Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 132 (2018) 451–460

Procedia Computer Science

www.elsevier.com/locate/procedia

International Conference on Computational Intelligence and Data Science (ICCIDS 2018)

Traffic Management using Logistic Regression with Fuzzy Logic

Anurag Singh Tomar[a,b], Mridula Singh[c], Girish Sharma[d], K.V. Arya[e]

[a]*School of Computer Science, University of Petroleum and Energy Studies, Dehradun, India*
[b]*Department of Computer Science Engineering, Uttarakhand Technical University, Dehradun, India*
[c]*Department of Electronics and Telecommunication, College of engineering Roorkee, India*
[d]*Department of Master of Computer Application, Bhai Parmanand Institute of Business Studies, Shakarpur, New Delhi, India*
[e]*Department of Computer Science Engineering, Institute of Engineering and Technology, Lucknow, India*

Abstract

Traffic congestion is one of the major problems in most of the cities across the globe and it leads to several other problems like pollution, time wastage, long traffic queues on roads and may cause accidents. Improvement of Road infrastructure is not always the feasible solution to resolve the problem. In real life scenario shorter distance route towards the destination attracts majority of people and at times it may aggravate traffic jam conditions. Therefore, a real time traffic information for intelligent decision making to decide the route preference is required. Moreover, a system which considers the factor of distance towards the destination along with real time traffic situation on that route will add to the solution to the congestion problem. certain parameters such as distance, weather condition, road location, day of week and time are considered to formulate the problem and to find solutions to these problems This paper outlines a combination of logistic regression with fuzzy logic such that a smart decision to preferred path can be taken. It is used to compute the probability of each possible path by considering the real time traffic information, distance and road condition and later is used to take decisions in an uncertain scenario. Proposed Method considers the number of parameters like distance, weather condition, road location, day of week and time.

1877-0509 © 2018 The Authors. Published by Elsevier Ltd.
This is an open access article under the CC BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/3.0/)
Peer-review under responsibility of the scientific committee of the International Conference on Computational Intelligence and Data Science (ICCIDS 2018).
10.1016/j.procs.2018.05.159

Keywords:- Logistic regression ;Traffic management; congestion; fuzzy logic; optimization algorithm; fuzzy controller

1. Introduction

Enormous increase of population, along with economic development and equated monthly installment (EMI) provided by the banks plays a major role in purchasing vehicles by and individual. . Moreover, for traversing even shorter distance people use individual vehicles [8,9] which is adding to the increased number of vehicles on road this increase in number of vehicle leads to a major problem viz. traffic congestion. Several other factors which are responsible for traffic congestion are inadequate road space, poor infrastructure and maintenance of roads that has not been enhanced with time. Traffic Congestion leads to fuel wastage, more time consumption and disappointment of driver and passengers [10,11].

To overcome these problems, an intelligent transportation system is required which may include factors like adaptive traffic light system that regulate the duration of signal as per the traffic present at intersections, adaptive route guidance system, and correct traffic prediction system. Various soft computing methods, machine learning based algorithm, fuzzy logic has been used to model the traffic [4]. The objective of this paper is to provide a framework for an intelligent transportation system which will be able regulate the traffic in an efficient way by considering different factors such as distance between source and destination, local weather conditions, week day and the time at which a person is travelling. Including the number of parameters will help the system to take the Smart decision. This will be achieved by combining logistic regression and fuzzy logic which will make a better adaptive traffic management system.

2. Literature Survey

Due to the problems discussed in section 1, several researches are being carried out for intelligent transportation system. This includes very vast variety of research areas such as Traffic management with automation of traffic signal [12,13]; selection of best route using the methods of Fuzzy logic [1,2], swarm based intelligence [2], genetic algorithm [6] and multi agent based systems [1].

Taha and Ibrahim [3] developed the graphical user interface (GUI) to simulate and evaluate the performance of fuzzy based algorithm for intersection road traffic network in term of various parameters like average waiting time, queue length of traffic on roads. The authors designed road intersection network, and GUI to implement the connectivity with fuzzy logic in which user can define various fuzzy logic parameters like input variable, fuzzy rules, fuzzy inference engine, membership functions, output variable. One of the disadvantage of this paper was that authors did not give any specific algorithm to manage the traffic, traffic prediction mechanism as well as route guidance system for driver.

Kanan [4] presented the intelligent traffic control mechanism using fuzzy logic. the input was number of cars, average speed of vehicles defining the three membership function small, medium, large. author designed various fuzzy rules to help to get the values of output variable, waiting time and duration of green light.

Sharma et al. [5] presented a traffic prediction model for a particular day and time. the input used for modeling was day and time at which traffic is considered. Several fuzzy sets had been defined to predict the accurate traffic. Authors have also used the triangular membership function for input and output variable.

Collotta et al. [6] combined wireless sensor network to monitor real time traffic with fuzzy logic to dynamically manage the traffic at intersection by computing the duration of green light. To compute the duration of green light calculation of the length of queue or traffic count at section of road in each direction during the red light is considered. , Based on the length of the queue it will compute the priority of each phase of traffic light cycle on each direction and then will compute the green light duration. The limitation of this model is that it does not provide the real time information to user regarding path. it has ambiguity about that whether the driver should follow the same route or the alternate route.

The neural network and fuzzy logic has been combined to predict short term traffic by Deshpande and Bajaj [7]. they presented 5 layer neuro fuzzy model. The first layer was input that passes the crisp value to second layer and the input is fuzzfied by computing the value of membership function. Third layer contained fuzzy rules where neurons will be trained. Output membership function was on fourth layer and finally output was produced on the layer five after defuzzification. Proposed model combined the advantage of both training of neurons to produce the output and uncertainty handled by fuzzy logic.

Deshpande and bajaj [15] apply the machine learning technique support vector machine (SVM) for accurate traffic flow prediction [17] as well as measure the performance in term of mean square error, root mean square error, normalized mean square error.

Cong et al. [16] presented the Traffic flow forecasting model using Least square support vector machine [18] with fruit fly optimization algorithm to reach more optimum solution along with that compare the algorithm performance with existing algorithm.

3. Proposed Method

In this paper machine learning based Logistic Regression with fuzzy logic to take smart decisions about the preferred path is discussed. since there can be number of paths to reach the destination therefore first a system will fetch the traffic information from google map and length of route for each possible path., in this model user is supposed to put the familiarity about the road condition manually. Based on these parameters probability will be computed for each path by using logistic regression method. , Fuzzy logic will be then applied by considering the various parameters like distance, weather condition and location of location. The framework for the proposed traffic management system is given in figure1.

Section 3.1 describes the Logistic Regression method and 3.2 include fuzzy logic implementation in various parameters.

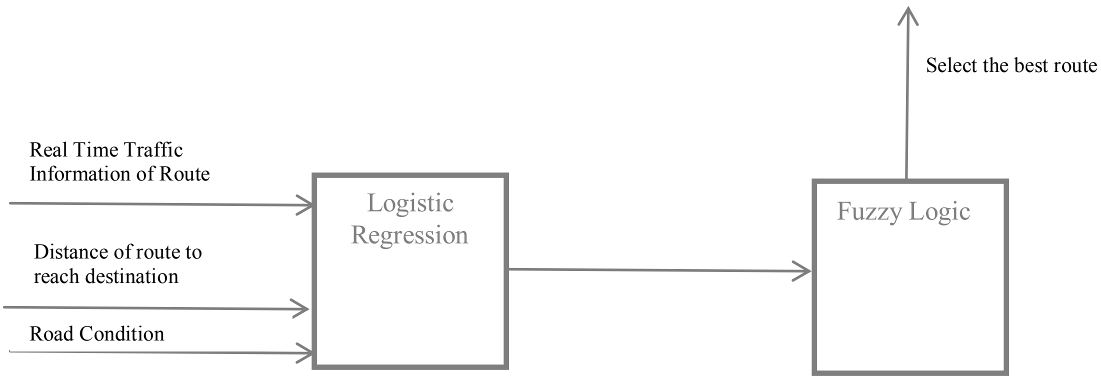

Fig. 1.Proposed Framework

A representative Traffic information from google map is shown in figure 2

3.1. Logistic Regression

This section now describes the Logistic Regression method and will be followed by the fuzzy logic implementation of various parameters in section 3.2

To compute the probability of each path to reach destination linear regression with sigmoid function has been used. The description of method is given below where:

$H_T(X)$ Represents Predicted value of output variable; T_i (for$i \in (0, 1, 2, 3)$are Coefficients, T_0 called bias and T_i (where i>0) indicate weight assigned to input variables; X_j (for $j \in (1, 2, 3)$Traffic Information, Distance, Road condition; $g(H_T(X))$ Represent Sigmoid function over $H_T(X)$; p is the Probability associate with path;

a. Compute $H_T(X) = T_0 + T_1X_1 + T_2X_2 - T_3X_3$ where X_1 is normalized distance of each path to arrive at destination, X_2 is Normalized traffic speed that is fetched from Google map as shown in figure 2 and X_3 is road condition

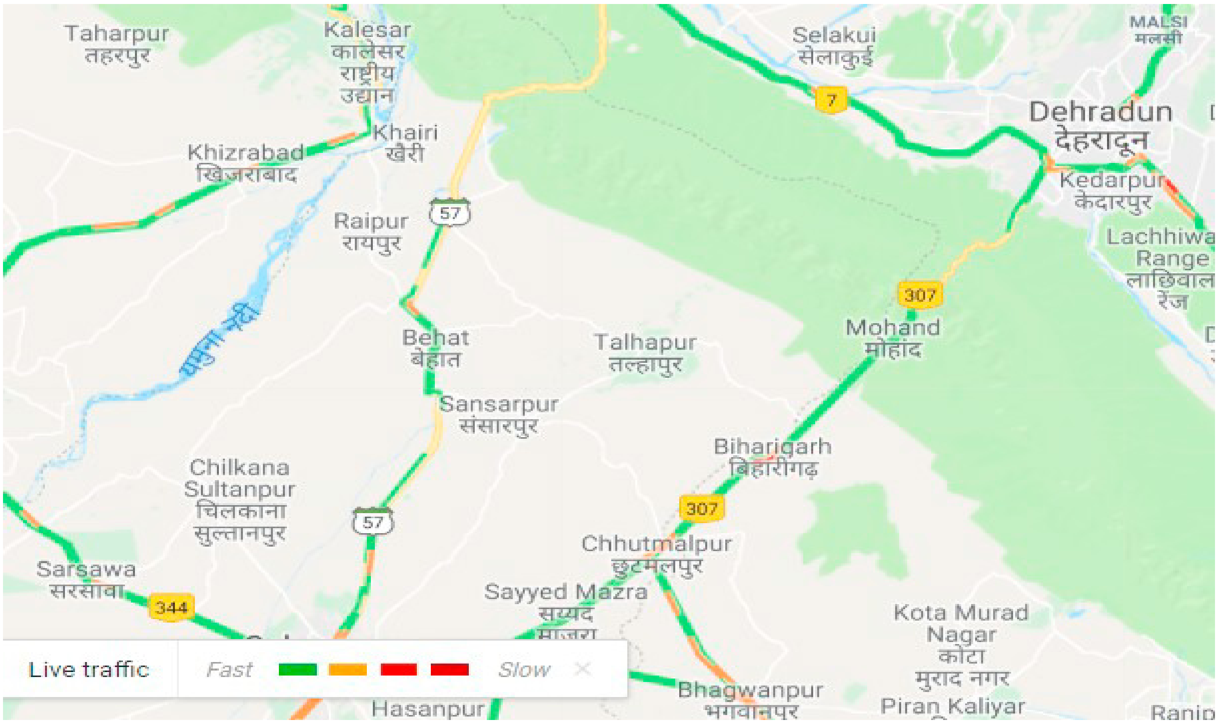

Fig. 2.Traffic Information from google map [14]

b. above equation has been rewritten in vector form as below:

$$H_T(X) = \begin{bmatrix} T0 \\ T1 \\ T2 \\ .. \\ Tn \end{bmatrix} * \begin{bmatrix} 1 \\ X1 \\ X2 \\ .. \\ Xn \end{bmatrix} \quad (1)$$

$$H_T(X) = \begin{bmatrix} T0 & T1 & T2 & .. & Tn \end{bmatrix} * \begin{bmatrix} 1 \\ X1 \\ X2 \\ .. \\ Xn \end{bmatrix} \quad (2)$$

$H_T(X) = T'X$, where T' is transpose of T. (3)

c. Compute probability using sigmoid function as follows:
$p=g(Z)= 1/(1+e^{-Z})$, where $Z= H_T(X)$. (4)

As per the nature of sigmoid function to get the probability greater than 0.5 the value of z must be positive, but if value is less than zero then probability is less than 0.5. User will select the route only if probability is greater than 0.5. Hence the route with probability more than 0.5 will be only selected.

3.2. Fuzzy Logic

Road traffic is unpredictable and uncertain in nature Therefore the concept of fuzzy logic is incorporated to take the decision about the preferred path. After computing the probability using Logistic Regression more factors like weather condition, probability, road location, day and time of week are fed to select the best path as shown in figure 3. Fuzzy sets will be used for the parameters and these fuzzy sets are mention below in table 1-5 will vary from 0 to 1.

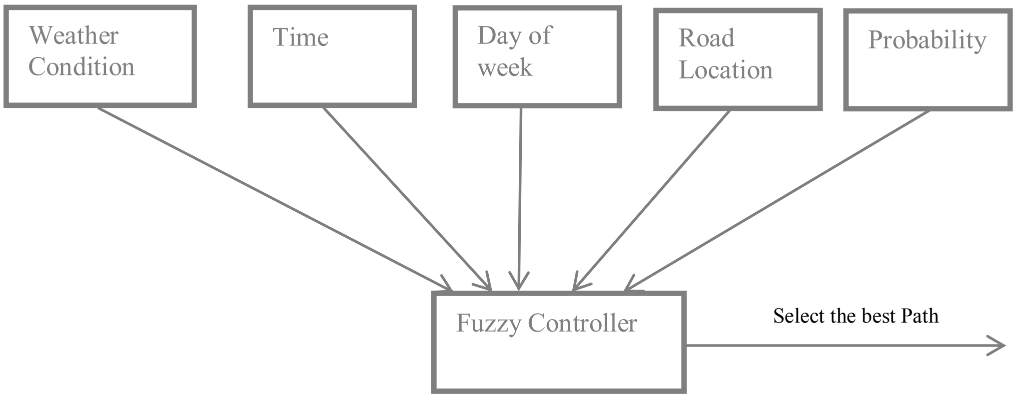

Fig. 3.Proposed Fuzzy Controller

Table1. Fuzzy Sets of computed Probability

Fuzzy Set 1	Fuzzy Set 2	Fuzzy Set 3
Probability is very low (less than 0.5)	Probability is average low (between 0.5 and 0.8)	Probability is high (greater than 0.8)

Table 1 categories the computed probability using logistic regression into three fuzzy sets that will help to decide the preferred path.

Table 2. Weather Fuzzy set

Fuzzy Set 1	Fuzzy Set 2	Fuzzy Set 3	Fuzzy Set 4
Rainy	Partially Rainy	Pleasant	Sunny Day

While taking decision to prefer the path user look into Weather Conditions that includes four fuzzy sets that are shown in above table 2.Weathercan be rainy, partially rainy, pleasant, sunny day so if weather is convenient to user then it will prefer the path in most cases

Table 3. Road Location Fuzzy set

Fuzzy Set 1	Fuzzy Set 2	Fuzzy Set 3
More work places	Less work places	Very less work place

Road Location includes the four fuzzy sets as shown in table 3, that are more, less, very less work places (wp) around by road location that definitely impact traffic on road

Table 4. Fuzzy set of Day

Fuzzy Set 1	Fuzzy Set 2
Normal Working Day	Week End

Day is categorized into two fuzzy sets as shown in table 4, either working day or week end, so during weekend more traffic is towards tourist places while on working day more traffic occurs on the road surrounded by more work places.

Traffic condition on roads changes with respect to time, i.e. same road is having different traffic conditions on same day at different times. Time is categorized into eight different fuzzy set that are shown in table 5.

Table 5. Fuzzy set of Time

Fuzzy Set 1	Fuzzy Set 2	Fuzzy Set 3	Fuzzy Set 4	Fuzzy Set 5	Fuzzy Set 6	Fuzzy Set 7
Mid (12.01 to 4am)	Early morning(4:01 to 8am)	morning1(8.01 to 10am)	morning2(10.01 am to 11.59am)	afnoon(12 to 4pm)	evening(4.01 to 8pm)	night(8.01 to 12pm)

4. Result and Discussion

The results obtained after implementation of algorithm and fuzzy rules are discussed herewith. Real time Traffic information and distance of the path were taken from the google map and road condition was taken manually as user input. Google map provide the real time traffic information about fast, average and worst traffic speed on path. Figure 4 represent the fuzzy logic framework used for implementation in MATLAB.

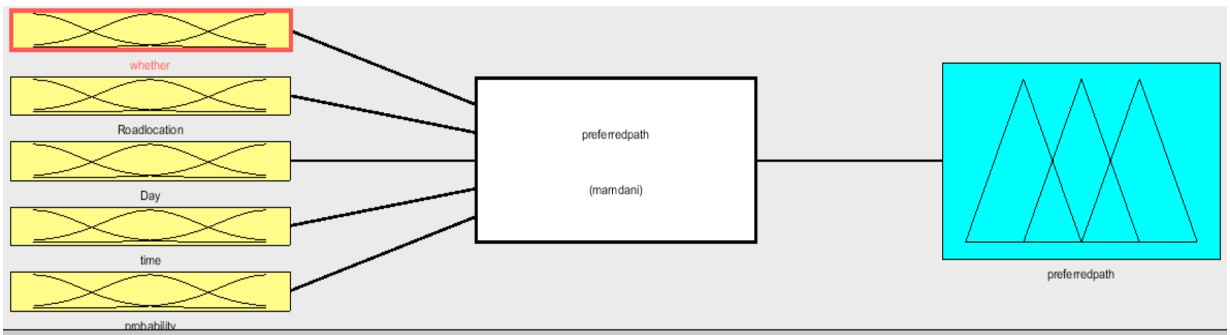

Fig. 4. Input and output variable of Fuzzy Logic

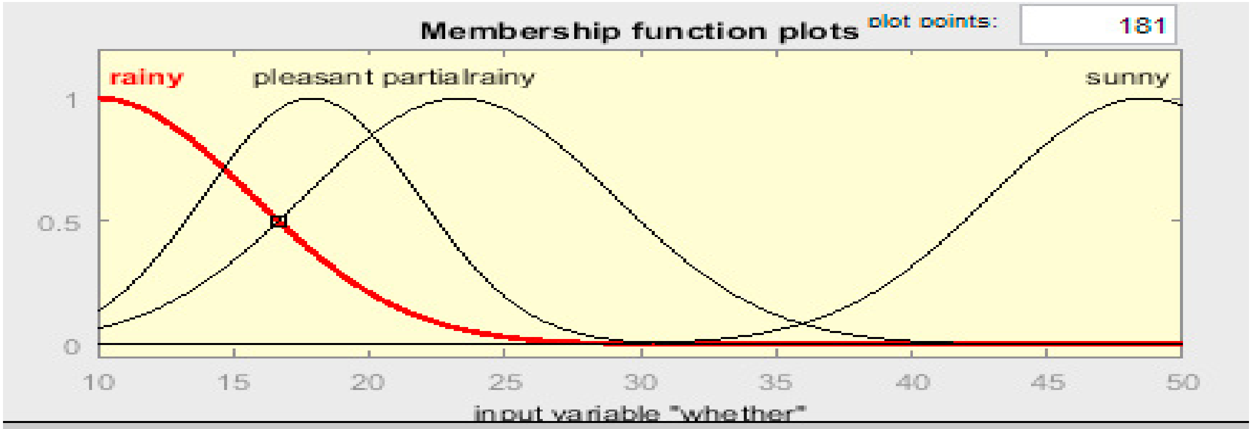

Fig. 5. (a) Membership function plot of weather condition

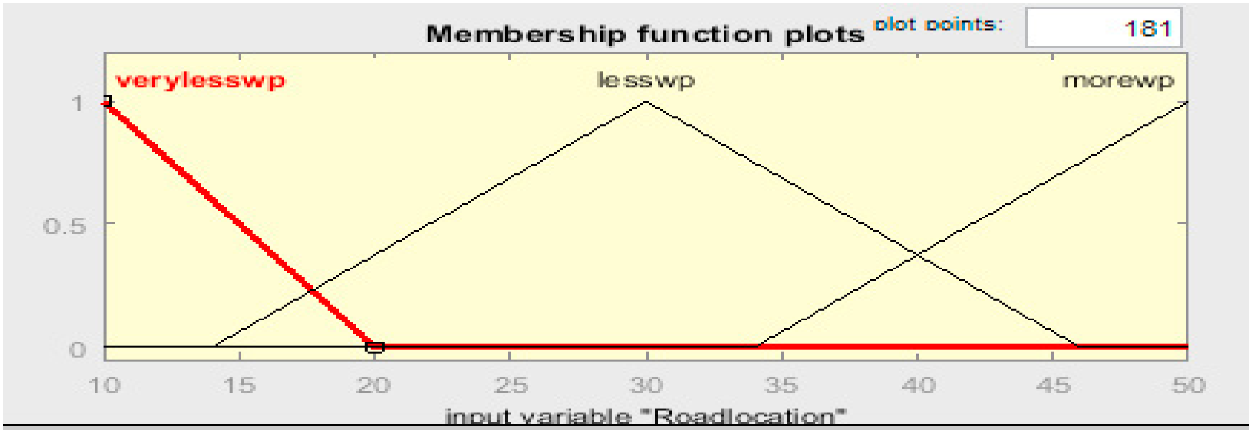

Fig. 5. (b) Membership function plot of Road Location

Membership function plot of weather condition and road location that has been categorized using temperature, humidity present into weather and number of work places around by road are as shown in figure 5(a) and (b). Triangular membership function is used for road location and weather condition. in this paper Gaussian membership function is used which is available in fuzzy tool box of Matlab.

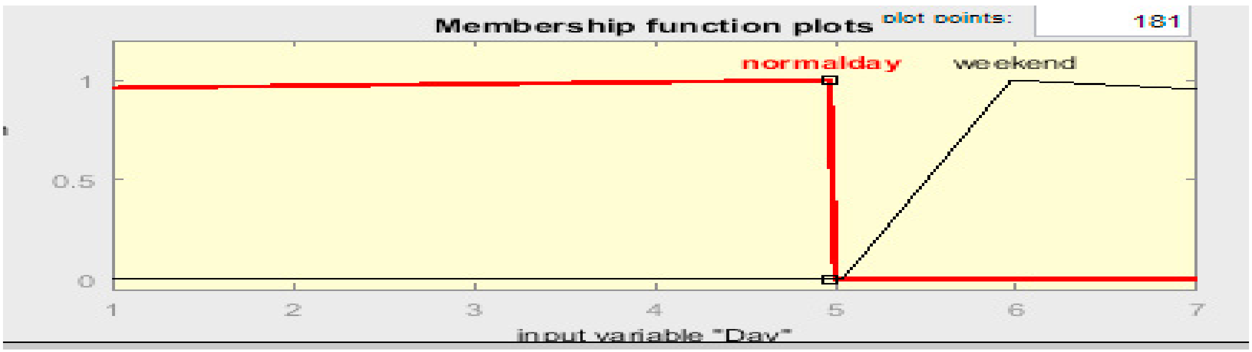

Fig. 6. (a) Membership function plot of Day

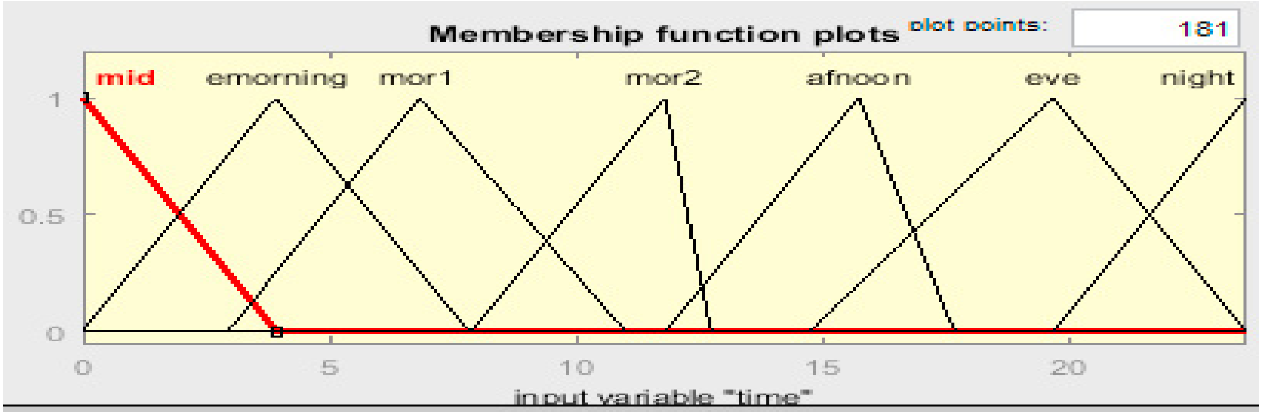

Fig. 6. (b) Membership function plot of Time

Working day is considered from Monday to Friday while Saturday and Sunday are considered as weekend. This has been implemented in fuzzy tool box using membership function as shown in fig 6(a) and 6(b). Triangular membership function is used to implement the time fuzzy set.

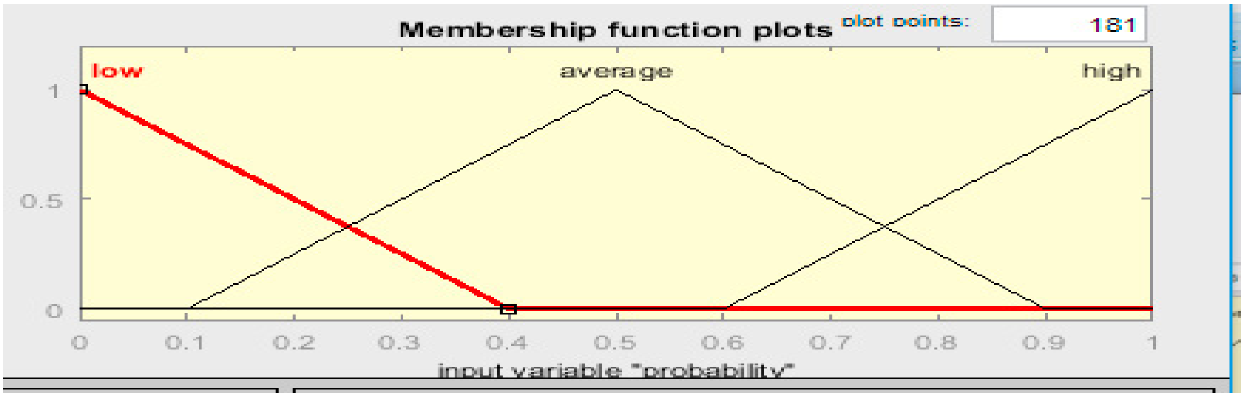

Fig. 7. (a) Membership function plot of probability

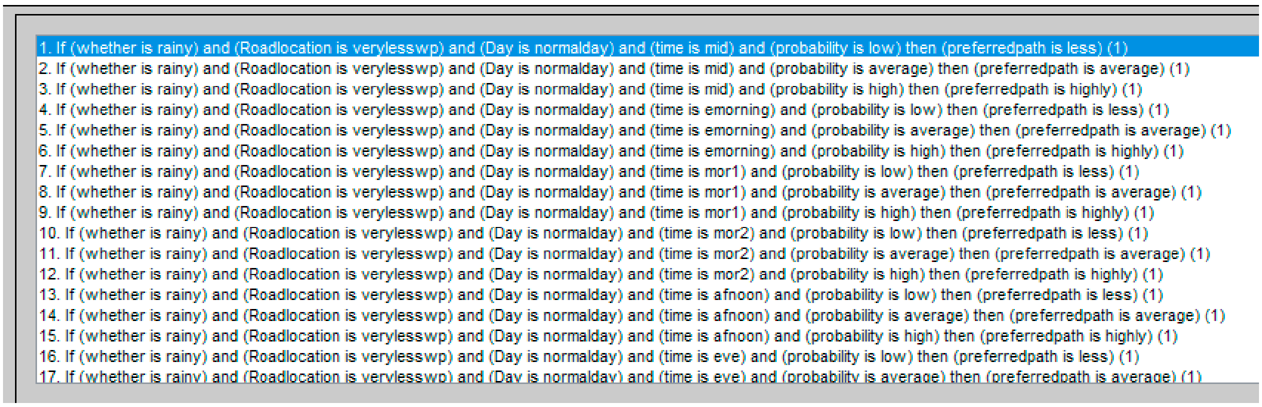
1. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mid) and (probability is low) then (preferredpath is less) (1)
2. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mid) and (probability is average) then (preferredpath is average) (1)
3. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mid) and (probability is high) then (preferredpath is highly) (1)
4. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is emorning) and (probability is low) then (preferredpath is less) (1)
5. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is emorning) and (probability is average) then (preferredpath is average) (1)
6. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is emorning) and (probability is high) then (preferredpath is highly) (1)
7. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mor1) and (probability is low) then (preferredpath is less) (1)
8. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mor1) and (probability is average) then (preferredpath is average) (1)
9. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mor1) and (probability is high) then (preferredpath is highly) (1)
10. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mor2) and (probability is low) then (preferredpath is less) (1)
11. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mor2) and (probability is average) then (preferredpath is average) (1)
12. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is mor2) and (probability is high) then (preferredpath is highly) (1)
13. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is afnoon) and (probability is low) then (preferredpath is less) (1)
14. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is afnoon) and (probability is average) then (preferredpath is average) (1)
15. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is afnoon) and (probability is high) then (preferredpath is highly) (1)
16. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is eve) and (probability is low) then (preferredpath is less) (1)
17. If (whether is rainy) and (Roadlocation is verylesswp) and (Day is normalday) and (time is eve) and (probability is average) then (preferredpath is average) (1)

Fig. 7. (b) Fuzzy Rules

Triangular Membership function is used to fuzzified the probability fuzzy set and further fuzzy rules are constructed to process fuzzy output.

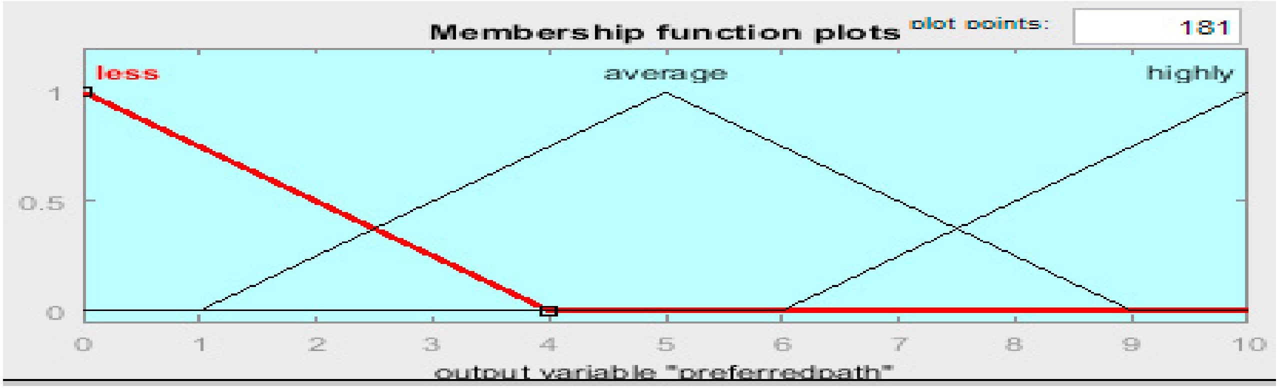

Fig.8. output variable preferred path

Preferred path decision is taken after processing of fuzzy rules and same has been implemented using triangular membership function.

5. Conclusion and Future Work

Genereally, a user follows the shortest distance path but sometimes it becomes worst traffic path. this paper therefore, proposed a method that not only considers the length of path to reach destination but also the current traffic information which in turn will help to take the smart decisions. Shorter distance path may have traffic jam conditions while alterative path based on traffic information at more distance may have very low traffic. Therefore, traffic information becomes an important factor while selecting the path. this paper, presented a guide to the user to take the intellegent decision by selecting appropriate path which will be governed by real time traffic information, length of each path and other factors like weather condition and road location. It includes the logistic regression to compute the probability of each possible path and further applying the fuzzy logic to select the best possible path that results in reducing the congestion, delay, pollution and energy consumption. The proposed method can be extended by providing, a mobile route guidance system or application in which google map will be integrated with an application to automatically collect the information and further implement fuzzy logic to take the best decision to select the path to reach destination comfortably and efficiently. In the future more machine learning algorithm like support vector machine along with optimization algorithm can be apply that result in more improvement in term of congestion and delay.

References

[1] H. M. Kammoun, I. Kallel, A. M. Alimi and J. Casillas (2011) "Improvement of the road traffic management by an ant-hierarchical fuzzy system", IEEE Symposium on Computational Intelligence in Vehicles and Transportation Systems (CIVTS) Proceedings, Paris, pp. 38-45.

[2] Habib M. Kammouna,IlhemKallel,JorgeCasillas,Ajith Abraham ,Adel M. Alimi (2014) "Adapt-Traf: An adaptive multiagent road traffic management system based on hybrid ant-hierarchical fuzzy model", Transportation Research Part C: Emerging Technologies Volume 42,Pages 147-167.

[3] Mohammad A. Tahaa,LaheebIbrahimb (2012) "Traffic Simulation System Based on Fuzzy Logic", Procedia Computer Science volume 12 pp.356 – 360 .

[4] M. Ramzanzad and H. RashidyKanan (2013) "A new method for design and implementation of intelligent traffic control system based on fuzzy logic using FPGA," 13th Iranian Conference on Fuzzy Systems (IFSC), Qazvin,pp. 1-4.

[5] Bharti Sharma,Vinod Kumar Katiyar,Arvind Kumar Gupta (2014) "Fuzzy Logic Model for the Prediction of Traffic Volume in Week Days",International Journal of Computer Applications Volume 107 – No 17, pp. 1-6 .

[6] Collotta, M., Bello, L.L., Pau, G. (2015) "A Novel Approach for dynamic traffic lights management based on Wireless Sensor Networks and Multiple Fuzzy Logic Controllers", Expert Systems with Applications.

[7] M. Deshpande and P. R. Bajaj (2016) "Short term traffic flow prediction based on neuro-fuzzy hybrid sytem," International Conference on ICT in Business Industry & Government (ICTBIG), Indore, pp. 1-3.

[8] S. K. Rana, I. Younas and S. Mahmood (2009) "A real time traffic management system," 2nd IEEE International Conference on Computer Science and Information Technology, Beijing, pp. 193-197.

[9] Jing Yuan,Yu Zheng, Chengyang Zhang, WenleiXie,XingXie, Guangzhong Sun, Yan Huang (2010) "T-drive: driving directions based on taxi trajectories", Proceedings of the 18th SIGSPATIAL International Conference on Advances in Geographic Information Systems Pages 99-108.

[10] Q. Li , T. Zhang & Y. Yu (2011) “Using cloud computing to process intensive floating car data for urban traffic surveillance”, International Journal of Geographical Information Science, 25:8, 1303-1322.

[11] Luc Wismansa, Erik de Rompha, KlaasFrisoa, Kobus Zantemaa (2014)"Real time traffic, decision support for traffic management", 12th International Conference on Design and Decision Support Systems in Architecture and Urban Planning, pp. 220-235.

[12] TanviTushar Thakur, AmeyaNaik, Sheetal Vatari, ManjiriGogate (2016)"Real Time Traffic Management using Internet of Things" International Conference on Communication and Signal Processing, pp. 1950-1953.

[13] A. Saikar, M. Parulekar, A. Badve, S. Thakkar and A. Deshmukh (2017) "TrafficIntel: Smart traffic management for smart cities," 2017 International Conference on Emerging Trends & Innovation in ICT (ICEI), Pune, India, pp. 46-50.

[14] https://www.google.co.in/maps.

[15] M. Deshpande and P. R. Bajaj (2016) "Performance analysis of support vector machine for traffic flow prediction," International Conference on Global Trends in Signal Processing, Information Computing and Communication (ICGTSPICC), Jalgaon, pp. 126-129.

[16] Yuliang Cong, Jianwei Wang, Xiaolei Li (2016) “Traffic Flow Forecasting by a Least Squares Support Vector Machine with a Fruit Fly Optimization Algorithm” Procedia Engineering .

[17] Jianming HU, Pan GAO, Yunfei Yao and Xudong XIE (2014), “Traffic flow forecasting with Particle Swarm Optimization and Support Vector Regression”, 17th International Conference on Intelligent Transportation Systems (ITSC) Qingdao, China.

[18] Sukriti Sharma, Vidya Meenakshi.K, Apurva VS, Saritha Chakrasali, Shreyas Satish (2013), “Real-time Traffic Congestion Detection using Combined SVM”, International Journal of Scientific & Engineering Research, Volume 4, Issue 11.