Solving Sequencing Problem on Neutrosophic Set

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Abstract

The selection of suitable order for a series of jobs to be done in a finite number of machines has got more importance in real life situation. Industry producing a number of products, each of which to be processed through different machines always try to minimize the total elapsed time. ie, to minimize the time from the start to first job to the completion of second job. In this paper sequencing problem has been redesigned to handle the case in which most values are given in terms of neutrosophic numbers, since in real life situations, there always exist uncertainty about the values.

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I. INTRODUCTION OF SEQUENCING PROBLEM:1

Consider a real life situation involving processing of 'j' jobs on m machines. They can be handled by a very lengthy and time consuming exercise. $(j!)^m$ different sequences would be required in such case. However, we do have a method applicable under the condition that no passing of jobs permissible and if either or both of the conditions stipulated before are satisfied.

Let there be n jobs, each of which is to be processed through K machines, say M_1, M_2, …..M_k in the order M_1, M_2,….M_k. The list of jobs with their processing time is:

	Job number	1	2	3………………………	n
Processing time on machine	M_1	t_{11}	t_{12}	t_{13}………………………	t_{1n}
	M_2	t_{21}	t_{22}	t_{23}………………………	t_{2n}
	M3	t_{31}	t_{32}	t_{33}………………………	t_{3n}
	.	.	.		.
	.	.	.		.
	.	.	.		.
	M_k	t_{k1}	t_{k2}	t_{k3}………………………	t_{kn}

An optimum solution to this problem can be obtained if either or both of the following conditions hold:

a) Minimum $t_{1j} \geq$ maximum t_{ij} for i = 1,2, 3,…….k-1 (Or)
b) Minimum $t_{kj} \geq$ maximum t_{ij} for i = 1,2,…..k-1

II. INTRODUCTION OF NEUTROSOPHIC SETS: 2

Neutrosophic set (NS) first introduced by Smarandache (1999) [10] in order to handle the problems with indeterminate and inconsistent information.NS is difficult to apply in real problems, so the single valued neutrosophic set was introduced by Wang (2010)[12] to be applied to real scientific and engineering situations. In this section, some basic concepts and definitions on neutrosophic sets and single valued neutrosophic sets are reviewed from the literature.

A. *Definition: 2.1*

Let X be a space of points with generic elements in X denoted by x; then the neutrosophic set A (NS A) is an object having the form A= {<x : $T_A(x)$, $I_A(x)$,$F_A(x)$ > , x∈ X} where the function T, I, F : X $\rightarrow$ $]^-0, 1^+[$ define respectively the truth membership function, an indeterminacy membership function, and a falsity membership function of the element x∈ X to the set A with the condition: $^-O \leq T_A(x) + I_A(x) + F_A(x) \leq 3^+$ ---------------(1)

The function $T_A(X)$, $I_A(X)$ and $F_A(X)$ are real standard or nonstandard subsets of $]^-0, 1^+[$ and it is difficult to apply NS to practical problems

B. *Definition: 2.2*

Let X be a space of points (objects) with generic elements in X denoted by x. A single valued neutrosophic set A (SVNS A) is characterized by truth membership function $T_A(x)$, an indeterminate membership function $I_A(x)$ and a falsity membership function $F_A(x)$.

For each points xin X $T_A(x)$, $I_A(x)$, $F_A(x)$ in [0, 1]

A SVNS A can be written as $A = \{<x: T_A(x), I_A(x), F_A(x) > x \in X\}$ (2)

C. *Definition: 2.3*

Let $A_1 = (T_1, I_1, F_1)$ and $A_2 = (T_1, I_1, F_2)$ be two single valued neutrosophic numbers. Then the operations for SVNS are defined as follows:

1) $\tilde{A}_1 + \tilde{A}_2 = < T_1 + T_2 - T_1T_2, I_1I_2, F_1F_2>$
2) $\tilde{A}_1 \times \tilde{A}_2 = < T_1 + T_2, I_1 + I_2 - I_1I_2, F_1 + F_2 - F_1F_2>$
3) $\lambda \tilde{A}_1 = < 1-(1-T_1)^{\lambda}), I_1^{\lambda}, F_1^{\lambda}>$
4) $\tilde{A}_1^{\lambda} = (T_1^{\lambda}, 1-(1-I_1)^{\lambda}, 1-(1-F_1)^{\lambda})$, where $\lambda > 0$

D. *Definition: 2.4*

The empty set O_n may be defined as $O_n = \{<x, (0,1,1) > x \in X\}$
A convenient method for converting single valued neutrosophic number is by use of score function.

E. *Definition: 2.5*

Let $\tilde{A}_1 = (T_1, I_1, F_1)$ be a single valued neutrosophic number. Then, the score function $S(\tilde{A}_1)$ accuracy function $a(\tilde{A}_1)$ and certainty function $C(\tilde{A}_1)$ of SVNS are defined as follows.

$$S(\tilde{A}_1) = \frac{2+T_1-I_1-F_1}{3}; \quad \text{(ii) } a(\tilde{A}_1) = T_1 - F_1; \text{ (iii) } C(\tilde{A}_1) = T_1$$

F. *Definition: 2.6*

Suppose that $\tilde{A}_1 = (T_1, I_1, F_1)$ and $\tilde{A}_2 = (T_2, I_2, F_2)$ are two single values neutrosophic numbers. Then we define ranking method as follows.

1) If $S(\tilde{A}_1) > S(\tilde{A}_2)$, then is $\tilde{A}_1$ greater than $\tilde{A}_2$ that is, $\tilde{A}_1$ is superior to $\tilde{A}_2$, denoted by $\tilde{A}_1 > \tilde{A}_2$.
2) If $S(\tilde{A}_1) = S(\tilde{A}_2)$ and $a(\tilde{A}_1) > a(\tilde{A}_2)$ then $\tilde{A}_1$ is greater than $\tilde{A}_2$, that is $\tilde{A}_1$ is superior of $\tilde{A}_2$, denoted by $\tilde{A}_1 > \tilde{A}_2$.
3) If $S(\tilde{A}_1) = S(\tilde{A}_2)$, $a(\tilde{A}_1) = a(\tilde{A}_2)$ and $C(\tilde{A}_1) = C(\tilde{A}_2)$ then $\tilde{A}_1$ is greater than $\tilde{A}_2$ that is, $\tilde{A}_1$ is superior to $\tilde{A}_2$ denoted by $\tilde{A}_1 > \tilde{A}_2$.
4) If $S(\tilde{A}_1) = S(\tilde{A}_2)$, $a(\tilde{A}_1) = a(\tilde{A}_2)$ and $C(\tilde{A}_1) = C(\tilde{A}_2)$ then $\tilde{A}_1$ is equal to $\tilde{A}_2$ that is $\tilde{A}_1$ is indifferent to $\tilde{A}_2$ denoted by $\tilde{A}_1 = \tilde{A}_2$.

III. ILLUSTRATIVE EXAMPLE

Now we will solve a problem to verify the proposed approach.

1) There are 6 jobs, each of which has to go through 3 machines M_1, M_2 and M_3 in the order M_1 M_2 M_3. Find the minimum elapsed time if no passing of jobs is permitted. Also determine the idle time for each machine. Here each job has been assigned to single valued neutrosophic number as follows.

Table - 1

Jobs / *Machines*	*A*	*B*	*C*	*D*	*E*	*F*
M_1	*(.1,.2,.4)*	*(.2,.2,0)*	*(.5,.5,.5)*	*(.2,1,0)*	*(.1,.2,0)*	*(.2,.2,.2)*
M_2	*(.1,.8,.6)*	*(.1,.7,.5)*	*(.1,.7,.6)*	*(.2,.5,.7)*	*(.2,.7,.6)*	*(.2,.8,.6)*
M_3	*(.2,.2,.1)*	*(.8,.7,.2)*	*(.2,.2,.3)*	*(.3,.1,.2)*	*(.1,.2,.5)*	*(.1,.1,.1)*

A. *Solution*

The neutrosophic set of values is converted by means of a score function is as follows: The above problem transformed into

Table - 2

Jobs / *Machines*	*A*	*B*	*C*	*D*	*E*	*F*
M_1	*.5*	*.67*	*.50*	*.4*	*.63*	*.60*
M_2	*.233*	*.3*	*.267*	*.33*	*.3*	*.27*
M_3	*.63*	*.63*	*.567*	*.67*	*.467*	*.63*

Minimum $M_{1j} = .4$, J = 1, 2,…….6
Maximum $M_{2j} = .33$, J = 1, 2,…….6
Minimum $M_{3j} = .467$, J = 1, 2,……..6
Min $M_{1j} \geq$ Max M_{2j} and
Min $M_{3j} \geq$ Max M_{2j}

The problem can be converted into that of 6 jobs and 2 machines respectively. These two fictitious machines are denoted by G and H, where each
$G = M_{1j} + M_{2j}$, J = 1, 2,………..6

And $H = M_{2j} + M_{3j}$, J = 1, 2,………..6
The equivalent problem involving 6 jobs and 2 fictitious machines G and H becomes

Table - 3

	A	*B*	*C*	*D*	*E*	*F*
G	*.733*	*.97*	*.767*	*.73*	*.93*	*.87*
H	*.863*	*.93*	*.834*	*.10*	*.767*	*.90*

By examining, we find the smallest value. It is .1 hour for H in 4th column. Then we schedule job D in the last as shown below.

G→

					D

←H

The scheduled set of processing time is

Table - 4

	A	*B*	*C*	*E*	*F*
G	*.733*	*.97*	*.767*	*.93*	*.87*
H	*.863*	*.93*	*.834*	*.767*	*.9*

The smallest value is .73. it is for machine G for Job A. Then we schedule job Ain first column as given below.

G→

A					D

←H

Then the reduced set of processing time becomes

Table - 5

Jobs / *Machines*	*B*	*C*	*E*	*F*
G	*.97*	*.767*	*.93*	*.87*
H	*.93*	*.834*	*.767*	*.9*

There are two equal minimal values .762: Job C for machine G and Job E for machine H. According to the rules Job C is scheduled next to A and Job E is scheduled next to Job D as shown below:

A	*C*			*E*	*D*

The reduced set of processing time becomes

Table - 6

Jobs / *Machines*	*B*	*F*
G	*.97*	*.87*
H	*.93*	*.9*

Next smallest value is .87 hours. It is for machine G for Job F. Therefore, we schedule Job F next to C and we get the optimal sequence as

A	*C*	*F*	*B*	*E*	*D*

Now we can calculate the elapsed time corresponding to the optimal sequence, using the individual processing time given in the problem. The details are shown in the table below:

Table - 7

Machines / *Jobs*	M_1		M_2		M_3	
	In	*Out*	*In*	*Out*	*In*	*Out*
A	*0*	*.5*	*.5*	*.733*	*.733*	*1.363*
C	*.5*	*1*	*1*	*1.267*	*1.363*	*1.93*
F	*1*	*1.6*	*1.6*	*1.87*	*1.93*	*2.56*
B	*1.6*	*2.27*	*2.27*	*2.57*	*2.57*	*3.2*
E	*2.27*	*2.9*	*2.9*	*3.2*	*3.2*	*3.667*
D	*2.9*	*3.3*	*3.3*	*3.63*	*3.667*	*4.337*

Then the minimum elapsed time is 4.337 hours.
Idle time for machine M_1= 1.037 hours
For machine M_2 = .5+.267+.333+.4+.33+.1+.707
= 2.637 hours
And for machine M_3 = .733 +.01
= .743hours

IV. CONCLUSION

This paper is introduced to solve sequencing problem for m machines and n jobs on neutrosophic set ie, under uncertainty environment by converting it in to 2 machines and n jobs problem. We can also solve the same sequencing problem by converting it into m machines and two jobs sequencing problem.

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