A Study on The Application of Artificial Intelligence in Mathematical Modeling

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Abstract: This paper discusses the application of artificial intelligence in the field of mathematical modeling. It analyzes the unique advantages of AI techniques, such as machine learning and deep learning, in improving the efficiency of mathematical modeling and solving complex problems. The specific application scenarios of AI in mathematical modeling in various fields, including natural science, engineering technology, social economy and so on, are introduced in detail. At the same time, we analyze the challenges of data quality and model interpretability in the application process, and look forward to the future trend of the integration of AI and mathematical modeling. The aim is to reveal the changes brought by AI to mathematical modeling, to provide reference for research and practice in related fields, and to promote new breakthroughs in mathematical modeling under multidisciplinary cross-fertilization.[1].

Keywords: Artificial Intelligence; Mathematical Modeling; Machine Learning; Applied Research that.

1. Introduction

Mathematical modeling, as an effective means of solving practical problems by mathematical methods, plays a key role in many disciplines and fields. From the simulation of physical phenomena in natural sciences, to the optimal design of systems in engineering and technology, to the prediction of market trends in socio–economic fields, mathematical modeling provides a clear logical framework and quantitative analysis for the solution of complex problems. However, with the increasing complexity of practical problems, traditional mathematical modeling methods face many challenges in dealing with large-scale data, highly nonlinear relationships and dynamic processes. The rapid development of artificial intelligence technology has injected new vitality into mathematical modeling.

2. The Technological Basis of Artificial Intelligence and Its Advantages in Mathematical Modeling

2.1. The technological basis of artificial intelligence

Machine learning, as one of the core fields of artificial intelligence, covers various paradigms such as supervised learning, unsupervised learning and semi-supervised learning. Supervised learning learns from labeled data and constructs predictive models for classification or regression prediction of new data, and common algorithms include decision trees, support vector machines, neural networks, etc. Unsupervised learning seeks to discover the intrinsic structure and patterns of data from unlabeled data, such as clustering. Unsupervised learning is dedicated to discovering the intrinsic structure and pattern of data from unlabeled data, such as clustering algorithms, principal component analysis, etc. Deep learning, as a branch of machine learning, is based on deep neural networks, which automatically learns complex feature representations from a large amount of data by constructing neural network models containing multiple hidden layers, and

has achieved great success in the fields of image recognition and speech recognition.

2.2. Advantages in mathematical modeling

Artificial intelligence shows significant advantages in mathematical modeling. First of all, its powerful data processing ability can quickly process massive data, mine valuable information from the data, and provide rich data support for the construction of mathematical models. Compared with traditional manual data processing, it greatly improves the efficiency and accuracy of data processing. Secondly, the self-learning ability of artificial intelligence makes the model able to adjust and optimize its own parameters according to new data, adapt to the dynamic changes of the problem, and improve the generalization ability of the model. For example, in time series prediction modeling, machine learning models can continuously learn new data patterns over time to improve the accuracy of prediction. Moreover, for complex nonlinear problems, artificial intelligence models such as neural networks can effectively solve highly nonlinear problems that are difficult to be handled by traditional mathematical models by constructing complex nonlinear mapping relationships, providing a more powerful tool for mathematical modeling.

3. Application Scenarios of Artificial Intelligence in Mathematical Modeling

3.1. In the field of natural sciences

In physics, mathematical modeling using artificial intelligence can be used to simulate complex physical systems. For example, when modeling the many-body problem in quantum mechanics through deep learning models, traditional mathematical methods are difficult to solve accurately due to high computational complexity, while deep learning models can predict the quantum state and physical properties of the many-body system by learning from a large amount of simulation data. In astronomy, AI-assisted mathematical modeling is used for galaxy evolution simulation and celestial

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contributed papers from the BIOMAT 2009 Ninth International Symposium on Mathematical and Computational Biology and the contributions of the Keynote Speakers which present the state of the art of fundamental topics of interdisciplinary science to research groups and interested individuals on the mathematical Modelling of biological phenomena New results are presented on cells particularly their growth rate and fractal behavior of colony contours on control mechanisms of molecular systems the Monte Carlo simulation of protein models and on fractal and nonlinear analysis of biochemical time series There are also new results on population dynamics such as the paleodemography of New Zealand and a comprehensive review on complex food webs Contributions on computational biology include the use of graph partitioning to analyse biological networks and graph theory in chemosystematics The studies of infectious diseases include the dynamics of reinfection of Tuberculosis the spread of HIV infection in the immune system and the real time forecasting of an Influenza pandemic in the UK New contributions to the field of Modelling of physiological disorders include the study of macrophages and tumours and the influence of microenvironment on tumour cells proliferation and migration **Computing and Simulation for Engineers** Ziya Uddin,2022 This book presents the reader with comprehensive insight into various kinds of mathematical modeling and numerical computation for problems arising in several branches of engineering such as mechanical engineering computer science engineering electrical engineering electronics and communication engineering and civil engineering The book Discusses topics related to clean and green energy production and storage Bridges the gap between core theory and costly industrial experiments Covers advanced biomechanics and nanodrug delivery topics Explores diversified applications of mathematical techniques to solve practical engineering problems The text in this book emphasizes mathematical treatment of soft computing image and signal processing fluid flows in various geometries biomechanics biological modeling a mathematical description of the solar cell analytical and numerical treatment of problems in fracture mechanics and antenna design modeling It also discusses the numerical computations of biomechanics problems and problems arising in cryptography The text further covers optimization techniques that are useful for real world problems This material is primarily written for graduate students and academic researchers in a number of engineering fields including electrical electronics and communication industrial manufacturing mechanical computer science and mathematics

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directions For the benefit of public health professionals whose contact with mathematics may not be recent there is an appendix covering the necessary mathematical background There are indications which sections require a strong mathematical background so that the book can be useful for both mathematical modelers and public health professionals

   Advances in mathematical and computational oncology, volume III George Bebis,Dinler Amaral Antunes,Ken Chen,Mohammad Kohandel,Kathleen Wilkie,Mamoru Kato,Jinzhuang Dou,2023-10-25   Mathematical Modeling for Big Data Analytics Passent El-Kafrawy,Mohamed F. El-Amin,2025-11-01 Mathematical Modelling for Big Data Analytics is a comprehensive guidebook that explores the use of mathematical models and algorithms for analyzing large and complex datasets The book covers a range of topics including statistical modeling machine learning optimization techniques and data visualization and provides practical examples and case studies to demonstrate their applications in real world scenarios Users will find a clear and accessible resource to enhance their skills in mathematical modeling and data analysis for big data analytics Real world examples and case studies demonstrate how to approach and solve complex data analysis problems using mathematical modeling techniques This book will help readers understand how to translate mathematical models and algorithms into practical solutions for real world problems Coverage of the theoretical foundations of big data analytics including qualitative and quantitative analytics techniques digital twins machine learning deep learning optimization and visualization techniques make this a must have resource Provides comprehensive coverage of mathematical and statistical techniques for big data analytics Gives readers practical guidance on how to approach and solve complex data analysis problems using mathematical modeling techniques with an emphasis on effective communication and presentation of results Includes leading edge information on current trends and emerging technologies and tools in the field of big data analytics with discussions on ethical considerations and data privacy   *Aspects of Mathematical Modelling* Roger J. Hosking,Ezio Venturino,2008-03-02 The construction of mathematical models is an essential scientific activity Mathematics is associated with developments in science and engineering but more recently mathematical modelling has been used to investigate complex systems that arise in other fields This book demonstrates the application of mathematics to research topics in ecology and environmental science health and medicine phylogenetics and neural networks theoretical chemistry economics and management   **Advances in Mathematical and Computational Oncology** Doron Levy,George Bebis,Russell C. Rockne,Ernesto Augusto Bueno Da Fonseca Lima,Katharina Jahn,Panayiotis V. Benos,2022-05-05   Methods of Mathematical Modelling Harendra Singh,Hari M Srivastava,Dumitru Baleanu,2022-06-10 Methods of Mathematical Modeling Infectious Diseases presents computational methods related to biological systems and their numerical treatment via mathematical tools and techniques Edited by renowned experts in the field Dr Hari Mohan Srivastava Dr Dumitru Baleanu and Dr Harendra Singh the book examines advanced numerical methods to provide global solutions for biological models These results are important for medical professionals biomedical engineers mathematicians scientists and researchers

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