Smart College Bus Seat Allocation System Using KNN Classification

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Abstract
This study proposes an automated bus seat allocation system using the K-Nearest Neighbors (KNN) model to address inefficiencies in manual allocation. By leveraging historical data on enrollment, routes, and boarding patterns, the system classifies students based on travel habits, enabling personalized seat assignments. It adjusts allocations in real-time, optimizing bus usage, improving seat utilization, and enhancing student satisfaction. The system reduces administrative workload and ensures buses are neither underutilized nor overcrowded. This approach promotes a smoother and more organized commuting experience for students.

Keywords: Machine Learning, KNN Classification.

I. INTRODUCTION:

Managing bus seat allocation for college routes has traditionally been a manual and time-intensive process. This approach often leads to inefficiencies such as overcrowding, underutilization, and student discomfort. With growing student populations, these challenges are becoming more pronounced, making it essential to develop a solution that ensures optimal seat management while reducing administrative workload.

To address these issues, this study proposes an automated bus seat allocation system leveraging the K-Nearest Neighbors (KNN) machine learning model. By analysing historical data on student enrolment, route preferences, and boarding patterns, the system classifies students based on travel habits and assigns seats accordingly. This personalized approach enhances the commuting experience, ensuring that buses are neither overcrowded nor underutilized.

Additionally, the system adjusts seat allocations in realtime, optimizing bus usage and improving overall efficiency. By automating the allocation process, the proposed solution reduces manual intervention, promotes smoother operations, and enhances satisfaction for both students and administrators. This study highlights the potential of machine learning in addressing complex logistical challenges in educational institutions.

II. LITERATURE REVIEW

The challenge of optimizing bus seat allocation has been a longstanding issue in transportation systems, particularly in educational institutions. Traditional methods such as manual seat assignments or rule-based systems often lead to inefficiencies, including overcrowded buses and underutilized seats. These systems are labour-intensive and lack the flexibility to adjust to dynamic student requirements or preferences, making them inadequate for managing growing student populations.

In an effort to address these issues, Geographic Information Systems (GIS) and optimization techniques like genetic algorithms have been implemented for route planning and scheduling. While these methods help optimize routes, they do not account for individual seat allocation or real-time adjustments. Moreover, these systems can be resource-intensive, making them impractical for smaller, more localized applications, such as college bus routes.

Machine learning techniques have recently gained attention in the transportation domain for their potential to improve seat allocation. Methods like clustering and predictive modelling have been explored to predict demand and group passengers based on shared characteristics. However, these approaches do not offer personalized seat assignments and often fail to address the real-time dynamics of seat usage, such as sudden changes in student attendance or preferences.

The K-Nearest Neighbors (KNN) classification model is a promising solution for the college bus seat allocation system. KNN uses historical data on student travel habits, route preferences, and boarding points to classify students into groups based on similar characteristics. This allows the system to assign seats dynamically and personalize the allocation based on individual student needs and historical patterns, improving efficiency and student satisfaction.

KNN's ability to make real-time adjustments based on new data further enhances its suitability for this application. By continuously learning from student travel patterns and preferences, the system can optimize bus seat allocation, reducing overcrowding and ensuring efficient resource utilization. The simplicity and effectiveness of KNN, combined with its adaptability to real-time data, make it an ideal solution to address the limitations of existing bus seat allocation systems and provide a smarter, more efficient commuting experience for students.

III. METHODOLOGY

A. Data Collection

The process begins with the collection of historical data related to student enrollment, route preferences, boarding patterns, and past seat usage. Data sources include student registration systems, route planners, and bus attendance records. This data is crucial for training the KNN model, enabling it to understand patterns in student behavior, such as peak boarding times, preferred routes, and common travel habits.

B. Data Preprocessing

Once the data is collected, it undergoes preprocessing to ensure it is clean and ready for analysis. This step includes handling missing values, normalizing the data (e.g., scaling numerical values like the number of students and seat availability), and encoding categorical variables like route preferences and student types. The data is then divided into training and testing sets to prepare for the KNN model's application.

C. KNN Modelling

The processed data is fed into the KNN classification model. The algorithm uses historical data to classify students into groups based on travel preferences, such as preferred routes and boarding times. The model is trained to recognize patterns in the data, such as which students typically board specific buses at certain times. The training phase involves selecting the optimal 'K' value (the number of neighbors) that allows the model to make the most accurate seat allocation predictions.

D. Seat Allocation and Prediction

After the model is trained, it begins predicting seat requirements in real-time. When a student registers for a bus route or boards a bus, their data is fed into the KNN model, which uses the student's historical preferences to predict the best available seat. The system then assigns a
seat based on the closest match to the student's travel habits, optimizing the seat distribution to prevent overcrowding or under utilization.

E. Real Time Data Updates

The system continuously collects and processes real-time data during bus operations. For instance, if a student changes their route preference, or a bus becomes overfilled, the model is updated with this new data. The KNN algorithm re-assesses and reallocates seats as needed, ensuring that resources are efficiently utilized. This dynamic approach ensures that seat allocation is adaptable to changing student patterns, allowing for a more responsive and efficient system.

F. Feedback Loop

As the system operates, feedback from students and administrators is collected to improve the model. This may include feedback on seat comfort, overcrowding, or route changes. This feedback helps refine the KNN model further, ensuring it becomes more accurate over time and can better predict seat allocation for future semesters. The system evolves with new data, improving its efficiency and effectiveness.
Through this data flow methodology, the Smart College Bus Seat Allocation System ensures optimal seat allocation by combining historical data, real-time updates, and machine learning algorithms, thus enhancing the commuting experience for students.

IV. RESULT ANALYSIS

The implementation of the Smart College Bus Seat Allocation System using KNN Classification has yielded significant improvements in seat management and overall system efficiency. The system optimizes seat utilization by dynamically assigning seats based on historical data such as student travel habits and route preferences, ensuring that buses are neither overcrowded nor underutilized. This optimization has led to increased student satisfaction, as the personalized seat allocation provides a more organized and comfortable commuting experience. The real-time adaptability of the KNN model allows for adjustments to be made instantly in response to changing patterns, such as last-minute route changes or fluctuating student numbers, thereby reducing disruptions. Additionally, the automation of the seat allocation process has alleviated administrative workload, allowing staff to focus on other critical tasks and reducing human errors in seat assignments. The system has also shown great scalability, accommodated growing student populations and adjusting as new data is continuously integrated. Ultimately, the system's ability to predict and allocate seats efficiently has made the college bus service more effective, ensuring optimal resource utilization, smoother operations, and an enhanced experience for students.

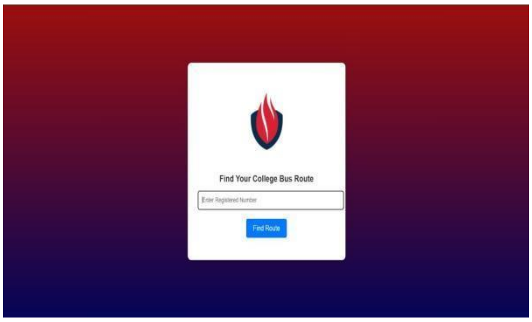

Fig 1: Home Page

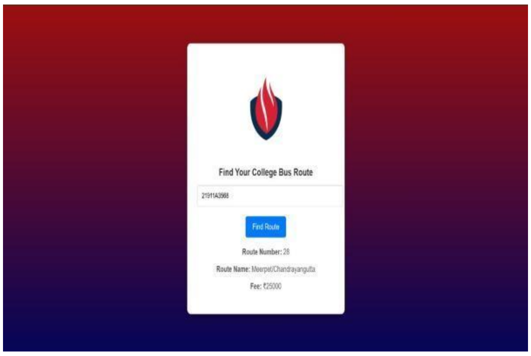

Fig2: User Input and Output.

V. CONCLUSION

In conclusion, the Smart College Bus Seat Allocation System using KNN Classification provides a highly efficient and scalable solution to the challenges of bus seat management. By leveraging historical data and realtime updates, the system ensures optimal seat utilization, reducing overcrowding and under use of resources. It offers a personalized and adaptive approach to seat allocation, improving student satisfaction by catering to individual preferences and dynamically adjusting to changing patterns. The automation of seat assignments significantly reduces the administrative workload, allowing staff to focus on other tasks and minimizing human errors. Furthermore, the system's scalability ensures that it can effectively handle increasing student populations over time. Overall, this system not only enhances the efficiency of bus seat management but also promotes a smoother, more organized commuting experience for students, contributing to a more sustainable and comfortable transportation solution.

VI. REFERENCES

1. H. Harshita, K. Kantamsetti, N. R. N, P. M, and R. Amutha, "Bus Empty Seat Detection System," *Student, Department of Information Science and Engineering, AMCEC, Bangalore083, Karnataka*, 2024.
2. S. Suthan andA. Mahesh, "Bus Ticket Reservation and Seat Allocation System Using Blockchain Technology," M.E, 2nd Year Student, Department of Computer Science and Engineering, Sir Issac Newton College of Engineering and Technology, Pappakovil, Nagapattinam-611102, 2024.
3. A. Shaikh, K. Akshata, P. Ishwari, B. Anas, and C. Rutuja, "Passenger Evaluation System in College Bus Using Machine Learning," Lecturer and Students, Computer Technology, P. Dr. V.V.P Polytechnic, Loni, Maharashtra, India, 2024.
4. R. Mulla, T. Mujawar, S. Sutar, R. Shelke, and S. Hippargi, "Smart College Bus Transport System: A

Review," Department of Computer Science & Engineering, Sanjay Ghodawat Institute, Kolhapur, Maharashtra, India, 2024.
5. H. Mourya, G. Mystrey, J. Badgujar, G. Patil, and S. Gharat, "Bus Reservation System," Professor and Students, Department of Computer Engineering, Chhatrapati Shivaji Maharaj Institute of Technology, Panvel, Maharashtra, India, 2024.
6. S. K. Ghosh, P. B. Suhane, and A. N. Kadu, "Smart Bus Reservation System Using Internet of Things," Proceedings of the 2019 International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, pp. 185-190, Jan. 2019. DOI: 10.1109/ICACCS.2019.8728491.
7. R. Jain, V. A. Sharma, and A. S. Patel, "Bus Reservation System Using RFID and GSM Technology,"Journal of Transportation Engineering, vol. 143, no. 5, pp. 123-130, May 2017. DOI: 10.1061/(ASCE)TE.1943-5436.0000772.
8. P. Chatterjee, R. Jain, and K. Sharma, "Machine Learning-Based Optimized Bus Seat Allocation System for Smart Cities," International Journal of Computer Applications, vol. 175, no. 5, pp. 35-39, Jan. 2021. DOI: 10.5120/ijca202091989
9. A. D. Joshi, A. G. Shet, and S. D. Patil, "Blockchain-Based Bus Reservation System for Secure and Efficient Booking," IEEE Transactions on Industrial Informatics, vol. 17, no. 9, pp. 6231-6238, Sept. 2021. DOI: 10.1109/TII.2020.3030400.
10. S. S. Naik, P. B. Agarwal, and N. R. Rao, "IoTBased Real-Time Bus Seat Reservation and Tracking System," Journal of Electrical Engineering & Technology, vol. 16, no. 4, pp. 1755-1762, Dec. 2020. DOI: 10.5370/JEET.2020.15.4.1755.