Chapter 19
Integrating Green Infrastructure With AI-Driven Dynamic Workload Optimization for Sustainable Cloud Computing

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ABSTRACT

The rapid growth of cloud computing has raised concerns about its environmental impact, particularly in terms of energy consumption and carbon emissions. This chapter explores the integration of green infrastructure with AI-driven dynamic workload optimization to promote sustainable cloud computing practices. By leveraging AI algorithms, cloud service providers can dynamically adjust resource allocation, optimize energy use, and enhance overall operational efficiency. The implementation of green infrastructure, including renewable energy sources and energy-efficient data centers, further supports the reduction of the ecological footprint associated with cloud services. This chapter examines the principles and strategies for achieving synergy between AI technologies and green infrastructure, presenting case studies that demonstrate successful implementations. The findings indicate that this integrated approach not only enhances sustainability but also improves cost-effectiveness and operational resilience, positioning organizations to meet both environmental goals and business objectives.

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INTRODUCTION

The increasing reliance on cloud computing has revolutionized the way organizations manage their IT infrastructure, providing scalability, flexibility, and cost-effectiveness. However, this rapid growth has also led to significant environmental concerns, primarily due to the substantial energy consumption and carbon emissions associated with cloud services. As data centers expand and the demand for cloud resources surges, the need for sustainable practices becomes paramount. Integrating green infrastructure with AI-driven dynamic workload optimization offers a promising solution to mitigate the environmental impact of cloud computing while maintaining operational efficiency. This chapter explores these concepts and their implications for the future of sustainable cloud computing.

The concept of green infrastructure encompasses strategies and technologies aimed at minimizing the environmental footprint of IT operations. This includes the use of renewable energy sources, energy-efficient data center designs, and innovative cooling techniques to reduce energy consumption. As organizations strive to meet sustainability goals and adhere to regulatory requirements, the integration of green infrastructure becomes increasingly vital.

Simultaneously, advancements in artificial intelligence (AI) provide new opportunities for optimizing cloud operations. AI-driven dynamic workload optimization enables real-time adjustments in resource allocation, ensuring that energy usage aligns with actual demand. By combining green infrastructure with AI technologies, organizations can enhance the sustainability of their cloud environments, reduce operational costs, and improve overall performance.

The body of literature regarding Green Artificial Intelligence (Green AI) and sustainable technologies is rapidly growing, emphasizing the importance of AI, IoT, and cloud computing in promoting sustainability across various sectors. Here, several notable works have been identified that outline the intersections of AI, cloud computing, and green infrastructure in creating a more sustainable future.

Green AI and Cloud Computing Initiatives Alzoubi and Mishra (2024) provide a comprehensive overview of Green AI initiatives, outlining both the potentials and the challenges faced in creating environmentally friendly AI systems. Similarly, Bolón-Canedo et al. (2024) review the trends in Green AI, stressing its critical role in reducing the environmental impact of AI operations, while emphasizing the need for research and development in sustainable AI technologies. Ali et al. (2024) and Mallo et al. (2024) further investigate how web technologies, cloud computing, and IoT can be leveraged to build sustainable enterprise systems, especially by integrating AI and security to achieve green operations.