Evaluate Neural Network for Vehicle Routing Problem

Dr.Luma Salal Hasan
Al-Qadisyah University
Mathematic & Computer Science Faculty
Computer Science Deptt.
Diwanyah, Iraq
Email: lumasalal69@yahoo.com

***Abstract*: In this paper, apply the cascade forward back propagation learning algorithm for symmetric vehicle routing problem to find the best tour with minimum travel time.**
To validate the cascade forward algorithm, use mean square error. The proposed algorithm testing for five nodes with one vehicle without any constraints. From the experiments, conclude that the algorithm gives the best routes but it required more time for computation and learning the network when increase the number of vehicle with number of demands. Also, the network learns very quickly compared with other type of learning algorithm. Further more, the network determines its own size and topology, it retains the structures it has built even if the training set changes.
Therefore, this paper is expected to provide the foundation that can solve a more orders with multiple vehicles.

Keywords: cascade forward back propagation, symmetric vehicle routing problem, mean square error.

I. Introduction

The field of neural networks can be thought of as being related to artificial intelligence, machine learning, parallel processing, statistics, and other fields. The attraction of neural networks is that they are best suited to solving the problems that are the most difficult to solve by traditional computational methods.

Artificial Neural Network (ANN) usually called Neural Network (NN) is a mathematical model or computational model that is inspired by the structure & for functional aspects of biological neural network[4].

Local adaptations are using independent learning rates for every adjustable parameter (every connection). Therefore they are able to find optimal learning rates for every weight.

Scott E. Fahlman and Christian Lebiere have presented a new learning architecture called cascaded correlation algorithm [1].

The Cascade-Correlation is a type of local adaptation and supervised learning algorithm for ANN. Instead of just adjusting the weights in a network of fixed topology. Cascade-Correlation begins with a minimal network, then automatically trains and adds new hidden[5] .

II. METHOD MATERIALS

A. CASCADE FORWARD NN ARCITHECTURE

This algorithm differs in many ways from all other approaches. It begins with a minimal network, then automatically trains and adds new hidden units one by one, creating a multi-layer structure.

Once a new hidden unit has been added to the network, its input-side weights are frozen. The hidden units are trained in order to maximize the correlation between the unit output and the output error. So a training cycle is divided into two phases. First the output units are trained to minimize the total output error.

The model starts with a minimal topology which consisting the required input and output units (with a bias input that equal to 1 always) only. Then it trains until no improvement is obtained. The error for each output is computed.

Next, one hidden unit is added to the net in a two steps.

First step: a candidate unit is connected to each of the input units only. The weights on the connection from the input unit to the candidate are adjusted to maximize the correlation between the candidate's output and the residual error at the output unit. the quantity that should be propagated back when this training is completed, the weights are frozen and the candidate unit becomes a hidden unit in the net.

$$(s = \sum_{o} \sum_{p} \left| \left(v_p - \bar{v} \right) \left(E_{p,o} - \bar{E}_o \right) \right| \qquad (1)$$

- Where o : network output at which error is measured and p is the training pattern.

Values of V averaged over all the patterns (records). And E_o averaged over all the patterns (records).[5]

Second step: the new unit is added to the net that now begins. The new hidden unit is connected to the output unit and adjusted the weights on the connection.

Now all the connection to the output are trained .

A second hidden unit is then added using the same process. This unit receives an input signal from both input and previous hidden unit. all weights on these connection are adjusted and then frozen. The connection to the output are established and trained.

The process of adding new unit ,training its weights from the input and the previously added hidden units, freezing the weights, followed by training all connections to the output units, is continued until the error reaches an acceptable level or the maximum number of epochs or hidden units.

B. VECHILE ROUTING PROBLEM

The vehicle routing problem (VRP) is a combinatorial optimization and integer programming seeking to service a number of a customers[6], proposed by Datzig & Ramser in 1959.

Also, plays a central role for many physical distribution and logistics. The VRP consists one or several depots, nodes(customer's position) and their demand, travel times or cost, and one or more vehicles with capacities. The problem designed for searching optimal delivery or collection routes from one or several depots to a number of nodes depending on several constraints like vehicle capacity, total travel time ,time window for each customer & total length of tours. The objective is to minimize the total distance or time traveled by all vehicles.

In this paper deals with capacitated vehicle routing problem (CVRP) which means the vehicle return to the central node when ordering the tours. With total distance of the tour.

III. SYSTEM MODULATION

A. PROPOSED ALGORITHM

Apply the cascade forward back propagation algorithm for CVRP which described briefly in II.A depending on the following steps:

Step1: input the data
Number of layers(4), number of customers (5) with one vehicle, matrix for distance between the node and maximum of length tour is 6.

Step 2: check if any order is satisfy , & if satisfy the condition for length tour .

Step 3: perform cascade forward algorithm for learning the network.

Step 4: if the learning enough, go to step 5 otherwise go to step 3.

Step 5: find the optimal route.
The steps for cascade forward algorithm can see in the figures 1 through figure 4.

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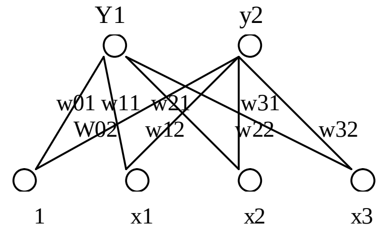

Figure 1. Stage 0, no hidden units

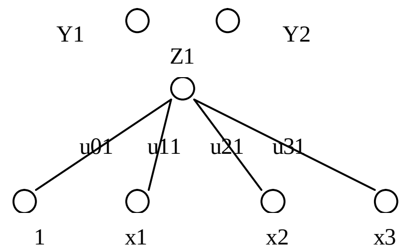

Figure 2. Stage 1,one candidate unit z1

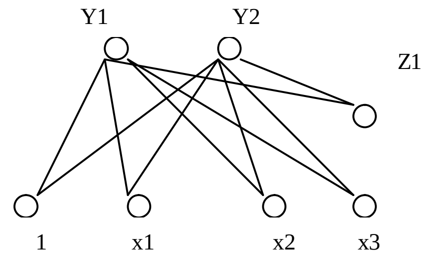

Figure 3. Stage 1 , one hidden unit z1

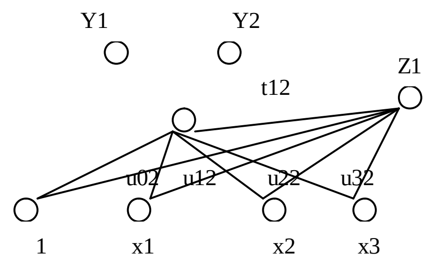

Figure 4. Stage 2,new candidate unit z2

B. VALIDATION OF CASCADE ALGORITHM

To evaluate the performance system , use the mean error square to minimize the training error , which defined in eq.2 [2].

$$MSE = \left[\sum_{1}^{N} \left[\frac{Q_{exp} - Q_{cal}}{n} \right]^2 \right] \qquad (2)$$

Where, Q_{exp} is observed value while Q_{cal} predicated value. N is the number of candidates.

Apply the cascade forward algorithm for the CVRP.
To validate the proposed algorithm, test the system with five customers, assume the total length tour is six (number of node in each tour). The distance matrix that is used , see in table 1.

Table 1. Distance matrix

Node/Demand	1	2	3	4	5
1	0	4	5	6	7
2	4	0	6	7	8
3	5	6	0	3	2
4	6	7	8	0	3
5	7	8	4	5	0

C. RESULTS

To validate the proposed algorithm combining cascade forward learning algorithm for searching the optimal solution for VRP depending on the matrix distance , by using one vehicle for five customers with 6 maximum number of nodes in each route.

With the above data, run the system with 3 layers, 4 input neurons with learning factor varies between 0.1 to 0.5 . with varying of number of learning case. The distance matrix with demands are shown in table 1.

Obtain the best tour node 1-2-4-5-3 and the total travel time is 21.
In figure 5, display the MSE with standard derivation (SD) for four learn cases with 0.1 learn factor.

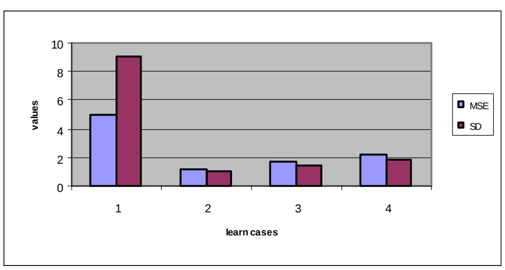

Figure 5. MSE for four learn cases that are shown in table 1.

Table 2. Learn cases for the four tours

Learn case's number	Tour's Node				
L1	2	3	4	5	6
L2	1	3	4	2	5
L3	1	4	2	5	3
L4	3	2	1	4	5

While in figure 6, show the MSE for five learn cases.

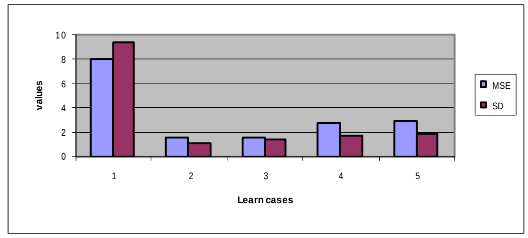

Figure 6. MSE for five learn cases

IV. CONCLUSION

In this paper, apply cascade forward back propagation algorithm for symmetric vehicle routing problem. From experiments , conclude that in the routing system with travel times, the proposed algorithm gives better routes but it required more time for computation and learning the network when increase the number of vehicle with number of demands.

Also, the network learns very quickly compared with other type of learning algorithm [3] further more, the network determines its own size and topology, it retains the structures it has built.

Therefore, this paper is expected to provide the foundation that can solve a more orders with multiple vehicles.

V. REFRENCES

[1] S.E. Fahlman & C.Lebiere," The cascade correlation Learning Architecture", CMU-CS-90-100,feb.1990.

[2] S.Goyal & G.K.Goyal, "Cascade & feedforward backpropagation artificial neural network models for prediction of sensory quality of instant coffee flavoured sterilized drink", Candain Journal of AI,Machinelearning and pattern regognition Vol.2,No. 6,Aug.2011.

[5] L.S.Hasan & S.A.M.Rizvi, " Development of knowledge base using fuzzy logic and genetic algorithm", IJCCE 2009, vol.1,may,2009.

[3] B.Krose & P.V.Smagt, " An introduction to neural network", 8th ed., Nov.1996.

[4] A.Mahrashi, P.Tangaraj & A.Limaji, "Cascade correlation algorithms in neural network", CSE 590, Data mining concepts and techniques.

[6] http://en.wikipedia.org/wiki/vehicle_routing_problem.