SHEDULING THE PACKET ROUTING USING NEURAL NETWORK FOR OPTIMIZING QUALITY OF SERVICE PARAMETERS

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Abstract— Computer network packet routing is an major important function in the computer based communication, The quality of service parameters efficiencies are highly depends on the how the packet travel and using which path. The strategically scheduling of routing can play major role in the network performance also essential to choose proper routing while designing the computer network. Artificial neural networks are basically known to as systems of connected "neurons" which are communicating through exchange messages between. The communication having the stastical figure known as weights that can be adjust based on experimental and real knowledge, which makes the neural network a adaptive to inputs and capable of learning. Using Hopfield artificial neural networks one can fast computation and leaning and with low energy in its basic stable formation. They are good contender for the implementation of neural routing algorithm. We are utilizing the Hopfield neural network for neural routing computation of shortest path in the network in this paper.

Keywords— Packet Routing, Hopfield Neural Network, Associative memory, Artificial Neural Network.

I. INTRODUCTION

Computer network have basically two strategy of communication I. Connection oriented II. Connection less. In the connection less strategy can be implement based on packet switching network communication. Where there will be two hosts, One computing device node will send a block of data call a packet with delivery address to receiving computing devices know as receiving host. packet, which is addressed to the destination host. The latter on forwards the packet to an intermediate computing and switching node, It also may be routes the packet to another, and so on, It is likely in fashion until the data packet reach to the final destination node or host..

The time taken by a typical packet to travel from the source node to the linking node of the destination host is called the end-to-end delay of the network. We are here call the routing and selecting node using which the packet is getting transmitted in selection of the path is known as packet routing strategy.

The main aim behind the routing strategy is to minimize the delay here the delay is know as mean kelay of the packets. The packets are the block of data to get deliver is also depends on the reliability or capacity of the path. There involve the post exact mathematical methods having some critical properties of the mean delay to optimized the QoS parementer and optimization. It is also involve the require complex and lengthy mathematical calculations. The resulting involve heuristic procedure, We have to here take care of computation time and throughputs while processing the packets which can effect basically the quality of service parameters. The routes through packets travel without creating the network congestions. Routing having category like static routing, adaptive routing, and optimal routing. First one is consists of determined paths to be followed by the different packets based on the strategies of the network, like the topology and anticipated mean congestion or traffic on the communication links.

The newest in the neural network is to get the intrest in the recongnition that the brain perfoms the computation in slitely different then the regular digital computes they are definitely the fast and exact at execution and algorithms. A humanoid information computing and processing system is made of lot many neurons and switching at lower speeds about a million times slower than computer gates. Still the human are more powerful than computers at computationally complicated tasks mainly like speech understanding, visual recognition, etc.

ANN are designed to evaluate the basic computational power of human mind. It can be applied to study a bigger variety of the computational problem in the area of engineering and entrepreneurs scheme [1, 2, and 3]. Using the neural network we can do the efficient computing complex task in small or lesster time. The usage of internet is increasing in 3-4 folde now a days need high demind of bandwith and spped of network. The high speed of computer network require at all level reach and some algorithms which can be dynamically stable and enough fast to accept the dynamically the changes in the system. This is also so much depends on the packet processing and routing and efficiencies of devivering the packet. It is also require network to deliver data efficiently . So with the use of neural network and Hopfield’s neural network theory we can deploy neural network in routing process for fast and efficient shortest path calculation In some of researches ANN show very interesting results as compared to Traditional routing algorithms.

The main goal of this paper is to find the optimal path for routing between source and destination for routing purpose by considering the three parameters bandwidth delay throughput using neural network. Primary goal is to develop a Routing strategy using neural network that can efficiently calculate the shortest path in less time and by doing so improving the efficiency of routing algorithm.

II. ARTIFICIAL NEURAL NETWORK AND ROUTING

2.1. Train the Neural Network

A Hopfield neural network is a single layer and all nodes are fully connected with internetwork where each node is working input node as well as output node. It is also called content addressable memories. It is because any one can access location by its binary content. It can also known as associative memories. Associative memory can be located through its contents. Here we are storing the patters in content addressable memories and then identifying given input patterns basically based on one or more patterns stored. Hopfield network checks the input against the patterns stored in the network and based on same matching it gives the activation to the neurons.

To train the network, suppose we want to calculate the weight matrix for the pattern $S1$ = {10110} Then we are using the following formula for calculating the weights between connection matrixes

$$W_{ij} = \sum_{s=1}^{n} (2X_i^s - 1)(2X_j^s - 1) \qquad \text{-------} \quad (1)$$

Where Wij is the connection weight between neuron i and j. Xs is the input vector or the training pattern as mention above where superscript s is for the respective pattern.

As Hopfield networks are fully connected networks hence there is $n(n-1)$ /2 links are present so to store them we required a $N \times N$ matrix as shown below Here we are representing matrix for the five node network

Connection matrix

0	W12	W13	W14	W15
W21	0	W23	W24	W25
W31	W32	0	W34	W35
W41	W42	W43	0	W45
W51	W52	W53	W54	0

Calculation of Weight

W12 = (2X1 - 1)(2X2 - 1) = (0 - 1)(2 - 1) = (-1)(1) = -1
W23 = (2X2 - 1)(2X3 - 1) = (2 - 1)(2 - 1) = (1)(1) = 1
W24 = (2X2 - 1)(2X4 - 1) = (2 - 1)(0 - 1) = (1)(-1) = -1
W25 = (2X2 - 1)(2X5 - 1) = (2 - 1)(2 - 1) = (1)(1) = 1
W34 = (2X3 - 1)(2X4 - 1) = (2 - 1) (0 - 1) = (1) (-1) = -1
W13 = (2X1 - 1)(2X3 - 1) = (0 - 1)(2 - 1) = (-1)(1) = -1
W14 = (2X1 - 1)(2X4 - 1) = (0 - 1)(0 - 1) = (-1)(-1) = 1
W15 = (2X1 - 1)(2X5 - 1) = (0 - 1)(2 - 1) = (-1)(1) = - 1
W35 = (2X3 - 1)(2X5 - 1) = (2 - 1) (2 - 1) = (1)(1) = 1

So now connection matrix is given below

0	-1	-1	1	-1
-1	0	1	-1	1
-1	1	0	-1	1
1	-1	-1	0	-1
-1	1	1	-1	0

Now we are taking second pattern $S2$ = {1,0,1,0,1} And by doing same process again we get weight matrix as follows

0	-1	1	-1	1
-1	0	-1	1	-1
1	-1	0	-1	1
-1	1	-1	0	-1
1	-1	1	-1	0

Now by adding both matrices we get the following matrix

0	-2	0	0	0
-2	0	0	0	0
0	0	0	-2	2
0	0	-2	0	-2
0	0	2	-2	0

So now we have a weight matrix for a 5 node Hopfield network that's meant to recognize the patterns (0 1 1 0 1) and (1 0 1 0 1). The thing onecan observe is that the patterns only differ by 2 bits. It close might be hard to tell apart. This is sowing that that it is might be difficult to recognized a lower case "e" from "c" or an upper case "O" from "0". So we have to start from the pattern (1 1 1 1 1), which only differs from each of these patterns by 2 bits.

$$V_{i}in = \sum_{j \neq i} W_{ji} V_j$$

$V_i \rightarrow 1$ if $V_{i}in = 0$
else $V_i \rightarrow 0$ ---------------- (2)

In this case, the value of node V3 doesn't change. It's worth noticing that weight of node 3 to itself is 0, then just the dot product ex 3rd column as below:

V3in = (0 0 0 -2 2) * (1 1 1 1 1) = -2 + 2 = 0

Hopfield network updating node like a perceptron. To stop at point we have to evaluate the cycle. if you go through all the available computing nodes and not a single of them changes, you can stop. Or if you found same pattern repeating.

2.3. Hopfield neural network for routing

John Hopfield has invented the Hopfield network in 1982. It is provide as content-addressable memory systems with binary threshold nodes. It is surefire to provide to a local minimum Adaptation of Hopfield's network. It is used to clear the problem of selecting routes in packet switching computer networks. This method of heuristic proved eht shortest path between any two nodes. The shortest path provide minimum end to end delay in the computer packet switching network. The Hopfield network basically work on energy network function. This is also converge to a problem solution if not the best is at close to select the optimum. The Hopfield networks design a class of artificial neural networks which design of n neurons totally connected, each neuron having possibly two states: Vi = 1 and Vi =1

Hopfield introduces the concept of energy of a neural network at a given time t. The states of the network are $Vi \in [-1, +1]$ then the energy of the network is defined as:

$$E = -\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}V_iV_j \quad \text{-------------} \quad (3)$$

Where Wij=Resistive connection between neurons i and j, element of the connection matrix of the network Vi =Output or state of the Ith neuron.

This method is based on a solution for the traveling salesman problem (TSP) [7] In order to map the optimal message routing problem onto Hopfield neural network architecture, the same approach used in [7] to solve the TSP problem is taken to construct the network for this problem. This Architecture requires n sets of n neurons where n are the number of nodes in the message network. One set of n neurons is assigned to each node. The output of that particular set of neurons determines what position in the path to be followed. This approach allows for either a centralized routing scheme or an isolated routing scheme.

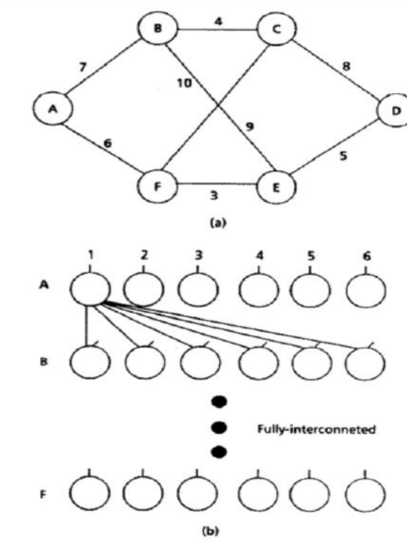

Figure 1: a) Sample test network for a Hopfield net; b) Corresponding Hopfield Network

Output of Hopfield neural network will be like as Let message was being routed from A to D, using the path A->F->E->D, The output of the network would be interpreted to be as shown in below table

1	2	3	4	5
A	1	0	0	0
B	0	0	0	0
C	0	0	1	0
D	0	0	0	0
E	0	0	0	0
F	0	1	0	0

III. IMPLEMTATION N RESULTS

3.1. Shortest Path on NN

A neural network architecture arranged in a two-dimensional array of size n x m, where m is the number of nodes forming the path. The output Vxi of the neuron at location (x, i) is defined as follows:

$$V_{xi} = \begin{cases} 1 \text{ if node } x \text{ is the ith node to be visited in path} \\ 0 \quad \text{otherwise} \end{cases} \quad \text{-------} \quad (3)$$

This above architecture requires prior knowledge of no of nods used to forming shortest path that is a limitation of that model so we approached with alternate presentation of the network model in this model network is stored in $(n \times n)$ matrix with all diagonal elements either set to 0 or removed. it conveys the following meaning Each element in the matrix is a neuron representing that place in the model and represented by double indices (x, i) where row subscript x and column subscript i denotes the node number hence total no of neuron required for computation is $n(n - 1)$and characteristics of particular neuron is denoted by Vxi where

$$V_{xi} = \begin{cases} 1 \text{ if the arc from node } x \text{ to node i is in the shortest path} \\ 0 \quad \text{otherwise} \end{cases} \quad \text{---} \ (4)$$

We define ϱxi as

$$\varrho_{xi} = \begin{cases} 1 \text{if the arc from node } x \text{ to node } i \text{ does not exis} \\ 0 \quad \text{otherwise} \end{cases}$$

In addition to this parameters the cost of an arc from node x to node i will be denoted by Cxi, a finite real positive number. To solve the shortest path problem we have to define the energy function for the hopefield network whose minimization bring the network into lowest energy state and also stable state corresponds to the shortest path in the network.

$$E = \frac{\mu_1}{2}\sum_{\substack{x=1 \\ (x,i)\neq(d,s)}}^{n}\sum_{\substack{i=1 \\ i\neq x}}^{n} C_{xi}\cdot V_{xi} + \frac{\mu_2}{2}\sum_{\substack{x=1 \\ (x,i)\neq(d,s)}}^{n}\sum_{\substack{i=1 \\ i\neq x}}^{n} \rho_{xi}\cdot V_{xi} + \frac{\mu_3}{2}\sum_{x=1}^{n}\left\{\sum_{\substack{i=1 \\ i\neq x}}^{n} V_{xi} - \sum_{\substack{i=1 \\ i\neq x}}^{n} V_{ix}\right\}^2 + \frac{\mu_4}{2}\sum_{i=1}^{n}\sum_{\substack{x=1 \\ x\neq i}}^{n} V_{xi}\cdot(1 - V_{xi}) + \frac{\mu_5}{2}(1 - V_{ds}). \quad \text{----} \ (5)$$

Equation (5) the µl term minimizes the total cost of a path. The µ2 term prevents nonexistent links. The µ3 term is zero if for every node in the solution, the number of incoming arcs equals the number of outgoing arcs. The p4 term pushes the state of the neural network to converge to one of the $2n-12$ corners of the hypercube, defined by $Vxi€\{0,1\}$, The µ5 term is zero when the output of the neuron at location (d, s) settles to 1.

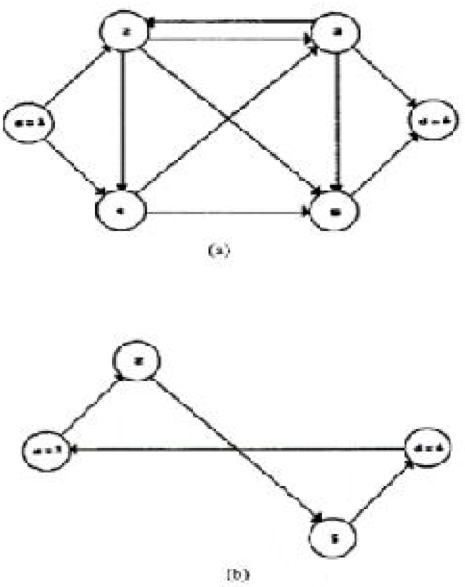

Figure 2: (a) six node network and (b) sample path from source S to Destination D

B	1	2	3	4	5	6
1	**B**	1	0	0	0	0
2	0	**B**	0	0	1	0
3	0	0	**B**	0	0	0
4	0	0	0	**B**	0	0
5	0	0	0	0	**B**	1
6	1	0	0	0	0	**B**

Table above show output of Hopfield network that corresponds to Figure 2(b) primary solution to SP problem. The B denoted here is the blank value of the node. The figure is self explanatory.

3.2. Proposed Algorithms

1. Computer the connection matrix of network
2. Define the initial input
3 Compute bias term
4. Computer the weight using Eq. 1
5. Use the heuristic process for each neuron
6. Recursion till process all neurons
7. Make neuron 1/0
8. Repeat till all neuron set selected

We have done the implementation of neural network in MatLab. There are 9 nodes. We are also selecting the matrix as an input parameter having 9 nodes. We conclude the following table to optimizing the SP problem.

Complexity	Computation	Communication	Adaptation
Hopfield network	O(N3) Initially the number of Messages in learning phase	Post communication none	Possible
Bellman-Ford (Asynchronous Distributed)	O(N3)	Latest routing cost will be broad cast by Each node to respective neighbors	Possible
Dijkstra Algo	O(N2)	Latest neighbor connectivity will be broad cast by each node to all other node	Possible

CONCLUSIONS

From this paper work shows that the routing using hot-potato routing, Dijkstra, floyed-warshall algorithm and bell-men ford are inefficient compare to the Hopfield neural network for optimizing quality of service paremets of communication network. The demand of the field increasing of internet facilities by 2-3 fold now a day need high bandwidth and throughput require dynamic optimization scheme for optimal routing. The main reason for the exploring the neural network capability to solve above problem is the capabilities of neural network for such purpose. A new solution to the shortest path problem was proposed, using a Hopfield type neural network. The energy function is been used to justify N x N matrix input to identify the proposed work. The proposed methods combines converge and scalling, relativity and programming complexity to execute proposed algorithms to realworld. The above feature shows the best performance of hpfield neural network as routing solution. The proposed model was then applied to the optimum minimum delay routing problem in computer networks and our proposed works shows that better result of using neural network than traditional routing algorithms in many cases. It conclude that there is a strong chance that future belongs to neural network algorithms for routing.

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