Environmental AI Literacy Framework

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ITHAKA S+R

Through research, collaboration, and innovation, Ithaka S+R informs policy, guides strategies, and builds evidence-based tools to broaden access to postsecondary education, improve student and workforce outcomes, and advance scholarship.

Ithaka S+R is part of ITHAKA, a nonprofit with a mission to improve access to knowledge and education for people around the world. We believe education is key to the wellbeing of individuals and society, and we work to make it more effective and affordable.

Introduction to the framework

Incorporating AI literacy as a component of the core curriculum is increasingly a priority for colleges and universities. "AI literacy" commonly encompasses understanding how the technology works, how to responsibly employ AI tools, and its impact on society.[1] Certain AI literacy frameworks for higher education mention its environmental impacts as a component of their learning competencies, but lack sufficient detail or guidance for learners or instructors to easily integrate this into their curricula.[2]

Ithaka S+R's Environmental AI Literacy Framework aims to help bridge that gap. The framework is intended to complement existing generalized AI literacy frameworks. It is designed for postsecondary instructors, librarians, and students, but can readily be adapted to audiences or institutions beyond the higher education context.

The framework aims to guide the learner in understanding the types and extents of AI technologies' impacts on the environment, their related impacts on human well-being, and the actions that could be taken to mitigate these impacts.

[1] For example, the Digital Education Council's AI Literacy Framework defines AI literacy as "The essential knowledge and skills needed to understand, interact with, and critically assess AI technologies. AI literacy includes the ability to use AI tools effectively and ethically, evaluate their output, ensure humans are at the core of AI, and adapt to the evolving AI landscape in both personal and professional settings," https://www.digitaleducationcouncil.com/post/digital-education-council-ai-literacy-framework. Leo S. Lo has defined AI literacy as "the ability to understand, use, and think critically about AI technologies and their impact on society, ethics, and everyday life," https://doi.org/10.5860/crln.86.3.120.

[2] See for example UNESCO's AI competency framework for students, p. 23, https://doi.org/10.54675/JKJB9835; or Stanford University Teaching Common's AI Literacy Framework within their Understanding AI Literacy module, https://teachingcommons.stanford.edu/teaching-guides/artificial-intelligence-teaching-guide/understanding-ai-literacy.

It is organized around four domains:

1) Impacts across the AI life cycle
   What are the different types of environmental impacts of AI across its life cycle?

2) Quantifying and contextualizing impacts
   How can we measure and make sense of the extent of AI's environmental impact?

3) Sustainability strategies and efforts
   What are the necessary steps to making AI more environmentally sustainable?

4) Health and social impacts
   How do the environmental impacts of AI extend to human health and social impacts?

Each frame contains *knowledge bases* and *knowledge practices*. *Knowledge bases* describe learner competencies within each domain, while *knowledge practices* offer suggestions for how learners can apply and evaluate their knowledge levels by actively engaging with the topic in a practical sense. The *knowledge bases* and *knowledge practices* can be selected or adapted as needed.

Environmental AI literacy requires continuous learning. Staying abreast of new estimates and developments in experts' understandings of its environmental impacts is essential. This framework should be used with the assumption that knowledge bases or practices may need to be adapted as our understanding of this topic grows.

The Environmental AI Literacy Framework

1) Impacts across the AI life cycle

What are the different types of environmental impacts of AI across its life cycle?

Knowledge bases

- Understand that AI's environmental footprint comes in varied forms across its life cycle, including energy, land and water use, greenhouse gas emissions, and e-waste, and why these impacts occur.
- Understand why AI technology relies on data centers and the types of environmental impacts that result from data centers.
- Understand that physical supply chains, hardware infrastructure, and geographic locations sit behind common industry metaphors (e.g., "the cloud," "virtual," "clean tech").

Knowledge practices

- Review corporate sustainability reports or media coverage of AI and highlight how and if they disclose different types of environmental impact (e.g., water consumption, e-waste) or sustainability practices (e.g., renewable energy use).
- Examine how your institution reports on its environmental impacts and whether or not impacts of AI systems are included.

2) Quantifying and contextualizing impacts

How can we measure and make sense of the extent of AI's environmental impact?

Knowledge bases

- Be familiar with best available, evidence-based estimates of greenhouse gas emissions, energy use, and water use in AI systems, while remaining aware that quantifying AI's impact is imprecise for many reasons (e.g., lack of corporate transparency, evolving evidence and technological innovation, methodological variance in how to define and attribute impacts, etc.).
- Be aware of how resource use varies based on the type of tool and use case (e.g., generative versus non-generative AI, large versus small models, text versus image versus video generation, agentic versus non-agentic AI, etc.).
- Be familiar with why geographic and regulatory factors affect the environmental impact of data centers.
- Be familiar with emissions scoping, and with standard units of measurement used in tech sustainability, such as carbon dioxide equivalents (CO_2e) and kilowatt-hours for energy efficiency (kWh).

Knowledge practices

- Seek out up-to-date information about where there are gaps in knowledge to quantify the environmental impacts of AI.
- Explain to a peer the extent of AI's impact in a specific area (e.g., emissions, energy use, water use) by using appropriate units of measurement and/or comparing AI's impact with that of other common uses of digital technology.
- Explore online AI carbon footprint estimators, identifying which variables they account for and which they omit.

3) Sustainability strategies and efforts

What are the necessary steps to making AI more environmentally sustainable?

Knowledge bases

- Be familiar with existing examples of AI models, infrastructure, and regulation that purposefully mitigate negative environmental impacts.
- Understand the roles the AI sector, policy makers, and other stakeholders can respectively play in AI-related sustainability efforts.
- Be familiar with expert opinions on effective strategies for reducing the negative environmental impacts of the AI sector through infrastructure, policy and regulation, and/or technological innovation.

Knowledge practices

- Make informed decisions about which type of AI tool to employ and whether to employ AI or non-AI tools for specific tasks, taking environmental costs into account.
- Reflect on and discuss possible negative environmental consequences for the area where you live, work, or study if a data center were to be built nearby and how those impacts could be mitigated.
- Draft targeted environmental accountability questions to ask software vendors, campus IT departments, or developers before adopting or purchasing a new AI tool.

4) Health and social impacts

How do the environmental impacts of AI extend to human health and social impacts?

Knowledge bases

- Understand how AI's environmental impacts have direct and indirect risks for human health.
- Understand how and why the environmental impacts of AI have uneven impacts on different people and regions, mapping onto existing inequalities.
- Gain familiarity with debates around data center construction, and identify where these debates may be happening in your local area.
- Understand the human labor involved in the hardware life cycle, from hazardous mineral extraction to data center construction and electronic waste processing.

Knowledge practices

- Identify key issues within local policy conversations concerning AI's potential harms to human health and livelihoods.
- Write to community leaders/local media with an informed opinion about data centers or construction plans in your area.
- Write to university leadership with institutional policy recommendations that prioritize mitigating environmental impacts alongside technological advancement.