ARTIFICIAL INTELLIGENCE AND THE ENVIRONMENT

AI and the Environment: the Double-Edged Sword

- Climate change, driven by human caused greenhouse gas (GHG) emissions, is leading to extreme weather, food insecurity, biodiversity loss, fewer habitable regions, and more.
- Artificial Intelligence (AI) is revolutionizing global economies and societies at an unprecedented rate, and some applications can support solutions for climate change, biodiversity loss, and more.

AI for environment - example applications

- Predictive AI applications can help reduce GHG emissions in buildings by automatically switching to cleaner energy sources when available.
- AI supported monitoring systems are helping Indigenous Communities and authorities protect land by detecting and reporting illegal logging or fishing.
- AI diagnostic tools can identify early stages of plant disease and enable more precise application of pesticides, thereby reducing the overall chemical load.

However… left unchecked, AI can also negatively impact our environment

With demand for AI services predicted to grow by 30–40% annually over the next 5–10 years, it is crucial to ask:

- **What are the dangers of rampant growth of AI on our environment?**
- **What can be done to mitigate these dangers and meet our climate and sustainability goals in the digital age?**

Direct Impacts of AI on the Environment

Direct pathways include: production [building and assembly of physical components and infrastructure], operations [training and deployment of AI], and end of life of computing resources [waste disposal, recycling]. However there is limited information on these pathways.*

Energy consumption and greenhouse gas (GHG) emissions

- Developing and training certain cutting edge AI algorithms (such as large language models that use deep neural network(s) requires energy intensive data centers. These centers contribute to 1% of GHG emissions in the energy sector and use up to 1.3% of global electricity. Training a single model, like ChatGPT, can emit almost 5 times more emissions than that of a car, including fuel consumption, throughout its lifetime.
- Generative AI (models that generate images and text) have large footprints. For example, carbon dioxide emissions from generating 1,000 images can be equivalent to emissions from driving 4.1 miles in a gasoline-powered car.
- In its deployment stages, generative AI can take up to 30 times more energy than AI models developed for a specific task. While text generation is less energy consuming in comparison, they use 4–5 times more energy for a search when compared to traditional web searches.
- Presently, the overall footprint of the ICT sector is relatively small (~1.4% of global GHG emissions), but researchers estimate by 2027 AI energy consumption will be 10 times higher than it was in 2023. While renewable energy can help reduce these emissions, energy demand does not reduce. Is renewable energy better used heating a home or powering a data center?

Water consumption

- Energy intensive data centers used to power AI generate a large amount of heat, requiring constant cooling using freshwater. At the end of this cooling process, water is significantly contaminated with chemical coolants and heavy metals and discarded.
- Data centers supporting GPT-4 in Iowa were reported to have consumed up to 6% of the district's water in the last month of training the AI model.

Raw-material extraction

- There is now increasing demand for rare earth materials, such as lithium, cobalt, zinc, needed to build the specialized equipment required for AI development.
- Extraction of these rare earth minerals have been linked to severe negative consequences, such as deforestation, soil erosion, groundwater contamination, and biodiversity loss and social impacts such as human rights violation and political instability, particularly in vulnerable regions.

E-waste

- In 2022, 62 billion kg of e-waste (electrical and electronic equipment waste) was produced around the globe (a new record). Only 22% of that amount was recycled.
- E-waste can impact communities through multiple ways including lead and mercury emissions and leakage of plastic in ecosystems. Currently only 42% of nations have policies in place to regulate e-waste, and even fewer with collection targets.

So… what can we do to mitigate these dangers?

Best Practices to reduce the Direct Impacts of AI on the Environment

Is AI always the solution?

- Explore alternatives to AI – use AI in specific-use cases where no alternatives exist or opt for human decision making and avoid using generative AI tools for simple tasks such as a conventional search on the web.
- Conduct a cost-benefit analysis to determine if the environmental cost of the AI application outweighs the environmental benefit gained (see here for some criteria).

Increase data transparency

- Manufacturers of computational hardware should provide details around the environmental impacts of their assembly process, including carbon emissions, water usage, and rare earth materials used, to help increase transparency in the AI supply chain.
- Computer scientists and researchers should disclose, to the best of their ability, resources leveraged in training and deploying AI models (for example, time, carbon emissions) to better enable comparisons between models.
- Separate AI emissions from other ICT emissions, for example dedicated data centers to train AI, in order to get access to more accurate AI carbon footprint data.

Incorporate circularity where ever possible across the AI supply chain

- Reuse water consumed in data centers (e.g filter and reuse water used in cooling servers) and use alternate sources other than fresh drinking water (for example treated wastewater).
- Dismantle, reclaim, and recycle materials from processors and old lithium batteries in or around data centers to help build a closed loop on-site whilst also reducing transportation emissions.
- Aim to use at least 50% of recycled/re-used materials when replacing parts or building future data centers to reduce E-waste.
- Use clean and low-tech energy to power data centers.

***Many factors complicate the ability to accurately monitor and report the complete footprint of AI, and these include:**

- **Lack of environmental data on the manufacturing processes of computational hardware.**
- **The overlap with general computing (non-AI related) resources.**
- **AI is not contained to one application or sector.**

Indirect Impacts of AI on the Environment

The use of AI applications can also cause harm to the environment through indirect pathways. AI can fuel socioeconomic transformations, and impacts from these transformations are harder to anticipate, measure, and monitor, and therefore less understood.

Rebound effects and increased consumerism

- Increased efficiencies brought about by AI are lowering costs of producing goods and services. While it can lead to positive impacts at the individual product level, these benefits can be undone by overall increases in demand for the product.

Innovation in polluting industries

- AI advancements can help identify new extraction sites for carbon intensive industries such as fossil fuels, aiding to further environmental degradation and fueling greenhouse gas emissions.

Overall uncertainty around AI impacts

- Given its cross-cutting nature, it is extremely difficult to map the growing number of indirect pathways by which AI impacts our environment. This uncertainty is troubling, as there is a growing concern that indirect risks of AI could outweigh the direct impacts.

Best practices in navigating indirect impacts

1. Encourage policy makers to adopt a precautionary principle and design policies that acknowledge, anticipate, and limit the negative indirect impacts of AI.

2. Awareness around the environmental impacts of AI should be increased across policy makers, youth, tech innovators, civil society, and researchers to help develop AI tools that center around environmental and social values.

3. Increase access to education programs on environmental digital sustainability, for example, a mandatory certification on digital sustainability for ICT sector professionals and CEOs and other individuals in leadership positions at high stake AI companies.

4. Scenario mapping and quantification: Researchers (and climate modelers) are calling for a better understanding of how AI can impact climate goals under different socioeconomic and political settings, with some proposed starting points.

Key takeaways

- Establish national level AI regulations that take into consideration environmental and societal risks and help govern current and future use of AI.
- Raise public awareness around the environmental impacts of AI.
- Use AI as a precision-tool rather than a silver bullet to all problems.
- Limit the broad scale application of AI, in particular generative AI, when less energy intensive alternatives exist.

SUSTAINABILITY IN THE DIGITAL AGE

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