Enhancing Road Traffic Safety in-Kenya using Artificial Neural Networks

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Abstract

The world loses a human live in every 24 second due to Road Traffic Accidents (RTAs). In Kenya approximately 3000 lives are lost annually due to RTAs. The interventions to improve road traffic safety (RTS) failed because they were not informed by any scientific research. In this paper we employed the multi-layer feed forward perceptron neural network model to classify the road traffic safety status (RTSS) as:-excellent, fair, poor or danger states which model?s output are. We considered the vehicle internal factors that contribute to RTAs as model?s inputs which included:-inside-vehicle-condition, entertainment, safety-awareness, passager?s (attention, criminal-history, health-history, movement inside vehicle, body posture, frequency of journey, drunkenness?, drug-influence, use-of-mobile-phone and load), luggage-type and the safetybelt.

Index terms— traffic, safety, neural-network, policy, model, MSE.

1 Introduction

ccording to ((K.N.B.S), 2017) road traffic accident statistical abstracts,3000 persons die while approximately 14,000 persons are injured annually due to RTAs. The vehicles involved on RTAs are approximately 9,000. The levels of disability caused by RTAs are on rise. Economically Kenya incurs a loss of approximately US$50 million annually according to (Mutune Peter Kasau, Prof. Eng. G. N. Mang'uriu, Dr.

Stephen Diang'a, 2017), due to RTAs. in all PSV's and commercial vehicles whose weight limit should not exceed the 3,048 kilograms, speed limit of 80 kilometers per hour, fitting of seat belts on all vehicles, employment of drivers and conductors on permanent basis, indication of route details and painting of a yellow band on Matatus (a passenger Vehicle) for purposes of easy identification, re-testing of drivers after every two years and approval of all driver's identification by the police and also ban on night travelling. It also launched a six-month Road Safety Campaign in 2003 and declared war on corruption, which contributes and indirectly to the country's unacceptably high levels of RTAs. These policies failed to deliver the expected results which compelled the government to resort to intermitted crackdown on the public service vehicles in an attempt to reduce the RTAs. The crackdown increased the level of corruption which led to increased RTAs. The traffic act was amended to introduce the safety belt and blood alcohol level laws. The aim was to enhance the safety of passengers and ensure the drivers were always sober while driving. The inspection of road vehicles was also introduced. The government enacted the National Transport Safety Authority (NTSA) Act in 2012.The NTSA was mandated to ensure the safety of the roads was enhanced and managed well. This was to be achieved through registration road vehicles, licensing of drivers, testing the drivers, regulating the driving schools and also conducting research on road safety to provide the advice to the government on the RTS policies and also implementing of road safety policies. Under the NTSA people are still losing lives, the properties destroyed due to RTAs. This is attributed to the implementations of policies which are not informed by a scientific research.

An accurately classification of RTSS of inside the vehicle conditions using the artificial neural network can ultimately enhance the RTS and prevent the loss of human lives. By knowing the current safety state of vehicle, the necessary precautions can then be taken in advance to prevent an occurrence of RTA. According to (Maja Urosevic,2018), the trained neural network is an expert in the category of information it has been given to analyze, this expert can then be used to classify the RTSS of vehicle dynamically and give alerts in real time averting an impending occurrence of RTA in case of poor or danger safety state of vehicle. According to (Antonio Celesti, Antonino Galletta, Lorenzo Carnevale, Maria Fazio, Aime Lay-Ekuakille and Massimo Villar), Year 2 019( ) D

Enhancing Road Traffic Safety in-Kenya using Artificial Neural Networks modern vehicles have inbuilt sensors, control devices and micro-controller chips. By leveraging this emerging technologies in automobile industry compounded by the artificial neural network as the expert while sensors as input devices and control devices as RTS regulator, the RTA can be reduced.

In this study we applied a multi-layer perceptron feed-forward trained neural network with forty three selected input variables to model and to classify RTSS outcomes to determine the safety state of vehicle to inform the RTS vehicular policies and decisions in Kenya. The purpose of this study was to examine patterns of vehicular accidents, design and develop a neural network model and evaluate the model performance on classifying RTSS.

2 II.

3 Materials/Tools

Materials used in study were data, statistical programming software i.e. R, database management system i.e. Oracle Database, Neural Network Framework i.e. Neuroph Studio.

4 a) Data Requirements

In this research data was collected from RTAs Reports from NTSA daily and fatal reports and KNBS statistical abstracts. This data is readily available in websites. The categorical data was collected from experts in RTSA which included:-traffic police, NTSA, drivers, St John's ambulance and the public via guided questionnaires. We primarily considered the factors that contributed to RTAs as models inputs and RTS status as model's output as shown in This was due to their easy to handle aspect by the riders making them ideal for busy towns to ease traffic congestion.

5 The Neural Network Model for Enhancing Road Traffic Safety

In this research we utilized a multi-layer neural network with one hidden layer of neurons. After preprocessing of classical data, there were 43 model inputs and 4 model outputs. The classical data was converted into binary number format as shown in Table 1 in

6 Evaluation of Neural Network Architectures

The training data set was divided into 70% training, 15% testing and 15% validation to facilitate neural network model development, experimentation and performance assessment. The results of Evaluation of various neural network architectures are shown in Table **??** in the appendices. The best neural network architecture was Backpropagation, Momentum 0.7, Maximum error 0.01, learning rate 0.5, number of epochs 1, had a MSE 000166.The Resilient Backpropagation and Dynamic Backpropagation were not able to learn. The overall classification accuracy for the best model was 76.0%, it had the precision of 1.0, and the recall of 0.7666666666666667 as shown in Fig 8.

7 Conclusion

In this research we employed a multi-layer feedforward neural network with backpropagation learning rule to classify the Road Traffic Safety Status of Vehicle based on vehicle internal factors that contributed to RTAs. The model was trained, tested, and validated using 20,000data samples compiled from categorical data collected from experts in RTSA which included:traffic police, NTSA, drivers, St John's ambulance and the public via guided questionnaires. Forty three input variables consist of categorical data elements including: inside-vehicle-condition, entertainment, safetyawareness, passager's (attention, criminal-history, health-history, movement-inside-vehicle, body-posture, frequency-of-journey, drunkenness', drug-influence, use-of-mobile-phone and load), luggage-type and the safety-belt. These inputs and the multi-layer neural network model were used to classify road traffic safety state as: excellent, fair, poor or danger state. The multilayer perceptron feed forward neural network model with one hidden layer of fifteen neurons, variable learning rate of backpropagation, momentum value of 0.7, learning rate of 0.5 and weighted summation and sigmoid hidden activation functions achieved the best performance.

The Resilient Backpropagation and Dynamic Backpropagation were not able to learn.

Classification accuracy in most model architectures exceeded 74%. This model may be used to inform Road Traffic Safety policies and decisions. Model can be adopted in emerging vehicle automation technologies such as sensors, control devices, and micro controller chips as a safety measure hence saving loss of human lives on roads.

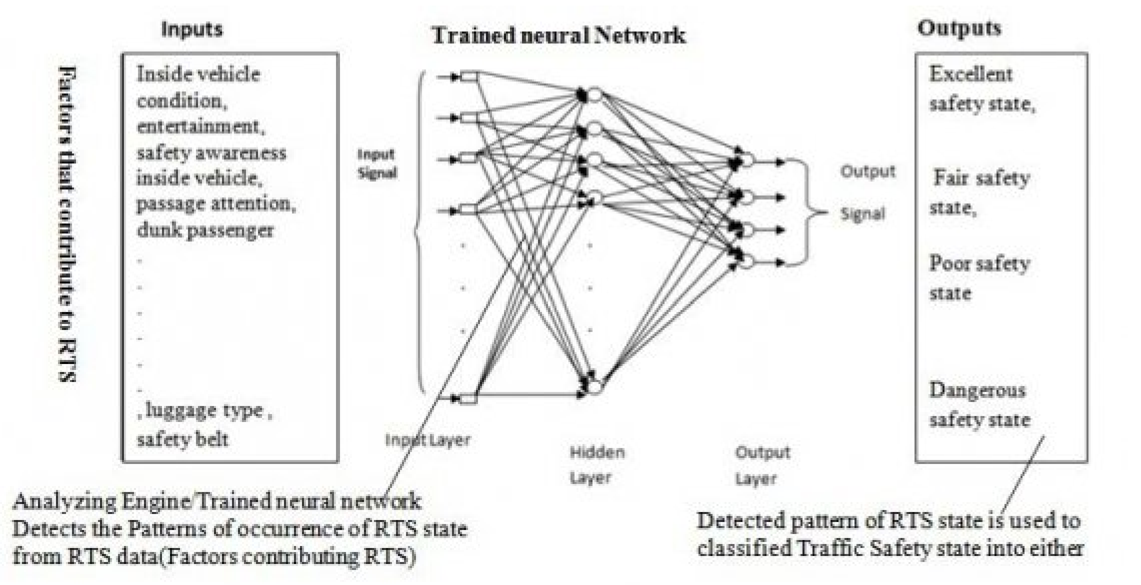

Figure 1:

1

Figure 2: Fig. 1 :

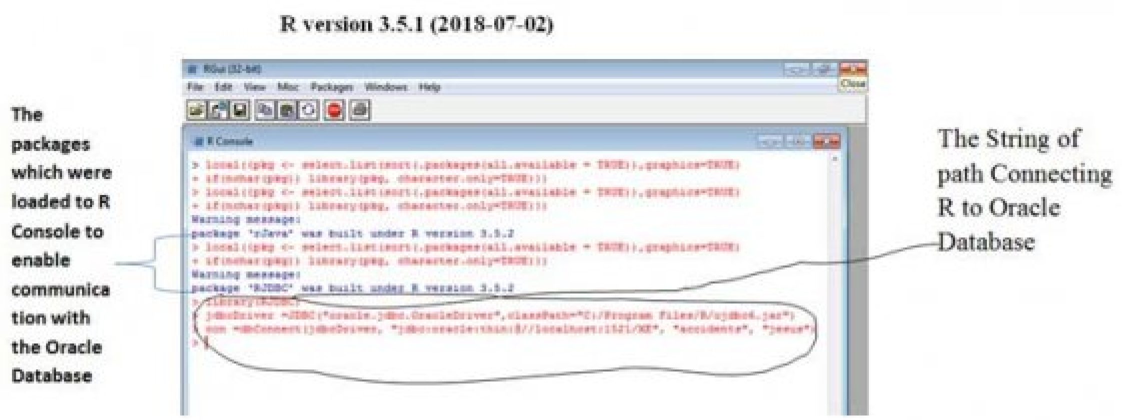

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Figure 3: Fig. 2 :

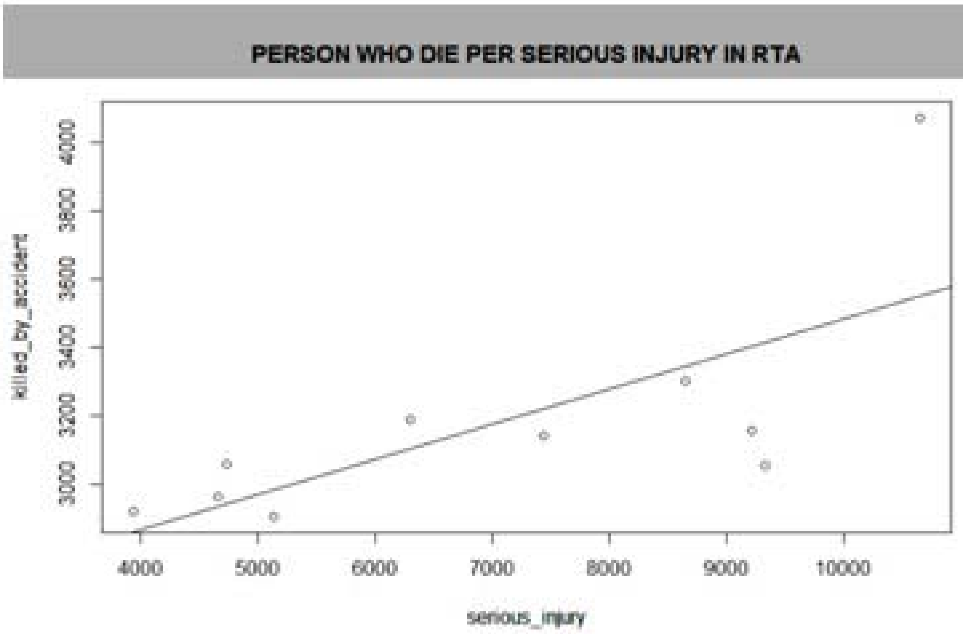

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Figure 4: Fig. 3 :

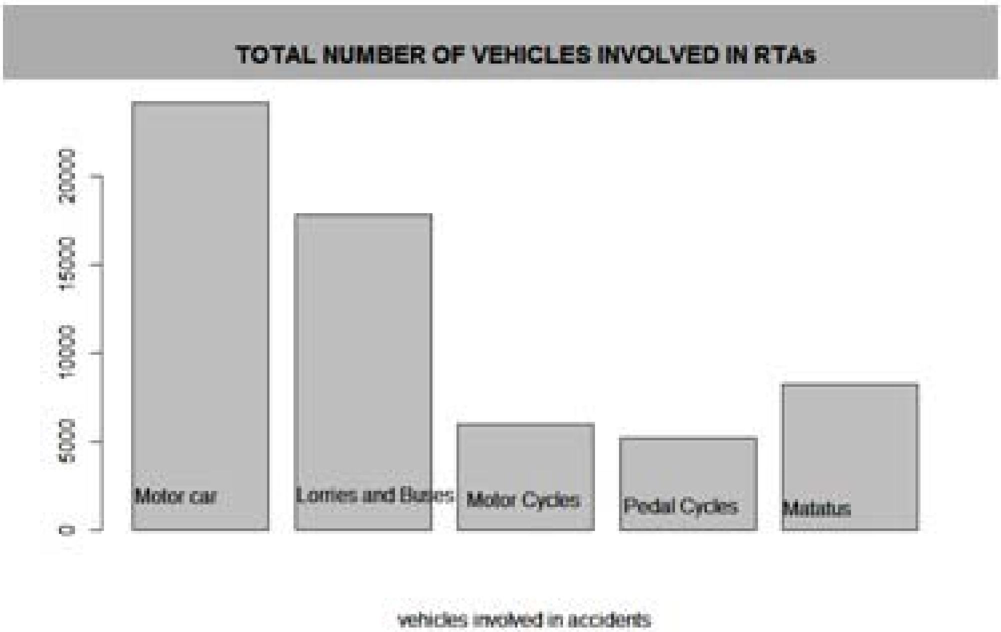

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Figure 5: Fig. 4 :

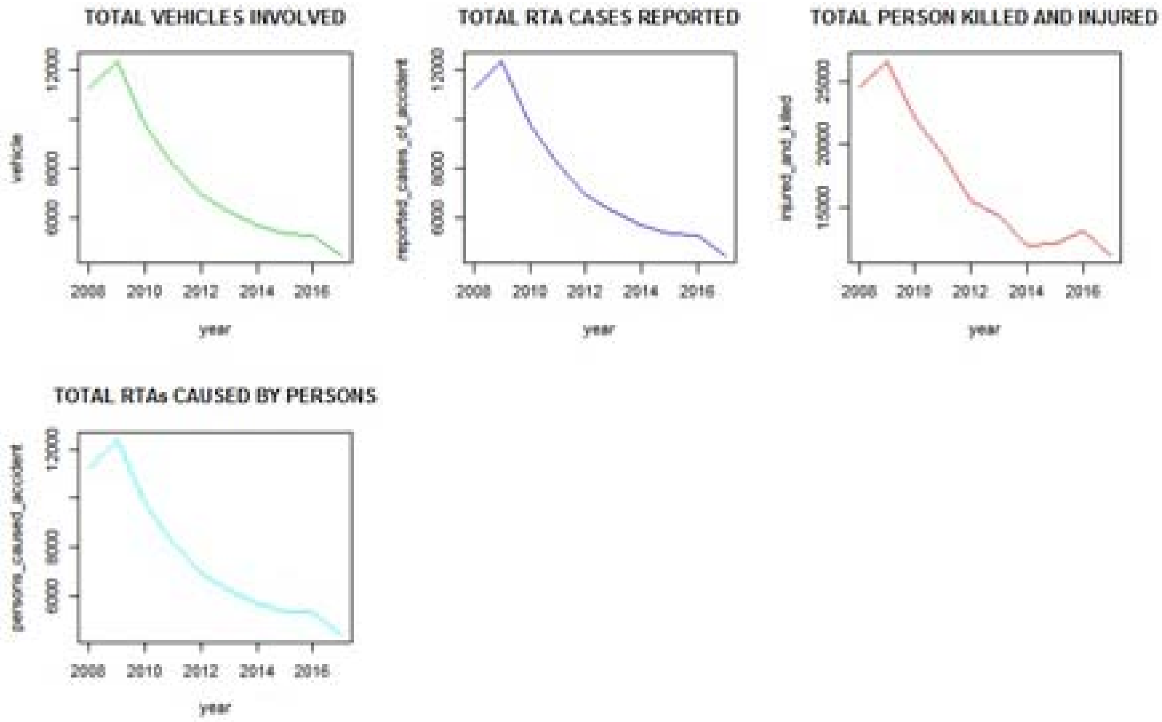

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Figure 6: Fig. 5 :

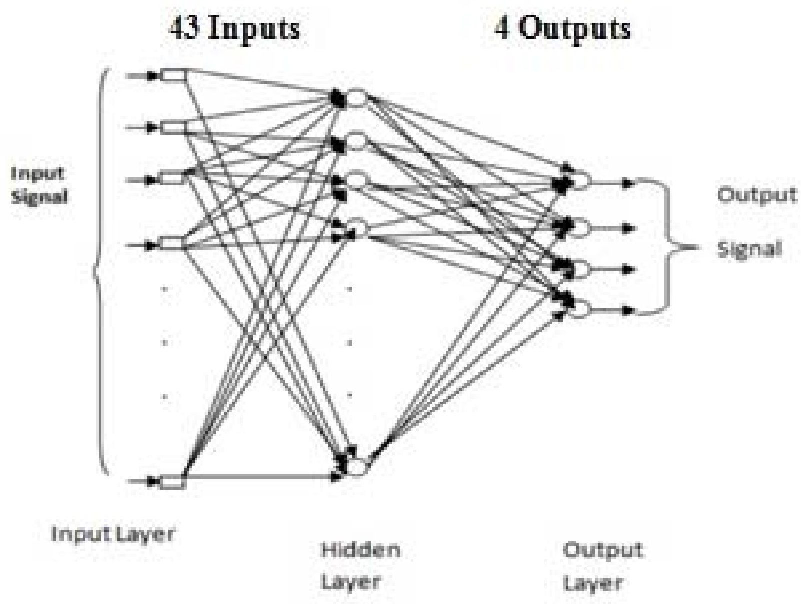

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Figure 7: Fig. 6 :

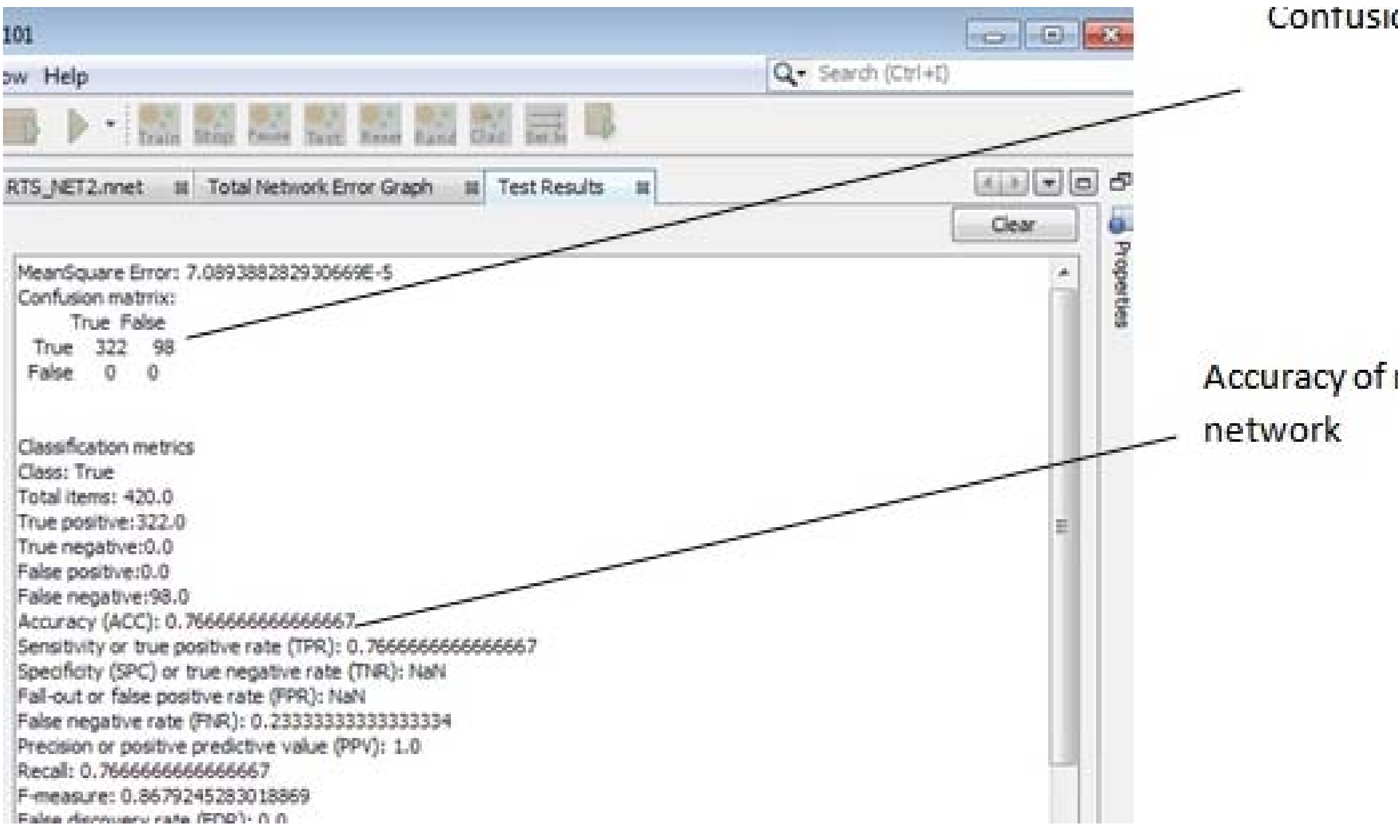

Figure 8:

8 Appendices

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[1] ( ) D © 2019 Global Journals Enhancing Road Traffic Safety in-Kenya using Artificial Neural Networks

1

No.	Variable	Description	Data Type	Location	Code
1	Inside vehicle condition	Inside vehicle condition	categorical input	Worse 1 0 0 0 Poor Fair Good	0 1 0 0 0 0 1 0 0 0 0 1
2	Entertainment	Entertainment	categorical input	Low High Excess high 0 0 1	1 0 0 0 1 0
3	Safety awareness	Safety awareness inside vehicle	categorical input	Lack Few Many	1 0 0 0 1 0 0 0 1
4	Passenger attention	Passenger attention	categorical input	Sleeping 1 0 0 Dozing Alert	0 1 0 0 0 1
5	Criminal history	Criminal history of passenger	categorical input	law breaker ever broken law law abiding	1 0 0 0 1 0 0 0 1
6	Passenger health history	Passenger health history	CategoricalInput	no health issue have health issue	1 0 0 1
7	Movement inside vehicle	Movement inside vehicle	categorical input	Minimal movement Much movement Excessive r	
8	Body posture	Body posture	categorical input	Improper sitting position 1 0 Proper sitting 0 1	
9	Frequency of passenger journey				

Figure 9: Table 1 :

[(K N B] (K N B . http://www.knbs.or.ke1 *2017 'Road traffic Accidents*, (2018' Road traffic injuries)

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