Original Article

Empowering Women Safety: Innovative App Leveraging Machine Learning And Flutter For Emergency

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Abstract

We read several articles about rapes, violent crimes against women, and other such accidents every day. The crime rate in India is increasing alarmingly. Today, the number of smartphone users have increased rapidly and smartphone can be used for assisting in such situations. We have developed an innovative application for smartphone which will help in ensuring women safety. In case of emergency, proposed application will automatically send live location to emergency contacts. The user can also predict the crime using machine learning for a given city through this application. The app offers a wide range of additional functionalities to enhance the user experience. It includes a chatroom where users can share their experiences related to different locations. Moreover, the application enables users to add a guardian and engage in chat conversations with them. Users can share their real-time location and images with their designated guardian and various government security agencies for added safety. Furthermore, the app provides information about nearby locations, and in case of emergencies, users have the option to directly call for emergency services.

1. Introduction

According to a report, approximately 9% of women in cities in India feel that public transport is safe, while 3% agree that it is not at all safe. [1]. According to data released by the National Bureau of Criminal Records (NCRB), crimes committed against females increased compared to the previous year [2]. Working women often overcome racial, organizational, and political barriers to peace. Women's safety is important, as we are all aware, but we must also recognize that they need to be adequately safeguarded. The government has made great efforts, but the number of crimes against women has not decreased.

The escalating rate of crimes against women makes it evident that the technological community must step forward to address this pressing issue. The rise in eve-teasing has left parents and guardians deeply worried about the safety of their children. Technology has transformative potential and can play a vital role in shaping a safer society. With the increasing prevalence of mobile phones, they can serve as powerful tools to safeguard women and protect them from potential harm.

In this work, we have developed a mobile app that will automatically activate whenever it receives emergency information and send a warning to emergency personnel and agencies. Crime prediction can be used in applications that use machine learning to identify safe and unsafe locations. The machine-learning model makes predictions based on a set of parameters. GPS tracking features that update the user's location

continuously are included. The application also facilitates Messenger, where users may post messages anonymously, talk about problems they are having, and pick up new self-defense skills. The users can also add their parents or guardians to the application, where they can chat and share images and locations with each other. The other features of the application include the location of the nearest hospital, police station, bus stand, and pharmacies. The option to call emergency services like the police, women's helpline, ambulance, and Fire Brigade is given. The user is also provided with news and self-defense techniques in the mobile application.

Section I talks about the introduction, while Section II presents an overview of the related work that supports the proposed work. Section III delves into our proposed model efforts to enhance the existing features and introduce novel ones. Section IV described the machine learning algorithm and the data set used. Section V contains result and discussion. The final section, presents the summary and conclusion.

2. Literature Survey

Various solutions and approaches have been made regarding the issue of the safety of females. We looked into various already-available applications for women's safety. These current methods have some shortcomings, including: poor application performance, user friendliness, inconsistent reliability. Some of the popular mobile applications available for women's safety are summarized in Table 1. The majority of these applications can send an alert when the user is in danger since they are reactive. When activated, these programmes offer a way to get in touch with the authorities, particular contacts, or guardians.

Data mining has recently been utilised as a technique for crime prediction to analyse crime data gathered from many sources to find trends and patterns that can improve crime solving and automatically report to the police. However, selecting the appropriate data mining technique is essential for improving crime detection. This paper reviews literature on various data mining applications, particularly those applied to solving crimes, and identifies research gaps and challenges in crime data mining. The dataset includes attributes such as murder, rape, kidnapping, robbery, burglary, cheating, dowry deaths, and more [8].

The research in this study, by J. M. Caplan, L. W. Kennedy, and J. Miller, has two basic goals. The initial goal is to predict the likelihood of shootings in a specific location using risk terrain modelling (RTM). The study aims to evaluate the chances of future shootings in different geographic areas by developing risk terrain maps that consider relevant contextual information related to the factors that contribute to shootings. Additionally, the study intends to examine the effectiveness of these risk terrain maps in predicting shootings for two consecutive six-month periods and compare their accuracy with retrospective hot spot maps, which identify past areas with a high frequency of shootings. The research findings indicate that risk terrain maps exhibit significantly higher accuracy compared to retroactive hot spot mapping when it comes to predicting future shootings at various locations and time intervals. Furthermore, the information produced by the risk terrain maps can be easily and efficiently operationalized by police administrators to direct police patrols to high-risk areas that have been identified through the maps. This study thus provides important insights into the use of RTM as a predictive tool for crime prevention and highlights the potential of risk terrain maps to inform policing strategies and interventions [9].

The collaborative study by M. Cahill and G. Mulligan examines violent crime in Portland, Oregon, considering spatial patterns and related factors. They use a global least-squares model with standard structural measures based on the Opportunity Framework to analyze all study sites. However, they also introduce Geographically Weighted Regression (GWR) as an alternative method to traditional crime modelling. GWR estimates local models that provide varying parameter estimates and significance values across different locations. The study concludes that the relationship between structural measures and crime varies significantly depending on the location. Therefore, incorporating both spatially varying and fixed parameters in mixed models may offer more accurate crime predictions. The research highlights the utility of GWR in studying local processes influencing crime rates and challenges the adequacy of global models in understanding urban violence. [10]-[12].

Table 1: Comparison of various safety applications

Features	[3]	[4]	[5]	[6]	[7]
Alert Message	✓	✓	✓	✓	✓
Crime Information	×	×	×	✓	×
Parental Features	×	×	×	×	×
Live GPS Tracking	×	×	×	✓	✓
Chat Room	×	×	×	×	×
Send Location	✓	✓	✓	✓	✓

✓ : Feature available × : Feature not available

3. Proposed Model

We have used Flutter to create smart mobile applications. The proposed system includes all elements available in current systems, such as GPS tracking and other features that can be used based on the user's assessment of the situation. It also includes all the special features, including live location tracking. Our proposed solution to this problem is to develop an Android application using which the person in distress can send an alert message to its trusted contacts. It contains several additional features along with the core features necessary for the application. Our model uses the power of machine learning technology to provide information about crime. Our system is set up to be distinct from other apps already in use by including all their features. The user must register in order to launch the programme. Users who register with their email address and password can log in. The user must manually enter emergency phone numbers. The Firebase Database will record them as users. Figure 1 Shows the proposed model. The components and features of this application have been described here [13][14].

A. Registration/Login Module

Our app must first be downloaded and installed on the mobile device. A new user must register by providing the required information, including her ID, name, password and other relevant information. Figure 2 shows a screenshot of this module. To access the system if the user is already registered, she must input her login information and proceed to login into the application. In order to send messages to five people to request assistance in an emergency, the user must register their contact information.

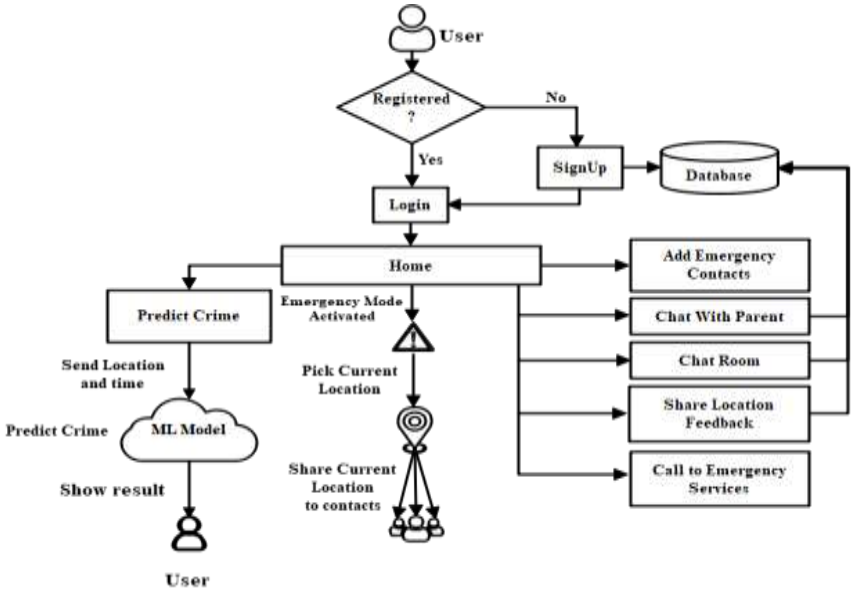

Figure 3.1: Proposed Model

B. Timer Scheduled SMS

Timer SMS is a function that enables users to schedule SMS requesting assistance or providing information to be sent to a specified number. Figure 3 shows a screenshot of this module. The user needs to pick a recipient number, and SMS will be sent. When a person is travelling to a location, she is unfamiliar with, this special feature is crucial.

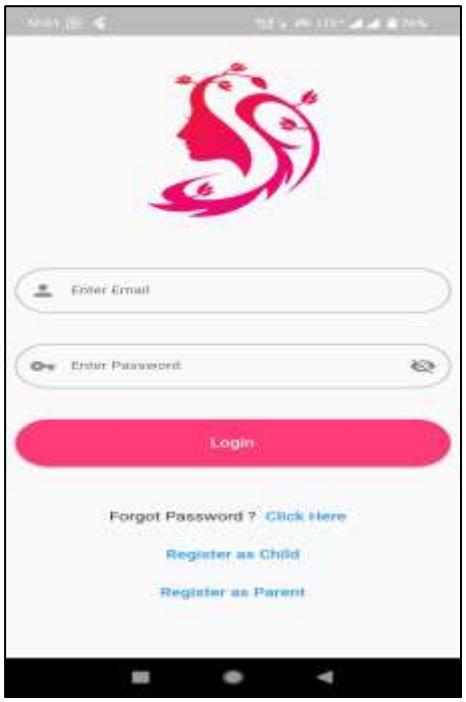

Figure.2: Login/Registration Module

Figure.3: Timer Scheduled SMS

Figure 4: Emergency Contacts

Figure 5: Chat Room

C. Emergency Contacts

Users can save emergency contacts from their contacts, saving search time when calling in an emergency. Users can save contacts of family and friends. It also has the ability to dial phone numbers directly. Figure 4 shows a screenshot of this module [15].

D. Chartroom

It is a social media like forum where ladies can talk about their problems and share their experience and tell the others to stop doing the same offences. There in the forum the users can talk about safe and unsafe areas and self-defense methods. Figure 5 shows a screenshot of this module [16].

E. Chat with parent

The app also provides option to the user to register as a parent to track the current location of the added child. So that the parent can receive instant information. The child will be provided an option to chat with the parent and share the live location with the parent. The parent can manage multiple child users in the application. Figure 6 shows a screenshot of this module.

F. Nearby Locations

With the help of this module the user can get the nearby location of various places like police station, pharmacies, hospitals and bus stops within a single tap on the screen. This could help the user to save time in case of hurry.

G. Crime Prediction Module

Whenever the user is passing through unknown area or city and she wants to be sure about her safety, the user can get information about that area/city. street and wants to ensure her safety. Figure 7 shows a screenshot of

this module.

Figure. 6: Chat with Parent

Figure 7: Crime Prediction

4. Algorithms AND Deta Set

This section presents machine learning algorithms and dataset used.

4.1 Machine Learning Algorithms used

A. Decision Trees

Decision trees are widely recognized as powerful and popular tools for classification and prediction. They adopt a tree-like structure where each central node represents an attribute test, branches correspond to tests, and leaves contain class labels. By analyzing the characteristics of a given dataset, decision trees make decisions or tests and provide solutions based on the situation at hand. The name "decision tree" stems from its resemblance to a tree, with branches spreading from the base to form a tree-like structure. The construction of the tree involves utilizing the CART algorithm (Classification and Regression Tree Algorithm). In essence, a decision tree poses a question, divides the tree into subtrees based on the answer (yes/no), and continues this process recursively.

B. Logistic Regression

Logistic regression uses independent variables to estimate the probability of an event and forecast categorical outcomes. It is a supervised learning approach that is frequently used for binary and multi-class classification tasks. Logistic regression converts the outcomes into probability scores by computing the outcome variable's log-odds and using a logistic function. It has uses in many different industries, including healthcare, finance, and social sciences.

C. Random Forest

Popular supervised learning method Random Forest can tackle classification and regression issues. It is a component of the ensemble learning strategy, which brings together various classifiers to address complicated problems and improve model performance. Each of the decision trees in Random Forest was trained using a distinct subset of the dataset. The total predictive accuracy is increased by averaging the forecasts from these trees. Random Forest uses majority voting among the predictions, as opposed to just one decision tree, to determine the outcome. Due to the greater number of trees in the forest, this method avoids overfitting and produces higher accuracy results.

D. K-Nearest Neighbour

A simple supervised machine learning algorithm which can be applied to classification or regression is the k-nearest neighbours (KNN) algorithm. It functions by storing all currently available cases and categorising new cases using a similarity metric (like distance functions, for example). A class can be assigned to an unlabelled case using KNN by a majority vote of its k nearest neighbors.

4.2 Dataset used

The crime data set of Indore city is taken from kaggle.com in csv format. The figure 8 shows some of the rows of the dataset. The attributes of the data set are Timestamp, Act379, Act13, Act279, Act323, Act363, Act302, Latitude, Longitude.

In data pre-processing step we dropped null values, added a crime column, and dropped different acts crime columns and the Timestamp decomposed into more features such as year, month, day, hour, dayofyear, week etc. Figure 9 shows some of the rows of the dataset after pre-processing.

	timestamp	act379	act13	act279	act323	act363	act302	latitude	longitude
0	28-02-2018 21:00	1	0	0	0	0	0	22.737260	75.875987
1	28-02-2018 21:15	1	0	0	0	0	0	22.720992	75.876083
2	28-02-2018 10:15	0	0	1	0	0	0	22.736676	75.883168
3	28-02-2018 10:15	0	0	1	0	0	0	22.746527	75.887139
4	28-02-2018 10:30	0	0	1	0	0	0	22.769531	75.888772

Figure 8: Indore Crime Dataset

	month	day	hour	dayofyear	week	weekofyear	dayofweek	weekday	quarter	latitude	longitude	crime
0	2	28	21	59	9	9	2	2	1	22.737260	75.875987	act379
1	2	28	21	59	9	9	2	2	1	22.720992	75.876083	act379
2	2	28	10	59	9	9	2	2	1	22.736676	75.883168	act279
3	2	28	10	59	9	9	2	2	1	22.746527	75.887139	act279
4	2	28	10	59	9	9	2	2	1	22.769531	75.888772	act279

Figure 9: Pre-processed dataset

Figure 10 is a graph showing the different types of crime as that are in dataset.

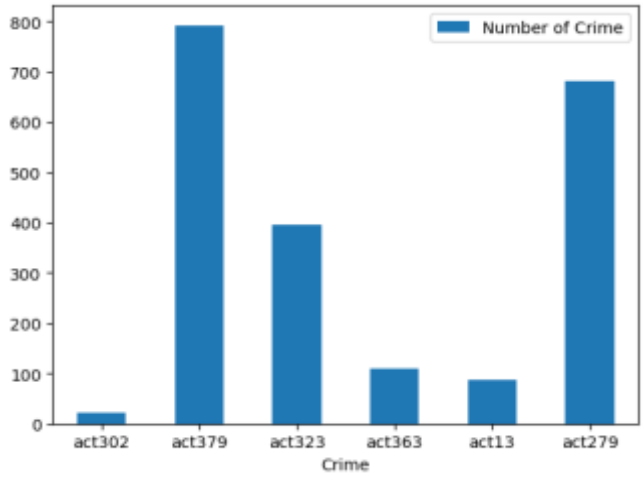

Figure 10: Different Classes in Dataset

5. Result and Discussion

We assessed the performance of our proposed model by calculating recall, F1 score, precision, and accuracy. Instances of True Positive, True Negative, False Positive, and False Negative are used to calculate the metrics.

True Positive (TP): When the model predicts a positive outcome correctly and the result turns out to be positive.

True Negative (TN): When the result is negative and the model correctly predicted a negative outcome.

False Positive (FP): when the model predicts an incorrectly positive result while the actual result is negative, this occurs.

False Negative (FN): This occurs when a result is truly positive but the model anticipates a negative outcome.

Accuracy: Accuracy is measured as the proportion of accurately predicted observations to all observations. It assesses the model's overall effectiveness in accurately predicting both positive and negative cases.

$$\textbf{Accuracy} = \frac{(\textbf{TN}+\textbf{TP})}{(\textbf{TN}+\textbf{TP}+\textbf{FN}+\textbf{FP})} \qquad (1)$$

Precision: The precision ratio is the ratio of correctly projected positive findings to all correctly anticipated positive findings. It counts the percentage of real positives that the model accurately predicted.

$$\text{Precision} = \frac{\text{TP}}{(\text{TP}+\text{FP})} \qquad (2)$$

Recall: It measures how many correctly predicted positive observations there are compared to all positive observations combined. Out of all the actual positive examples, it calculates the percentage of actual positives that the model properly detected.

$$\text{Recall} = \frac{\text{TP}}{(\text{TP}+\text{FN})} \qquad (3)$$

F1-Score: Harmonic median of recall and accuracy is known as the F1-Score. It provides a statistic with a single number that combines recall and precision.

$$\text{F1} - \text{Score} = \frac{2\text{TP}}{(2\text{TP}+\text{FP}+\text{FN})} \qquad (4)$$

To use our proposed application, the user has to register on the application and after successful registration and login into account, the user needs to add some emergency contacts into the application. If the user is in trouble, she can alert her contacts through the application. If user finds out that a location is unsafe, she can alert the

other users about it by sharing her experience through the chat room of the application. A machine learning model has been used to predict crime of a given location. User needs to input the location and time for predicting. The accuracy of different machine learning models is compared in below table 2.

Model	**Accuracy**
Decision Tree	83%
KNN	80%
Random Forest	83%
Logistic Regression	40%
SVM	67%

Table 2: Model Accuracy Comparison

For KNN, the graph of Error rate vs K value for choosing optimum value of K is given in figure 11.

Figure 11: Error rate vs K value

We can see from the graph that a K value of less than 20 is more suitable.

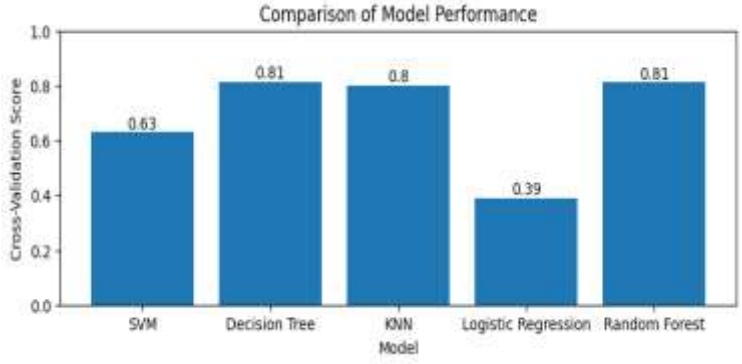

Figure 12: Comparison of Model Performance

The different cross validation score of the KNN, Decision tree, SVM, Logistic regression and random forest are visualized and compared in figure 12. Confusion matrices of different algorithms are given in figure 13.

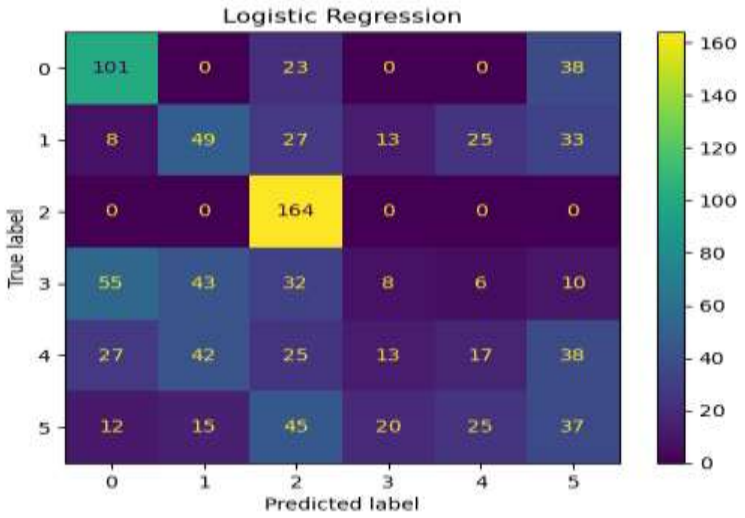

Figure 13 (a): Confusion Matrix (Logistic Regression)

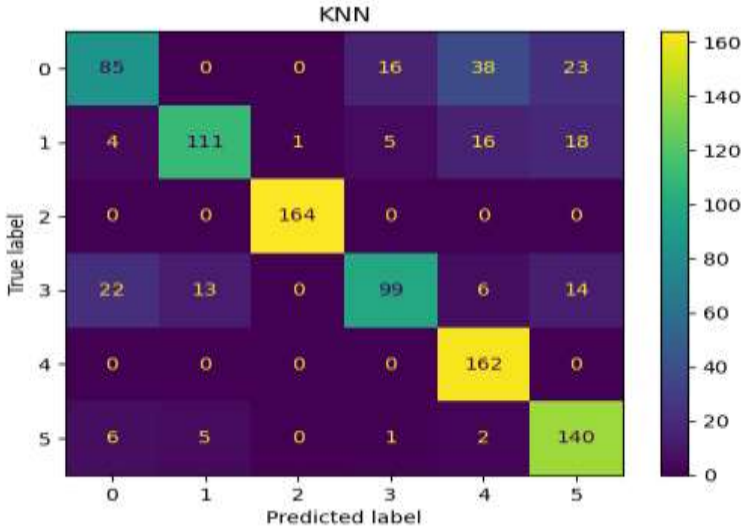

Figure 13 (b): Confusion Matrix (KNN)

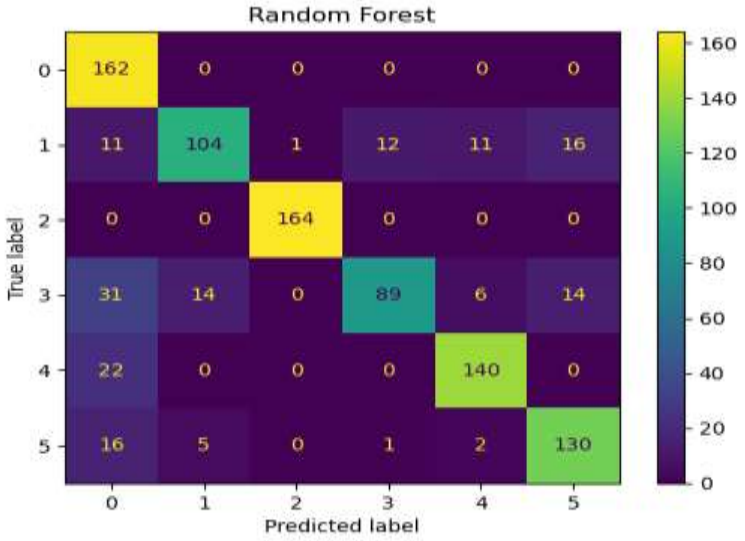

Figure 13 (c): Confusion Matrix (Random Forest)

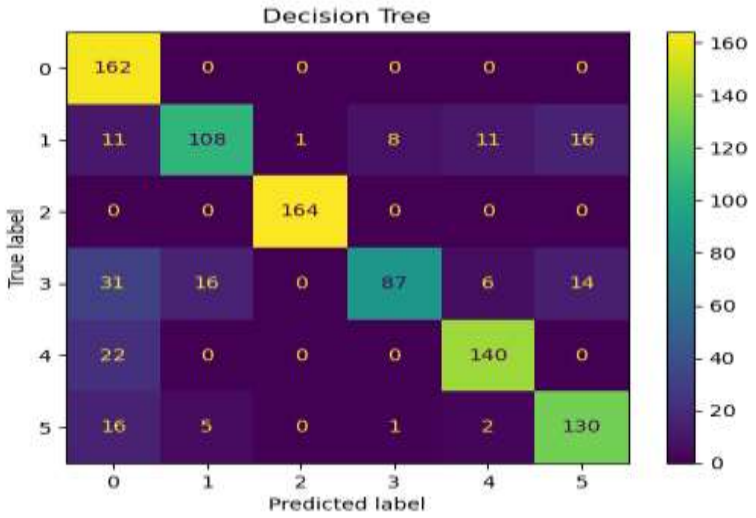

Figure 13 (d): Confusion Matrix (Decision Tree)

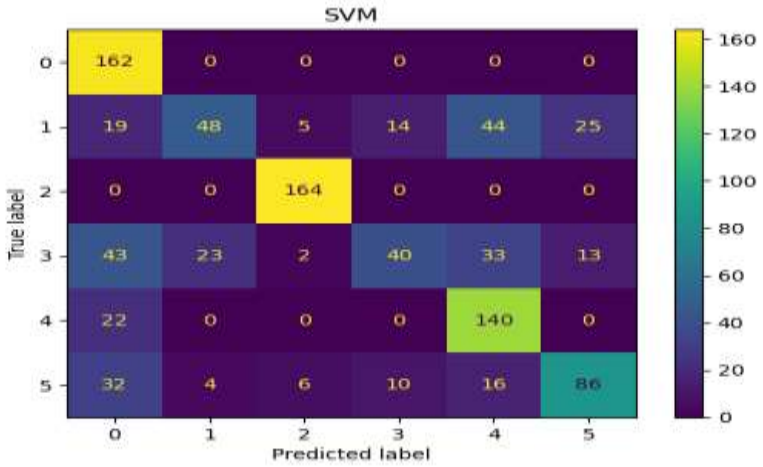

Figure 13 (e): Confusion Matrix (SVM)

Classification report of the algorithms for all the classes of crime in the dataset are compared and given in Tables 3-7.

Table 3: SVM Classification Report

S. No.	Precision	Recall	F1-Score	Support
0	0.58	1	0.74	162
1	0.64	0.31	0.42	155
2	0.93	1	0.96	164
3	0.62	0.26	0.37	154
4	0.6	0.86	0.71	162
5	0.69	0.56	0.62	154
Accuracy			0.67	951
Macro Avg.	0.68	0.67	0.64	951
Weighted Avg	0.68	0.67	0.64	951

Table 4: Decision Tree Classification Report:

S. No.	Precision	Recall	F1-Score	Support
0	0.67	1	0.8	162
1	0.84	0.7	0.76	155
2	0.99	1	1	164
3	0.87	0.56	0.7	154
4	0.88	0.86	0.87	162
5	0.81	0.84	0.83	154
Accuracy			0.83	951
Macro Avg.	0.85	0.83	0.83	951
Weighted Avg	0.85	0.83	0.83	951

Table 5: Random Forest Classification Report:

S. No.	Precision	Recall	F1-Score	Support
0	0.67	1	0.8	162
1	0.84	0.67	0.75	155
2	0.99	1	1	164
3	0.91	0.58	0.7	154
4	0.88	0.86	0.87	162
5	0.81	0.84	0.83	154
Accuracy			0.83	951
Macro Avg.	0.85	0.83	0.82	951
Weighted Avg	0.85	0.83	0.83	951

Table 6: KNN Classification Report:

S. No.	Precision	Recall	F1-Score	Support
0	0.73	0.52	0.61	162
1	0.86	0.72	0.78	155
2	0.99	1	1	164
3	0.82	0.64	0.72	154
4	0.72	1	0.84	162
5	0.72	0.91	0.8	154
Accuracy			0.8	951
Macro Avg.	0.81	0.8	0.79	951
Weighted Avg	0.81	0.8	0.79	951

Table 7: Logistic Regression Classification Report:

S. No.	Precision	Recall	F1-Score	Support
0	0.5	0.62	0.55	162
1	0.33	0.32	0.32	155
2	0.52	1	0.68	164
3	0.15	0.05	0.08	154
4	0.23	0.1	0.14	162
5	0.24	0.24	0.24	154
Accuracy			0.4	951
Macro Avg.	0.33	0.39	0.34	951
Weighted Avg	0.33	0.4	0.34	951

The learning for both the train and validation are compared in figure 12.

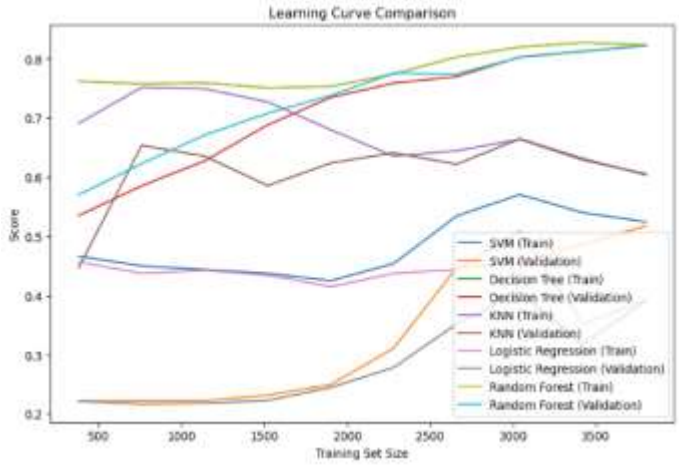

Figure 14: Learning Curve

After evaluating the performances of all these models, we selected random forest model for crime prediction purpose because it was giving a good overall performance. In the application the user can see location of nearby police station, bus stand, hospitals, and pharmacies on map through the application.

6. Conclusion And Future Work

Women's safety and protection are two of the major issues in this era of technology. This work has developed an innovative smartphone application that has the potential to provide protection from crime in terms of security and privacy for women. This application provides the feature of automatic emergency calls and SMS to the concerned government agencies in order to keep them informed. During the sending of the information to the central agencies, it has the potential to send information such as a live location. This application also provides facilities to connect with families, security agencies, and other concerns. Through this application, all those concerned personnel and departments can share their experiences, which can help further enhance the application. So, these concerned agencies provide quick support and help to the victims of the information gained from the application. This model can also predict the crime statistics of a particular area. Due to the continuous running of the application in the background, it quickly consumes battery power. This is one of the limitations of the proposed application that may be further addressed in our future work.

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