A Study on Factors for Preferring Old Age Home using Bidirectional Associative Memory(BAM)

Dr.A.Praveenprakash [1], Kanimozhiraman [2]

[1]Professor, Department of Mathematics ,Hindustan University, Chennai, India

[2]Assistant Professor, Department of Mathematics, KCG College of Technology, Chennai, India

Email id: kanimozhiraman1999@gmail.com

Abstract: Bidirectional Associative Memory(BAM) is a hetero-associative, content-addressable memory consisting of two layers. It uses the forward and backward information flow to produce an associative search for stored stimulus-response association. Number of old age homes are increasing due to the deterioration of joint family system. In this paper, the important common factors for preferring old age homes are analyzed.

Keywords- BAM, Synaptic Projections, Neuronal field, Binary Pair, Activation Equation , State Vector, Old age people, Old age home.

1.INTRODUCTION

The BAM was introduces by Bart Kosko. It is heteroassociative, content-addressable memory. A BAM consists of neurons arranged in two layers say A and B. The neurons are bipolar binary. The neurons in one layer are fully interconnected to the neurons in the second layer. There is no interconnection among neurons in the same layer. The weight from layer A to layer B is same as the weights from layer B to layer A. Dynamics involves two layers of interaction. Because the memory process information in time and involves Bidirectional data flow, it differs in principle from a linear association, although both networks are used to store association pairs. It also differs from the recurrent auto associative memory in its update mode[1]. The network structure of the Bi-directional Associative Memory model[2,3] is similar to that of the linear associator model, but the connections are bidirectional in nature, i.e., wij = wji, for i = 1, 2, ..., m and j = 1, 2, ..., n. The units in both layers serve as both input and output units depending on the direction of propagation. Propagating signals from the X layer to the Y layer makes the units in the X layer act as input units while the units in the Y layer act as output units. The same is true for the other direction, i.e., propagating from the Y layer to the X layer makes the units in the Y layer act as input units while the units in the X layer act as output units.

2. BAM MODEL

A group of neurons forms a field. Neural networks contain many fields of neurons. Fx denotes a neuron field which contains n neurons and Fy denotes a neuron field which contains p neurons.

2.1neuronal 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.

$$X_i = g_i(X,Y,\ldots),\ Yi{=}h_j(X,Y,\ldots)$$

where xi and yj denote respectively the activation time function of the ith neuron in Fx and the jth neuron in Fy. The over dot denotes time differentiation, gi and hj 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 behavior. 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.

2.1.1 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.

$$X_i^{k+1} = \sum_{j=1}^{p} S_j(y_j^{\,k})m_{ij} + I_i \qquad (1)$$

$$Y_j^{k+1} = \sum_{i=1}^{n} S_i(x_i^{k}) m_{ij} + J_j \qquad (2)$$

Where $m_{ij} \in M$, Si and Sj 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 Fx neurons and $V=(V_1,V_2\ldots,V_n)$ for Fy neurons. The threshold binary signal functions corresponds neurons.

2.1.2 Synaptic Connection Matrices

Let us suppose that the field F_x with n neurons is synaptically connected to the field F_y with p neurons. Let m_{ij} be a synapse where the axon from the i^{th} neuron in F terminates, m_{ij} can be positive, negative or zero. The synaptic matrix M is a n × 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, a p × n synaptic matrix and describes the backward projections F_y to F_x.

2.1.3 Unidirectional Networks

These kinds of networks occur when a neuron synoptically interconnects to itself. The matrix N is n × n square matrix.

Bidirectional Networks.

A network is said to be a bidirectional network if $M = N^T$ and $N = M^T$

2.1.4 Bidirectional Associative Memories

When the activation dynamics of the neuronal fields F_x and F_y lead to the overall stable behavior, 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.

2.1.5 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 xi< Ui or yj< Vj.

$$x = -A_i x_i + \sum_{j}^{p} S_j(y_j^k) m_{ji} + I_i$$

$$y = -A_j y_j + \sum_{i}^{n} S_i(x_i^k) m_{ij} + J_j$$

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. A each moment any of the 2^n subsets of F_x neurons or the 2^p subsets of the Fy 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 ie 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 weightage according to their feelings. If x F_x and y F_y the forward projections from Fx to Fy is defined by the matrix M.: $\{P(x_I, x_j)\} = M$, 1<I<n, 1<j<p.

The backward projection is defined by the Matrix M^T. : $\{F(y_j,x_I)\} = (m_{ij}) = M^T$, 1< I < n, I<j<p.

2.1.6 Bidirectional Stability

All BAM state changes lead a fixed-point stability. This property holds for synchronous as well as asynchronous state changes.

A BAM system (Fx, Fy, M) is bidirectionally stable if all inputs converge to fixed pint 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

$$\begin{aligned}
&A \to M \to B \\
&A' \leftarrow M^T \leftarrow B \\
&A' \to M \to B' \\
&A'' \leftarrow M^T \leftarrow B' \\
&\cdots \\
&A_f \to M \to B_f \\
&A_f \leftarrow M^T \leftarrow B_f \\
&\qquad \vdots
\end{aligned}$$

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. Based on the synaptic matrix M which is developed by the investigators feelings, the time at which bi directional stability is attained also varies accordingly.

3.DESCRIPTION OF THE PROBLEM

The closing period in the life span is old age. The dividing line between middle and old age is usually considered as age sixty. Old people have to adjust with their declining strength and gradually failing health. This often means the roles they played in the home and outside have changed dramatically. The urban family is undergoing in its traditional status and roles due largely to the impact of migration, changes in occupation, high level of education, urbanization and breaking up of joint family. Families have led to increase in the problem of old age like personal, social, economic, family and psychological problems. To explore these factors the present study was undertaken.

The most important common factors for preferring old age home are

A_1 - Daughter in law

A_2 - No male Child

A_3 - Finance Problem

A_4 - No children

A_5- Attitude Problem

A_6 - Health Problem

To analyze the factors the following family status where analyzed

B_1.Poor family,

B_2. Low middle family,

B_3. Middle family,

B_4. High middle family

B_5. Rich family

We take the neuronal field F_x as the attributes connected with the factors of the old age people and F_y as the attributes of their family status. The 6 × 5 matrix V represents the forward synaptic projections from the neuronal field F_x to the neuronal field F_y. The 5× 6 matrix M^T represents the backward synaptic projections from the neuronal field F_x to the neuronal field F_y.

$$V = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \\ A_6 \end{array} \begin{array}{c} \begin{array}{ccccc} B_1 & B_2 & B_3 & B_4 & B_5 \end{array} \\ \begin{pmatrix} 5 & 6 & 0 & 6 & 2 \\ 8 & 8 & 6 & -5 & 4 \\ 6 & 9 & 10 & 9 & 5 \\ 10 & 6 & 8 & 5 & -4 \\ -5 & -4 & 6 & 7 & 8 \\ -3 & 0 & 5 & 8 & 9 \end{pmatrix} \end{array}$$

$$V^T = \begin{array}{c} \\ B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \end{array} \begin{array}{c} \begin{array}{cccccc} A_1 & A_2 & A_3 & A_4 & A_5 & A_6 \end{array} \\ \begin{pmatrix} 5 & 8 & 6 & 10 & -5 & -3 \\ 6 & 8 & 9 & 6 & -4 & 0 \\ 0 & 6 & 10 & 8 & 6 & 5 \\ 6 & -5 & 9 & 5 & 7 & 8 \\ 2 & 4 & 5 & -4 & 8 & 9 \end{pmatrix} \end{array}$$

Let X_k be the input vector given as (3 -4 0 2 6 5) at the K^{th} time period. We suppose that all neuronal state change decisions are synchronous.

The binary signal vector

$S(X_k)$ = (1 0 0 1 1 1)

$S(X_k)V$ = (7 8 19 26 15)

= Y_{k+1}.

From the activation equation

$S(Y_{k+1})$ = (1 1 1 1 1)

Now

$S(Y_{k+1})V^T$ = (19 24 39 25 12 19)

= X_{k+2} .

From the activation equation

S (Xk+2) = (1 1 1 1 1 1)

S (Xk+2)V = (21 25 35 30 24)

= Yk+3.

From the activation equation

$S(Y_{k+3})$ = (1 1 1 1 1)

$S(Y_{k+3})V^T$ = (19 24 39 25 12 19)

= X_{k+4}

From the activation equation

$S(X_{k+4})$ = (1 1 1 1 1 1)

Thus the binary pair {(1 1 1 1 1 1) , (1 1 1 1 1)} represents a fixed point of the dynamical system. Equilibrium of the system has occurred at the time K+2, when the starting time was K. When these factors are in on state, the factors no male children, Finance problems become ON. From this we can conclude that Daughter in law, No children, Attitude Problem, Health Problem are the major factors for proffering old age home.

Suppose we take Daughter in Law in the ON state. Say at the K_{th} time we have

X_k = (5 0 0 0 0 0)

$S(X_k)$ = (1 0 0 0 0 0)

$S(X_k)V = (5\ 6\ 0\ 6\ 2)$
$= Y_{k+1}.$
$S(Y_{k+1}) = (1\ 1\ 0\ 1\ 1)$
$S(Y_{k+1})V^T = (19, 15, 29, 17, 8, 14)$
$= X_{k+2}.$
$S(X_{k+2}) = (1\ 1\ 1\ 1\ 1\ 1)$
$S\ (X_{k+2})V = (21\ 29\ 35\ 30\ 24)$
$= Y_{k+3}.$
$S(Y_{k+3}) = (1\ 1\ 1\ 1\ 1)$
$S(Y_{k+3})V^T = (19\ 24\ 39\ 25\ 12\ 19)$
$= X_{k+4}$
$S(X_{k+4}) = (1\ 1\ 1\ 1\ 1\ 1)$
$S\ (X_{k+4})V = (21\ 29\ 35\ 30\ 24)$
$= Y_{k+5}.$

Thus the binary pair { (1 1 1 1 1 1) , (1 1 1 1)} represents a fixed point of the dynamical system. Thus in this system given by the expert even if only Daughter-in-Law is in ON state, all the other states become ON.
Daughter-in-Law the one of the factor for preferring old age home.The following table gives the fixed points when other attributes are kept in ON state consecutively.

Sl.No	Input vector	Fixed Point
1	(1 0 0 0 0 0)	(1 1 1 1 1 1),(1 1 1 1 1)
2	(0 1 0 0 0 0)	(1 1 1 1 1 1),(1 1 1 1 1)
3	(0 0 1 0 0 0)	(1 1 1 1 1 1),(1 1 1 1 1)
4	(0 0 0 1 0 0)	(1 1 1 1 1 1),(1 1 1 1 1)
5	(0 0 0 0 1 0)	(1 1 1 1 1 1),(1 1 1 1 1)
6	(0 0 0 0 0 1)	(1 1 1 1 1 1),(1 1 1 1 1)

4.CONCLUSION

T o analyze our problem by BAM, each factor is kept in ON state. When the factor A_1 is in ON state, the other factors A_2, A_3, A_4, A_5, A_6 becomes ON and also the family status B_1, B_2, B_3, B_4, B_5 becomes ON. This shows that A_1 is one of the important factors. Similarly for all the other factors A_2, A_3, A_4, A_5, $A_{6,}$ every other factors for each case becomes ON and also the family status B_1, B_2, B_3, B_4, B_5.

REFERENCES:

[1] Yash Pal Singh, V.S.Yadav, Amit Gupta, Abhilash Khare,” Bi Directional Associative Memory Neural Network Method in the Character Recognition”, Journal of Theoretical and Applied Information Technology,2009.

[2] Jeff Heaton,” Introduction to Neural Networks for C#”, 2nd Edition, Heaton Research, Inc.,2008.

[3] Kosko, “Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence”, Prentice Hall, 1992.
[4] http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4/cs11/report.html.

[5] B.D.C.N.Prasad, P E S N Krishna Prasad, Sagar Yeruva,”A Study on Associative Neural Memories”, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 1, No. 6, December 2010.

[6] Satish Kumar “Neural Networks, A Classroom Approach” ,TMH,2004