Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
FAIR Future Artificial Intelligence Research

Green-Aware Artificial Intelligence

Methods and Solutions to Improve AI Sustainability

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Sustainable Artificial Intelligence

- **Sustainable AI** refers to the development, deployment, and usage of artificial intelligence technologies in ways that are *environmentally*, *socially*, and *economically* responsible.

- Key principles:

  - **Environmental responsibility**: minimize the energy consumption and carbon footprint of AI training and deployment.

  - **Ethical practices**: ensure fairness, transparency, and accountability in AI systems to avoid perpetuating biases or harm.

  - **Economic viability**: develop AI solutions that are cost-effective and accessible across diverse socioeconomic contexts.

The case of GPT-3

- Training GPT-3 on a database of 500 billion words required:
  - 1287 MWh of electricity and 10,000 computer chips, equivalent to the energy needed to power approximately 121 homes for a year in the USA.
  - 550 tons of carbon dioxide emissions, comparable to flying 33 times between Australia and the UK.

- While training is resource-intensive, inference also consumes considerable energy:
  - In January 2023, GPT-3 logged 590 million accesses, consuming energy equivalent to 175,000 people.
  - On average, each ChatGPT query uses the same amount of energy as running a 5 W LED bulb for 1 hour and 20 minutes, amounting to 260.42 MWh of daily energy consumption.

Bolón-Canedo, V., Morán-Fernández, L., Cancela, B., & Alonso-Betanzos, A. (2024). A review of green artificial intelligence: Towards a more sustainable future. Neurocomputing, 128096.

AI for Green

- AI technologies are leveraged to enhance environmental sustainability by enabling innovative solutions to address societal and ecological challenges.
  - **Energy optimization**: improving the efficiency of energy systems, such as smart grids, demand-response systems, and renewable energy integration (e.g., solar and wind).
  - **Climate modeling**: analyzing large datasets to improve climate forecasting, track deforestation, and monitor environmental changes.
  - **Resource management**: helping optimize water usage, reduce waste, improve recycling processes and enhance transportation efficiency.
  - **Sustainable Agriculture**: supporting precision farming by optimizing irrigation, fertilizer use, and crop monitoring, reducing environmental impact and wastes.

Green for AI

- The environmental impact of AI systems is minimized by making their development and deployment eco-friendlier and more sustainable.
  - **Energy-efficient AI models**: designing and training AI systems that consume less energy through techniques like model pruning, quantization, and distillation.
  - **Hardware optimization**: developing specialized chips and hardware for AI tasks that are more energy-efficient than general-purpose processors.
  - **Edge AI**: developing innovative techniques for on-device learning on resource-constrained devices, seamlessly integrating AI capabilities with the low-latency and privacy benefits of edge computing.
  - **Bias mitigation**: developing techniques to identify and address biases within AI systems, preventing discrimination and promoting fairness, transparency, and trust in AI adoption.

A virtuous cycle

- As **AI for Green** contributes to cleaner energy systems and reduced environmental impacts, it creates conditions (e.g., higher renewable energy availability) that support more sustainable AI practices under Green for AI.
- Conversely, improvements in **Green for AI** lower the environmental footprint of AI technologies, enabling their broader use in sustainability initiatives under AI for Green.

- **This cycle, when scaled, promotes an effective integration of technology and environmental responsibility, driving progress toward a more sustainable future.**

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Enjoy!