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Intelligent Transportation and Control Systems Using Data Mining and Machine Learning Techniques

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Abstract- Traffic congestion is becoming the issues of the entire globe. This study aims to explore and review the data mining and machine learning technologies adopted in research and industry to attempt to overcome the direct and indirect traffic issues on humanity and societies. The study's methodology is to comprehensively review around 165 researches, criticize and categories all these studies into a chronological and understandable category. The study is focusing on the traffic management approaches were depended on data mining and machine learning technologies to detect and predict the traffic only. This study has found that there is no standard traffic management approach that the community of traffic management has agreed on. This study is important to the traffic research communities, traffic software companies and traffic government officials. It has a direct impact on drawing clear path for new traffic management propositions. This study is one of the largest studies with respect to the size of its reviewed articles that were focused on data mining and machine learning. Additionally, this study will draw a general attention to a new traffic management proposition approach.

Keywords- Artificial Intelligent, Data Mining; Intelligent Transportation; Machine Learning

I. INTRODUCTION

Traffic congestion is a major challenge for our day to day life. Traffic congestion is a state where the speed of the vehicles is slower than the actual free stream speed on a road and highway. This is after effect of expanded traffic volume. When traffic is stopped for a specific time interval then congestion situation arises. This can be solved by implementing a well-planned process that handles the congestion in a smart manner. The first step to solving congestion problem is to understand the basic reasons for congestion in various congestion-tackling phases. It can also be done by developing the relevant congestion indicators for monitoring and utilising the existing infrastructure and creating additional capacity using new technology.

These days, more and more data regarding cities and urban areas are produced. This information is critical for automating several procedures, such as road traffic control. With urban living increased exponentially in the last century, road traffic congestion has become a significant problem of our era. Moreover, it is common sense, that high traffic congestion may affect other areas such as the environment, health, the economy etc. [1]. There is no panacea, but as far as the solution for this problem is concerned, analyzing congestion data for future traffic prediction could make a significant difference. It is predicted that by 2050 more than 67 percent of the total global population will live in urban areas [2]. This report also indicates that from 1950 to 2018, urban living exponentially increased from 751 million to 4.2 billion people. This overpopulation, with the large amount of data which record smart cities procedures and functions broaden the horizon of data science for smart cities. These data can be analyzed for the sake of each city's procedure optimization. One of these procedures that needs to be optimized is traffic flow, which causes many issues related to several social and economic sectors [1]. Our paper researches and develops a prototype model to forecast traffic congestion. We evaluated this model in Thessaloniki, Greece, a highly populated city with average at best public transport infrastructures and no metro subway, with Tsimiski Street (one of the busiest main roads in the city) as a case study. We present a step by step methodology, describing the data engineering part, the data transformation part, and the data mining part.

II. MOTIVATION

The primary motivation of this paper is to analyze the possibility of using data mining techniques to improve the performance of the intelligent transportation systems. In recent years, due to the acceleration of urbanization, many people are moving to cities rapidly. In many countries around the world, especially developing ones, the growing demand for public transport services and the growing number of private vehicles are putting enormous pressure on existing transport systems. Frequent traffic accidents, serious traffic congestion, longer commuting time and other problems greatly reduce the efficiency of urban operations and affect the travel experience of passengers. To address these challenges, an increasing number of cities in the world have been developing intelligent transportation systems (ITS) to facilitate efficient traffic management by optimizing the utilization of system resources. Typically, an intelligent transportation system can leverage a set of technologies and tools including connected sensors, real-time communication, advanced control and optimization methods to allow a variety of road users to efficiently share information in the road networks. For instance, a roadside camera can be facilitated in a highway network to timely track moving vehicles by using computer vision techniques. Such a system can be used to accurately estimate the average speed of vehicles, predict future traffic flow as well as timely incident and congestion detection among many others. At the heart of ITS applications is often driven by some learning-based algorithms and mechanisms which allow optimal decisions to be made for some traffic scenarios of interest. Specifically, graph-based machine learning methods have attracted tremendous interest and research efforts in recent years by researchers and practitioners worldwide thanks to their capability to effectively capture traffic data contained in the graph data structure. Currently, these algorithms have been increasingly applied to address various intractable challenges which were hardly tackled in the past.

III. SURVEY IN TRAFFIC CONGESTION MANAGEMENT

There are several potential congestion administration procedures, however, most can be categorised as one of two classes – the one is which offer new limit or free up existing limit and another one offers top, limit or generally manage traffic levels on the new or authorised perimeter[4]. Suggested two related measures are; Regularity measures and Economic measures. Access management comes under regularity measures and parking management and pricing policies come under economic measures [5]. Likewise, gather to guarantee that area use arranging, and the group targets it incorporates is composed with congestion management strategies. In this way, ECMT really depicts three periods of interest side clog administration; regulatory, money related and arrive use. These three phases are also depicted by as successful interest side clogs relief measures [6].

IV. TRAFFIC CONGESTION AND EVENT DETECTION

Traffic congestion refers to the situation where the volume of traffic exceeds the design capacity of a road network (Nair et. al., 2019). This situation can often happen in large cities during peak time which will inevitably reduce the speeds of moving vehicles, leading to reduced traffic flow, longer travel time for commuters, as well as an increased level of pollution in the living environment (Chen et al., 2016; Zhang et al., 2011). To deal with such a challenge, traffic event detection aims to timely identify such a situation from road networks through various methods and tools such as road-side computer vision-based cameras, wireless sensor devices in vehicles and social media channels (Wang et al., 2017; Gu et al., 2016). The collected information can not only be used to provide real-time information to drivers to allow them to make decisions on alternative routes but also can be used to instruct traffic infrastructures, e.g., by coordinating traffic lights in a more effective manner, thereby reducing the number of vehicles on busy roads, and smoothing the traffic flows.

V. PROPOSED METHODOLOGY

A hypothesis is a tentative statement or prediction that can be tested by scientific research. It proposes a potential relationship between two or more variables.

Hypotheses are essential for conducting experiments and statistical tests because they provide a clear focus for the research and help in determining what data to collect and how to interpret it.

Types of Hypotheses

Null Hypothesis (H_0): This is the hypothesis that there is no effect or no relationship between variables. It is a statement of no change or no difference and serves as the default or starting assumption.

Example: There is no difference in the mean test scores of students who use a new study method versus those who use the traditional method.

Alternative Hypothesis (H_1 or Ha): This is the hypothesis that there is an effect or a relationship between variables. It is what the researcher aims to support or prove.

Example: Students who use the new study method have higher mean test scores than those who use the traditional method.

Data Analysis Test: Data analysis tests are statistical methods used to determine whether the data supports the hypothesis. These tests help in making inferences about the population from which the sample data is drawn. The choice of test depends on the type of data, the sample size, and the research question.

Common Types of Data Analysis Tests

T-Test: Compares the means of two groups to determine if they are significantly different from each other.

Independent T-Test: Used when comparing the means of two independent groups.

Paired T-Test: Used when comparing the means of the same group at different times.

Chi-Square Test: Assesses the association between categorical variables.

Chi-Square Test of Independence: Determines if there is a significant association between two categorical variables.

Chi-Square Goodness of Fit Test: Checks if the distribution of a categorical variable matches an expected distribution.

ANOVA (Analysis of Variance): Compares the means of three or more groups to see if at least one mean is different.

One-Way ANOVA: Used when there is one independent variable.

Two-Way ANOVA: Used when there are two independent variables.

Regression Analysis: Examines the relationship between a dependent variable and one or more independent variables.

Linear Regression: Used for continuous dependent variables.

Logistic Regression: Used for binary dependent variables.

Correlation Analysis: Measures the strength and direction of the relationship between two continuous variables.

Pearson Correlation: Assumes linearity and normal distribution of the variables.

Spearman Rank Correlation: Used for ordinal data or non-linear relationships.

Steps in Hypothesis Testing

Formulate Hypotheses: Define the null and alternative hypotheses.

Choose a Significance Level (α): Commonly set at 0.05, representing a 5% risk of concluding that an effect exists when it does not.

Select the Appropriate Test: Based on the data type and research question.

Calculate the Test Statistic: Use the chosen test to compute a value from the sample data.

Determine the P-Value: The probability of obtaining test results at least as extreme as the observed data, assuming the null hypothesis is true. Compare P-Value with α:

If P-Value ≤ α: Reject the null hypothesis (evidence supports the alternative hypothesis).

If P-Value > α: Fail to reject the null hypothesis (insufficient evidence to support the alternative hypothesis).

Draw Conclusions: Interpret the results in the context of the research question.

VI. RESULT AND SIMULATION

Hypothesis

- **H09:** There is no significant possibility of finding the shortest path through cloud computing.
- **H9:** There is a possibility of finding the shortest path through cloud computing.

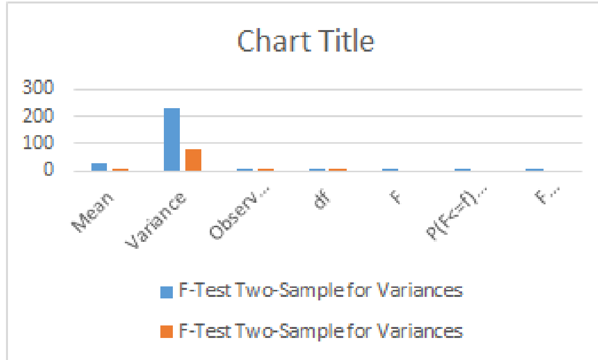

Figure 1: F-Test Two-Sample for Variances Hypothesis.

Test statistics Result

In this F- Test F < Fcritical, hence Null hypothesis accepted, and the alternate hypothesis is not accepted.

Interpretation and Discussion

It is seen that, There is no significant possibility of finding the shortest path through cloud computing.

Hypothesis

- **H010:** It is no significant possibility that cloud computing technology will become available to everyone.
- **H10:** It is possibility that cloud computing technology will become available to everyone.

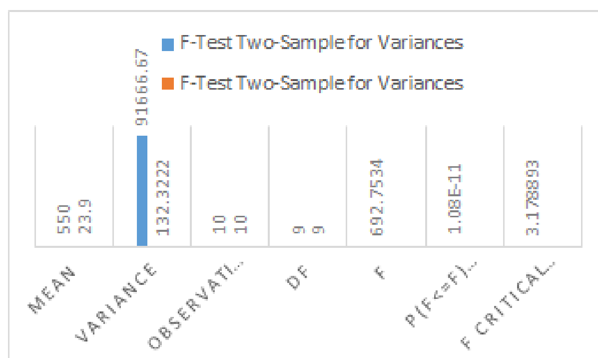

Figure 2: F-Test Two-Sample for Variances Hypothesis.

Test statistics Result

In this F-Test Test F > Fcritical, hence Null hypothesis reject, and the alternate hypothesis is accepted.

Interpretation and Discussion

It is seen that, it is possibility that cloud computing technology will become available to everyone.

VII. CONCLUSION

Traffic congestion is an important problem in Indian cities. The characteristics of Indian roads and traffic make the problem interesting to solve. There is scope for evaluating existing ideas in different and challenging traffic scenarios, innovate new solutions and empirically evaluate ideas in collaboration with public and private sectors. This paper includes study of two different sections. First section has been discussed some well-known studies path computation algorithm to find out best path of ATIS application Vehicle detection is an important part on smart vehicles with limited or full driver automation. It is also an essential basis for adaptive cruise control, blind spot detection, objects tracking and prediction, parking assistance and more. Vehicle's detection tracking and authentication are done by different studies using different algorithms. most of studies as, used algorithms of artificial neural network, fuzzy logic, machine learning algorithms.

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