Application Research of Optimization Theory in Mathematical Modeling

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Abstract: The optimization theory and method is mainly to study how people use a variety of resources to coordinate the technology, and to maximize the value of limited resources by combining the establishment of mathematical models. Through the research in this paper, we have found that there are already mature technologies in both the field of mathematical modeling and the field of optimization theory. This paper proposes the possibility of combining different technologies by combing the respective concepts and characteristics, and introduces the classic combination fields.

1. Introduction

In reality, complex and specific problems can often be expressed in mathematical expressions through semantic abstractions and mathematical notation. The process of expressing reality with mathematical symbols and relationships is mathematical modeling. The purpose of mathematical modeling is not only for mathematical research, but more importantly, to better solve problems in real life. The optimization theory is an important subject of recent hot development, mainly used to solve the problem of seeking the optimal solution. The application aspect mainly solves the optimal solution in the pure mathematical environment and the optimal solution problem in daily life. For the second point, the premise of solving the problem is to transform the problems in daily life into mathematical models, so the mathematical modeling and the optimal solution problem are mutually complementary.

2. Modeling characteristics

2.1 The meaning of mathematical modeling

The meaning of data modeling is to use the language of mathematics to represent real-life problems. For simple problems, by abstracting them into mathematical problems, it is beneficial to our understanding and calculation, such as commodity prices and sales volume; for complex problems, data modeling is more effective, especially in our era of big data. Mathematical modeling has a special meaning. There is a lot of value in the data, which has become the consensus and data processing in the era of big data. It needs to collect, store and process the data. The core link is the processing of data. How to exert the great value contained in the data requires careful design of data analysis methods. The role of mathematical models is enormous. In all industries, models are developed by professionals and implemented by business people in various forms.

In the process of data modeling, there are often special requirements for the knowledge capabilities of modelers. In addition to a solid mathematical foundation, good industry knowledge is also a prerequisite for establishing an excellent mathematical model. In the era of fine division of labor in the industry, professional knowledge that is good at your own work is a must, but the establishment of mathematical models is itself a work that requires extensive knowledge. For example, for a job that builds a model used in architectural design drawings, a mathematician who does not understand architectural drawings at all cannot do so anyway. This work requires people who understand both mathematics and architectural design drawings. The two aspects of knowledge do not need to be very professional, but they must be sufficient.

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2.2 Mathematical modeling process

The establishment of the data model is a scientific system. Under the research of this discipline, the process of standard mathematical model establishment includes model preparation, model hypothesis, model establishment, model solving, model analysis and model checking.

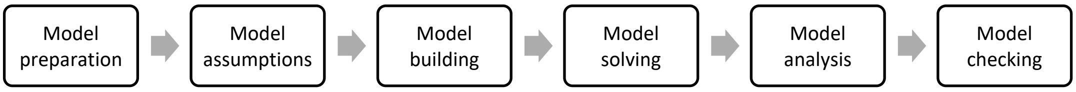

Fig.1 standard mathematical model

Model preparation refers to the knowledge background that needs to understand the problem before modeling, understand the requirements in the corresponding scene, and use mathematical thinking to understand the essence of the problem. The model hypothesis refers to the abstraction of mathematical language to the problem of understanding, describing the problem in a mathematical language, and requiring a clear and accurate degree. Model building refers to the use of appropriate mathematical tools to build corresponding mathematical expressions based on understanding. Model solving is an important step in the model. By obtaining the actual parameters in the actual problem, it is substituted into the mathematical expression obtained in the previous step, and the result is obtained. Model analysis is the analysis of the correctness of the results. The model test is to repeatedly calculate different parameters and make detailed predictions and evaluations on the overall correctness of the mathematical model.

3. Application of optimization theory in modeling

Optimization theory is a routine focus in mathematical modeling. Optimization theories and methods are mainly used to study which solutions are most beneficial to their own decisions when they are unable to judge a multi-solution problem. Through optimization techniques, we can macroscopically derive an optimal solution to the current situation. The main factors in the application of optimization techniques are decision variables and parameters, constraints and target values. With the need to consider time as the standard, the optimization technology can be divided into static optimization and dynamic optimization, in which static optimization does not need to consider time factors.

3.1 Extreme problem

A typical optimization model can be expressed in the following form:

$$\max\{f(x) \mid x \in y\}$$

The optimal solution is obtained from the function. The value of the parameter of the optimal solution has a range. The focus of mathematical modeling lies in the model, and the most important point of the model is how to solve the real life focus. Among them, $x \in y$ is us as a constraint function, and $\max\{f(x) \mid x \in y\}$ as a whole is us as an objective function. Based on the characteristics of these two functions, we can divide the problem into linear and nonlinear. Linearity is the case where there is only one optimal solution, and nonlinearity is when there are multiple objective functions. The method of linear solution is currently a very mature technology in the optimization technology, and the nonlinear problem has many choices due to the specific conditions. For nonlinear optimization problems, the current common approach is to convert them into linear problems as much as possible. In this way, no matter what kind of mathematical model, the basic solution is obtained, but not all nonlinear problems can be solved by linear problems.

3.2 Genetic algorithm

Another important application of optimization theory in mathematical modeling is genetic algorithms. Genetic algorithm is a very mature application technology of optimization theory and an important algorithm in the field of artificial intelligence.

The genetic algorithm is a specific package and design for the specific problem in the process of establishing the mathematical model. An adaptive, global probabilistic search algorithm that mimics the inheritance and evolution of the survival of the fittest in the natural environment. Genetic algorithms are used in a wide range of applications, both for solving linear problems and for solving nonlinear problems.

$$\left\{\begin{matrix} \max f(X) \\ X \in R \\ R \in U \end{matrix}\right\}$$

Where X is the decision variable, the objective function of $\max f(X)$, $X \in R$, $R \in U$ are constraints, Uis the basic space, and Ris a subset of U. The aaa that satisfies the constraint is a feasible solution, and the set X represents a set of all solutions satisfying the constraint, and becomes a feasible solution set.

The current genetic algorithm is a typical representative of the application of the optimal solution theory in mathematical models. The main processes include initialization, individual evaluation, population evolution, and termination testing. Academically, the most studied areas are coding representations, fitness, and genetic operators. In the coding problem, the current mainstream coding methods are Gray code coding, real coding, decimal coding and non-numeric coding. For different problems, choose different coding methods. In the specific mathematical model, if the selectable result is nonlinear and can be divided into specific types, it is recommended to use non-numeric coding, which can use the problem Expertise-friendly efficiency to get the optimal solution.

4. Conclusion

By studying the commonly used modeling methods and optimization theory techniques, this paper explores the combination of the current mainstream mathematical modeling and optimization theory. In the search for the optimal feasible solution and the optimal solution, different methods are respectively corresponding. This paper finds that under the constraint condition, the premise of finding the optimal solution is to find the relevant parameters according to the mathematical modeling process. After substituting the function calculation, an index is used as the reference optimal solution index. Through inspection and analysis, the effect evaluation of the optimal solution is obtained. At present, the mathematical modeling of optimal solution technology is widely used in the field of machine learning. In this area of research, we will continue to focus on data mining, neural networks and other aspects.

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