AI solutionism as a barrier to sustainability transformations in research and innovation

AI-driven approaches dominate research and innovation, but are they addressing social complexities and deeper ethical challenges? Following a critique of the growing reliance on technical solutions to sustainability issues, the author calls for a shift toward value pluralism and epistemic humility, offering reforms to reshape research and higher education priorities.

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Abstract
In this article, the impact of AI-driven solutionism in research and innovation is critically examined, with a particular focus on sustainability challenges. It is argued that overreliance on technical solutions often ignores ethical complexities, leading to two risks: overlooking diverse values and epistemic hubris. The author examines how current trends in academia, research funding, and industry partnerships perpetuate a solutionist ideology, potentially marginalizing critical ethical discourse and participatory decision-making. He highlights the need for a shift towards value pluralism and epistemic humility in research and innovation. He concludes by proposing reforms in higher education and research funding to foster these principles, offering concrete examples of their implementation.

Keywords
academia, AI solutionism, ethical complexities, integrative approach, sustainability issues

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Technological advances in artificial intelligence (AI) have fueled optimism about its ability to tackle sustainability challenges, such as welfare, climate change, and food insecurity (Alston 2019, Nishant et al. 2020, Sakapaji and Puthenkalam 2023). However, this optimism often reflects a solutionist ideology that emphasizes technical solutions while overlooking the ethical complexities of these issues – the fundamental questions of justice, power relations, cultural values, and human and non-human dignity that shape sustainability challenges (Alston 2019, Nishant et al. 2020, Bracarense et al. 2022).

This paper will examine the challenge of AI-driven solutionism in impeding sustainable transformation within higher education institutions, by looking at the tension between AI-driven approaches, value pluralism, and epistemic humility in sustainability research and innovation. Value pluralism in this context refers to the recognition that there are multiple, sometimes conflicting values that cannot always be reduced to a single measure or ranked in a consistent hierarchy (Berlin 1969). Epistemic humility, on the other hand, involves acknowledging the limits of our knowledge and the fallibility of our beliefs, particularly when dealing with complex systems (Matthews 2006).

Philosophical underpinnings of AI solutionism

Solutionism, as described by Morozov (2013), frames technological innovation as the primary solution to complex social, political, economic, and environmental challenges, often neglecting ethical considerations. This ideology is evident in much of the public discourse on AI and emerging technologies, which is based on the belief that technology alone can resolve sustainability issues. Examples include publications like *AI is essential for solving the climate crisis* from the Boston Consulting Group (Maher et al. 2022) and a *CNN* report on AI's potential in combating climate change (Duffy and Ramirez 2023). These approaches depict AI as a key tool for managing complex climate data, suggesting that the technology can effectively address issues such as carbon emissions (Maher et al. 2022, Duffy and Ramirez 2023). Even The White House promotes AI solutionism in a blog post (Brainard et al. 2023). Such views reduce sustainability challenges to >

technical problems, ignoring their interdisciplinary nature and ethical complexities.

AI can indeed offer potential benefits for sustainability research through its ability to monitor environmental changes and optimize resource use, from tracking deforestation to predicting extreme weather events (Vinuesa et al. 2020). However, its applications ignore the significant environmental costs, including energy consumption, mineral extraction, and e-waste (Brevini 2023). While AI's capabilities are valuable, focusing solely on its analytical and predictive power without mechanisms for concrete action inadvertently reinforces a technocentric approach to sustainability that overlooks both crucial ethical dimensions and AI's environmental impact (Falk and van Wynsberghe 2024, Brevini 2023). Solutionism reduces sustainability issues to data optimization and prediction, often ignoring biases and power dynamics in algorithmic systems (Hicks 2017). For example, advances in natural language processing, such as large language models (LLMs), demonstrate technical progress but perpetuate biases (Bender et al. 2021). Or consider AI systems used for urban resource allocation; they may optimize based on digital engagement data, inadvertently discriminating against communities with limited technological access or ignoring cultural practices such as resource sharing that are not captured in individual usage metrics. This underscores the need for robust accountability frameworks for AI development that consider multiple stakeholders and their ethical responsibilities in the social, environmental, and economic spheres (Capasso and Umbrello 2022).

As Noble (1984) argues, technology is not a neutral tool but is embedded in social, political, and economic contexts. This can be seen, for example, in computer modeling in fisheries management, where quantitative analysis sometimes overshadows broader ethical considerations (Townsend et al. 2019). The belief in the neutrality of technical methods fails to take into account the ethical responsibilities inherent in sustainability issues (Porter 1995, Bell 2004). Debates on climate justice, conservation, welfare, or education are not solely about facts, but involve competing visions of a just and equitable future, requiring, as Heilinger et al. (2024) argue, a distinction between "thin" and "thick" sustainability in AI development. While "thin" sustainability might focus on isolated improvements like energy efficiency or social impact, "thick" sustainability requires a comprehensive assessment that considers both environmental and social impacts, both in terms of the means of AI production and its intended ends. Under current conditions of growth-oriented economies, even supposedly sustainable AI solutions may ultimately contribute to unsustainable outcomes through rebound effects and increased resource use.

In essence, solutionist rhetoric often downplays ethics in sustainability, favoring narrow technical solutions. This trend risks marginalizing the necessary interdisciplinary discussions on science's ethical implications, which are critical to developing effective sustainability strategies. Addressing AI solutionism requires examining its underlying assumptions to foster a more balanced and effective approach to sustainability.

Manifestations in research and innovation

The increasing emphasis on AI solutionism in research and innovation (Mariani et al. 2022) raises concerns about sustainability transformation. It has been argued that while most literature tends to sprinkle some ethics and responsibility garnishes throughout the text, this amounts to nothing more than ethics-washing with almost no actual real-world impact (Steinhoff 2023).

Current trends in higher education prioritize technical and entrepreneurial skills, potentially marginalizing the importance of ethical education. Writing for *Inside Higher Ed,* Ho (2020) expresses concern that this focus could lead to a societal divide, disadvantaging those without access to elite education and exacerbating socioeconomic disparities. This shift in higher education to emphasize narrow skill sets risks impeding the development of ethically and socially aware graduates and calls for a reassessment of educational priorities towards a balance of technical and sociopolitical education, in line with Dewey's (1916) vision of higher education as a driver of societal progress.

This issue is evident in approaches that treat sustainability challenges as neutral problems that can be solved by increasing computational power and data. For instance, efforts to address deforestation through satellite imagery and predictive land use models often ignore the complex political factors driving environmental degradation (Hosonuma et al. 2012).

University partnerships with tech companies focused on "AI for social good" tend to prioritize technical achievements over participatory decision-making and critical assessment of unintended consequences (Campolo et al. 2022). This approach favors novel computational methods over inclusive discussions about public interests. Furthermore, the prevailing academic culture often values entrepreneurship and innovation, resulting in a sustainability curriculum prioritizing technical skills for commercial application over ethical reasoning and critical reflection (Parry and Metzger 2021).

Obscuring uncertainties and plural values in academia

Currently science, technology, engineering[1], and mathematics programs often address sustainability issues inadequately (Zizka et al. 2021). Technical emphasis frequently comes without a corresponding integration of ethical considerations (Aguilera et al. 2021). This results in an academic divide, with programs tending to focus either on technical skills or on the humanities and social sciences, neglecting a holistic educational approach.

This reflects a positivist belief in technical institutions that views sustainability challenges as empirical problems solvable through data. Jasanoff (2004) underlines that policy disputes over climate adaptation involve factual disagreements, conflicting normative judgments and cultural knowledge, which are crucial in shaping responses to environmental challenges. Moreover, computational modeling, while useful for simplifying data analysis,

1 See also Banwell and Roelens (2024, in this issue) for a critical discussion of techno-solutionism in engineering education.

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often oversimplifies complex realities. For example, AI models predicting biodiversity impacts may ignore local knowledge, and satellite analyses of agricultural patterns can miss social nuances. Prioritizing data and efficiency risks overlooking ethical implications and marginalizing diverse value systems. In the solutionist paradigm, these complexities are treated secondary rather than central to a responsible approach to sustainability science, though not all agree with this critique.

Some argue that AI could offer more neutral and inclusive solutions to sustainability issues (Zhang et al. 2019). Properly developed and deployed, AI has the potential to remove bias-causing attributes and detect unconscious biases in decision-making processes (Vinuesa et al. 2020). Zhang et al. (2019) show how AI can reduce both conscious and unconscious biases in hiring, suggesting that AI-driven solutions can lead to more objective and fair decision-making than human counterparts. Vinuesa et al. (2020) underscores AI's potential in advancing the *Sustainable Development Goals (SDGs)* by addressing existing limitations through technology. However, this view adopts a solutionist lens, assuming that technological implementation alone can resolve deeply rooted issues like bias, and that with the right frameworks and regulatory measures, risks can be managed and the benefits of AI fully harnessed. While both papers acknowledge potential adverse effects, they focus primarily on the positive impacts of AI on sustainable development, reflecting a belief in the efficacy of technology to bring about significant positive change and solve global problems.

Sætra (2022) critiques the isolationist analysis of AI, arguing that examining AI solutions in controlled settings or specific use cases ignores how these technologies operate within broader sociotechnical systems that can fundamentally alter their impact. In addition, Zhang et al. (2019) and Vinuesa et al. (2020) do not sufficiently emphasize that sustainability is a wicked problem requiring the balance of multiple conflicting goals. Currently, multi-goal AI agents are ineffective due to difficulties in value estimation and key optimization (Feng 2022). While not explicitly addressing AI in sustainability, Feng's work on "sparsity of goal-reaching rewards" and "unreliable value estimation" (Feng 2022, p. 401) in multi-goal agents highlights broader AI limitations in addressing multifaceted sustainability challenges that require balancing multiple, often conflicting, goals.

Substituting optimization for inclusive dialogue in academia

Research funding structures and partnerships are driving a shift where corporate funders increasingly prioritize efficient discovery and control over critical ethical discourse and participatory decision-making (Mazov and Gueryev 2020). This is exacerbated by the fact that in the current AI hype, funding agencies are increasingly focusing on AI technical innovation in their research portfolios as they plan how to allocate their funds for the foreseeable future (Rahkovsky et al. 2021).

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For example, industry grants for conservation often push teams to develop data-driven tools and models to access these grants (Clark et al. 2016), thus marginalizing community needs and perspectives in favor of showcasing data management skills. This approach often neglects to create forums for diverse viewpoints, which is crucial for fair and effective sustainability. Similarly, sustainability education is shifting towards methodologies that emphasize resource optimization, often at the expense of developing critical thinking and ethical decision-making skills (Ivanova and Rimanoczy 2022). This focus on computational efficiency replaces essential processes like inclusive dialogue and participatory agenda-setting, sidelining the voices of vulnerable communities affected by sustainability issues. The substitution occurs because algorithms promise quick, quantifiable solutions, while community engagement requires months of dialogue – making it appear as a slow "bottleneck" in project timelines driven by technical deliverables.

Furthermore, academic partnerships with tech companies often focus on developing and publishing optimized techniques. These collaborations prioritize technical efficiency and transparency, such as revealing biases in datasets and adhering to policy standards. However, they frequently overlook broader issues of justice, dignity, and self-determination in technological debates (Mittelstadt 2019). As a result, these partnerships may inadvertently prioritize narrow technical success metrics over the pluralistic concerns essential to resolving public disputes over technology's societal impact.

Foreclosing pluralistic discourses

The dominance of technical-solutionist orientations in research and innovation narrows evaluation principles to quantifiable performance indicators, thereby foreclosing pluralistic academic engagement with questions of justice. Common methodologies in climate change research and resilience planning focus on broad carbon accounting measures and equal distribution, neglecting diverse notions of individual autonomy, human dignity, and minority rights specific to local contexts. Simplifying complex, localized viewpoints into technical issues can lead to injustice. It reduces these concerns to mere adjustments in statistical indicators or model parameters, rather than addressing the underlying political conflicts. Similarly, discourses on responsible AI (Lyons et al. 2023) focus primarily on uncovering biases in training dataset, improving transparency through quantitative model audits, and optimizing computational efficiency – rather than grappling with plural notions of self-determination or relational worldviews central to public disputes over appropriate technological interventions.

These tendencies reflect entrenched assumptions in university curricula, funding structures, and research cultures that view sustainability issues as empirical problems that can be addressed through ideologically neutral expert analysis, longitudinal collection of large amounts of data, and analytical techniques free from political interests or ethical entanglements. This perspective frames AI as an ideologically neutral tool capable of providing unbiased expert analysis. However, as Feenberg (2002) observes, purportedly neutral computational systems (including AI) inherently embed specific interests, modes of ascribing validity, forms of categorization, and means of delimiting admissible evidence that shape collective priorities and policy visions while claiming an impossible view from nowhere.

Responsible research and innovation should do more than showcase computational models. It needs to amplify overlooked voices, consider marginalized perspectives on risks, and reflect on how different frameworks prioritize certain concerns. Only by embracing contested pluralism in research and innovation can we illuminate the otherwise obscured complex interdependencies vital for mapping sustainability transformations.

Moving beyond AI solutionism

To effectively address the current sustainability crisis through research and innovation, we must move beyond simplistic AI solutionism. As Spindler et al. (2020) argue, this means moving from parallel "accompanying research" to integrating diverse perspectives from the start. Following Balmer et al.'s (2016) framework for interdisciplinary collaboration, we should create institutional spaces that foster collaborative experimentation, reflexive practices, and an appreciation for the unpredictability of complex systems. These spaces should encourage critical thinking about AI's role in sustainability and a balanced view of its potential benefits and limitations.

Solutionist sustainability narratives often reflect hubristic overconfidence in computational and predictive capabilities, obscuring endemic uncertainties in systems modeling and eliding risks of imposing simulated scenarios derived from limited data on diverse populations (Wynne 1992). Prevailing techniques focus on quantifying uncertainties within model ensembles, rather than highlighting exclusions ingrained in the design of computational experimental systems and plural forms of understanding human-environment and interpersonal relations beyond mere capture in calculated metrics.

To effectively address sustainability challenges, we need to change what we teach future researchers and innovators in research and innovation[2]. Drawing on studies of interdisciplinary integration (Spindler et al. 2020), we need to move beyond simply adding ethics courses alongside technical training and create truly integrated learning environments that help students recognize their biases and the ethical implications of their work, especially in systems modeling. Such a shift encourages understanding and addressing wicked problems over controlling the world through technology. By incorporating diverse perspectives and acknowledging the limitations and potential harms of technological solutions, educators can prepare students for the complex ethical choices they will need to make. To cultivate value pluralism and epistemic humility, educational reforms should em-

2 See also Banwell and Roelens (2024, in this issue).

phasize interdisciplinary learning to equip students for the complex, multifaceted nature of sustainability challenges.

For example, educators might assign an exercise on building an AI-driven model to predict and prevent educational attrition by identifying students at risk of dropping out. In such an exercise, students would typically be tasked with understanding the technical aspects of the model and implementing a predictive model that results in high accuracy and perhaps some consideration of how the results are distributed within the confusion matrix. The resulting AI would be solutionist. To avoid AI solutionism, students should be required to build a system that goes beyond mere technical implementation and accuracy metrics. To do this, educators would first have to make it clear to students that these models often reduce socio-educational phenomena to quantifiable metrics while failing to capture crucial qualitative factors such as family dynamics, socioeconomic pressures, or cultural attitudes towards education. Students would be exposed to how models perpetuate historical biases embedded in educational data, potentially reinforcing systematic disadvantages faced by marginalized communities. They would also be shown how a focus on individual-level predictions obscures systemic institutional factors contributing to attrition, such as curriculum design, pedagogical approaches, or institutional support structures.

To overcome such limitations, students should develop frameworks that integrate technical implementation with critical social analysis. This includes examining how different demographic groups might be impacted by automated intervention systems, and how institutional practices rather than individual characteristics contribute to attrition patterns – something often overlooked by typical machine learning approaches. Alternative approaches should include qualitative assessment mechanisms that capture student narratives and lived experiences, the development of culturally responsive intervention strategies, and the integration of community-based support systems. The technical implementation should explicitly account for potential biases in historical data and incorporate mechanisms for regular stakeholder feedback and system adaptation. This could include the development of >

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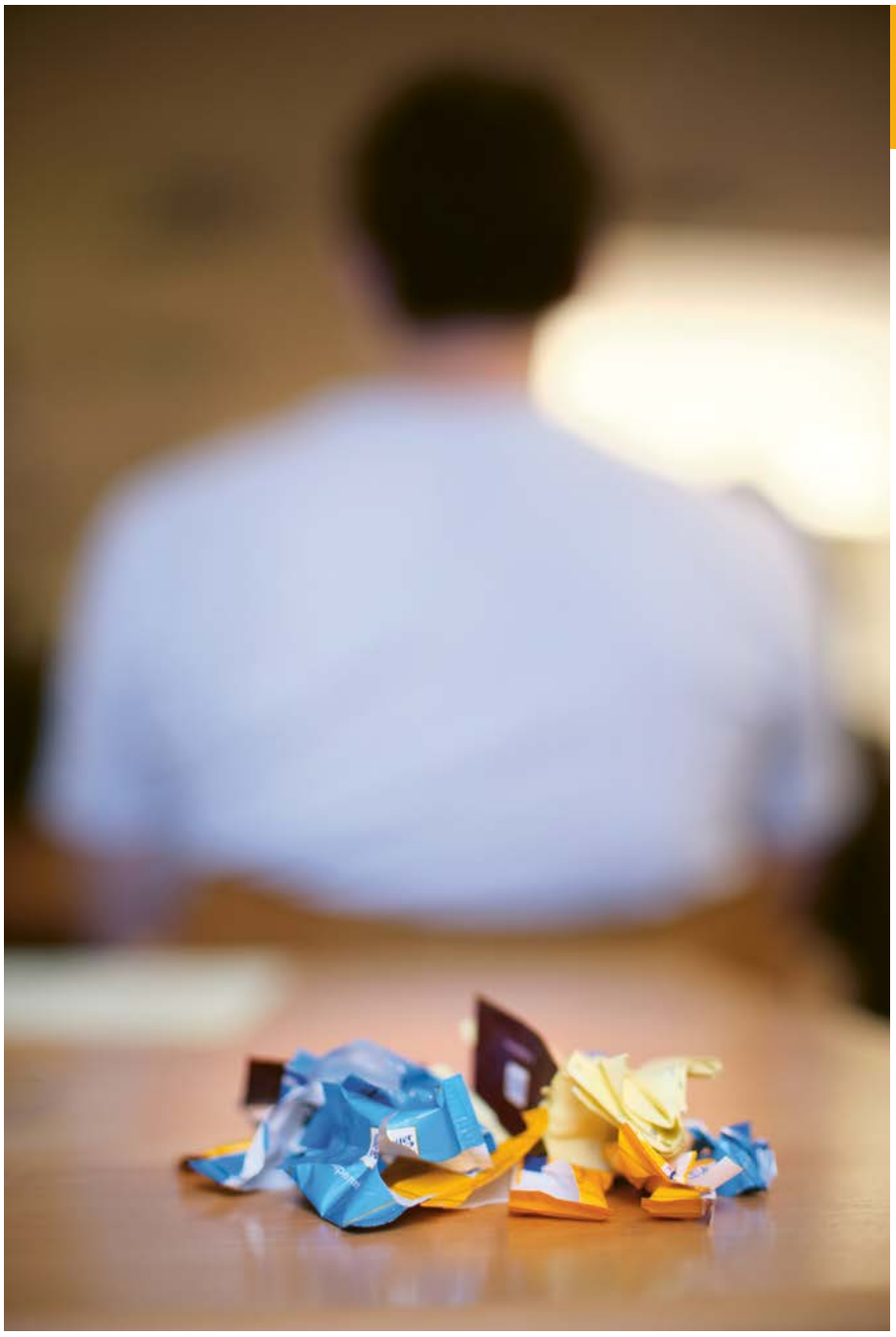

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hybrid evaluation frameworks that combine quantitative predictions with qualitative assessments from educators, counselors, and community members. Crucially, students should examine how their AI systems might complement rather than replace existing support structures. This includes analyzing how predictive insights can enhance rather than automate human decision-making, and how technology can support rather than supplant relationship-building between students and educators. Such analysis can help students understand that preventing educational attrition requires addressing systemic inequities and institutional barriers, rather than simply predicting individual outcomes.

To complement the educational shift, I believe, in line with Spindler et al. (2020), that research funding programs, partnerships, and publication criteria must be reformed to move beyond their solutionist obsession with novel displays of technical prowess. Instead, they should enable researchers and innovators to pursue open-ended investigations of the drivers of marginalization, contested sociotechnical imaginaries, and philosophical tensions in sustainability aspirations.

While data-intensive computational techniques are likely to expand, we must ensure ethical considerations guide their use through inclusive, participatory governance mechanisms. Current corporate and governance funds often prioritize marketable outcomes, novel technical methods, or anything related to AI use. To counter this, we need new review processes assessing stakeholder engagement, including marginalized voices, and researchers' responsiveness to criticism and unintended consequences.

Building on Balmer et al.'s (2016) vision for funding structures that explicitly support calculated risk-taking in interdisciplinary work while maintaining what they term "neighborliness" – respecting differences while working closely together, – I can envision in practice a national research funding agency launching a new *Community Futures* grant program. Applications would require research teams with a diverse set of academic backgrounds and community partners, with proposals detailing plans for ongoing community engagement and addressing locally identified challenges. The review process would involve a panel that includes academic experts as well as community leaders, policymakers, and marginalized group representatives. Evaluation criteria would give equal weight to technical merit, potential social impact, and the robustness of the proposed participatory research methods. Funded projects would be required to hold regular public forums

to share progress and gather feedback. They would also be required to produce outputs accessible to non-academic audiences, such as policy briefs or community workshops, alongside traditional academic publications. Mid-term and final evaluations would assess not only research outputs, but also the quality of community engagement, the project's responsiveness to local needs, and its ability to navigate and reconcile diverse perspectives on complex societal issues.

Conclusion

Today's ascendant ideologies promoting entrepreneurial sciences, startup incubator models, and university-industry partnerships risk fueling a reductionist view that technological advances alone can resolve sustainability issues by improving predictability, optimizing efficiency, and imposing top-down control devoid of serious ethical parsing. The solutions in this paper's last chapter offer a way forward that embraces value pluralism and epistemic humility, aligning with frameworks proposed by other authors like Spindler et. al (2020).

By reforming educational practices to include diverse perspectives and stakeholder engagement, we are fostering value pluralism in future researchers and innovators. The example of the AI-driven predictive policing exercise demonstrates how students can learn to consider multiple viewpoints and ethical implications, moving beyond simplistic technical solutions to address complex social issues and the limitations of technological interventions.

The proposed *Community Futures* grant program embodies what Matthews (2006) calls epistemic humility, acknowledging that academic expertise alone is not sufficient to address complex societal challenges. By involving community leaders, policymakers, and marginalized voices in the review process, this approach values diverse knowledge and experience. Its emphasis on public engagement and responsive research design reinforces the idea that knowledge is co-produced and evolving rather than fixed and solely expert-driven.

These reforms in education and research funding make value pluralism and epistemic humility practical guiding principles. Here, I follow Sætra (2022) who argues that we must move beyond viewing AI as an isolated technology and develop more interdisciplinary, ethically informed approaches to sustainability challenges. This shift promises to yield solutions that are not only technically sound, but also ethical and adaptable to the complex, evolving nature of sustainability issues.

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