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Improvement Transportation Efficiency Using Modified Clustering Algorithm

Ankit Shridhar, Assistant Professor Mr. Vinay Deulkar
Department of civil engineering,
Jawaharlal Institute of Technology, Borawan Dist. Khargone

Abstract- Exploring urban travel patterns can analyze the mobility regularity of residents to provide guidance for urban traffic planning and emergency decision. Clustering methods have been widely applied to explore the hidden information from large-scale trajectory data on travel patterns exploring. How to implement soft constraints in the clustering method and evaluate the effectiveness quantitatively is still a challenge. In this study, we propose an improved trajectory clustering method based on fuzzy density-based spatial clustering of applications with noise to conduct classification on trajectory data. Firstly, we define the trajectory distance which considers the influence of different attributes and determines the corresponding weight coefficients to measure the similarity among trajectories. Secondly, membership degrees and membership functions are designed in the fuzzy clustering method as the extension of the classical method. Finally, trajectory analysis in MATLAB software, india, are divided into two types (workdays and weekends) and then implemented in the experiment to explore different travel patterns.

Keywords- AI, Tool and Fuzzy Logics.

I. INTRODUCTION

A traffic system is made up of a network, operating regulations, a traffic command and management system, and entities that utilize the network. The network consists of a series of roadways and intersections. The automobiles move through the framework according to the Highway Code's rules. The control operations are focused to visualize information from the management platform in the network using signals such as traffic lights and electronic traffic signals.

The main goal of the traffic system is to enable users to accomplish their network journeys in a reasonable amount of time and with a high level of safety (Chabrol et al., 2006). A traffic management system adapts two strategies to maintain healthy transport; it can either sustain the global level of performance or improve the system's standards in order to potentially lower the time and the number of traffic jams. These steps are required to follow by management; characterizing and modeling the load proposed to the system, investigating the load splitting in the system to identify pivotal regions that cause jams, and dealing with the system to sustain and improve the system's state. The operations are mostly focused on configuration, coordination, and monitoring.

A critical feature of any traffic system is the interaction between traffic networks and land use. The availability of basic access is a crucial component of the design and construction of production developments, such as shopping centers, sports and recreation centers, office buildings, or multi-unit housing projects. For road traffic, this includes access to and from the city development car parking. Aside from the development's instant links to the road network, traffic planners and engineers are also involved in the new development's effects on the traffic system in the nearby region.

As a result, considering the volume of traffic created by a development, as well as the parking requirements, is an important part of traffic analysis. The proportion of motor traffic in the transport system is affected by road speed heterogeneity. Speedier roadways are much more appealing to car operators, giving rise in traffic congestion along such routes. The amount of vehicles crossing through a route or a junction within a specified time interval can be used to determine its primacy. Aside from the variety of road speeds, the inbuilt topology of the transport system has a significant impact on the upsurge of road hierarchies. The dead-end roads, for instance, are at the bottom of the road hierarchical system.

II. PROBLEMS IN TRAFFIC SYSTEMS

The effective mobility of people and goods through physical highways and main road network systems is an intriguing problem in a transportation system. A multitude of characteristics distinguishes transportation systems, making them difficult to analyze, regulate, and improve. The systems generally encompass multiple physical regions, have a big proportion of people participating, the participants' aims and objectives are not always aligned with one another or that of the network operator (i.e., system optimum vs. user optimum), and there are several system primary inputs that are beyond the operator's and participants' control (e.g., the weather conditions, the number of users, etc.). Furthermore, road and street mass transit systems are generally complex and dynamic in nature, meaning that the percentage of components in the system fluctuates with time and with a high degree of unpredictability. The number of cars traversing large cities is also rapidly increasing at the present time.

This upsurge, which can be attributed to population expansion including the use of automobiles as a mode of transportation, causes plenty of issues in the transportation system. Because there are so many active participants in the system at the moment, there are a lot of interactions going along at the same time. There are several other things that concern traffic, such as traffic diversion and the lack of protection among drivers as a result of an incident in transportation activity (Rocha et al., 2020). Traffic safety is commonly regarded as a severe issue in the contemporary healthcare system; traffic jams, can destabilize living operations inside a region and place impose a substantial burden on socio-cultural wellbeing and economic growth; and the climate. Traffic congestion is recognized to be a primary contributor to air and noise pollution, which will have a negative influence on the physical surroundings and a negative impact on human health. When personal efforts are tallied up to interpret issues such as carbon dioxide emissions, the quality of traffic systems can have significant ecological impacts, at least at the community scale and most probably at the worldwide scale.

Road traffic systems have a big impact on automotive fuel usage and regional ecological destruction. Issues such as gas mileage and ways to conserve energy sources, air pollution, including gaseous pollutants, noise and vibration and visual intrusion and physical degradation have all arisen in traffic monitoring.

III. ADAPTIVE MEASURES TO REDUCE TRAFFIC PROBLEMS

Computer simulation is now a common tool in transportation engineering, with diverse applications from scientific research to planning, training, and validation. The advancements in traffic theory, computer hardware innovation and programming tools, the expansion of the general information architecture, and society's desire for a more comprehensive examination of the implications of traffic measures and strategies are the five driving forces behind this progress. The classic Webster's formula is an example of an early utilization simulation with practical consequences in the field of traffic signal control. Traffic systems provide an outstanding application environment for simulation-based design and analysis strategies, as they are an application area where the use of advanced analytics, while critical, is restricted to the subsystem and sub-problem level. The traditional simulation issue in road and street traffic analysis with a functional approach is concerned with traffic flow, that is, the potential and operational characteristics of facilities.

With a rising global enthusiasm in traffic circles, postponements and queue lengths at crossings are a never-ending subject of analysis and simulation studies. Modeling and simulating vehicle movement in existing transportation systems, particularly big urban road channels, is a critical task. It aids in the recognition and control of traffic issues, the optimization of traffic laws, and the real-time adaptation of congestion control for unexpected disaster events. Scientists and engineers have been paying close attention to the matter of traffic congestion in the past few years. As a result, a wide range of traffic models has been addressed in recent times to investigate the complex patterns. Nagatani (2002) proposed a simple lattice hydrodynamic model and deduced the mKdV equation (non-linear partial differential equation) to explain traffic congestion in aspects of kink density waves near the critical point in 1998. The basic concept is that drivers fine-tune their speed in response to headway. But this phenomenon is usually exhibited in single lane. The anticipation method is very effective in sustaining traffic flow on two-lane highways, and it should be taken into account when modeling traffic flow on two-lane highways. This anticipation effect is used in the new lattice hydrodynamic model of traffic flow whereby anticipation driving individual behavior in sensing relative flux is considered. Linear and nonlinear analyses were used to examine traffic behavior.

Innovations in transportation technology are essentially born out of three necessities: efficiency, ease and safety. Scientists and transportation industry professionals work side-by-side to ensure that these new technologies get more people (or things) to their destination faster, safer and with the fewest amount of resources possible. For example, this is why we’ve seen a shift away from coal-powered trains toward ultra-fast bullet trains, luxurious aircrafts to budget-friendly, cost-saving models and a switch from gas-guzzling vehicles to 100 percent electric cars.

As technologies like artificial intelligence, data science, manufacturing and deep learning become more advanced, so too will vehicles themselves. These fields act as the backbone for everything from autonomous vehicles to aerospace travel, and even function as the basis for ride-hailing platforms like Uber and Lyft. Because of the enormous potential these technologies hold, transportation technology has become one of the fastest-growing and highly-contested fields in the world. Thousands of startups are racing to create the ”next big thing” in the world of transportation.

India is a developing country where personal vehicles are increasing day by day. With the expansion of transportation, the country continuously grows in different economic and social dimensions. It is essential to consider a better traffic management system, due to the rise in congestion of roads in large cities. The main purpose of the project is to define a better traffic management system to increase the efficiency of transportation in India. Manual control of traffic is considered an effective solution for the problem. However, an adaptive and automated traffic management system seems to be a better choice to deal with the traffic problems in India.

India is the world's biggest democratic republic. It has a population of 1.3 billion inhabitants and a geographical area of 3.1 million square kilometers. India's population and urbanization grow, so does the demand of usage for vehicles, putting a strain on the current traffic management system. One of the most crucial matters for smart cities is to implement more environmentally friendly and sustainable alternatives to alleviate traffic congestion and levels of pollution. Moreover, the rise in the magnitude and frequency of commercial vehicle load capacity has placed an undue strain on operating road networks that leads to traffic blocking. All traffic control metrics are presently controlled manually and thus does not aid the vehicle in real time.

The phenomenon of continuous migration to major metropolitan areas of India such as New Delhi, Mumbai, Bangalore, Hyderabad, Ahmadabad, etc. is being observed. It has resulted in an increase in the total count of urban populations. Mobility requests are outstripping infrastructure potential in this urban environment, resulting in greater traffic congestion. The spread of existing road infrastructure is a feasible alternative, but it is not always possible due to land-use prohibitions and budget constraints.

An effective use of current infrastructure through the implementation of dynamic and intelligent control methods, which are flexible to current traffic conditions, is an alternative to the urban traffic congestion problem. Such traffic control techniques will intend to maximize the throughput of the urban traffic network by reducing traffic congestion obstacles, which are frequently found at network crossings.

This research study will help devise the measures to minimize the strain offered by an increased number of transportation entities and limiting the waiting time that will ensure an effective traffic system of India. The main problem which should be faced by the India’s traffic system is many of the roads are un-surfaced which causes many traffic problems and they are not suitable for the use of vehicular traffic in a significant manner. Due to poor quality of roads in India there were to the wear and tear of vehicles even on many National Highways since the quality of roads was very poor. Therefore, it creates the biggest challenge that must require solutions to promote appropriate activity.

IV. BENEFITS OF TRANSPORTATION TECHNOLOGY

As transportation technology continues to advance, the way we get from one place to another will improve. The transportation sector has the ability to help humans create more sustainable modes of travel — as demonstrated by electric cars and biofuel-powered airplanes. Even major industry players like Boeing see the benefits of more sustainable travel, as the company has announced plans to deliver planes that run completely on biofuel by 2030.

Transportation technology also allows people and goods to get to their destinations faster. Improved speed for trains or delivery systems can save companies and consumers alike valuable time and money. The logistics industry is also set to benefit from improved transportation methods and infrastructure, as the two industries often work together to move goods efficiently and affordably. Connected cars and freight trucks are one way logistics may improve, thanks to further transportation technology development. As the number of IoT sensors in CCTV cameras along highways grow, data can be collected to help solve traffic and congestion problems along major thoroughfares and delivery routes. Connected cars are also able to predict traffic patterns with the help of signal phase and timing information collected through IoT vehicles.

Although autonomous vehicles are not quite widespread yet, manufacturers and developers in the field hope that one day self-driving cars will improve safety for millions of people. Nearly 40,000 people were killed in traffic accidents in 2020 in the United States alone. As autonomous vehicles continue to develop, their capabilities of preventing accidents and sense collisions will drastically alter the number of fatal car accidents each year.

It is known that “the fleet of vehicles in Russia is heterogeneous. For example, in terms of ownership, it is distributed as follows. Privately-owned trucks amount to 53% of all registered vehicles. Only 50 thousand trucks out of the total number of vehicles, which is 5.3 mln units, work at the enterprises of the Road Transport industry. The rest of the vehicles are owned by enterprises of various sectors of the economy” [3]. More than 90% of the total freight traffic in the national economy is performed by vehicles of enterprises and organizations through own-account transportation by vehicles privately-owned or those owned on other legal grounds [1]. The competitiveness of the product is largely determined by its price, which includes the transportation cost from the production place to the consumption place. Operational scheduling has significant potential for efficiency enhancement, including reduction of the transportation cost to meet practical needs. Scientists [4,7] emphasize that measures should be developed to reduce consumption of transport products at the scheduling stage of transport production (traffic) since if transportation is completed, it is simultaneously consumed, and hence transportation products are used inefficiently. The paper considers transportation of own cargoes of companies of a non-transport profile by nonpublic transport vehicles on various routes, using both privately-owned and rented vehicles.

V. FUZZY-BASED MODIFIED CLUSTERING ALGORITHM

A fuzzy-based modified clustering algorithm combines fuzzy logic principles with traditional clustering algorithms to improve the flexibility, robustness, and accuracy of clustering in handling complex and overlapping data patterns. Fuzzy logic allows for a more nuanced representation of data by assigning degrees of membership to data points, enabling them to belong partially to multiple clusters rather than strictly to a single cluster. This approach is particularly useful when dealing with data that exhibit uncertainty, ambiguity, or gradations of similarity.

Here's an explanation of how a fuzzy-based modified clustering algorithm works:

Fuzzy Membership Functions
In traditional clustering algorithms like K-means, data points are assigned to clusters based on hard boundaries, meaning a data point either belongs to a cluster or does not. In contrast, fuzzy clustering algorithms use fuzzy membership functions to assign degrees of membership to data points, indicating the extent to which a data point belongs to each cluster. These membership degrees range from 0 (not a member) to 1 (full membership).

Fuzzy C-Means (FCM) Algorithm
One of the most widely used fuzzy clustering algorithms is the Fuzzy C-Means (FCM) algorithm. FCM extends the K-means algorithm by incorporating fuzzy logic principles. Instead of assigning data points to the nearest cluster centroid as in K-means, FCM calculates membership degrees for each data point across all clusters based on distance and similarity measures.

Objective Function
The FCM algorithm aims to minimize an objective function that represents the overall fuzzy clustering quality. This objective function takes into account the distances between data points and cluster centroids, weighted by their respective membership degrees. The algorithm iteratively updates cluster centroids and membership degrees until convergence, optimizing the clustering solution.

Fuzzy Rules and Granularity
Fuzzy logic allows for the incorporation of fuzzy rules and granularities into the clustering process. Fuzzy rules define relationships and constraints between data features, while granularities determine the level of detail or fuzziness in the clustering. This flexibility enables the algorithm to handle complex data patterns and variations in data characteristics more effectively.

Handling Overlapping Clusters
Fuzzy-based clustering algorithms are well-suited for handling overlapping clusters, where data points may belong partially to multiple clusters. The fuzzy membership degrees capture the degree of overlap between clusters, providing a more nuanced representation of the data distribution.

Applications
Fuzzy-based modified clustering algorithms find applications in various domains such as pattern recognition, image segmentation, customer segmentation, medical diagnosis, and data mining. They excel in scenarios where data are inherently uncertain, noisy, or exhibit gradual transitions between clusters.

Overall, fuzzy-based modified clustering algorithms leverage fuzzy logic principles to enhance traditional clustering methods, offering improved flexibility, robustness, and accuracy in capturing complex data relationships and patterns.

VI. RESULT AND SIMULATION

In MATLAB, the Fuzzy Logic Toolbox is a specialized tool designed for working with fuzzy logic systems, membership functions, fuzzy inference, and fuzzy control. It provides a range of functions, algorithms, and graphical tools to design, simulate, and implement fuzzy logic systems for various applications.

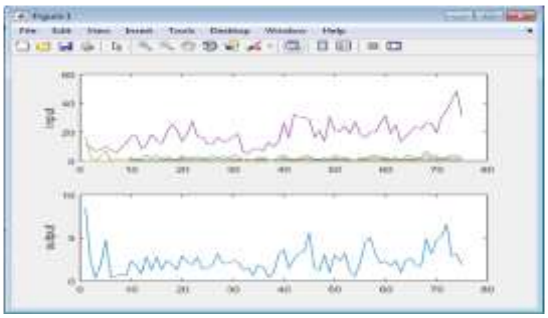

Fig.1: Load distribution day Vise.

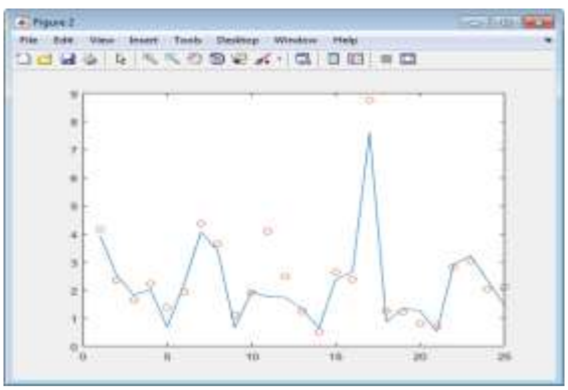

Fig.2: Efficiency Prediction Cluster 1.

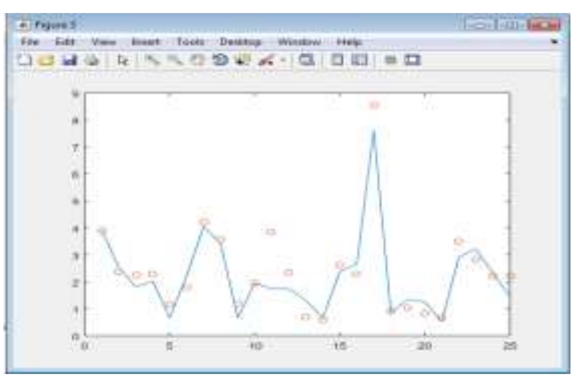

Fig.3: Efficiency Prediction Cluster 2.

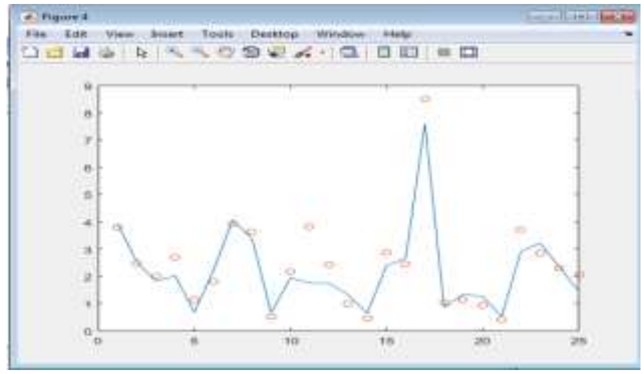

Fig. 4: Efficiency Prediction Cluster 3.

VII. CONCLUSION

In this paper, we have made a survey on work carried out by different researchers using K-means clustering approach. We also discussed the evolution, limitations and applications of K-means clustering algorithm. It is observed that a lot of improvement has been made to the working of K-means algorithm in the past years. Maximum work carried out on the improvement of efficiency and accuracy of the clusters. This field is always open for improvements. Setting appropriate initial number of clusters is always a challenging task. At the end it is concluded that although there has been made plenty of work on K-means clustering approach, there is a scope for future enhancement.

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