Designed a New Model of Neural Networks to Solve a Single Machine Distinct Due Date Earliness and Tardiness Problem

Abdelaziz Hamad Elawad

Abstract

In this paper our objective is to designed a new model of multi layer neural networks to sequence the jobs on the single machine with distinct due date, so that the total penalty cost is minimized. These cost are contains of the total penalty cost due to earliness and tardiness of jobs .We use the concept of units vectors and Mat Lab Software to develop our model. We measured our performance of the model by numerical examples. We found that our model work very well for single machine distinct due date. Further investigation can be carried out for common due date one.

Keys Word: Single Machine, Distinct Due Date, Neural Networks, earliness and tardiness.

I. Introduction

Single machine distinct due date earliness and tardiness machine problem is recommend in just in time scheduling problems areas , because it have more significantly in the range of optimality and the demand situation faced by just in time manufacturing. In this paper we concern about non regular measure that means with multi performance measures, earliness and tardiness of single machine one. We use the Multi layer Neural Network as heuristic method to solve this problem and the concept of units vectors to learn the neural networks with Mat lap Software

T. Garey and Wilfong (1988) were the first to show that the problem of single machine with distinct due date, is NP-hard. Form our experience and working with multi layer neural networks we found that whenever we gives more information with a specific details about the jobs to the neural networks, we will success to find more and accurate scheduling and sequencing. Abdelaziz H. and Bahrom S. (2011) they solve single machine scheduling problem with due date by neural network and they use the concept of Units Vectors.

In this Paper we use the same concept but by adding more units vectors so as to gives more information to the neural network to learn about a the relation between the inputs and output units to give us a good results.

2. Single Machine with Distinct Due Date

In this problem normally there is a set of n independent jobs has to be scheduled on a single machine, which can handle only one job at a time. The machine is assumed to be continuously available from time 0 onwards. Job J_i (i= 1,…, n) has a given processing time P_i and should ideally be completed at a given distinct due date d_i. That means the earliness and tardiness model has different due dates in the job set. This feature tends to make it more difficult to determine a minimum cost schedule than in the problem of common due date one. We assume that the due dates are given and distinct and the slack for each job is small,

And our objective function is a following equation be minimize

$$f(S) = \sum_{i=1}^{n} (\alpha_i E_i + \beta_i T_i). \qquad (1)$$

Manuscript received Jan, 2018.
Abdelaziz Hamad Elawad, *Department of Mathematics Faculty of Science, University Of Albaha.,Albaha , Suadi Arabia*

$$unit1 = \frac{P_i}{M_p}, \quad (2.1)$$

$$unit2 = \frac{d_i}{M_d}, \quad (2.2)$$

$$unit3 = \frac{SL_i}{M_{sl}}, \quad (2.3)$$

$$unit4 = \frac{\alpha_i}{10.0}, \quad (2.4)$$

$$unit5 = \frac{\beta_i}{10.0} \quad (2.5)$$

$$units6 = \frac{P_i}{\alpha_i \times 100}, \quad (2.6)$$

$$units7 = \frac{P_i}{\beta_i \times 100}, \quad (2.7)$$

$$unit8 = \frac{\bar{p}}{M_p}, \quad (2.8)$$

$$unit9 = \frac{\bar{d}}{M_d}, \quad (2.9)$$

$$unit10 = \frac{S\bar{L}}{M_{sl}}, \quad (2.10)$$

$$units11 = \frac{\sum \left(P_i - \bar{P}\right)^2}{n \times \bar{P}^2}, \quad (2.11)$$

$$unit12 = \sqrt{\frac{\sum (P_i - \bar{P})^2}{n \times \bar{P}^2}}, \quad (2.12)$$

$$units13 = \frac{\sum \left(d_i - \bar{d}\right)^2}{n \times \bar{d}^2}, \quad (2.13)$$

$$units14 = \sqrt{\frac{\sum (d_i - \bar{d})^2}{n \times \bar{d}^2}}, \quad (2.14)$$

$$units15 = \frac{\sum (Sl_i - S\bar{l})^2}{n \times S\bar{L}^2}, \quad (2.15)$$

$$unit16 = \sqrt{\frac{\sum (Sl_i - S\bar{L})^2}{n \times S\bar{L}^2}}, \quad (2.16)$$

Where d_i :Distinct due date for job i;

Sl_i: Slack is the different between the due date and processing time;

M_p: longest processing time among the n jobs

M_{SL}: largest slack for the n jobs

$M_{d:}$ latest due date of the n jobs

$\overline{P} : \frac{\sum_{i=1}^{n} P_i}{n}$;

$\overline{SL} : \frac{\sum_{i=1}^{n} SL_i}{n}$;

$\overline{d} : \frac{\sum_{i=1}^{n} d_i}{n}$.

3. A Neural Network for Single Machine Distinct Due Date

The neural network that is proposed for the single machine distinct due date schedule problem is organized into three layers of processing units. There is an input layer of 16 units, a hidden layer, and an output layer that has a single unit. The number of units in the input and output layers is dictated by the specific representation adopted for the schedule problem. In the proposed representation, the input layer contains the information describing the problem in the form of a vector of continuous values. The sixteen input units are designed to contain the following information for each of the **n** jobs that have to be scheduled

The neural network is trained by presenting it with a predefined set of input and target output patterns. Each job is represented by a 16-input vector, which holds information particular to that job and in relation to the other jobs in the problem. The output unit assumes values that are in the range of 0.02 - 0.2, the magnitude being an indication of where the job represented at the input layer should desirably lie in the schedule. Low values suggest lead positions in the schedule; higher values indicate less priority and hence position towards the end of the schedule. The target associated with each input training pattern is a value that indicates the position occupied in the optimal schedule. The target value G_i for the job holding the *ith* position in the optimal schedule is determined as.

$$G_i = 0.02 + 0.2\left(\frac{i-1}{n-1}\right), \quad i = 1,.., n. \qquad (3)$$

Equation (3) ensures that the n target values are distributed evenly between 0.02– 0.2. The number of units in the hidden layer is selected by trial and error during the training phase. The final network for single machine has 16 units in its inputs layer and 1 unit of output layer

The steps for training and employing the neural network for single machine schedule are as follows:

i) Select the input and output training patterns from the solved problems.
ii) Train the neural network model by using the neural network Software in Mat Lap.
iii) Use the trained neural network to solve new problems.

4. Training Example

To illustrate how the neural network is trained the data (see Table 1) are taken from Sunita Gupta and M.M. Rambha (2011), they solve the problem by heuristic algorithm their scheduling sequence J_4, J_2, J_1, J_5, and J_3 with total penalty cost is equals 237.6 units. We use this data to train our Multi Layer Neural Networks model. The 5-jobs are converted first into their vector representations by using the set of equations (2.1-2.16). The result of this pre-processing stage is presented in Table 2 where the vectors V_1-V_5 represent job numbers 1-5 respectively, and the desired output for each of the input vectors is given in the low most row of Table 2. To train the neural network, each vector with their desired output is presented individually at the input layer and output layer of the neural network. Training is considered completed after an average of 5000 cycles is done using a Mat Lap Software. A cycle is concluded after the network has been exposed once, in the course of the back propagation algorithm, to each one of the available training patterns.

Table 1: Training Data

Job i	P_i	d	α	β
J_1	8	9	2	3
J_2	19/3	7	2	3
J_3	17	18	2	3
J_4	29/3	10	2	3
J_5	9	10	2	3

Table 2: Input Vectors for Training Data

	V1	**V_2**	**V_3**	**V_4**	**V_5**
U_1	0.47	0.37	01	0.57	0.53
U_2	0.50	0.39	1	0.56	0.56
U_3	0.2	0.1	0.2	0.05	0.2
U_4	0.2	0.2	0.2	0.2	0.2
U_5	0.3	0.3	0.3	0.3	0.3
U_6	0.04	0.03	0.09	0.05	0.05
U_7	0.03	0.02	0.06	0.03	0.3
U_8	0.59	0.59	0.59	0.59	0.59
U_9	0.6	0.6	0.6	0.6	0.6
U_{10}	0.8	0.8	0.8	0.8	0.8
U_{11}	0.16	0.16	0.16	0.16	0.16
U_{12}	0.4	0.4	0.4	0.4	0.4
U_{13}	0.12	0.12	0.12	0.12	0.12
U_{14}	0.35	0.35	0.35	0.35	0.35
U_{15}	0.11	0.11	0.11	0.11	0.11
U_{16}	0.33	0.33	0.33	0.33	0.33
out	**0.27**	**0.26**	**0.31**	**0.25**	**0.28**

5. Numerical Example

In this example we have taken the data of R. J. James (1997), (see Table 3) which the solution is known. He solved the problem by Tabu Search his optimal schedule is J_2, J_1, J_3, J_4, with total cost equals 1585 units. Table 3 shows 4-job single machine tardiness and earliness problem. The 4- jobs are converted first into their vector representation by using the set of equations (2.1-2.16). The result of this pre-processing stage is presented in Table 4, where the vectors V_1-V_4 represented job numbers 1-4, respectively. To solve the schedule problem, each vector is presented individually at the input layer of the neural network. A feed forward procedure of calculations generates a value that appears at the output unit for each of the Fourth input vectors. The output computed by the neural network for each of the input vectors is given in the Table 5.

Table 3: 4- job scheduling problem

Job i	P_i	d_i	α_i	β_i	SL_i
1	81	336	2	5	255
2	82	306	4	6	224
3	103	309	1	8	206
4	141	307	1	3	166

Table 4: Input Units Vectors

	V1	**V_2**	**V_3**	**V_4**
U_1	0.57	0.58	0.73	1
U_2	1	0.91	0.92	0.91
U_3	1	0.88	0.81	0.65
U_4	0.2	0.4	0.1	0.1
U_5	0.5	0.6	0.8	0.3
U_6	0.41	0.21	1	1
U_7	0.73	0.51	0.39	1
U_8	0.72	0.72	0.72	0.72
U_9	0.94	0.94	0.94	0.94
U_{10}	0.83	0.83	0.83	0.83
U_{11}	0.06	0.06	0.06	0.06
U_{12}	0.24	0.24	0.24	0.24
U_{13}	0.002	0.002	0.002	0.002
U_{14}	0.04	0.04	0.04	0.04
U_{15}	0.02	0.02	0.02	0.02
U_{16}	0.15	0.15	0.15	0.15

The Best Validation performance after more than 5000 cycle rotation for the neural net works in Mat Lap software is shown in Figure below.

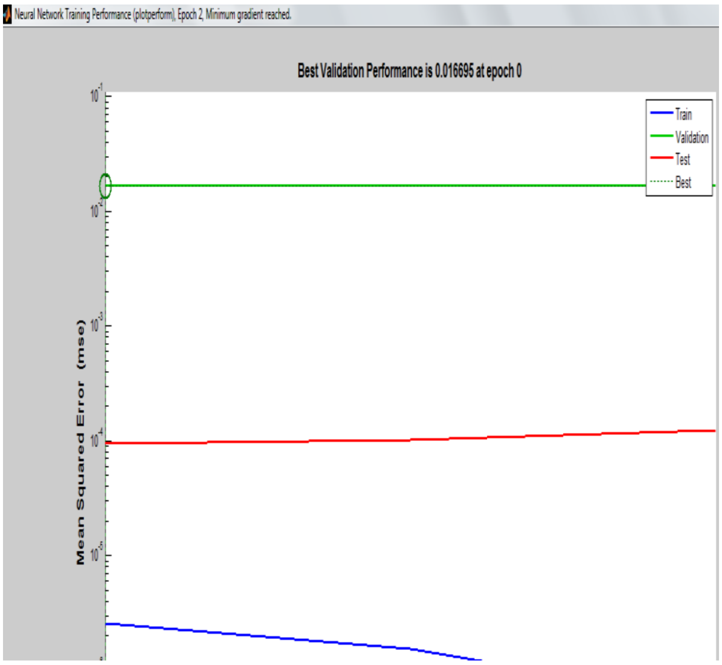
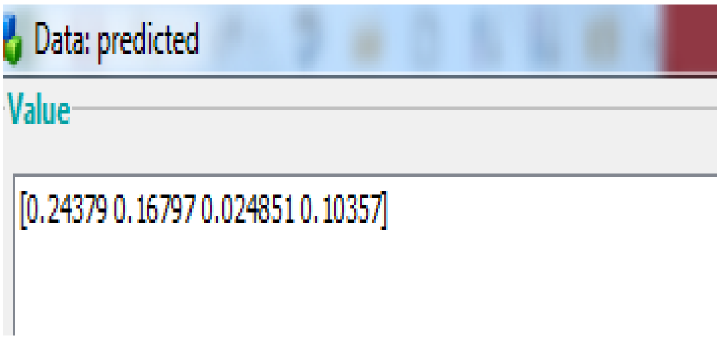


Table 5. Neural Networks Outputs



According to the output predicted by neural networks above the jobs scheduling will be in the order of increasing values is J_3, J_4, J_2 and J_1, with total cost equals 744 units .Which is butter than R. J. James solution .

6. Conclusions

In this paper the single machine schedule with distinct due date with earliness and tardiness penalties was studied. W developed a new model of neural networks to solve this problem, so that the total cost of earliness and tardiness by minimized. It is found that our new model of the neural networks give us an optimal or near optimal solutions. Further investigation cab be carried out for common due date one.

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Abdelaziz Hamad Elawad

Associate Prof. of Mathematics,
Department of Mathematics Faculty of Science, University Of Albaha. Albaha, Saudi Arabia,
PhD (2002) UTM, Malaysia,
Scheduling and neural l Networks . My Research Areas Neural Networks, Scheduling with due date and Fuzzy , Also areas of Fluid Mechanics like Forced KdV equations and any Equations their solutions produces Solitons .

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