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Editorial Article

Green AI for Sustainability: Leveraging Machine Learning to Drive a Circular Economy

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As artificial intelligence continues[1] its relentless march towards advancing capability, there is surprisingly little discussion around advancing responsibility. The data centers underpinning AI research devour massive amounts of energy and contribute substantially to emissions. But what if AI could flip the script and help curb emissions instead? An emerging field known as Green AI provides solutions by building economic and environmental sustainability directly into AI systems. In a paper published this week, researchers set out an innovative framework for leveraging machine learning to accelerate the transition to a circular economy.[2] This model moves away from the traditional linear take-make-dispose economy towards one where products, parts, and materials can be reused, remanufactured, and recycled in closed loops. AI and automation will provide the optimization backbone to make such closed-loop supply chains efficient and cost-effective.

The applications put forth in this visionary roadmap are comprehensive, from intelligent production planning to predictive maintenance, remanufacturing automation, and reuse marketplaces[3]. The machine learning capabilities to enhance reuse, sharing, repair, refurbishment and recycling are maturing rapidly and will only continue improving. Operationalizing these innovations can minimise waste and virgin resource usage. We already see pioneering examples, like AI-based apps matching discarded electronics to spare parts buyers. As the applications in this paper demonstrate, the potential impact from combining AI[4] and sustainability spans the entire value chain. The authors also address the imperative to make AI itself more sustainable through data efficiency, energy-efficient chips, and renewable energy usage in training systems.

Realizing this green AI revolution will certainly face challenges in overcoming legacy infrastructure and mindsets. However, every journey begins with intention followed by initiative[5]. This paper lays out an innovative intention. It is time for researchers, companies, and governments to demonstrate initiative by investing in sustainable AI solutions that implement these visions. The opportunities touch every industry sector; the imperative touches every living being. The framework presented in this paper focuses on industry-wide transformations toward a circular economy accelerated by AI. But as promising innovations emerge from research, much more work remains to scale solutions beyond isolated pilots. Companies must look past proof-of-concepts to large-scale implementation strategies. While open data sets have catalyzed progress in narrow AI, availability of operational data for circular systems modeling remains limited. Standards and protocols for cross-company data sharing will open new avenues for economy-wide Impact. Governments also have a role in enabling an ecosystem for public-private collaboration. Society is beginning to debate if AI should be regulated for trustworthiness and safety. It is time to also embed responsibility - for sustainability as a foundational principle. We must expand development of AI dedicated to environmentally regenerative use cases along with reducing AI's own carbon footprint based on full life cycle analyses. Research funding agencies should prioritize proposals in green AI and data center energy efficiency.

Education is also pivotal. Academic and industry AI curricula must include sustainability concepts; scientists should be trained to minimize data, energy and computational requirements. As this paper recommends, the addition of dedicated Green AI tracks in major AI research conferences will formally ingrain focus on environmental impacts in the AI community. Transitioning from our current extraction-driven linear economy toward a sustainable circular model powered by AI will demand overcoming inertia and reimagining growth. An economy based on abundance rather than scarcity of resources requires new metrics and business models that monetize reuse, repair, and refurbishment. Policy incentives should be realigned from production volume toward longevity and recovery of resources. Companies must expand responsibility from financial shareholders toward environment stakeholders.

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The vision outlined in this paper provides a starting point. But research must now leap from the lab into the real world. The climate situation grows more urgent by the day; promises and potential will not protect fragile ecosystems. Now is the time to demonstrate Green AI in action and enable a sustainable future fueled by artificial intelligence.

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Conflicts of Interest

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