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Optimal Ambulance Positioning for Road Accidents With Deep Embedded Clustering

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ABSTRACT

The number of casualties and fatalities brought on by road accidents is one of the most significant concerns in the modern world. Instead of dispatching ambulances only at the time of demand, pre-positioning them can reduce the response time and provide prompt medical attention. Deep learning techniques hold great potential and have proven to be essential for problem-solving and decision-making in the field of healthcare services. This study introduces a deep-embedded clustering-based approach to predict optimal locations for ambulance positing. Various factors and patterns in a geographical region greatly influence the occurrence of road crashes, hence understanding such relationships while model building is crucial. The present study also emphasizes the need of preserving such patterns during model building to ensure real-time results and implements them with the help of another deep-learning-based model, Cat2Vec. The proposed framework is also compared with traditional clustering algorithms like K-means, GMM, and Agglomerative clustering. Moreover, to calculate response time and distance in real time, a novel scoring function has also been introduced for the performance evaluation of various algorithms. The proposed ambulance-positing system exhibits remarkable performance, achieving an accuracy of 95% with k-fold cross-validation and a novel distance score of 7.581 proving the use of the proposed approach is better than all the other traditional algorithms used.

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1.INTRODUCTION

Today one of the leading causes of death worldwide among children and adults is road accidents. The injuries caused by these fatal accidents cause considerable economic and personal losses to individuals, their families, and the country. An estimated 1.3 million individuals each year die as a result of road accidents. Between 20 and 50 million individuals experience non-fatal injuries, with many of them becoming disabled as a result [1]. The ever-increasing growth in the number of automobiles is certain to have some negative. consequences, the most likely of which is an increase in the frequency of fatal road accidents in densely populated places, resulting in a huge burden on the urban infrastructure. It is dreaded that if we fail to take definitive precautionary measures to overcome these statistics, then road accidents will take over as the fifth major cause of death by 2030. Despite these fatal consequences, this problem receives scanty attention and there is a lack of developing systematic methods to improve road safety. Studies show that over 90 percent of the global traffic accidents occur in medium to lower income countries such as Kenya [2], [3] which is one such example as more than a thousand fatalities occur due to road crashes consisting of a mean of 7 out of 35 casualties each day [4]. Majority of these deaths and severe injuries occur to the population of 15-59 years who are also the economically active citizens of the country, reducing the economic activity of the country.. Kenya, as a country ranking in the range of lower-middle income, has seen an increase in regional trade deals over the past decade. Based on the reports from National Transport Safety Authority (NTSA), which is the agency responsible for transportation in Kenya, a record of 5186 minor injuries, 6938 major injuries and 3572 deaths was concluded in 2019.

The number of injuries, and fatalities brought on by these deadly accidents can be decreased if preventive measures are taken, the most crucial of which are prompt medical attention for accident victims, information about the precise situation to the aid personnel, and accurate data analysis considering every single factor to diagnose and predict the accident-prone zones in a city. The delay in the arrival of an ambulance has a significant impact on

human life especially in the case of emergency response pertaining to road accidents [5]. If the ambulance fails to reach the crash site in the critical hour, casualties may increase, therefore making each second very significant to human life. In every big metropolis, choosing the best places to place emergency responders throughout the day as they wait to be summoned is essential due to the dense traffic patterns and the city's distinctive layout. Monitoring and controlling these killer accidents is even more difficult due to the lack of expertise in stationing emergency response systems. Therefore, the prompt, automated, and timely positioning of ambulances can aid the first responders and doctors by reducing the effort required on their end and enabling earlier treatment decisions.

2.LITERATURE SURVEY

[1]Traffic Risk Mining from Heterogeneous Road Statistics: Existing System: The research focuses on addressing challenges related to extracting meaningful insights and patterns from diverse road-related data sources to understand traffic risks. The approach employs matrix factorization to uncover hidden patterns and relationships within the data. The advantages include facilitating data-driven decision-making, optimizing processes, and enhancing adaptability in addressing traffic-related challenges. This innovative methodology contributes to the evolving landscape of traffic safety measures.

[2]Artificial Neural Network (ANN) for Traffic Accident Severity Prediction: Existing System: The current system tackles the critical challenge of predicting the severity of traffic accidents using an Artificial Neural Network (ANN) model. The approach incorporates the K-means clustering algorithm for effective feature learning and improved generalizability. By leveraging diverse contributing factors, the ANN model demonstrates efficacy in predicting accident severity, providing valuable insights for targeted interventions. This research aims to advance the field of traffic safety, offering a powerful predictive tool and a deeper understanding of the dynamics influencing accident outcomes.

[3]Bayesian Prediction Model for Non-Recurring Road Accident Duration: Existing System: This research addresses the challenge of predicting the duration of

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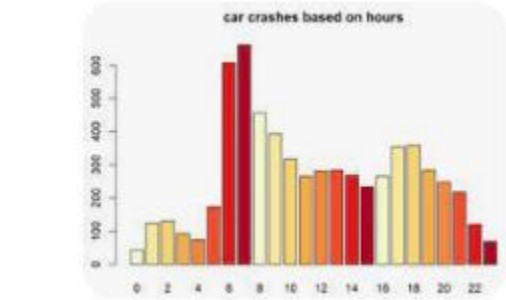
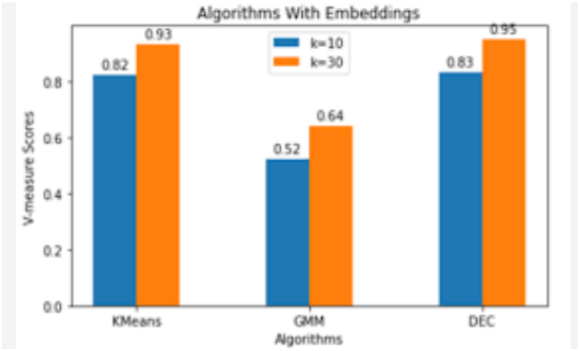
non-recurring road accidents through a Bayesian prediction model using the Naive Bayes algorithm. The approach emphasizes multi-source integration for a comprehensive analysis, utilizing prior knowledge to enhance prediction accuracy and interpretability. The methodology contributes to accurate predictions and offers a valuable framework for understanding the dynamic nature of non-recurring road incidents, emphasizing the importance of incorporating prior knowledge in decision-making

3. OUTPUTSCREENS





4. CONCLUSION

Over the past 20 years, methods for identifying accident hotspots and determining optimal paramedic positions have evolved and now plays a significant role in the successful implementation of traffic safety management programs. This study aimed to develop and compare models for predicting optimal locations for positioning ambulances in Nairobi city, based on the Nairobi accidents dataset from 2018 to 2019. The final model utilized the Cat2Vec model for converting categorical data to numerical data in the form of embeddings for respective categorical attributes. Following data preprocessing and feature selection, a clustering-based approach was followed using Deep Embedded Clustering along with standard

machine learning algorithms like K-Means clustering, GMM, and Agglomerative clustering to identify five clusters, the centroids of which provided the optimal ambulance positions. In order to evaluate the clustering algorithms, performance metrics including the Silhouette score, Calinski-Harbasz score, Davies Bould in Score, and V-measure were used. To evaluate the distance of the centroid and the predicted ambulance locations, a novel scoring method namely Distance score was implemented. Among the developed model the DEC-AE model with Cat2Vec embeddings provided the highest accuracy of 95% in k-fold cross validation. The distance score of 7.581 for the DEC-AE model which is higher than standard machine learning algorithms depicts that the distance between possible crash locations and ambulance positions is minimum. The analysis of various clustering metrics mentioned above reveals that the proposed DEC-AE model consistently outperforms other models in terms of clustering performance. This finding highlights the effectiveness and robustness of the DEC-AE model in accurately clustering the data and capturing underlying patterns. The study will advise decision-makers on where best to invest or implement security measures.

5. REFERENCE

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