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Using Data Mining Technique to Predict Cause of Accident and Accident Prone Locations on Highways

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Abstract Road accident is a special case of trauma that constitutes a major cause of disability, untimely death and loss of loved ones as well as family bread winners. Therefore, predicting the likelihood of road accident on high ways with particular emphasis on Lagos – Ibadan express road, Nigeria in order to prevent accident is very important. Various attempts had been made to identify the cause(s) of accidents on highways using different techniques and system and to reduce accident on the roads but the rate of accident keep on increasing. In this study, the various techniques used to analyse the causes of accidents along this route and the effects of accidents were examined. A technique of using data mining tool to predict the likely occurrence of accident on highways, the likely cause of the accident and accident prone locations was proposed using Lagos –Ibadan highway as a case study. WEKA software was used to analyse accident data gathered along this road. The results showed that causes of accidents, specific time/condition that could trigger accident and accident prone areas could be effectively identified.

Keywords Data Mining, Decision Tree, Accident, WEKA, Data Modelling, Id3 Algorithm, Id3 Tree, Functional Tree Algorithm

1. Introduction

Road accident is a special case of trauma that constitutes a major cause of disability and untimely death. It has been estimated that over 300,000 persons die and 10 to 15 million persons are injured every year in road accidents throughout the world. Statistics have also shown that mortality in road accidents is very high among young adults that constitute the major part of the work force. In actual fact, accidents kill faster than AIDS and it gives no preparatory time to its victims. In order to combat this problem, various road safety strategies have been proposed and used. These methods mainly involve conscious planning, design and operations on roads. One important feature of this method is the identification and treatment of accident prone locations commonly called black spots; black spots are not the only cause of accidents on the highway. Also various organizations such as Police High Way Patrol, Vehicle Inspection Officer (VIO), Federal Road Safety Commission (FRSC) among others are charged with the responsibility of maintaining safety thereby reducing road accidents. However, lack of good forecasting techniques has been a major hindrance to these organizations in achieving their objectives.

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It is against this background that Decision Tree is being proposed to model data from road accident database to determine causes of accidents and accident prone locations using historical data collected from Ibadan-Lagos express road as reference point.

2. Objective

The primary objective of this research is to use data mining technique; decision tree to predict causes of accident and accident prone locations on highways using data collected on Lagos – Ibadan express way.

3. Methods

3.1. Data Mining

Data Mining is an interactive process of discovering valid and novel, useful and understandable patterns or models in large database (Han, Mannila and Smyth, 2001). Data Mining, according to Han, Mannila and Symth (2001) is a process that uses a variety of data analysis tools to discover patterns and relationships in data that may be used to make a valid prediction. Data mining uses advances in the field of Artificial Intelligence (AI) and Statistical techniques. Therefore, decision tree is being used in this research

3.2. Decision Trees

Decision Trees have emerged as a powerful technique for modelling general input / output relationships. They are tree – shaped structures that represents a series of roles that lead to sets of decisions. They generate rules for the classification of a dataset and a logical model represented as a binary (two – way split) tree that shows how the value of a target variable can be predicted by using the values of a set predictor variables. Decision trees, which are considered in a regression analysis problem, are called regression trees. Thus, the decision tree represents a logic model of regularities of the researched phenomenon.

3.3. Accidents along Lagos - Ibadan Express Way

Lagos to Ibadan Express road is one of the busiest roads in Africa. This is because. Lagos was the capital of Nigeria until the seat of government moved to the Federal Capital Territory Abuja and also the headquarters of many national institutions while Ibadan is said to be the largest city in black Africa. The traffic along this route is very heavy because it is a gateway linkage of the heavy traffic going from the Northern, Eastern and Majority of Western states. Fig 3.1 shows the frequency of accidents between the distances of 1 and 40km from Ibadan to Lagos between January 2002 and December 2003.The statistics shows that having a means of predicting likely location of accident base on some input values is essential to advice on dangerous locations.

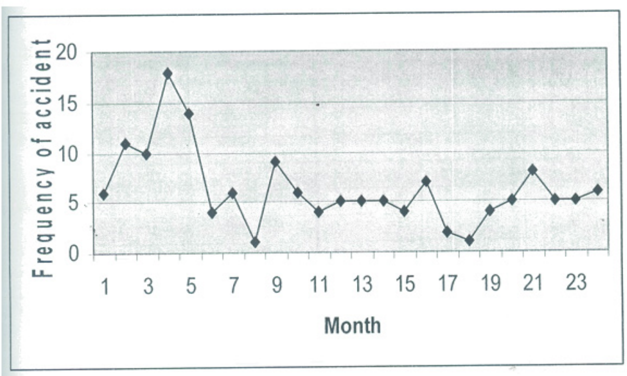

Figure 3.1. Graph of Frequency of Accidents against Month

Several works have been carried out by different researchers both on road accident analysis and forecasting, using Decision Tree and Artificial Neural Networks. Martin, Grandal and Pilkey (2000), analysed the relationship between road infrastructure and safety by using a cross-sectional time-series data base collected for all 50 U.S. states over 14 years. The result suggested that as highway facilities are upgraded, there are reduced fatalities. Gelfand (1991) studied the effect of new pavement on traffic safety in Sweden. The result of his study shows that Traffic accidents increased by 12 % after one year of resurfacing on all types of roads. Akomolafe (2004) employed Artificial Neural Network using multilayer perceptron to predict likelihood of accident happening at particular location between the first 40 kilometers along Lagos-Ibadan Express road and discovered that location 2 recorded the highest number of road accident occurrence and that, tyre burst was the major cause of accident along the route. Ossenbruggen (2005) used a logistic regression model to identify statistically significant factors that predict the probabilities of crashes and injury crashes aiming at using these models to perform a risk assessment of a given region. Their study illustrated that village sites are less hazardous than residential and shopping sites. Abdalla et al (1987) studied the relationship between casualty frequencies and the distance of the accidents from the zones of residence. As might have been anticipated, the casualty frequencies were higher nearer to the zones of residence, possibly due to higher exposure. Akomolafe et al (2009) used geo spatial technology to identify various positions along major roads in Nigeria. The study revealed that the casualty rates amongst residents from areas classified as relatively deprived were significantly higher than those from relatively affluent areas.

Table 3.1. Record of Accidents along Lagos Ibadan between year 2002 and 2003

S/NO	Month	No of Accident
1	Jan 2002	6
2	Feb 2002	11
3	March 2002	10
4	April 2002	18
5	May 2002	14
6	June 2002	4
7	July 2002	6
8	August 2002	1
9	September 2002	9
10	October 2002	6
11	Nov. 2002	4
12	December 2002	5
13	Jan 2002	5
14	Feb 2003	5
15	March 2003	4
16	April 2003	7
17	May 2003	2
18	June 2003	1
19	July 2003	4
20	August 2003	5
21	September 2003	8
22	October 2003	5
23	Nov. 2003	5
24	December 2003	6

3.4. Process of Data Mining

The process of data mining consists of three steps which are:

3.4.1. Data Preparation

This includes; Data collection, Data cleaning and Data transformation.

3.4.2. Data Modeling

This research considers the data of accident record between the first 40km from Ibadan to Lagos. The data were organized into a relational database.

The unknown causes in Table 3.2 may include other factors such as Law enforcement agent problems, attitude of other road users, inadequate traffic road signs, traffic congestion and general vehicle conditions

The sample data used covered the period of 24 Months, that is, January 2002 to December 2003 as indicated in Fig. 3.1.

The output variable is the location and the locations can be divided into three distinct regions tagged regions A, B and C, meaning we have three outputs. Where

First location 1 – 10km is Region A or location 1, Above10km – 20km is region B or Location 2 and above 20km is region C or Location 3

The data sample used covered a period of twenty four Months starting from January 2002 to December 2003.The data were collected by Akomolafe (2004) and this is presented in Table.3.3.

3.4.3. Deployment

In this stage, new sets are applied to the model selected in the previous stage to generate predictions or estimates of the expected outcome.

Table 3.2. showing variables given both continuous and categorical values

S/N	Variable	Description	Value	Type
1.	Vehicle Type	Small cars Heavy Vehicle	1 2	categorical categorical
2.	Time of the day	Morning Afternoon Evening Night / Midnight	1 2 3 4	Categorical Categorical Categorical Categorical
3.	Season	Wet Dry	1 2	Categorical Categorical
4.	Causes	Wrong Overtaking Careless Driving Loss of Control Tyre Bust Over Speeding Obstruction Pushed by another vehicle Broken Shaft Broken Spring Brake Failure Road problem Unknown Causes Robbery Attack	A B C D E F G H I J K L M	Categorical Categorical Categorical Categorical Categorical Categorical Categorical Categorical Categorical Categorical Categorical Categorical Categorical

Table 3.3. Sample Data collected from FRSC (Akomolafe O.P 2004)

SNO	DATE	TYPE	TIME	SEASON	CAUSE	LOCATION	REG. NO
1	6.1.2002	2	2	1	2	31	XG 506 LND
2	7.1.2002	2	1	1	1	14	XC 720 ACD
3	11.1.2002	1	1	1	1	14	AM 713 LND
4	12.1.2002	2	1	1	2	27	XE 905 JJJ
5	19.1.2002	1	2	1	3	27	AA 559 LAF
6	30.01.02	3	3	1	2	12	AA 156 NWD
7	03.02.02	2	2	1	2	35	XF 635 JJJ
8	05.02.02	2	1	1	2	10	XE 141 AKD
9	05.02.02	2	3	1	2	14	XE 124 AKD
10	06.02.02	2	3	1	2	31	XE 124 AKD
11	11.02.02	1	1	1	3	5	AG 276 LAR
12	14.02.02	1	1	1	2	14	
13	18.02.02	1	2	1	2	18	
14	21.02.02	2	1	1	2	19	XD 249 SMK
15	21.02.02	3	2	1	2	19	XC 361 KTU
16	24.02.02	2	1	1	2	18	XE 716 SMK
17	27.02.02	2	3	1	2	35	XC 307 SGM
18	03.03.02	2	1	1	2	16	XE 807 NSR
19	05.03.02	1	2	1	2	10	XC 348 AKP
20	07.03.02	2	1	1	2	2	OY 2270 JB
21	07.03.02	1	1	1	2	13	AP 820 LSD
22	07.03.02	3	2	1	2	18	XE 322 APP
23	19.03.02	2	2	1	2	19	XC 993 AGL

24	19.03.02		3	1	2	2	LA 1804 RF
25	30.03.02	1	4	1	2	14	AM 343 FST
26	31.03.02	1	2	1	2	14	KC 461 ABA
27	31.03.02	1	2	1	2	14	BS 142 KJA
28	01.04.02	2	1	2	2	22	AA 807 EGB
29	01.04.02	1	1	2	2	22	BX 527 GGE
30	01.04.02	2	2	2	2	18	AG 787 GNN
31	02.04.02	1	1	2	1	7	AU 725 MAP
32	02.04.02	2	2	2	2	27	XG 358 APP
33	04.04.02	1	1	2	2	15	CY 65 EKY
34	04.04.02	1	2	2	2	17	AJ 21 AGG
35	05.04.02	1	2	2	1	6	AW 45 FST
36	06.04.02	2	1	2	2	30	XB 855 AKD
37	07.04.02	1	2	2	1	13	AL 567 YAB
38	09.04.02	2	2	2	2	12.5	XA 787 WWP
39	13.04.02	2	1	2	1	1	XB 791 GNN
40	13.04.02	2	1	2	1	11	XA 127 AFN
41	13.04.02	1,2	1	2	1	11	AH 202 AKN
42	22.04.02	1	2	2	1	15	RA 01 KRD
43	22.04.02	1,3	2	2	1	11	BB 731 KJA
44	27.04.02	2	2	2	2	27	AU 739 JJJ
45	28.04.02	1	2	2	1	14	AE 316 FST
46	03.04.02	1	3	2	2,1	12	AZ 824 AAA
47	5.8.2002	1	1	2	2	20	AA 654 GBY
48	5.8.2002	1	1	2	2	30	XF 65 JJJ
49	5.10.2002	2&1	1	2	1	35	DM 207 AAA
				2			BL 86 AAA
50	5.10.2002	1	1	2	1&2	35	BR 608 LSR
51	5.11.2002	3	1	2	2	26	XB 606 APP
52	5.13.2002	2	1	2	1	2	XA 616 YLW
53	5.13.2002	1	1	2	1	26.5	BM 566 GGE
54	5.14.2002	2	3	2	2	15	XC 348 AKD
55	5.15.2002	1	2	2	2	19	OY 2077 JB
56	5.15.2002	1	2	2	2	14	AJ 101 NND
57	5.20.2002	1		2	2	26	AU 682 ABC
58	5.21.2002	2		2	2	24	XG 719 FST
59	5.25.2002	1	1	2	2	12	AV 70 LSR
60	6.2.2002		3	2	1	12	AZ 191 MUS
61	6.3.2002	2	2	2	2	16	AQ 742 YYY
62	6.15.2002	2	1	2	2	12	XA 682 YRE
63	6.16.2002	1	1	2	2	21	AL 885 AKN
64	6.16.2002	2	1	2	2	21	XE 751 SMK
65	7.15.2002	2	1	2	3	12	XH 649 GGE
66	7.20.2002	2	2	2	2	10	XB 286 KNR
67	8.8.2002	3	2	2	2	12	XE 232 SGM
68	9.19.2002	1	3	2	2	22	XA 940 KNH
69	9.20.2002	2	1	2	2	4	AX 94 JJJ
70	9.20.2002	3	2	2	2	7	XC 768 BDJ
71	9.21.2002	1	1	2	1	29	BL 254 SMK
72	9.21.2002	2	1	2	1	16	AP 647 AKR
73	9.21.2002	2		2	2	18	XC 253 GGE
74	9.22.2002	2	1	2	2	10	LA 979 BG
75	9.22.2002	2	3	2	2	16	XU 510 GGE
76	9.27.2002		2	2	2	12	
77	10.1.2002	1	2	2	1	6	AA 05 MHA
78	10.14.2002	2	1	2	2	13	XE 869 MUS
79	10.16.2002	2	2	2	2	15	XB 888 AKR
80	10.29.2002		2	2	2	7	
81	10.29.2002	2	2	2	2	17	XD 168 BDJ
82	10.29.2002	3	1	2	2	6	AA 342 LES
83	11.4.2002	2	1	1	1	5	BX 877 KJA
84	11.10.2002	2	1	1	2	12	XC 637 RKJ
85	11.10.2002	2	2	1	2	11	XC 937 SGM
86	11.12.2002	1		1		12	AA 466 KNR

87	2.12.2004	2	1	1	2	14	XG 182 JJJ
88	12.7.2002	3	2	1	2	1	XA 425 CRC
89	12.10.2002	2	3	1	3	13	XD 695 EKY
90	12.11.2002	2	2	1	2	16	XA 350 EDY
91	12.12.2002		1	1	2	14	XG 955 KSF
92	23.01.2002	1	3	1	1	16	XA 411 EJG
93	18.01.03	1	3	1	1	18	AE 015 GBN
94	27.01.03	2	2	1	2	8	XD 125 LSR
95	29.01.03	3	4	1	2	12	XC 616 KTU
96	29.01.03	2		1	2	14	XF 797 AKD
97	02.02.03	2	1	1	2	18	CW 293 AAA
98	12.02.03	1	2	1	1	18	AV 3 GGE
99	12.02.03	2	2	1	2	18	XB 6 WWD
100	12.02.03	1	3	1	1	12	HB 40 KJA
101	17.02.03	2	3	1	2	11	XB 446 MNY
102	05.03.03	1	2	1	2	6	AE 753 KRE
103	19.03.03	2	1	1	2	12	XH 382 ABC
104	28.03.03	3		1	1	12	AG 145 NRK
105	31.03.03	2	3	1	2	13	AA 499 GBY
106	05.04.03	2	2	2	3	11.5	XD 432 KSF
107	06.04.031	1	1	2	3	12	CE 188 JJJ
108	06.04.03	2	1	2	2	12	FA 01 JJ
109	14.04.03	1	1	2		28	FV 43 AAA
110	24.04.03	1	2	2	2	7	OY 01 SE
111	24.04.03	3	2	2	2	9	XB 328 MAG
112	30.04.03	3	3	2	1	16	XD 644 NRK
113	10.05.03		1	2		40	AA 399 KTU
114	16.05.03	1	3	2	2	20	XH 327 ADC
115	02.06.03	1	1	2	1	8	XB 144 YRE
116	20.07.03	2	1	2	2	27	5K 324 LND
117	26.07.03	1	2	2	2	9	DG 329 LSR
118	28.07.03	2	2	2	2	13	XJ 179 LND
119	28.07.03	2	2	2	1	18	XF 114 EPE
120	02.08.03	1	1	2	2	13	CB 434 MUS
121	02.08.03	1	1	2	1	8	XG 954 FST
122	09.08.03	1	1	2	1	19	AG 802 SGB
123	16.08.03	2	2	2	2	2	XF 450 SMK
124	31.08.03	1	1	2	1	14	OY 1281 TD
125	01.09.03	3	2	2	1	8	XA 362 KJA
126	08.09.03	1		2		18	XH 723 JJJ
127	14.09.03			2		19	
128	16.09.03	1	2	2	2	6	AA 112 YRE
129	21.09.03	2	1	2	2	31	XB 766 AGG
130	24.09.03	2	2	2	1	18	XC 115 EDE
131	28.09.03	2	1	2	2	14	XN 739 AAA
132	28.09.03	2	3	2	2	13	XD 642 NRK
133	06.10.03	1	2	2	2	11	DG 548 LND
134	14.10.03	2	2	2	2	12	XA 730 FUF
135	18.10.03	2	3	2	2	28	XA 286 GBH
136	19.10.03		1	2	2	22	AA 188 AAA
137	20.10.03	2	2	2	2	27	LG 016 KNE
138	01.11.03	3	1	1	1	9	XA 847 KEH
139	02.11.03	2	2	1	2	18	XC 575 GGE
140	25.11.03	1	1	1	3	24	BO 984 APP
141	27.11.03	1	1	1	2	18	AJ 06 SGB
142	27.11.03	2	2	1	2	13	XB 369 EKY
143	06.12.03	2	1	1	2	13	AP 938 KJA
144	09.12.03	3	3	1	1	13	BM 130 MAP
145	13.12.03	2	1	1	1	7	XA 610 ARP
146	22.12.03	1	1	1	1	11	BL 500 GGE
147	24.12.03		1	1	3	12	JB 356 KJA
148	24.12.03	2	2	1	2	13	XG 562 AKD

4. Results

4.1. Analysis

The major step required to obtain result of the research was carried out by analysing the data using WEKA. WEKA is a collection of machine learning algorithms and data processing tools. It contains various tools for data pre-processing, classification, regression, clustering, association rules and visualization. There are many learning algorithms implemented in WEKA including Bayesian classifier, Trees, Rules, Functions, Lazy classifiers and miscellaneous classifiers. The algorithms can be applied directly to a data set. WEKA is also data mining software developed in JAVA it has a GUI chooser from which any one of the four major WEKA applications can be selected. For the purpose of this study, the Explorer application was used.

The Explorer window of WEKA has six tabs. The first tab is pre- process that enables the formatted data to be loaded into WEKA environment. Once the data has been loaded, the preprocess panel shows a variety of information as shown in figure 4.3 below.

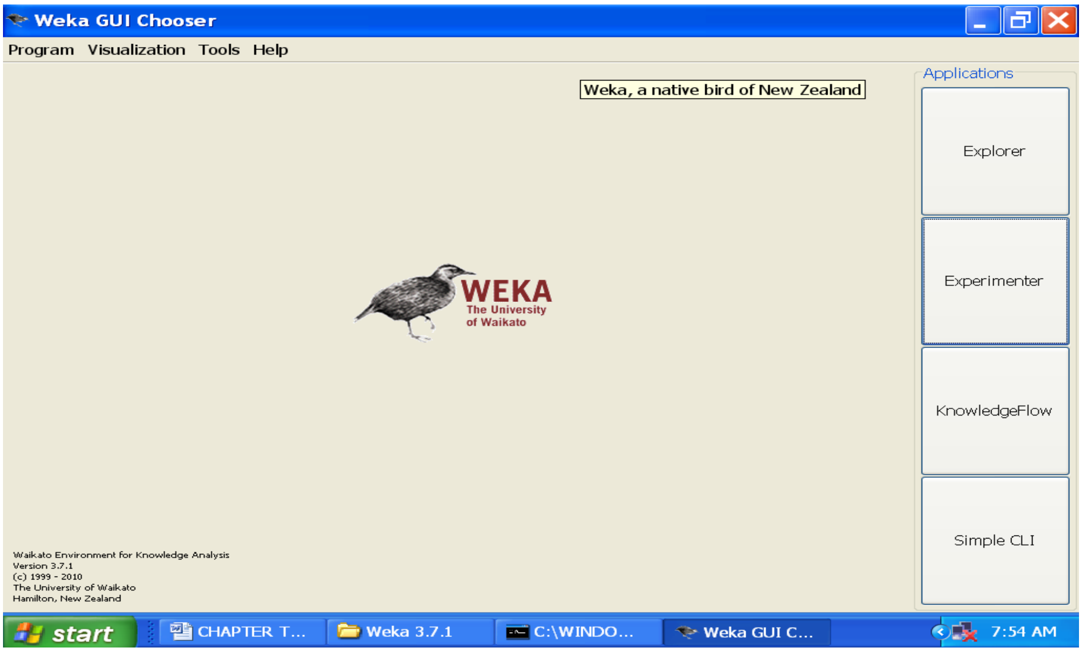

Figure 4.1. WEKA GUI chooser

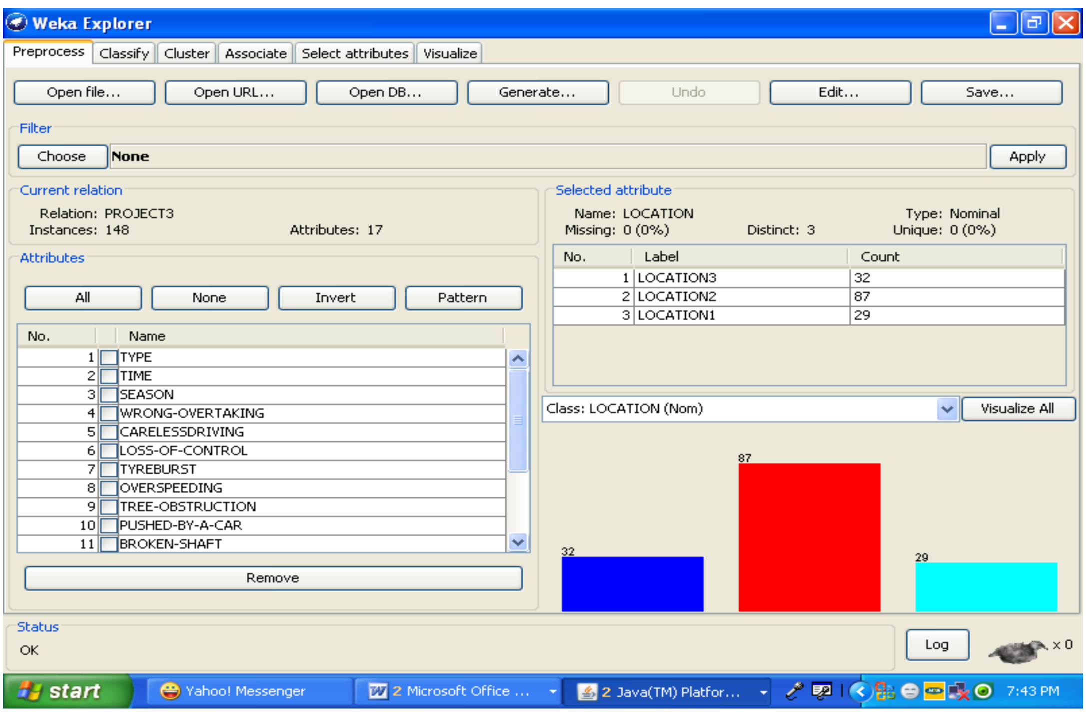

Figure 4.2. WEKA Explorer

4.1. Weka Classifiers

There are several classifiers available in WEKA but Function Tree and Id3 were used in this study in case of Decision Tree. Prism Rule based learner was generated using WEKA. Attribute importance analysis was carried out to rank the attribute by significance using information gain. Finally, correlation based feature subset selection (cfs) and consistency subset selection (COE) filter algorithm were used to rank and select the attribute that are most useful. The F- measure and the AUC which are well known measures of probability tree learning was used as evaluation metrics for model generated by WEKA classifiers.

Several numbers of setups of decision tree algorithms have been experimented and the best result obtained is reported as the data set. Each class was trained with entropy of fit measure, the prior class probabilities parameter was set to equal, the stopping option for pruning was misclassification error, the minimum n per node was set to 5, the fraction of objects was 0.05, the maximum number of nodes was 100, surrogates was 5, 10 fold cross-validation was used, and generated comprehensive results.

The best decision tree result was obtained with Id3 with 115 correctly classified instances and 33 incorrectly classified instances which represents 77.70% and 22.29% respectively.

Mean absolute error was 0.1835 and Root mean squared error was 0.3029.

The tree and rules generated with Id3 algorithm are given thus:

4.2. Id3 Tree

```
TYREBURST = TRUE
|  SEASON = WET
|  |  TYPE = HAEVY VEHICLE
|  |  |  TIME = EVENING: LOCATION2
|  |  |  TIME = AFTERNOON: LOCATION2
|  |  |  TIME = MORNING: LOCATION2
|  |  |  TIME = NIGHT: null
|  |  TYPE = SMALL CAR: LOCATION2
|  |  TYPE = MOTOCYCLE: null
|  SEASON = DRY
|  |  TIME = EVENING
|  |  |  TYPE = HAEVY VEHICLE: LOCATION2
|  |  |  TYPE = SMALL CAR: LOCATION3
|  |  |  TYPE = MOTOCYCLE: null
|  |  TIME = AFTERNOON
|  |  |  TYPE = HAEVY VEHICLE: LOCATION2
|  |  |  TYPE = SMALL CAR: LOCATION2
|  |  |  TYPE = MOTOCYCLE: null
|  |  TIME = MORNING
|  |  |  TYPE = HAEVY VEHICLE: LOCATION3
|  |  |  TYPE = SMALL CAR: LOCATION3
|  |  |  TYPE = MOTOCYCLE: null
|  |  TIME = NIGHT: null
TYREBURST = FALSE
|  TIME = EVENING
|  |  OVERSPEEDING = FALSE: LOCATION2
|  |  OVERSPEEDING = TRUE
|  |  |  TYPE = HAEVY VEHICLE: LOCATION2
|  |  |  TYPE = SMALL CAR: LOCATION2
|  |  |  TYPE = MOTOCYCLE: null
|  TIME = AFTERNOON
|  |  LOSS-OF-CONTROL = FALSE
|  |  |  OVERSPEEDING = FALSE
|  |  |  |  BRAKE-FAILURE = FALSE
|  |  |  |  |  TYPE = HAEVY VEHICLE
|  |  |  |  |  |  WRONG-OVERTAKING = FALSE
|  |  |  |  |  |  |  BROKEN-SHAFT = FALSE: LOCATION1
|  |  |  |  |  |  |  BROKEN-SHAFT = TRUE: LOCATION3
|  |  |  |  |  |  WRONG-OVERTAKING = TRUE: LOCATION2
|  |  |  |  |  TYPE = SMALL CAR
|  |  |  |  |  |  SEASON = WET: LOCATION3
|  |  |  |  |  |  SEASON = DRY
|  |  |  |  |  |  |  CARELESSDRIVING = FALSE: LOCATION3
|  |  |  |  |  |  |  CARELESSDRIVING = TRUE: LOCATION2
|  |  |  |  |  TYPE = MOTOCYCLE: LOCATION3
|  |  |  |  BRAKE-FAILURE = TRUE
|  |  |  |  |  TYPE = HAEVY VEHICLE: LOCATION1
|  |  |  |  |  TYPE = SMALL CAR: LOCATION1
|  |  |  |  |  TYPE = MOTOCYCLE: LOCATION2
|  |  |  OVERSPEEDING = TRUE
|  |  |  |  TYPE = HAEVY VEHICLE: LOCATION2
|  |  |  |  TYPE = SMALL CAR
|  |  |  |  |  SEASON = WET: LOCATION2
|  |  |  |  |  SEASON = DRY: LOCATION2
|  |  |  |  TYPE = MOTOCYCLE: null
|  |  LOSS-OF-CONTROL = TRUE
|  |  |  TYPE = HAEVY VEHICLE: LOCATION2
|  |  |  TYPE = SMALL CAR
|  |  |  |  SEASON = WET: LOCATION2
|  |  |  |  SEASON = DRY: LOCATION1
|  |  |  TYPE = MOTOCYCLE: LOCATION1
|  TIME = MORNING
|  |  SEASON = WET
|  |  |  OVERSPEEDING = FALSE
|  |  |  |  TYPE = HAEVY VEHICLE
|  |  |  |  |  WRONG-OVERTAKING = FALSE
|  |  |  |  |  |  CARELESSDRIVING = FALSE: LOCATION1
|  |  |  |  |  |  CARELESSDRIVING = TRUE: LOCATION2
|  |  |  |  |  WRONG-OVERTAKING = TRUE: LOCATION1
|  |  |  |  TYPE = SMALL CAR
|  |  |  |  |  CARELESSDRIVING = FALSE
|  |  |  |  |  |  LOSS-OF-CONTROL = FALSE: LOCATION3
|  |  |  |  |  |  LOSS-OF-CONTROL = TRUE: LOCA-
```

TION2
| | | | | CARELESSDRIVING = TRUE: LOCATION1
| | | | TYPE = MOTOCYCLE: LOCATION2
| | | OVERSPEEDING = TRUE: LOCATION2
| | SEASON = DRY
| | | BROKEN-SHAFT = FALSE
| | | | TYPE = HAEVY VEHICLE
| | | | | CARELESSDRIVING = FALSE
| | | | | | LOSS-OF-CONTROL = FALSE
| | | | | | | BROKEN-SPRING = FALSE
| | | | | | | | OVERSPEEDING = FALSE: LOCATION2
| | | | | | | | OVERSPEEDING = TRUE: LOCATION2
| | | | | | | BROKEN-SPRING = TRUE: LOCATION2
| | | | | | LOSS-OF-CONTROL = TRUE: LOCATION2
| | | | | CARELESSDRIVING = TRUE: LOCATION3
| | | | TYPE = SMALL CAR
| | | | | CARELESSDRIVING = FALSE
| | | | | | OVERSPEEDING = FALSE
| | | | | | | UNKNOWN-CAUSES = FALSE
| | | | | | | | ROBBERY-ATTACK = FALSE
| | | | | | | | | WRONG-OVERTAKING = FALSE
| | | | | | | | | | LOSS-OF-CONTROL = FALSE
| | | | | | | | | | | TREE-OBSTRUCTION = FALSE
| | | | | | | | | | | | BRAKE-FAILURE = FALSE: LOCATION3
| | | | | | | | | | | | BRAKE-FAILURE = TRUE: LOCATION2
| | | | | | | | | | | TREE-OBSTRUCTION = TRUE: LOCATION2
| | | | | | | | | | LOSS-OF-CONTROL = TRUE: LOCATION2
| | | | | | | | | WRONG-OVERTAKING = TRUE: LOCATION2
| | | | | | | | ROBBERY-ATTACK = TRUE: LOCATION3
| | | | | | | UNKNOWN-CAUSES = TRUE: LOCATION3
| | | | | | OVERSPEEDING = TRUE: LOCATION3
| | | | | CARELESSDRIVING = TRUE: LOCATION1
| | | | TYPE = MOTOCYCLE: null
| | | BROKEN-SHAFT = TRUE: LOCATION3
| TIME = NIGHT: LOCATION2

Prism rules

Rule 1 If BROKEN-SHAFT = TRUE then LOCATION3

Rule 2 If ROBBERY-ATTACK = TRUE
and TYPE = SMALL CAR then LOCATION3

Rule 3 If TREE-OBSTRUCTION = TRUE
and TIME = EVENING then LOCATION3

Rule 4 If TYREBURST = TRUE
and TIME = MORNING
and TYPE = SMALL CAR
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 5 If TYPE = MOTOCYCLE
and CARELESSDRIVING = TRUE then LOCATION3

Rule 6 If ROAD-PROBLEM = TRUE
and TYPE = SMALL CAR
and TIME = AFTERNOON
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and TYREBURST = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 7 If TYREBURST = TRUE
and SEASON = DRY
and TIME = MORNING
and TYPE = HAEVY VEHICLE
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 8 If UNKNOWN-CAUSES = TRUE

and TYPE = SMALL CAR
and TIME = MORNING
and SEASON = DRY then LOCATION3

Rule 9 If TYREBURST = TRUE
and TYPE = HAEVY VEHICLE
and TIME = AFTERNOON
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 10 If TIME = MORNING
and OVERSPEEDING = TRUE
and TYPE = SMALL CAR
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and TYREBURST = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 11 If TYREBURST = TRUE
and TIME = EVENING
and TYPE = SMALL CAR then LOCATION3

Rule 12 If TYREBURST = TRUE
and TYPE = HAEVY VEHICLE
and TIME = AFTERNOON
and SEASON = WET
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 13 If TIME = MORNING
and LOSS-OF-CONTROL = TRUE
and TYPE = HAEVY VEHICLE
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and TYREBURST = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 14 If UNKNOWN-CAUSES = TRUE
and TYPE = SMALL CAR
and TIME = MORNING
and SEASON = WET
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and TYREBURST = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 15 If TYREBURST = TRUE
and TYPE = HAEVY VEHICLE
and SEASON = WET
and TIME = EVENING
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 16 If TIME = MORNING
and TYREBURST = TRUE
and TYPE = HAEVY VEHICLE
and SEASON = WET
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE

and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION3

Rule 17 If CARELESSDRIVING = TRUE
and TYPE = HAEVY VEHICLE
and SEASON = DRY then LOCATION3

Rule 18 If TIME = MORNING
and TYPE = SMALL CAR
and SEASON = DRY
and CARELESSDRIVING = FALSE
and WRONG-OVERTAKING = FALSE
and LOSS-OF-CONTROL = FALSE
and TREE-OBSTRUCTION = FALSE
and BRAKE-FAILURE = FALSE then LOCATION3

Rule 19 If TIME = NIGHT then LOCATION2

Rule 20 If WRONG-OVERTAKING = TRUE
and TYPE = SMALL CAR then LOCATION2

Rule 21 If TIME = EVENING
and CARELESSDRIVING = TRUE then LOCATION2

Rule 22 If TIME = EVENING
and UNKNOWN-CAUSES = TRUE then LOCATION2

Rule 23 If TIME = EVENING
and LOSS-OF-CONTROL = TRUE then LOCATION2

Rule 24 If TIME = EVENING
and ROBBERY-ATTACK = TRUE then LOCATION2

Rule 25 If TIME = EVENING
and TYPE = HAEVY VEHICLE
and SEASON = DRY then LOCATION2

Rule 26 If SEASON = WET
and TYPE = MOTOCYCLE then LOCATION2

Rule 27 If SEASON = WET
and OVERSPEEDING = TRUE
and TIME = MORNING then LOCATION2

Rule 28 If TYREBURST = TRUE
and SEASON = WET
and TYPE = SMALL CAR then LOCATION2

Rule 29 If TYREBURST = TRUE
and SEASON = WET
and TIME = MORNING
and TYPE = HAEVY VEHICLE
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 30 If TYPE = HAEVY VEHICLE
and ROBBERY-ATTACK = TRUE then LOCATION2

Rule 31 If TYPE = HAEVY VEHICLE
and OVERSPEEDING = TRUE
and TIME = AFTERNOON then LOCATION2

Rule 32 If TYREBURST = TRUE
and SEASON = WET
and TIME = EVENING
and TYPE = HAEVY VEHICLE
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 33 If TYREBURST = TRUE
and SEASON = WET
and TYPE = HAEVY VEHICLE
and TIME = AFTERNOON
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 34 If TYPE = HAEVY VEHICLE
and TIME = EVENING then LOCATION2

Rule 35 If TYPE = HAEVY VEHICLE
and OVERSPEEDING = TRUE
and TIME = MORNING
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and TYREBURST = FALSE

and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 36 If TYREBURST = TRUE
and TIME = AFTERNOON
and TYPE = SMALL CAR
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 37 If BRAKE-FAILURE = TRUE
and TYPE = MOTOCYCLE then LOCATION2

Rule 38 If WRONG-OVERTAKING = TRUE
and TIME = AFTERNOON then LOCATION2

Rule 39 If TREE-OBSTRUCTION = TRUE
and TIME = MORNING then LOCATION2

Rule 40 If BROKEN-SPRING = TRUE
and TYPE = HAEVY VEHICLE
and TIME = MORNING
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and TYREBURST = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 41 If TYPE = HAEVY VEHICLE
and TYREBURST = TRUE
and TIME = AFTERNOON
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 42 If LOSS-OF-CONTROL = TRUE
and TIME = MORNING
and TYPE = SMALL CAR then LOCATION2

Rule 43 If UNKNOWN-CAUSES = TRUE
and TYPE = HAEVY VEHICLE
and SEASON = DRY then LOCATION2

Rule 44 If OVERSPEEDING = TRUE
and TIME = AFTERNOON
and SEASON = WET then LOCATION2

Rule 45 If TYPE = HAEVY VEHICLE
and LOSS-OF-CONTROL = TRUE
and TIME = MORNING
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and TYREBURST = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 46 If SEASON = WET
and LOSS-OF-CONTROL = TRUE
and TIME = AFTERNOON
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and TYREBURST = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE
and TYPE = HAEVY VEHICLE then LOCATION2

Rule 47 If CARELESSDRIVING = TRUE
and TIME = AFTERNOON
and TYPE = SMALL CAR then LOCATION2

Rule 48 If OVERSPEEDING = TRUE
and TIME = AFTERNOON
and TYPE = SMALL CAR

and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and TYREBURST = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 49 If SEASON = WET
and TIME = EVENING
and TYPE = SMALL CAR
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and LOSS-OF-CONTROL = FALSE
and TYREBURST = FALSE
and OVERSPEEDING = TRUE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

Rule 50 If TYPE = HEAVY VEHICLE
and LOSS-OF-CONTROL = TRUE
and TIME = AFTERNOON
and SEASON = DRY
and WRONG-OVERTAKING = FALSE
and CARELESSDRIVING = FALSE
and TYREBURST = FALSE
and OVERSPEEDING = FALSE
and TREE-OBSTRUCTION = FALSE
and PUSHED-BY-A-CAR = FALSE
and BROKEN-SHAFT = FALSE
and BROKEN-SPRING = FALSE
and BRAKE-FAILURE = FALSE
and ROAD-PROBLEM = FALSE
and UNKNOWN-CAUSES = FALSE
and ROBBERY-ATTACK = FALSE then LOCATION2

5. Discussion

There are 50 rules generated from this tree. Rule 1- 18 indicate the occurrence of accident in Location 3 and rule 19-50 also shows the occurrence of accident in location 2.This indicate that, location 2 has the highest number of road accident occurrence with Heavy-vehicle in the afternoon and during the dry season.

Rule 41 is the best one that can be used for prediction. The rule says that, Tyre bust is the cause of road accident with heavy vehicle within location 2 in the day time and during the dry season.

Decision Tree Performance Analysis on Id3

Table 5.1. Detailed Accuracy By class

Class	TP rate	FT rate	Precision	Recall	F- measure	Roc Area
Location (3)	0.688	0.069	0.733	0.688	0.71	0.942
Location (2)	0.897	0.361	0.78	0.897	0.834	0.888
Location (1)	0.517	0.025	0.833	0.517	0.638	0.95
Weighted Avg.	0.777	0.232	0.78	0.777	0.769	0.912

Table 5.2. Confusion matrix Predicted category

Actual category	Location (3)	Location (2)	Location (1)
Location (3)	22	10	0
Location (2)	6	78	3
Location (1)	2	12	15

Decision Tree performance Analysis on FunctionTree (FT)

Table 5.3. Detailed Accuracy by Class

Class	TP rate	FT rate	Precision	Recall	F- measure	Roc Area
Location (3)	0.625	0.086	0.667	0.625	0.645	0.869
Location (2)	0.77	0.361	0.753	0.77	0.761	0.736
Location (1)	0.586	0.101	0.586	0.586	0.586	0.832
Weighted Avg.	0.703	0.25	0.702	0.703	0.702	0.783

Table 5.4. Confusion Matrix Predicted category

Actual category	Location (3)	Location (2)	Location (1)
Location (3)	20	12	0
Location (2)	8	67	12
Location (1)	2	10	17

6. Conclusions

Using WEKA software to analyze accident data collected on Lagos-Ibadan road, it was found that decision tree can accurately predict the cause(s) of accident and accident prone locations along the road and other roads if relevant data are gathered and analyzed as in this case.

In Decision Tree Performance analysis, the, dataset were experimented with two algorithms; Id3 and FT (function tree) For Id3 algorithm, there were 115 correctly classified instances and 33 incorrectly classified instances which represent 77.70% and 22.29% respectively. Mean absolute error was 0.1835 and Root mean squared error was 0.3029.

Also for functional tree algorithm (FT), total number of tree size was 5 with 105 correctly classified instances representing 70.27% and 44 incorrectly classified instances representing 29.73%.

From the detailed accuracy by class and confusion matrix, Id3 attained accuracy rate of 0.777 and FT attained accuracy rate of 0.703.

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