Original Article

Preliminary Sensing of Wrong-Lane Accidents by Comparing Random Forest with Logistic Regression, Decision Tree and SVM Algorithm for Better Accuracy

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Abstract

Aim: The proposed study aims to perform detection of wrong-lane accidents using Novel Penalty Based Logistic Regression (LR) algorithm and compare accuracy with Decision Tree (DT), Support Vector Machine (SVM) and Random Forest (RF) algorithm. **Materials and Methods:** Novel Penalty Based Logistic Regression 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 Novel Penalty Based Logistic Regression with Decision Tree, SVM 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 Novel Penalty Based Logistic Regression (90.0%) with minimum mean error when compared with Decision Tree (89.88%), SVM (89.90%), Random Forest (89.77%) and attained significance value of p = 0.02. **Conclusion:** The study proves that the Novel Penalty Based Logistic Regression Algorithm exhibits better accuracy than the Decision Tree, SVM and Random Forest in detection of wrong-lane accidents.

Keywords: Novel Penalty Based Logistic Regression, Decision Tree, Support Vector Machine, Random Forest, Accident Detection, Wrong-Lane, Data Mining, Classification.

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INTRODUCTION

The wrong-lane road accidents are a completely common difficulty in densely 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. The work is more useful to identify those people who don't comply with visitors' policies (M et al. 2021) and strict regulations can be employed.

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 is used widely to improve accident detection. (Patil et al. 2020) proposed 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 accident detection accurately. (Chen and Chen 2020) proposed a criteria based spatial grouping of applications with Novel Penalty Based Logistic Regression performed by other models by achieving 75.6% to predict accidents. (Oza and D. Y Patil School of Engineering Lohegaon 2020) proposed a feature selection algorithm with a classifier 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 Decision Tree 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 accident detection of wrong-lane travelling vehicles and improve the classification accuracy by incorporating Novel Penalty Based Logistic Regression and comparing the performance with Decision Tree, SVM and 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.).

Novel Penalty Based Logistic Regression (LR)

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 LR classifier penalty as a parameter.

Step 4: l2 was used as a parameter value.

Step 5: Analyze the dataset by varying dependent and independent variables.

Step 6: LR predicts the outcome in a categorical variable.

Step 7: Finally predicts the possibility of event using the log function.

This study uses the Novel Penalty Based Logistic Regression class from the sklearn.linear model library. This innovative method uses a penalty-based approach. It takes the penalty as a parameter. "LR" is used as the parameter value. The data set is randomly divided into training (80%) and test (20%). Select samples at random and analyze the data set by varying the dependent variables and independent variables. Finally, it provides for the possibility of an event using the log function.

Decision Tree (DT)

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.

Support Vector Machine (SVM)

Input: Accident dataset
Output: Accuracy

Step 1: Load the dataset.

Step 2: Split the dataset randomly into training (80%) and testing (20%) dataset.

Step 3: Set the target variable.

Step 4: Generate the SVM classifier based on the training set.

Step 5: Train the classifier using the rbf kernel parameter.

Step 6: Predict the testing set based on the training dataset.

Step 7: Evaluate the classifier.

Step 8: Return Accuracy.

Support Vector Machine (SVM) is a regulated machine learning algorithm which can be utilized for both classification and regression challenges. In this study, to train the SVM the svc class of scikit learn library class was used. The dataset is split randomly into training (80%) and testing (20%) sets.The target variable is selected. Then, the SVM classifier based on the training set is generated. Rbf was used as the value of the kernel parameter. The testing set is predicted based on the training set. The SVM classifier is evaluated and the accuracy is calculated.

Random Forest (RF)

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).

Initially, 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 LR, DT, SVM and RF for 10 iterations each. The different parameters for the analysis can be calculated as follows: Accuracy identifies the number of instances that were correctly classified as shown in the following Equation 1.

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

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 four groups with four parameters under study (Ogungbemile, n.d.). The independent variables are Speed Limit, Junction Control. The dependent variables are Accuracy, Prediction.

RESULTS

The proposed algorithm Novel Penalty Based Logistic Regression, Decision Tree, SVM and Random Forest were run at a time for performing detection of wrong-lane accidents. Table 2 shows the different parameters of the four groups. Accuracy is calculated for LR, DT, SVM and RF. Two-group analysis shows that LR has higher accuracy (90.0%) than DT, SVM and RF. Table 3 shows the statistical analysis of LR, DT, SVM and RF with different sets of test data. Figure 1 shows the weekday of vehicle collisions. Figure 2 shows the policing area and collision severity. Figure 3 shows the day and month of collision. Figure 4 shows the speed limit and junction detail. Figure 5 shows the collision severity. Figure 6 shows the comparison of LR, DT, SVM and Random Forest algorithms. The average accuracy of the LR model appears to be higher than that of the other three models such as DT, SVM and RF model. The performance of the LR algorithm is superior to that of the DT, SVM and RF algorithm. There is no significant difference between the four groups. Therefore, LR is better than DT, SVM and RF. Statistical analysis of the four independent groups shows that LR has a higher mean accuracy (90.0%). The mean error of LR is a little less than all the other three algorithms such as DT, SVM and Random Forest.

DISCUSSION

The work shows that Novel Penalty Based Logistic Regression is better than DT, SVM and RF at detection of wrong-lane accidents in terms of accuracy. From the experimental results performed in Jupyter, the accuracy of LR is 90.0%, while DT, SVM and RF provide the accuracy of 89.88%, 89.90% and 89.77% .This shows that LR is better than all the other three algorithms such as DT, SVM and Random Forest. The different parameters such as TP rate, FP rate are also compared. According to the SPSS plot, the proposed Novel Penalty Based Logistic Regression classifier performs better in terms of accuracy (90.0%) than the DT, SVM and RF algorithms.

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 accident detection was proposed using an accident dataset (Al-Ghamdi 2002). Popular data mining algorithms in machine learning, 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 LR 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 DT models with only a few significant variables identified by LR, or major variables identified by the Decision Tree, or LR models with only a few significant variables identified by LR should be selected for greater sensitivity (Somboon et al. 2022). The accuracy of the LR classification data mining algorithm depends on the size of the training and testing data set. In our study, the accuracy appears to be better than DT, SVM and RF. 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 LR, the average error seems to be higher than DT, SVM and RF. It would be preferable if the average error could be considerably reduced. However, the work can be improved by applying optimization data mining 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 Novel Penalty Based Logistic Regression outperforms the other three algorithms such as Decision Tree, Support Vector Machine and Random Forest in terms of Accuracy. The Proposed Novel Penalty Based Logistic Regression proved with better accuracy (90.0%) when compared with Decision Tree (89.88%), SVM (89.90) and Random Forest (89.77).

DECLARATIONS

Conflicts of interests
No conflicts of interest in this manuscript.

Authors Contribution
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.

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TABLES AND FIGURES

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

Iteration No.	ACCURACY			
	RF	LR	DT	SVM
1.	89.77	90.00	89.88	89.90
2.	88.10	89.20	88.10	88.10
3.	89.50	91.25	89.20	89.05
4.	90.20	90.30	90.30	88.20
5.	88.60	89.40	89.15	90.20
6.	89.40	90.50	88.56	88.15
7.	88.30	91.08	90.10	89.20

8.	90.40	89.80	89.70	88.80
9.	88.32	90.20	88.37	90.30
10.	89.60	90.15	89.35	89.50

Table 2. Experimental analysis in Jupyter for Accuracy for LR, DT, SVM and RF. LR provides better Accuracy (90.0%) than DT, SVM and RF.

MODEL	ACCURACY(%)
LR	90.00
DT	89.88
SVM	89.90
RF	89.77

Table 3. Statistical Analysis of Mean, Standard Deviation and Standard Error Mean and Accuracy of LR, DT, SVM and RF algorithms. There is a statistical difference in accuracy values between the data mining algorithms. LR had the higher mean accuracy (90.1880%) than DT(89.2710%), SVM(89.1400%) and RF(89.2320%).

ACCURACY (Algorithm)	N	Mean	sig	Std. Deviation	Std.Error Mean	95% Confidence Interval for Mean	
						Lower	Upper
LR	10	90.1880	.02	.65132	.20597	.25881	1.57519
DT	10	89.2710		.74651	.23607	.25794	1.57606
SVM	10	89.1400		.83327	.26350	.34240	1.75360
RF	10	89.2320		.84513	.26725	.24382	1.66818

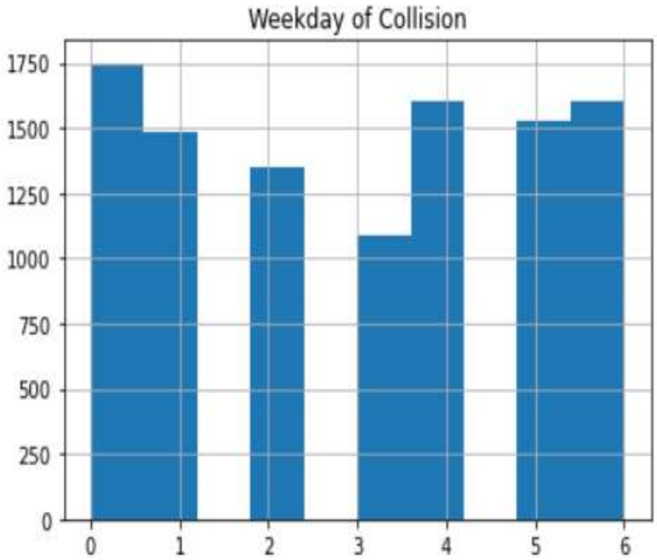

Fig. 1. Weekday of Collision of Vehicles

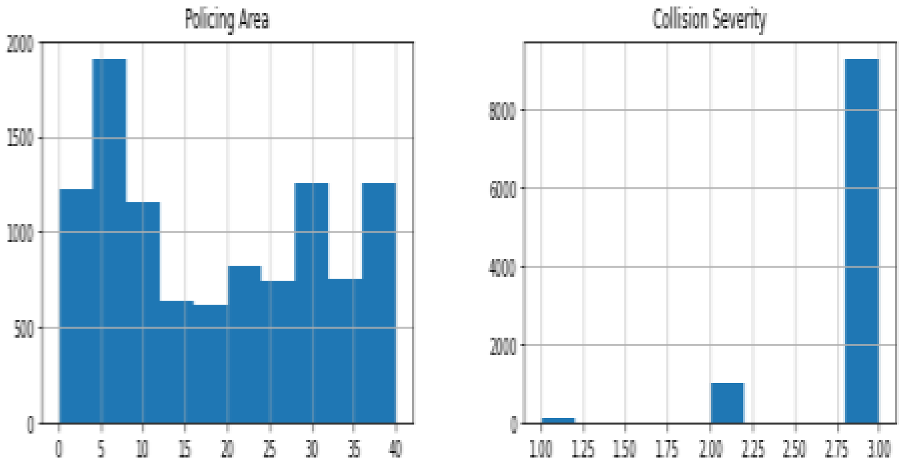

Fig. 2. Policing Area and Collision Severity

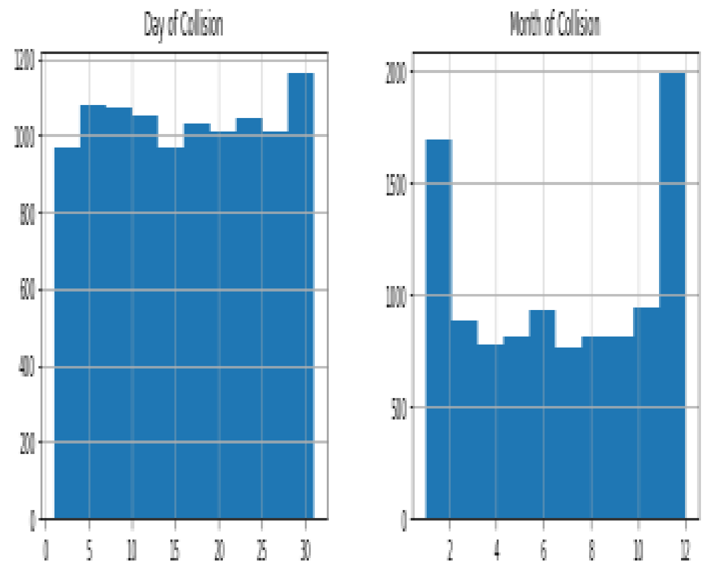

Fig. 3. Day And Month of Collision

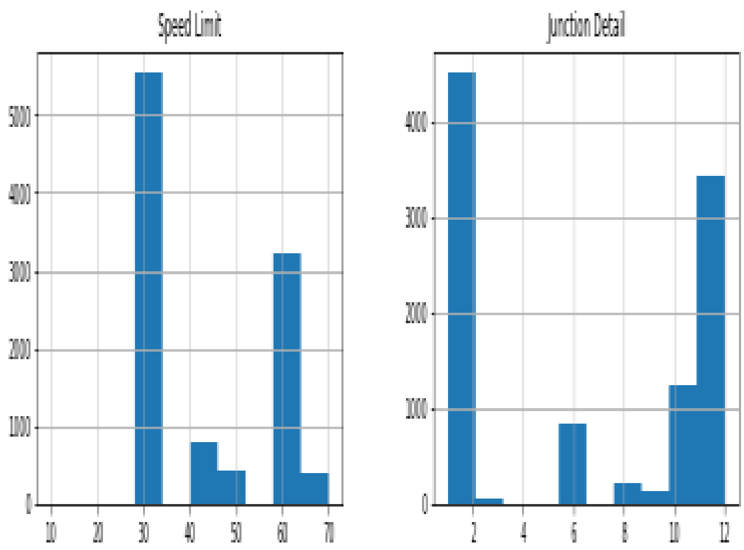

Fig. 4. Speed Limit And Junction Detail

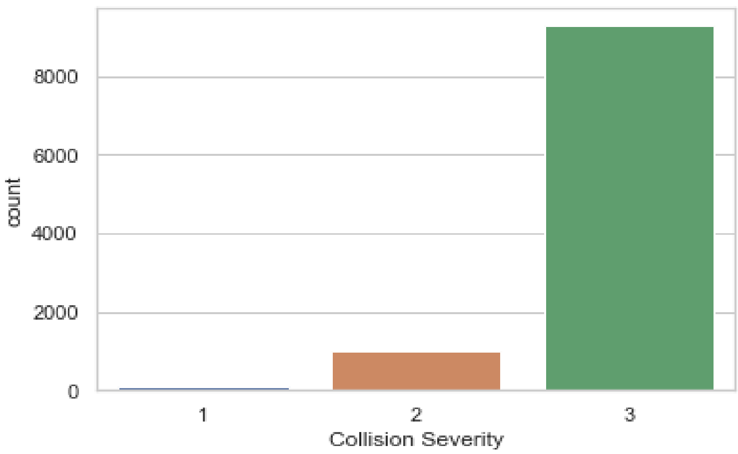

Fig. 5. Collision Severity

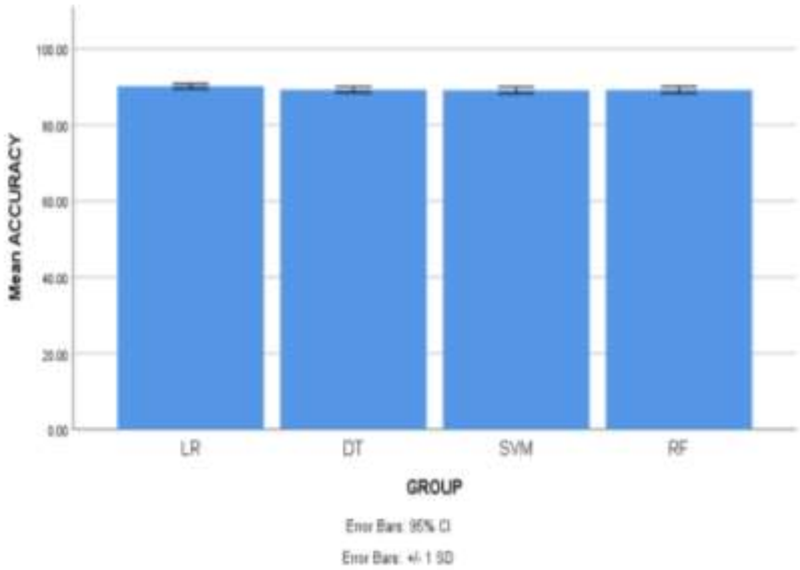

Fig. 6. Comparison of mean accuracy of LR, DT, SVM and Random Forest algorithms. LR appears to produce more consistent results with higher accuracy. X-axis: LR vs DT vs SVM vs RF. Y-axis: Mean Accuracy of ± 1 SD.