Behavior of Driver Attitude towards Roads using Fuzzy Relational Maps

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Abstract: *Driving safely is a primary issue in all developing countries around the world. It alarms towards driver's attitude and behavior changes towards road safety. The main objective of this paper is to correlate on causes and effects between psychological and human factors that makes destruction on road safety was illustrated using fuzzy relational maps. The paper was constituted into four section with basic definition of fuzzy relational maps, description of study, adaptation of problem to FRM, and conclusion and suggestion based on study.*

I. Introduction

Fuzzy relational mappings are constructed analogous to FCMs. In FCMs correlations between causal associations among concurrently active units are promoted. But in FRMs the very causal associations are divided into two disjoint units. Thus a domain space and a range space which are disjoint in the sense of concepts are needed to define an FRM.

The elements of the domain space are taken from the real vector space of dimension n and that of the range space are real vectors from the vector space of dimension m (m in general need not be equal to n). D denotes the nodes D_1, D_2, …, D_n of the domain space where D = $\{(x_1,\ldots, x_n) / x_j = 0 \text{ or } 1\}$ for i = 1, 2,…, n. If $x_i = 1$ it means that the node D_i is in the on state and if $x_i = 0$ it means that the node D_i is in the off state. We denote by R the set of nodes $R_1,\ldots, R_m$ of the range space, where R = $\{(x_1,\ldots, x_m) / x_j = 0 \text{ or } 1\}$ for j = 1, 2, …, m. If $x_i = 1$, it means that the node R_i is in the on state and if $x_i = 0$ it means that the node R_i is in the off state.

Definition 1:

A FRM is a directed graph ora map from domain space D to range space R with concepts like policies or events etc., as nodes and causalities as edges. It represents causal relations between spaces D and R. Let D_i and R_j denote that the two nodes of an FRM. The directed edge from D_i to R_j denotes the causality of D_i on R_j called relations. Every edge in the FRM is weighted with a number in the set {0, ±1}. Let e_{ij} be the weight of the edge D_iR_j, $e_{ij} \in \{0, \pm1\}$. The weight of the edge D_i R_j is positive if increase in D_i implies increase in R_j or decrease in D_i implies decrease in R_j i.e., causality of D_i on R_j is 1. If $e_{ij} = 0$, then D_i does not have any effect on R_j . We do not discuss the cases when increase in D_i implies decrease in R_j or decrease in D_i implies increase in R_j .

Definition 2:

When the nodes of the FRMare fuzzy sets then they are called fuzzy nodes. FRMs with edge weights {0, ±1} are called simple FRMs.

Definition 3:

Let D_1, …, $D_n$be the nodes ofthe domain space D of an FRM and R_1, …, R_m be the nodes of the range space R of an FRM. Let the matrix E be defined as E = (e_{ij}) where e_{ij} is the weight of the directed edge D_iR_j (or R_jD_i), E is called the relational matrix of the FRM.

Definition 4:

Let D_1, ..., $D_n$and $R_1,\ldots, R_m$denote the nodes of the FRM. Let A = $(a_1,\ldots,a_n)$, $a_i \in \{0, 1\}$. A is called the instantaneous state vector of the domain space and it denotes the on-off position of the nodes at any instant. Similarly let B = $(b_1,\ldots, b_m)$, $b_i \in \{0, 1\}$. B is called instantaneous state vector of the range space and it denotes the on-off position of the nodes at any instant $a_i = 0$ if a_i is off and $a_i = 1$ if a_i is on for i= 1, 2,…, n Similarly, $b_i = 0$ if b_i is off and $b_i = 1$ if b_i is on, for i= 1, 2,…, m.

Definition 5:

Let $D_1, \ldots, D_n$and $R_1,\ldots, R_m$be the nodes of an FRM. Let D_iR_j (or $R_j D_i$) be the edges of an FRM, j = 1, 2,…, m and i= 1, 2,…, n. Let the edges form a directed cycle. An FRM is said to be a cycle if it possess a directed cycle. An FRM is said to be acyclic if it does not possess any directed cycle.

Definition 6:

An FRM with cycles is saidto be an FRM with feedback.

Definition 7:

If the FRM settles down witha state vector repeating in the form $A_1 \rightarrow A_2 \rightarrow A_3 \rightarrow \ldots \rightarrow A_i \rightarrow A_1$ (or $B_1 \rightarrow B_2 \rightarrow \ldots.\rightarrow B_i \rightarrow B_1$) then this equilibrium is called a limit cycle.

I.1 Method of determining the Hidden pattern

Let $R_1, R_2, \ldots, R_m$ and $D_1, D_2, \ldots, D_n$ be the nodes of a FRM with feedback. Let E be the relational matrix. Let us find a hidden pattern when D_1 is switched on i.e. when an input is given as vector $A_1 = (1, 0, \ldots, 0)$ in D_1, the data should pass through the relational matrix E. This is done by multiplying A_1 with the relational matrix E. Let $A_1E = (r_1, r_2, \ldots, r_m)$, after thresholding and updating the resultant vector we get $A_1 E \in R$. Now let $B = A_1 E$ we pass on B into E^T and obtain BE^T. We update and threshold the vector BE^T, so that $BE^T \in D$. This procedure is repeated till we get a limit cycle or a fixed point.

II. Description of the Study

The road crashes are caused by poor human behavior and that the causes are dominated by intentional errors only, such as violations and traffic offences. And many studies tell us that in almost all crashes the human being is to blame, and only a minority of crashes can be attributed to roads and vehicles.

In today's modern world, everybody is always surrounded by uncertainties immaterial about the age group which they belong. A man starts from his house, no surety that he will return home safely. People become victim of others irresponsible behavior on the roads. The indiscipline behavior of road user creates kayos in the road. People unwilling to follow the road rules while driving, the negligence of pedestrians while crossing , parking the vehicles in the no parking areas, engorgement of roads, speeding in the wrong places and the traffic police not maintain the law and order are some of the issues everyone facing and contributing negatively for others safety. Many of the fatal accident are happening on the roads due to irresponsible behavior of other persons.

The economic development of a country mainly depends on the transport system. The main objective of any public transport system is to provide an efficient, safe and economical system to move from one place to another place. The number of road casualties per jurisdiction in a certain period of time (a couple of years for example) is changing. In a substantial numberof countries an increase has been observed, whereas some other countries show a decrease. The Global Status report (WHO, 2013) presented a decline in 88 countries; 42 of which were high income countries, 41 were middle-income countries, and 5 were lowincome countries. But the same report indicated an increase in the number of fatalities in 87 countries. Sometimes it is stated that an increase in economic growth, resulting in increased motorization and an increase in kilometers travelled, will inevitably result in an increase in the number of road casualties.

To understand the causes of a crash are not easy to find. In the past, we relied on police information which was written down in crash report forms. These forms focused on violations, in order to assist in police activities, as they are supposed to do.In the majority of crashes, more than one cause plays a role. The human being failed in one way or another. This leads us to three questions: which factors increase risk, how can we influencethese factors in order to reduce risk, and howcost-effective are these interventions?

Two main approaches for further improvement can be defined:

- Elimination of extreme behavior
- Creation of a Safe System in which human errors are considerably reduced, if not eliminated

The second approach has a positive impact on the first. Assume that in the future we will build cars with a seat-belt lock and an intelligent speed adaptor, in which it will be impossible to drive without proper

use of a seat belt and without opportunity to drive faster than the prevailing speed limit. We will then not have to rely on the traditional ways of improving driving behavior, such as police enforcement. However, as we do not have these locks (yet) and we are not sure whether they will ever become a standard feature in future cars, we cannot eliminate the first approach so we thought eliminate the wrong mindset of road users will help to eliminate the causes of road crashes.

III. Adaption of Problem to FRM

We have adapted this model Fuzzy Relational Maps is more suitable tool to study the influence of Psychological factors and Human factors as two disjoint classes. Using an unsupervised method and identifying the relevant linguistic variables the problem was studied.Around hundred road users of Chennai interviewed using the unsupervised method.

IV. Table I

Attributes related to Psychological factors as the nodes of domain space

Attribute	
P1	Lack of Experience
P2	Risk Taking Behaviour
P3	Impulsiveness
P4	Defective Judgement
P5	Delay in decision
P6	Aggressiveness
P7	Poor Perception
P8	Family Dysfunction

V. Table II

Attributes are identified with following expressions for Psychological factors

Expressions	
P1	Overestimate their skill and underestimate the hazard
P2	Over suspicious, overexcited feeling
P3	Quick decision without forethought
P4	Fail to take correct solution
P5	Stunned, slow in making decision
P6	Deliberately travelling in Unsafe manner
P7	Impatient nature of road user
P8	Denial , Disrespect for others, and Unfair

VI. Table III

Attributed related to Human factors as range space

Attribute	
H1	Age
H2	Gender
H3	Education Awareness
H4	Stress
H5	Lack of Body Protection
H6	Coughing /Sneezing
H7	Heart Attack
H8	Impaired Vision
H9	Fatigue

VII. Table IV

Attributed are identified with following expression for human factors

Expressions	
H1	Young / Old
H2	Male / Female
H3	Poor Education Standards
H4	Mental Agony
H5	Not wearing Seat Belts / Helmet
H6	Sudden Illness
H7	Illness with pain unable to resort
H8	Poor Eye sight / Unclear vision
H9	Feeling sleepy on wheels

Using the expert opinion, the following directed graph is formulated

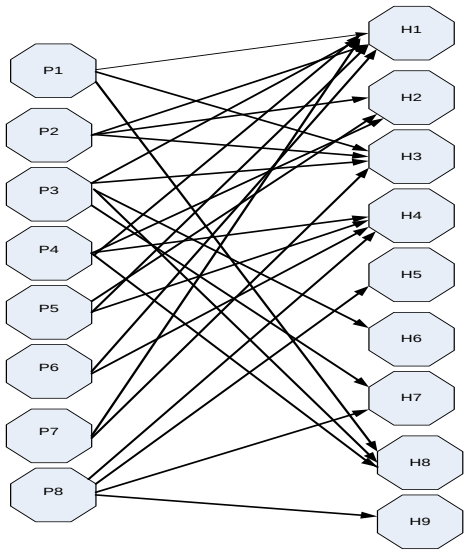

Fig. 1 Graph depicting a map between Psychological and Human factors.

The relational matrix M by expert opinion with simple FRM

$$M = \begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 1 \end{bmatrix}$$

Consider the state vector

X1=(1 0 0 0 0 0 0 0)

X1M = (1 0 0 0 1 0 0 0 0)

↪ (1 0 0 0 1 0 0 0 0) =Y1

$Y1M^T$ = (2 2 1 0 1 1 2 1)

↪ (1 1 1 0 1 1 1 1)=X2

X2M = (6 2 2 2 4 3 4 1 2)

↪(1 1 1 1 1 1 1 1 1)=Y2

$Y2\ M^T$=(2 5 3 2 3 4 4 5)

↪ (1 1 1 1 1 1 1 1)= X3

X3M = (6 2 2 2 4 3 4 1 2)

↪(1 1 1 1 1 1 1 1 1)=Y3

$Y3\ M^T$=(2 5 3 2 3 4 4 5)

↪ (1 1 1 1 1 1 1 1)= X4=X3

Hence the pair of limit point is

(1 1 1 1 1 1 1 1 1)(1 1 1 1 1 1 1 1)

VIII. Table V

Limit points for various set of initial input vectors

Input Vector	Limit Points
(1 0 0 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 1 0 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 0 1 0 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 0 0 1 0 0 0 0 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 0 0 0 1 0 0 0 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 0 0 0 0 1 0 0 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 0 0 0 0 0 1 0 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 0 0 0 0 0 0 1 0)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1)
(0 0 0 0 0 0 0 0 1)	(1 1 1 1 1 1 1 1 1), (1 1 1 1 1 1 1 1 1)

IX. Results and Discussion

The study clearly indicates that factors of psychological behavior correlates with human natural behavior and mannerism which have very large impact towards road traffic collision. Lack of experience, poor judgement, delayed reaction, aggressiveness and distraction off the road enforces people for road traffic accidents.

The following awareness measures are to be followed

a) To Develop economic status of any country, the measure of awareness with education to road safety and prevention from road death with serious injuries
b) It should focuses on safer and reduced speeds along with air pollution and energy consumption.
c) Consequent measure to reduce the growing number of vehicles on roads
d) Drivers with awareness of road safety
e) Enforce most efficient license procedure to train the drivers

X. References

[1] Axelrod. R. Structure of decision.The cognitive maps of politicalelites. Princeton University, 1976.

[2] Bernard Wechsler. H. PersonalityRulesAdvertising, marketing, public relation Community.

[3] BartKosko. Neural Networks and Fuzzy System prentice .Hall of India private Limited. New Delhi -110001, 2003

[4] Klir, G.J. and Folger, N.J. T.A. Fuzzy Sets Uncertainty and Information, Prentice Hall Englewood, Cliffs, 1998

[5] W.B.VasanthaKandasamy andFlorentinSmarandache. Analysis of Social Aspects of Migrant Labourers Living with HIV /AIDS using Fuzzy theory and Neutrosophic Cognitive Mapswith Special Reference to Rural Tamilnadu in India.Published by Xiquan, Phoenix, USA, 2004

[6] W.B.VasanthaKandasamy,Florentin Smarandache and K.Ilanthenral. Elementary Fuzzy Matrix Theory and Fuzzy Models for Social Scientists.Published by Automaton. Los Angeles. USA, 2007.

[7] Wickens C.D. and Hollands J. Engineering and Psychology and human performance Colombus,Tornoto London, Sydney; Longman 573, 1999.

[8] Kosko, Bart. Fuzzy Cognitive Maps, International Journals of Man –Machine Studies 34,65-75, 1986.

[9] A.Victor Devadoss and J. Befija Minnie, A Study of Personality Influence in Building Work Life Balance Using Fuzzy Relational Maps (FRM) ,International Journal of Data Mining Techniques and Applications, Vol.02, pp.211-216, 2012.

[10] A.Victor Devadossand S.M.A. Shahul Hameed. A Study of Attitude of Road User Using Combined Fuzzy Cognitive Maps (CFCMs), International Journal of Computer Application Vol.59, Issue No.13, December- 2012.

[11] A.Victor Devadossand S.M.A. Shahul Hameed. Fatigue of Driver on Roads using Combined Disjoint Block Fuzzy Cognitive Maps (CDBFCMS) International Journal of Computer Algorithm, Vol.02, pp 201-210, October 2013.

[12] A.VictorDevadossand S.M.A. Shahul Hameed. A Study of Attitude of Road User Using in Enhancing Gross National Happiness Combined Fuzzy Cognitive Maps (CFCMs). International Journal of Data Mining Techniques and Application, Vol.2, pp.193- 197, October 2013.

[13] A.Victor Devadoss and S. Christopher, A Study of Periyar Philosophy on Self Respect Using Induced Fuzzy Cognitive Maps (IFCMS). International Journal of Computer Algorithm, Vo1.2. pp 152-155, October 2013.

[14] A.Victor Devadoss and A. Felix. Fuzzy Clustering Approach to Study the Degree of Aggressiveness in Youth Violence,International Journal of Computer Algorithm, Vo1.2. pp 156-160, October 2013.

[15] A.Victor Devadoss and M. Syed Ismail , A Study on Religious Practices in Islam Towards Sustainable Development Using Neutrosophic Relational Maps,International Journal of Computer Algorithm, Vo1.2. pp 211-213, October 2013.