Green Computing with Deep Learning for Data Centers

Doni Kavya
GMR Institute of Technology, Rajam, India
donikavya098@gmail.com

Abstract*: Due to development in cloud services, lots of data is transferred between users and servers of the cloud. This transmission of data consumes huge amounts of energy. This energy consumption occurs during the operation of network infrastructure, the conversion of electrical to optical signals to travel long distances, and signal amplification. As Green computing is the use of computing devices in an environmentally friendly way, i.e., using electrical energy efficiently as Data centers require a significant amount of electricity to operate and cool the servers, leading to carbon emissions from the burning of fossil fuels. Green computing in cloud services is about optimizing energy consumption and by incorporating deep learning algorithms, we can enhance the energy efficiency of cloud infrastructure. These algorithms can analyze real-time data from sensors, optimize resource allocation, and dynamically adjust power usage. Through intelligent workload scheduling, server consolidation, and power management, deep learning enables the reduction of energy waste and carbon emissions. The integration of deep learning in cloud services not only improves energy efficiency but also enhances performance and cost-effectiveness. Here we are using a deep learning model which can be used for workload prediction and resource provisioning. By analyzing historical workload patterns and user behavior, deep learning algorithmscan predict future resource demands and allocate resources accordingly, leading to more efficient resource utilization and energy savings.*

Keywords: Deep Learning, Green computing, Cloud Computing, Intelligent Workload Scheduling, Server Consolidation, Power Management

REFERENCES

[1] Wang, S., Sun, Y., Shi, X., Zhu, S., Ma, L. T., Zhang, J., ... & Liu, J. (2023). Full Scaling Automation for Sustainable Development of Green Data Centers. arXiv preprint arXiv:2305.00706.(Base paper)

[2] Rajput, S., Widmayer, T., Shang, Z., Kechagia, M., Sarro, F., & Sharma, T. (2023). FECoM: A Step towards Fine-Grained Energy Measurement for Deep Learning. arXiv preprint arXiv:2308.12264.

[3] Venkataswamy, V. (2022). Job Scheduling in Datacenters using Constraint Controlled RL. arXiv preprint arXiv:2211.05338.). Deep learning-based multivariate resource utilization prediction for hotspots and coldspots mitigation in green cloud data centers. The Journal of Supercomputing

[4] Patel, Y. S., Jaiswal, R., &Misra, R. (2022). Deep learning-based multivariate resource utilization prediction for hotspots and coldspots mitigation in green cloud data centers. The Journal of Supercomputing, 78(4), 5806-5855.

[5] Memmel, E., Menzen, C., Schuurmans, J., Wesel, F., &Batselier, K. (2022). Towards Green AI with tensor networks--Sustainability and innovation enabled by efficient algorithms. arXiv preprint arXiv:2205.12961.

[6] Yousefpour, A., Guo, S., Shenoy, A., Ghosh, S., Stock, P., Maeng, K., ... &Mironov, I. (2023).Green Federated Learning. arXiv preprint arXiv:2303.14604.

[7] Savazzi, S., Rampa, V., Kianoush, S., & Bennis, M. (2022). An energy and carbon footprint analysis of distributed and federated learning. IEEE Transactions on Green Communications and Networking, 7(1), 248-264.

[8] Malik, S., Tahir, M., Sardaraz, M., &Alourani, A. (2022). A resource utilization prediction model for cloud data centers using evolutionary algorithms and machine learning techniques. Applied Sciences, 12(4), 2160.

[9] Jayaprakash, S., Nagarajan, M. D., Prado, R. P. D., Subramanian, S., &Divakarachari, P. B.(2021). A systematic review of energy management strategies for resource allocation in the cloud: Clustering, optimization and machine learning. Energies, 14(17), 5322.

[10] Grishina, A., Chinnici, M., Kor, A. L., Rondeau, E., & Georges, J. P. (2020). A machine learning solution for data center thermal characteristics analysis. Energies, 13(17), 4378.

[11] Jayaprakash, S., Nagarajan, M. D., Prado, R. P. D., Subramanian, S., &Divakarachari, P. B.(2021). A systematic review of energy management strategies for resource allocation in the cloud: Clustering, optimization and machine learning. Energies, 14(17), 5322.

[12] Zeng, J., Ding, D., Kang, K., Xie, H., & Yin, Q. (2022). Adaptive DRL-based virtual machine consolidation in energy-efficient cloud data center. IEEE Transactions on Parallel and Distributed Systems, 33(11), 2991-3002.

[13] Zhou, Q., Xu, M., Gill, S. S., Gao, C., Tian, W., Xu, C., &Buyya, R. (2020, May). Energy efficient algorithms based on VM consolidation for cloud computing: comparisons and evaluations.In2020 20th IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing (CCGRID) (pp. 489-498). IEEE.

[14] Hu, X., & Sun, Y. (2020). A deep reinforcement learning-based power resource management for fuel cell powered data centers. Electronics, 9(12), 2054.

[15] Bharany, S., Sharma, S., Khalaf, O. I., Abdulsahib, G. M., Al Humaimeedy, A. S., Aldhyani, T. H., ... &Alkahtani, H. (2022). A systematic survey on energy-efficient techniques in sustainable cloud computing. Sustainability, 14(10), 6256.

[16] Hu, X., & Sun, Y. (2020). A deep reinforcement learning-based power resource management for fuel cell powered data centers. Electronics, 9(12), 2054.

[17] Lee, W., & Chung, B. C. (2023). Ensemble deep learning based resource allocation for multichannel underlay cognitive radio system. ICT Express, 9(4), 642-647.

[18] Salles, A. C., Lunardi, G. L., & Thompson, F. (2022). A Framework Proposal to Assess the Maturity of Green IT in Organizations. Sustainability, 14(19), 12348.

[19] Islam, R. U., Ruci, X., Hossain, M. S., Andersson, K., &Kor, A. L. (2019). Capacity management of hyperscale data centers using predictive modelling. Energies, 12(18), 3438.

[20] Joloudari, J. H., Mojrian, S., Saadatfar, H., Nodehi, I., Fazl, F., Alizadehsani, R., ... & Acharya, U. R. (2022). The state-of-the-art review on resource allocation problem using artificial intelligence methods on various computing paradigms. arXiv preprint arXiv:2203.12315.