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RESEARCH ARTICLE

Mathematical Analysis on Troubleshooting Problem During Covid-19 Pandemic

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Abstract

Mathematics is closely related to people's daily lives, such as the various shapes that can be seen everywhere, and the various distance relationships. Similarly, industrial production is inseparable from mathematics. The problem of nesting is a representative planning problem in industry and is widely used in the fields of construction, clothing, machinery and wood. With the development of computers, the nesting problem has been significantly improved by relying on the emergence of some intelligent algorithms. However, at the beginning of the problem, establishing a reasonable mathematical model is an essential step. This article summarizes the common mathematical models in the troubleshooting problem and analyzes the advantages and disadvantages during COVID-19 pandemic.

Keywords: *Nesting, mathematical models, troubleshooting problem.*

Introduction

The nesting problem, also known as the unloading problem. It refers to the slitting out of a variety of parts of different lengths from a specification of the material to maximize the utilization rate of the material. According to the dimensionality of raw materials, nesting problems can be classified into the following categories: one-dimensional blanking problems, two-dimensional blanking problems, and three-dimensional blanking problems during COVID-19 pandemic.

Depending on the type of part, one-dimensional nesting problems can be divided into one-dimensional nesting problems with a single specification (the length of raw materials are equal) and one-dimensional nesting problems with multiple specifications (different lengths of raw materials).

According to the quantity of raw materials, it can be divided into complete unloading (the quantity of raw materials is sufficient to obtain all required profiles) and incomplete unloading (the number of raw materials is limited, only part of the demand profiles can be obtained) problems. The one-dimensional blanking problem belongs to the NP problem, the number of solutions is incalculable, and it cannot be solved using a simple exhaustive method, so some accurate mathematical models are needed to describe it.

Mathematical models

In the nesting problem, some mathematical models are often needed to represent the solution results, and the quality of the model is related to the quality of the results. This section describes two common mathematical models.

Kantorovichmode [1]

$$\min \sum_{i=1}^{m} yi$$

$$s.t \sum_{i=1}^{m} xij \ge dj , \quad \forall j$$

$$\sum_{j=1}^{n} lj\, xij \le L\, yi, \quad \forall k$$

where: m is the total number of raw material roots of the unloading, i is the serial number of the raw material, i = 1, 2,3,.,m, n is the number of parts to be unloaded, j is the serial number of the part, j = 1,2,3,.,n, lj is the length of the part j, dj is the demand quantity of the part j, L is the length of the raw material, xij is the number of cutting roots of the first part in the i root raw material, yi is the variable 0-1, if the i root raw material is used for the blanking, then yi = 1, otherwise yi = 0.

Gilmore-Gomorymode [2]

$$min \sum_{i=1}^{m} c_j \, x_j$$

$$s.t \sum_{j=1}^{m} a_{ij} \, x_j \geq d_j \ , \quad \forall i$$

$$\sum_{j=1}^{n} a_{ij} \, l_i \leq L \ , \quad \forall j$$

where: i is the part serial number, i = 1, 2,3,......,n, j is the unloading mode serial number, j = 1,2,3,. ,m, and cj is the cost of using the jth unloading mode; aij is the number of cuts in the part i in the unloading mode j; xj is the number of raw materials required to use the j-type unloading mode.

Analyze

There are the following examples: there are 1 m long raw materials, now need to get 0.2 m long 3, 0.3 m long 4, 0.4 m long 1, 0.5 m long 2, how to cut the most economical material. In the second section, two mathematical models are introduced. The objective function of the Kantorovich model is the total number of roots consumed by the raw material, and the decision function is that the number of parts of a single kind needs to be greater than the number of demanded parts, and the length of each raw material needs to be greater than all the parts obtained from the raw material. Using the results of the model, two results may appear as shown in Figure 1, Figure 2, wherein the first way is 0.2 m, 0.3 m, 0.5 m for a group, cut two, 0.3 m, 0.3 m, 0.4 m for a group, cut one, 0.2 m for a group, cut one; The second way is 0.2 m, 0.3 m, 0.5 m for a group, cut two, 0.2 m, 0.3 m, 0.4 m for a group, cut one, 0.3 m for a group, cut one. Comparing the two methods, both meet the Kantorovich model, but the utilization rate obtained at this time is obviously different [3-12].

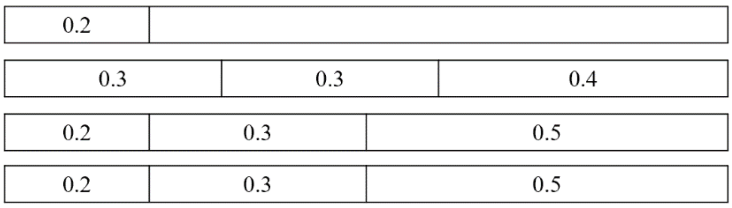

Fig 1: The first cutting method

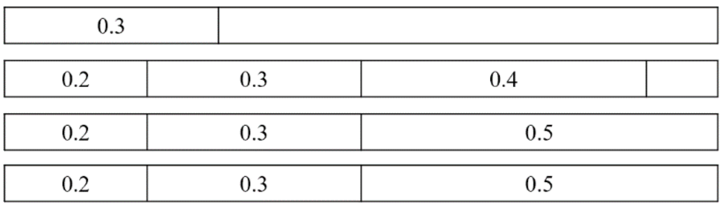

Fig 2: The second cutting method

In the Gilmore-Gomory model, there is a m-seed unloading pattern, where the objective function is the scrap rate of raw materials, and the decision function is consistent with the Kantorovich model. For the Gilmore-Gomory model, the problem on the Kantorovich model was solved to some extent, but it would undoubtedly cost more time before waiting for the results.

Comparing the two models, the Kantorovich model solves the time cost, while the Gilmore-Gomory model saves materials, and the choice of the two modes should be combined with the production reality, balancing the relationship between time and material [12-19].

Summary

Mathematical thought refers to the spatial form and quantitative relationship of the real world reflected in human consciousness, through the thinking activities and produce a result, it is the basic view of dealing with problems in mathematics, is a summary of the basic knowledge of mathematics and the essence of basic methods, is the guideline for the creative development of mathematics [20-26]. Through the cultivation of mathematical ideas, the ability of mathematics will be greatly improved. To master mathematical ideas is to master the essence of mathematics. For mathematics, the ultimate goal must be to combine it with reality, and mathematics divorced from reality is meaningless. In industry, mathematics is often linked to increasing the number of productivity, utilization, etc., and to improve these values, more accurate mathematical models are needed, so our learning of mathematics should be more in-depth and not stagnant [27-33].

Conflict of interest

We have no conflict of interests to disclose and the manuscript has been read and approved by all named authors.

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