Tuning Parameters Using Machine Learning for Minimizing Slowness of Traffic in Smart Cities

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Abstract: ***In recent years a drastic change is noticed in a traffic flow that has undergone significant changes such as competition, work style, heavy duties, and hectic timings. In regards to these changes, the main concern is the environment, commercial market, customer satisfaction, restrictions, and a competitive edge. Urban logistics and consumer markets highly depend on the moment and travel. Due to which the traffic inflows and outflows are increased drastically. To manage such huge flow's traffic is monitored and behavior is observed from the analytical end. In this article, urban traffic parameters are considered which affect the slowness inflow. These parameters are tuned using machine learning methods. The study extracts certain parameters that are critical and attention is majorly required. The extracted parameters are thereby tuned by facilitating requirements in order to improve the flow of traffic. Tuning uses machine learning methods for predicting the behavior of traffic for a week's time in urban cities.***

Keywords: Machine Learning, Smart Cities, Traffic, Tuning, cross validation, Transportation;

I. INTRODUCTION

Traffic control and management in metropolitan cities is tedious task during peak hours. Many solutions are provided by constructing fly over, under pass and building more roads still the problem persists. Many solutions were provided such as changing the timings of many organizations and increase the amount of people travelling in each vehicle (Affonso, Sassi, & Ferreira, 2011). Though people do work in day and night shifts still the congestion on roads transit is not diminishing. Yet, an efficient path with laid and structured infrastructure could regulate traffic flow. Novel traffic controlling strategies are required to handle the scenario in peak hours for better progress of the country (Ferreira & Sassi, 2010). With the current estimates of number of vehicles on roads there is a need to estimate exponential growth of the vehicles in upcoming years. Model or the solution, which is expected, should be able to cope with uncertain situations by incorporating necessary measures.

The traffic congestion in urban life inflicts delay, frustration in people, accidents and mental tension to all classes of people. Although many counter measures are initiated and implemented still people face difficulties and dissatisfaction during their journey. On the other hand, transit accompanies the financial and economic activities through an increase in demand of trade, exchange and connectivity. This movement of people and goods from one place to another increases the revenue for the government following that, increases the global marketing of products and changes in demand and supply. These effects will change share market value globally.

Research study on traffic reveals a variety of policies were executed for reducing the traffic congestion. Political measures appeal is more in peak period travel. These vehicles are undermined in the flexible hours. Due to these measures some complex behavioral changes are determined which effect organization upgrades or financial enticements. These properties arouse the difficulties in significant wealth transfers and distrust exceptionally problematic to ratify in a democracy.

The percentage of vehicles such as cars, two wheels, bus, railway and walk are basic people's transit modes are 45%, 25%, 10%, 18% and 12% respectively. The traffic congestion is not only the problem, people are advancing the modes of travel as they are automobile dependent and on the other end this even increases the social and environmental problems.

The present study focuses on peculiar challenge in combining different parameters to enable comprehensive evaluations in order to tune for a better transit. These parameters are tuned using machine learning algorithms with a view to adapt as per the requirements.

II. RELATED WORK

A brief overview of these techniques in order to track and control the congestion is discussed in this section.

- Anders Kofed-Petersen et.al presented a prototype-based system which uses past vehicle counts in intersection with updated signal plans with reasoning. A framework jCOLIBRI is applied as an automation signal indicator and simulation tool for administrating public roads (Anders, Ole, & Agnar, 2014)

- Fuzzy sets of artificial Intelligence and Genetic algorithms are applied on unpredictable traffic scenarios. This model proposed by Gilberto et.al comprises of supervisors and controller agents which monitor the traffic and adapt the measures to control the urban traffic in Brazil (Gilberto & Vinicus, 2011).
- A survey was conducted defining several problems pertaining to traffic and various trends in traffic behavior of Los Angeles area. Some features under this study, by Genevieve Giuliano and Kenneth A., Small, are alternate policies, including inaction, land in use, highway capacity expansion, low technology, mass transit and pricing. These features are tuned to minimize the traffic congestion (Genevieve & Kenneth, 1993).
- J C Falcocchio and H S Levinson expressed the speed of transit has exponentially raised land development, expansion of city, pattern of movement and technology transformation in their research study (Falcoccohio & Levinson, 2015).
- Yuta Asano et.al proposed, SUMO a simulation map was constructed on Kobe city to address the traffic challenges. Parameters are tuned in accordance with the routing algorithm (I.Nobuyasu & Yuta, 2014).
- A research study created a database of specific mobility, parameters representing technical characteristic, vehicle type and multi-mode transport system in urban areas. Helmut Brunner study proposed a model "weighted traffic performance indices" using the weights on different vehicles (Helmut & Mario, 2018).

III. AIM OF THIS STUDY

The present study aims at a comprehensive evaluation of different parameters for slow in traffic and measures to improvise the means of transit. The parameters considered in the study are Immobilized bus, Broken Truck, Vehicle excess, Accident victim, Running over, occurrence involving freight, incident involving dangerous freight, lack of electricity, Fire accident, point of flooding, Manifestation, defect in the network of trolley buses, tree on the road, semaphore off, intermittent semaphore and slowness in traffic(%). The dataset considered is taken from open repository from urban habits. And these are a few parameters considered for the study.

The main objective of the study includes the following items:

1) Tuning of different parameters slows down the traffic in the urban cities in Peek hours from 7:00 am to 20:00pm
2) From Monday to Friday every 30 minutes, traffic is monitored with respect to considered parameters.

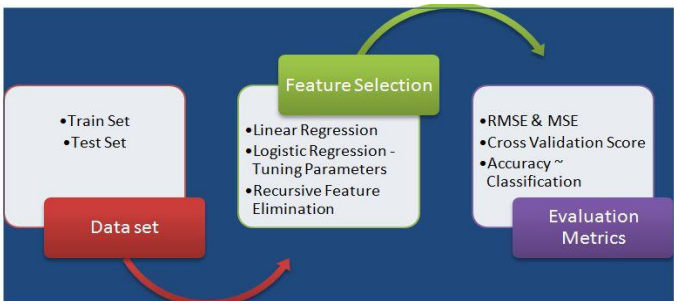

***Fig 1**: Model for tuning parameters using ML methods*

Evaluating the parameters based on the introduced methodology will tune the parameters to mobilize the traffic in efficient way [12]. These parameters are partitioned are independent and dependent data. Slowness in traffic is considered as a measure of dependent variable. From the dataset, proposed model in figure 1 predicts the slowness of traffic under various parameters.

In the figure 1 a data set is partitioned into train set and test set in the first phase. In the second phase the features are tuned by machine learning models linear and logistic regression. In the final phase metrics are computed for categorising the parameters which affect the slowness of the traffic.

From the predictions drawn the parameters are tuned to improve the flow and evaluate the reasons for congestions. These evaluations can be implemented for better congestion control and smooth flow. This study based on wide range of criteria provides insights and challenge to combine the various partially conflicting parameters in a smart, objective and reprehensive way.

The objective evaluation is based on limited selection of features. Some aspects may be construction, maintenance of streets, road widening, white topping and other repair works. The implemented evaluations can be applied by taking into account of some more additional features for any cities. Furthermore, evaluation is neutralized, physically based comparison indices. Research does not include the ecological imbalances and environmental issues.

IV. IMPLEMENTED METHODOLOGY

A model is established to evaluate the parameters and tune according to the requirement. The model analyses the correlation between all the reflected parameters in the dataset. Each parameter is simulated and evaluated by using two machine learning models one is classification model and the other is regression model.

Initially the regression model Linear Regression computes the RMSE and correlation coefficient between the pair of attributes. From the computed error logistic regression – a classification model that categories the attributes whether the parameter is affecting the slowness in the traffic or not. This model measures the probability of each parameter which contributes towards slowness in traffic. Recursive Feature elimination method is used to select appropriate features that are affecting the traffic. Once the parameters are observed the measures in providing the necessary tools and other solutions are evaluated.

Recursive feature elemination method builds a model by using the selected parameters which contribute the most to acheieve accuarte predictions for the target variables. This method uses filters to recursively eleminate the inadequate parameters. Cross validation score and accuaracy are calculated to improvise the parameters in order to control the traffic congestions.

V. EVALUATIONS

Correlation is computed between each pair of parameters in Figure 2. If the correlation coefficient is positive then the parameter is considered it is affecting the slowness in traffic otherwise it is no-correlation or it is negatively correlated.

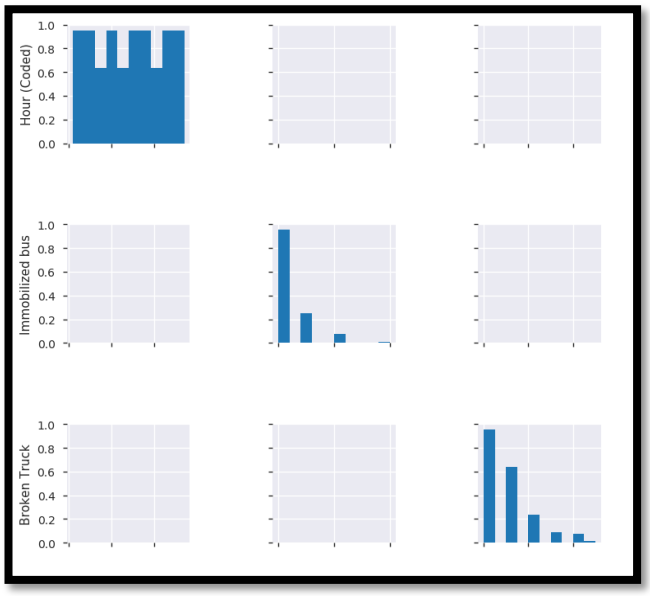

Fig 2: *Correlation between the parameters*

Figure 3 shows the heat map representing all parameters where the darken portion represents no correlation between the parameters and lighten portion represents the high correlation. From the observations hour(coded) parameter effect the slowness for around 0.87 percent. And semaphore off is affecting the lack of electricity parameter for 0.78 percent. To name a few there is no correlation between fire and occurrence involving freight.

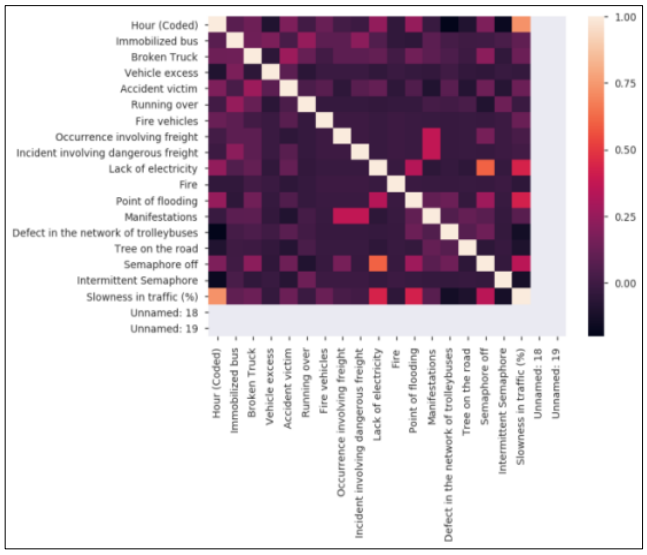

Fig 3: *Heat Map represents 15 parameters of the dataset*

Cross validation trains the model on a large portion of the dataset. This technique assists in gauging the effectiveness of model's performance. If the model results a positive quantity, current model is appropriate and if it results a negative quantity then there is a need for improving the model.

In the figure 4 the graph represents the cross-validation results in order to tune the parameters. X – Axis represents the selected parameters and y- axis represents the accuracy score. Among 15 parameters 9 parameters are considered which impact the traffic.

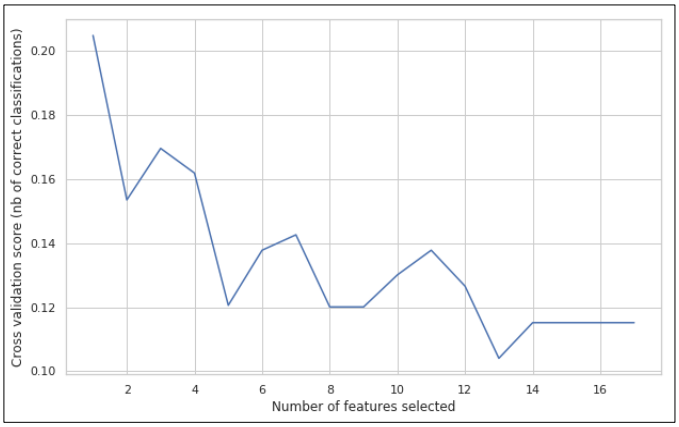

Fig 4: *Cross Validation for tuning parameters*

The figure 4 gives a brief summary of the parameters which affect the traffic slowness. The y – axis denote the parameters of the dataset. In the first graph lined up in figure 4 conveys the peak hours of traffic. Traffic flow between 9:00 to 11:00 AM and 5:00 to 8:00 PM is heavy and if the parameters such as immobilized bus, broken truck, tree, accident victim, fire accident and tree on the road affect the slowness in traffic.

From the figure 5 a heat-map is generated which depicts the relation between the parameters and it gives the appropriate measure that can be considered for the traffic slowness. The parameters immobilized bus and mobility of the vehicle has the correlation coefficient as 0.87.

The parameter broken truck, Accident victim and Semaphore Off have the correlation of 0.56, 0.43 and 0.38 respectively. Lack of electricity and Point of flooding parameters have the major effect on traffic slowness from the graph i.e. 0.92 and 0.89 respectively. These two peculiar parameters affect the major portion in traffic slowness.

From this result it is evident these parameters listed above need to improve for better movement of traffic and reduce the slowness. If these parameters are tuned by providing necessary measures and availing the requirements slowness in the traffic can be controlled which definitely increases the traffic flow.

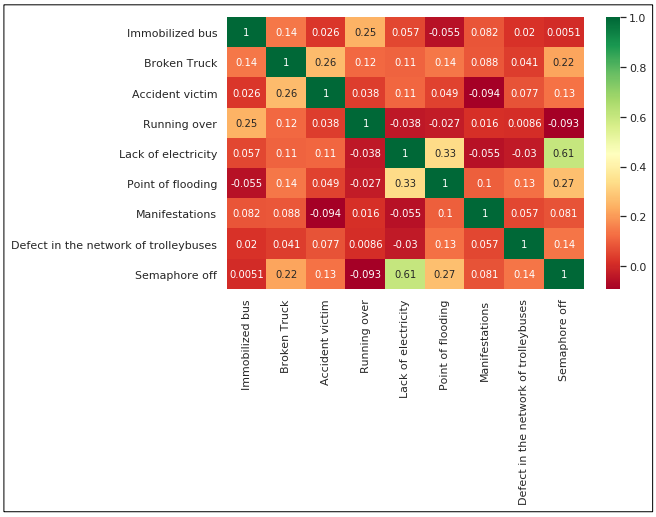

Fig 5: *Heat Map representing 9 parameters after cross validation*

VI. IMPROVEMENT STRATEGY

In cities without acceptable urban structuring this issue may to become by permanent. Some places a jam causes traffic due to which re-routing is required. The traffic needs to be observed accordingly and need to be re-routed using dynamic routing algorithms for efficient movement of vehicles.

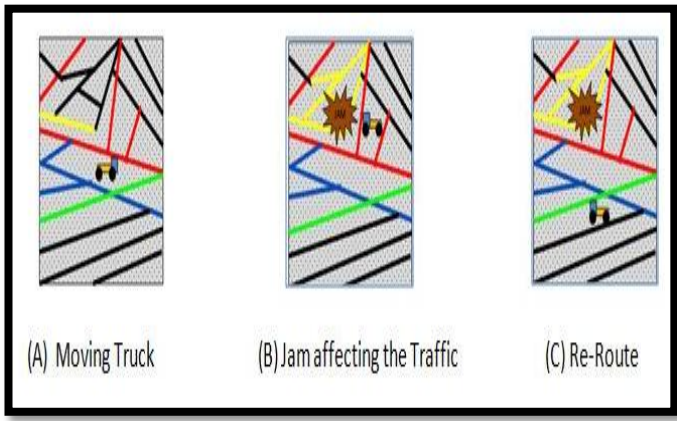

Fig 6: *Stages of Moving Truck at time of traffic jam*

By applying dynamic re-routing algorithms, a moving truck is travelling in the path as shown in figure 6 of (A) then after travelling a little distance, traffic got slow down. That is observed from figure (B) of there is a jam and the yellow line represent the traffic is slow due to heavy congestion. Then in (C) a re-route technique is applied to find a new way there so minimal congestion and that is depicted using green lines. Due to this jam many other areas are affected those lines are represented using red lines.

Application of dynamic re-routing uses certain critical parameters for learning the behaviour and depicts the complexity for re-routing the vehicles. It uses various levels such as link level which is based on time dependency.

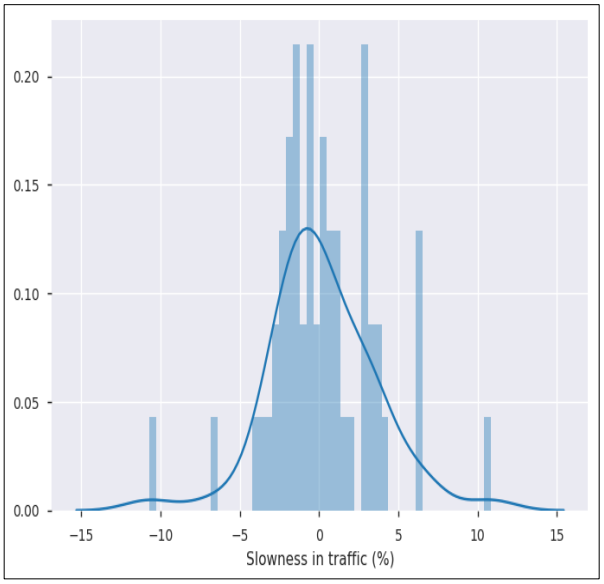

Fig 7: *Slowness in Traffic in regards to parameters*

Route level examines the longest or shortest path for optimal benefit. Demand level clears the traffic in case of emergency and reroutes in an efficient way to avoid slowness parameter. The route choice can be chosen necessarily or computed against each time interval of travel. Hence, one of these three levels are used by dynamic algorithms to re-route accordingly.

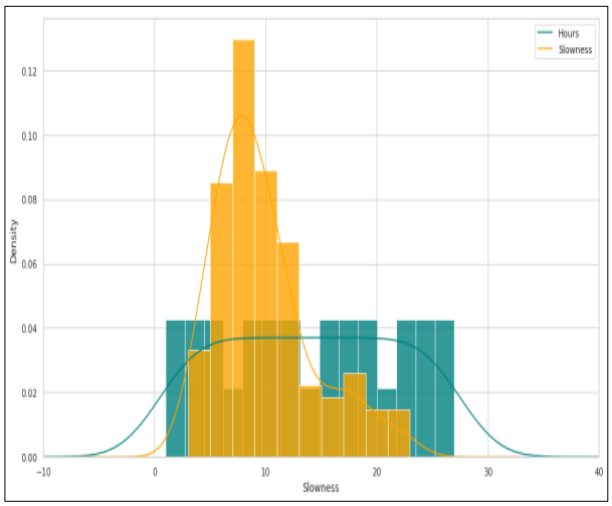

Fig 8: *Hours and Slowness of Traffic*

Figure 7 describes the slowness in traffic in percentages due to various parameters. This histogram and a normal bell curve show the variations in the traffic due to parameters. Each parameter is affecting the traffic so strategic planning would be to interpret the behaviour of traffic that affects the slowness %. In figure 8 the graph represents two histograms and normal curves. Blue histogram represents the hours and yellow represents the slowness. From this graph it is evident that which parameters contribute to slowness of traffic. Each bin is considered as time slots and the curve in the middle region shows the highest peak for time between 8:00 Am to 11:00 Am and another peak is for 5:00 Pm to 8:00 Pm.

VII. CONCLUSION

The study provides a database with specific mobility related criteria and parameters which usually, affect the slowness in traffic. From the above study the movement of heavy vehicles during the peak hours affects the slowness. Considering various parameters among which certain should be tuned by making available necessary tools, requirements and equipment.

Some of the observations need to be addressed for improving the urban mobility are listed below:

- Individual taxi vehicles dominated more than private cars
- Small vehicles can be efficient mode of transport
- Heavy vehicle mobility should be restricted during the peak hours.
- Use of public transport such as Buses, Metro Trains or walk mode should be preferred.
- Sensor need to be installed to track the congestion during peak hours.

The prediction of traffic behaviour can contribute to decision making prior to routing and supports in transit, even if distance is a little bigger, and there is a

savings in time and fuel. From the study some parameters that are affecting the traffic slowness can be detected and those regions are needed to be monitored for proper channelling and congestion control.

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