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The Analysis about Two Types of Special Assignment Problems

Zhao Chun-Xue
School of Mathematics and Statistics, Anyang Normal University, Anyang, China
Corresponding Author: Zhao Chun-Xue

Abstract: *The athlete selection problem is a typical assignment problem of the optimization. In this paper, we analyze two types of assignment problems about the number of people is less than the number of tasks and use integer programming algorithm to solve the them, which provides method guidance for the athlete assignment problem.*

Keywords: *assignment problem; integer programming; Lingo*

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I. Introduction

In the application of optimization theory, the assignment problem is often used to solve the practical problem. For example, Liu[1] analyzed the multiple attribute group decision making based on the optimal linear assignment. Goldberg et.al.[2] researched the messy genetic algorithms. Cantu-Paz[3] gave a summary of research on parallel genetic algorithms. Eshelman[4] provided the CHC adaptive search algorithm. Srinivas[5] had a research on the adaptive probabilities of crossover and mutations in GAs. Houck et.al.[6] gave a genetic algorithm for function optimization. Tsujimura et.al.[7] provided the genetic algorithms for solving multi-processor scheduling problems.Nakano[8] studied the conventional genetic algorithm for job shop problems. Li et.al.[9] gave uniform approach to model-based fuzzy control system design and structural optimization. Carlisle et.al.[10] tracked changing extreme with adaptive particle swarm optimizer. Carlisle et.al.[11] adapted particle swarm optimization to dynamic environments. Goldberg et.al.[12] researched the messy genetic algorithms. The assignment problem also emerge in endlessly in the areas of sports, and it is common in different part of the sports activities. There are many different kinds of sports competitions, and requirements are also different. Then the different requirements cause changes in the assigned project. In the paper, we deal with the assignment problems where the number of people is less than the number of tasks.

II. Modeling

The assignment problem that the number of people is less than the number of tasks can be divided into two situations. One situation is that one person can only correspond to one task, and the other situation is that one person can correspond to multiple tasks. We first discuss one situation is that one person can only correspond to one task, we need to set several persons in imaginary, The number of imaginary persons is equal to the difference between the number of tasks and the number of persons, and set all the coefficients in the coefficient matrix corresponding to the imaginary persons to zero. At this time, the problem is transformed into the assignment problem in general form. The specific solving process is as follows. There are four persons and five competitions, We need to choose four people respectively taking part in four different projects from five projects. The usual performance of each athlete is showed in table 2 (unit: min). Assuming each athlete can only take part in a competition, there can be only one person in each game, and players play normally. We will give the select scheme in which the comprehensive effect of the game is best.

Table 1 The long distance running time to men（unit：min）

Project / Players	800 meters	1000 meters	1500 meters	3000 meters	5000 meters
He Bing	2.39	3.30	5.03	10.36	17.58
Xu Chenglong	2.49	3.32	5.14	12.11	19.45
Wang Zhiwei	2.23	3.20	4.58	10.39	18.38
Guo Xu	2.16	3.05	4.42	11.49	20.21

In table2, there are four players and five projects, then let A_1, A_2, A_3, A_4 stand for He Bing, Xu Chenglong, Wang Zhiwei, Guo Xu, respectively， $B_1, B_2, B_{3,} B_4, B_5$ stand for 800meters、1000meters、1500meters、 3000meters,5000meters, A_5 is the imaginary player. Assuming c_{ij} denotes the costing time that A_i $(i=1,2,\cdots,5)$ take part in B_j $(j=1,2,\cdots,5)$. Then its mathematical model is as follows:

$$\min z=\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}x_{ij}$$

$$s.t.\begin{cases}\sum\limits_{j=1}^{n}x_{ij}=1, i=1,2,3,4,5\\ \sum\limits_{i=1}^{n}x_{ij}=1, j=1,2,3,4,5\\ x_{ij}=0\text{或}1, i, j, n=1,2,3,4,5\end{cases}$$

Where

$$(c_{ij})_{n\times n}=\begin{bmatrix}2.39 & 3.30 & 5.03 & 10.36 & 17.58\\ 2.49 & 3.32 & 5.14 & 12.11 & 19.45\\ 2.23 & 3.20 & 4.58 & 10.39 & 18.38\\ 2.16 & 3.05 & 4.42 & 11.49 & 20.21\\ 0 & 0 & 0 & 0 & 0\end{bmatrix}$$

Using Lingo software, we get the result in figure 2.From figure 2, we find that the total number of variables is 25, when $x_{14}=x_{22}=x_{31}=x_{43}=x_{55}=1$,the optimal solution appears and the optimal solution is $\min z=20.33$,i.e.when He Bing competes in the 3000m, Xu Chenglong competes in the 1000m Wang Zhiwei competes in the 800m, Guo Xu competes in the 1500m, no one competes in the 5,000m, the total time 20.33 is shortest and the overall effect of the competition is the best.

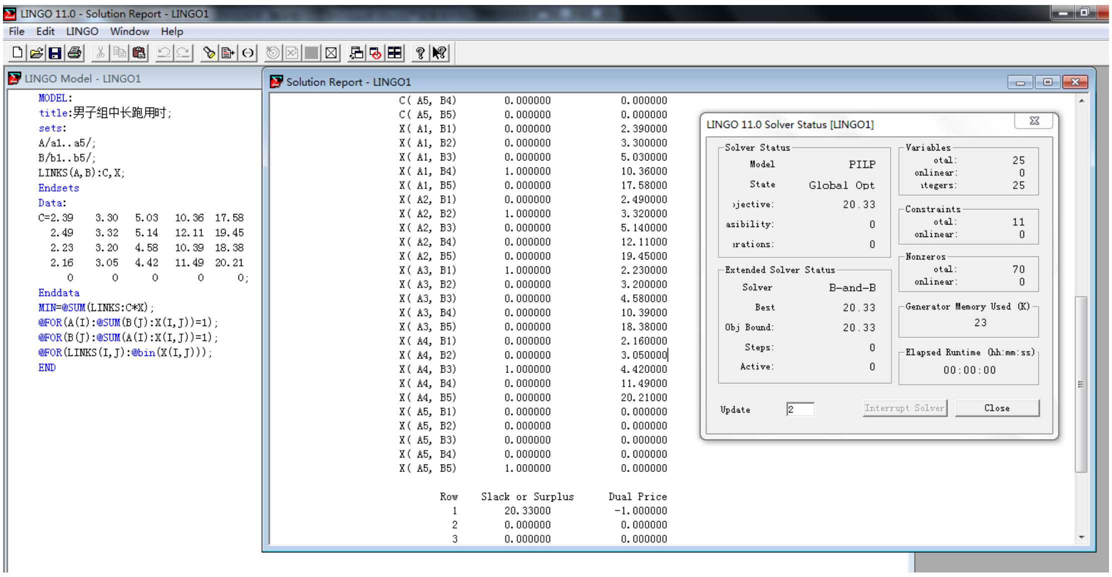

Figure 1 Lingo program and the running result

For the assignment problem that one person can correspond to many tasks and the number of people is less than the number of tasks, we need to first set several persons in imaginary who can deal with multiple tasks. The number of imaginary persons is equal to the difference between the number of tasks and the number of persons. Let the coefficient of the coefficient matrix corresponding to imaginary persons be the same coefficient corresponding person and then translate it into the assignment problem of the general form.

The specific solving process is as follows. There are four persons and five competitions. The usual performance of each athlete is showed in table 3 (unit: min). Assuming that He Bing can participate in two competitions at the same time, the remaining athletes can only participate in one competition, and players play normally. We will give the select scheme in which the comprehensive effect of the game is best.

Table 2 The long distance running time to men（unit：min）

Project / Players	800 meters	1000 meters	1500 meters	3000 meters	5000 meters
He Bing	2.39	3.30	5.03	10.36	17.58
Xu Chenglong	2.49	3.32	5.14	12.11	19.45
Wang Zhiwei	2.23	3.20	4.58	10.39	18.38
Guo Xu	2.16	3.05	4.42	11.49	20.21

In table3, there are four players and five projects, then let A_1, A_2, A_3, A_4 stand for He Bing, Xu Chenglong, Wang Zhiwei, Guo Xu, respectively， B_1, B_2, B_3, B_4, B_5 stand for 800meters、1000meters、1500meters、3000meters,5000meters, A_5 is the imaginary player He Bing. Assuming c_{ij} denotes the costing time that A_i $(i=1,2,\cdots,5)$ take part in B_j $(j=1,2,\cdots,5)$. Then its mathematical model is as follows:

$$\min z = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij} x_{ij}$$

$$s.t.\begin{cases} \sum_{j=1}^{n} x_{ij} = 1, i = 1, 2, 3, 4, 5 \\ \sum_{i=1}^{n} x_{ij} = 1, j = 1, 2, 3, 4, 5 \\ x_{ij} = 0\text{或}1, i, j, n = 1, 2, 3, 4, 5 \end{cases}$$

Where

$$(c_{ij})_{n\times n} = \begin{bmatrix} 2.39 & 3.30 & 5.03 & 10.36 & 17.58 \\ 2.49 & 3.32 & 5.14 & 12.11 & 19.45 \\ 2.23 & 3.20 & 4.58 & 10.39 & 18.38 \\ 2.16 & 3.05 & 4.42 & 11.49 & 20.21 \\ 2.39 & 3.30 & 5.03 & 10.36 & 17.58 \end{bmatrix}$$

Using Lingo software, we get the result in figure 3.From figure 3, we find that the total number of variables is 25, when $x_{15} = x_{22} = x_{31} = x_{43} = x_{54} = 1$,the optimal solution appears and the optimal solution is $\min z = 37.91$,i.e.when He Bing competes in the 3000m and 5000m, Xu Chenglong competes in the 1000m Wang Zhiwei competes in the 800m, Guo Xu competes in the 1500m, the total time 37.91 is shortest and the overall effect of the competition is the best.

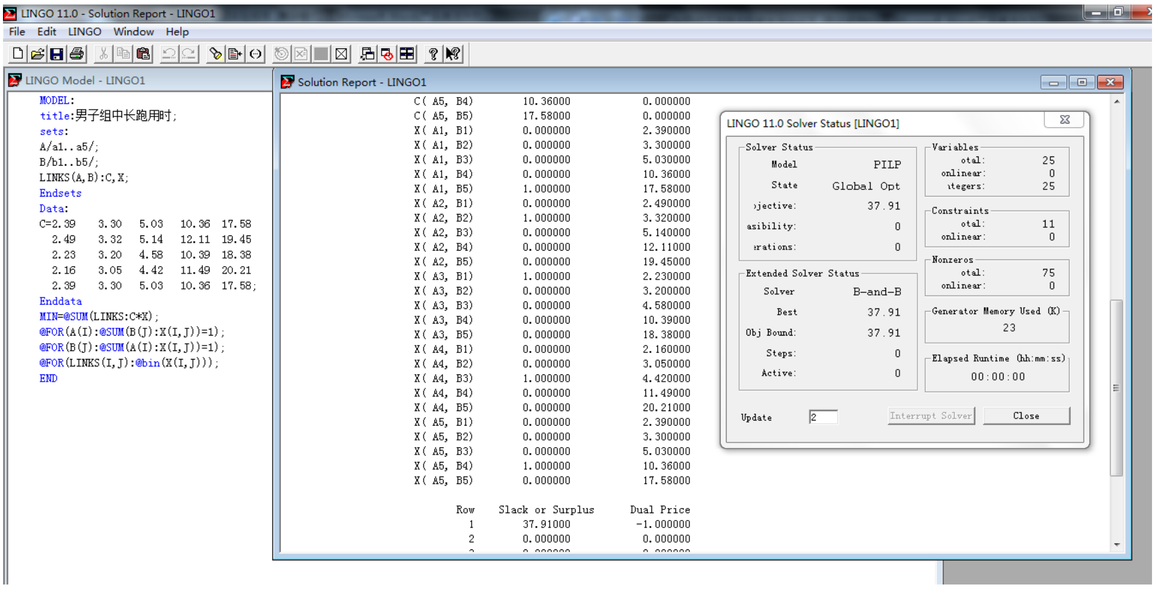

Figure 2 Lingo program and the running result

III. Conclusion

In this paper, we discussed two types of athlete assignment problems, One situation is that one person can only correspond to one task, and the other situation is that one person can correspond to multiple tasks. During the progress of solving, the integer linear programming and the Lingo software are used. The method provides theoretical guidance for solving practical issue.

Acknowledgements

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