

462CPE:7102: High Performance Computing

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Towards Sustainability and Energy Efficiency Using Data Analytics for HPC Data Center

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February 2025

Abstract

Data centers for high-performance computing (HPC) use vast amounts of energy, which greatly increases operational costs and raises environmental issues. This research aims to achieve energy efficiency and sustainability within the ENEA CRESCO6 cluster using data analytics and machine learning methods. The research follows a four-phase methodology: (1) a pattern in job execution with cooling performances and temperature variations is identified by means of Exploratory Data Analysis; (2) examination of relationships residing in Thermal conditions and operational parameters is conducted using Inferential Statistical Analysis; (3) hot-aisle temperatures and cooling strategies are predicted and optimized using Predictive Modeling; and (4) methods of managing idle nodes and their thermal efficiency goals are analyzed for Energy Optimization.

Based on the set objectives, machine learning-based predictive cooling and optimized workload distribution greatly improve system energy waste in conjunction with thermal stability. The study addresses and underscores the strategic necessity of HPC infrastructure resource management, removing the "silo" approach and passing a large portion of energy management over proactively managed resources. The resultant findings provide insight into new advanced operational frameworks in which HPC efficiency and sustainability, as well as environmental care coexist.

References

- [1] Chinnici, A.; Ahmadzada, E.; Kor, A.-L.; De Chiara, D.; Domínguez-Díaz, A.; de Marcos Ortega, L.; Chinnici, M. Towards Sustainability and Energy Efficiency Using Data Analytics for HPC Data Center. *Electronics* 2024, 13, 3542. <https://doi.org/10.3390/electronics13173542>.