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The Application and Challenges of Computer Technology in Big Data Mining

Qianwei Jin

School of Computer Science, Chengdu Jincheng College, Chengdu, China
2975719089@qq.com

Abstract. This thesis primarily investigates the practical application of contemporary computer technology in big data mining alongside the challenges encountered. The research objective is to enhance the analysis and identification of both the advantages and areas requiring improvement within big data mining. The study employs case analysis, literature review, and data analysis methodologies. It reveals that in this era of rapid computer advancement, big data mining presents numerous practical application scenarios alongside significant challenges awaiting resolution. Numerous application scenarios exist, such as within contemporary e-commerce platforms, where big data mining is frequently employed to analyse and explore user preferences, thereby enabling user categorisation. Amidst today's rapid development, we still face numerous challenges. For instance, how should we enhance algorithms to improve their adaptability when confronted with low compatibility? Furthermore, what risks arise from the immense resource consumption involved in storing and transmitting vast amounts of data? These issues demand thorough analysis and resolution.

Keywords: Big Data Mining, Computer Science and Technology, Big Data

1. Introduction

Big data mining is typically associated with computer science and achieves the aforementioned objectives through numerous methods, including statistics, analytical processing, intelligence retrieval, and machine learning.

Data mining draws upon concepts from the following fields: sampling, estimation, and hypothesis testing from statistics; Search algorithms, modelling techniques, and learning theories from artificial intelligence, pattern recognition, and machine learning. Data mining has also rapidly incorporated concepts from other domains, including optimisation, evolutionary computation, information theory, signal processing, visualisation, and information retrieval. Several other fields provide crucial supporting roles. Notably, database systems are required to deliver efficient storage, indexing, and query processing capabilities. Techniques originating from high-performance (parallel) computing are often crucial for processing massive datasets. Distributed technologies also aid in handling vast data volumes and become indispensable when data cannot be centralised for processing.

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Big data mining has garnered significant societal attention, primarily due to the existence of vast quantities of data that are widely available, coupled with an urgent need to transform this data into more useful information and knowledge.

This paper will primarily explore the connections between big data distributed architectures, cloud computing architectures, and computer technology through literature analysis, thereby identifying potential areas for improvement. By analysing the relationship between big data mining and computer science and technology, one can gain a better understanding of contemporary data processing capabilities and the learning potential inherent in data mining. Integrating this with computer technology can foster progress in modern science and technology.

2. Big data analysis and its relationship with computer technology

The relationship between big data technology and computer science is intrinsically linked. Computer technology forms the foundation of big data technology, while big data technology represents an expansion and enhancement of computer technology in terms of data scale and processing capabilities.

Firstly, computer technology provides essential hardware and software support for big data. The rapid advancement of modern computer technology has equipped us with the capability to store, process, and analyse vast quantities of data. For instance, the emergence of distributed computing and cloud computing enables large-scale data processing and analytical mining in the cloud, free from constraints imposed by hardware limitations. Concurrently, high-performance computer hardware delivers formidable computational and analytical capabilities for big data applications.

Secondly, the advancement of big data technology has propelled progress in computer technology. As data volumes continue to expand, traditional computing approaches struggle to meet contemporary demands. Consequently, the emergence and evolution of big data technologies have driven continuous innovation in computing to address new challenges. For instance, distributed storage and parallel computing technologies have emerged to handle the changing scale and variety of big data. Furthermore, big data processing frameworks such as MapReduce and Spark have been developed to enhance data processing efficiency [1].

3. The application of computer technology in big data mining

3.1. Applications of distributed architecture in everyday life

Within contemporary internet industries, most cloud service providers such as Alibaba Cloud, AWS, and Google Cloud extensively employ distributed systems to deliver computational resources, storage capacity, and massive data processing capabilities. For instance, distributed computing frameworks like Hadoop MapReduce, Spark, and Flink are utilised for real-time and batch data analysis, handling scenarios ranging from log processing at various scales, web scraping, recommendation systems, to advertising campaign analytics.

One of the core functionalities of popular domestic social media platforms like WeChat—including user information display, content push notifications, and message delivery—relies on distributed architectures for implementation. For instance, the seamless operation of data distribution and aggregation services enables users to swiftly access the latest updates; conversational history storage and real-time communication, meanwhile, involve distributed databases [2].

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3.2. Application of risk assessment in cloud computing architecture

With the gradual advent of the digital finance wave, the challenges faced by financial institutions in processing and analysing vast volumes of customer data have become increasingly pronounced. Accurately assessing customer credit risk during evaluations has progressively emerged as a core requirement for fostering robust business development. Cloud computing technology, leveraging its formidable resource integration and high-efficiency computational capabilities, offers financial institutions a novel solution. A major commercial bank generates daily transaction data and customer information updates amounting to several terabytes. Under traditional IT architectures, storing and processing such data necessitated extensive hardware infrastructure, resulting in sluggish processing speeds that failed to meet the fundamental requirements for real-time risk assessment. Following the adoption of cloud computing, the bank selected Alibaba Cloud as its data processing and storage platform. Alibaba Cloud provides distributed storage services, enabling the dispersal of massive datasets across multiple nodes. This approach ensures data security and reliability while leveraging high-speed networks to facilitate rapid data read and write operations [3].

3.3. Machine learning algorithms for precise user insights

In our daily lives, we typically employ supervised learning, unsupervised learning, and reinforcement learning alongside analytical models and metrics to gain precise insights from machine learning algorithms. Within supervised learning, we frequently utilise decision trees, support vector machines, and neural networks to predict customer purchasing intentions in e-commerce, thereby enabling personalised recommendations. Appropriate machine learning algorithms can be selected based on varying prediction objectives. For instance, classification problems may employ algorithms such as logistic regression or random forests, whilst sequence prediction tasks are well-suited to recurrent neural networks (RNNs) or long short-term memory networks (LSTMs). Model training necessitates hyperparameter tuning through cross-validation to prevent overfitting or underfitting, thereby ensuring the model's generalisation capability [4].

4. Challenges and opportunities faced by computer technology in big data mining

4.1. Specific challenges faced by computer technology in big data mining

4.1.1. Complex algorithms exhibit low adaptability

In the process of big data mining, the characteristics exhibited by data are becoming increasingly complex and diverse. Particularly within the social media domain, data encompasses not only conventional textual information but also a range of unstructured data, such as images, videos, and audio, alongside semi-structured data including intricate social relationships between users. Conventional algorithms prove inadequate when confronted with such complex data. Consequently, we must directly address one of the challenges encountered in big data mining within computer technology [5]. In the process of big data mining, the characteristics exhibited by data are becoming increasingly complex and diverse. Particularly within the social media domain, data encompasses not only conventional textual information but also a range of unstructured data such as images, videos, and audio, alongside semi-structured data including intricate social relationships between users. Conventional algorithms prove inadequate when confronted with such complex datasets. Consequently, we must directly address the challenges posed by big data mining within computer technology [6].

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4.1.2. Challenges in resource consumption for massive data storage and transmission

With the increasing prevalence of the Internet of Things and mobile internet, data has exhibited explosive growth. Enterprises and institutions now generate daily data volumes reaching petabyte (PB) or even exabyte (EB) levels, posing immense challenges to storage and transmission resources. In data storage, traditional hard disk storage methods are costly and severely limited in scalability. For mechanical hard disks, individual storage capacity typically remains at several terabytes (TB). Faced with massive data volumes, storage arrays must be constructed using large numbers of hard disks, not only increasing hardware procurement costs but also incurring substantial operational and maintenance expenses. Concurrently, the rapid growth of data demands storage systems with robust scalability. Traditional storage architectures, however, encounter significant issues during expansion, including compatibility problems and performance degradation. Furthermore, network bandwidth becomes a bottleneck at the data transmission level. During operations such as remote big data backup, cross-departmental sharing, or uploading to the cloud, slow transmission speeds severely impact the efficiency of data mining work.

4.2. Opportunities faced by computer technology in big data mining

4.2.1. Manifestations of intelligence in computer technology and data mining

With the advancement of societal standards, people's incomes continue to rise, lifestyles become increasingly diverse, and consumption patterns undergo constant transformation. Concurrently, enterprises enhance their production capacity and other capabilities, resulting in a proliferation of diverse goods within the marketplace to satisfy the demands of the majority. Consequently, for businesses to deliver products accurately and reliably to customers, it is imperative to optimise warehouse storage and transportation operations, thereby fostering the sustainable development of the logistics sector. Relevant enterprises are actively adopting advanced technologies, fully leveraging computer systems to enhance control over warehousing operations. This ensures timely identification of operational issues and enables effective corrective measures to minimise the impact of operational errors. Such approaches effectively integrate big data capabilities, thereby achieving intelligent operations.

4.2.2. Virtualisation

In everyday life, traditional data reports often struggle to intuitively reveal the intricate relationships and underlying patterns within data. Through VR technology, users can viscerally experience data fluctuations and spatial distributions within a virtual environment, thereby swiftly identifying patterns and trends within the data to determine which form of support to provide. For instance, in corporate market analysis, integrating big data with virtual reality enables entry into a simulated marketplace where consumer behaviour data and market trend metrics are vividly presented through visualisation. Virtual reality (VR) and big data technology represent two pivotal domains within contemporary science and technology, complementing each other across multiple industries.

5. Conclusion

This thesis primarily explores the relationship between big data mining and contemporary computer technology. Research reveals a profoundly close connection between the two, exemplified by distributed architectures structuring popular chat applications, cloud computing institutions

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conducting risk assessments, and machine algorithms achieving precise user insights. Future research may address issues such as the low adaptability of complex algorithms and the substantial resource consumption associated with storing and transmitting vast datasets. An in-depth investigation into these issues will significantly advance the future development of both computer science and big data domains.

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