The Article Title Should be at Least 5 Words but no More Than 30 Words

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Abstract. This article studies the attendance situation of employees and temporary workers in the sorting center in the future, and ensures a balance between attendance rate and actual hourly efficiency. Establish a multi-objective linear programming model and list multiple constraints, such as personnel non negative integer constraints, task quantity compliance constraints, formal worker quantity constraints, attendance rate constraints, continuous attendance days constraints, and maximum work efficiency constraints. In order to obtain the optimal solution, the NSGA-III algorithm was used for optimization and solving. The paper elaborates on the establishment process of a multi-objective linear programming model, clarifies decision variables and objective functions, and introduces objectives such as minimizing the total number of people, balancing actual worker performance, and balancing attendance rates. In addition, the paper introduces the basic principles of the NSGA-III algorithm and the model solving process based on this algorithm, demonstrating some of the prediction results. This study has important guiding significance for managers to optimize work arrangements and improve work efficiency.

Keywords: NSGA-III Algorithm, Multi-objective Planning, Employee Scheduling.

1. Introduction

In the operation of modern logistics and sorting centers, reasonable scheduling of employees is not only a fundamental management task, but also a core link that directly affects the entire operation system. By scientifically planning and optimizing employee scheduling, work efficiency can be effectively improved, ensuring the rational utilization of human resources, and thus reducing the operating costs of the enterprise. In addition, reasonable scheduling can ensure service quality and customer satisfaction, ensure timely processing and accurate delivery of orders, enhance the competitiveness and reputation of enterprises in market competition, and thus achieve sustained and stable business development [1].

In order to provide reasonable employee scheduling, this algorithm has been widely adopted and continuously optimized in the research of Flexible Job Shop Scheduling Problem (FJSP) to adapt to complex production scheduling requirements. The improved NSGA-III algorithm, such as the version proposed by Song Cunli et al., further enhances the efficiency and quality of solving FJSP through innovative population initialization, adaptive mutation strategy, and elimination mechanism, providing a powerful optimization tool for production scheduling in intelligent manufacturing [2]. The improved NSGA-III algorithm, such as the version proposed by Han Rui et al. in the AGC coordinated optimization strategy for power systems, effectively coordinates the output of photovoltaic, hydroelectric, and thermal power units by introducing multi-objective optimization based on Pareto theory, and optimizes the frequency regulation of the power grid [3]. In the field of HVAC systems, the NSGA-III algorithm plays an important role, especially in the high-dimensional multi-objective optimization of small-diameter finned tube evaporators. Wu Junhong et al. proposed a hybrid optimization method by combining steady-state distributed parameter method and NSGA-III algorithm, effectively analyzing the influence of structural parameters and flow path on evaporator performance and optimizing the design [4]. The application of this algorithm not only improves the heat transfer efficiency of the evaporator, but also reduces the pressure drop on the refrigerant and air sides, while controlling costs, providing a powerful optimization tool for improving the energy efficiency and controlling manufacturing costs of air conditioners. These studies demonstrate the effectiveness and flexibility of the NSGA-III algorithm in solving complex system optimization problems with multiple objectives and constraints [5]. Future research may further explore algorithm improvements and their effectiveness in more practical application scenarios.

For the scheduling problem of SC60 Sorting Centre, considering that it has 200 regular workers, it is necessary to design a reasonable scheduling strategy to maximize the efficiency of manpower use and reduce manpower costs [6]. In the process of scheduling, it is necessary to fully consider the attendance rate of regular workers, the limit of consecutive days of attendance and other constraints, and design a scheduling plan that meets the actual situation. At the same time, the use of temporary workers also needs to be taken into account to ensure that manpower costs are reduced as much as possible on the premise that the cargo demand of each shift is met. To complete this problem, a flexible scheduling algorithm is required, which takes into account various constraints to achieve the best scheduling results. In this process, the study introduces the concept of marginal contribution and employs a new algorithm, the NSGA-III algorithm, for scheduling optimisation solution. This algorithm is particularly suitable for dealing with optimisation problems involving multiple objectives and complex constraints, and it effectively balances the conflicts and trade-offs between multiple objectives by means of a non-dominated sorting method based on reference points to achieve the optimal scheduling results. As for data sources, the study is based on data from number modelling competitions for analysis and model construction. Through this approach, the study is not only able to provide managers with an effective work scheduling optimisation strategy, but also to ensure the flexibility and adaptability of the scheduling scheme to accommodate the various changes and demands that may arise in future sorting centres [7].

2. Basic principles of NGSA-III

2.1. Structure of NSGA-III

NSGA-III is a genetic algorithm developed based on NSGA-II for solving multi-objective optimization problems. NSGA-III mainly targets problems with multiple (usually three or more) objective functions and aims to improve the algorithm's ability to handle high-dimensional multi-objective optimization problems [8]. The basic structure is shown in Figure 1.

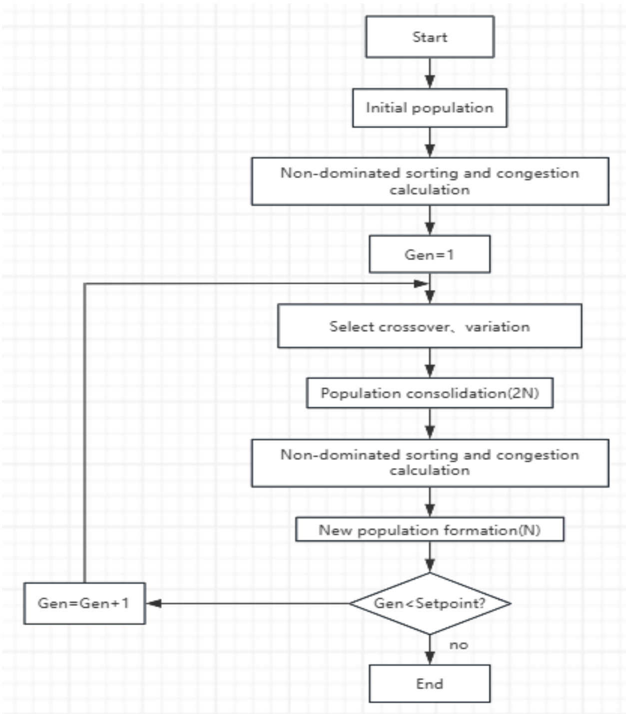

Figure 1. NSGA-III basic structure

2.2. The basic process of NSGA-III

The general model of NSGA-III consists of five basic steps [9], which are:

(1) Utilize non dominated level population classifiers. In NSGA-III, programs that use the usual dominance principle to identify non dominated frontiers are also employed.

(2) Use a set of predefined H reference points to ensure the M diversity of solutions to the objective function, and place the points on p a standardized $M-1$ dimensional hyperplane of partitions.

$$H = \binom{M+p-1}{p} = \frac{(M+p-1)!}{p!\,(M-1)!} \tag{1}$$

(3) Identify the objective function $f_i(x)$ and determine the ideal points of the population, search for the extremum points on the target axis z_i^{min}, calculate the intercept of each linear hyperplane a_i to normalize the objective function.

$$ASF(x,w) = \max_{1\le i\le M} \frac{f_i'(x)}{w_i}, \qquad \forall x \tag{2}$$

$$f_i^n(x) = \frac{f_i'(x)}{a_i - z_i^{min}} = \frac{f_i(x) - z_i^{min}}{a_i - z_i^{min}}, \qquad \forall i \tag{3}$$

(4) Perform adaptive regularization on each target and associate each population member with a reference point. And implement small habitat protection operations, which refers to places with lower population density.

(5) Using genetic manipulation for elitist selection, creating offspring populations and maintaining diversity among solutions.

3. Experimental procedure and analysis of results

3.1. Establishment of Experimental Model

Firstly, it is necessary to clarify the objectives and constraints of the model establishment. In the process of solving the problem, considering that taking the maximum efficiency every time may lead to an increase in worker efficiency deviation; in order to better and more conveniently achieve the goal, this article introduces four decision variables x_{ijk} and $P_{ij} y_{ij}$, T_{ij}. The goal is to make the actual worker performance as close to equilibrium as possible every hour of the day, which means minimizing efficiency differences between shifts as much as possible. For this purpose, an objective function was set to minimize efficiency deviation [10].

The formula for calculating the objective function of the problem model and its related approximate variables are as follows:

(1) Constraint on the number of formal workers

$$\sum_{k=1}^{200} x_{ijk} \le 200, \quad \forall i,j \tag{4}$$

(2) Non negative integer constraint on attendance status

$$x_{ijk}, y_{ij} \in N^*, 0 \le x_{ijk} \le 1, \qquad \forall i,j,k \tag{5}$$

(3) Approximately number of attendance times per day

$$\sum_{j=1}^{6} x_{ijk} \le 1, \ \forall i,k \tag{6}$$

(4) Continuous attendance days constraint

$$\sum_{i=st}^{st+7} x_{ijk} \le 7, \quad \forall j,k \tag{7}$$

(5) Formal attendance rate constraint

$$\sum_{i=1}^{30} \sum_{j=1}^{6} x_{ijk} \le 26, \ \forall k \tag{8}$$

(6) Task quantity meets the standard constraint

$$\sum_{k=1}^{200} x_{ijk} \times P_{ij} + y_{ij} \times T_{ij} \geq C_i, \quad \forall 1 \leq i \leq 30, 1 \leq j \leq 6 \tag{9}$$

(7) Maximum efficiency constraint

$$P_{ij} \leq 25,\ T_{ij} \leq 20 \qquad \forall i, j \tag{10}$$

(8) Objective function one: Minimize the total number of people

$$Minf(1) = \sum_{i=1}^{30} \sum_{j=1}^{6} \left(\sum_{k=1}^{200} x_{ijk} + y_{ij} \right) \tag{11}$$

(9) Objective Function 2: Minimize the Mean Difference in Actual Worker Performance

$$Minf(2) = \sum_{i=1}^{30} \sum_{j=1}^{6} \sum_{k=1}^{200} \left| e_{ijk} - \bar{e}_{ij} \right| \tag{12}$$

(10) Objective Function Three: Minimize the Mean Difference in Actual Worker Attendance Rates

$$Minf(3) = \sum_{i=1}^{30} \sum_{j=1}^{6} \sum_{k=1}^{200} \left| a_{ijk} - \bar{a}_{ij} \right| \tag{13}$$

In the above model, by adjusting the T_{ijk}values of decision variables x_{ijk}andy_{ij}, P_{ijk}, the optimal solution is found that minimizes the total number of person days while satisfying all constraints.

3.2. Analysis of experimental results

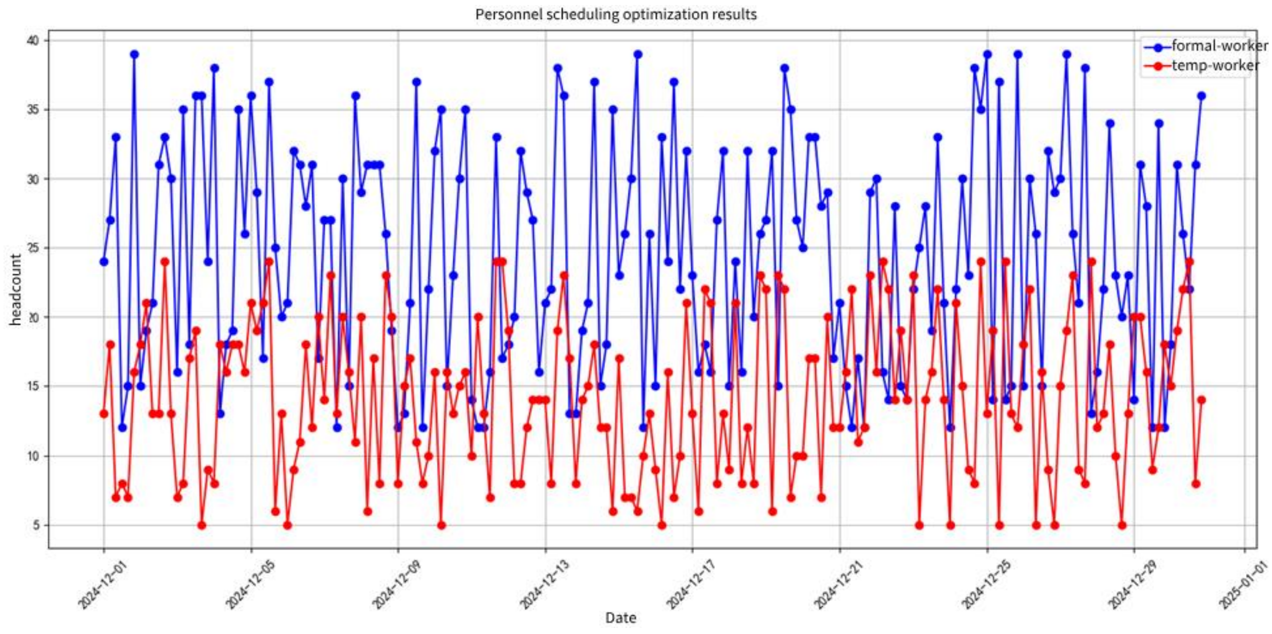

Figure 2. Personal scheduling optimization results

In this experiment, by observing Figure 2, we can see that the daily attendance numbers of permanent staff exhibit a certain regularity, indicating that the attendance rate of permanent employees is relatively stable. Additionally, when the number of permanent staff increases, it is often accompanied by a decrease in temporary staff numbers; conversely, when there is a continuous increase in the number of permanent staff members on duty, the number of temporary staff rises to replace the permanent staff.

Based on this analysis, we can conclude that the NSGA-III algorithm demonstrates high accuracy and efficiency in solving employee scheduling problems. It not only can quickly search for a set of non-dominated solutions but also ensures that these solutions have good diversity and distribution characteristics. Therefore, the algorithm plays a significant role in helping companies achieve effective utilization and optimization of human resources.

4. Conclusion

In the context of human resource management and efficiency improvement, this article proposes how to optimize the attendance of sorting center employees and the arrangement of temporary work shifts. To solve this problem, the author adopted a multi-objective linear programming model and introduced the NSGA-III algorithm for solution. The conclusion of the study is that this method can achieve a balance between attendance and actual hourly efficiency, while minimizing the total number of people, providing managers with an effective work arrangement optimization strategy.

In the future, this research area will further integrate technologies such as artificial intelligence and big data to optimise human resource management and enhance organisational effectiveness through data-driven decision-making. Meanwhile, the rise of new business employment models will drive innovation in management strategies, while policy orientation and compliance will guide the rational application of HRM technologies. Interdisciplinary research methods will provide new perspectives for solving complex management problems and help companies remain competitive in the rapidly changing market environment.

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