STUDY OF TRAFFIC POLICE HEALTH HAZARDS USING BI-DIRECTIONAL ASSOCIATIVE MEMORIES (BAM)

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Abstract: Work plays a vital role in sustaining life. Each one spends at least 8 to10 hours in the workplace daily. The working population represents half of the world's population and being major contributors to socioeconomic development, their health is determined not only by the workplace hazards but also by social and individual factors as well as access to available health services. In this paper we have analyzed health hazards of traffic police using Bi-directional associative memories (BAM).

Keywords: Bi-directional associative memories (BAM), Traffic police health problems.

Introduction: Surveillance of work environment and detection of workers' knowledge on occupational health and safety measures are important components of occupational health and safety service. Occupational health services constitute comprehensive health sources which are essentially preventive and allow a substantial component of curative and rehabilitative services. The services must adapt to the needs of the working environment.[7]

Policing is a complex occupation. Differences in job design and in the wider societal context within which police work occurs, add to the complexity of policing. **"All they know, few actually walk it",** but in policing it is not so. Actually few know the way and a large majority are uncertain about it. What is needed is to change this few into significant few who can make lasting impact on quality of policing.[8]

It is important that more and more research be conducted on the health and safety issues of police officers in order to identify the associated hazards and find ways to reduce risks. The failure to identify and solve the health and safety issues of officers has potentially serious consequences for the health and wellbeing of officers and their families.

Besides being exposed to physical health hazards, traffic police are also subject to anxiety and mental stress. Rules are broken frequently, and these people responsible for maintaining law and order are very likely to develop high blood pressure and anxiety syndromes. They are exposed to vehicular fumes, scorching heat, rain and cold apart from constant stress of handling traffic and indulging in verbal duels with commuters. As shifts between field and office staffs don't happen often.

2.Bi-directional Associative Memories (BAM): Bi-directionality, forward and backward information flow, is introduced in neural networks to produce two-way associative search for stored stimulus-response associations (A_i, B_i). A group of neurons forms a field. Neural networks contain many fields of neurons. F_x denotes a neuron field which contains n neurons and F_y denotes a neuron field which contains p neurons.

Neuronal Dynamical Systems: The neuronal dynamical system is described by a system of first order differential equations that govern the time evaluation of the neuronal activations or membrane potentials.

$X_i = g_i(X,Y,...)$ and $Y_j = h_j(X,Y,...)$ Where x_i and y_j denote respectively the activation time function of the i^{th} neuron in F_x and the j^{th} neuron in F_y. The over dot denotes time differentiation, g_i and h_j are functions of X, Y etc., where $X(t) = (x_1(t),\ldots\ldots,x_n(t))$, $Y(t) = (y_1(t),\ldots\ldots,y_n(t))$ define the state of the neuronal dynamical system at time t. Additive Bivalent Models describe asynchronous and stochastic behaviour. At each moment each neuron can randomly decide whether to change state, or whether to omit a new signal given its current activation. The BAM is a non-adaptive, additive, bivalent neural network.[4]

2.1. Bivalent Additive BAM: In neural literature, the discrete version of the earlier equations is often referred to as the Bidirectional Associative Memories or BAMs. A discrete additive BAM with threshold signal functions, arbitrary thresholds and inputs, an arbitrary but a constant synaptic connection matrix M and discrete time steps K are defined by the equations.

$$x_i^{k+1} = \sum_j^p S_j\left(y_i^k\right) m_{ij} + I_i$$

$$y_j^{k+1} = \sum_i^n S_i\left(y_i^k\right) m_{ij} + I_j$$

Where, $m_{ij} \in M$, S_i and S_j are the signal functions. They represent binary or bipolar threshold functions. For arbitrary real-valued thresholds $U = (U_1, U_2 \ldots, U_n)$ for F_x neurons and $V = (V_1, V_2 \ldots, V_n)$ for F_y neurons. The threshold binary signal functions corresponds neurons[4].

2.2. Synaptic Connection Matrices: Let us suppose that the field F_x with n neurons is synoptically connected to the field F_y with p neurons. Let m_{ij} be a synapse where the axon from the ith neuron in F terminates, m_{ij} can be positive, negative or zero. The synaptic matrix M is a $n \times p$ matrix of real numbers whose entries are the synaptic efficacies m_{ij}. The matrix M describes the forward projections from the neuronal field F_x to the neuronal field F_y. Similarly, M^T, $p \times n$ synaptic matrix and describes the backward projections F_y to F_x.[4]

2.3. Unidirectional Networks: These kinds of networks occur when a neuron synoptically interconnects to itself. The matrix N is $n \times n$ square matrix.

2.4. Bidirectional Networks: A network is said to be a

bidirectional network if $M = N^T$ and $N = M^T$.

2.5. Bidirectional Associative Memories: When the activation dynamics of the neuronal fields F_x and F_y lead to the overall stable behaviour, the bi-directional networks are called as Bi-directional Associative Memories or BAM. A unidirectional network also defines a BAM if M is symmetric i.e. $M = M^T$.

2.6. Additive Activation Models: An additive activation model is defined by a system of $n+p$ coupled first-order differential equations that interconnects the fields F_x and F_y through the constant synaptic matrices M and N described earlier. $S_i(x_i)$ and $S_j(y_j)$ denote respectively the signal function of the i^{th} neuron in the field F_x and the signal function of the j^{th} neuron in the field F_y. Discrete additive activation models correspond to neurons with threshold signal functions. The neurons can assume only two values **ON** and **OFF**. ON represents the signal value +1 and OFF represents 0 or -1 (-1 when the representation is bipolar). The bipolar version of these equations yield the signal value -1 when $x_i<U_i$ or $y_j<V_j$.

$$\dot{X}_i = A_i X_i + \sum_j^p S_j\left(y_j^k\right)\mathrm{m_{ij}} + \mathrm{I_i}$$

$$\dot{Y}_j = A_j y_j + \sum_i^n S_i\left(y_i^k\right)\mathrm{m_{ij}} + \mathrm{I_j}$$

The bivalent signal functions allow us to model complex asynchronous state-change patterns. At any moment different neurons can decided whether to compare their activation to their threshold. An each moment any of the 2^n subsets of F_x neurons or the 2^p subsets of F_y neurons can decide to change state. Each neuron may randomly decide whether to check the threshold conditions in the equations given above. At each moment each neuron defines a random variable that can assume the value ON (+1) or OFF (0 or -1). The network is often assumed to be deterministic and state changes are synchronous i.e. an entire field of neurons is updated at a time. In case of simple asynchrony only one neuron makes a state change decision at a time. When the subsets represent the entire fields F_x and F_y synchronous state change results.

In a real life problem the entries of the constant synaptic matrix M depends upon the investigator's feelings. The synaptic matrix is given a weight age according to their feelings. If $x \in F_x$ and $y \in F_y$ then, The forward projections from F_x to F_y is defined by the matrix $M.:\{F(x_i,y_j)\} = (m_{ij})=M,\ 1<i<n,\ 1<j<p$. The backward projection is defined by the matrix $M^T.:\{F(y_j,x_i)\} = (m_{ji}) = M^T,\ 1<i<n,\ 1<j<p.$[4]

2.7. Bidirectional Stability: All BAM state changes lead a fixed-point stability. This property holds for synchronous as well as synchronous state changes. A BAM system (F_x, F_y, M) is bi-directionally stable if all inputs coverage to fixed point equilibrium. Bidirectional stability is a dynamic equilibrium. The same signal information flows back and forth in a bidirectional fixed point.

Let us suppose that A denotes a binary n vector and B denotes a binary p-vector. Let A be initial input to the BAM system. Then the BAM equilibrates a bi-directional fixed point (A_i,B_j) as

$$A \rightarrow M \rightarrow B$$
$$A' \leftarrow M' \leftarrow B$$
$$A' \rightarrow M \rightarrow B'$$
$$A'' \leftarrow M^T \leftarrow B' \ldots$$
$$A_f \rightarrow M \rightarrow B_f$$
$$A_f \rightarrow M^T \rightarrow B_f$$

where A', A",.. and B', B" ... represents intermediate or transient signal state vectors between A and A_f , B and B_f. respectively. The fixed point of a bidirectional system is time dependent. The fixed point for the initial input vectors can be attained at different times which are illustrated later. Based on the synaptic matrix M which is developed by the investigators feelings, the time at which bidirectional stability is attained also varies accordingly.[2],[4]

3.Description of the Study: The main five reasons are taken as the attributes of the domain space and the health hazards of traffic police are taken as the attributes of the range space.

The attributes of the domain space are

D_1: Air Pollution: Environment pollution plays a significant role in the development of various respiratory diseases. Different particles and gases from vehicular emission like carbon dioxide, carbon mono-oxide, sulphur, benzene, lead, nitrogen dioxide, and black smoke are at the root of the problem. Traffic police officers who work at busy intersections are at the highest risk of developing asthma or chronic bronchitis, apart from other allergic conditions like pharyngitis, rhinitis etc.

D_2: Noise Pollution: Another factor is the noise. There is no anti-honking law everywhere you go, large vehicles are running along the road honking loudly, exposing these officers to high decibels of noise. Sound waves below 60 decibels are not harmful; they become annoying at 80; and when they're above 85, they could lead to hearing impairment upon prolonged exposure. Our officers need to think about this and consider implementing an anti-honking law.

D_3: Long Duty Hours: There are also the consequences of prolonged standing to consider. Traffic police who are on the streets every day are prone to developing varicose veins, a dilation of the superficial veins of the lower limbs due to damage of valves. This leads to swelling in the legs and a lot of discomfort.

D_4: Work Tension: When they feel overwhelmed at work, they lose confidence and may become irritable or withdrawn. This can make you less productive and less effective in their job, and make the work seem less rewarding. If they ignore the warning signs of work stress, they can lead to bigger problems. Beyond interfering with job performance and satisfaction, chronic or intense stress can also lead to physical and emotional health problems.

D_5: Contagious diseases: Due to drainage issues in the city, dirty water from sewers frequently overspill onto the streets and our officers are forced to waddle through these

germ-ridden puddles putting themselves at the risk of diseases. Leptospira, for instance, is a bug that can be found in rat urine and sewers and is transmitted through the skin. It causes jaundice fever, may be associated with a bleeding disorder, and could even be fatal. Just last year there were reports of leptospirosis causing a lot of morbidity in the country.

To uncover alcohol intake, night time officers have begun smelling the driver/rider's breath, instead of using a proper breath analyser. If the person being checked is harbouring infectious respiratory diseases like viral flu and tuberculosis, to name a few, and happens to cough during the check, the officer could very well get infected.

Attributes described by the range space are

R_1:Respiratory diseases
R_2:Breathlessness and suffocation
R_3:Bronchitis
R_4:Flu
R_5:Insomnia
R_6:Auditory Fatigue
R_7:Pneumonia
R_8:Muskuloskeletal disorders
R_9:Varicose Veins.

As the data is an unsupervised one and involves lot of uncertainties we are given a dynamical system in matrix M and its reverse M^T with weighted values in the range [-5,5]

The connection matrix

$$M = \begin{pmatrix} 4 & 3 & 5 & 2 & 0 & 0 & 4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 4 & 5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 3 & 0 & 0 & 5 & 5 \\ 0 & 0 & 0 & 0 & 4 & 0 & 0 & 3 & 3 \\ 3 & 2 & 2 & 3 & 0 & 0 & 4 & 0 & 0 \end{pmatrix} \quad \text{And } M^T = \begin{pmatrix} 4 & 0 & 0 & 0 & 3 \\ 3 & 0 & 0 & 0 & 2 \\ 5 & 0 & 0 & 0 & 2 \\ 2 & 0 & 0 & 0 & 3 \\ 0 & 4 & 3 & 4 & 0 \\ 0 & 5 & 0 & 0 & 0 \\ 4 & 0 & 0 & 0 & 4 \\ 0 & 0 & 5 & 3 & 0 \\ 0 & 0 & 5 & 3 & 0 \end{pmatrix}$$

Suppose in the initial vector air pollution node is in ON state (i.e) D1 is in ON

$X_1 = (1\ 0\ 0\ 0\ 0)$

$X_1 \circ M = (4\ 3\ 5\ 2\ 0\ 0\ 4\ 0\ 0)$

$\mapsto (1\ 1\ 1\ 1\ 0\ 0\ 1\ 0\ 0) = Y_1$

$Y_1 \circ M^T = (18\ 0\ 0\ 0\ 14)$

$\mapsto (1\ 0\ 0\ 0\ 1) = X_2$

$X_2 \circ M = (7\ 5\ 7\ 5\ 0\ 0\ 8\ 0\ 0)$

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

$Y_2 \circ M^T = (18\ 0\ 0\ 0\ 14)$

$\mapsto (1\ 0\ 0\ 0\ 1) = X_3\ (=X_2)$

The fixed Bi-vector is

$\{(1\ 0\ 0\ 0\ 1), (1\ 1\ 1\ 1\ 0\ 0\ 1\ 0\ 0)\}$

($\mapsto$ denotes updating and thresholding)

Conclusion: The above calculation shows that if the first state D_1 is in ON condition ((i.e) Air pollution is in ON condition) it will induce contagious diseases so the node D_5 also ON in X. In the fixed resultant vector of Y , The nodes R_1,R_2,R_3,R_4,R_7 are also in ON condition .So, which conclude that air pollution will cause contagious diseases and these two together will cause respiratory diseases, Breathlessness and suffocation , Bronchitis , Flu , and Pneumonia. "Prevention is better than cure" So the traffic officials should take care about themselves they should regularly wear the face mask and their higher officers are also should take care about them. They should regularly arrange medical camps and they should give the duty in highly polluted areas inturn.If any body is sick they can be given office work for some days.

The states D2, D3, D4, D5 were taken in ON condition and the fixed bi-vector is shown below in Table-I

Input Vector	**Fixed Bi Vector**
(0 1 0 0 0)	{(0 1 1 1 0), (0 0 0 0 1 1 0 1 1)}
(0 0 1 0 0)	{(0 1 1 1 0), (0 0 0 0 1 1 0 1 1)}
(0 0 0 1 0)	{(0 1 1 1 0), (0 0 0 0 1 1 0 1 1)}
(0 0 0 0 1)	{(1 0 0 0 1), (1 1 1 1 0 0 1 0 0)}

Table – I Different input vectors and their resultant bi vectors

Clearly the table shows that Noise pollution, long duty hours and work tension will cause Insomnia, Auditory fatigue, Musculoskeletal disorders and varicose vein problems and air pollution and contagious diseases are the main reasons for respiratory diseases, Breathlessness and suffocation, Bronchitis, Flu, and Pneumonia. In the list of diseases we have mentioned only acute diseases before it will change it as a chronic they should strictly take the precautionary measures.

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