Artificial Neural Network Model for the Road Network Optimization

Sanjiv Kumar Shukla
Dr C V Raman University, Kota, Bilaspur, India

Lokesh Kumar Sharma
National Institute of Occupational Health, Ahmedabad- 380016, India

Sunil Kumar Kashyap
Disha Institute of Management and Technology, Raipur, India

Abstract
Road network is a key factor of economic, social and every other form of development in the region and the state itself. In this paper, an artificial neural network (ANN) model for the road network management (RNM is introduced. The RNM transformed into ANN, thus it is treated as a problem and this is the centre of the further study. The problem of RNM is proportional to ANN in this paper. ANN is the best tool to provide a multilevel solution with justification.
Keywords: Artificial Neural Network, Road Network Management

1. Introduction

Road Network optimization or modelling is widely used in Computer Science and Engineering research and it is applied very effectively in Computer simulation of traffic. This is useful in research of traffic modelling, planning and development of traffic networks and systems. Traffic congestion in road networks is one of the main issues to be addressed by today's traffic management schemes. Automation combined with the increasing market penetration of on-line communication, navigation, and advanced driver assistance systems will ultimately result in Intelligent Vehicle Highway Systems (IVHS) that distribute intelligence between roadside infrastructure and vehicles and that in particular on the long term - are one of the most promising solutions to the traffic congestion problem. Road Network optimization has been also used to overcome the traffic congestion problem. The current trend of research work in road network management is to investigate in intelligent approaches integrating soft computing techniques, distributed and collaborative intelligence, bio-inspired intelligence, hybrid approaches, and others. The challenge is to take advantage of each research trend and provide an innovative road network management (Deng and Tong, 2011; Kammoun et al., 2014; Kammoun et al., 2008).

In this paper, we propose an Artificial Neural Network (ANN) model for Road Network Management (RNM). The RNM transformed into ANN, thus it is treated as a problem and this is the centre of the further study. Now, RNM-ANN became a problem. More precisely, the problem is nothing but to justify the RNM. The RNM cannot be accepted as primary level, because there may be various objectives still to achieve. There are numerous hidden goals may be unobserved. These are several hidden options, may not be explored. Hence, without filtering these, how RNM is accepted? The hypothesis of RNM are also required to check and justified via filtering method. After testing the hypothesis, ensuring the fixed hypothesis, we go ahead to plan for the next one, i.e. execution, RNM is reduced to put as the sequential solution for treating as the multi-layer problem. The problem of RNM is proportional to ANN in this paper. ANN is the best tool to provide a multilevel solution with justification.

2. The Proposed Model

The ANN is a technique to find the relationship between the different characteristics and the configurations. In ANN, there may be n-layers, but there is must be 3-layers at least. It means ANN can be defined over the bounded layer interval as, [0, n] or $\leq$ ANN < or ANN ϵ [3, n]. In the base ANN, there are the 3-layers, as input, hidden or middle and output layer. The number of state variables lies in the input layer. It's also referred as the control layer. The number of configurations is associated with the output layer. There are some resultant nodes and these correspondences to the configuration. It should be one-one correspondence. There are the two very important characteristics, which are efficiency and accuracy. These comprise with the middle layer. The conditions and constraints are involved in this study as per the followings:

    a.   n (Hidden Layers) <, =, > n (Output Layers)
    b.   n (Input Layers) <, =, > n (Hidden Layers)
    c.   n (Input Layers) <, =, > n (Output Layers)

Which condition occurs, it is proportional to define the RNM as per the objective. The RNM based NN can be described in the figure 1 and the desired RNM-ANN can be structured figure 2.
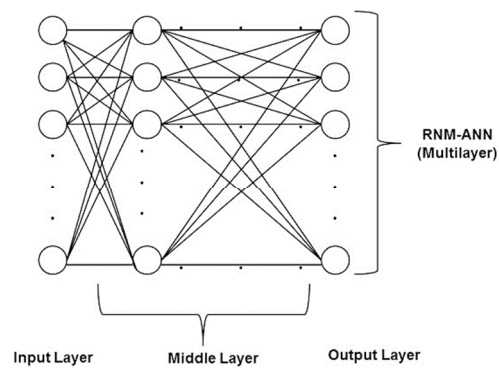
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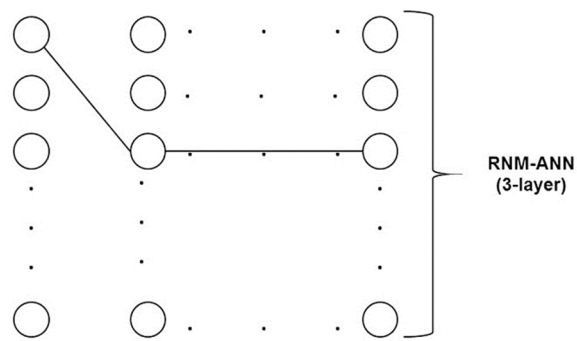
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Figure1. Architecture of ANN.

Figure 2. Architecture of RNM-ANN

The mathematics of this filtration is present below:

Let, Road Vector = R = (r1, r2…rn)T ϵ Rn and Input Vector = I = (i1, i2…in)T ϵ (0, 1). Hence, the RNM-ANN Model = f (R, I). Its configuration Matrix will be as follows:

$$C = \begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix}_{4\times 2}$$

Hence, there exists a difference vector, i.e. D = (d$_1$, d$_2$… d$_n$) ϵ (0, 1), its configuration Matrix will be,

$$C_D = \begin{bmatrix} 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 \end{bmatrix}_{4\times 2}$$

Thus, the error is defined as,

E = C - C$_D$

Therefore, the modified RNM-ANN model will be f (R, E). This can be generalized by ANN basics as

$$\left. \begin{matrix} R_1 & w(R_1) \\ R_2 & w(R_2) \\ \vdots & \vdots \\ R_n & w(R_n) \end{matrix} \right\} \Sigma_1 \to \varphi_1$$

According to the probability

$$\left. \begin{matrix} R_1 & p(R_1) \\ R_2 & p(R_2) \\ \vdots & \vdots \\ R_n & p(R_n) \end{matrix} \right\} \sum_2 \to \varphi_2$$

The one-one correspondence of the both will be,

$$\left. \begin{matrix} R_1 & \dfrac{w(R_1)}{p(R_1)} \\ R_2 & \dfrac{w(R_2)}{p(R_2)} \\ \vdots & \vdots \\ R_n & \dfrac{w(R_n)}{p(R_n)} \end{matrix} \right\} \sum \to \varphi$$

Hence, RNM-ANM is again modified as f (Σ, Ψ). The configuration matrix corresponds with the modified RNM-ANM model as,

$$\begin{matrix} R_1 \\ R_2 \\ \vdots \\ \\ R_n \end{matrix} \begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} \to \begin{bmatrix} 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$
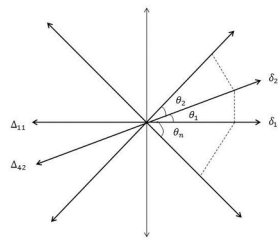
$$\Delta \qquad\qquad\qquad \delta$$

Figure 3: Weight of probability and its representation

The strings are proportional to minors of the above correspondence matrix, as,

$\Delta_{11} = [0] \cdots \Delta_{42} = [1]$

$\delta_{11} = [0] \cdots \delta_{42} = [1]$

The correspondence between Δ and δ will be represented by

$\Delta_{11} \quad \rightarrow \quad \delta_{11}$

$\vdots \quad \vdots \quad \vdots$ It's the isomorphic condition for the RNM-ANF. So, the ANN is applied for RNM also as per the

$\Delta_{42} \quad \rightarrow \quad \delta_{42}$

weight of probability and its representation will be as figure 3.

$O \leq P(R) \leq 1$

Let, the angular distribution of Road as,

$\Theta \in [0, 1]$

$O = \Theta 1 \leq \Theta 2 \leq ... \leq \Theta n = 1$

This is the partition, as per the probability distribution. Hence, the new RNM-ANN model is formed, as the angular configuration matrix.

$$C_\theta = \begin{bmatrix} \theta_1 \\ \theta_2 \\ \vdots \\ \theta_n \end{bmatrix}$$

and its correspondence weight as per the C_Θ is

$$C_{w(\theta)} = \begin{bmatrix} cos\theta_1 \\ cos\theta_2 \\ \vdots \\ cos\theta_n \end{bmatrix}$$

So, the RNN-ANN model will be

$\left. \begin{matrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{matrix} \right\} C_\theta \quad \rightarrow \quad C_{w(\theta)} \quad \rightarrow \quad \Sigma \quad \rightarrow \quad \varphi$

or $\qquad f(R, \varphi)$

or

$$\begin{bmatrix} cos_{\theta_1} \\ cos_{\theta_2} \\ \vdots \\ cos_{\theta_n} \end{bmatrix} \quad \rightarrow \quad \begin{bmatrix} cos_{\varphi_1} \\ cos_{\varphi_2} \\ \vdots \\ cos_{\varphi_n} \end{bmatrix}$$

Thus the RNM-ANN will be layered as figure 4.
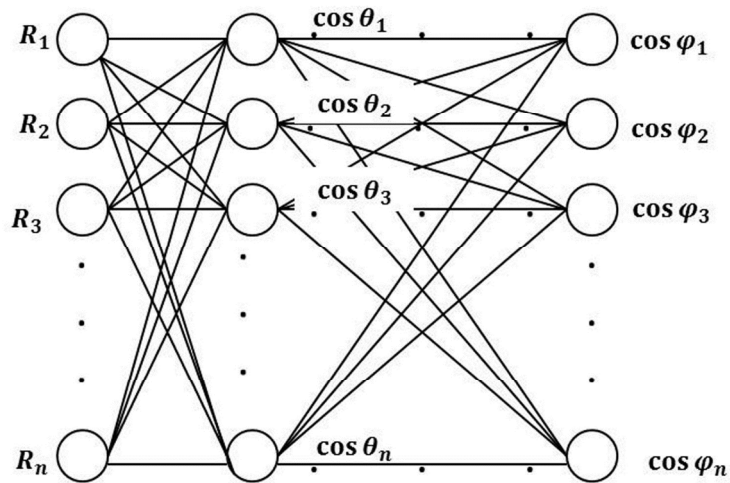

Figure 4: Architecture of RNM-ANN

This is the RNM-ANN problem, and its solution is

$\theta = (\theta_1, \theta_2, \dots, \theta_n) \in (0,1)^n$

$\varphi = (\varphi_1, \varphi_2, \dots, \varphi_n) \in (0,1)^n$

$\Rightarrow \theta \to \varphi$

&

$R = (R_1, R_2, \dots, R_n) \in R^n$

$\Rightarrow R = (\dfrac{w(R_1)}{p(R_1)}, \dfrac{w(R_2)}{p(R_2)}, \dots, \dfrac{w(R_n)}{p(R_n)}) \in (0,1)^n$

$\therefore R \to \theta \to \varphi : \forall R, \theta, \varphi \in (0,1)^n$

3. Conclusion

The road network management study is an important research area for the economic growth. In this paper, we proposed artificial neural network based road network management. This model is simple and easy and can be used to solve the road network problem.

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