2021 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS) | 978-1-6654-4854-3/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICITBS53129.2021.00205

Human Resource Allocation Method Based on Multi Objective Optimization

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***Abstract*—To realize the reasonable assignment of employees' tasks, this paper proposes a multi-objective human resource allocation model based on genetic algorithm for the multi-stage combinatorial optimization problem. We analyzed the basic idea of the resource allocation model, established the necessary network model and a multi-objective mathematical model. Then, the global optimal solution can be found by searching from the point set with the objective of optimizing the three practical indexes of reasonable grouping. Finally, a multi-objective optimization method based on genetic algorithm was proposed to solve the model, and it was verified by an example case. The experimental results showed that the method can maximize the sum of the effective cumulative rate of all the roles who undertake the task, and it had the characteristics of clear logic, simple calculation and practical application value.**

Keywords-GA; human resource allocation; muli objective optimization; Matlab

I. INTRODUCTION

Human resource needs to meet the company's overall strategy or business objectives in terms of quality and quantity, and achieve its human resource business objectives through a series of human resource business processes. In recent years, the research on the optimal allocation model of human resources at home and abroad has achieved fruitful results, gradually from focusing on qualitative research to quantitative research. The model of human resource allocation is based on the rank structure of a company and quantifies the rank of employees. The human resources department of the company sets up management line and professional line posts according to the importance of the post, whether it is more inclined to implementation, whether it is more inclined to management or strategy formulation, whether it has professional technology or skills, and sets up different levels accordingly. Accordingly, the differences of positions and levels are reflected in the corresponding salary system. In the process of project implementation, many projects are likely to use a large number of key resources, especially the key human resources. This brings the enterprise the difficulties of multi project schedule management, multi project resource optimization and risk control.

Genetic algorithm takes all individuals in a population as objects, and uses randomization technology to guide efficient search for a coded parameter space. Due to the parallelism of the algorithm itself and less restrictions on solving the problem, the algorithm has the characteristics of strong generality, fast convergence and simple calculation, so the use of genetic algorithm to optimize the human resource allocation problem can achieve good results. Therefore, this paper uses the multi GA optimization decision model to deal with the problem, and regards the task as a series of interactions between the decision-maker and the outside world in different stages of GA, the corresponding constraints are generated according to the demand, and then the problem is transformed into a process of finding a set of Pareto optimal solutions. Then, the optimized GA is used to determine the parameters combined with the experimental simulation to obtain the multi-objective optimal human resource allocation. Finally, the test results show that the scheme is feasible and efficient.

II. NETWORK MODEL OF HUMAN RESOURCE ALLOCATION

A. Network Model Construction of Multi Objective Human Resource Allocation

The fundamental problem of human resource allocation is to reasonably allocate several human resources to several tasks, to maximize the efficiency of human production. Such kind of problem is generally described by hierarchical mathematical model, and the available human resources and cost information are regarded as the total resource constraints of the project. Considering the optimal total income and the minimum time consumption of an enterprise, how to solve the human resource allocation equation according to the known conditions, especially the rational use of scarce resources, is very important for the internal circulation of resources, long-term scientific development and effective management of employees.

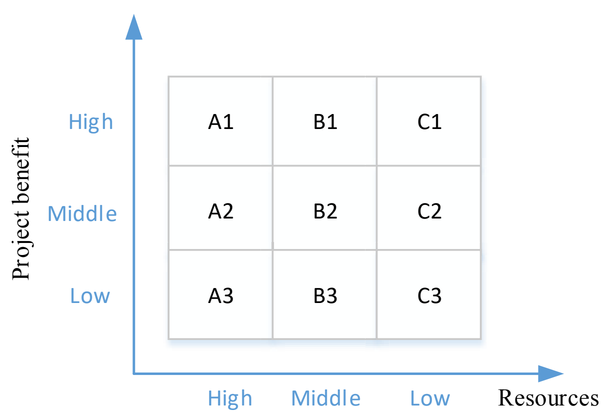


Figure 1. Priority classification of project resource allocation

As shown in figure 1, in the initial stage, the existing projects are classified into three categories: A, B and C according to different types of project returns and completion complexity. Then each major project is further divided into three sub categories: 1, 2 and 3 according to professional level and resource demand. For the weight of project benefits, we can refer to the capacity planning model in figure 1 to clearly show the profit rate and personnel utilization rate of each sub project. This model can also effectively guide the progress planning of super large projects, so as to give clear guidance for the flow of internal staff.

B. Mathematical Expression

In the mathematical model of dual criteria resource allocation problem, m employees are assigned to n different projects to maximize profits and minimize costs under resource constraints, which is expressed as the following dual criteria integer programming model.

$$\max z_1(y)=\sum_{i=1}^{n} f_1(y_i) \tag{1}$$

$$\max z_2(y)=\sum_{i=1}^{n} f_2(y_i) \tag{2}$$

$$s.t.\ G_0(y)=\sum_{i=1}^{n} g_i(y_i) \le M \ , \quad y_i = 0,1,\ldots,M \ \forall i$$

According to the above mathematical model, it can be extended to a new mathematical model of multi-objective optimization. In the dual criteria resource allocation problem, n different tasks are assigned to m employees to maximize profit and minimize cost under resource constraints. It is expressed as a bi-criteria integer programming model as follows:

$$\max z_1(x)=\sum_{i=1}^{n}\sum_{j=0}^{M} p_{ij}x_{ij} \tag{3}$$

$$\max z_2(x)=\sum_{i=1}^{n}\sum_{j=0}^{M} c_{ij}x_{ij} \tag{4}$$

$$s.t.\ G_0(x)=\sum_{i=1}^{n}\sum_{j=0}^{M} jx_{ij} \le M$$

$$s.t.\ G_i(x)=\sum_{j=0}^{m} x_{ij} = 1, \forall i$$

$$x_{ij} = 0 \ or\ 1, \forall i, i$$

Parameters and variables in the model:
i is the local store index (i= 1, 2, 2, n);
j is the sales assistant index (j = 1, 2, ..., m);
N is the total number of local stores;
M is the total number of salesmen;

c_{ij} denotes the cost of place i when j salesmen are allocated;

p_{ij} is the profit of place i when one salesman is distributed;

III. OPTIMIZATION MODEL OF HUMAN RESOURCE ALLOCATION BASED ON GENETIC ALGORITHM

A. Overall Design Idea

As a multi-stage decision-making model, the problem of human resource allocation refers to the optimization of multi-objective, such as improving work efficiency and realizing human resource under the constraints of resources. Under the given conditions, the mathematical description is usually completed by a group of functions. Generally, the flow of human resource allocation system based on genetic algorithm is depicted as figure 2:

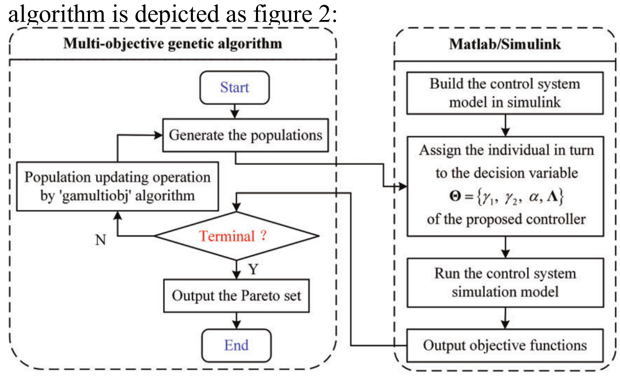


Figure 2. Multi objective optimization process of GA

B. Detailed Design

1) Coding method

Point coding means that each gene value of an individual is represented by a floating point number in a certain range. When the individual length is short, it may not meet the accuracy requirements. When the individual coding length is long, although it can improve the accuracy, it increases the difficulty of decoding and makes the search space of genetic algorithm expand rapidly. Therefore, the floating-point coding method is used to deal with the complex constraints of decision variables.

Given the mode number of each activity as m_i, the value of the initial individual on each locus in generated randomly in $\{1,2,\ldots,m_i\}$, and the group size is repressed by N_{size}. Then the chromosome structure is depicted as figure 3.

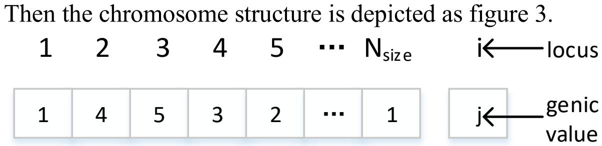


Figure 3. Chromosome structure

2) Fitness calculation

Fitness function is used to distinguish the quality of individuals in the population. Fitness function has an important impact on the direction of evolution, and it is also a key factor affecting the operation efficiency. In the design of fitness function, we should have a clear goal and let the system evolve in the required direction. When the optimization objective is to find the maximum value of the function, and the objective function is always positive, the fitness of the individual can be directly set equal to the corresponding value of the objective function, that is, $F(X)=f(X)$. Then, after N generations of natural selection, the preserved individuals are highly adaptable individuals. We transform the efficiency optimization objective into the maximization problem as:

$$\max \theta_2 = \frac{i^T X(t_m)/l(t_m)}{L(t_m)} \tag{5}$$

3) Selection operator

In this paper, the tournament selection method with competition scale of 2 is used as the selection operation method. When selecting, two individuals are selected, and the individuals with low individual level are preferred. If the individual level is the same, the individuals with large crowding distance are selected, and the operation is repeated until all individuals complete the selection operation.

4) Crossover operation

The crossover does not necessarily take place between any two parents, and the operation has a certain probability. The crossover probability q_c controls the frequency of crossover operation. Establish a mapping relationship according to the two groups of genes exchanged, as shown in figure 4. We can see that there are two genes 1 in the second step. At this time, it will be transformed into gene 3 through the mapping relationship, and so on until there is no conflict. Finally, all the conflicting genes will be mapped to ensure the formation of a new pair of offspring genes.

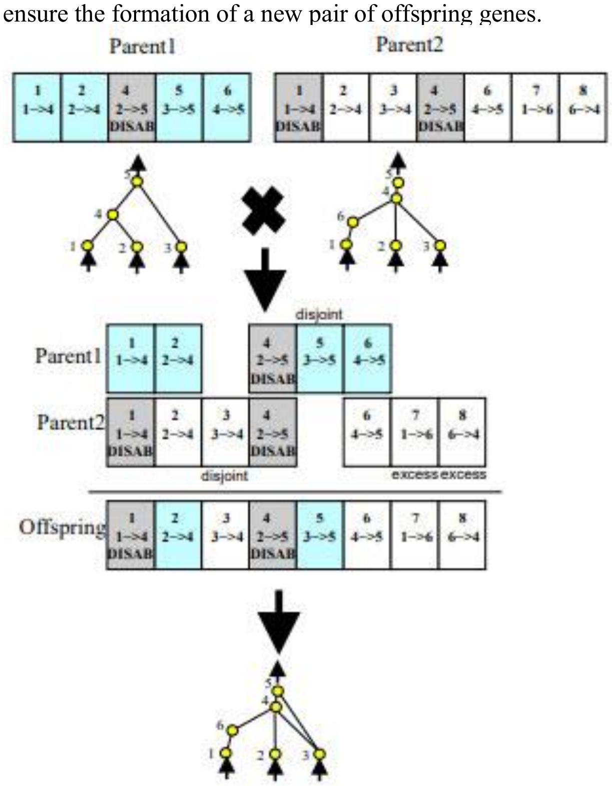


Figure 4. Example of crossover operation

5) Mutation operator

Mutation operation is an auxiliary method to generate new individuals, which determines the local search ability of genetic algorithm. The mutation operation in genetic algorithm is to replace the gene values of some loci in the coding string of individual chromosome with other alleles on the locus, so as to form a new individual. For individuals with floating-point coding, if the gene value at a mutation point is in the range of $[U_{min}, U_{max}]$. Non-uniform mutation is used in this paper, and the key part of the algorithm uses pseudo codes are described as follows:

```
void ga::Mutation(MatrixXi & x, int group_number, int chromlength)
    {
        srand((unsigned)time(NULL));
        double ran1 = rand() % 100 / (double)101;
        if (ran1 > Mutation_probability)
            return;
        for (int i = 0; i < group_number; i++)
        {
            double ran2 = rand() % 100 / (double)101;
            cout << ran2 << endl;
            int place = ran2 * chromlength;
            if (x(i, place) == 0)
                x(i, place) = 1;
            else
                x(i, place) = 0;
        }
}
```

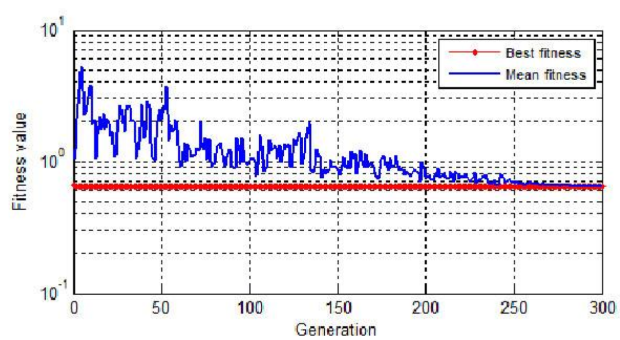
IV. PERFORMANCE EVALUATION OF SCHEME

To verify the performance of the algorithm, this paper combined with a specific example to simulate and test the human resource allocation model. Firstly, the priority factors among several projects are obtained by using balanced scorecard and fuzzy comprehensive evaluation method. The parameter setting between these projects basically meets the basic needs of human resource management of large enterprises, and there is no cross in task planning, and the core path is fixed. In the human resource allocation, the key tasks should be given priority. Limited by the total amount of resources, even if the main project does not need a specific resource at the same time, there will be local overlap competition events in the set time period. The data of the project are shown in Table 1.

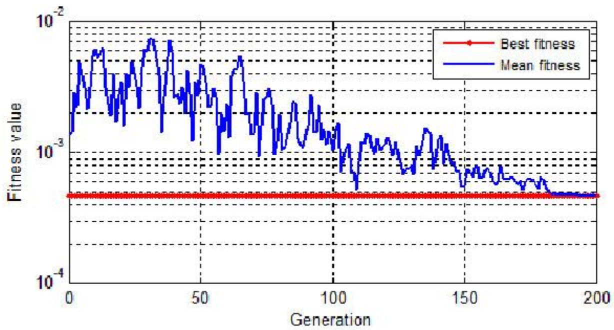
Table 1. Principle data of the project

Project	Priority weight factor	Estimated completion time	Delay cost loss	Workload (person/day)
1	0.43	10	100	100
2	0.34	9	150	80
3	0.29	12	90	120

Matlab is used to solve the optimization function of GA model under constraint conditions, and the comparison algorithm is the traditional linear optimization operation. The experimental results of GA with different parameters are shown in figures 5(a) and (b). It can be seen that the genetic algorithm is feasible in solving the human resource allocation under two common parameter settings, and it can get the Pareto optimal solution quickly with less iterations.



(a) α=1 and β=0



(a) α=0.5 and β=0.5

Figure 5. Experimental result of different parameter settings

To test the performance stability of the algorithm, we increase the sub project value of a project to 6. The random generating function is used to generate a positive integer that does not exceed the encoding length, and the maximum number of terminated population is 500. When the initial population reaches the 100th iteration, all the operators stop and replace the mutation point gene with another value. In this way, through GA toolbox, the final human resource allocation scheme is obtained, as shown in Table 2. It can be seen that in the case of efficiency and income being given equal priority, the human resource allocation strategy chooses the comprehensive value as balanced as possible to meet the sum of the effective cumulative rate, while the remaining resources participate in other tasks with the second highest weight at the same time. It ensures the implementation and final efficiency of the enterprise's overall work plan.

Table 2. Human resource allocation plan

	B_1	B_2	B_3	B_4	B_5	B_6
A_1	0	28	0	70	0	0
A_2	137	0	75	14	0	0
A_3	0	19	0	0	85	32

V. CONCLUSIONS

In order to realize the principle of dynamic adaptation, quantitative analysis should be used to allocate and adjust the positions of employees in modern enterprise human resource management. According to the characteristics of modern human resource allocation requirements, this paper designs a solution method based on multi-objective genetic algorithm. Based on the matching model, a multi-objective hybrid genetic algorithm is proposed to solve the combinatorial optimization problem, which can solve the multi-objective and multi-stage human resource allocation problem at the same time. The results show that the model and algorithm are effective and feasible, which can provide reference for enterprise personnel decision-making.

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