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Application of Mathematical Modeling in Social Science

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Abstract. With the promotion and application of big data, mathematical models are also more widely referenced in the research and development of different professions. In this paper, the relationship between mathematical modeling and social sciences will be explored by examining the application of mathematical modeling in social sciences through quantitative analysis. In addition, the author is willing to learn about different models related to economics, psychology, and sociology. Based on the analysis, this paper provides relevant suggestions for solving potential problems in the application of models, including, that attention should be paid to the description of contextual details, that the results of the study should take into account motivational factors, and that the data involved must be valid and not too superficial.

Keywords: social science, mathematical model, econimics, psychology, sociology, applications.

1. Introduction

Due to the long-term influence of inductive, deductive, and inferential research paradigms, the recognition of data value in the field of humanities and social sciences is relatively late. Against the backdrop of big data, open data, and intelligent technological innovation, theoretical and empirical research in the field of humanities and social sciences are gradually being influenced by the tide of data. Data driven approaches have become a new paradigm pursued by humanities and social sciences, and data resources have been described as an emerging source of knowledge discovery and academic innovation. In this context, the humanities and social sciences field has opened up many explorations of old scenarios, new problems, and new scenarios and problems. Model involves starting from practical problems, conducting in-depth investigation and research, understanding object information, making simplified assumptions, analyzing internal laws, and using mathematical symbols and language to express and establish mathematical models.

Social science refers to the science that focuses on social phenomena as its research object. Its task is to study and elucidate various social phenomena and their development laws. The application of mathematical modeling in social sciences mainly involves establishing mathematical models to analyze social problems in detail and provide decision-making support for policies. Social science encompasses disciplines such as economics, political science, history, sociology, psychology, etc [1-3].

This paper analyzes the application of mathematical modeling and quantitative perspectives to economics, psychology and sociology. The paper begins by discussing specific references to mathematical models in economics, sociology and psychology, and explains and describes models relevant to the social sciences, including the “APC” model, the Marshall Trade Tables, and others. Based on the above analysis, the article will suggest solutions to the problems of the relevant models.

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Meanwhile, the article uses the research methods of example argumentation and quantitative analysis in order to enhance the validity of the research and analysis.

The research in this article analyzes the application and combination of mathematical modeling in different professional directions, and the mathematical models are constantly being optimized while promoting the development of different industries. According to the analysis, new directions can be given to the development of related models in the future.

2. Overview

Economics deals with a rather complex real world, and the use of models makes economics a science where economists can use relevant models to deepen their understanding of the real world. However, the use of models also makes economists often go astray, thus thinking that they are also half physicists or mathematicians [4-5]. Yet models are neither easy to define nor easy to generalize. Some of the most important models in the history of economics introduced in this paper reflect what can be considered models in economics, either as physical objects, or as paper-based objects of charts, algebra, or arithmetic. Although they may take different forms, these objects all have identifiable features: each model depicts, presents, represents, or in some way provides a certain representation of ideas about certain aspects of the economy [1]. For economists, it is precisely because they can infer the various representations presented in this chapter that they have all become economic models [2]. By carefully analyzing how these objects are manufactured and used in economics, this research is able to understand the significance of significant changes in economics. The researcher provide material for both the naturalized philosophy of economic modeling and the historical narrative of economic model naturalization.

A model that combines the logic and knowledge of four mathematical and economic fields is described next.

2.1. Economic model

2.1.1 The first model. The first is the supply balance model. Marshall detailed the supply and demand curve and how they determine market prices in his classic work "Principles of Economics". The supply and demand balance model is one of the most basic and core concepts in economics. It describes how the supply and demand of goods or services in a market reach equilibrium. When the supply equals the demand, the market reaches equilibrium, and the price at this time is called the equilibrium price.

2.1.2 The second model. The second one is the Table auÉ economy, which is a wonderful numerical object: a combination of tables and matrices that presents the accounting situation of the French economy and displays the social classes of people in the economy. There are horizontal and diagonal lines in a zigzag shape between them, and the numbers on the top represent the quantity of goods or currency transferred between different social classes.

2.1.3 The third model. The third chart is Marshall's trade chart [6]. In 1879, Marshall created a trade model that explained the trade relationship between two countries and analyzed the trade relationship between Germany and the United Kingdom.

2.1.4 The fourth model. The fourth model is the sunk cost model, where the cost is the maximum cost given up, and if there is nothing to give up, there is no cost. Sunken costs refer to expenses that have already occurred but cannot be recovered. At the same time, Thünen depicted the relationship between farm prices and distance to the city, using figures drawn from his farming experience on his Tyrolean estate [3] In early economics, economic tables, accounts, and spatial diagrams with figures, each of these three objects intended to show how the agricultural economy worked, jutted themselves out from the sea of words that surrounded them.

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2.2. Psychological Model

Secondly, the author will state the application of mathematical modeling in psychology. In psychological research, quantitative methods and data analysis are crucial tools that help researchers transform subjective psychological phenomena into objective numerical data for statistical analysis and the establishment of scientific models. In the field of psychology, there is a very classic quantitative model called the "relationship model". The "relationship model" places the supervisory relationship at the top and core of the supervisor's mind, and guides the supervisor to create an interpersonal environment - in this environment, the supervisor can experience the things happening here and now in the supervisory relationship, and such work is ethical. This model provides a framework within which both parties can have a greater sense and understanding of the supervisory and clinical relationships. Therefore, the author will take marriage or romantic relationships as an example, the happiness of an intimate relationship is equal to the geometric average of the personality development levels of two individuals in the relationship. Among the researchers: H - happiness level A, B - personality development level of two independent individuals in the relationship H, A, and B are all scored on a percentage scale, with a value of (0100).

2.3. The Sociological Model

This paragraph focuses on the use of mathematical models in sociology, introducing mathematical models corresponding to social structure and social change.

2.3.1 The first model. One of the more typical social structure models is the hexagonal model of Chinese society. This model is based on a homogeneous assumption, that is, all markets are in the same latitude plain, and various resources are evenly distributed. This is an abstract pure mathematical model. But in reality, the ideal and standard market area should be circular. When a region is filled with market areas, they squeeze each other without overlap or gaps, forming a honeycomb shape, with each market area squeezed into a hexagon. The intensive circulation process of the basic market of this model [5].

2.3.2 The second model. Another model related to social change is called the "APC" model, which mainly describes the process of social change and introduces the problems and strategies of using aggregated hierarchical data modeling to analyze age, period, and cohort effects. These strategies involve constraint estimation, factor feature method, estimable function, and variance decomposition [7].

3. Discussion

3.1. In economics

Mathematical modeling and data analysis are used to study various economic phenomena, such as market supply and demand, economic growth, trade, etc. For example, econometrics extensively uses methods such as regression analysis and time series analysis to explore the relationships between economic variables. In psychology, these methods can help researchers understand the complexity of human behavior and psychological processes. For example, through structural equation modeling, researchers can study how multiple psychological factors (such as personality, emotions, motivation, etc.) collectively affect behavior.

3.2. In psychology

mathematical modeling and data analysis can be used to study social structure, social change, social problems, and so on. For example, using social network analysis, researchers can study the relationships between individuals in social networks and how these relationships affect social phenomena.

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3.3. In sociology

The application of mathematical modeling and data analysis in the field of social sciences not only enriches research methods, but also improves the accuracy and predictive ability of research. Through this article on mathematical modeling and the application of data analysis in social sciences, I have come to understand that mathematical modeling provides new perspectives and possibilities for social science research, which helps us to have a deeper understanding of the essence and laws of social phenomena. A data model that presents social data can help researchers process large amounts of data more accurately and efficiently.

4. Conclusion

This paper has analyzed a variety of models related to the social sciences, including models commonly used in three areas: psychology, sociology, and economics. Through mathematical models and algorithms, researchers can better reveal patterns and relationships in the data and thus predict future trends and behaviors more accurately. However, there are some shortcomings in this study. The authors did not examine the application of mathematical modeling and data analysis in social science fields other than economics, psychology, and sociology. For example, in the field of political science, these methods have been used to study electoral behavior, political trust, international relations, etc.; in the field of communication studies, these methods have been used to study media communication effects, public opinion, information dissemination, and so on. At the same time, the authors do not consider the limitations of mathematical modeling and data analysis. For example, they usually require large amounts of data and computational resources, which may limit their use by some small research teams or individuals. In addition, these methods require researchers to have appropriate knowledge of mathematical statistics, otherwise misuse or misinterpretation of results may occur.

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