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
According 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'uru, 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© 2019 Global Journals
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, safety-awareness, passenger’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:

Analyzing Engine Trained neural network
Detects the Patterns of occurrence of RTS state from RTS data (Factors contributing RTS)

Detected pattern of RTS state is used to classified Traffic Safety state into either

Figure 2: Fig. 1:

Oracle database 11g Express Edition with RTAs Data from N.T.S.A Daily Fatal Reports

The prefix NTS from NTS_TRAFFIC_ACCIDENT show it’s a table of RTA Data uploaded into oracle database from M5 Excel Reports of NTSA Daily fatal reports

Figure 3: Fig. 2:

R version 3.5.1 (2018-07-02)

The String of path Connecting R to Oracle Database

The packages which were loaded to R

Console to enable communication with the Oracle Database
Figure 4: Fig. 3:

Figure 5: Fig. 4:
Figure 6: Fig. 5 :

Figure 7: Fig. 6 :
Figure 8:

Appendices
<table>
<thead>
<tr>
<th>No.</th>
<th>Variable Description</th>
<th>Data Type</th>
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<th>Code</th>
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<td></td>
<td></td>
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<td>Excess high</td>
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<td>Lack Few</td>
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<td></td>
<td>Many</td>
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<td>0 0 1</td>
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<td></td>
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<td>Alert</td>
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<td>Criminal history of law breaker</td>
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<td>Frequency of passenger journey</td>
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</tbody>
</table>

Figure 9: Table 1:


Lesinski et al. () Application of an Artificial neural Network to predict Graduation Success at the United States military Academy, Gene Lesinski, Steven Corns, Cihan Dagli. 2016.


Urosevic () Lenses Classification using Neural Networks, Maja Urosevic. 2018.