Analysis of Occupational Hazards of Traffic Police using Fuzzy Cognitive Bi Maps

Dr.A. Praveen Prakash and N. Vanathi

Abstract--- The traffic policemen are losing their health for the general public and are more exposed to occupational hazards. They are exposed to air pollution, noise pollution, sunlight, rain and prolonged standing. It is the responsibility of the health personnel to help them in turn to take care of their health, as many of these health problems are preventable. In this paper health hazard of traffic police is analyzed by fuzzy cognitive bi maps. Section 1 describes the development of FCM, section two explains the method of determining the hidden pattern in section three the problem is analyzed through two methods FCBMS has a common vertex and FCBMS has a common sub graph and conclusion based on the method is given.

I. DEVELOPMENT OF FUZZY COGNITIVE MAPS

Political scientist R. Axelrod introduced cognitive maps for representing social scientific knowledge and describing the methods that are used for decision making in social and political systems. Then B. Kosko enhanced the power of cognitive maps considering fuzzy values for the concepts of the cognitive map and fuzzy degrees of interrelationships between concepts. FCMs can successfully represent knowledge and human experience; introduce concepts to represent the essential elements and the cause and effect relationships among the concepts to model the behavior of any system. It is a very convenient, simple, and powerful tool, which is used in numerous fields such as social, economic, medical etc.

Dr.A. Praveen Prakash, Professor, Mathematics, Hindustan University, Chennai
N. Vanathi, Assistant Professor, Mathematics, KCG College of Technology, Chennai.

Fuzzy Cognitive Maps (FCMs) are more applicable when the data in the first place is an unsupervised one. The FCMs work on the opinion of experts. FCMs model the world as a collection of classes and causal relations between classes.[18-21]

Definition 1.1: An FCM is a directed graph with concepts like policies, events etc. as nodes and causalities as edges. It represents causal relationship between concepts.

Definition 1.2: When the nodes of the FCM are fuzzy sets then they are called as fuzzy nodes.

Definition 1.3: FCMs with edge weights or causalities from the set {-1, 0, 1} are called simple FCMs.

Definition 1.4: The edges eij take values in the fuzzy causal interval [–1, 1]. eij = 0 indicates no causality, eij > 0 indicates causal increase Cj increases as Ci increases (or Cj decreases as Ci decreases). eij < 0 indicates causal decrease or negative causality. Cj decreases as Ci increases (and or Cj increases as Ci decreases). Simple FCMs have edge values in {–1, 0, 1}. Then if causality occurs, it occurs to a maximal positive or negative degree. Simple FCMs provide a quick first approximation to an expert stand or printed causal knowledge. If increase (or decrease) in one concept leads to increase (or decrease) in another, then we give the value of 1. If there exists no relation between two concepts, the value 0 is given. If increase (or decrease) in one concept decreases (or increases) another, then we give the value –1. Thus FCMs are described in this way, Consider the nodes or concepts C1,… Cn of the FCM. Suppose the directed graph is drawn using edge weight eij $\in$ {0, 1, -1}. The matrix E be defined by E = (eij), where eij is the weight of the directed edge CiCj. E is called the adjacency matrix of the FCM, also known as the connection matrix of the FCM.

It is important to note that all matrices associated with an FCM are always square matrices with diagonal entries as zero.

Definition 1.5: Let $C_1, C_2, , C_n$ be the nodes of an FCM. Let A= $(a_1, a_2, , a_n)$, where $a_i \in \{0,1\}$.

A is called the instantaneous state vector and it denotes the on-off position of the node at an instant.

$a_i = 0$ if a_i is off =1

$a_i = 1$ if a_i is on, where i = 1, 2, , n.

Definition 1.6**:** Let $C_1, C_2,... C_n$ be the nodes of an FCM. Let $\overrightarrow{c_1c_2}, \overrightarrow{c_2c_3},\ldots \overrightarrow{c_ic_j}$be the edges of the FCM(i j). Then, the edges form a directed cycle. An FCM is said to be cyclic if it possesses a directed cycle. An FCM is said to be acyclic if it does not possess any directed cycle.

Definition 1.7: An FCM with cycles is said to have a feedback.

Definition 1.8: When there is a feedback in an FCM, i.e., when the causal relations flow through a cycle in a revolutionary way, the FCM is called a dynamical system.

Definition 1.9: Let , $\overrightarrow{c_1c_2}, \overrightarrow{c_2c_3},\ldots , \overrightarrow{c_ic_j}$be a cycle. When C_i is switched on and if the causality flows through the edges of a cycle and if it again causes Ci, we say that the dynamical system goes round and round. This is true for any node C_i, for i = 1, 2, , n. The equilibrium state for this dynamical system is called the hidden pattern.

Definition 1.10: If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point. Consider a FCM with $C_1, C_2, \ldots, C_n$ as nodes. For example let us start the dynamical system by switching onC_1. Let us assume that the FCM settles down with C_1 and C_n on, i.e. the state vector remains as (1, 0, 0, …, 0, 1). This state vector (1, 0, 0, …, 0, 1) is called the fixed point.

Definition 1.11: If the FCM settles down with a state vector repeating in the form $A_1 \rightarrow A_2 \rightarrow \ldots\ldots \rightarrow A_i \rightarrow A_1$, then this equilibrium is called limit cycle.

Definition 1.12: Fuzzy Cognitive Bi-maps (FCBMs) are fuzzy signed directed bi-graphs with feedback. The directed edge e_{ij}^p from causal concept C_i^p to concept C_j^p measures how much C_i^pcauses C_j^p, (p = 1, 2). The edge e_{ij}^p takes values in the fuzzy causal interval [-1, 1], $e_{ij}^p = 0$ indicates no causality $e_{ij}^p>0$ indicates causal increase C_j^p increases C_i^pincreses (or C_j^p asC_i^pdecreases). $e_{ij}^p<0$ indicates causal decrease C_i^p decreases as C_j^p increases (and or C_j^p increases or C_i^pdecreases).

II. METHOD OF DETERMINING THE HIDDEN PATTERN

Let $C_1, C_2,., C_n$ be the nodes of an FCM, with feedback. Let E be the associated adjacency matrix. Let us find the hidden pattern when C1is switched on. When an input is given as the vector A_1= (1, 0, 0,., 0), the data should pass through the relation matrix E. This is done by multiplying A_1 by the matrix E. Let A_1E =$(a_1, a_2,., a_n)$ with the threshold operation, that is, by replacing a_i by 1 if a_i >k and ai by 0 if a_i < k (k is a suitable positive integer).We update the resulting concept, the concept C1 is included in the updated vector by making the first coordinate as 1 in the resulting vector. Suppose $A_1E \rightarrow A_2$ then consider A_2E and repeat the same procedure. This procedure is repeated till we get a limit cycle or a fixed point.

III. ANALYSIS OF PROBLEM

Men in white are facing serious health issues due to their occupational hazards. They have been affected by air pollution, noise pollution, prolonged standing and exposed to sunlight and rain. Though the shelters are given effective use of shelters are very minimal. The current scenario where ever you go even in small offices have proper rest rooms, but these officers who gave their almost half of their life to protect us do not have a proper rest room facility. They have to withstand in all types of climates like very hot summer, heavy rain. It is heartening to see that the projection of police officers in cinemas and media as a

comedian. Automobiles are mobile polluters and the petrol vehicles are the worst. The highest emission rates occur during motor idling deceleration and at lower speeds. In signals all the vehicles start, slow down and produces greater emissions. In this condition the hydrocarbons react with nitrogen oxides, sulpher dioxide, lead and suspended particulate matter creates toxic pollutants which directly affects the police officers. The police official who is engaged in heavy traffic junction belongs to the high risk group of affected by noise pollution. Noise louder than 80 dB (decibels) is considered to be potentially hazardous and continued exposure to >85 dB of noise may cause gradual but permanent damage to hearing. Health effects of noise include both the auditory as well as non auditory effects. Besides being exposed to physical health hazards the traffic police are subject to mental stress and anxiety

If we have two FCMs given by two different experts with two different set of attributes on the same problem we can use the Fuzzy Cognitive Bi-maps model i.e., if M_1 is the connection matrix of the FCM given by the expert on the problem P and M_2 is the connection matrix of the FCM given by another expert on the same problem P, both the experts using two different sets of attributes give the Bi-matrix of the Fuzzy Cognitive Bi-maps(FCBM).The functioning of the FCBM will be explicitly shown in the following section.

The two sets of experts are

- General physician
- An ENT Doctor

A. Directed Bi-graph has a Common Vertex

The set of attributes given by the first expert is

A1 : Standing in a polluted area for a long time

A2 : Head ache

A3 : Breathlessness and suffocation

A4 : Tension

A5 : Fatigue

A6 : Blood pressure.

The set of attributes given by the second expert is

B1 : Standing in a noisy area

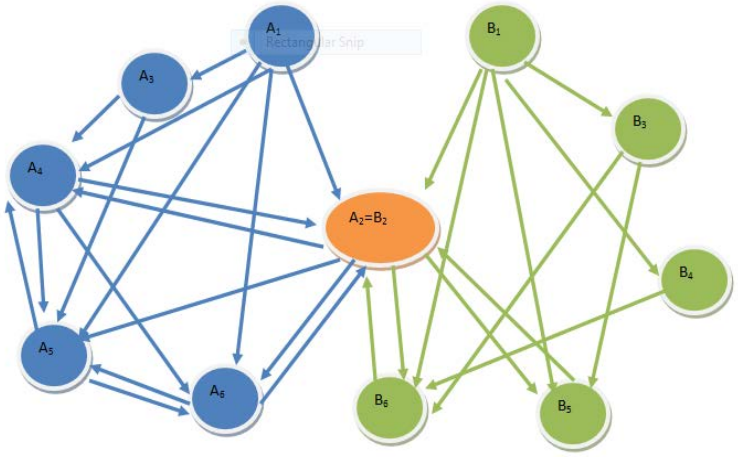
B2: Head ache

B3 : Nausea

B4 : Auditory fatigue

B5 : Insomnia

B6 : Frustration



Here the attribute A2 and B2 are same

The connection bi matrix $M = M_1 \cup M_2$ associated with this pair of attributes

$\{A_1,A_2,A_3,A_4,A_5,A_6\}$ and $\{B_1,B_2,B_3,B_4,B_5,B_6\}$ is given below

$$M_1=\begin{pmatrix}1&1&1&1&1&1\\0&0&0&1&1&1\\0&0&0&1&1&0\\0&1&0&0&1&1\\0&0&0&1&0&1\\0&1&0&0&1&0\end{pmatrix}$$

$$M_2=\begin{pmatrix}1&1&1&1&1&0\\0&0&0&0&1&1\\0&0&0&0&1&1\\0&0&0&0&0&1\\0&1&0&0&0&0\\0&1&0&0&0&0\end{pmatrix}$$

Suppose we work with the ON state of the bivector

$X = X_1 \cup X_2$

$= (1\ 0\ 0\ 0\ 0\ 0) \cup (1\ 0\ 0\ 0\ 0\ 0)$

$X \circ M = (X_1 \cup X_2) \cup (M_1 \cup M_2)$

$= (X_1 \circ M_1) \cup (X_2 \circ M_2)$

$= (1\ 1\ 1\ 1\ 1\ 1) \cup (1\ 1\ 1\ 1\ 1\ 1)$

$\rightarrow (1\ 1\ 1\ 1\ 1\ 1) \cup (1\ 1\ 1\ 1\ 1\ 1)$

$= Y_1 \cup Y_2$

$Y \circ M = (Y_1 \circ M_1) \cup (Y_2 \circ M_2)$

$= (1\ 3\ 1\ 4\ 5\ 4) \cup (1\ 3\ 1\ 1\ 3\ 3)$

$\rightarrow (1\ 1\ 1\ 1\ 1\ 1) \cup (1\ 1\ 1\ 1\ 1)$

$= Z_1 \cup Z_2$

Y = Z is the fixed bivector

($\rightarrow$ Symbol denotes that the bivector has been updated and thresholded)

Input Vector	Fixed Bi Vector
$(1\ 0\ 0\ 0\ 0\ 0) \cup (1\ 0\ 0\ 0\ 0\ 0)$	$(1\ 1\ 1\ 1\ 1\ 1) \cup (1\ 1\ 1\ 1\ 1\ 1)$
$(0\ 1\ 0\ 0\ 0\ 0) \cup (0\ 1\ 0\ 0\ 0\ 0)$	$(0\ 1\ 0\ 1\ 1\ 1) \cup (0\ 1\ 0\ 0\ 1\ 1)$
$(0\ 0\ 1\ 0\ 0\ 0) \cup (0\ 0\ 1\ 0\ 0\ 0)$	$(0\ 1\ 1\ 1\ 1\ 1) \cup (0\ 1\ 1\ 0\ 1\ 1)$
$(0\ 0\ 0\ 1\ 0\ 0) \cup (0\ 0\ 0\ 1\ 0\ 0)$	$(0\ 1\ 0\ 1\ 1\ 1) \cup (0\ 1\ 0\ 0\ 1\ 1)$
$(0\ 0\ 0\ 0\ 1\ 0) \cup (0\ 0\ 0\ 0\ 1\ 0)$	$(0\ 1\ 0\ 1\ 1\ 1) \cup (0\ 1\ 0\ 0\ 1\ 1)$
$(0\ 0\ 0\ 0\ 0\ 1) \cup (0\ 0\ 0\ 0\ 0\ 1)$	$(0\ 1\ 0\ 1\ 1\ 1) \cup (0\ 1\ 0\ 0\ 1\ 1)$

Table1: Different Input Vectors and their Corresponding Fixed Bi-Vectors

If the node standing in a polluted area is ON results the remaining all other nodes Head ache, Breathlessness and suffocation, Tension, Fatigue, Blood pressure are in ON condition. In the second if the first node" Standing in a noisy area " is in ON condition the remaining nodes Head ache, Nausea, Auditory fatigue, Insomnia , Frustration are in On condition. So their work nature is the main reason for all their problems. If (A2,B2),(A3,B3) …(A5,B5) are in ON condition the resultant fixed bi vector is tabulated in the table.

B. The Directed Bi-graph has A Common Sub-graph

A Psychiatrist and a senior police official were interviewed regarding the problems faced by the police officials and the health hazards related to them.

The set of attributes given by the psychiatrist are

A1: They could not spend quality time with family

A2: Depression

A3: Don't have proper shelter and toilet facility

A4: Cardiovascular diseases

A5: Diabetic

A6: Anger

A7: Fatigue

A8: Gastric Problem

A9: In media low range comments about the traffic police

The Set of attributes given by a senior police officer

B1: They could not spend quality time with family

B2: Depression

B3: Don't have proper shelter and toilet facility

B4: Tension

B5: People are not following traffic rules

B6: Life at risk(i.e) No guarantee to life while standing in the middle of the road.

B7: Often falling sick

B8: Daily seeing accidents and deaths

B9: Blood Pressure.

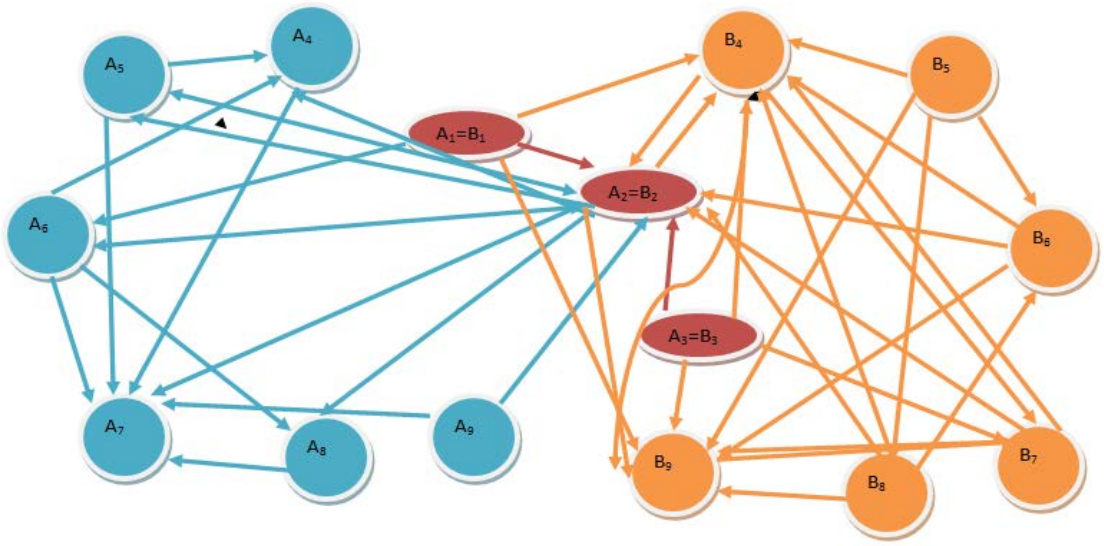
Here the attribute A1,A2,A3 and B1,B2,B3 are same

The connection bi-matrix M = M1∪ M2 associated with this pair of attributes

{ A_1,A_2,A_3,A_4,A_5,A_6,A7,A8,A9}

and { B_1,B_2,B_3,B_4,B_5,B_6,B7,B8,B9 }is given below

$$M=\begin{pmatrix}0&1&0&0&0&1&0&0&0\\0&0&0&1&1&1&1&1&0\\0&1&0&0&0&1&0&1&0\\0&0&0&0&0&0&1&0&0\\0&1&0&1&0&0&1&0&0\\0&1&0&1&0&0&1&1&0\\0&0&0&0&0&0&0&0&0\\0&0&0&0&0&0&1&0&0\\0&1&0&0&0&1&1&0&0\end{pmatrix}\cup\begin{pmatrix}0&1&0&1&0&0&0&0&1\\0&0&0&1&0&0&0&0&1\\0&1&0&1&0&0&1&0&1\\0&1&0&0&0&0&1&0&1\\0&0&0&1&0&1&0&1&1\\0&1&0&1&0&0&0&0&1\\0&1&0&1&0&0&0&0&1\\0&1&0&1&0&1&0&0&1\\0&0&0&1&0&0&1&0&0\end{pmatrix}$$



$X = X_1 \cup X_2$

$= (1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)$

$\cup (1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0)$

$X \circ M = (X_1 \cup X_2) \cup (M_1 \cup M_2)$

$= (X_1 \circ M_1) \cup (X_2 \circ M_2)$

$= (0\ 1\ 0\ 0\ 0\ 1\ 0\ 0\ 0)$

$\cup (0\ 1\ 0\ 1\ 0\ 0\ 0\ 0\ 1)$

$\rightarrow (1\ 1\ 0\ 0\ 0\ 1\ 0\ 0\ 0)$

$\cup (1\ 1\ 0\ 1\ 0\ 0\ 0\ 0\ 1) = Y_1 \cup Y_2$

$Y \circ M = (Y_1 \circ M_1) \cup (Y_2 \circ M_2)$

… …Proceeding likes this we are getting a fixed bivector

$\rightarrow (1\ 1\ 0\ 1\ 1\ 1\ 1\ 1\ 0) \cup (1\ 1\ 0\ 1\ 0\ 0\ 1\ 0\ 1)$

Input Vector	Fixed Bi Vector
(1 0 0 0 0 0 0 0 0)∪(1 0 0 0 0 0 0 0 0)	(1 1 0 1 1 1 1 1 0)∪(1 1 0 1 0 0 1 0 1)
(0 1 0 0 0 0 0 0 0)∪(0 1 0 0 0 0 0 0 0)	(0 1 0 1 1 1 1 1 0)∪(1 1 0 1 0 0 1 0 1)
(0 0 1 0 0 0 0 0 0)∪(0 0 1 0 0 0 0 0 0)	(0 1 1 1 1 1 1 1 0)∪(0 1 1 1 0 0 1 0 1)
(0 0 0 1 0 0 0 0 0)∪(0 0 0 1 0 0 0 0 0)	(0 0 0 1 0 0 1 0 0)∪(0 1 0 1 0 0 1 0 1)
(0 0 0 0 1 0 0 0 0)∪(0 0 0 0 1 0 0 0 0)	(0 1 0 1 1 1 1 1 0)∪(0 1 0 1 1 1 1 1 1)
(0 0 0 0 0 1 0 0 0)∪(0 0 0 0 0 1 0 0 0)	(0 1 0 1 1 1 1 1 0)∪(0 1 0 1 0 1 0 0 1)
(0 0 0 0 0 0 1 0 0)∪(0 0 0 0 0 0 1 0 0)	(0 0 0 0 0 0 1 0 0)∪(0 1 0 1 0 0 1 0 1)
(0 0 0 0 0 0 0 1 0)∪(0 0 0 0 0 0 0 1 0)	(0 1 0 1 1 1 1 1 0)∪(0 1 0 1 0 1 1 1 1)
(1 0 0 0 0 0 0 0 0)∪(1 0 0 0 0 0 0 0 0)	(0 1 0 1 1 1 1 1 1)∪(0 1 0 1 0 0 1 0 1)

Table 2: Different Input Vectors and their corresponding Fixed Bi-Vectors

If the nodes (A1,B1) are in ON condition then he is getting the following problems

Depression, Cardiovascular diseases, Diabetic, Anger, Fatigue, Gastric Problem and Depression, Don't have proper shelter and toilet facility, Tension, People are not following traffic rules, Life at risk(i.e) No guarantee to life while standing in the middle of the road, Often falling sick, Daily seeing accidents and deaths, Blood Pressure. The above table shows that if different input vectors are and their resultant vectors are shown.

IV. CONCLUSION

The problem was analyzed by fuzzy cognitive bi-maps which function like two FCMs simultaneously. A general physician, an ENT doctor were interviewed according to their opinion one attribute was common for both of them. So for that bi-map one vertex was common. As an example one node in M1 and one node in M2 were taken in ON state and the functioning of bi-maps was explained and table1 shows that different nodes were taken in ON condition and the fixed bi-vectors were given. Similarly a psychiatrist and senior police officials were interviewed according to their opinion three attributes were common so the corresponding bi-map has a common sub graph. As an example one node in M1 and one node in M2 were taken in ON state and the functioning of bi-maps was explained and table2 shows that different nodes were taken in ON condition and the fixed bi-vectors were given. "Prevention is better than cure" .This survey would help as an eye opener for the traffic police officers .They have to take preventive measures like regularly using face masks, hearing protection devices, rain coats and sun glasses. They have to do regular medical checkups and follow the medicines regularly.

REFERENCES

[1] Thomas A, Nor Mariah A, Fuad S, Kuljit R,Philip. Noise Exposure and Noise Induced Hearing Loss Among Kuala Lumpur Traffic Point Duty Personnel. Med Malaysia 2007; 62(2):152-55.

[2] Omidvari M., Nouri, J. Effects of noise pollution on traffic policemen. Int. J.Environ. 2009; 3(4):645-52.

[3] Abdel-Aziz Kamal M, SamiaEldamati E,Ricky Paris. Hearing threshold of Cairo traffic policemen. International Archives of Occupational And Environmental Health 2004; 62:543–45

[4] Itrat Jawed, AyubMusani, RaanaMahmood,Wadood, YousufKhambaty, MohamadAsim. The effect of traffic noise on the hearing level of people on Karachi streets. J Pak Med Assoc. 2010; 60(10): 813-816.

[5] Nandi SS, Dhatrak SV. Occupational noise induced hearing loss in India. Indian journal of occupational and environmental medicine.2008.12(2):53-56

[6] Shrestha I, Shrestha BL, Pokharel M, Amatya,RCM, Karki DR. Prevalnace of Noise Induced Hearing Loss among Traffic Police Personnel of Kathmandu Metropolitan City.Kathmandu Univ Med J. 2011;36(4):274-78

[7] Tripathi SR, Tiwari RR. Self-reported hearing quality of traffic policemen: a questionnaire- based study. Indian journal of occupational and environmental Medicine.August 2006; 10(2): 82-84.

[8] Kavana G, Venkatappa, Vinutha Shankar MS, NachalAnnamalai. Assessment of knowledge, attitude and practices of traffic policemen regarding the auditory effects of noise. Indian J Physio Pharmacol 2012;56(1):69–73

[9] Park K. Text book of preventive and social medicine. 18th ed. Jabalpur: M/s Banarsidas BhanotPublishers; 2005. p. 13, 606.
[10] Stanhope Marcia, Lancaster Jeanetta. Community and public health nursing. 6th ed. Missouri,USA: Mosby Publications; 2000. p. 249-50.
[11] Satapathy DM, Behera TR, Tripathy RM. Health status of traffic police personnel in Brahmapur city. Indian J Community Med 2009 Jan;34(1):71–72.
[12] Gupta C, Mahajan BK. Textbook of preventive and social medicine. 3rd ed. New Delhi: Jaypee publications; 2005. p. 75.
[13] Lewis Sharon L, Heitkemper Margaret Mclean, Dirken Shannon Ruff, O'Brien Patricia Graber, Bucher Linda. Medical Surgical Nursing assessment and management of clinical problems. 7th ed. Missouri,USA: Mosby, an imprint of Elsevier publications; 2007. p. 631.
[14] Atimay AT, Emri S, Bagci T, Demir AU. Urban CO exposure and its health effects on traffic policemen in Ankara. Environ Res 2000 Mar;82(3):222-30.
[15] Most cops suffer from stress related problems 2010. 2 Available from: URL:www.dnaindia.com/bangalore/report. Accessed September 19, 2010
[16] Josy V Johns, Proforma For Registration Of Subjects ForDissertation, Rajiv Gandhi University Of Health Sciences, Bangalore
[17] 16.Shelke BN, A STUDY ON HEARING THRESHOLD PROFILE IN TRAFFIC POLICE PERSONNEL, International Journal of Medical Research &Health Sciences, DOI:10.5958/j.2319-5886.2.4.131
[18] Axelrod, R. (1976). Structure of decision: The cognitive maps of political elites. Princeton, NJ: Princeton University Press.
[19] Kosko, B., "Fuzzy Cognitive Maps", International journal of man-machine studies, January, (1986), 62-75
[20] Kosko, B. Hidden Patterns in Combined and Adaptive Knowledge Networks, Proc. of the First IEEE International Conference on Neural Networks (ICNN-86 (1988) 377-393.
[21] Kosko, B., Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence, Prentice Hall of India, 1997.