

APPLICATION OF ARTIFICIAL INTELLIGENCE IN CLOUD COMPUTING TECHNOLOGIES

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Abstract

Cloud computing technology has revolutionized digital services, allowing users to use large-scale computing resources in a demanded and flexible manner. However, along with these capabilities, it also created problems for resource management, security, and fault tolerance. Artificial intelligence (AI) provides advanced solutions to these problems, making cloud infrastructures more efficient, secure, and reliable. This article thoroughly analyzes resource optimization, fault detection, and cybersecurity enhancement techniques implemented using AI.

Keywords: Cloud computing, Artificial intelligence, Resource optimization, Fault prediction, Cybersecurity Energy efficiency.

Introduction

Cloud computing technology has radically changed the infrastructure of information technology. At the same time, managing such systems creates significant problems - in particular, in the areas of resource allocation, security, and fault tolerance. Traditional management methods are often weak in adapting to the changing characteristics of cloud workloads. For this very reason, the use of artificial intelligence has become a necessity. AI can be used to automate resource management, enhance security, and develop advanced crash prevention measures.

Models for the efficient allocation of resources using AI are of particular importance. These models, based on machine learning algorithms, analyze future workloads in advance and automatically change resources on this basis. As a result, costs decrease, and productivity increases. Optimization of the distribution of virtual machines (VM) using AI allows you to increase or decrease the amount of resources depending on the real-time statistics of the system. This is crucial for maintaining the elasticity and efficiency of cloud infrastructure.

Troubleshooting is another important area where AI can be applied. Traditional methods usually begin to take action only after a malfunction occurs. However, since cloud systems are large-scale and complex, such an approach is insufficient. With the help of predictive fault

detection systems based on artificial intelligence, problems are identified in advance, and measures are taken to ensure the continuity of services. AI also has great potential in strengthening security in cloud systems. Machine learning-based models can detect suspicious network activity or changes in data transmission. These models update themselves and adapt more quickly to threats over time. In addition, artificial intelligence is also used to optimize energy consumption in cloud centers. This will reduce the cost of services and reduce the environmental impact. In this article, we will examine the state of application of artificial intelligence in cloud computing systems in areas such as resource management, fault tolerance, security, and energy efficiency. We also analyze existing research and propose new directions for making cloud technologies more efficient using AI.

METHODOLOGY

Resource management is one of the most important aspects of cloud computing. This directly affects not only the performance of the system, but also the cost of the service and user satisfaction. For this reason, methods based on artificial intelligence (AI) are widely used in this field. With the help of AI approaches, such as machine learning and evolutionary algorithms, the possibilities of load balancing, task planning, and dynamic resource allocation in cloud systems have significantly expanded.

Using machine learning models, it is possible to predict the load in advance. Such models analyze future workloads in advance through historical usage data and real-time monitoring. This allows for the advance allocation of resources based on needs, reduces the use of surplus resources, and ensures the allocation of sufficient power at the required time. As a result, cloud service performance indicators will be stable and costs will be significantly reduced. Algorithms for task planning, developed using AI, also make a significant contribution to the efficient use of resources in a cloud environment. For example, evolutionary algorithms determine how best to allocate resources - taking into account factors such as operating speed, energy consumption, and service costs. These algorithms are especially suitable for complex and variable cloud environments, capable of optimally satisfying the needs of several users simultaneously. Another important area is preventive maintenance in cloud systems. In this case, large amounts of sensor data and work logs are analyzed using deep learning models. As a result, the probability of a malfunction is determined before it occurs, and preventive measures are taken before interfering with the system. This increases system reliability and reduces the number of service interruptions. This approach is especially relevant in large cloud data centers, where traditional maintenance methods become ineffective. In the context of fog computing (i.e., "fog computing"), a new direction of cloud computing, the application of AI methods is also expanding. In such an environment, computing resources are brought closer to the user. Therefore, the question of where to perform tasks - on a central cloud server or in a fog node close to the user - becomes relevant. AI-based planning algorithms help solve this problem: they allocate tasks in the most efficient way, taking into account latency, energy consumption, and the system's scalability capabilities. In general, AI-based resource management technologies provide significant advancements in the field of cloud computing. They serve to make systems more flexible, efficient, and scalable. In the future, as AI

technologies continue to develop, resource management in cloud computing is expected to become more intelligent and autonomous.

DISCUSSION

Ensuring reliability and continuity in cloud computing systems is one of the most important requirements. To ensure uninterrupted and stable operation of services, hardware or software errors must be detected and corrected in a timely manner. In such conditions, artificial intelligence (AI) tools play an important role in troubleshooting and increasing system reliability.

AI-based fault management systems allow for the detection of problems even before they arise. That is, they can study certain behaviors, statistical indicators, or unusual situations through predictive analysis and foresee potential malfunctions. Such systems are especially important for large cloud infrastructures, where manual error detection is very complex and inefficient. One of the main advantages of AI models is that they constantly monitor performance indicators in the system and are capable of detecting any deviations. For example, symptoms such as unexpected jumps in processor load, memory leaks, or abnormal network traffic signals may be signs of potential failures. AI identifies such signs and begins to take automatic corrective measures to prevent service interruptions - such as transferring resources to other servers or restarting services. Models based on deep learning technologies allow for more effective preventive maintenance. Such models study internal connections in the system based on log files, sensor readings, and many other data, and provide warnings before failures occur. This ensures uninterrupted service delivery and maintains a high level of service quality. In addition, the creation of fault-tolerant systems using AI also increases energy efficiency. These models manage resources intelligently, reduce overloads, and minimize repetitive and unnecessary operations. As a result, energy consumption is reduced while maintaining reliability. This is especially important in large data centers, where energy costs can be very high. AI-based fault tolerance and reliability approaches are crucial for the stable operation of cloud computing systems. Proactive - that is, with the help of proactive management mechanisms, the continuity of services is ensured, user satisfaction increases, and systems continue to operate at the level of modern requirements.

Further research in this area will focus on deeper integration of AI models with cloud control platforms and the development of advanced mechanisms that allow for the prediction of more complex malfunctions.

In cloud computing systems, security and quality of service (QoS) are always among the priority issues. These systems often store users' personal and corporate information, therefore it is necessary to ensure their reliable protection and uninterrupted and stable service. The greatest advantage of AI-based security models is their ability to detect threats early and respond to them immediately. Machine learning algorithms can detect abnormalities in network traffic, login attempts, or user behavior. Potentially dangerous situations are detected at an early stage.



RESULTS

Such AI systems constantly learn from new data and update their knowledge. This makes them resilient and adaptable to ever-changing cyber threats. For example, one of the AI-based anomaly detection models detects a user attempting to access the system at a different time than usual or detects unauthorized data transmission. In these cases, the system automatically blocks access or notifies security specialists. Along with security, AI technologies also play an important role in service quality management (QoS). The ability of AI models to analyze data and predict performance trends in real time allows them to automatically adjust the system's operation. Thanks to this, the necessary quality of service for users - such criteria as latency, availability, throughput - are maintained at a constant level. Especially in multi-cloud environments - that is, systems that use the services of several providers simultaneously - resources are coordinated and the optimal operating state is maintained using AI.

In addition, AI-based task planning algorithms are also useful for optimizing energy consumption in cloud centers. They automatically adjust resources based on real-time demand - which reduces unnecessary electricity consumption and overall operating costs. As a result, such systems also contribute to environmental sustainability. In general, the integration of AI technologies into security and service quality management is a huge step for modern cloud computing systems. They identify threats early, maintain service quality in accordance with requirements, and achieve environmental efficiency. The continuous development of AI models will ensure that cloud services become more reliable, flexible, and of higher quality in the future.

Artificial intelligence technologies have revolutionized cloud computing. With the help of AI, advanced and effective solutions are being found to such important problems as resource management, fault tolerance, strengthening security, and increasing energy efficiency.

CONCLUSION

Artificial intelligence-based models make cloud infrastructures more intelligent and adaptable. These models optimize real-time systems, maintain a high level of service, and reduce energy and costs. Such capabilities serve to increase the stability, reliability, and flexibility of cloud services to user needs.

In the future, research in this area should be aimed at a deeper integration of AI models with cloud management platforms. This leads to the creation of advanced systems that can adapt to various situations, work in real time, and solve a wide range of problems.

In the current environment, where cloud computing systems are becoming increasingly complex, AI technologies will become the main force shaping future generations of cloud services. With the help of these technologies, digital ecosystems become more reliable, efficient, and secure.

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