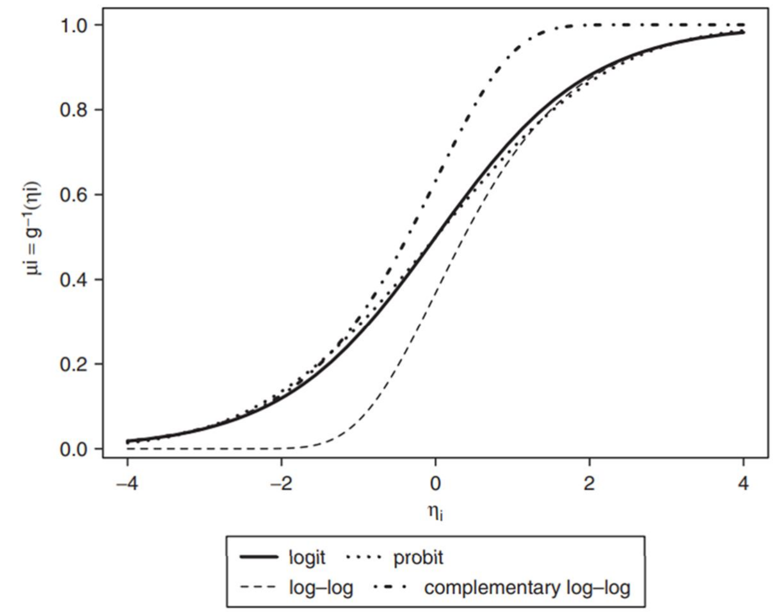

Fig 3.2: Structure of Generalized Linear Model

C. Gradient Boosted Model

This sequentially builds models on subsequent models by reducing errors of the previous model. This is done by building one tree at a time.

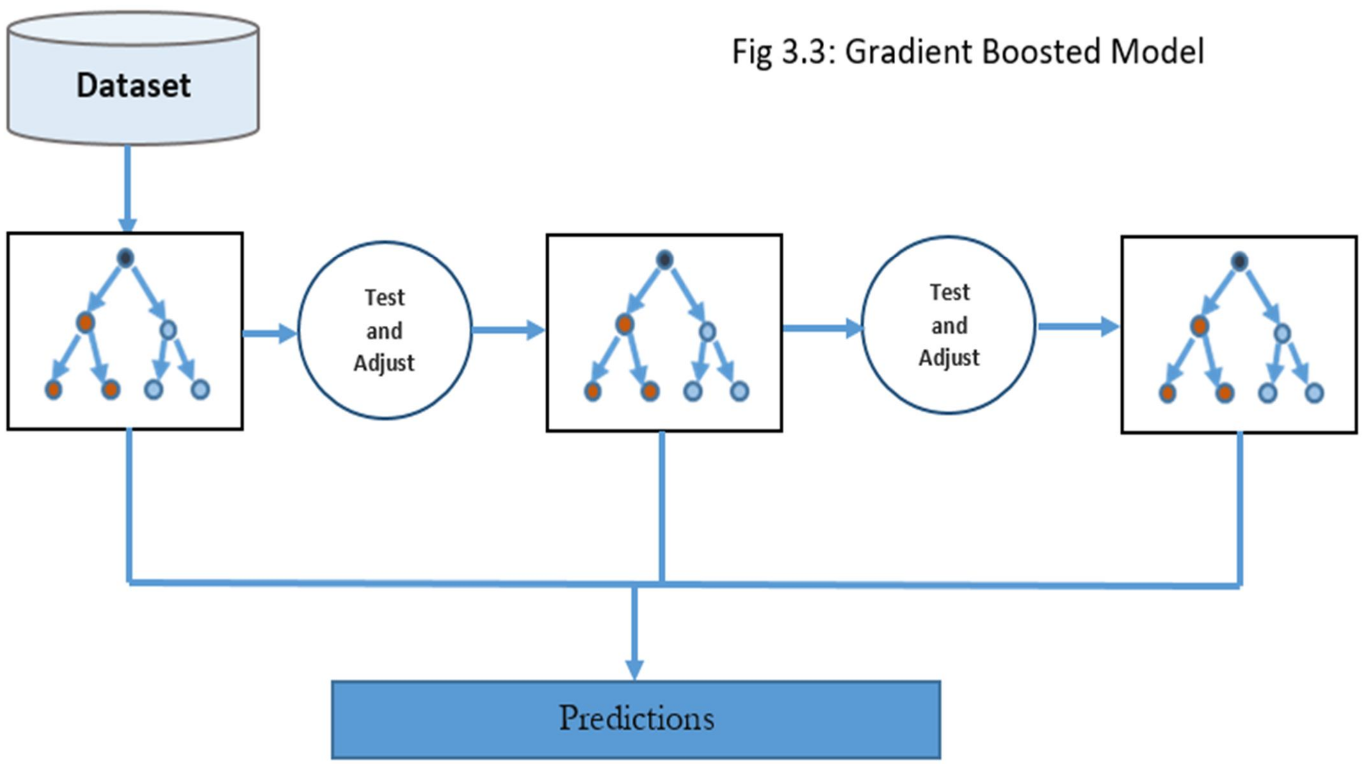

Fig 3.3: Gradient Boosted Model

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D. K-Means

This places unlabeled data points in separate groups based on similarities. It is used in clustering model. It then tries to figure out what are the common attributes from each dataset and groups them together. It is particularly helpful when using a large dataset and trying to implement a personalized plan.

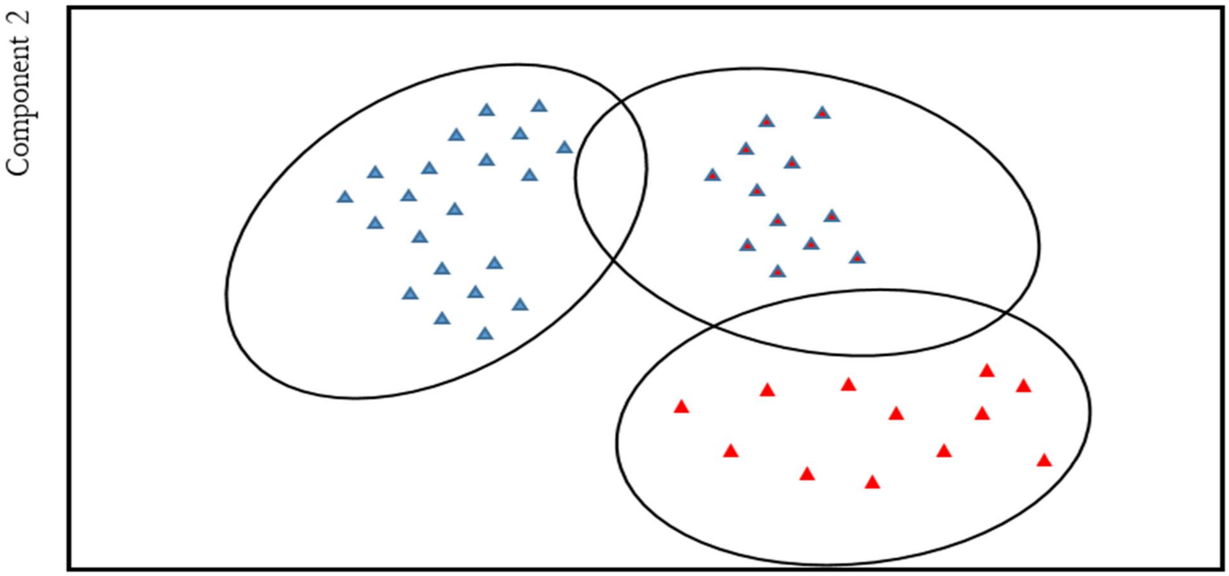

Fig 3.4: K-Means

E. Prophet

This is usually used in time series and forecast models. It is used by Facebook and was developed by them [19].

IV. CHOSEN ALGORITHM FOR THE SYSTEM

The algorithm for the system is Random Forest which can handle both classification and regression analyses. Here dataset created in csv file or from live google map is fed into the algorithm. For simplicity, this paper covers the analysis on csv file run in python to predict the most congested route in a particular city. In this paper, roads of Greater Noida, India, have been chosen for convenience. The dataset has roads like;

1) Surajpur road
2) Sector 51 road
3) Rampur road and
4) Greater Noida road

The range of numbers deemed to constitute congestion has been between 0 and 40. These numbers are nominal such that numbers towards 40 are meant to constitute high congestion.

The understanding of Random Forest can be deciphered in this pseudo code;

1) Randomly select some arbitrary **k** features from a total of **m**
   - Where **k << m**
2) Among the arbitrary **k** features, calculate the node **d** using the **best split** point
3) Split the node into **daughter nodes** using the **best split**
4) Then repeat the above steps until some number of nodes has been reached
5) Build forest by repeating the above steps for **n** number of times to create **n** number of trees

Then the basing on the above operation, comes the prediction part which is the goal of this research paper.

a) Take the **test features** and use the rules of each randomly created decision tree to predict the outcome and keep the value as target value

b) Calculate the **votes** for each target value of a decision tree

c) Then consider **high voted** predicted target as the **final prediction** from the random forest algorithm.

The final outcome of the actual code in python is a sorted value of congested roads in ascending order or values between 0 and 1. Where values close to 1 indicate high congestion. Here the road user is able to see which road is less congested at a particular runtime.

V. CONCLUSION

The ITS is a transport system that aims at assisting transport users to use the roads or highway to the efficiency of their resource by avoiding congestion. This congestion is detected using Machine Learning techniques for making predictive analyses through classification and regression. Among the techniques, Random Forest has been chosen because of its versatility in using continuing data. This technique will also help traffic road users in planning purposes while helping reduce overall congestion.

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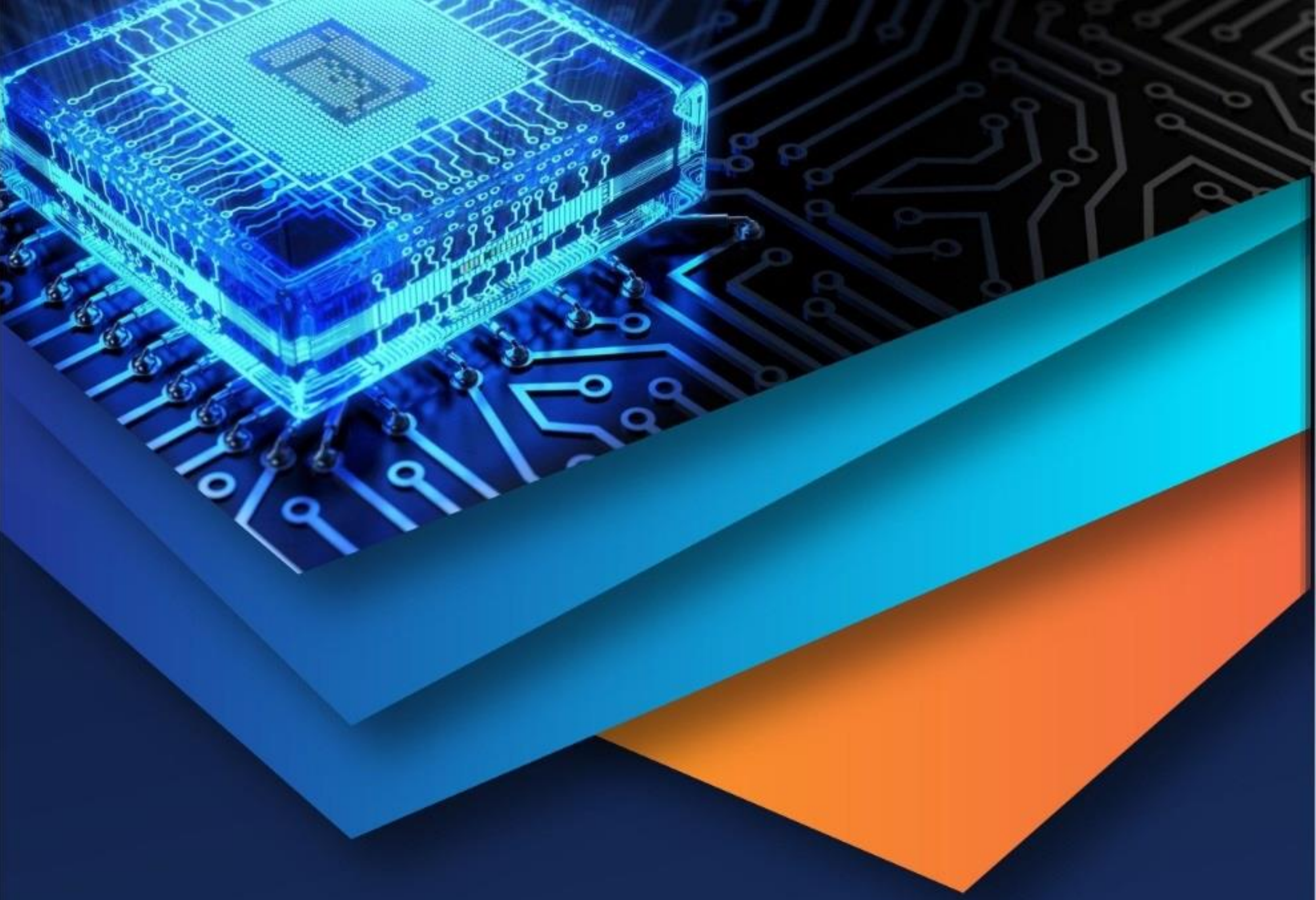

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