Original Article

Wrong-Lane Accidents Detection using Random Forest Algorithm in comparison with Decision Tree for Improved Accuracy

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Abstract

Aim: The proposed study aims to perform detection of wrong-lane accidents using Decision Tree (DT) algorithm and compare accuracy with Random Forest (RF) algorithm. **Materials and Methods:** Decision Tree is applied on a road accident dataset that consists of 1834 records. A Machine learning technique for the detection of wrong-lane accidents which compares Decision Tree and Random Forest has been proposed and developed. Sample size was calculated as 21 in each group using G power. Sample size was calculated using clinical analysis, with alpha and beta values of 0, 05 and 0.5, 95% confidence, 80% pre-test power and enrolment ratio is 1. The accuracy of the detection of wrong-lane accidents was evaluated and recorded. **Results:** The accuracy was maximum in detection of wrong-lane accidents using Decision Tree (89.88%) with minimum mean error when compared with Random Forest (89.77%) and attained significance value of p = 0.02 (p<=0.05). **Conclusion:** The study proves that Decision Tree Algorithm exhibits better accuracy than Random Forest in detection of wrong-lane accidents

Keywords: Decision Tree, Random Forest, Accident Detection, Wrong-Lane, Data Mining, Classification, Novel Criteria Based Method.

DOI: 10.47750/pnr.2022.13.S04.060

INTRODUCTION

Wrong-Lane road accidents are a completely common difficulty in populated countries. The capability of the roadway isn't always enough for the developing wide variety of motors and hence imbalance is created(Clarke, Forsyth, and Wright 1998). Every 12 months because of wrong-lane riding accidents, there are numerous deaths and authorities property harm too, which causes massive losses to the countries(Zhao et al. 2021). The drivers do now no longer comply with visitors policies and take gain of riding withinside the wrong-facet in instances of crimson visitors signals(K.m. and Umamaheswari 2020). It will increase visitors on one facet and hamper visitors greatly. It additionally will increase the opportunity of head-on collision in several instances(Alkhorshid et al. 2016). About 355 humans die each 12 months because of the crashes in wrong-manner riding withinside the United States. So, it's very essential to prevent drivers from riding on the incorrect facet. To make certain of it, people who don't comply with visitors' policies want to discover and strict regulation has to be applied(M et al. 2021).

Most referred articles similar to this work have been explored. Around 45 related articles published in IEEE Xplore were published related to this work in google scholar.(Vasavi 2016) Classification algorithm and Novel Criteria Based Method is used widely to improve the detection of accidents. (Patil et al. 2020) proposed Novel Criteria Based Method of the system's performance is measured in terms of classification accuracy, and the results reveal that it has a lot of potential for forecasting the detection of accidents accurately.(Chen and Chen 2020) proposed a criteria based spatial grouping of applications as Novel Criteria Based Method with Decision Tree performed by other models by achieving 78.8% to predict accidents. (Oza and D. Y Patil School of Engineering Lohegaon 2020) proposed a feature selection algorithm with a classifier same as the Novel Criteria Based Method for designing a high level intelligent system to predict the accidents taking place.

Our team has extensive knowledge and research experience that has translate into high quality publications(Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021). The research

gap that is identified from the literature survey is that classification models adopting Random Forest require lots of training data and don't encode the position and orientation of the object into their predictions. And also, the existing approaches have poor accuracy. The aim of this study is to implement detection of wrong-lane travelling vehicles and improve the classification accuracy by incorporating Decision Tree and comparing the performance with Random Forest.

MATERIALS AND METHODS

The research work was carried out at the Department of Computer Science and Engineering, Saveetha School of Engineering, SIMATS. This Study was implemented using Jupyter, and the hardware configuration required is an intel i5 processor, 500 GB HDD, 8GB Ram, and the software configuration required is a windows OS, Jupyter. The work was carried out on 1834 records from an accident severity dataset. The accuracy in detection of wrong-lane accidents is performed by evaluating two groups. A total of 10 iterations were performed on each group to achieve better accuracy. The Study uses an accident severity dataset downloaded from kaggle (Pote n.d.).

Random Forest (RF) - Group 1

Input: Accident dataset
Output: Accuracy

Step 1: Import and read the dataset.

Step 2: Select the features randomly from the dataset.

Step 3: Generate the RF classifier criterion as a parameter.

Step 4: Gini was used as a parameter value.

Step 5: Construct a decision tree using RF classifiers and predict the result for every sample.

Step 6: Voting was performed for every predicted result.

Step 7: Most voted prediction results were selected as the final outcome.

In this study, the Random Classifier class of the sklearn ensemble library is used. It takes citerian as a parameter. "Gini" is used as the parameter value. The dataset is splitted randomly into training (80%) and testing (20%). It selects samples randomly and the decision trees were collected for every sample to predict the result. Voting was performed for every predicted result and the most voted result was selected as the final result. The algorithm uses a Novel Tree Specific Random Forest Classifier (NTSRF).

Decision Tree (DT) - Group 2

Input: Accident dataset
Output: Accuracy

Step 1: Import and read the dataset.

Step 2: Select the features randomly from the dataset.

Step 3: Generate the DT classifier criteria as a parameter.

Step 4: Gini was used as a parameter value.

Step 5: Construct a decision tree using DT classifier and predict the result for every sample.

Step 6: Voting was performed for every predicted result.

Step 7: Most predicted results were selected as final output.

In this study, the Decision Tree Classifier class of the sklearn library is used. It takes

citerian as a parameter. “Gini” is used as the parameter value. The dataset is splitted randomly into training (80%) and testing (20%). It selects samples randomly and the decision trees were collected for every sample to predict the result.
ially, the data set was divided into two parts: the training and test sets. Then, the algorithm is tested on the training and test sets. The training and testing sets are changed 10 times depending on the size of the test set. Table 1 shows the comparison between the accuracy of RF and LR for 10 iterations. The different parameters for the analysis can be calculated as follows:

Accuracy :- It identifies the number of instances that were correctly classified as shown in the following Equation 1.

$$\text{Accuracy} = \frac{True\ Positive + True\ Negative}{True\ Positive + True\ Negative + False\ Positive + False\ Negative} \quad (1)$$

Statistical Analysis
The SPSS statistical software was used in the research for statistical analysis. Group statistics and independent sample t-tests were performed on the experimental results and the graph was built for two groups with two parameters under study (Komol et al. 2021). The independent variables are Speed Limit, Junction Control. The dependent variables are Accuracy, Prediction.

RESULTS

The proposed Novel Criteria Based Decision Tree Method and Random Forest were run at a time for performing detection of wrong-lane accidents. Table 1 shows the accuracy achieved during the evaluation of RF algorithm and DT models for classification with different iterations. Table 2 shows the different parameters of the two groups. Accuracy is calculated for RF and DT. Two-group analysis shows that DT has higher accuracy (89.88%) than RF. Table 3 shows the statistical analysis of DT and RF with different sets of test data. Fig. 1 shows the weekday of vehicle collisions. Fig. 2 shows the policing area and collision severity. Fig. 3 shows the day and month of collision. Fig. 4 shows the speed limit and junction detail. Fig. 5 shows the collision severity. Fig. 6 shows the comparison of mean accuracy of DT and RF algorithms. The average accuracy of the DT model appears to be higher than that of the RF model. The performance of the DT algorithm is superior to that of the RF algorithm. There is no significant difference between the two groups. Therefore, DT is better than RF. Statistical analysis of two independent groups shows that DT has a higher mean accuracy(89.88%). The mean error of DT is a little less than RF.

DISCUSSION

The work shows that Decision Tree is better than Random Forest at detection of wrong-lane accidents in terms of accuracy. From the experimental results performed in Jupyter, the accuracy of DT is 89.88%, while Random Forest provides the accuracy of 89.90% .This shows that DT is better than Random Forest. The different parameters such as TP rate, FP rate are also compared. According to the SPSS plot, the proposed Decision Tree classifier performs better in terms of accuracy (89.88%) than the Random Forest algorithm.
The most important aspect in detection of wrong-lane accidents is accuracy. In the study of, a machine learning-based diagnostic system for wrong-lane detection was proposed using an accident dataset (Ghandour, Hammoud, and Al-Hajj 2020). Popular machine learning algorithms, three feature selection algorithms and seven classifier performance metrics such as classification accuracy, specificity, sensitivity, Matthews correlation coefficient, and delay execution were used by the study (Das et al. 2018).

Based on the above summary, if overall prediction performance is the primary concern, then the integrated method should be selected, in which the RF models with only a few significant variables identified by DT or important variables identified by the tree , can be entered to achieve more precision(Gazder, Ahmed, and Shahid 2021). If the focus is on major accident prediction performance, the integrated method, where RF models with only a few significant variables identified by DT, or major variables identified by the Random Forest, or DT models with only a few significant variables identified by DT should be selected for greater sensitivity (Siddiqui et al. 2021). The accuracy of the DT classification algorithm depends on the size of the training and testing data set. In our study, the accuracy appears to be better than Random Forest. However, the average error appears to be higher in our proposed work which should be minimized.
The results of the study are better in both experimental and statistical analysis, there are some limitations in the work. Accuracy assessment cannot provide a better result on larger data sets. In addition, in DT, the average error seems to be higher than RF. It would be preferable if the average error could be considerably reduced. However,

the work can be improved by applying optimization algorithm techniques, to achieve lower mean error as a future work. Feature selection algorithms can be used prior to classification to improve the classification accuracy of classifiers. Therefore, thanks to the data mining algorithms, the computation time can be reduced and the accuracy of the classification of classifiers can be improved.

CONCLUSION

The results show that the proposed Decision Tree outperforms Random Forest in terms of Accuracy. The Proposed Decision Tree proved with better accuracy (89.88%) when compared with Random Forest (89.77%).

DECLARATIONS

Conflicts of interests
No conflicts of interest in this manuscript.

Author Contributions
Author PB was involved in data collections, data analysis, algorithm framing, implementation and manuscript writing. Author VN was involved in designing the workflow, guidance, and reviewing the manuscript.

Acknowledgements
We thank Saveetha School of Engineering, Saveetha Institute of Medical And Technical Sciences (formerly Saveetha University) for providing facilities and continued assistance to complete this study.

Funding: We thank the following organisations for providing financial support that enabled us to complete the study.

1. Mass Datta Developers , Chennai, India.
2. Saveetha University.
3. Saveetha Institute of Medical And Technical Sciences.
4. Saveetha School of Engineering.

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TABLES AND FIGURES

Table 1. Accuracy achieved during the evaluation of RF algorithm and DT models for classification with different iterations.

Iteration No.	ACCURACY	
	RF	DT
1.	89.77	89.88
2.	88.10	88.10
3.	89.50	89.20
4.	90.20	90.30
5.	88.60	89.15
6.	89.40	88.56

7.	88.30	90.10
8.	90.40	89.70
9.	88.32	88.37
10.	89.60	89.35

Table 2. Experimental analysis in Jupyter for Accuracy for RF and DT. DT provides better Accuracy (89.88%) than RF.

MODEL	ACCURACY(%)
RF	89.77
DT	89.88

Table 3. Statistical Analysis of Mean, Standard Deviation and Standard Error Mean and Accuracy of RF and DT algorithms. There is a statistical difference in accuracy values between the data mining algorithms. DT had the higher mean accuracy (89.2710%) and RF had mean accuracy of (89.2190%).

ACCURACY (Algorithm)	N	Mean	sig	Std. Deviation	Std.Error Mean	95% Confidence Interval for Mean	
						Lower	Upper
RF	10	89.2320	.02	.83037	.26259	-.79384	.68984
DT	10	89.2710		.74651	.23607	-.79443	.69043

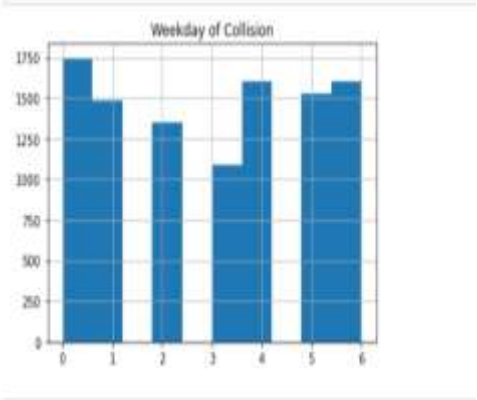

Fig. 1. Weekday of Collision of Vehicles

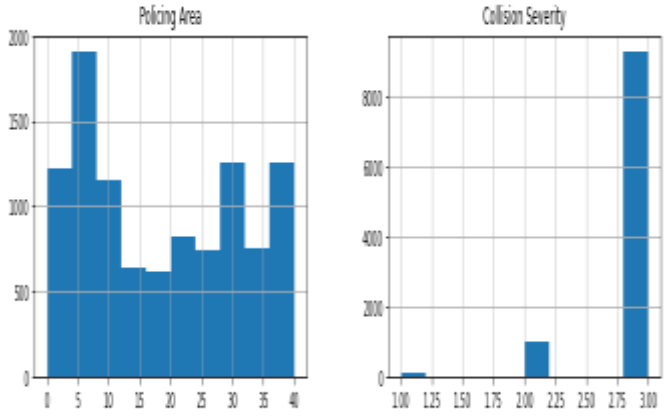

Fig. 2. Policing Area and Collision Severity

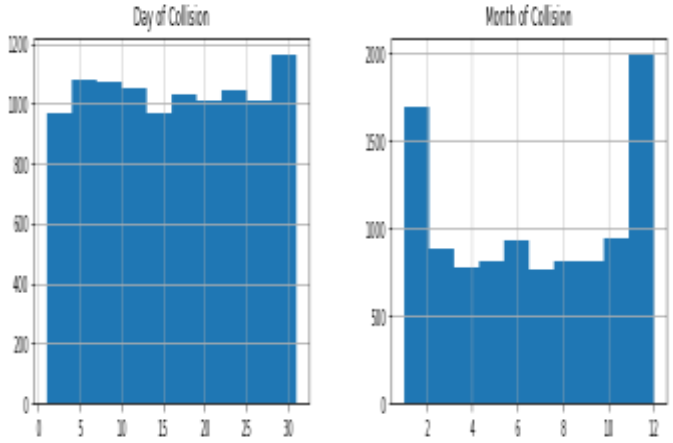

Fig. 3. Day And Month of Collision

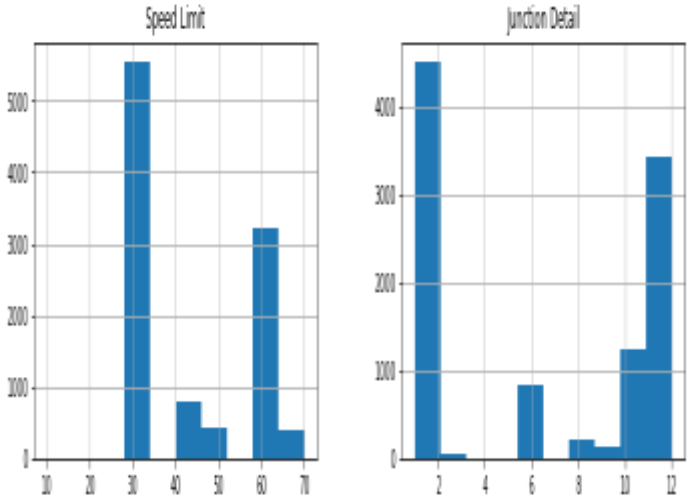

Fig. 4. Speed Limit And Junction Detail

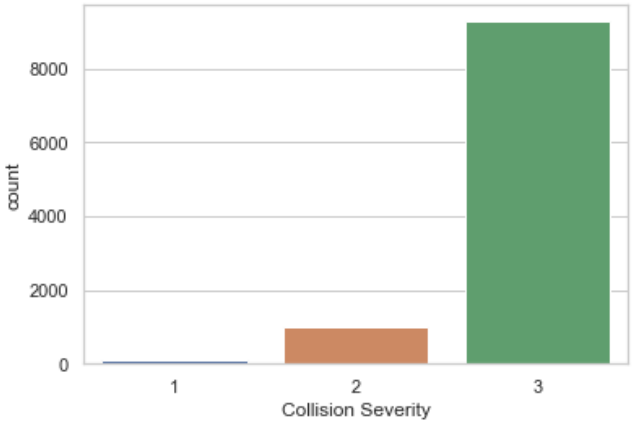

Fig. 5. Collision Severity

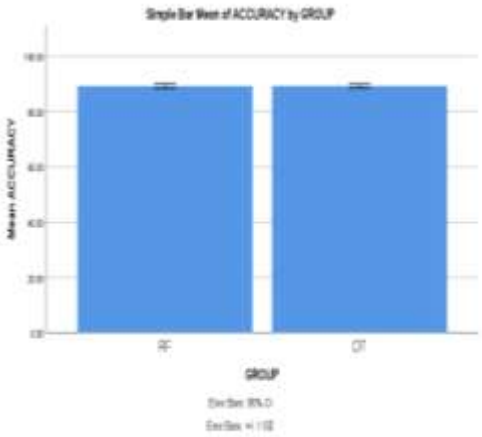

Fig. 6. Comparison of mean accuracy of RF(89.77%) and DT(89.88%) algorithms. DT appears to produce more consistent results with higher accuracy. X-axis: DT vs RF. Y-axis: Mean Accuracy of ± 1 SD.