Green and Sustainable Computing

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This special issue highlights the urgent need for green and sustainable computing practices. Three critical topics, human-centered artificial intelligence, the computing continuum, and green machine learning, are discussed as important for creating environmentally friendly and efficient computing systems.

The world is facing unprecedented challenges in terms of environmental sustainability, and the computing industry is no exception. Is the increasing use of computing devices, cloud computing, and machine learning algorithms having a significant impact on the environment, as measured by carbon emissions, energy consumption, and waste generation? The answer is yes, as the many instantiations of computing collectively consume as much as 10% of the world's electricity today, and this number may grow to be more than 20% by the decade's end. Therefore, in our resource-constrained world, there is an urgent need to adopt green and sustainable computing practices to mitigate these impacts and create a more environmentally friendly computing industry.

Green and sustainable computing involves the development of energy-efficient, environmentally friendly, and socially responsible computing systems that can reduce the negative impact of computing on the environment. The concept of green and sustainable computing applies across the entire spectrum of the field and includes but is not limited to energy-efficient computing devices, sustainable data centers, efficient algorithms, and responsible use of computing resources.

This special issue focuses on three interrelated topics that are critical to the development of green and sustainable computing: 1) human-centered artificial intelligence (AI), 2) the computing continuum, and 3) green machine learning. The articles in this issue provide insights into how these topics can be addressed to create sustainable computing systems that not only benefit the environment but also provide efficient and effective computing solutions for users.

The first article in this issue[A1] addresses human-centered AI, which emphasizes the importance of involving users in the development and testing of AI algorithms. By prioritizing user interaction and feedback, human-centered AI seeks to create more ethical, practical, and legal AI systems that enhance human experiences. The article explores the need for a human-centered framework for AI and how it can lead to fairer, more transparent, accountable, and explainable AI systems that align with human values and preserve human rights.

The second article[A2] focuses on the computing continuum, which aggregates

APPENDIX: RELATED ARTICLES

A1. D. Shin and E. Y. Shin, "Human-centered AI: A framework for green and sustainable AI," *Computer*, vol. 56, no. 6, pp. 16–25, Jun. 2023, doi: 10.1109/MC.2023.3241071.
A2. S. Galantino, F. Risso, V. C. Coroamă, and A. Manzalini, "Assessing the potential energy savings of a fluidified infrastructure," *Computer*, vol. 56, no. 6, pp. 26–34, Jun. 2023, doi: 10.1109/MC.2023.3244033.
A3. M. Gutiérrez, M. Angeles Moraga, F. García, and C. Calero, "Green-IN machine learning at a glance," *Computer*, vol. 56, no. 6, pp. 35–43, Jun. 2023, doi: 10.1109/MC.2023.3254646.

geographically dispersed computing resources into logical resource pools. This article analyzes the benefits of the computing continuum and how it can be used to create more energy-efficient computing infrastructures. The use case presented in this article focuses on a university lab where end user devices are aggregated into a continuum substrate, demonstrating how the distribution of workload across heterogeneous computing devices can bring valuable improvements in terms of energy consumption.

The third article in this issue[A3] addresses green machine learning, which seeks to develop machine learning models that meet operational requirements while ensuring a suitable tradeoff between performance/reliability and energy consumption. The article presents a green-in-driven approach to the development of machine learning models and illustrates how it can make a variety of contributions in the life cycle of such models.

Overall, this special issue provides a comprehensive overview of green and sustainable computing practices, highlighting the importance of human-centered AI, the computing continuum, and green machine learning in creating more efficient, effective, and environmentally friendly computing systems. We hope that the articles in this issue will inspire further research and development in this important area of computing.

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