

Safest Route Navigation with ML and A* Algorithm for Women Security

Snehal Rathi¹, Kunal Suryawanshi², Sarthak Sarikar³, Omkar Warule⁴, Aditya Gaikwad⁵ and Krishna Jodh⁶

¹⁻⁶Department of Computer Engineering, Vishwakarma Institute of Information Technology, Pune

Email: snehal.rathi@viit.ac.in , kunal.22210438@viit.ac.in, sarthak.22210794@viit.ac.in, omkar.22210054@viit.ac.in, aditya.22210331@viit.ac.in, krishna.22210553@viit.ac.in

Abstract— The safety of women on different roads while traveling in today's world is very important. So, for women to detect the different crime spots and figure out the safest path can enhance the women safety. In research to detect crime spots we compare the different Machine Learning models: 'Logistic Regression, Grading Boosting Classifier, Support Vector Machine (SVM), KNN, Naïve Bayes' to detect crime rate and A* Algorithm for calculating a safer path for women. The result of best machine learning model will work as metrics for A* algorithm as crime spots or crime scores, along with separate overall grades for crime based on rates of assault and harassment. These comparative benchmarks to detect crime spot gives accurate result which plays vital role for A* algorithm for finding safest path for women. In order to determine a safer path, our study compares the precision, accuracy and computing efficiency of the different models. The results from the experiments indicate that even Grading Boosting Classifier gives higher accuracy to detect crime spot and generalization on varying environmental conditions than other which has high compute cost to the model and is less applicable for large datasets and A* algorithm for finding path. It also considers how these models can be integrated into real-time navigation systems, focusing on the benefits this is for women in their urban mobility and providing reliable safety assessments.

Keywords— WOMEN SAFETY, A* ALGORITHM, MACHINE LEARNING, Grading Boosting Classifier, PYTHON.

I. INTRODUCTION

The urban safety is a big cause for concern, specifically for women who are frequently at more danger when traversing metropolitan streets. It is critical to include data on crimes into route selection since traditional pathfinding algorithm favor shortest time to travel as well as distance over their safety.

This study suggests a machine learning method for determining safer routes by analyzing incident information, such as violence and harassing occurrences, using comparative study of different ML algorithms [11]. Although we concentrate on enhancing women's safety, the strategy may be used navigation decisions. We evaluated the accuracy, precision, and computing cost of the ML techniques to safe route prediction using real crime datasets and finding path using A* Algorithm.

Our goal is to integrate these models into navigation systems so that we can assist users in traveling about cities in a safer manner and develop another useful tool particularly for safer travel for women as well as every traveler.

II. LITERATURE REVIEW

Recent years researchers resolve the issue of street harassment particularly for women using secure path identification.

It involves the use of 'Dijkstra's algorithm' using python OSM Api with average run-time. The research particularly uses the methodology of algorithm as we can consider safety score on basis of crime data as node of graph and then to travel from one destination to another, we can make use of safety score with optimization and adding important parameter as safety [1].

Researcher focus on evaluating the route security and predict the safest alternative using risk factor and the cost-effective infrastructure for accurate path analysis with all security concerns. The Research involves the GPS tracking and obtain destination using A* algorithm.

It contains the parameters like severity of mishap frequency and last event occurred and based on last event occurred it update the security [2].

In recent times one of the research suggests the architecture which is free of human interaction identifying tourism places as the shortest route with purpose of accuracy and tremendous usefulness. It focused to give benefits to the ministry of tourism.

The research reviews the all techniques such as 'Dijkstra's algorithm', 'A* algorithm', 'Genetic algorithm', 'Ant Colony algorithm', 'Breadth first algorithm', 'Bellman ford algorithm' and researcher conclude the scenario of all algorithms achieve the purpose of accuracy and usefulness [3].

Further, A research particularly dedicated for Medellin's women to decrease rate of sexual harassment. In that research, researcher worked on path safety with optimized path from one location to another location. And tried to reduce the risk of harassment. In that research using DSA algorithms and for shortest path using Dijkstra's algorithm the researcher optimized the process with time complexity of $O((V+E) \log V)$. And using that research focused on women safety [4].

Earlier, The System which automatically gathers the whole data from the sensors and responds accordingly to the system with the help IOT based technologies like GPS, GSM, Raspberry and Bluetooth this tech things are used to capture the motion of women. Share the tracked data to the guardian or nearby police-stations in an emergency situation [5].

By using Logistic Regression model, Neural Network, KNN and Decision tree classifier for safety prediction and detect the crime spots and by comparative study of above machine learning model [11] it observed with of accuracy KNN is the one of the best algorithms for safety prediction. The research focuses then further integrate that algorithm inside women safety app which has live tracking system, emergency alarms, SMS system, self-defense guidance and safety prediction [6].

After 2020, The one of the research who address the Violence against women and violence against children. here, contributions were categorized in 4 application domains. In which most research focus on online settings, Safety solution, offline detection. categorization for each domain the best solution based on category gives the best solution from the research. [7]

This year, this has been the bruising factor with regard to thefts or any form of assault on men and women — particularly applying to rape and harassments that no one could ever dream would happen in daylight against a woman as well standing alone! A highly sophisticated technological feat for higher degree safety than normal capabilities appear. An emergency alert and live tracking alerts are sent through this compact, lightweight device with fingerprint module, GSM & GPS capabilities respectively. [8]

Exploration of the impacts of safety concerns on women's travel choices in India: In the year ahead, we learned that a large majority avoid using specific modes due to fear. While sentiment analysis showed a great distaste for current measures, AI and machine learning hold potential to improve travel safety. The results of the research emphasize Technology is very much required in future to be incorporated for peace making transportation planning sustainable as long as Women Safety Is Concerned [9].

This year, we also found research on female solo traveler's risk perception and security concerns in India; Based on 100 conversations with women in Kolkata that were part of research, the report explores different forms for harassment faced by women; safety issues when moving around and what public culture shifts have translated to as changes in travel behavior.

It highlights the need for more research on tourism [10].

The research fills the gap for women safety by a machine learning based system which will find out the most secure path in metropolitan cities.

It looks at that crime data and model the crime patterns in order to help practitioners identify certain trend of crimes such as assault, harassment and other safety issues.

III. METHODOLOGY

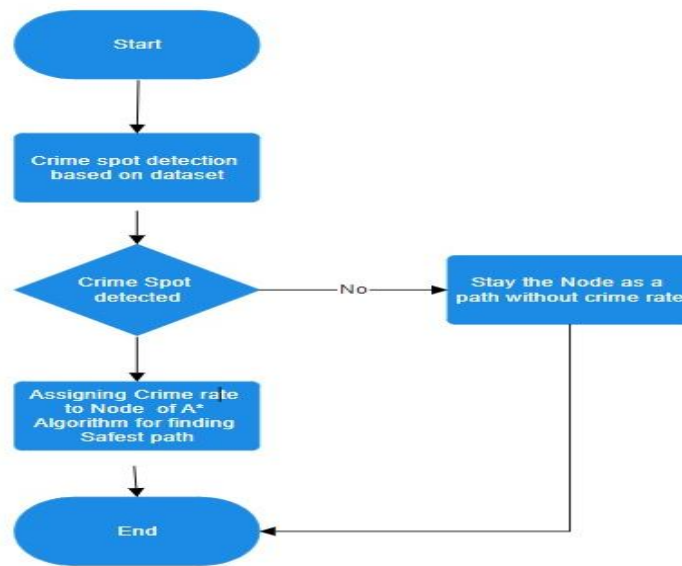


Fig 1: Flow for Research Methodology

A. Dataset Description

We used the dataset from renowned platform named 'Kaggle', In which one of the datasets contains arrest id, arrest date and corresponding location., while another dataset (Indian dataset) focuses on crime frequency and types of crimes in different regions. Both the datasets are cleaned and normalized using python libraries. This ensures the data is ready for accurate machine learning analysis and safest pathfinding using A* algorithm.

So, from Fig (1), we first detect the crime spots:

Crime Spot Detection

Logistic Regression: Logistic regression is a supervised machine learning algorithm which is primarily used for binary classification tasks. By using key features from our corresponding datasets, such as crime type, location, and frequency, the specific crime spot or safer path is detected by algorithm. The reason of choosing logistic Regression was due to its interpretability and simplicity, which make it useful for prediction of corresponding decision as the spot is safe or not. This algorithm gives the accuracy of 89.3% as shown in Fig (4).

Grading Boosting Classifier: So, the grading boosting classifier gives maximum accuracy of 92.7 % Fig (4) with minimum amount of error as shown in Fig (2) from confusion matrix of grading boosting classifier. The predictions of multiple weak learners are combined to enhance accuracy in the grading boosting classifier technique. This method processed by repetitively focusing on the errors of prior models, and accurately minimizing prediction errors. The key features like crime type, location, and frequency to determine whether an area is safe or not used by grading boosting classifier.

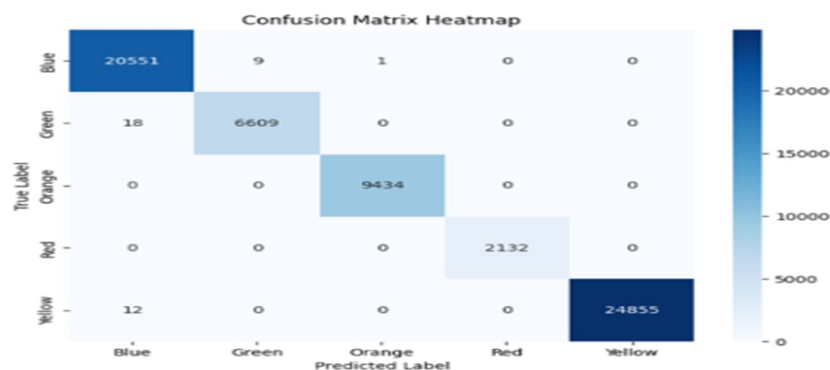


Fig 2: Confusion Matrix for Grading Boost Algorithm (Algorithm with best accuracy)

Support vector machine (SVM): SVM is, a dominant classification algorithm that works by detecting the optimal hyperplane to divide data into distinct classes. It is especially effective in controlling high-dimensional information, making it well-suited for detecting spot is safe or not with accuracy of 82.3% as shown in fig (4).

KNN: To find safe spots, we used the K-Nearest Neighbors algorithm, a simple yet effective the basis of majority class of their nearest neighbor. By analyzing features KNN detects crime prone areas by comparing them to similar known regions with the accuracy of 86.2% [fig (4)], making it a good method for finding risky zones.

Safest path finding using A based on above result of crime spot detection*

A* Algorithm

A* algorithm is a popular pathfinding algorithm that efficiently finds the shortest path between two points while considering additional factors like crime spots. By using the crime hotspot data detected earlier, A* assigns a cost to each location based on its proximity to high-risk areas and prioritizes safer routes. The algorithm balances the total distance and crime severity, ensuring that the selected path to be optimized as shown in fig (3).

IV. RESULT

Our A* Algorithm suggest the optimal path from source to destination. It provides a map as a result and the district-to-district way from source to destination Each district has crime rates and the output is minimum total crime rates from source to goal. In Each time the algorithm checks the shortest as well as safest means the district with minimum crime rates path and in this manner the algorithm finds the best result. In result the total crime rates also mention from source to destination and the district comes in between. crime data and advance classification techniques, the system provides the safest route on device. Approach to solve these problems are collect improved data, and effective integration into real-time navigation as sample result shown in Fig (3).



Figure 3 : Sample output of algorithm for finding path

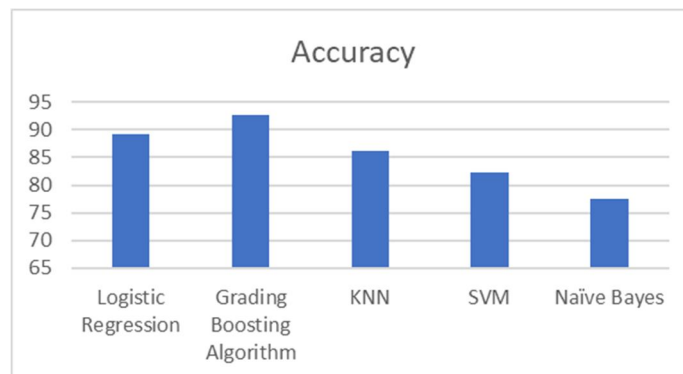


Figure 4: Model V/S Accuracy for crime spot detection

V. CONCLUSION

The implementation of a 'Gradient Booster Classifier and A* algorithm' for determining the safest path offers a promising solution to increasing travel safety. And as travel safety is one of the measure issues of women safety will resolve due to this research. The comparative study of determining the crime detection algorithms will ensure the accuracy and form the nodes and it will definitely help to determine the safest path between different

points and ensuring the safety as first priority especially for women and other disadvantaged group. Also, the real time update of data can ensure the all possibilities for detection of safety. Because of machine learning algorithms this system can integrated into any safety platform. So, with maximum accuracy using this research we ensure the safest travelling path at any time and we can avoid future unwanted incident.

REFERENCES

- [1] Merchán, Lina S. B., Mauricio Toro, Camilo C. Bedoya, and Andrea Serna. 2022. "Safest Path Finding Algorithms on Street Harassment Prevention." November 8. doi: 10.31219/osf.io/3a28q.
- [2] S. A. Ruk, S. Gul, S. Saddar, and S. M. Z. Ahmad, "Evaluating Route Security and Predicting a Safest Alternative Using Risk Factors," 2018. doi:10.17485/ijst/2018/v11i27/130543.
- [3] Madyatmadja, E. D., Nindito, H., Bhaskoro, R. A., Sano, A. V. D., & Sianipar, C. P. M. (2021). "Algorithm to Find Tourism Place Shortest Route: A Systematic Literature Review". *Journal of Theoretical and Applied Information Technology*, 99(4), 787-795.
- [4] Manrique, Sara V. C., Juan F. R. Buitrago, Andrea Serna, and Mauricio Toro. 2022. "Finding the Shortest Path Preventing Sexual Harassment Through Algorithms." doi:10.31219/osf.io/qtj2c."
- [5] Farooq, M. S., Masooma, A., Omer, U, Tehseen, R., Gilani, S. A. M., &Atal, Z. (2023). "The Role of IoT in Woman's Safety: A Systematic Literature Review" doi: 10.1109/ACCESS.2023.3241234.2023
- [6] Rodríguez, D. A., Díaz-Ramírez, A., Miranda-Vega, J. E., Trujillo, L., & Mejía-Alvarez, P. (2021). "A Systematic Review of Computer Science Solutions for Addressing Violence Against Women and Children". doi:10.1109/ACCESS.2021.3103459.
- [7] Jeyanthi, P., Gladence L., M., Tarunjee N., S., & Nagavamsi, S. (2024). Integrated Women's Security System with Safe Route Navigation and Instant Law Enforcement Reporting: Quantum Network. In C. Ananth, O. I. Khalaf, & J. Anand (Eds.), *Quantum Networks and Their Applications in AI* from <https://doi.org/10.4018/979-8-3693-5832-0.ch012>
- [8] Batul, A. "A Study of Common Challenges Faced by Women as Solo Travelers in India". www.researchgate.net/publication/370764909_A_Study_of_Common_Challenges_Faced_by_Women_as_Solo-Travelers_in_india.
- [9] D. N. Sisanalli (2024), "Women Safety Device with GPS Tracking and Alerts,". Doi: 10.22214/ijraset.2024.57870
- [10] Sree, V. G., Abinaya, S., Aarthi, S., & Geethu, S. S. (2024). Women Safety Analytics: Protecting Women from Safety Threats. *International Journal of Research Publication and Reviews*, 5(12).
- [11] Rath, S., Paygude, P., Shaikh, N., Sawant-Patil, S., Patil, T., & Patil, R. (2024). Learning style prediction of e-learner using hybrid optimizer-based neural network. *Journal of Integrated Science and Technology*, 13(1), 1007. <https://doi.org/10.62110/sciencein.jist.2025.v13.1007>