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A Road Accident Prediction Model Using Machine Learning

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ABSTRACT: Due to the exponentially increasing number of vehicles on the road, the number of accidents occurring on a daily basis is also increasing at an alarming rate. With the high number of traffic incidents and deaths these days, the ability to forecast the number of traffic accidents over a given time is important for the transportation department to make scientific decisions. In this scenario, it will be good to analyze the occurrence of accidents so that this can be further used to help us in coming up with techniques to reduce them. Even though uncertainty is a characteristic trait of majority of the accidents, over a period of time, there is a level of regularity that is perceived on observing the accidents occurring in a particular area. This regularity can be made use of in making well informed predictions on accident occurrences in an area and developing accident prediction models. In this paper, we have studied the inter relationships between road accidents, condition of a road and the role of environmental factors in the occurrence of an accident. We have made use of data mining techniques in developing an accident prediction model using Apriori algorithm and Support Vector Machines. Bangalore road accident datasets for the years 2014 to 2017 available in the internet have been made use for this study. The results from this study can be advantageously used by several stakeholders including and not limited to the government public work departments, contractors and other automobile industries in better designing roads and vehicles based on the estimates obtained.

KEYWORDS: Traffic Accidents, Accident Prediction Models, Data Mining Techniques, Apriori Algorithm, Support Vector Machines (SVM), Environmental Factors

I. INTRODUCTION

Machine Learning is a system of computer algorithms that can learn from example through self-improvement without being explicitly coded by a programmer. Machine learning is a part of artificial Intelligence which combines data with statistical tools to predict an output which can be used to make actionable insights.

The breakthrough comes with the idea that a machine can singularly learn from the data (i.e., example) to produce accurate results. Machine learning is closely related to data mining and Bayesian predictive modeling. The machine receives data as input and uses an algorithm to formulate answers.

A typical machine learning tasks are to provide a recommendation. For those who have a Netflix account, all recommendations of movies or series are based on the user's historical data. Tech companies are using unsupervised learning to improve the user experience with personalizing recommendation.

Machine learning is also used for a variety of tasks like fraud detection, predictive maintenance, portfolio optimization, automatize task and so on.

Machine Learning vs. Traditional Programming

Traditional programming differs significantly from machine learning. In traditional programming, a programmer code all the rules in consultation with an expert in the industry for which software is being developed. Each rule is based on

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a logical foundation; the machine will execute an output following the logical statement. When the system grows complex, more rules need to be written. It can quickly become unsustainable to maintain.

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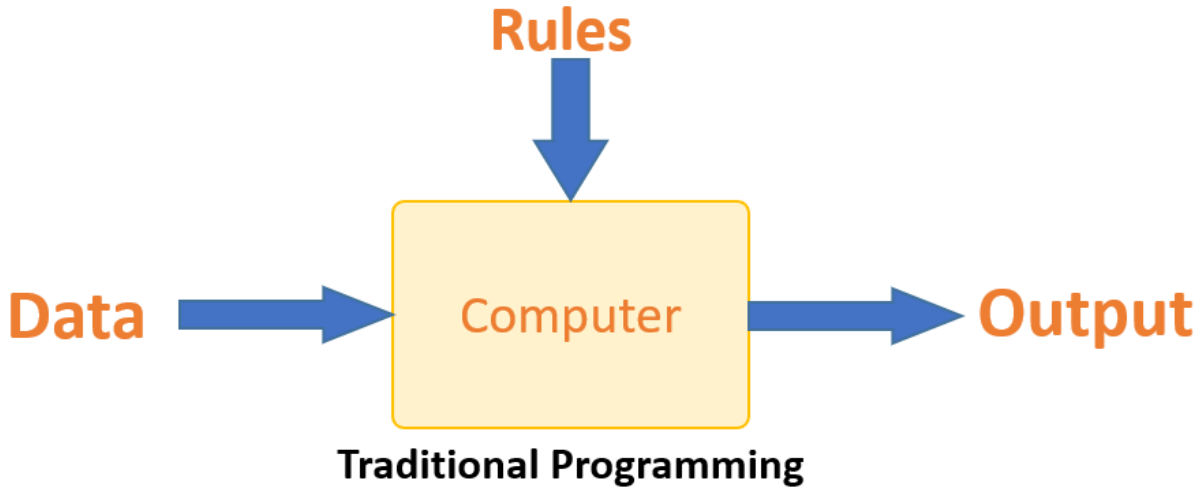
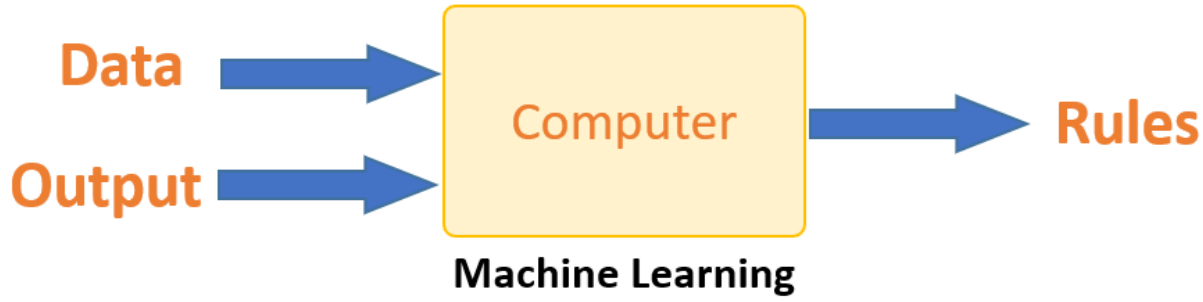


Machine learning is supposed to overcome this issue. The machine learns how the input and output data are correlated and it writes a rule. The programmers do not need to write new rules each time there is new data. The algorithms adapt in response to new data and experiences to improve efficacy over time.



How does Machine Learning Work?

Machine learning is the brain where all the learning takes place. The way the machine learns is similar to the human being. Humans learn from experience. The more we know, the more easily we can predict. By analogy, when we face an unknown situation, the likelihood of success is lower than the known situation. Machines are trained the same. To make an accurate prediction, the machine sees an example. When we give the machine a similar example, it can figure out the outcome. However, like a human, if its feed a previously unseen example, the machine has difficulties to predict.

The core objective of machine learning is the **learning** and **inference**. First of all, the machine learns through the discovery of patterns. This discovery is made thanks to the **data**. One crucial part of the data scientist is to choose carefully which data to provide to the machine. The list of attributes used to solve a problem is called a **feature vector.** You can think of a feature vector as a subset of data that is used to tackle a problem.

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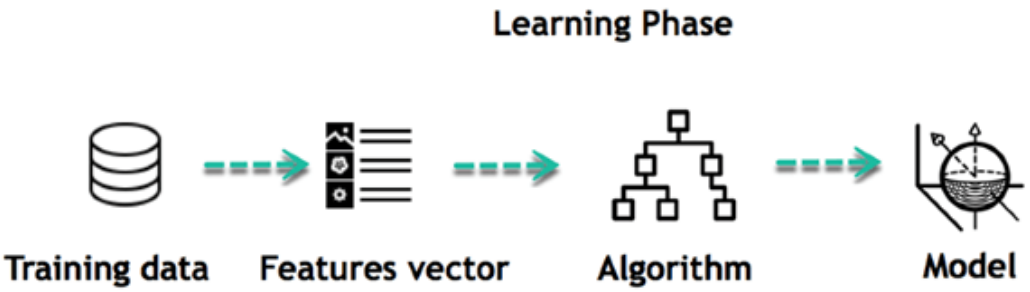
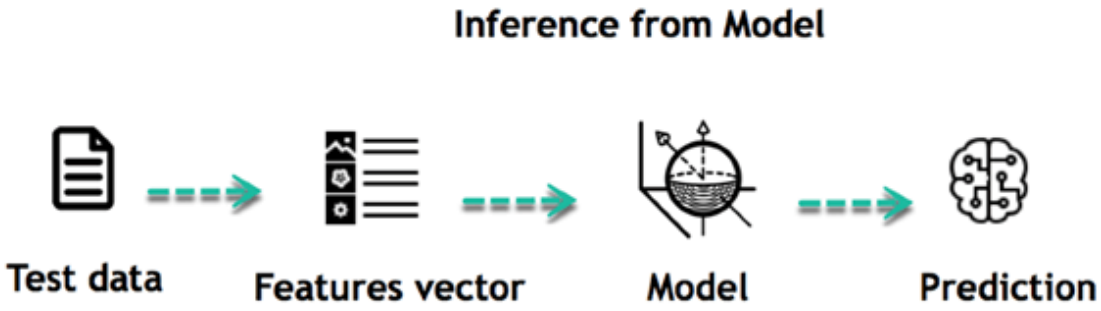
The machine uses some fancy algorithms to simplify the reality and transform this discovery into a **model**. Therefore, the learning stage is used to describe the data and summarize it into a model.



For instance, the machine is trying to understand the relationship between the wage of an individual and the likelihood to go to a fancy restaurant. It turns out the machine finds a positive relationship between wage and going to a high-end restaurant: This is the model.

Inferring

When the model is built, it is possible to test how powerful it is on never-seen-before data. The new data are transformed into a features vector, go through the model and give a prediction. This is all the beautiful part of machine learning. There is no need to update the rules or train again the model. You can use the model previously trained to make inference on new data.



The life of Machine Learning programs is straightforward and can be summarized in the following points:

1. Define a question
2. Collect data
3. Visualize data
4. Train algorithm
5. Test the Algorithm
6. Collect feedback
7. Refine the algorithm
8. Loop 4-7 until the results are satisfying
9. Use the model to make a prediction

Once the algorithm gets good at drawing the right conclusions, it applies that knowledge to new sets of data.

The alarming rate of increase of accidents in India is now a cause for serious concern. According to some recent statistics [1], India accounts for roughly six percent of global road accidents while owning only one percent of the global vehicle population. There are a lot of accident cases reported due to the negligence of two-wheelers, whereas over-speeding is also another contributing factor. Accidents caused while under the influence of alcohol or during

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general traffic violations are also common. In spite of having set regulations and the highway codes, the negligence of people towards the speed of the vehicle, the vehicle condition and their own negligence of not wearing helmets has caused a lot of accidents. While the major cause of road accidents is attributed to the increasing number of vehicles, the role played by the condition of the roads and other environmental factors cannot be overlooked. The number of deaths due to road accidents in India is indeed a cause for worry. The scenario is very dismal with more than 137,000 people succumbing to injuries from road accidents. This figure is more than four times the annual death toll from terrorism. Accidents involving heavy goods vehicles like trucks and even those involving commercial vehicles used for public transportation like buses are some of the most fatal kind of accidents that occur, claiming the lives of innocent people. Weather conditions like rain, fog, etc., also play a role in catalysing the risk of accidents. Thus, having a proper estimation of accidents and knowledge of accident hotspots and causing factors will help in taking steps to reduce them. This requires a keen study on accidents and development of accident prediction models. To implement a well-designed road framework management system for looking into road security aspects, it is often desired to have an optimized accident prediction model which can analyze potential issues arising due to infrastructure fallbacks and to estimate the effect of existing models in reducing the occurrence of accidents. The main challenges involved in the creation of such a model include the evaluation of the weight that can be attributed to the impact of each variable in contributing to the accident and assessing how the model can be best designed to incorporate the effects of all such variables. Data mining techniques and models have in the past been found useful for the purpose of data interpretation in a variety of domains including but not limited to credit risk management, fraud detection, healthcare informatics, recommendation systems and so on. Approaches involving artificial intelligence and machine learning have further helped to augment these studies. For this project, we have investigated the inter-relationship between the occurrences of road accidents and the roles played by the underlying road conditions and environmental factors in contributing to the same. Since such a study requires us to cover several aspects affecting accidents, we can make use of data mining techniques to analyze this data to extract relevant details from them, as these huge volumes of data would otherwise be meaningless without the right interpretation applied to them. In this project, we are discussing the effects of such an accident prediction model in identifying the risks involved in road accident scenarios. The next section discusses the prior works done with respect to analyzing the different accidents that have taken place over the years. This is followed by a summarized description of the methodology used in this work. Further, the different components of implementation including the system architecture, software and languages used, simulation, user interface and screenshots of the developed application are discussed. Finally, the discussion and conclusions derived from the present study and the future scopes are outlined in the last two sections. The results from this study have been used to propose a model that can be used as a tool to estimate the possibility of road accidents in a particular area chosen by the user.

II. LITERATURE SURVEY

Analyzing accidents through various computational techniques has become increasingly significant for understanding patterns, predicting outcomes, and developing preventive measures. Several studies highlight advancements in text mining, data mining, and machine learning approaches in accident analysis across different sectors.

Williams, Betak, and Findley (2016) analyzed railroad accident investigation reports from the United States and Canada using text mining techniques like probabilistic topic modeling and k-means clustering. Their study identified recurring accident types, including track defects, wheel defects, grade crossing accidents, and switching accidents. Notably, bridge-related accidents were more prominent in Canadian reports, emphasizing regional differences in accident themes.

Suganya and Vijayarani (2017) applied classification algorithms to analyze road accident data in India. Using algorithms such as linear regression, logistic regression, decision trees, SVM, Naïve Bayes, KNN, Random Forest, and gradient boosting, the study evaluated their performance based on accuracy, error rate, and execution time. The findings indicated that the KNN algorithm outperformed others in terms of performance metrics.

Sarkar, Pateshwari, and Maiti (2017) developed a predictive model for incident occurrences in a steel manufacturing plant in India. Using a dataset of 9,488 occupational accident observations, text mining techniques were employed to extract insights, which were then used by classifiers such as Support Vector Machines, Random Forest, and Maximum

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Entropy. Random Forest and Maximum Entropy emerged as the most effective classifiers for predicting injuries and their causes, based on high area-under-curve (AUC) values.

Nour (2020) examined road traffic accident injury data using advanced data analytics techniques to predict injury severity levels. The study utilized publicly available UK Department of Transport data spanning 2005–2019. Tree-based techniques like XGBoost outperformed regression-based models, identifying key risk factors contributing to accident severity. The study also addressed data quality issues and proposed a generalizable approach for different datasets globally.

Rajkumar, Prabhakar, and Priyadharsini (2020) focused on the severity of road accidents using machine learning algorithms. The study categorized accidents into severity levels such as slight, severe, and fatal. Logistic regression demonstrated the highest accuracy in multilabel classification. Factors such as the number of vehicles involved, lighting conditions, and road features were significant contributors to accident severity.

Existing System

- Having a proper estimation of accidents and knowledge of accident hotspots and causing factors will help in taking steps to reduce them. This requires a keen study on accidents and development of accident prediction models.
- The main challenges involved in the creation of such a model include the evaluation of the weight that can be attributed to the impact of each variable in contributing to the accident and assessing how the model can be best designed to incorporate the effects of all such variables.

Existing System Disadvantages

- Less Efficiency
- Less Accuracy

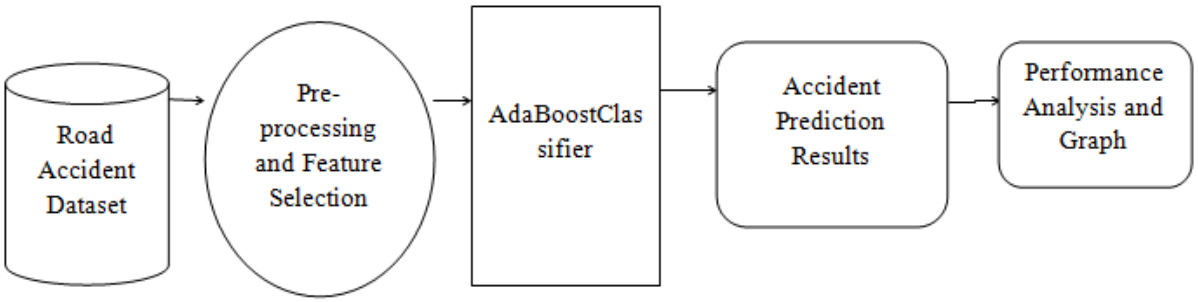
Proposed System

- In this project, a road accident prediction model has been developed and implemented, taking into consideration different possible causative factors. The range of factors chosen for the study are limited to mainly the condition of the road, weather influences and the nature of accident cause.
- The emotional state of mind and experiential influence of the driver have not been considered as in past literature. We have made use of data mining techniques in developing an accident prediction model using Apriori algorithm and Support Vector Machines.

Proposed System Advantages

- More Efficiency with added emotional state of mind
- More Accuracy

SYSTEM ARCHITECTURE



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Explanation

A performance graph can visually represent the model's accuracy and how it varies with different thresholds or parameters. This flowchart illustrates a typical workflow for building a road accident prediction system using machine learning techniques. By accurately predicting accident-prone areas and conditions, such systems can aid in implementing preventive measures and improving road safety.

III. METHODOLOGIES

Modules

This project having the following 7 modules:

- Data Collection
- Dataset
- Data Preparation
- Model Selection
- Analyze and Prediction
- Accuracy on test set
- Saving the Trained Model

Modules Description

Data Collection:

This is the first real step towards the real development of a machine learning model, collecting data. This is a critical step that will cascade in how good the model will be, the more and better data that we get, the better our model will perform.

There are several techniques to collect the data, like web scraping, manual interventions and etc.

A Road Accident Prediction Model Using Data Mining Techniques

We given the data set in the project folder

Dataset:

The dataset consists of 576 individual data. There are 15 columns in the dataset, which are described below.

1. States/Uts: States And Union Territories of India
2. Junction: Types of Junction's Road
3. Vehicle Age: in Year
4. Human Age And Sex: Human Age and Male / Female
5. Person Without Safety Precautions
6. Area: Types of Area in India
7. Types of Places: Urban or Rural
8. Loads of Vehicle: Types of Loads of Vehicle
9. Traffic Rules Violation: Types Traffic Rules Violations
10. Weathers: Weather Condition
11. Vehicle Type and Sex: Types of Vehicles and Male / Female
12. Types of Roads
13. Licenses: License Valid Permanen / Without Licence / Learner's Licence
14. Time
15. Accident Occurrence: Yes or No

Data Preparation

Wrangle data and prepare it for training. Clean that which may require it (remove duplicates, correct errors, deal with missing values, normalization, data type conversions, etc.)Randomize data, which erases the effects of the particular order in which we collected and/or otherwise prepared our dataVisualize data to help detect relevant relationships between variables or class imbalances (bias alert!), or perform other exploratory analysis

Split into training and evaluation sets

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Model Selection

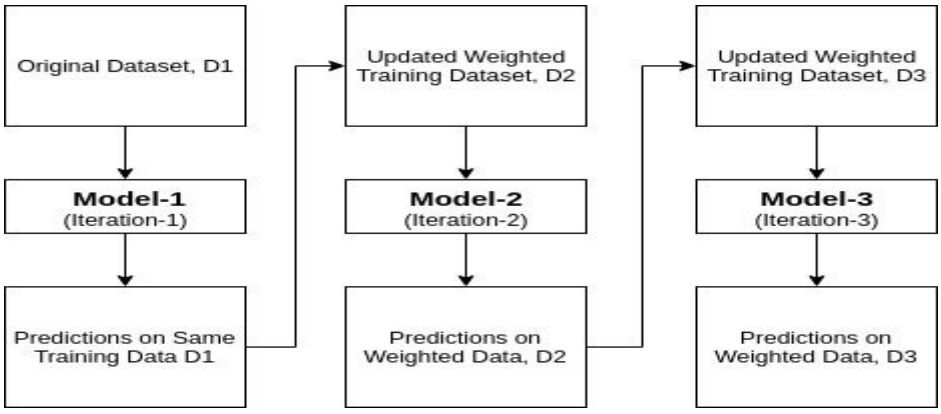
We used decision tree Ada Boost Classifier algorithm, We got a accuracy of 94.7% on test set so we implemented this algorithm.

Ada Boost Classifier

Ada-boost or Adaptive Boosting is one of ensemble boosting classifier proposed by Yoav Freund and Robert Schapire in 1996. It combines multiple classifiers to increase the accuracy of classifiers. AdaBoost is an iterative ensemble method. AdaBoost classifier builds a strong classifier by combining multiple poorly performing classifiers so that you will get high accuracy strong classifier. The basic concept behind Adaboost is to set the weights of classifiers and training the data sample in each iteration such that it ensures the accurate predictions of unusual observations. Any machine learning algorithm can be used as base classifier if it accepts weights on the training set. Adaboost should meet two conditions:

The classifier should be trained interactively on various weighed training examples.

In each iteration, it tries to provide an excellent fit for these examples by minimizing training error.



Implementation

Support Vector Machine (SVM):

A Support Vector Machine (SVM) is a powerful machine learning algorithm widely used for both linear and nonlinear classification, as well as regression and outlier detection tasks. SVMs are highly adaptable, making them suitable for various applications such as text classification, image classification, spam detection, handwriting identification, gene expression analysis, face detection, and anomaly detection.

SVMs are particularly effective because they focus on finding the maximum separating hyperplane between the different classes in the target feature, making them robust for both binary and multiclass classification. In this outline, we will explore the Support Vector Machine (SVM) algorithm, its applications, and how it effectively handles both linear and nonlinear classification, as well as regression and outlier detection tasks.

Apriori Algorithm in Machine Learning

The Apriori algorithm uses frequent itemsets to generate association rules, and it is designed to work on the databases that contain transactions. With the help of these association rule, it determines how strongly or how weakly two objects are connected. This algorithm uses a **breadth-first search** and **Hash Tree** to calculate the itemset associations efficiently. It is the iterative process for finding the frequent itemsets from the large dataset.

Python Implementation of Apriori Algorithm

Now we will see the practical implementation of the Apriori Algorithm. To implement this, we have a problem of a retailer, who wants to find the association between his shop's product, so that he can provide an offer of "Buy this and Get that" to his customers.

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The retailer has a dataset information that contains a list of transactions made by his customer. In the dataset, each row shows the products purchased by customers or transactions made by the customer. To solve this problem, we will perform the below steps:

- Data Pre-processing
- Training the Apriori model on the dataset
- Visualizing the results

Ada Boost Classifier

Ada-boost or Adaptive Boosting is one of ensemble boosting classifier proposed by Yoav Freund and Robert Schapire in 1996. It combines multiple classifiers to increase the accuracy of classifiers. AdaBoost is an iterative ensemble method. AdaBoost classifier builds a strong classifier by combining multiple poorly performing classifiers so that you will get high accuracy strong classifier. The basic concept behind Adaboost is to set the weights of classifiers and training the data sample in each iteration such that it ensures the accurate predictions of unusual observations. Any machine learning algorithm can be used as base classifier if it accepts weights on the training set. Adaboost should meet two conditions:

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Experiment Results

Figure: Homepage

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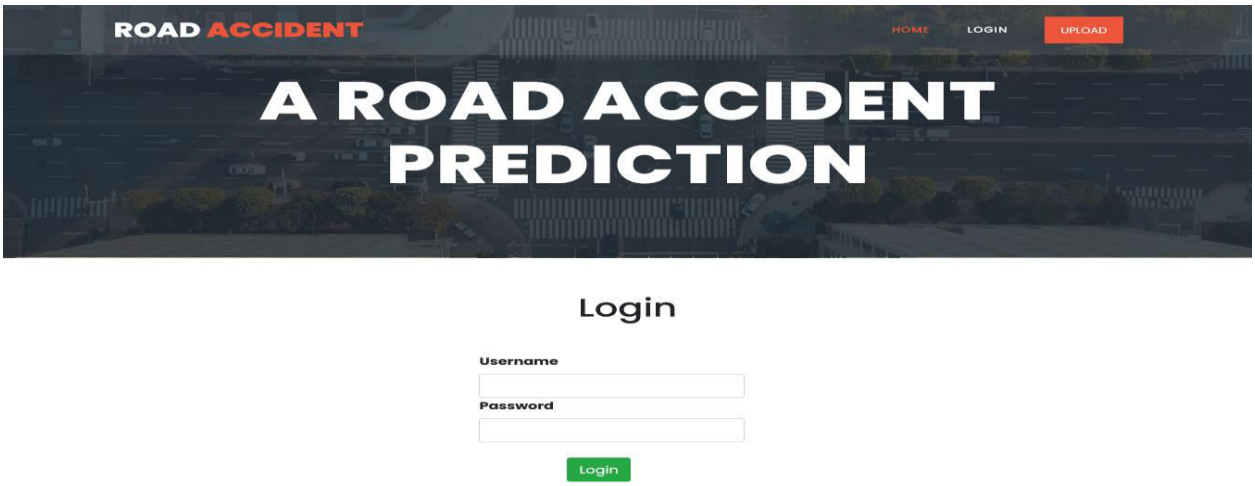

Figure: login page

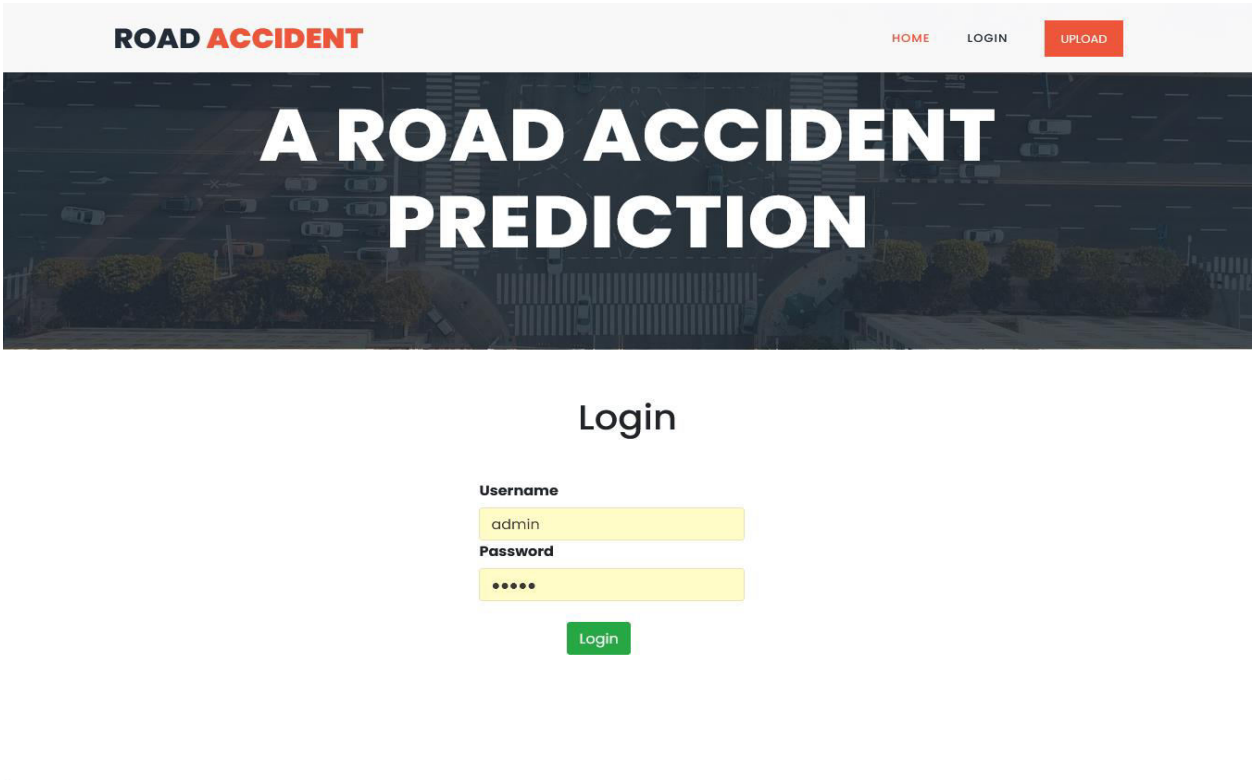

Figure: Login credentials

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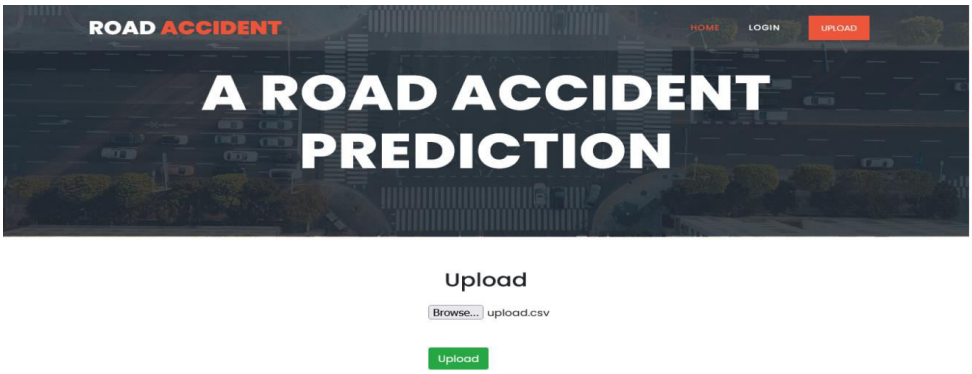

Figure: Upload cv

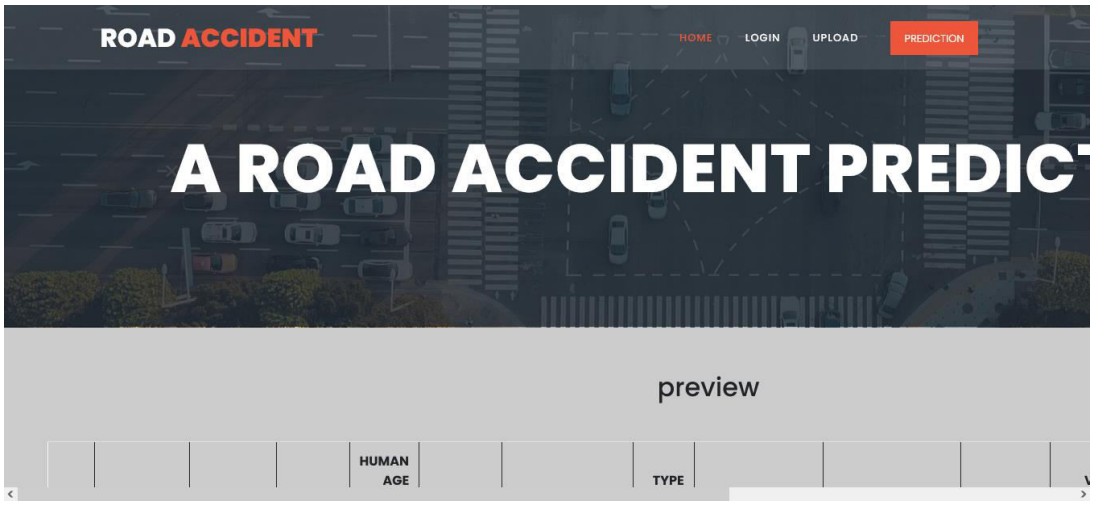

Figure: Preview

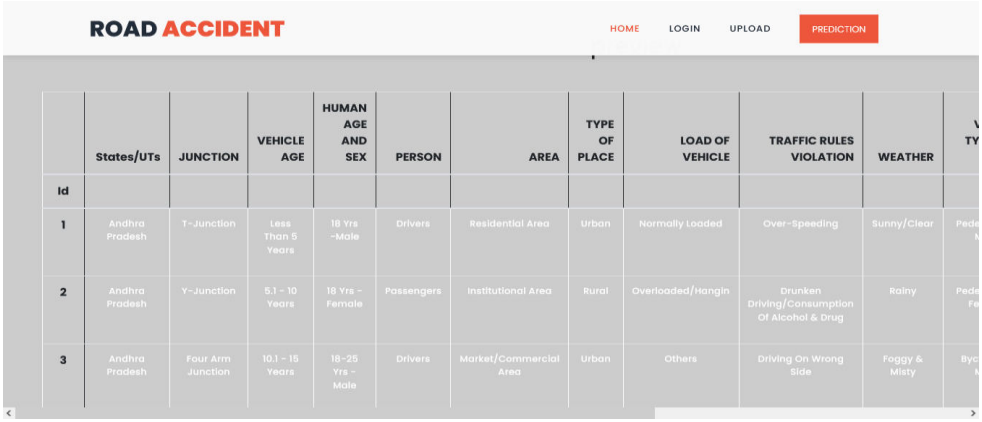

Figure :Dataset

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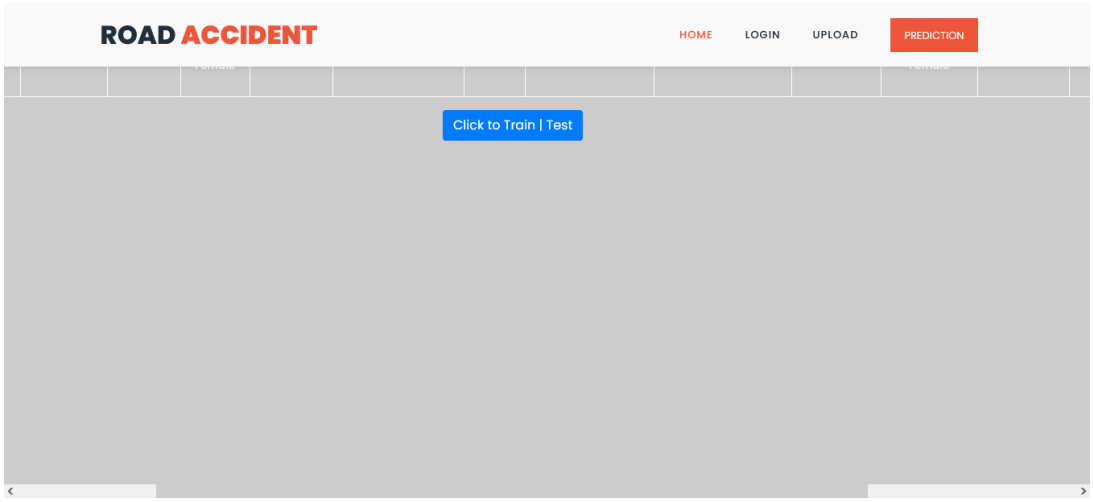
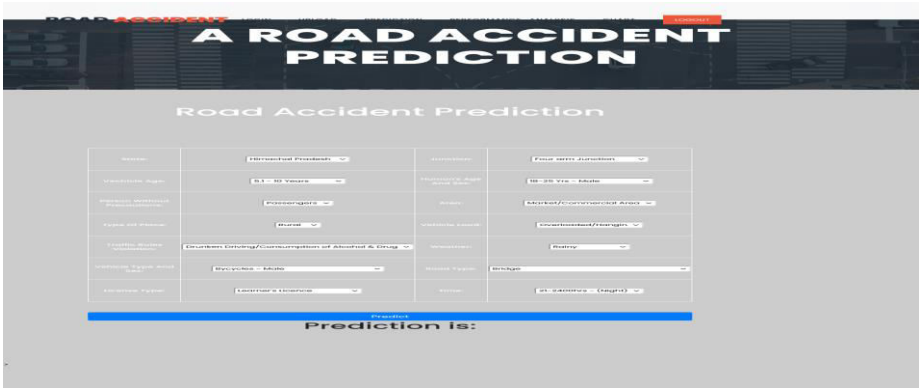
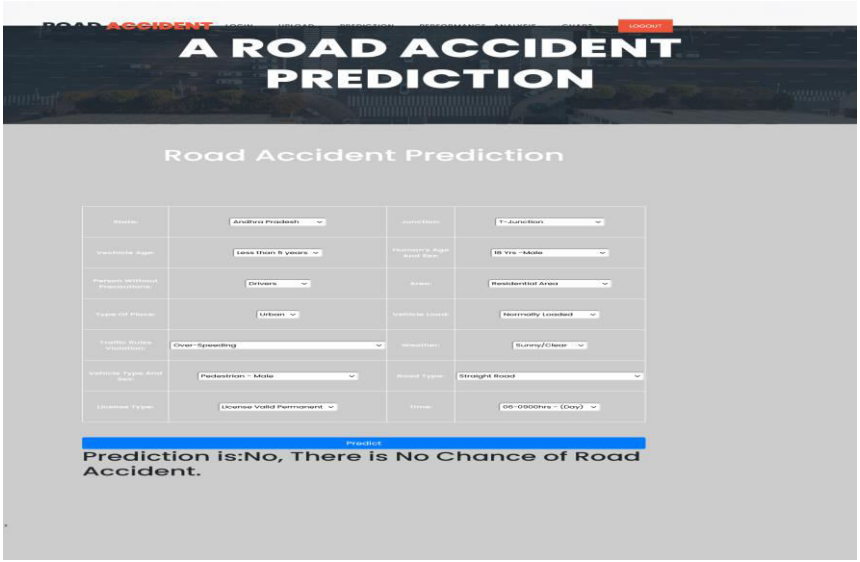


Figure: Train & Test





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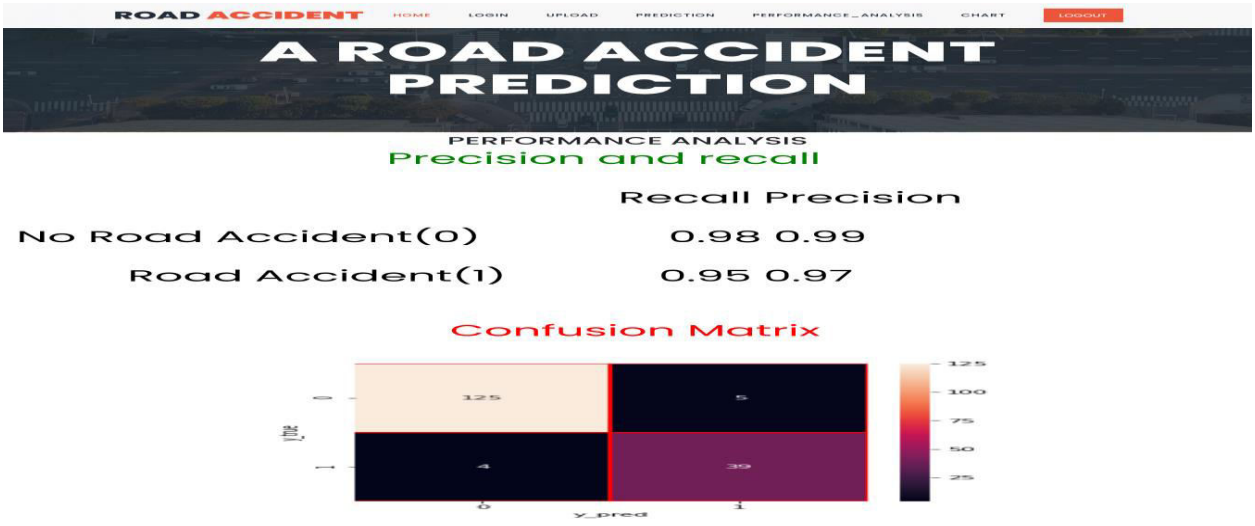

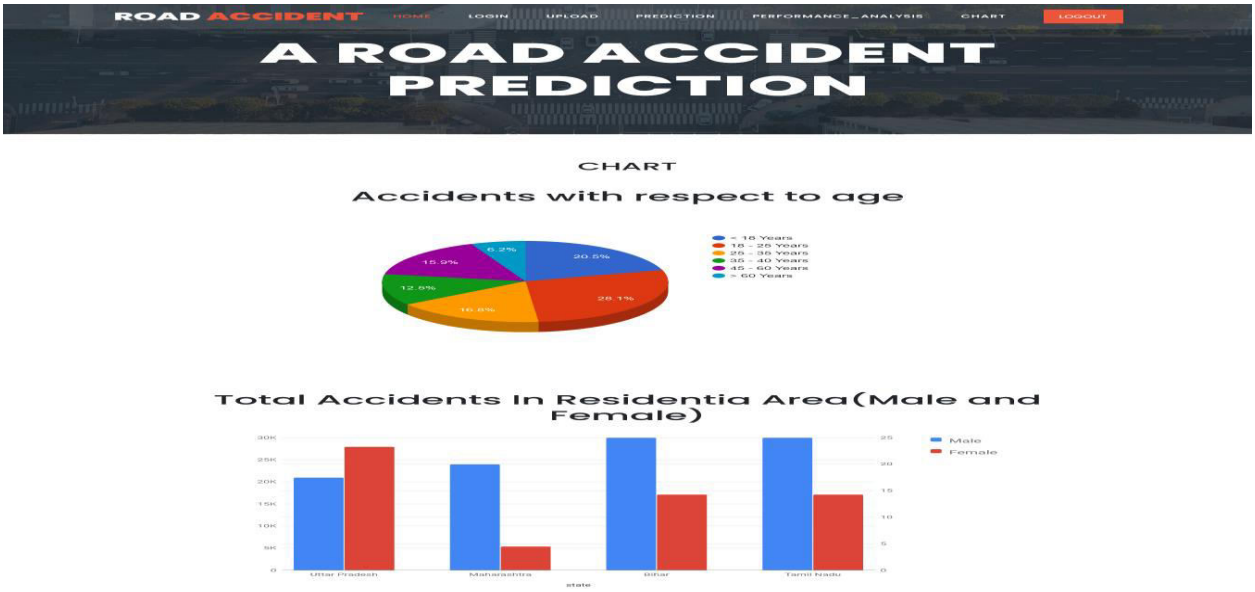

IV. CONCLUSION

An accident can change the lives of many people. It is up to each of us to bring down this increasing number. This can be made possible by adopting safe driving measures to an extent. Since all instances of accidents cannot be attributed tote same cause, proper precautionary measures will also need to be exercised by the road development authorities in designing the structure of roads as well as by the automobile industries in creating better fatality reducing vehicle models. One thing within our capability is to predict the possibility of an accident based on previous data and observations that can aid such authorities and industries. This project was successful in creating such an application that can help in efficient prediction of road accidents based on factors such as types of vehicles, age of the driver, age of the vehicle, weather condition and road structure, so on. This model was implemented by making use of several data

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mining and machine learning algorithms applied over a dataset for India and has been successfully used to predict the risk probability of accidents over different areas with high accuracy.

V. FUTURE ENHANCEMENT

The model can be further optimized in future to include several constraints that have been left out in the current study. These optimized models can be efficiently utilized by the government to reduce road accidents and to implement policies for road safety. Another scope of this work would be to develop a mobile app that will help the drivers in choosing a route for a ride. A call out to the driver through the maps service can also be implemented that would also announce the risk probability in a chosen route along with the directions.

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