At a trail in Mount Rainier, US, stewarded by Native American tribes, a kid's pink sneaker was found to be left on a rock. (Photo credit: Sun)

Addressing Global HCI Challenges at the Time of Geopolitical Tensions through Planetary Thinking and Indigenous Methodologies

INTERACT25 Global HCI Workshop

Organizers:

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Sponsored by IFIP TC13 WG13.8 – Interaction Design for International Development: **https://ifip-idid.org/globalhci/**

Abstract

HCI researchers and practitioners witness an even more divided world in 2025 that manifests global inequalities and disparities, triggered by local politics and global and regional geopolitical tensions, and perpetuated by sociocultural structures. This workshop invites participants to reimagine a new world order of HCI at the time of geopolitical tensions with the emerging ontology of the *planetary thinking*. We aim to explore local design principles, rationales, and heuristics for global HCI design projects. It is our first step towards defining how planetary thinking can help scale up HCI design approaches to address global challenges and

risks to nurture the well-being of diverse species for and with the planet that we live on. Our goal is to achieve technology diversity by including diverse local values and intellectual traditions in our design processes with an emic strategy inspired by indigenous design methodologies. For example, a business knowledge sharing system developed with participatory Ubuntu values in South Africa, or a Scandinavian minimalist HCI design of an energy saving system.

This full-day hybrid workshop is organized by IFIP TC13 WG13.8 – Interaction Design for International Development. Researchers and practitioners are invited to submit a position paper or a design case on the subject matter. The collection of accepted position papers and design cases will be shared one week before the workshop—extended versions of the workshop papers will be published by Springer in the LNCS series. To build a sustainable research community for advocating local research and mentoring junior scholars, we will host quarterly Zoom meetings and/or monthly speaker series to invite our participants or researchers in this area to share their work-in-progress or working papers.

Submission Procedure
Please submit your position paper or design case of up to 4 pages in the **Springer LNCS format** to Huatong Sun at huatongs at gmail dot com with a subject line INTERACT 25.
Deadline: June 1, 2025
Decision of notification: June 10, 2025
Workshop date: September 8 or 9, 2025, precise date TBC.

Call for Participation

Introduction

HCI researchers and practitioners witness an even more divided world in 2025 that manifests global inequalities and disparities, triggered by local politics and global and regional geopolitical tensions, and perpetuated by sociocultural structures. As computing technology is even more deeply entangled in divided politics and bloody wars, is global HCI an imagination or a possibility? How can we identify shared goals for the global HCI community organized by ACM CHI.

In the charged atmosphere, this workshop invites interested HCI scholars and practitioners to reimagine a new world order of HCI at the time of geopolitical tensions [1,6] with the emerging ontology of the planetary, after the neoliberal concept globalization—"a totalising and capitalist-centric concept that homogenises the entire planet into a territory to conquer" [16]—has become inadequate to inform design practices.

The planetary thinking was introduced by Heidegger as a confrontation of the limits of Western thought [9, 23]. It was advanced by the decolonial literary theorist Spivak as a call to "imagine ourselves as planetary subjects rather than global agents, planetary creatures rather than global entities" [19]. This "planetary thinking" philosophy resets the colonial, hegemonic and capitalist influences of the globalization concept with subalternism, alterity and heterogeneity as the key dimensions [16]. The planetary turn represents a transcultural phenomenon with urgent economical and political underpinnings

[7, p.xii]. As Clark and Szerszynski analyze, we're "at a *planetary* juncture" and "at a *historical* juncture" [5, p.7, emphasis original]. The globalized intellectual hierarchy dominated by Western science, which has ignored and erased many Indigenous or traditional ways of knowing, is now heavily contested. Indeed, it is the weakening of the globalization project that rendered the planetary visible, humans are so to speak at a point in history where the global(ization) reveals to humans the existence and importance of the planetary [4]. Associated with the Anthropocene, the planetary thinking directs design attention to the repercussions of human agency emerging as existential crisis [15], which requires design for climate change and biodiversity decline to steward our global ecosystem. This highlights the interconnectedness of different agents surrounding the human conditions [2] and invites us to interrogating the dynamics of the local and the global on multiple levels with lens of mobilities [24] and hybridity [12] caused by traumatizing political-geographical phenomena.

Sculpture "Les Voyageurs" (The Travelers) in Marseille, France by Artist Bruno Catalano, positioned , portrays the emigrants who had to abandon their past to embrace an unpredictable new life. (Photo credit: [3])

Rather than being an over-sweeping concept, planetary thinking emphasizes the entanglement of human agency in "our material and psychological intimacy with the living atmo/bio/eco-sphere around us" [16]. Earth is not just a decontextualized and disembodied stage for us but assembles important geological forces as our ecosocial contexts. For example, the introduction of the ironing board is not only shaped by technology conditions, social structures, but also influenced by the dynamics and structures of the Earth [5].

Sculptures of the Lost Bird Project by Artist Todd McGrain, displayed in Bellevue Botanical Garden (Washington of U.S.) to remember those American species that went extinct during the period of 1844-1932. (Photo credit: Sun)

In that regard, planetary thinking –e.g., "planetary partiality" [5] – promotes an emic strategy that is constructive and participatory to advocate empowerment from "within". Such emic strategies include a culturally sensitive approach with *user localization* strategies [20], e.g., Africanization of the HCI curriculums [13]; a decolonial approach that questions the norms and design standards of the Western epistemology and Western design paradigm from the Global South vantage [8, 21, 25]; or a feminist geopolitics view sees technology as part of everyday life, grounded in local and rooted in community [11]. Unless there is local access to cultures, not compromised by geopolitical tensions, it is hard to access emic perspectives.

Based on her fieldwork with minority groups in post-war Bosnia-Herzegovina, Pilarska [17] articulates an emic strategy shares the core goals of the indigenous methodologies [14,18] including "healing, mobilization, transformation and decolonization on many levels" (p. 164). She suggests all of the parties (e.g. Bosnian Serbs, Bosnian Croats, and Bosnian Muslims) have their own narratives, so the goal of research is better "to *understand*, *emancipate* and *deconstruct* the cultural and social worlds that unfold in front of the researcher while they interact with the subjects of the research" (emphasis added, pp. 169-170). Such fieldwork insights help HCI researchers and practitioners to grasp the criticality of cultural differences in the design process [21,22] and promotes inclusive design empowerment at this time. Planetary thinking has been quickly taken up as a new relational ontology and epistemology in the fields such as geography, English studies, philosophy, sociology, science and technology studies, and media studies in recent years. Named as "Planetary Turn" [7], it provides a new critical framework to address a vast range of issues HCI researchers and practitioners are interested in on the global level in this post-Covid world. The Planetary Thinking ontology facilitates an analysis of geopolitical tensions in HCI, which are not defined only as threats of external destruction or the end of diversity, but that can also be defined as opportunities for the creation of diversity, including "biodiversity, noodiversity, and technodiversity" [10]. The workshop will assess the value of this ontology in identifying geopolitical tensions and

transforming them into design resources, emphasizing indigenous perspectives to ensure technology diversity by integrating local values and traditions.

Focusing on advocacy, empowerment, and emancipation amid geopolitical tensions, we invite discussions on:

1. How can we design collaborative, globally beneficial technologies beyond the zero-sum rhetoric?
2. How can we foster trust and reduce risks in HCI across geopolitical blocs?
3. How can social justice-oriented design bridge cultural divides?
4. How can we apply planetary thinking to design for existential crises with local and indigenous problem-solving?
5. How can planetary thinking guide ethical technology development amid global fragmentation?
6. How can recognizing geopolitical tensions shape a new HCI paradigm?
7. How can planetary thinking inform new design and innovation opportunities in association with mobilities and hybridity for migrants and diasporas?

Workshop Objectives

Organized by IFIP TC13 WG13.8 – Interaction Design for International Development, this hybrid workshop aims to explore local design principles, rationales, and heuristics for global HCI design projects in the current global climate with heightened geopolitical tensions, and from different geo-political viewpoints.

The workshop is a first step towards defining how planetary thinking can help scale up HCI design approaches to address global challenges and risks to nurture the well-being of diverse species for and with the planet that we live on and the planets that we may want to live as articulated in one of the co-authors' earlier work [6]. Global challenges and risks include epidemics, climate change, biodiversity loss, wars and regional conflicts resulted from resource shortage, rising individual traumas due to misinformation and disinformation, societal polarization, cyber insecurity, identity theft, and work burnouts (e.g., [26]).

Through engaging discussions on local and indigenous designs across the globe, this workshop will explore and celebrate cultural differences against the single-world ideology out of the Euro-American historical experiences and accomplish a design goal of the pluriverse— "a world where many worlds fit" [8, p. xvi], promoting a design shift from cultural diversity to epistemic diversity.

We intend to have a mix of HCI scholars and practitioners for imagining our future HCI at this critical juncture when the INTERACT conference will return to Brazil after more than a decade. We aim to facilitate intriguing and inspiring deep conversations grounded in real design cases. As workshop organizers, we are ready to embrace unexpected outcomes, alternative views and viewpoints, and novel interpretations of planetary thinking for HCI design contributed by participants.

Expected Outcomes

The collection of accepted position papers and design cases will be published as workshop proceedings, and shared with the participants one week before the workshop. For the purposes of community building and mentoring junior scholars, we plan to conduct quarterly Zoom meetings (about 1 hour) to catch up with each other. If there is enough interest, organizers will host monthly speaker series to invite our participants or researchers in this area to share their work-in-progress or working papers. A Q&A session will follow each speech. While we don't have a budget to offer honorarium to our speakers, we hope our

speakers will find our group feedback helpful for their in-progress work or their working papers. For people who are interested in publication opportunities, we will develop a special issue for a reputable journal in the fields of HCI, IS, or professional communication.

Target Audience

The target audience for this workshop includes researchers and practitioners working on topics related to HCI diffusion, education, capacity building, and social studies of science and technology and critical research on HCI. Early-stage researchers and PhD students are also encouraged to submit work-in-progress papers.

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INTERACT 2025 Workshop: Addressing Global HCI Challenges at the Time of Geopolitical Tensions through Planetary Thinking and Indigenous Methodologies

Updated Agenda

Sept. 9, 2025, Tuesday

Morning:

- 8:15-8:30 Technology setup and check-in
- 8:30-8:45 Introduction: Group introduction
- 8:45-9:00 Workshop Preview
- 9:00-10:00 Lightning talks–Panel 1 (5 speakers): Participants will give brief talks about their position papers or design cases. Each speaker will be assigned for **10-12 minutes**, including brief Q&A right after the talk.
    - Fabiano Ramos & Sean Siqueira: Pluriversal Strategies for Human-AI Design: Onto-Technological Reframings inspired by Brazilian Indigenous Knowings and Practices
    - Uriens Maximiliano Ravena Cañete: Co-production as a Proposal to Face the Global Challenges of HCI in Times of Geopolitical Tensions
    - Katalin FEHER: Planetary Foresight for Generative AI Governance
    - Isaac Okola, Daniel Orwa Ochieng, Gilbert Ong'isa Ouma: Towards the Interaction Techniques for Integrating the Food-Energy-Water Nexus and Climate Change Vulnerability
    - Favour Aladesuru, José Abdelnour-Nocera, Parisa Saadati, Teresa Mac: Leveraging Cognitive Diversity for Workplace Wellbeing: Adaptive Thinkers as Drivers of Creative Scenario Design

- 10:00-10:30 Coffee break

- 10:30-11:30 Lightning talks– Panel 2 (5 speakers)
    - Luciana Sá Brito, Adriana Santarosa, Vivacqua, and Juliana Baptista dos Santos França: Wiki-hackathon Shared Views: Photovoice as a Data Literacy Strategy in Complexo do Alemão Community
    - Michael Kagiri, Daniel Ochieng, Peter Waiganjo, Salome Ireri, and Michael Anindo: Reimagining eCHIS Usage through Planetary HCI: A Multidimensional Approach from Kenya's Community Health Information Systems
    - Noluntu Mpekoa, Sheethal Liz Tom: Enhancing Malware Author Attribution through Tra-ditional Analysis Techniques
    - Iginio Gagliardone: The past and the future: digital sovereignty and networked sovereignty
    - Huatong Sun, Jiajin Qian, Justin Wang: A Planetary Thinking Approach to Cultivating Community-Based AI Literacy
- 11:30-11:45 Group exercise: People work in groups to identify topics they want to work on this afternoon to explore local design principles, rationales, and heuristics for global HCI design projects

Lunch Time: 11:45-13:45

Afternoon:

- 13:45-14:45 Themed group workshops: Multiple groups are formed to engage in team work on the themes identified in the morning. Formats of group work include discussion, design activities, or sketches.

- 14:45-15:30 Share out: Groups report their work.

- 15:30-16:30 Coffee break and IHC posters and demos

- 16:30-17:30 Discussions: Design principles, rationales, and heuristics are identified through the big group discussions.
- 17:30-18:00 Conclusion: Review the work of the day and discuss the next step.

Pluriversal Strategies for Human-AI Interaction Design: Onto-Technological Reframings inspired by Brazilian Indigenous Knowings and Practices

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Abstract. This position paper presents a pluriversal perspective on human–AI interaction design, grounded in emic approaches inspired by Indigenous methodologies. It contends that contemporary modes of interaction with generative artificial intelligences—such as large language models—are predominantly shaped by epistemological assumptions rooted in Western modernity, which prioritize control, instrumental rationality, and individual autonomy. These dominant assumptions not only restrict the potential uses of AI but also narrow the relational possibilities between humans and intelligent systems. By drawing from Indigenous relational ontologies, oral storytelling traditions, ritualized communication, and ecologies of knowledge, this paper proposes alternative interactional paradigms that foreground interdependence, cosmopolitical awareness, and epistemic pluralism. Such paradigms invite a reimagining of AI not as a tool to be mastered, but as a relational entity embedded in broader networks of meaning, care, and reciprocity. In articulating these possibilities, the paper contributes to the expansion of Human–Computer Interaction (HCI) as a field open to multiple worlds, onto-epistemic commitments, and culturally situated values. Ultimately, it advocates for the development of AI systems that are more ethical, inclusive, and responsive to the diverse ways of knowing and being that characterize a truly pluriversal world.

Keywords: Generative AI · Pluriverse · Human–AI interaction · Indigenous methodologies · Emic strategies · Decolonial HCI

1 Introduction

The proliferation of generative AI systems has marked a turning point in how humans interact with computation. These systems, epitomized by tools such as ChatGPT, Midjourney, and DALL·E, offer new affordances for creativity, communication, and cognition [1,3,4]. However, their interfaces and affordances are deeply rooted in the paradigms of modern Western rationality, often abstracting away the cultural, ethical, and ontological frameworks within which users actually live and know. This presents a significant challenge for communities

whose epistemological grounds are not represented in the data used to train these models, nor in the interaction logics embedded in their design [3].

Within this paper, the aim is to explore how a pluriversal framework might enable alternative modalities of designing interactions between humans and artificial intelligences. The term “pluriverse” evokes the coexistence of multiple worlds, each with its own values, languages, and modes of knowledge. It stands in contrast to the “One-World World” — a colonial legacy in design and computation that assumes one valid form of rationality, knowledge, and agency [1,4]. By foregrounding pluriversal approaches, the paper invites reflection on how human–AI interfaces might be reoriented to become more inclusive of other ways of being and knowing.

2 Ontological and Epistemological Groundings

Our theoretical grounding is informed by three central concepts: the pluriverse, the ecology of knowledges, and the articulation of Indigenous methodologies. Escobar argues that "modernity is not a universal endpoint but one of many cultural narratives [1]". He suggests that design can be a form of ontological politics: "the making of worlds rather than just solutions". When applied to AI, this framing compels one to recognize how current systems enforce a singular ontology—flattening knowledge, erasing context, and ignoring histories of violence and resistance.

Complementing this, Santos resists epistemic monism by proposing a "respectful coexistence among distinct ways of knowing [4]". In the context of AI, this implies the need to go beyond merely diversifying datasets or translating interfaces into different languages. Instead, it calls for a "fundamental reimagining of what constitutes valid knowledge in AI training and interaction". The ecology of knowledges encourages methodological pluralism and epistemic humility—qualities urgently needed in the design of responsive, ethical systems.

Kovach, Krenak and Ray brings these questions into practice through Indigenous methodologies [5,6,7,8]. Their work emphasizes story as method, relationality as ethics, and land as epistemology, as these methodological values "defy positivist paradigms that separate the knower from the known [5]", instead positioning knowledge as emergent, embodied, and co-created through relation. Applying these principles to AI implies treating interactions as dialogical events, not transactions, and recognizing the agency of communities, non-human entities, and even technologies themselves as part of a broader network of meaning [6,7,8].

3 Toward Pluriversal Interaction with AI

In reimagining AI interaction through a pluriversal lens, the goal is not to reject AI as inherently colonial or extractive, but to intervene in its development and deployment in order to allow for more situated and ethical engagements [1,2,3,5]. One possible avenue lies in rethinking the prompt itself. Rather than framing

prompts as commands issued to a neutral system, one might understand them as invitations to dialogue, inquiry, or reflection. In Indigenous oral cultures, for instance, knowledge is often passed through stories, songs, and ceremonial dialogue—not through direct questioning or factual exchange. Translating this into AI interaction design, prompts might take the form of shared narratives, metaphorical language, or collective inquiry.

This shift also repositions the AI as a participant in meaning-making rather than as a repository of information. An AI trained with consideration for relational principles could, for example, respond with multiple perspectives or acknowledge uncertainty. It could incorporate protocols for silence or cyclical exchange, rather than defaulting to immediacy and closure. Furthermore, it might offer generative ambiguity, fostering poetic or speculative responses rather than reductive ones. Such an approach would challenge assumptions embedded in current systems about productivity, accuracy, and singular truth.

Another important consideration is the temporality of interaction. In many Indigenous frameworks, time is cyclical or spiral rather than linear. Applying this principle to AI might involve designing interfaces that revisit previous conversations in non-linear ways, or that evolve in rhythm with natural or social cycles. Relational time could also structure when and how interaction occurs, acknowledging rest, rituals, or temporal pauses as integral parts of engagement.

4 Global HCI and Epistemic Justice

This paper proposes to contribute to Global HCI by offering both a critique and an alternative pathway. The critique is that much of HCI, even in its most progressive variants, remains bound to paradigms of design rooted in Western liberal individualism and capitalist modernity. The alternative pathway proposed is based on pluriversal engagement and decolonial design. It does not simply ask "how can AI be adapted to local users?" but rather "what kinds of AI are possible if one begins from other worlds?" This reorientation demands new design languages, new evaluation metrics, and new ethical frameworks.

Pluriversal HCI can also support political and pedagogical work within communities. For example, workshops on co-design with Indigenous youth using AI tools might foreground ancestral stories and community values, not merely as "content" but as ontologies. These workshops might avoid extraction altogether, choosing instead to create ritual protocols for interaction, or to design for refusal. In such cases, the value of design does not lie in market impact but in sustaining relational worlds and resisting epistemic violence.

Moreover, Global HCI must grapple with the fact that AI systems are often produced through exploitative labor, environmental degradation, and massive data extraction. A pluriversal strategy recognizes these material conditions and resists complicity with technological extractivism. It aims to build technologies that are not only culturally responsive but also materially just, recognizing land, labor, and lineage as part of the ethical horizon of design.

5 Conclusion

A pluriversal strategy for human–AI interaction design does not claim to offer universal solutions. Rather, it affirms that universality itself must be decentered. By grounding AI interaction in relational ontologies, emic design practices, and Indigenous methodologies, it becomes possible to begin building systems that honor the plurality of worlds that are inhabited. This is not a return to tradition, nor a rejection of technology. It is an invitation to imagine otherwise—to consider what might emerge when different ways of knowing are allowed to shape the future of interaction. Such futures require care, reciprocity, and imagination. They require listening to silence as much as to data, and engaging with the unknown as a condition for ethical design.

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Planetary Foresight for Generative AI Governance

Workshop@INTERACT2025

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1. Introduction

The global Human–Computer Interaction (HCI) community finds itself at a historic inflection point. The year 2025 is marked not only by widening geopolitical rifts and escalating ecological crises but also by what can increasingly be seen as a techno-political coup—a concentration of infrastructural and epistemic power in the hands of a few private actors shaping the digital architectures of society (Abdelnour Nocera et al. 2025, Schaake, 2024; World Economic Forum, 2024). In this volatile terrain, generative AI (GenAI) emerges not merely as a new technological wave but as an evolutionary leap in artificial intelligence—disrupting and reconfiguring foundational structures of society, governance, and legitimacy (Feher, 2025).

Unlike prior automation waves, GenAI is not a neutral device; it is a synthetic epistemic agent. It generates content, norms, design paradigms, and increasingly, public policies. Its role in shaping outputs—from educational content or workflow to strategic models—renders it not only a tool of production but a lens of planetary perception. GenAI thus functions as both driver and mirror of global structural change. This duality makes it a force with ontological weight: it can either reinforce dominant power structures or create rupture points for epistemic justice (Kay et al. 2024; Bender et al., 2021).

This position paper draws from the author's book Generative AI, Media and Society (Feher, 2025), using strategic foresight to interrogate how GenAI acceleration, ecological instability, and geopolitical volatility converge to reshape policy architectures and knowledge systems.

Rather than viewing GenAI merely as a design material, I argue it is now a planetary actor—one demanding proactive, inclusive, and long-view HCI engagement. In this moment, strategic foresight becomes essential—not only to mitigate risks but to build systemic resilience, embed indigenous values, and avoid short-sighted techno-solutionism. In response, I advocate an open-source, community-centered, and intuitively grounded GenAI ecosystem, inspired by experimental methodologies, participatory research and strategic foresight. By fostering relational trust and shared uncertainty navigation, these ecosystems challenge extractive AI governance models and offer actionable frameworks for embedding generative AI into context-sensitive, participatory, and anticipatory policy cycles—particularly in regions underrepresented in current AI governance debates.

2. Context: GenAI as a Planetary Force

Generative AI systems represent a paradigmatic transformation in the evolution of intelligent machines. These technologies do not merely automate—they synthesize novel outputs from massive datasets, human prompts, and multi-modal learning. These outputs span a vast spectrum: from text and visual media to prototypes, simulations, economic predictions, and even policy drafts (OECD, 2025; Feher, 2025). GenAI marks the shift from automation to co-intelligence—from tool to agent, from efficiency to influence (Mollick, 2024).

This acceleration introduces sweeping socio-technical consequences. GenAI is entangled with disinformation, biased systems, exploitative labor structures, and carbon-intensive computing (Koves

et al. 2024). It destabilizes established economic and cultural systems while rapidly redrawing the contours of authorship, authenticity, and power. In this sense, GenAI is not just a technology—it is a governance disruptor and cognitive reassembler.

At the geopolitical level, the dominance of Western institutions and Big Tech actors creates epistemic asymmetries, further marginalizing the Global South in shaping AI futures. GenAI risks becoming a mechanism of digital colonialism, as it reflects and amplifies the dominant worldviews embedded in its training data (Kay et al. 2024), while reinforcing geopolitical inequalities through uneven country-level access to models and computational infrastructure (OpenAI, 2025). Although now more frequently included in discussions, the ecological footprint of GenAI still challenges the credibility of 'green AI 'narratives. The energy costs of model training and inference (UN Global Pulse, 2024; Bender et al., 2021) directly contradict "Green AI" narratives.

Furthermore, GenAI serves as a last-minute lens before the synthetic overtakes the authentic. As synthetic content becomes indistinguishable from human-originated knowledge, the boundaries between fact, fabrication, and future become blurred. This urgency elevates GenAI not just as an object of governance but as a critical medium through which planetary futures are constructed, perceived, and contested.

Thus, HCI must act—quickly and critically. Foresight-infused HCI frameworks must integrate planetary sustainability, uncertainty management, and culturally pluralistic design rationales. GenAI must be treated not only as an innovation but as a reflexive mirror and catalytic input—shaping, testing, and co-producing the very systems and epistemologies that define the future.

Position: Designing with Foresight Embedding Generative AI in Planetary HCI

The future of Human–Computer Interaction must move beyond anthropocentric and technocratic paradigms, particularly in a world marked by agentic AI, geopolitical polarization, economic uncertainty, and ecological risk. In this context, Generative AI (GenAI) is not just a technical milestone—it represents an evolutionary leap in artificial intelligence, capable of reshaping knowledge systems, labor structures, and policy processes.

GenAI introduces a profound shift: from user-centered interfaces to world-making infrastructures. It generates not only content, but also values, norms, and decision logics. Its rapid deployment across sectors amplifies asymmetries in data access, compute capacity, and epistemic influence—raising urgent questions about whose realities are encoded, reproduced, or erased. Strategic foresight emerges as a critical lens to anticipate these long-term societal impacts, mitigate emerging inequalities, and navigate the geopolitical and planetary implications of GenAI.

Foresight is not prediction; it is preparation. It enables proactive, diverse, and inclusive responses—especially as AI becomes a key driver of governance, economic innovation, and cross-cultural knowledge futures. Embedding strategic foresight into HCI can turn GenAI from a disruptive tool into a catalyst for just, regenerative, and culturally attuned futures.

To embed GenAI into a truly planetary HCI practice, three pillars should guide future development:

I) Pluralistic Knowledge Futures

GenAI presents a dual potential: to reinforce Western-centric epistemologies or to open up decolonized, context-sensitive futures. In planetary HCI, foresight-driven design must draw on indigenous knowledge systems and regional ethical frameworks—from open source principles and indogenius data governance to participatory foresight methodologies.

Policy relevance: These approaches challenge dominant AI governance models and call for epistemic equity, ensuring that the knowledge systems shaping GenAI are not limited to a few actors or geographies.

II) Responsible Tech Governance and Policy Prototyping

Traditional regulatory frameworks are insufficient in the face of GenAI's planetary scale, speed, and opacity. We need anticipatory governance, rights-based AI principles, and policy prototyping tools that foreground contextual and responsible innovation.

Strategic foresight in action: Mapping the long-term impact of GenAI on labor, education, creativity, and environmental justice, while actively involving affected communities in iterative policy experimentation.
Environmental dimension: GenAI systems must include built-in mechanisms for environmental auditability and climate accountability, especially given their rising energy demands and material dependencies.
Policy infrastructure: Embedding AI literacy, ethical reflexivity, and participatory foresight into national digital strategies and HCI design teams from the outset.

III) Post-Anthropocentric Design Logics
A planetary perspective in HCI demands that we move beyond human-centered optimization toward ecosystem-centered design. GenAI's scalability makes it a crucial agent in shaping futures that honor planetary boundaries and long-term interdependencies.
Design foresight: Align GenAI with social–ecological frameworks like Doughnut Economics and Circular AI to build sustainable, system-aware applications.
Cultural foresight: Encourage reflective and regenerative design practices over extractive efficiency logics—shifting from innovation-at-any-cost to care-based, pluralist imaginaries.

4. Conclusion: Recalibrating HCI for Planetary Futures

In today's fractured geopolitical and ecological context, entrusting the trajectory of GenAI to corporate interests alone is not only strategically myopic—it is a blueprint for systemic failure. As an evolutionary leap in artificial intelligence, it demands a reorientation of Human–Computer Interaction (HCI) beyond optimization and usability—toward anticipatory, pluralistic, and planetary frameworks.
Planetary HCI—infused with strategic foresight—offers a powerful lens for guiding GenAI's integration into social, cultural, and policy ecosystems. This approach calls for design paradigms that honor uncertainty, embed ethical reflexivity, and draw on diverse epistemologies. The stakes are high: without intentional governance and cross-cultural foresight, GenAI risks accelerating disinformation, digital colonialism, and climate costs under the guise of progress.
To meet this challenge, HCI must evolve from reactive adaptation to proactive shaping.

> *GenAI must be treated not merely as a tool, but as a sociotechnical infrastructure with political, environmental, and epistemic consequences.*

Strategic foresight enables HCI practitioners, researchers, and policymakers to navigate complex futures, stress-test governance frameworks, and co-create equitable design solutions.
For academia, this means embedding foresight into HCI curricula, fostering regional and indigenous methodologies, and developing environmental audit models for AI systems. For policymakers, it requires investing in AI and policy literacy, advancing globally inclusive governance structures, and prototyping foresight-based policy labs to test scalable, context-aware interventions.
GenAI's future is still malleable. The imperative is clear: GenAI design not only with intention, but with foresight—before the synthetic overtakes the authentic.

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The past and the future: digital sovereignty and networked sovereignty

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Abstract. The prevailing discourse around digital sovereignty has emerged from fundamentally retrospective frameworks of technological governance. During the Internet's early proliferation, states primarily sought to exclude specific data and information from their jurisdictional boundaries. This exclusionary approach – what can be termed "lock-out sovereignty" – represented a defensive posture rooted in a classical Westphalian conception of the nation-state, where sovereignty is conceived as an absolute, territorially-bounded authority exercised within clearly demarcated borders. More recently, the rise of artificial intelligence has generated a shift towards "AI sovereignty", which operates through an almost inverse logic, emphasizing states' capacity to access, harness, and deploy data generated within their territorial jurisdictions—a strategy of "lock-in sovereignty". Despite their differences, both approaches remain tethered to a backward-looking imaginary of digital evolution, where the nation-state is treated as the natural and necessary container of sovereignty. This framework inherently limits their transformative potential by anchoring digital governance in antiquated models of territorial control and exclusionary politics. This paper critiques such a framing, particularly in the African context, rethinking features – e.g. softness, fragility – that have historically been perceived as negative attributes of African nation-states, and reconnecting with early ideas of decolonization as a world-making, rather than a state-making process. In particular, it advocates for a fundamental reorientation toward the transformative possibilities embedded in "networked sovereignty", a concept rooted in pre-colonial African political traditions that transcends the limitations of state-centric governance.

Keywords: Digital sovereignty · Artificial Intelligence · Decoloniality.

1 Navigating AI Sovereignty in Africa: Resistance and Experimentation

The concept of digital sovereignty has evolved significantly since the early days of the internet. Initially, it was associated with efforts to keep data outside a state's jurisdiction, such as censorship and firewalls, and protect the nation from external threats (what I call lock-out sovereignty). The emergence of artificial intelligence (AI) has introduced a different paradigm—one in which states seek access to and control over data produced within their jurisdictions (lock-in sovereignty).

This shift is particularly relevant in Africa, where states are navigating the challenges of digital dependence while striving for technological autonomy. In this piece, I ex-amine new forms of resistance and experimentation that are emerging in Africa through two case studies: (1) Kenyan gig workers' challenge to Big Tech's labor exploitation, and (2) South Africa's evolving National Data and Cloud Policy. These cases highlight pathways for resistance, negotiation, and adaptation in the pursuit of AI sovereignty, suggesting new possibilities for the cross-national networking of resources in the pursuit of an African—rather than a national vision—for the future of AI.

2 Contesting Digital Exploitation: The Case of Kenyan Gig Workers

Kenya has emerged as a critical site of resistance against tech giants' exploitative practices, with the country highlighting tensions between less powerful states that seek to enforce their policies and norms and foreign companies that often take advantage of imbalances in the global labor market to their benefit. Companies such as Meta and OpenAI have outsourced AI training and content moderation to low-wage workers in Kenya and Uganda through third-party firms like Sama. For a long time, this practice of exploiting unequal distribution of labor, benefits, and responsibilities has gone unchallenged. This reality has been couched in powerful narratives that celebrate disruptive innovation, considered an inevitable feature of global capitalism, or justified through the creation of new concepts such as "impact sourcing." Impact sourcing emerged in the late 2000s in opposition to traditional forms of aid. It was designed as a type of outsourcing that sought to give dignified work to the poorest people in ways that could guarantee them a living wage and possibly benefit their immediate communities. This narrative was brought into question, however, when Daniel Motaung, a South African employee of Sama's office in Nairobi, began revealing the exploitative working conditions under which data workers in Kenya actually operated. In 2022, TIME's Billy Perrigo published a damning investigation based on Motaung's and other workers' testimonies. It emerged that gig workers were reportedly paid as little as USD 1.50 per hour to review graphic and traumatic content, violating Sama's own purported commitment to pay living wages. These revelations received global attention, leading to discussions about fair compensation, mental health support, and labor rights in AI-related work. Kenyan courts played a crucial role in challenging Big Tech's dominance. In a landmark ruling, the courts recognized Meta as the "true employer" of these content moderators, undermining the company's strategy of seeking immunity by outsourcing responsibility. This ruling, the first of its kind in the world, could have game-changing consequences for Meta, preventing the company from claiming immunity for the dire working conditions of their moderators, just because

this activity is outsourced to third parties. More broadly, it serves as a warning for other tech giants engaging in forms of exploitation of digital labor in the Global South. It challenges the idea that such companies can exploit imbalances of power and rights while facing no accountability for the dire conditions in which their outsourced employees have to operate. It also conveys an important message that highlights the plight of content moderators and data annotators in Africa and around the world, countering the process of their invisibilization and illustrating how those standing up for better working conditions and the recognition of basic rights, even against some of the world most powerful companies, can find support in an expanding network of institutions, activists, and media.

3 Shifting Policies: South Africa's Data Sovereignty Debate

South Africa's evolving data sovereignty policy provides a different lens through which to understand Africa's halting efforts to navigate an independent, sovereign path toward AI. Initially, the country's 2021 Draft National Policy on Data and Cloud took a strong stance against Big Tech's data extraction practices. The draft policy criticized the dominance of North American, European, and Chinese companies in Africa's cloud infrastructure and proposed measures to ensure that data generated in South Africa remained under national control. Three years later, when the final policy was released, these radical provisions had been significantly diluted. The final version emphasized the importance of cross-border data flows for economic growth and positioned South Africa as an attractive destination for foreign digital investments. The shift from strong data localization policies to a more business friendly approach illustrates the challenges African states face in asserting data sovereignty while remaining integrated into the global economy. South African regulators reportedly faced opposition from tech giants, who leveraged their position of dominance to convince less powerful players to abandon attempts to set a different course. As of 2025, South Africa is the only country in the region where all the major cloud service providers—IBM, Amazon, Microsoft, Google, Alibaba, Oracle, and Huawei—operate.

While claiming greater state control over data stored on servers owned by foreign companies might have been an opportunity to cash in on the country's position as the continent's largest data warehouse, such an approach created risks. Other countries on the continent, such as Kenya, Nigeria, and Egypt, represent emerging markets with strong appeal to international tech firms; South Africa's initially proposed moves might have backfired and convinced companies to relocate elsewhere.

At a more fundamental level, the assertions of sovereignty advanced in South Africa's 2021 draft policy were built on a misleading understanding of what the government could actually do if it controlled the information produced in the country but that was stored by foreign tech companies. While it is encouraging to see how a policy document could be receptive of arguments made in critical media and AI scholarship—denouncing the concentration of tech power in the

hands of a few multinational companies and their extractivist practices—the document advanced a narrow conception of the value of data. As technologist Gabriella Razzano writes in her analysis of the policy, the idea that simply gathering more data will lead to economic benefits does not recognize the microeconomic realities of data. Owning more data offers scant guarantees that it will generate significant value when sold to third parties. It is the ability to use data, its resultant "network effects," that generates value. Because of economies of scale, it is mostly large firms in dominant positions that can extract value from feeding volumes of data into their own products and services. This reading highlights the limitations of using tactics that seek to beat tech giants at their own game rather than imagining different, creative strategies that better align with the distinct socio-technical conditions characterizing countries in the Global South. Many of these countries may be unable to compete in the frontier segments of AI innovation (such as the development of cutting-edge large-language models, or LLMs), but they could break new ground when it comes to national or cultural solutions, such as curating or unlocking datasets to allow new forms of imagination. (For a practical example, see the video and artwork "Noga Mo Jozi," produced by a colleactive of artists and architects at Wits Univeristy, which uses generative AI to build on artwork, rituals, and architecture derived from lost or partially destroyed Indigenous knowledge to create a dreamscape of a parallel Johannesburg.)

4 Toward Networked Sovereignty

The pursuit of AI sovereignty in Africa is shaped by a complex interplay of resistance, adaptation, and strategic negotiation. The Kenyan case illustrates the potential for bottom-up mobilization to challenge Big Tech's labor practices, while South Africa's policy evolution underscores the difficulties governments face in asserting control over data without a clear and strategic understanding of how such data will be used. Rather than adopting a purely protectionist or laissez-faire approach, African states could embrace new types of networked sovereignty to achieve AI autonomy. As Achille Mbembe explained, precolonial African political systems relied on fluid, networked governance structures that prioritized cooperation over rigid borders. Applying this idea to AI sovereignty, African states could benefit from implementing collective approaches rather than engaging in nationalistic competition. Instead of creating fragmented, state-by-state policies, regional collaborations could help African nations leverage shared resources, including data, infrastructure, and talent. By fostering regional partnerships, investing in AI education, and promoting fair labor practices, Africa can carve out a distinctive AI trajectory that prioritizes both technological advancement and social equity. The future of AI in Africa depends on whether governments, workers, and innovators can collectively navigate these challenges to build an inclusive and sovereign digital ecosystem.

Addressing Global HCI Challenges at the Time of Geopolitical Tensions through Planetary Thinking and Indigenous Methodologies

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Abstract. HCI researchers and practitioners witness an even more divided world in 2025 that manifests global inequalities and disparities, triggered by local politics and global and regional geopolitical tensions, and perpetuated by sociocultural structures. This workshop invites participants to reimagine a new world order of HCI at the time of geopolitical tensions with the emerging ontology of the *planetary thinking*. We aim to explore local design principles, rationales, and heuristics for global HCI design projects. It is our first step towards defining how planetary thinking can help scale up HCI design approaches to address global challenges and risks to nurture the well-being of diverse species for and with the planet that we live on. Our goal is to achieve technology diversity by including diverse local values and intellectual traditions in our design processes with an emic strategy inspired by indigenous design methodologies.

Keywords: Planetary thinking, Geopolitical tensions, Emic, Indigenous design, Cultural differences

1 Introduction

HCI researchers and practitioners witness an even more divided world in 2025 that manifests global inequalities and disparities, triggered by local politics and global and regional geopolitical tensions, and perpetuated by sociocultural structures. As computing technology is even more deeply entangled in divided politics and bloody wars, is global HCI an imagination or a possibility? How can we identify shared goals for the global HCI community?

In the charged atmosphere, this workshop invites interested HCI scholars and practitioners to reimagine a new world order of HCI at the time of geopolitical tensions [1,5] with the emerging ontology of the planetary, after the neoliberal concept

globalization—"a totalising and capitalist-centric concept that homogenises the entire planet into a territory to conquer" [15]—has become inadequate to inform design practices.

The planetary thinking was introduced by Heidegger as a confrontation of the limits of Western thought [8, 22]. It was advanced by the decolonial literary theorist Spivak as a call to "imagine ourselves as planetary subjects rather than global agents, planetary creatures rather than global entities" [18]. This "planetary thinking" philosophy resets the colonial, hegemonic and capitalist influences of the globalization concept with subalternism, alterity and heterogeneity as the key dimensions [15]. The planetary turn represents a transcultural phenomenon with urgent economical and political underpinnings [6, p.xii]. As Clark and Szerszynski analyze, we're "at a *planetary* juncture" and "at a *historical* juncture" [4, p.7, emphasis original]. The globalized intellectual hierarchy dominated by Western science, which has ignored and erased many Indigenous or traditional ways of knowing, is now heavily contested. Indeed, it is the weakening of the globalization project that rendered the planetary visible, humans are so to speak at a point in history where the global(ization) reveals to humans the existence and importance of the planetary [3]. Associated with the Anthropocene, the planetary thinking directs design attention to the repercussions of human agency emerging as existential crisis [14], which requires design for climate change and biodiversity decline to steward our global ecosystem. This highlights the interconnectedness of different agents surrounding the human conditions [2] and invites us to interrogating the dynamics of the local and the global on multiple levels with lens of mobilities [23] and hybridity [11] caused by traumatizing political-geographical phenomena.

Rather than being an over-sweeping concept, planetary thinking emphasizes the entanglement of human agency in "our material and psychological intimacy with the living atmo/bio/eco-sphere around us" [15]. Earth is not just a decontextualized and disembodied stage for us but assembles important geological forces as our ecosocial contexts. For example, the introduction of the ironing board is not only shaped by technology conditions, social structures, but also influenced by the dynamics and structures of the Earth [5].

In that regard, planetary thinking –e.g., "planetary partiality" [4] – promotes an emic strategy that is constructive and participatory to advocate empowerment from "within". Such emic strategies include a culturally sensitive approach with *user localization* strategies [19], e.g., Africanization of the HCI curriculums [12]; a decolonial approach that questions the norms and design standards of the Western epistemology and Western design paradigm from the Global South vantage [7, 20, 24]; or a feminist geopolitics view sees technology as part of everyday life, grounded in local and rooted in community [10]. Unless there is local access to cultures, not compromised by geopolitical tensions, it is hard to access emic perspectives.

Based on her fieldwork with minority groups in post-war Bosnia-Herzegovina, Pilarska [16] articulates an emic strategy shares the core goals of the indigenous methodologies [13,17] including "healing, mobilization, transformation and decolonization on many levels" (p. 164). She suggests all of the parties (e.g. Bosnian Serbs, Bosnian Croats, and Bosnian Muslims) have their own narratives, so the goal of

research is better "to *understand*, *emancipate* and *deconstruct* the cultural and social worlds that unfold in front of the researcher while they interact with the subjects of the research" (emphasis added, pp. 169-170). Such fieldwork insights help HCI researchers and practitioners to grasp the criticality of cultural differences in the design process [20, 21] and promote inclusive design empowerment at this time.

Planetary thinking has been quickly taken up as a new relational ontology and epistemology in fields such as geography, English studies, philosophy, sociology, science and technology studies, and media studies in recent years. Named as "Planetary Turn" [6], it provides a new critical framework to address a vast range of issues HCI researchers and practitioners are interested in on the global level in this post-Covid world. The Planetary Thinking ontology facilitates an analysis of geopolitical tensions in HCI, which are not defined only as threats of external destruction or the end of diversity, but that can also be defined as opportunities for the creation of diversity, including "biodiversity, noodiversity, and technodiversity" [9]. The workshop will assess the value of this ontology in identifying geopolitical tensions and transforming them into design resources, emphasizing indigenous perspectives to ensure technology diversity by integrating local values and traditions.

Focusing on advocacy, empowerment, and emancipation amid geopolitical tensions, we invite discussions on:

1. How can we design collaborative, globally beneficial technologies beyond the zero-sum rhetoric?
2. How can we foster trust and reduce risks in HCI across geopolitical blocs?
3. How can we apply planetary thinking to design for existential crises with local and indigenous problem-solving?
4. How can planetary thinking inform new design and innovation opportunities in association with mobilities and hybridity for migrants and diasporas?

2 Workshop Objectives

This hybrid workshop aims to explore local design principles, rationales, and heuristics for global HCI design projects in the current global climate with heightened geopolitical tensions, and from different geo-political viewpoints.

The workshop is a first step towards defining how planetary thinking can help scale up HCI design approaches to address global challenges and risks to nurture the well-being of diverse species for and with the planet that we live on and the planets that we may want to live as articulated in one of the co-authors' earlier work [5]. Global challenges and risks include epidemics, climate change, biodiversity loss, wars and regional conflicts resulted from resource shortage, rising individual traumas due to misinformation and disinformation, societal polarization, cyber insecurity, identity theft, and work burnouts (e.g., [26]).

Through engaging discussions on local and indigenous designs across the globe, this workshop will explore and celebrate cultural differences against the single-world ideology out of the Euro-American historical experiences and accomplish a design goal

of the pluriverse— "a world where many worlds fit" [7, p. xvi], promoting a design shift from cultural diversity to epistemic diversity.

We intend to have a mix of HCI scholars and practitioners for imagining our future HCI at this critical juncture when the INTERACT conference will return to Brazil after more than a decade. We aim to facilitate intriguing and inspiring deep conversations grounded in real design cases. As workshop organizers, we are ready to embrace unexpected outcomes, alternative views and viewpoints, and novel interpretations of planetary thinking for HCI design contributed by participants.

3 Expected Outcomes

The collection of accepted position papers and design cases will be published as workshop proceedings, via https://ceur-ws.org, and shared with the participants one week before the workshop. For the purposes of community building and mentoring junior scholars, we plan to conduct quarterly Zoom meetings (about 1 hour) to catch up with each other. If there is enough interest, organizers will host a monthly speaker series to invite our participants or researchers in this area to share their work-in-progress or working papers. A Q&A session will follow each speech. While we don't have a budget to offer honorarium to our speakers, we hope our speakers will find our group feedback helpful for their in-progress work or their working papers. For people who are interested in publication opportunities, we will develop a special issue for a journal in the fields of HCI, IS, or professional communication or an edited book with Springer, CRC, and ACM.

4 Target Audience

The target audience for this workshop includes researchers and practitioners working on topics related to HCI diffusion, education, capacity building, and social studies of science and technology and critical research on HCI. Early-stage researchers and PhD students are also encouraged to submit work-in-progress papers.

5 Organizing Committee

The workshop is organized by IFIP TC13 WG13.8 – Interaction Design for International Development. The organizers are:

Huatong Sun is a professor of digital rhetoric and global design at the University of Washington Tacoma, affiliated with DUB and the Center of AI & Culture. She authored award-winning books *Global Social Media Design* (2020) and *Cross-Cultural Technology Design* (2012) and received the Diversity and Inclusion Award from the Association for Business Communication. A Theodore von Kármán Fellow at RWTH Aachen University of Germany, she is a board member of the International Chinese Association of Computer-Human Interaction.

José Abdelnour Nocera is a professor of sociotechnical design and head of the sociotechnical group for Innovation and UX at the University of West London. He has worked on projects in Europe and Latin America spanning health, education, indigenous knowledge, and the sharing economy. He chairs the British Computer Society Sociotechnical Specialist Group and serves as vice-chair for equity and diversity in IFIP TC13.

Torkil Clemmensen is a professor at Copenhagen Business School's Department of Digitalization. He holds a PhD in psychology and is on the NordiCHI steering board. A founder of IFIP TC13.6 on Human Work Interaction Design, he co-organizes international workshops on work analysis and interaction design. He is a senior editor for *AIS Transactions on HCI* and contributes to major HCI, design, and information systems conferences.

Sheethal Liz Tom is a senior lecturer and researcher in the Department of Computer Science at IIE Varsity College, South Africa. She holds a Doctorate in Information Technology from South Africa, where her research focused on developing frameworks to support the adoption of ICTs for visually impaired learners in higher education. She has held several leadership roles, contributing to program committees, organizing committees, and mentorship programs, with a particular focus on initiatives across the African region and other developing countries. Her work emphasizes inclusivity, with a strong focus on advancing education and health through technology. Through active collaborations with NGOs, government bodies, and international academic communities, she strives to bridge the gap between research, policy, and practice, creating impactful solutions that address social, economic, and developmental challenges in underserved communities.

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Towards the Interaction Techniques for Integrating the Food-Energy-Water Nexus and Climate Change Vulnerability

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Abstract. The Food-Energy-Water Nexus (FEWN) security and Climate Change Vulnerability (CCV) are two systems that influence each other. Actions that enhance FEWN security can increase CCV and vice versa. This paper proposes the integration of Multi-Objective Optimization (MOO) with Visual Analytics (VA) to support the interpretation of the Pareto optimal solutions. This will promote stakeholder engagement and allow policymakers to plan for sustainable resource security and climate change adaptation strategies. Consequently, the paper advocates for a usability study that combines several methods to capture quantitative and qualitative data on how visual interaction techniques can be used to reveal synergies, trade-offs, and the balancing points when solving a Multi-Objective Optimization Problem (MOOP) that integrates the FEWN security and CCV.

Keywords: Food-Energy-Water Nexus, Climate Change Vulnerability, Multi-Objective Optimization, Interaction Techniques, Visual Analytics

1 Introduction

It is challenging to meet global demand for food, energy, and water amidst the effects of climate change [1], [2]. The Food-Energy-Water Nexus (FEWN) is an emerging field that examines the interconnections between food, energy, and water resources. The nexus addresses Climate Change Vulnerability (CCV) related to the accessibility and availability of these resources. Recognizing the interdependencies within the nexus is vital for sustainability amidst climate change impacts [3]. Effective climate change adaptation entails coordinated efforts between multiple sectors across scales that minimize tradeoffs and enhance synergies by efficiently utilizing land, water, energy, and other vital resources [4].

FEWN security and CCV affect each other, but traditionally, MOO of the two systems has been done in isolation. Current MOO approaches focus on minimizing GHG emissions [5] while maximizing Carbon sequestration [6] and FEWN security [7]. Therefore, they only consider climate change mitigation strategies while isolating

climate change adaptation strategies. This isolation can lead to conflicts hindering the achievement of the objectives of each system. Positive consequences in one system can cause negative consequences in another. Therefore, it is imperative to integrate the two systems and identify synergies and tradeoffs associated with them.

In this paper, we propose an approach to bridge this gap by combining MOO and VA to integrate the FEWN security and CCV. This will reveal synergies and trade-offs that occur when pursuing options to increase FEWN security and minimize CCV, thus giving insights for sustainability policies.

2 Description of the Multi-Objective Optimization Problem

The Multi-Objective Optimization Problem (MOOP) is expressed using Equation 1[8]:

$$min\ F(\vec{x}) = (\ f_1(\vec{x}), f_2(\vec{x}), \cdots, f_k(\vec{x})\ )^T \quad (1)$$

Subject to:

$$g_i(\vec{x})\ \leq 0, for\ i = 1, 2, \cdots, m$$

$$h_i(\vec{x})\ = 0, for\ i = 1, 2, \cdots, p$$

where $(\vec{x}) = (x_1, x_1, \cdots, x_n)^T$, is a decision vector representing decision variables x_i, $f_i(\vec{x}), for\ i = 1,2, \cdots, k$ denotes k objective functions, g_i is a nonlinear constraint, and h_i is a linear constraint.

Objective functions are formulated using composite indices representing the FEWN security and CCV [9], [10]. They are expressed as minimization equations to indicate that the lower the value, the higher the FEWN security and the lower the climate change vulnerability. A decision vector of decision variables is formulated to integrate the indicators representing the FEWN security and CCV. The constraints are expressed as the lower and upper bounds of the decision variables.

3 Interactive Multi-Objective Optimization

Interactive Multi-Objective Optimization (IMOO) requires the identification of the most-preferred alternative and the confirmation of the preferred alternative [11]. Therefore, based on the "human-in-loop" concept, the optimization algorithm generates the Pareto optimal solutions while the decision maker provides preferences and selects the best solution corresponding to the specified preferences [12]. Therefore, this study considers the steps for IMOO [12], [13] (see Fig. 1).

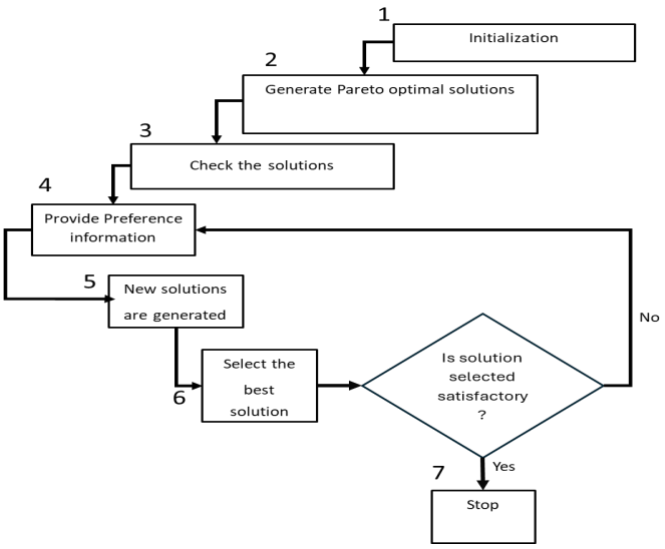

Fig. 1. The steps of Interactive Multi-Objective Optimization.

4 Proposed Optimization Tasks

In this study, we adapt the tasks proposed in [12] to facilitate the steps of the IMOO. This is intended to reveal solutions that create synergies, trade-offs, and the balancing points when integrating the FEWN security and CCV. The suggested tasks include:

T1: Comparing the Pareto optimal solutions.
T2: Specifying the preferred solution.
T3: Checking preferences feasibility.
T4: Determination of the most preferred solution.
T5: Understanding Multi-Objective Problem properties.
T6: Detecting correlations and clustering.
T7: Post-Processing of the most preferred solution.

5 Proposed Interaction Techniques

A decision maker can explore the objective space using visualization and interaction techniques to specify regions of interest based on preferences [14]. In this paper, we consider the seven interaction techniques proposed in [15], including Select, Explore, Reconfigure, Encode, Abstract/Elaborate, Filter, and Connect. Additionally, we consider the 12 interactive dynamics grouped under three categories proposed in [16], including (1) Data and view specification, representing Visualize, Filter, Sort, and Derive; (2) View manipulation consisting of Select, Navigate, Coordinate, and Organize; and (3) Analysis process and provenance entailing Record, Annotate, Share, and Guide. Therefore, we argue that the aforementioned interaction techniques can be

ingeniously fused to allow decision-makers to perform exploratory analysis of the decision space and objective space of the MOOP, integrating the FEWN and CCV.

6 Usability Study

This study can be conducted to evaluate the efficacy of the proposed interaction techniques in accomplishing the optimization tasks of integrating the FEWN security and CCV. Therefore, we propose a study design that combines four methods to assess qualitative and quantitative data. Table 1 summarizes the methodology proposed in this study, whereby the specific methods are conducted in subsequent stages.

Table 1. The stages of the hybrid usability study.

Stage	Method	Rationale
1. First impression	Five-second Test[17]	Gauge immediate comprehension through cognitive and perceptual salience
2. Exploration	Think-aloud Protocol [18]	Reveal the analytical reasoning capability of the decision maker
3. Task Evaluation	Task-based Testing [19]	Assess efficiency (task time), effectiveness (success rate), and accuracy (error rate)
4. Post-Analysis	Questionnaires [20] and Inter-Rater Reliability [21]	Captures qualitative data (opinions, clarity, preferences, appeal, user friendliness)

7 Conclusion

It is a challenge to manage the FEWN security and CCV in isolation because the actions that promote one system can cause negative consequences in the other system. MOO provides an integration backbone that can also reveal synergies and tradeoffs emanating from the two systems. However, it isn't easy to interpret manually the generated Pareto optimal solutions. Therefore, this paper proposes how visual analytics provide visualization and interaction techniques that can allow decision makers to gain insights into enhancing the FEWN security and reducing CCV.

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Leveraging Cognitive Diversity for Workplace Wellbeing: Adaptive Thinkers as Drivers of Creative Scenario Design

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Abstract. Understanding how individual cognitive styles influences creative ideation is important for design and innovation of any sort. This paper investigates the impact of cognitive styles on the quality of ideas generated in a future-scenario design context. We conducted an empirical study with 101 students who were tasked with envisioning future-design scenarios for Rolls-Royce workplace wellbeing initiative called LiveWell program. The participants were categorised based on their cognitive styles. This was done using the Hayes and Allison Cognitive Style Index. The students were grouped into analytic, intuitive and adaptive thinkers. Thereafter, the differences in the creativity and number of ideas produced was also examined. The results indicated that cognitive styles significantly affect idea generation with adaptive and analytical thinkers coming up with the most ideas than the intuitive participants. Although, there was no significant differences observed in the number of overall wordcount. These findings offer practical insights for interaction design teams on leveraging cognitive diversity for quality ideation outputs. Most importantly, the results suggest that including adaptive thinkers are strong drivers of idea generation. When these three categories of CSI profiles are balanced across design teams, it may maximise both the volume and robustness of creative outputs.

Keywords: ***Cognitive styles, Adaptive CSI, Idea generation, Design cognition***

1 Introduction

Over the years, there has been a growing recognition that effective problem solving in design often hinges not only on technical skills but on the human factors like cognitive differences and collaboration (Ren, Chen and Qiu, 2023). One key factor in this conversation is individual cognitive style, that is, a person's preferred way of processing information, thinking through certain problems and coming up with various ideas (C. W. Allinson and Hayes, 1996). It shapes one's ability to gather information from what is seen, arrange and analyse the information, and incorporate opinions into personal presumptions and cognitive frameworks which dictate how one behaves. The cognitive style index developed by Allinson and Hayes (1996) has become one of the most widely tool for determining these preferences along a spectrum from intuitive to analytical thinking as shown in Figure 1. The focus on cognition becomes even more critical as design challenges become more interdisciplinary and forward-looking. Analytical thinkers priorities systematic and structured way of thinking while the intuitive profiles rely majorly on insight-driven approaches. On the other hand, adaptive thinkers alternate between both styles and balances creativity with structure (Long, Liu and Wei, 2022), a cognitive flexibility that aligns with adaptive expertise in design and Human-Computer Interaction contexts. This flexibility is important because effective ideation often requires a combination of convergent and divergent thinking to generate a range of ideas, and to refine as well as communicate those ideas.

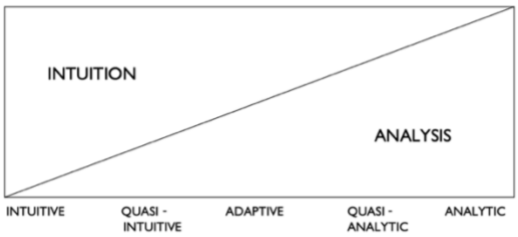

Fig. 1. A Continuum of Cognitive Style

Research has linked cognitive profiles to various patterns of creativity and problem-solving (Abdelnour-Nocera, Clemmensen and Guimaraes, 2017; Rani, 2017; Martinsen and Furnham, 2019; Chakraborty and Kumar, 2024), however empirical research that connects CSI profiles top actual idea generation in design tasks is limited. Little is also known about how cognitive styles shape measurable outputs of design ideation like the number of ideas that is being generated or the information richness of such ideas. This study addresses that gap by examining how cognitive styles influences idea generation during a scenario design exercise. In this study, we aimed to discover if the category of cognitive styles individuals belonged to influence the number of ideas they generate, along the density of information provided. It examines how cognitive styles affected the participants ideation process and the outcomes.

The rest of the paper is sectioned as follows: section 2 presents a summary of related works. This is tehn followed by section 3 which discus the methodology adopted for the study. The findings related to the cognitive styles and the future-scenario output is discussed in section 4, followed by the discussion of the findings in section 5. The paper then concludes with recommendations and limitations in Section 5

2 Literature Review

2.1 Cognitive Style and Cognitive Style Index (CSI)

The idea of cognitive styles garnered a lot of interest in the 1900s, especially because researchers aimed to explain individual differences in the way they process information and make decisions because they could be fully captured by intelligence or personality measures (Person, 2017). However, the field of psychology was unable to come to terms on a precise definition of cognitive styles or what features should be included in the expanding list of suggested cognitive styles. Cognitive style was largely described as the preferred method of coordinating and interpreting acquired information (Nugroho *et al.*, 2020), or as the inclination for the way a problem is solved. Riding and Cheema (1991) noted that a lack of conceptual clarity frequently caused people to confuse personality characteristics, approaches to learning, and cognitive styles. However, over the years, multiple models have been birthed to conceptualise and shape this concept (Kirton, 1976; Witkin *et al.*, 1977; C. W. Allinson and Hayes, 1996; Kirton, 2003). One of such described as most promising (Armstrong, Cools and Sadler-Smith, 2012a) is the Cognitive Style Index developed by Allinson and Hayes (1996). The CSI is a 38-item test used to determine where an individual falls on the continuum of analysis and intuition as seen in Figure 1. It is based on existing theory suggesting a unitary rather than a complex model (Agor, 1984). The opposite ends are intuition and analysis. The adoption of one is not possible if the other is fully exercised. Majority of individuals, nevertheless, have a cognitive style that combines aspects of analytic and intuitive. A balanced combination of the two cognitive styles is signified by the adaptive style, which falls within the middle bracket. The "Quasi-Intuitive" and "Quasi-Analytical" styles, which reflect a propensity towards but not complete acceptance of one of the extreme cognitive forms, fall on both ends of this (C. W. Allinson and Hayes, 1996). Intuition is the instantaneous judgement based on sentiment and the emergence of a global viewpoint, whereas analysis is the judgement founded on rational thinking and attention to specifics. Individuals that are analytical often prefer a methodological approach to problem solving and feel at ease with concepts that need meticulous examination. On the other hand, individuals with more intuitive style prefer an unrestricted approach to problem solving, and they do better with concepts that need comprehensive evaluation, and depend on haphazard exploratory techniques (Armstrong and Qi, 2016). Empirical studies have shown how the CSI can be used in both educational and organisational context, linking cognitive styles to decision making, group dynamic, and creative problem-solving (C. W. Allinson and Hayes, 1996; Armstrong, Cools and Sadler-Smith, 2012b; Damart and Adam-Ledunois, 2021). The Cognitive Style Index (CSI) provides a valuable lens for understanding how individuals approach design tasks, collaborate in codesign processes and engage with future scenario challenges, making it an essential framework for investigating the interplay between cognition, creativity and culture.

2.2 Cognitive Style, Design attitudes and Problem solving

A good number of scholarly works have sought to examine the relationship between cognitive styles and individual attitudes towards creative problem solving (Jablokow *et al.*, 2009; Martinsen and Furnham, 2019; Silk *et al.*, 2021). One thing that is consistent in the findings is that cognitive styles play a role in ideation and influences how people generate and communicate their design ideas. This is empirically supported by the works of Silk *et al.*, (2021), who in their study measured cognitive style using the Kirton Adaption-Innovative inventory (Kirton, 1976), the authors

investigated novice engineering designers and discovered that individuals with an innovative cognitive style came up with more diverse, novel and creative ideas. Opposingly, those with a more adaptive style had lower creative confidence. The authors suggest that most people equate creativity with the innovative style and may undervalue the more incremental and detailed creativity of adaptors. This signifies a possible bias that adaptive creativity might be overlooked even though it is imperative for innovation. Effective design thinking requires an adaptive mindset that can integrate intuitive leaps and analytical verifications, and switch when needed. In fact, leading design firms and practitioners emphasise cultivation an attitude that is open to both rational analysis and intuition (Öz, Dindler and Lindberg, 2025) rather than just favouring an extreme. Silk *et al.*, (2021) observed that when the way a task is framed in a way that is misaligned with a participant's natural cognitive style, these participants experienced discomfort but eventually experience cognitive growth. This means that they were able to move beyond their habitual approaches. Based on this, one could suggest that cognitive style may not essentially be a fixed limitation but rather could evolve through challenge and reflection. While Silk *et al.*, (2021) noticed a relationship between cognitive style and creative ideation, Saxena, Jaan and Jain (2014) reported a different finding in their study conducted among undergraduate students. The authors found no significant difference of cognitive style on problem solving ability across groups. This contrast may not necessarily indicate a contradiction, but rather, highlights the importance of contextual task demands. Saxena, Jaan and Jain (2014) assessed performance on general problem solving task that is structured, whereas Silk *et al.*, (2021) examined ideation outcomes within an open-ended creative design task that mostly requires ambiguity tolerance and conceptual framing. This could mean that cognitive styles may exert more influence in contexts that requires open-ended thinking as opposed to tasks that have fixed a logical step. Cognitive styles have an important role to play when it comes to problem solving and design attitudes. Other cognitive style framework has also been used to explore how individuals cognitively approach complex task. One of such is the field dependence-independence model (Witkin *et al.*, 1977). According to this model, individuals that are field-dependent are capable of restructuring information internally, relying more on internal cues as opposed to field-independent persons who are more reliant on external references when processing information. Using this model, Mefoh *et al.*, (2017) looked into how one's gender and cognitive style affected teenagers' capacity for problem-solving. Their findings showed that adolescent with a field-dependent cognitive style solved more task that those that are field-independent and male participants performed better than the female on a puzzle-solving task. This also signifies that the way individual process information can shape their problem-solving outcomes.

2.3 Cognitive Style and Idea generation

It has often been noted that the fiercely competitive and quickly evolving business climate of today puts an even greater pressure on all organisations to innovate (Lomberg, Kollmann and Stöckmann, 2017). People help organisations innovate by coming up with beneficial ideas for the company. For this reason, the question of how ideas are formed should have an established basis because of how crucial they are to creativity. Cognitive styles have been proven to influence how ideas are generated (Heininger *et al.*, 2018; Silk *et al.*, 2021). In Lomberg, Kollmann and Stöckmann, (2017) study, which included 191 participants originality style preference which is analogous to Kirton's innovator profile exhibited greater ideation fluency as opposed to those with a strong rule governance who generated fewer but more original ideas (Lomberg, Kollmann and Stöckmann, 2017). Similarly, using the Visual Creative Synthesis Task (VCST) Giancola *et al.*, (2022) posited that field-independent individuals (Giancola, D'Amico and Palmiero, 2023) consistently generated more original ideas that the field-dependent ones. Due to the fact that VCST demands participants to combine visual elements into novel solutions, these findings link cognitive styles with the quality of ideas produced, and not only general problem-solving abilities. Adding to these nuances, Giancola, D'Amico and Palmiero, (2023) also examined how working memory capacity (WMC) interacts with cognitive style in divergent thinking test, which measure ideational fluency and originality. The authors discovered that field-independent adolescent leverage WMC more effectively to enhance ideational fluency, while field-dependent individuals do not. This corroborates the fact that cognitive style moderates both the quality and the novelty of ideas generated. In contrast Cole *et al.*, (2023), in their study investigated idea generation in engineering design teams. They discovered that cognitive style did not predict whether individuals or teams produced paradigm-breaking versus paradigm-consistent ideas, in other words, cognitive styles may not directly determine the type of ideas generated or those selected by teams.

3 Methodology

This research adopts the Cognitive Style Index (CSI) by Allinson and Hayes, (1996) to categorise the participants in to their respective cognitive styles. The students were asked to complete the CSI questionnaire which has 38 statements

where individuals rate their agreement on a 3-point scale of true, uncertain and false. This questionnaire is designed to assess an individuals preferred approach to processing information specifically along a continuum from intuition to analysis (Allinson and Hayes, 1996). After this was completed, we analysed the questions based on the scoring key provided by the originators, and then categorised the students under intuitive, analytical and adaptive style (in order to simplify the interpretation, quasi-analytic, quasi-intuitive and quasi-adaptive profiles were merged with thie closest dominant category). The final distribution was: Adaptive = 36, Intuitive = 8, Analyst = 57. The second stage of the study involved asking the participants to write a future-scenario analysis for Rolls Royce LiveWell program. The goal of the task was to propose future-ready design scenarios for workplace well-being for the LiveWell program at Rolls-Royce. In total 115 students produced a future scenario response vis Microsoft form, and this served as a unit of analysis. However, 14 responses had to be excluded because those participants did not fill the CSI questionnaire to be categorised as needed for the study. Three outcome variables were derived from the submitted scenario text. The first is the word count which is the total length of each scenario. Secondly, the idea count which is the number of distinct idea present in each scenario was determined to capture the ideational fluency (Dumas *et al.*, 2022). Thereafter, the informational density was computed as the ratio of idea count to word count capturing how efficient ideas were expressed relative to the length of the text (Covington, 2009). The participants were given the same prompts, responses were collected digitally and coded by us the researchers. The idea count was gotten by identifying the unique and non-overlapping proposals within each scenario. The word count was computed automatically, and the information density was calculated by dividing the idea count by the word count. The data was analysed quantitatively using both descriptive and inferential analysis. a one-way ANOVA test was then performed to ascertain if the means differed significantly. In the instances where significant effects emerged, Tukey's HSD post hoc teste (Abdi and Williams, 2010) were then used to identify which group differed.

3 Results and Discussion

A total of 101 students participated in the study. Across all the groups, participants averaged 0.0416 information density, 23.97 ideas, and 630.7 words per scenario, as seen in Table 1. The adaptive participants had the highest information density (0.0464) with an idea count of (26.6) as seen in table 1. The participants that fell under the analyst profiles had mid-range values and the intuitive participants had the lowest scores across all measures. The median, standard deviation (SD), and ranges showed the same pattern with the adaptives scoring high in the idea count and density.

Table 1. Descriptive statistics of CSI Profiles

CSI Profile (n)	Info Density (M ± SD)	Idea Count (M ± SD)	Word Count (M ± SD)
Adaptive (36)	0.0464 ± 0.0202	26.61 ± 6.23	653.64 ± 264.49
Analyst (57)	0.0400 ± 0.0119	23.16 ± 5.55	618.60 ± 203.39
Intuitive (8)	0.0316 ± 0.0140	17.88 ± 7.45	613.63 ± 250.76
Overall (101)	0.0416 ± 0.0160	23.97 ± 6.37	630.69 ± 228.79

The Anova result as seen in table 2 showed that the groups showed significant differences in idea count ($F(2,98) = 8.26$, $p = <.001$) and information density ($F(2,98) = 3.70$, $p = .028$). however, there was no significant difference indicated in the word count ($F(2,98) = 0.28$, $p = .757$).

Table 2. ANOVA test results

Variable	F	p-value	Significance
Information Density	3.70	0.0283	$p < 0.05$
Idea Count	8.26	0.0005	$p < 0.05$
Word Count	0.28	0.7572	$p > 0.05$

The Tukey test indicates that the adaptive participants significantly generated more ideas than both the analyst ($p<.05$) and the intuitives ($p<.01$) and has a higher information density than the intuitives ($p<.05$) as seen in the table below

Table 3. Tukey test results

Variable	Treatment Pair	Tukey Q Statistic	Tukey p-value	Inference
Information Density	Adaptive vs Intuitive	3.4525	0.0430	* p < .05
	Adaptive vs Analyst	2.7471	0.1323	Insignificant
	Intuitive vs Analyst	2.0253	0.3290	Insignificant
Idea Count	Adaptive vs Intuitive	5.3081	0.0010	** p < .01
	Adaptive vs Analyst	3.8523	0.0207	* p < .05
	Intuitive vs Analyst	3.3231	0.0538	Insignificant

Our results show that participants with an adaptive cognitive style as measures by the cognitive style index, notably outperformed tehri analyst and intuitive counterparts in the generation of ideas, thereby producing not only a high quantity of idea, but also a rich information content per idea. An adaptive style represents a balanced mix of intuitive and analytical thinking styles, and according to Allinson and Hayes, (2012) the cognitive style of most people includes of intuition and analysis. These set of people are comfortable alternating between divergent and detailed oriented reasoning. This cognitive flexibility may be attributed to their superior performance i.e., adaptive thinkers have the tendency to come up with a brad range of ideas and elaborate on them meaningfully. As opposed to this, analytical thinkers have the tendency to impose structure early on, and filter ideas prematurely. On the other hand, intuitive thinkers might produce many spontaneous ideas with less meaning and elaboration (Smith, Festus and Joseph, 2025). This finding is also supported by Hongdizi *et al.*, (2023), who concluded that inducing an analytical mindset improved convergent problem solving but significantly reduced idea fluency on divergent tasks. Furthermore, the analysts in our study may have overemphasised rule-based reasoning at the expense of brainstorming fluidity. Also, intuitive thinkers have the propensity to generate ideas freely but not flesh out the details as evidenced by Silk *et al.*, (2021). The adaptive groups blend of both modes likely enabled them to avoid the pitfalls of either extreme, thereby leading to more idea generation and greater information density per idea generated. Our findings reinforce the view that cognitive flexibility, i.e., the ability to oscillate between expansive brainstorming and critical detailing is a key to creative performance (Karakuş, 2024). Simply put, the consistence outperformance of the adaptive group highlights that when intuitive insight and analytical rigor is in tandem, creativity is maximised.

These findings connote some important implications for interaction design practice. It suggests that people who are adaptive thinkers are especially productive in generating innovative solutions. This was also confirmed by the study of (Austin and Abdelnour-Nocera, 2013) who observed that successful interaction design professionals tend to cluster in the middle of the intuition-analysis spectrum. This argument is supported by the study's findings, which show that higher ideation depth and output may be achieved by combining analytical precision and creative intuition. This finding also highlights the importance of training that stretches people beyond their default cognitive styles, thereby helping teams to develop the adaptive flexibility that our study shows to be more effective. In addition to this, this study reaves that adaptive thinkers can also strengthen team ideation dynamics and inspire interaction design tools that supports various cognitive styles to balance creativity with structure. Furthermore, it extends recent studies that balancing intuitive and analytical profiles enhances creativity (Cupchik et al., 2024), by showing that adaptive individuals portray this balance and generate more ideation outcomes.

Our findings highlight the pivotal role of adaptive cognitive styles in design ideation, where adaptive thinkers generated more ideas with richer informational content than their analytical or intuitive counterparts. This aligns with emerging research on younger, digitally native cohorts such as Generation Z, who are often described as demonstrating flexible, adaptive cognitive strategies shaped by constant digital immersion. For instance, Promsron, Nilsook and Piriyasurawong (2024) show how adaptive microlearning approaches using mixed reality respond effectively to Gen Z's need for flexibility and immediacy in learning. Similarly, Chardonnens (2025) emphasises that digital natives' preferences for metacognitive and AI-supported learning reflect a fluid style of engagement that values adaptability. Shaleha and Roque (2024) also observe that while younger generations display cognitive adaptability to fast-paced, digitally mediated environments, they remain more vulnerable to distraction under stress. However, not all evidence

supports the claim that adaptive cognition is a purely generational trait. Brumberger (2023), for example, found no significant differences in visual engagement patterns across younger and older cohorts, suggesting that adaptability may be more closely tied to context, task demands, and individual variation than to generational belonging alone. Taken together, these perspectives indicate that while adaptive styles appear especially salient among digitally immersed generations, caution is needed in framing them as exclusively generational.

4 Conclusion

The aim of this study was to investigate how different cognitive styles, as measured by the Allinson and Hayes (2012) Cognitive Style Index, shape idea generation in a future scenario design task. By analysing idea count, word count, and information density across 101 participants, this research contributes empirical evidence to the growing body of work examining the role of cognitive styles in creative performance within conceptual ideation contexts. The results clearly showed that individuals with an adaptive cognitive style consistently outperformed their analytical and intuitive counterparts, producing not only a greater number of ideas but also ideas with richer informational content. This reinforces the view that adaptive cognition (blending intuitive creativity with analytical rigor) is particularly effective for ideation tasks.

From a practical perspective, our findings suggest that design teams benefit from the inclusion of adaptive thinkers, as their cognitive flexibility may enhance both the resilience and productivity of group ideation processes. Beyond individual differences, this work points to the importance of fostering cognitive adaptability more broadly, whether through training, task framing, or digital support tools that help participants move fluidly between divergent and convergent modes of thought. Future research could further explore how adaptive styles function in collaborative, multi-stakeholder settings, and how adaptive support features might be embedded into digital design environments to scaffold creativity at scale. By integrating cognitive style awareness into design education and practice, organisations may be able to leverage diversity more effectively and build teams that are both innovative and adaptable to complex, evolving challenges. Thinking about generational shifts is crucial to have a perspective of the past, present and future.

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Wiki-hackathon Shared Views: Photovoice as a Data Literacy Strategy in Complexo do Alemão Community

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Abstract. Photovoice is a methodology used by people with limited power due to social, linguistic, racial, class, ethnic, gender, or cultural barriers to promote critical dialogue and demand change through public policies and government actions. This experience report uses the photovoice methodology to describe the *Wiki-hackathon* Shared Views, one of the first Data Literacy initiatives in the Complexo do Alemão community. The activity, developed by UFRJ in partnership with Nave do Conhecimento Nova Brasília, involved an afternoon of theoretical and practical learning on a photography walk. Local photographers recorded images, shared them on *Wikimedia Commons*, and expressed opinions in a Wikibook. The acronym *SHOWeD* was used to create the *Tim-Lopes* version, adapted to the context of Brazilian popular education. This activity is part of a doctoral research project that contributes to the participatory design of strategies to foster data literacy in groups of residents of vulnerable regions using the DSR Approach inspired by the Paulo Freire Method.

Keywords: Human-Data Interaction · Data Literacy · Vulnerable populations

1 Introduction

Photovoice is a methodology used by people with limited power due to social, linguistic, racial, class, ethnic, gender, or cultural barriers to promote critical dialogue and demand change through public policies and government actions [1]. In this practice, people record images of everyday life accompanied by captions or interviews to reflect on local strengths and challenges. Data literacy is the ability and desire to actively participate in society through the conscious use of data, such as facts, statistics, or information, with the support of technology as an ally of human intentions [2]. In this research, we present the participatory project of a photovoice activity carried out with photographers from Complexo do Alemão, an area with one of the lowest development rates in the city of Rio

de Janeiro, intending to use residents' narratives to enable visibility, reparative justice, citizenship, cultural appreciation, and investments. This research is part of project 74758423.2.0000.5275 of the Platforma Brasil, ethical committee. It is part of the context of the 2030 Agenda in promoting digital literacy as essential for an education that develops agency, skills, and values for current learning [3] [4].

2 Background

Social, cultural, and economic inequalities deeply mark the construction of identity and the relationship between the individual and society, requiring critical analyses so that social transformation can be perceived and projected by the people themselves [5]. In this context, Popular Education presents itself as a process that breaks with the educational tradition focused only on elites, giving education an active social role [6]. This exclusionary tradition is rooted in the dehumanizing and limiting narratives constructed by colonizers about the reason and morality of natives and descendants of victims of transatlantic human trafficking [7] [8]. Brazilian Popular Education, with Paulo Freire as its primary reference, is structured politically and, since the 1960s, has proposed a method that challenges the current social order, valuing the protagonism of the working class and its capacity to interpret and transform the world based on their individual and collective experiences [9].

The Paulo Freire Method for literacy proposes that researchers and people are together as subjects in the investigation [9]. Two important concepts Freire addresses are banking education and *praxis*. The first refers to education in which the teacher deposits knowledge without awakening the critical sense of the students. The second refers to the interdependent relationship between consciousness and action to transform reality. The Paulo Freire Method presents an educational method and methodology aimed at peasant education. The central core of the Method is developed from a thematic investigation towards the discovery of the student's situational through dialogue, the construction of his/her historical consciousness, and the overcoming of the consumption of ideas with their production through action and communication, which ends up inserting the individual into reality [6].

The photovoice strategy includes choosing an audience of policymakers or community leaders; recruiting participants; presenting the methodology and discussing cameras, power, and ethics; obtaining informed consent; defining themes for the photos; distributing and reviewing the use of cameras; allowing time for recording images; discussing photographs and emerging themes; and planning with participants how to present photos and stories to decision makers [10]. The *SHOWeD* technique has been recommended to promote discussion about the photographs and identify emerging themes [10]. The acronym ***SHOWeD*** (***See-Happening-Our lives-Why-Do***) refers to questions supporting the critical analysis of images. It consists of the following questions: 1. *What do you* ***See*** *here?*; 2. *What is really* ***Happening*** *here?*; 3. *How does this relate to* ***Our***

lives?; 4. ***Why** does this situation, concern or strength exist?*; 5. *What can we **Do** about it?*

3 Methodology

The activity was carried out with a team of 15 photographers from the territory: 9 women and six men between 17 and 65 years old. The Wiki-hackathon used sticky notes, pens, sulfite paper, paper pads, color jets, and stencils. The event took place in three stages: in the first, a workshop on photovoice was held, the concept and schedule were presented, and the research theme was defined with the participants. The second consisted of a photographic walk in the community. In the third, after a coffee break, participants shared photos on Wikimedia Commons, gave pair interviews, and ended the activity. Wikimovimento Brasil, the Brazilian Wikimedia chapter, sponsored the event through the Wiki Apóia project.

4 Products

One hundred seventy-one photographs were uploaded to Wikimedia Commons in the categories "Complexo do Alemão" and "WikiApoiaCPX2024". The group created the Wikibook "Shared Views: Visions of the Complexo. Soul, culture, and everyday life". All participants wrote the book and shared their experiences during the Wiki-hackathon. We also created an adaptation of the SHOWed technique for the context of Brazilian popular education through the acronym **TimLopes**, with eight steps in Portuguese: **T**opic (theme of the image - Tema da imagem), **I**nterpretation (what is happening? - O que está acontecendo?), **M**otive (why is it happening? - por que isto está acontecendo?), **L**ink (how it connects with our lives - como isto se conecta com as nossas vidas?), **O**pportunity (questions that arise - quais perguntas podemos fazer a partir das imagens?), **P**erspective (point of view of the image - qual é o ponto de vista de quem fotografou a imagem?), **E**mpathy (how it affects us - como as questões presentes na imagem afetam o grupo?) and **S**olution (what we can do - quais ações podemos realizar a partir das informações que levantamos?). The name pays homage to journalist Tim Lopes (1950-2002), who inspired community photographers to work for peace and social transformation.

5 Conclusion

The Wiki-hackathon promoted collaborative reflection on community issues in a way that was aligned with their interests. The participants performed their art with plurality, consensus, and affection, making horizontal decisions that strengthened their bonds of trust. The photographs expanded the representation of the community on Wikimedia Commons by highlighting aspects of local culture and daily life. The activity proved to be a welcoming, creative, and critical

approach to developing data literacy skills related to defining themes, collecting data and interviews, textual presentation of results, and the socio-affective skills involved in collaboration. The acronym TimLopes will facilitate the data collection and organization stages in future experiments. However, we also intend to look for ways to transform the results obtained into public policy projects. We will carry out a data literacy assessment at the end of the activity to ensure the sustainability of the project's actions in the community.

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Reimagining eCHIS Usage through Planetary HCI: A Multidimensional Approach from Kenya's Community Health Information Systems

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Abstract. Providing an effective delivery of primary health care services at the community level is key to achieving Universal Health Coverage (UHC). Electronic Community Health Information Systems (eCHIS) was rolled out nationally in Kenya to enhance the work of Community Health Promoters (CHPs) in delivering primary health care and hence achieve universal health coverage. However, current evaluations of eCHIS usage in fulfilling the objective often rely on unidimensional metrics, such as login frequency, number of participants, duration, and task completion rate, that fail to reflect how system usage contributes to UHC. This paper seeks to integrate the Work System Framework (WSF) and Purpose–Subject–Consumer (PSC) model to propose a shift towards multidimensional usage metrics that better capture the relationship between eCHIS usage and hence capture community health outcomes more accurately as opposed to achieving only digital compliance. We propose three interdependent indicators: the proportion of active CHPs in eCHIS, the proportion of registered households via eCHIS, and the proportion of household visits undertaken via eCHIS. We seek to show how the WSF informs the identification of these key multidimensional eCHIS usage metrics and how the PSC model can inform their effective incorporation in eCHIS dashboards and evaluations, providing a more realistic assessment of eCHIS utilization in driving PHC and hence achieving UHC. The paper offers a grounded, context-sensitive approach towards measuring eCHIS usage using multidimensional metrics aligned to WHO's digital health strategy(2020-2025) on the design of digital health systems.

Keywords: eCHIS · WSF · PSC.· UHC.· multidimensional eCHIS usage.

1 Background

1.1 Introduction

Globally, health information systems are viewed as enablers of equitable healthcare, more so in low- and middle-income countries(LMICs). These systems have become central in strengthening the health systems in the settings. Countries have focused resources on establishing a strong primary health care system, which is key to realizing universal health coverage (UHC) - ensuring that all individuals and communities receive essential health services without financial strain. In Kenya, Kenya's electronic Community Health Information System(eCHIS) is one such platform that was rolled out to serve as critical infrastructure for strengthening PHC by enabling the planning, delivery, and monitoring of community health services at scale thereby becoming a driver of equitable and accountable health service delivery—a key pathway toward UHC. eCHIS has facilitated service delivery of several key community health functions: household registration, regular household visits, referrals, health education, and targeted screenings. Such functions form the building blocks of equitable PHC. Thus, when eCHIS is effectively used, it helps identify the underserved populations, monitor coverage gaps, and improve resource targeting. Guided by the purpose-subject-consumer(PSC) framework by [8], the dashboard metrics being used to monitor eCHIS usage must clarify the predefined purpose, tailored to an audience, and reflect the correct subject. It is through such alignment that these dashboards become effective tools for evaluating how eCHIS usage leads to UHC outcomes, rather than merely system activity.

1.2 Problem Statement

Despite the increasing integration of Health Information Systems, such as Kenya's eCHIS, evaluations of these systems are still predominantly based on isolated unidimensional usage metrics such as proportion of active CHPs, which fail to reflect whether eCHIS usage results in actual service delivery. For instance, Ethiopia's eCHIS usage was estimated at 50% based solely on active CHPs —a unidimensional indicator that ignored household registration coverage and household visits. Such an approach ultimately masks underlying gaps. For instance, if the proportion of household registration or household visits lags, a significant portion of the population may remain unserved or undocumented, undermining UHC's goal of inclusivity. This discrepancy between isolated unidimensional metrics and tangible impacts highlights the pressing need for a new evaluation approach—one that is firmly grounded in the specific context and genuinely focused on meaningful outcomes. Only then can the developed dashboards and evaluations truly guide equitable, universal health service delivery at the community level.

Objectives The objective of this study is to propose a multidimensional eCHIS usage measurement approach by integrating the WSF and PSC model.

1. To critique the limitations of isolated unidimensional eCHIS usage metrics.
2. To propose joint multidimensional eCHIS usage metrics that reflect actual community health service delivery through WSF.
3. To demonstrate how the PSC model enhances the effective application of these indicators in the dashboard design.

1.3 Research Significance

The study contributes in three unique ways. Firstly, it has responded to the urgent call for meaningful usage metrics that reflect the true value of HIS usage. Secondly, it contributes to the novel integration of two frameworks(WSF & PSC) to provide a holistic lens for eCHIS usage evaluation. Thirdly, advocacy for multidimensional eCHIS usage metrics enables health system stakeholders to better align HIS investments with service delivery goals and UHC outcomes. Finally, it responds to the global calls, such as WHO's digital health strategy(2020-2025), to create adaptable, equitable, and context-aware digital public goods.

2 Related Works

Whereas studies have adopted unidimensional usage metrics via self-reported Likert-scale ratings, these have failed to capture the true extent of eCHIS usage. For instance, [5] assessed eCHIS usage in Ethiopia via self-reported frequency scales and found significant gaps between high acceptability rates(over 90 %) and actual routine use(only 50 %). Additionally, a study by [7] found unidimensional metrics inadequate to evaluate actual EHR usage and that meaningful service delivery can only be better assessed through multiple dimensions of EHR use, underscoring the limitations of relying on single-indicator metrics. As a result, many health dashboards have failed to achieve their purpose because they rely on default, unidimensional metrics that are not aligned with the specific needs of the user or the intended outcomes. This results in limited insight into actual service delivery or health impact. WHO's global digital health strategy(2020-2025) has called for appropriate, people-centred and context-aware use of digital public goods.

2.1 Integrated Conceptual Framework

The Work System dimensions within the WSF [2] provide a social-technical lens for understanding how systems are used within social and organizational contexts. In this Paper, we adapt this framework to eCHIS by measuring eCHIS usage along three dimensions: participant(CHPs activity), information(Household registration), process(household visits). This multidimensional view contrasts with the traditional unidimensional metrics that often focus on each dimension, but in isolation. Additionally, the PSC model, developed by [8], complements WSF by ensuring the metrics designed and communicated via dashboards have a clear purpose, measure the right subjects, and serve the information needs

of their consumers. Therefore, dashboards must reflect usage metrics that link digital system interactions to health service delivery outputs. In the context of eCHIS, this calls for a shift toward metrics that assess how eCHIS usage enables community health actions. Thus it will act as a lens for evaluating eCHIS usage by ensuring that metrics align with the intended goal (UHC realization), accurately reflect the entities being measured (CHPs, households, service activities), and meet the information needs of decision-makers As a result, the WSF will be applied to identify what aspects of the eCHIS should be measured, whereas the PSC model will ensure that such measurements are used meaningfully for decision-making. This integration ensures that the multidimensional metrics are both operationally grounded and strategically actionable.

2.2 Proposed outcome-oriented usage Metrics

Therefore, to showcase the lived realities of eCHIS-driven community health service delivery, we propose a set of formative multidimensional usage indicators informed by WSF and PSC model. Being informed by the WSF, the multidimensional indicators identified include:

Participant The participants have been defined as people who perform activities in the IS[3]. Several studies have operationalized the participant dimension as proportion of active participants using the IS, namely: Proportion of active users of ERPs[9, 11], proportion of active users of KenyaEMR[10], proportion of active users of Geographic Information System(GIS)[1] Consistent with the literature and focusing on the extent of engagement with service delivery, the study proposes to operationalize the participant dimension as a proportion of CHPs actively using the eCHIS over the total number of registered CHP participants.

Information This dimension represents the data that's processed, stored, and utilized to facilitate service delivery [3]. Studies have operationalized the information dimension as the proportion of registered households entered into eCHIS, namely [6], assessed the feasibility of eCHIS in Ethiopia via the proportion of registered households in Ethiopia. Consistent with the literature and focusing on community coverage, the study proposes to operationalize the information dimension as the monthly proportion of registered households via eCHIS, which is a prerequisite for effective community coverage.

Process This represents the activities that occur within a work system to produce services for its customers [2]. Through this metric in eCHIS, CHPs can document the household visits where at least one community health services were rendered. In a normal case, each household is expected to receive at least one visit per month. Studies have operationalized the Process dimension as the proportion of household visits to evaluate usage. [4] applied the percentage of household visits undertaken monthly to guarantee proactive service delivery to

every household, even though only half were found to be actively using this metric. Consistent with the literature and focusing on service continuity, the study proposes to operationalize the process dimension as the proportion of household visits undertaken via eCHIS where at least one service was rendered. The PSC framework requires that metrics should be aligned with a clear purpose, thus, the proposed metrics should monitor how eCHIS is enabling household-level services and ensuring no one is left behind. Secondly, the PSC framework demands that the subject of the metrics should reflect what is being measured, which is represented by the proportion of active CHPs, proportion of households registered, proportion of household visits to showcase households served, health activities conducted, and community coverage achieved. Thirdly, PSC framework requires that metrics should show who will use the usage metrics and for what decisions. The proposed metrics jointly represent the performance of CHPs, household registration coverage, and visit completion rates to evaluate the extent of attaining UHC goal.

The above metrics, when jointly represented on the eCHIS dashboard, should be used to monitor progress towards UHC through attained PHC service delivery. It's only when all three metrics are jointly optimized one can claim that eCHIS is functionally supporting UHC. For instance, if the dashboard shows high active CHPs and household visits, but low household registration, it would indicate incomplete population coverage. Thus, our proposed multidimensional metrics would expose such gaps and enable more objective interventions.

3 Conclusion

The study affirms that evaluating eCHIS usage via unidimensional lens may create a false sense of progress and obscure key service delivery gaps. Having integrated the Work System Framework and the Purpose–Subject–Consumer model, the paper offers a robust conceptual foundation for defining, applying, and evaluating contextual outcome-driven multidimensional usage metrics. Thus, visualizing system usage metrics as multidimensional usage metrics grounded on community priorities offers a better approach for HIS evaluation and improvements. As a result, for equitable HCI, we need to shift away from techno-centric usage dashboards to community-centred dashboards where the usage metrics are grounded in user roles and lived realities. This endeavour will honour the relational, adaptive nature of CHPs' work. In the next phase of this study, multivariate change point analysis will be employed to empirically demonstrate how multidimensional usage metrics better reveal trends, shifts, and gaps in system usage. Such evidence is crucial for guiding investments, policies, and strategies aimed at accelerating progress toward UHC.

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Enhancing Malware Author Attribution through Traditional Analysis Techniques

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Abstract. Code authorship attribution is the crucial process of determining who created a given code segment. The fast-paced development of cybersecurity threats causes a notable increase in malware variants, mostly driven by the advanced mutation techniques used by malware authors. Strong approaches for analyzing the authorship of malicious code must first be given top priority if this growing difficulty is to be properly addressed. Advanced code authorship attribution methods help to greatly improve the capacity to recognize and classify the authors of malware, so strengthening the defenses against cyberattacks. This knowledge can assist in forecasting the kinds of tools and methods the author of a particular malware employs as well as the way the malware develops and spreads. This study proposes a malware author attribution tool to help better identify and assign malware to its creators. Aiming at revolutionizing malware attribution, the suggested solution is a creative, modular open-source tool. To precisely identify possible authors or groups engaged in malware activities, it combines explainable machine learning techniques with lightweight static analysis. This tool significantly enhances traditional analysis methods, increasing the accuracy of malware author identification and allowing law enforcement and cybersecurity teams to effectively track down and capture those accountable for threats.

Keywords: malware attribution, Advanced Persistent Threats (APT), code attribution.

1 Introduction

Africa's digital economy is seeing substantial growth, underscored by increasing internet accessibility, the widespread adoption of mobile banking, and the growth of e-commerce. This development opens up a host of opportunities for growth and innovation; however, it also brings forth significant challenges, particularly concerning cyber threats such as fraud, data breaches, and ransomware [3, 4, 15]. It is important to recognize that cybercrime is increasingly prevalent across the continent, necessitating

collaborative efforts to strengthen cybersecurity measures. Recent reports from Interpol and various cybersecurity organizations indicate that several African nations are experiencing an increase in phishing attacks, online scams, and financial fraud. Many systems in these regions can become more vulnerable due to challenges like poor infrastructure and low cybersecurity awareness [3, 14]. The significant cyber-attack on the second-largest hospital operator in South Africa during the COVID-19 pandemic highlights the critical need for strong cybersecurity practices to safeguard essential healthcare services. As essential sectors such as healthcare, energy, and transportation swiftly adopt digital technologies, it is important to identify and tackle the possible weaknesses that could emerge as a consequence. Cyberattacks on these critical systems could pose risks to essential services and, consequently, the well-being of individuals. It is imperative to prioritize robust cybersecurity measures to ensure the safety and stability of these services [6, 7]. Africa leads the world in mobile money usage. While this boosts financial inclusion, it also opens up new avenues for cybercriminals to exploit users who may not be well-versed in digital security. As the collection and storage of personal and business data online continues to grow, safeguarding this information becomes crucial [3, 5, 9, 15].

Data protection laws, like the Protection of Personal Information Act in South Africa and the Data Protection Regulation in Nigeria, are being developed or implemented in many African countries. However, both the infrastructure required and the enforcement of these laws are still in their infancy [14]. Because attacks on government systems, disinformation campaigns, and cyber espionage have the potential to destabilize political systems and erode public confidence, cybersecurity has emerged as a national security issue. Finding the author of a particular piece of code is known as code authorship attribution [9, 13]. Knowing who created these threats has become more crucial as the number of malware variants keeps growing as a result of sophisticated mutation techniques. The use of techniques that investigate the authorship of malicious code is crucial to solving this problem [1, 4]. Malware authors can be located and categorized using code authorship attribution techniques. This knowledge can help predict the tools and methods a given author will use, as well as explain how their malware propagates and changes over time [5, 7].

With the increasing significance of cyberwarfare as a geopolitical tool, reliable attribution is vital. It plays an integral part in developing international cyber policy and security architecture in addition to directing diplomatic and military responses [3, 5]. This study suggests a low-resource, lightweight, explainable malware attribution tool to fill this research gap. This tool is particularly relevant in the African context and accessible to under-resourced areas. Although indigenous design is not specifically discussed in the paper, its emphasis on open, modular architectures and the democratization of malware attribution is unmistakably consistent with inclusive and decentralized design theories. This strategy is very consistent with Ubuntu's basic principles. The remainder of the paper is as follows: Section 2 gives background and the current cybersecurity landscape in South Africa. Section 3 briefly provides the research methodology used to conduct the study. Section 4 presents the proposed solution and discussions. Section 5 concludes the paper, providing future work.

2 Background

2.1 South African Cybersecurity Landscape

South Africa ranks as the second highest country in Africa for data breaches and holds the 37th position globally. Importantly, there was a concerning increase of 164% in breach volume from the third quarter to the fourth quarter of 2024, underscoring a substantial rise in cyber incidents. A recent report from Cisco's 2025 Cybersecurity Readiness Index clearly shows a disconnect in South Africa's corporate landscape. While an impressive 85% of companies assert they are ready to tackle cyber threats, only a shocking 7% can genuinely claim to possess "mature" cyber resilience [9]. This reveals a crucial gap that must be addressed immediately. This evident distinction highlights a significant difference between individuals' perceptions of their readiness and their actual capability to respond to cyber threats. Critical infrastructure encounters a formidable danger, as illustrated by recent widely publicized breaches [6]. The South African National Defence Force (SANDF) has experienced the leak of operational data, while South African Airways (SAA) has had both employee and passenger information compromised. Additionally, the Department of Home Affairs has compromised biometric and identification data because of severely misconfigured servers [9]. Government systems are extremely vulnerable, and repeated breaches have continually exposed sensitive national data. Experts are warning that a similar breach at Eskom or Rand Water could result in significant national service disruptions. Immediate action is necessary to address these vulnerabilities [12, 13, 14].

2.2 Malware Background

Malicious software, commonly known as malware, is defined as software that is specifically designed to execute the harmful intentions of an attacker [15]. Its primary objectives are to infiltrate computer systems and network resources, disrupt normal computer operations, and collect personal information without the consent of the system's owner [1, 2]. This poses a significant threat to the availability of the internet, the integrity of its hosts, and the privacy of its users [4, 8, 10]. Malware comes in a wide range of variations like Virus, Worm, Trojan horse, Rootkit, Backdoor, Botnet, Spyware, Adware, etc. These classes of malware are not mutually exclusive, meaning that a particular malware may reveal the characteristics of multiple classes at the same time [11, 13, 14].

Malware presents a significant and pressing security threat that is one of the most formidable challenges facing the Internet today. Malware threats are growing quickly in terms of quantity, diversity, and speed. The landscape of these threats is constantly changing, with more advanced techniques and innovative strategies being used to target both computers and mobile devices [7, 12]. McAfee catalogs over 100,000 new malware samples every day, translating to an astonishing rate of approximately 69 new threats each minute—equating to nearly one threat every second. The emergence of advanced and readily available tools is fueling a new wave of cyber threats and attacks that are more targeted, persistent, and challenging to identify [1, 3, 4, 14].

2.3 Access to Attribution Tools

In Africa, identifying malware authors is an important and developing field in cybersecurity, particularly due to the increase in advanced cyberattacks aimed at financial institutions, government systems, and private companies [1, 3, 15]. Access to malware author attribution tools is crucial for enabling local institutions to conduct independent investigations and effectively respond to cyber threats. This independence is essential for enhancing the resilience of national cybersecurity, cultivating local skills, and encouraging innovation that is uniquely suited to regional threat environments. By diminishing reliance on global cybersecurity monopolies, African institutions can sidestep the limitations of generic, one-size-fits-all solutions. This shift paves the way for the development of defenses that are more relevant to their specific context [8, 12]. Additionally, local control over attribution capabilities greatly enhances trust and transparency in responses to cyber incidents, fostering strong collaboration among stakeholders and contributing to a more equitable global cybersecurity ecosystem [10]. Globally, a range of techniques pertinent to Africa are being actively adopted in cybersecurity research, demonstrating a significant shift in focus and commitment to addressing regional challenges [13, 14].

In their study, [13] examine various attribution techniques, obstacles, and real-world examples within the realm of cyber warfare. They investigate challenges such as misattributions, ethical dilemmas, legal constraints, and the complexities of the digital landscape. Additionally, they identify and discuss contemporary methods including malware analysis, network traffic examination, digital forensics, and the use of AI/ML technologies. These approaches enhance cybersecurity and inform strategies in cyber warfare. [1] explores the complexities of malware authorship attribution by merging traditional analytical techniques with advanced machine learning methodologies. This integrated approach, which includes both static and dynamic analyses, has produced promising results in the challenging field of malware attribution. Nevertheless, the study illuminated the many complexities at play, especially because of the advanced obfuscation methods often employed by attackers. The paper strongly advocates for a comprehensive attribution model and underscores the urgent need for continuous innovation to stay ahead of an ever-evolving threat landscape.

2.4 Contribution

The primary contribution of this paper is twofold. First, it provides a high-level status on cybersecurity posture in South Africa; it also gives a background on malware and concludes with an assessment of available attribution tools, particularly in Africa. Secondly, it introduces a lightweight and explainable malware attribution tool that is designed to be accessible and beneficial for regions with limited resources. This effort could play a crucial role in enhancing the overall cybersecurity ecosystem. In conclusion, this study offers suggestions for future research opportunities within this domain, encouraging further exploration to enhance the overall cybersecurity posture in Africa.

3 Research Methodology

This research started with a review of existing literature focused on offering a comprehensive summary of techniques for attributing malware authorship, along with an evaluation of the tools available for attribution. Examining the current attribution tools was crucial for uncovering their features and shortcomings. The research presents an innovative tool for attributing malware authorship that skillfully utilizes conventional analysis methods through an effective combination of qualitative and quantitative strategies. Malware samples were collected from publicly available repositories. Each sample underwent both static and dynamic analysis to extract key features, including opcode sequences, Application Programming Interface (API) call patterns, and behavioral logs. The characteristics were systematically organized and analyzed to identify stylistic and structural patterns that may suggest particular authorship. This study presents an innovative malware attribution tool designed to be explainable and resource-efficient, specifically aimed at supporting under-resourced regions, with a focus on the African context. The introduction of this tool is expected to significantly enhance cybersecurity capabilities in areas where such advancements are urgently required.

4 Proposed Solution and Discussion

The proposed solution is a dynamic and efficient open-source initiative aimed at improving malware attribution. This method effectively combines machine learning techniques with straightforward static analysis to accurately identify potential malware authors or groups. This combination enhances our ability to recognize and understand the underlying causes of such troubling behavior. This tool is a crucial asset for settings with constrained resources, as it is engineered to function effectively on hardware with lower specifications. Small Computer Emergency Response Teams (CERTs), universities, and local cybersecurity organizations in Africa and other developing countries must seize the significant benefits offered by this solution. It is essential for their growth and effectiveness in the ever-evolving cybersecurity landscape. The proposed solution features:

- A static code stylometry engine that combines rule-based heuristics with fundamental machine learning models.
- It offers a robust and transparent attribution dashboard that effectively displays decision-making processes, allowing analysts to confirm and fully grasp the outcomes. The dashboard underwent a thorough evaluation by analysts to ensure it meets all the necessary requirements.
- With its offline capabilities, this system is optimally designed for field investigations or operations in isolated networks.

This solution delivers substantial advantages, notably a diminished reliance on foreign cybersecurity vendors, which empowers and strengthens local analysts. It is

also highly cost-effective, being free and leveraging open-source software with minimal hardware requirements. It is specifically designed to enhance collaboration by effectively facilitating the sharing of threat intelligence on a regional scale.

5 Conclusion

Malware attacks present a substantial threat to national security, corporate networks, and public endpoint security. By identifying the Advanced Persistent Threat (APT) groups responsible for these attacks and categorizing their activities into distinct attack campaigns, security investigators can more effectively trace their operations, leading to improved security measures against future threats. The challenges associated with APT tracking are not adequately covered by the existing Cyber Threat Intelligence (CTI) elements, which primarily concentrate on recognizing malware families and outlining their behaviors. This study proposed a simple, lightweight tool for identifying malware. It is designed to be used in regions with few resources, especially in Africa. The proposed solution is a powerful, open-source, and flexible tool specifically developed to improve malware attribution. It successfully recognizes potential authors or organizations linked to malware activities by combining explainable machine learning methods with efficient static analysis. Future research in malware author attribution must focus on integrating hybrid models that effectively combine traditional analysis techniques with machine learning and deep learning approaches. This integration will improve the analysis's effectiveness and significantly progress the field.

Traditional techniques such as opcode analysis and control flow graph comparison provide valuable interpretability, but their effectiveness is significantly boosted when we integrate statistical learning. This approach allows us to identify subtle patterns across large datasets with greater precision. Researchers could explore standardized benchmarks and datasets with verified authorship to enhance the reliability of attribution studies. One avenue is the investigation of attribution techniques that are resistant to obfuscation and work across different platforms. As malware creators continue to employ obfuscation and polymorphism to avoid detection, future efforts should concentrate on honing traditional techniques to ensure they remain effective in such challenging circumstances.

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A Planetary Thinking Approach to Cultivating Community-Based AI Literacy

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Abstract. To cultivate critical AI literacy and nurture true empowerment of minoritized community voices, this paper introduces a community-engaged design project based on the emerging ontology of the planetary. It connects the design concept of discursive affordances to platform technologies for network building, incorporating rich experiences of minoritized students into the AI ecosystem and training them to become thought leaders in their communities, thereby owning the technology, promoting social and cultural understanding of AI, and achieving true empowerment.

Keywords: Planetary thinking, AI, cultural differences, discursive affordances, platform, community

1 Introduction

A new digital humanities education is needed to cultivate critical AI literacy and nurture the true empowerment of minoritized community voices. Constructed as "artificial intelligence (AI)" by big techs, popular AI-enhanced computing technologies and Large Language Models (LLMs) reduced the full experiences of human beings to data points and humanities-informed creative intellectual work to ideas and facts, uprooting writers, artists, and scholars from their communities of practice where they are deeply situated (Bender & Hanna, 2025). Built on Euro-American historical experiences and a single-world ideology, the pervasive AI has exacerbated our divided society with biased algorithms (e.g., Bender & Hanna, 2025; Broussard, 2023; Kang et al., 2016; Nkonde, 2023). As AI-based technologies rapidly replace entry-level jobs, minoritized students must not only understand the mechanisms and biases of AI algorithms but also excel in this competition to take up advanced skills with critical AI literacy (Bowen & Watson, 2024).

Our project applies the emerging ontology of the planetary (Elias & Moraru, 2015; Mould, 2023) and connects the design concept of discursive affordances (Sun, 2020) to platform technologies for network building to include rich experiences of minoritized

students into the AI ecosystem and train them into thought leaders to own the technology, promote social and cultural understanding of AI, and achieve true empowerment. It brings a critical design framework into grassroots activism. It explores ways to develop a network of champions and amplifiers for minoritized students and communities, engaging them in sustainable and purposeful self-advocacy work.

2 Land Acknowledgment and Godfather of AI

Land acknowledgment is a formal statement recognizing and respecting the stewardship of the land by Indigenous Peoples. Though it has become a common meeting protocol in North America in recent years, few people realized such a social-justice practice signals a new ontology of planetary thinking and calls for a situated, decolonizing, indigenous stance to appreciate the stewardship of the lands and natural resources, value a local way of being, reconcile the trauma of various forms of colonization and oppression (Miller, 2023, 6:24) with a potential of promoting healing in this globally divided world.

Shortly after ChatGPT was released in 2022, "Amanda", one of my Native American students, who was a communication specialist of her tribe in the land where my university sits, created a land acknowledgement with ChatGPT. To her surprise, it didn't look bad. It appreciates the Tribe's stewardship of the land and the environment, recognizes their contributions to the community and the world, and admires their resilience and perseverance. It asks the audience to acknowledge the ongoing and perpetuating impacts of colonization, forced relocation, and oppression in this land and invites people to honor and respect the sovereignty of the Tribe and all Indigenous peoples to promote healing and reconciliation.

However, from her heart, Amanda didn't feel right about the land acknowledgment. Acknowledging the land is her tribe's century-old cultural practice. Her tribe lived along the shores of the Puget Sound in Washington. When her canoe-traveling ancestors arrived at a new land, they stopped offshore, paid respect to the land and people first, and then requested permission to come ashore. The acknowledgment served as a foundation for their life philosophy and worldview, teaching them how to interact with tribe members and friends and how to steward the land and nature. AI technology can generate a written statement to acknowledge the land. Still, it didn't cultivate the respect and humility that comes from the authentic act of acknowledging the land close to her heart.

Amanda was not alone in having that concern. In our recent interview with an Indigenous computer scientist, "Alex" from a different tribe in the Pacific Northwest, indicated that his tribe's people didn't trust AI technology built in Silicon Valley. He said, "If the godfather of AI is a European person, how will they understand what Indigenous people need with AI?" He explained the cultural difference between Indigenous culture and Western culture in terms of relational interactions vs. transactional interactions. For his tribe, a person is more important than a meeting, but a meeting is more important than a person in Western culture. Before introducing AI

into his tribe with a top-down approach, he requested that AI be trained to understand his tribal culture first through a bottom-up manner.

ChatGPT-generated land acknowledgment delinks the embodied respect and humility that the Indigenous people cherish. While it calls for valuing the stewardship and legacy of the Indigenous people to the land, it ultimately uproots the practice of acknowledging the land itself. Operated on LLMs, AI technology can write a land acknowledgment on the fly by manufacturing the same communication for other lands as well, i.e., simply updating the names of the local Indigenous people.

In delinking the cultural values such as the ethnic, racial, gender, and sexual of the Indigenous people from the land where they and their ancestors live and steward, the statement constructs a "non-situated, universal, God-eyed" worldview, as Hispanic decolonial sociologist Ramón Grosfoguel (2011, p.5) put it. Decolonial scholarship renders colonial oppression in our language systems visible to inspire multiple knowledge systems valuing cultural diversity and Indigeneity. For Grosfoguel, the "non-situated, universal, God-eyed" worldview represents the hegemonic Eurocentric knowledge paradigm, associated with white supremacy. This Eurocentric paradigm "has allowed Western man (the gendered term is intentionally used here) to represent his knowledge as the only knowledge" (p. 6). The result? The local knowledge from the Indigenous people and their rich local cultural heritage is destroyed and eradicated.

3 Design Framework

In this section, we outline a community-engaged design project that combines theoretical exploration and platform building, rooted in an indigenous worldview of land acknowledgments to nurture healing in this divided world.

3.1 Planetary Thinking

Informed by the planetary thinking that resets the colonial, hegemonic and capitalist influences of current global design practices with key dimensions of "subalternism, alterity and heterogeneity" (Mould, 2023, p. 5), this project will further develop a decolonial design methodology, which questions the norms and design standards of the Western epistemology from the Global South vantage, and offers a critical design framework and a toolset of design facilitation methods to practice transformative listening (Ratcliffe, 2005), foster courageous conversations, bridge cultural differences, and thus promote inclusive empowerment.

With a focus on indigenous designs across the globe, including Indigenous creations, local designs (Sun, 2006, 2009, 2012a), and decolonial interventions (Sun, 2012b, 2020), this framework, founded in the planetary thinking, "represents a transcultural phenomenon" (Elias & Moraru, 2015, p. xii). Furthermore, it resonates with a profound shift in the humanities from cultural diversity to "epistemic diversality" (Grosfoguel, 2006), which celebrates cultural differences in opposition to the single-world ideology. This shift asserts that the "diverse forms of democracy, civil rights or women liberation can only come out of the creative responses of local subaltern epistemologies"

(Grosfoguel, 2011, p. 26). Escobar (2018) advances a design goal for the pluriverse—"a world where many worlds fit" (p. xvi)—to break away from the ideology of Euro-American historical experiences where we all live in a single world. He calls for "an ethical and political practice of alterity that involves a deep concern for social justice, the radical equality of all beings, and nonhierarchy" (p. xvi) to respond to "the interrelated crises of climate, food, energy, poverty, and meaning" (p. x)."

As advocated in the UNESCO report "Indigenous Protocols for AI" by a group of Indigenous design researchers from Australia, an Indigenous perspective will overcome the dualistic approach that separates AI research and practice into separate boxes of "technical work (data science) and ethical considerations" and thus bring an integrative perspective (Abdilla et al, 2021). So is planetary thinking, which emphasizes the entanglement of human agency in "our material and psychological intimacy with the living atmo/bio/eco-sphere around us" (Mould, 2023). Indeed, the key insight from "Indigenous Protocols for AI" states: "Indigenous protocols in AI might be enacted by a continuous process of engagement, challenge, innovation, and response embedded in our obligation to care for Country, and every layer of the digital stack that is built upon it. And that is a process that never ends" (Abdilla et al, 2021, p.16). To clarify, "Country" here should be interpreted as land, encompassing the environment, the community, the natural resources, the ways of living and interacting, and the local culture, as what we acknowledge in the Land Acknowledgement to steward and care. It shares the same position as Planetary Thinking advocates to imagine ourselves as "planetary subjects" (Spivak, 2003), which will help us to address the disparity issue that undermines the humanities undergraduate programs and disadvantages the first-generation, low-income, or minoritized students due to the lack of the AI literacy and uneven distribution of AI technologies—a new form of digital divide.

3.2 Community-Engaged Platform Building

To respond to the call to "improve our nation through better design" (White House, 2025) and create a shared vision of AI future in a multicultural American society, it is essential to include rich experiences of minoritized students into the AI ecosystem and train them into thought leaders to own the technology, promote social and cultural understanding of AI, and achieve true empowerment. This goal is to be achieved by creating a community-engaged platform, built upon our previous community-engaged design project (Sun, Li, & Teng, 2024).

A community-engaged platform refers to a community-engaged system and network that utilizes web platforms and social media marketing strategies to coordinate and facilitate interactions between multiple groups of users and stakeholders. Informed by the political-rhetorical power of network for community-building (Spinuzzi, 2008, 2015; Sun, 2020; Swarts, 2011) and communities of practice (Wenger, 2000), the platform concept is also influenced by the intellectual traditions from critical media studies (e.g., Klinger, Kreiss, & Mutsvairo, 2024; Poell, Nieborg, & Duffy, 2022; van Dijck, 2016) and economics (e.g., Hagiu, 2014) to achieve discursive affordances (Sun, 2020).

In contrast to geopolitical platforms influenced by state or corporate powers, the development of our bottom-up community platform will integrate the design process with the structuring processes of forming networks and communities, while being sensitive to issues of discursive power and the global political economy. In addition, the platform will be designed both as cultural institutions and as engaged communities towards a caring democracy (Tronto, 2013). For the latter, we will offer public scholarship activities such as community workshops and lecture series to complement the digital platform. For example, one of the core community-building practices is to train local K-12 students in developing key AI literacy to combat the increasing prevalence of AI-based fraud and advocate for their strategies as thought leaders and community influencers both locally and globally on social media platforms.

4 Conclusion

There is a proliferation of research on the critical investigation of digital media use in everyday life, along with rich field studies that inspire digital media design. However, there is a lack of research on translating critical investigations of digital media use into inclusive design for global social good or empowering marginalized communities through concrete, community-engaged practices. To close this gap, our project aims to address concrete and pressing questions, as follows: How should we design digital technology that is usable, meaningful, and empowering for culturally diverse users in a globally divided world? And how should we utilize platform technology to build an allyship network and empower traditionally marginalized communities?

It brings the following values to the global design community, which values local solutions: It questions the norms and design standards of Western epistemology and the Western design paradigm, presenting a decolonial design framework to approach cultural differences from a Global South vantage. Its anti-assimilationist stance will help local, indigenous communities achieve true empowerment and real belongingness.

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Co-production as a Proposal to Face the Global Challenges of HCI in Times of Geopolitical Tensions

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1. Introduction

Human-Computer Interaction (HCI), as a paradigmatic field in the design, development, and analysis of digital technologies, is currently at a critical inflection point. The intensification of global crises, such as the climate emergency, the escalation of geopolitical disputes, growing digital surveillance, and the exacerbation of technological inequalities, demands that we question the ontological and epistemic foundations underpinning the scientific agenda of this field. Historically, HCI approaches have been anchored in technical and cultural narratives imposed in a colonizing manner by the global North. Thus, the field of HCI calls for a re-examination of its frameworks in order to confront planetary challenges that necessitate plural, contextualized, and ethically committed responses.

Building on this premise, this proposal proactively debates the centrality of planetary thinking and Indigenous methodologies for stimulating and structuring HCI practices oriented by the co-production and co-theorizing (Rappaport, 2007; Harvey, Cochrane, Van Epp, 2019; Norström, 2020) of new uses and technological constructions, aiming toward cognitive justice, sociotechnical equity, and existential sustainability in an era marked by geopolitical tensions and transformations. The adoption of these perspectives is not merely about including diversity or engaging in epistemological exoticism, but involves the necessary rearticulation of ways of producing, circulating, and validating knowledge in HCI in view of the plurality of inhabited worlds (Rappaport, 2007; Descola, 2007; De La Cadena, 2008; Ribeiro & Escobar, 2008; Bonfil Batalla, 1987, 1991; Mignolo, 2002, 2017).

2. Objectives

2.1 General Objective

To understand the extent to which ontology, epistemes, and Indigenous thought in HCI can contribute to the co-production and co-theorization of digital technologies in order to address global challenges and contemporary sociotechnical inequalities.

2.2 Specific Objectives

- Contextualize the hegemonic ontological and epistemic foundations of HCI, identifying limitations and epistemic impacts of the global North on peripheral and traditional communities.
- Analyze contributions from planetary thinking and Indigenous epistemologies for the construction of plural, relational, and trans-cosmological approaches in HCI.
- Investigate participatory Indigenous and traditional knowledge methodologies that promote co-production and co-theorization practices in HCI projects.
- Propose guidelines and strategies to effectively integrate alternative forms of knowledge into HCI research, teaching, and professional practice, moving beyond superficial inclusion and fostering cognitive justice.
- Discuss the challenges, potentialities, and impacts of adopting decolonial practices in the infrastructure of interactive systems and the confrontation of global sociotechnical inequalities, especially those related to sustainability, environmental justice, and co-viability.

3. Theoretical Framework and Justification

The hegemony of modern Western thought in HCI is manifested in design frameworks, usability criteria, and theories of interaction that often suppress the

ontological, cosmological, and epistemological differences of peripheral communities, or are even subsumed within future-colonizing projects (Mignolo, 2002, 2017; Quijano, 2005). This kind of epistemic "monoculture" has hollowed out scientific practice, which remains anchored in the modern Western scientific mode of production. Thus, there is a pressing need for a pluralist approach to science, one sustained by trans-ontological dialogues and the appreciation of Indigenous, African, and traditional rationalities, whose relationships with the digital transcend usual dichotomies.

Planetary thinking, revisited by authors such as Latour (2000, 2004, 2011, 2014), proposes a relational and non-reductive approach to social and technical phenomena. It recognizes that the urgencies of our time cannot be addressed by fragmented rationalities or localist-universalist perspectives but require the recognition of interdependencies, shared vulnerabilities, and the appreciation of wisdoms that have often been marginalized and deemed lesser within scientific premises.

Such knowledge is regarded as the genesis of humanity's epistemic and ontological cognitive processes (Viveiros de Castro, 1996, 2002, 2006; Descola, 2007). Furthermore, Indigenous epistemologies have shown, through concrete experiences (Viveiros de Castro, 1996, 2002, 2006; Descola, 2007; Wawzyniak, 2003; Krenak, 2019, 2020), innovative ways of thinking about technology, collectivity, and "the human" itself, offering radical alternatives for the infrastructure of interactive systems and for the very meaning of innovation in a liminal era.

Finally, this work addresses the necessity for a broader, trans-cosmological and trans-ontological inclusion and understanding with respect to ways of thinking about the world, through concepts such as "co-viability" (Barriere et al., 2019)—a recently coined concept used to express the feasibility of coexistence that safeguards the viability of multiple species living together without one making another's existence unviable.

This category brings with it the proposition that such co-viability is already underway in alternative, traditional "other" societies of the so-called Third World. In this sense, science must point toward the need for strategies that transcend tokenistic inclusion and enable effective engagement with alternative knowledges capable of producing ruptures in the face of civilizational limits.

Nevertheless, there is a scarcity of participatory methodologies that are truly decolonizing and critical, as well as of institutional opportunities for integrating such epistemologies into research, education, and professional practice at scale. This issue inspires the present article, which is grounded in the construction and enactment of workshops and participatory processes with Indigenous peoples and traditional communities, which will co-theorize and co-produce (Rappaport, 2007; Harvey, Cochrane, Van Epp, 2019; Norström, 2020) processes of theorization and co-production in the use and creation of new technologies to tackle global challenges related to environmental management.

This work draws on inspiring reflections drawn from dossiers and books compiling Indigenous, quilombola, and traditional authors. Moreover, in-depth engagement with this literature is indispensable for facilitating true ontological dialogues that inform the aims of this article. Publications such as "Paneiro de saberes – Transbordando reflexividades indígenas" (Rezende, 2021), "Omerõ: constituição e circulação de conhecimentos Yepamahsã (Tukano)" (Barreto, 2018), "Dossiê Temporalidades e Interações Socioambientais no Noroeste Amazônico 2" (Andrello, Lolli, Meira, 2024), and "Colonização, quilombos: modos e significados" (Santos, 2015) are fundamental references.

In short, this article is guided by the following question: To what extent can ontology, epistemes, and Indigenous thought in HCI contribute to the co-production and

co-theorizing of digital technologies, thereby addressing global challenges and contemporary sociotechnical inequalities?

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