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Framework and Evolution of Task Orientation using Fuzzy and GA

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Abstract*: The process of selecting employees in any organization is done by mostly old ways. There is a lack of hypothetical support in this method, and error is possible in the result. In the research paper presented, we have outlined the recruitment and selection process of employees with the help of Fuzzy Triangular Number. The selection process given here is completely different from the methods given earlier. To find the ideal employee here, we use the modified method of solving assignment problem. Using certain linguistic variables, we use robust ranking method here. The solution obtained from this method is minimized using the revised approach of assignment. This modified approach is simpler than the Hungarian method previously used by other authors. Using this modified solution, the minimum solution is achieved by reducing the number of recurring assignments. After assignment process, finally selection of employees is given using criterion of GA.

***Keywords*: Fuzzy Triangular Count, Genetic Algorithm (GA), Linguistic Variables, Recruitment and Selection in Jobs, Robust Ranking Method.**

I. INTRODUCTION

The task assignment issue is an extraordinary kind of LP problem. its goal is the recruitment of n number of persons to n number of occupations with least cost and with most extreme benefit Distribution of any work can be entrusted to people by transferring jobs or various tasks in various works or in the real life of any kind. The method of assigning the tasks into different people was firstly discovered by the Kuhn HW [1], which is known as the Hungarian approach. By using this method, more and more work is done using minimum value. Many more methods were discovered in the context of assigning the tasks among different people, which could benefit the organization by using the least value or minimum cost. These methods include neural networks [2], genetic algorithms [3], fuzzy algorithms, etc. Several methods have been proposed for doing traditional tasks during recent years. In 1970, Bel & Zad gives the idea of fuzzy set theory into the fundamental steerage outlets including permeability and imprecision. Fuzzy Assignment Problems have gotten untrustworthy consideration recently. There are a few more paper's [9-11] having concept of Ggeneralized fuzzy numbers and for taking care of precise outlets. Linzhong Liu et al [7] found the Genetic Algorithm for confirming the fuzzy weighted conjunction and multiple work task issues. Lin and Wen [4] proposed a productive calculation in light of the naming strategy for tackling the Linear Fractional Programming Problem. J. Xu [8] built up a requirement dependent Genetic Algorithm to a Routing Assignment display with Fuzzy Vehicle Connection Network. Chen [5] talked about a fuzzy task show that considers all people to have same abilities. Long-Sheng Huang and Li-Pu Zhang [6] built up a numerical model for the fuzzy task issue and changed the model as certain task issue with confinement of capability. Refine approach for taking care of a lopsided task issue is examined by Yadaiah Ventepaka et al in their paper [16]. Also, this paper is the extension of the paper [17] in which author already defines the necessary preliminaries and the technique of selection of stage 1 and stage 2 of the proposed technique.

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II. BASIC PRELIMINARIES

A. Fuzzy Number

A fuzzy number is an extension of a generic, real number in the sense that it does not refer to one single esteem(value) but rather to a connected set of possible esteems(values), where each possible esteem(value) has its own weight between 0 and 1. This weight is called the membership function. i.e. fuzzy number is the quantity whose value is imprecise.

B. Triangular Fuzzy Number

Any Triangular Fuzzy Number $A(x)$ is represented by $A(a,b,c;1)$ with membership function $\mu(x)$ where

$$\mu(x)=\begin{cases} l(x)=\dfrac{x-a}{b-a}, & a\le x\le b \\ 1, & x=b \\ r(x)=\dfrac{c-x}{c-b}, & b\le x\le c \\ 0, & \text{otherwise} \end{cases}$$

Where $\mu \sim l(x)$ and $\mu \sim r(x)$ are the left and right membership function of the fuzzy set.

C. Non-Negative Triangular Fuzzy Number

If $a \geq 0$ then the Triangular Fuzzy Number $A = (a, b, c; 1)$ is known as non-negative TFN.

D. α-Cut

The alpha-cut of a fuzzy set A is the crisp set $a + A$ that contains all the elements of the universal set X where $A(\alpha) = \{x / \mu(x) \geq \alpha, \alpha \in [0,1]$.

E. Genetic Algorithm

The candid thinking behind the GA is that it is mainly to control the number of chromosomes and to keep them stable (the accumulation of genes). The solution is sought through this method until the nearest optimal solution is found. Through the use of genetic algorithms, there has been a great mastery in solving search and optimization problems. The following are some key parts of the genetic algorithm.

➢ **Fitness Function-** The fitness function used here is calculated as follows

$$\text{Fitness Function} = \left(\sum_{i=1}^{n} \text{Chromosome's Gene Value-1} \right)$$

➢ **Arithmetic Crossover-** Here primal formula for effective arithmetic crossover is calculated as follows

off spring 1: a*Parent$_1$ + (1-a)*Parent$_2$

off spring 2: (1-a)*Parent$_1$ + (a)*Parent$_2$

➢ **Boundary Mutation-** The use of mutation in the search space is done to preserve the diversity of chromosomes in order to find new dimensions to evaluate. Here, binary conversion is used for the fitness value generated after crossover than binary to decimal conversion was perform to get decimal value of each chromosome.

F. Fuzzy Assignment Problem

According to each physical structure, some mathematical phenomena occur regularly in daily routine.

we will draw up in detail the mathematical pattern of assignment issue by fuzzy theory for the selection of candidate in the recruitment strides.

Suppose that there be $n \times n$ jobs/peoples in the system. The cost of assignment is affected by various parameters in real life and therefore assignment cost coefficient also has an uncertain value and changes in different time limits respectively. Here, we assume the assignment cost as a fuzzy number and is given by $\tilde{c} = (\underline{c} / c / \bar{c})$ where $\underline{c}$, $\bar{c}$ and c is the most possible , most optimistic and most pessimistic assignment cost respectively. But natural if the cost coefficient is FN, the total assignment cost also becomes FN. Hence, the FAP can be given as,

$$Min.\ Z = \sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij} x_{ij}$$

Subject to

$$\sum_{i=1}^{n} x_{ij} = 1\ ,\ j = 1, 2, 3, \ldots\ldots\ldots\ldots, n$$

$$\sum_{j=1}^{n} x_{ij} = 1\ ,\ i = 1, 2, 3, \ldots\ldots\ldots\ldots, n$$

$$x_{ij} \in \{0,1\} \text{ for } i, j = 1, 2, \ldots\ldots\ldots\ldots, n$$

G. Robust's Ranking Method

Here we defined the transformation of fuzzy cost coefficient into crisp ones using ranking method. For this purpose, R-R technique is used here which satisfies linearity, compensation, and additive property. This procedure provides results that conform to human intuition. If $\tilde{c}$ is a FN then the R-R method is given by

$$R(\tilde{c}) = \int_0^1 0.5(c_l, c_u)\, d\alpha$$

Where (c_l, c_u) is the α - cut of the fuzzy number $\tilde{c}$.

III. Problem Narration And Algorithm

Employing employees in each organization/company is an important and a long-time job, which sometimes becomes difficult. The process of recruitment for four job titles Production Manager (PDM), Quality Control Analyst/ Manager (QCM), Laboratory Analyst (LBA) and Research - Development Manager (RDM) in the organization/ company is going on. For the PDM designation there are 2 vacancies, 4 vacancies for QCM are located, 3 vacancies are located for LBA and 1 vacancy for RDM is empty. This means that the organization has to appoint 10 employees. On the basis of necessary education and experience from the applications received for the above-mentioned posts, a total of 50 application forms have been received. Now the problem is to select the most suitable 10 candidates out of these 50 applications. Together, this process is to be fast and accurate too.

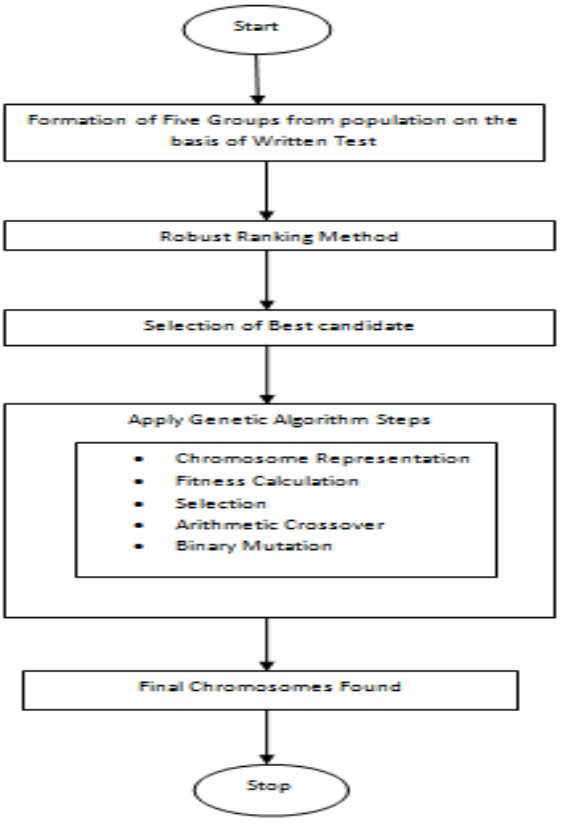

Fig. 1. Flow Chart of the Proposed Method

IV. IMPLEMENTATION

Stage1: At initial stage, after the written test of applicants we subdivide the all applicants in 5 groups having 10 candidates in each. In second round, the obtained score in the written test of candidate is evaluated by using R-R technique. Point to be noted that scale taken to be [10-25] for this purpose.

$$G_1 = (C_i)_{i=1}^{10},$$
$$G_2 = (C_i)_{i=11}^{20},$$
$$G_3 = (C_i)_{i=21}^{30},$$
$$G_4 = (C_i)_{i=31}^{40},$$
$$G_5 = (C_i)_{i=41}^{50}$$

The data in Table (1 – 5) is evaluated by using R-R technique. Here in Table 1 for C_1, the cost for PDM is 12 which is evaluated as follow:

For Fuzzy Triangular Number - (10, 12, 14)

$$(C_k^l, C_k^u) = [2k+10, 14-2k]$$
$$= 24$$
$$R(\tilde{C}) = \int_0^1 [(0.5) * 24] dk$$
$$= [12k]_0^1 = 12$$

Table-1: Marks for Group 1 Candidates

Candidate	(PDM, QCM, LBA, RDM)
C_1	(12,18,20,15)
C_2	(16,19,14,20)
C_3	(22,24,15,15)
C_4	(14,22,19,13)
C_5	(16,18,24,21)
C_6	(18,15,25,20)
C_7	(16,17,12,21)
C_8	(18,19,22,23)
C_9	(24,11,16,15)
C_{10}	(15,18,21,10)

Table-2: Marks for Group 2 Candidates

Candidate	(PDM,QCM,LBA,RDM)
C_{11}	(16,20,25,21)
C_{12}	(15,22,19,16)
C_{13}	(14,24,18,14)
C_{14}	(22,16,20,25)
C_{15}	(23,19,21,15)
C_{16}	(13,20,24,21)
C_{17}	(10,15,19,17)
C_{18}	(14,23,16,18)
C_{19}	(18,23,20,16)
C_{20}	(18,21,22,23)

Table-3: Marks for Group 3 Candidates

Candidate	(PDM,QCM,LBA,RDM)
C_{21}	(21,22,23,16)
C_{22}	(16,21,20,19)
C_{23}	(18,16,18,23)
C_{24}	(15,21,20,24)
C_{25}	(14,16,23,21)
C_{26}	(19,24,15,14)
C_{27}	(24,18,15,22)
C_{28}	(22,17,21,16)
C_{29}	(14,15,18,25)
C_{30}	(13,19,22,24)

Table-4: Marks for Group 4 Candidates

Candidate	(PDM, QCM, LBA, RDM)
C_{31}	(15,18,22,19)
C_{32}	(21,16,24,20)
C_{33}	(23,12,19,16)
C_{34}	(24,19,18,20)
C_{35}	(21,25,16,24)
C_{36}	(13,20,17,19)
C_{37}	(15,24,18,16)
C_{38}	(13,20,19,17)
C_{39}	(23,18,22,16)
C_{40}	(20,16,12,25)

Table-5: Marks for Group 5 Candidates

Candidate	(PDM,QCM,LBA,RDM)
C_{41}	(16,14,20,22)
C_{42}	(18,20,21,24)
C_{43}	(24,21,18,16)
C_{44}	(23,16,19,14)
C_{45}	(19,20,12,15)
C_{46}	(12,16,21,13)
C_{47}	(18,13,20,10)
C_{48}	(13,14,22,12)
C_{49}	(18,11,15,20)
C_{50}	(24,21,15,10)

Stage 2: Now **at *second stage*,** after applying assignment modified technique [18] , We have got four most efficient candidates from each group. That is 20 from 50 candidates have been selected out in this phase. After completing the first phase (written exam) and modified technique, the last 20 selected candidates are here.

PDM	$C_1, C_{16}, C_{30}, C_{38}, C_{46}$
QCM	$C_9, C_{17}, C_{23}, C_{33}, C_{48}$
LBA	$C_7, C_{13}, C_{27}, C_{40}, C_{45}$
RDM	$C_{10}, C_{15}, C_{26}, C_{37}, C_{47}$

Stage 3: Genetic Algorithm Implementation

In the third phase, genetic algorithm is applied to all selected groups found in the second phase. Here the genetic algorithm implementation is shown only for PDM post:

1. **Chromosome Narration-**

Generally, in GA, for representing chromosomes binary encoding is used. But here, value encoding has been used to represent chromosomes. In value encoding, genes of chromosomes can be represented by the sequence of real numbers and values.

2. **Fitness Value Evaluation-**

To obtain the proximity of an exceptional chromosomes' fitness value is used i.e. for finding the suitable candidate and to find its closeness to the optimum value. Here fitness function is given by:

$$Fit_{Val} = \left(\sum_{i=1}^{n} CGV - 1 \right)$$

Where

Fit_{Val} =Fitness Value and CGV = *Chromosomes Gene Value*

3. **Chromosome Selection Method-**

In order to find solution closer to the optimal solution, we have to select the best chromosome for next step evaluation. For this purposed Rank selection method is used here. After evaluating the fitness value, chromosomes are arranged in descending way, and then para-mounted chromosomes are selected.

4. **Crossover-**

Here value encoding is used for chromosomal representation, so we continue this by using arithmetic crossover operator. Arithmetic crossover operator generates two new offspring as given below-

$$Offspring\ 1: [A * P1 + (1-A) * P2]$$

$$Offspring\ 2: [(1-A) * P1 + A * P2]$$

5. **Mutation** –

To evaluate the mutation, Here, we used binary conversion from the binary to the fitness value generated after the decimal conversion. Each chromosome was exhibited to achieve the decimal value.

After performing all these steps, the best three chromosomes (based on their fitness value) are expelled from the population. The most suitable two candidates for Production Manager (PDM) are C_1 and C_{38} .

Table-6: Final Result for the PDM Post

Chromosome	$C16 = 13$ $C30 = 13$ $C38 = 13$ $C1 = 12$ $C46 = 12$
Fitness Value	12,12,12,11,11
After Crossover	12,12,11.6,11.4,11
Before Mutation Binary Form	1100, 1100, 10111, 101101, 1011
After Mutation Binary Form	1110, 1110, 10011, 100101, 1001
Decimal Value	14,14,19,37,9

Similarly, the complete procedure can be performed on all posts i.e. Quality Control Analyst/ Manager (QCM), Laboratory Analyst (LBA) and Research-Development Manager (RDM). The best suitable candidates can be selected and the final results shown in Table 7 for all the posts.

Table-7: Finally, Selected Candidates for all Posts

Post	Candidates	Decimal Value
PDM	C_1, C_{38}	37,19
QCM	$C_{48}, C_{17}, C_{23}, C_{33}$	113, 49, 25,19
LBA	C_{27}, C_{13}, C_7	105, 27,9
RDM	C_{15}	49

V. CONCLUSION

This process of recruitment of jobs at different places of work for different candidates has been done in the process by using fuzzy technique and modified process of assignment and using genetic algorithm in a phased manner.

As a result of this research paper, it is also known that with the view of genetic algorithm, fuzzy logic gives significant and favorable results. The data received here is more optimum than the data received from other methods in the past. The approach used here is a stepping process so it improves solution achieved in each stage or phase, and ultimately results in impeccable and optimal results. This technique is also useful for various LPP problems as transport problems, network flow problems, replacement problems etc.

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Dr. Anju Khandelwal, is passionate and creative educator who believes in making an everlasting Impact and contribution in imparting knowledge by means of Interactive Learning Methodologies. Her research area is Distributed Computed System, Cloud Computing and Fuzzy Theory. She has obtained her Ph. D. degree in Operations Research, M.Sc. in Mathematics with Computer Application and B.Sc. in Mathematics and Physics. She has more than 18 years teaching, 13 years research experience. She has written four books for UG and PG level students. Recently one of her books entitled, "Amalgamated Optimization Techniques", published by Lap Lambert Academic Publishing, Mauritius. She is a life member of different organizations such as IAPS, AMS, ORSI, VPI, CSI etc. and also a Reviewer/Editorial member of different National and International Journals such as Journal of Bizcraft, BJIT, SCIREA Journal of Computer, SCIREA Journal of Mathematics, American Journal of Mathematical and Computer Modelling (AJMCM) etc. She has organized 4 National Conferences which was sponsored by DST and Commission for Scientific and Technical Terminology, Ministry of HRD, Higher Education, New Delhi. She has published more than 25 Research Papers/ Articles in reputed National/International Journals. Also, she presented more than 30 papers in different National/ International conferences and attended more than 15 other courses such as Refresher/ Orientation Courses/ Workshop (Sponsored by DST)/ Quality Improvement Program/ Faculty Development Program Sponsored by AICTE etc. Apart from this also chaired sessions in different conferences and give invited talks also. She is Awarded "Bharat Vikas Award" certificate of Excellence for loyalty, Diligence & Outstanding Performance in the field of Fuzzy and Cloud Computing by Institute of Self Reliance on December, 2018. She also Awarded "Rashtriya Shiksha Samman Award" by National Education & Human Resource Development Organization (NEHRDO) Mumbai on Feb, 2019 in Mumbai.

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His research interests are Modeling, Optimization Techniques and Distributed Computing Systems. Solution provided for Unbalanced Assignment and Transportation problems with application in Distributed Systems. He always set the target to achieve the highest and serve for the humanity and society. He has set his principle of life as, "An optimal policy (set of decisions) has the property that whatever be the initial state and decisions are the remaining decisions must constitute an optimal policy with regard to the state resulting from the first decision"- 'Richard E Bellman's principle of optimality'.