Earth Friendly Computation: Applying Indigenous Data Lifecycles in Medical and Sovereign AI

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1. Overview

The rapid expansion of medical artificial intelligence (AI) is generating vast amounts of data, leading to increased energy consumption and a growing environmental footprint. While this growth is advancing healthcare, it also presents the risk of worsening the climate crisis, which could impact global health. The session, "Earth Friendly Computation: Applying Indigenous Data Lifecycles in Medical AI" at PSB 2025, will explore how Indigenous communities have historically approached technology development with a focus on sustainability and long-term resource management, in contrast to Western societies' focus on resource extraction and maximizing profit through exponential growth.

Indigenous communities have long optimized technologies in ways that prioritize harmony, balance, and the maintenance of abundance rather than short-term gains. This approach stands in stark contrast to the Western model of technological advancement, which prioritizes profit and efficiency, often leading to environmental degradation. The EFC 574 initiative embodies this Indigenous approach by proposing sustainable, renewable-powered data centers on tribal lands, promoting data sovereignty while addressing climate resilience. Complementary to building this infrastructure, the AI in Point-of-Care (POCT) project harnesses edge computing to deliver AI-driven diagnostics to remote areas, reducing energy consumption and supporting healthcare in resource-limited regions.

The projects featured in this session are supported by initiatives like the Univeristy of California Systems, *California Cares* Policy initiative, the Canadian government's *Abundant Intelligences* initiative and the University of Cambridge's, *Green Algorithms* initiative, which aim to create transparency around the environmental impacts of AI through carbon footprint calculators and incentivization programs. Together, these efforts demonstrate how Indigenous communities are positioned not just to participate in the AI revolution, but to lead it by prioritizing sustainable development that maintains harmony with the planet's health. Rather than optimizing every advancement for profit and exponential growth, this framework advocates for a future driven by industrial symbiosis and long-term relationships with the earth, ensuring technology serves both people and the environment for generations to come.

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2. Background & key terms

"We live in the future. Come join us."
—Prof. Bryan Kamaoli Kuwada

For the past five centuries, Indigenous communities have directly witnessed seismic shifts in the integrated global economy, from natural resource extraction such as that of spices, fur, wood, oil, uranium, and tourism, to the rise of movies, gaming, casinos, and other parts of the entertainment and attention economy. These industries have served as vital sources of income, yet they are also subject to the winds of change, as generations pass and the global economy evolves. Despite the rapid advancement of technology the underlying economic models and values often remain static, unresponsive to the shifting technological landscape or the rights and needs of the communities participating in them. As we stand on the brink of a new era, it is clear that data is emerging as the next pivotal economic base. The ten largest companies on earth no longer deal in steel, railroads, or oil, but in vast amounts of data and the tools needed to process it. This shift demands not only technological acumen to overcome the pressing challenges of scaling these new technologies but also a reevaluation of our values and the way we envision progress for future generations.

Tired stereotypes of Indigenous communities like - "*Hawaiian people have 1,000 ways to describe the rain*" - obscure the truth that in these high resolution environmental or natural observations are also "*our data*," informed by thousands of years of observations, input, and action. This collective knowledge, and the practices developed from it, will be critical to spurring the transition into an economy that incorporates artificial intelligence in a way that is sustainable for the planet and individual and collective sovereignty.

The right of Indigenous peoples to own, control, access, and possess data that pertains to them, their lands, and their cultures is called *Indigenous data sovereignty*. It is rooted in the principle that Indigenous nations hold the inherent authority to govern themselves and manage their own affairs. *Indigenous data governance*, on the other hand, refers to the mechanisms, processes, and systems through which Indigenous communities control and manage this sovereign data. Functionally, this means developing policies, standards, and practices for data collection, storage, access, and dissemination that align with the community's values and needs.

Indigenous peoples have historically been separated from their resources using violent means. In 1965, Fairchild Semiconductors - which would soon lose founding engineers that would go on to found Intel and other semiconductor behemoths opened their assembly plant in Shiprock, New Mexico on the Navajo nation reservation. At its peak, the plant employed over a thousand Navajos, the majority of whom were women. Yet despite simultaneously drawing on Navajo women's expertise and exploiting their labor, never once were Navajo or Indigenous knowledge systems considered, integrated, or acknowledged as guiding forces in the development of integrated circuit architecture and what would later become an entire economy that today spans cloud computation, data center architecture, e-waste management, and parallel computing (*See, Figure 1*). Until now.

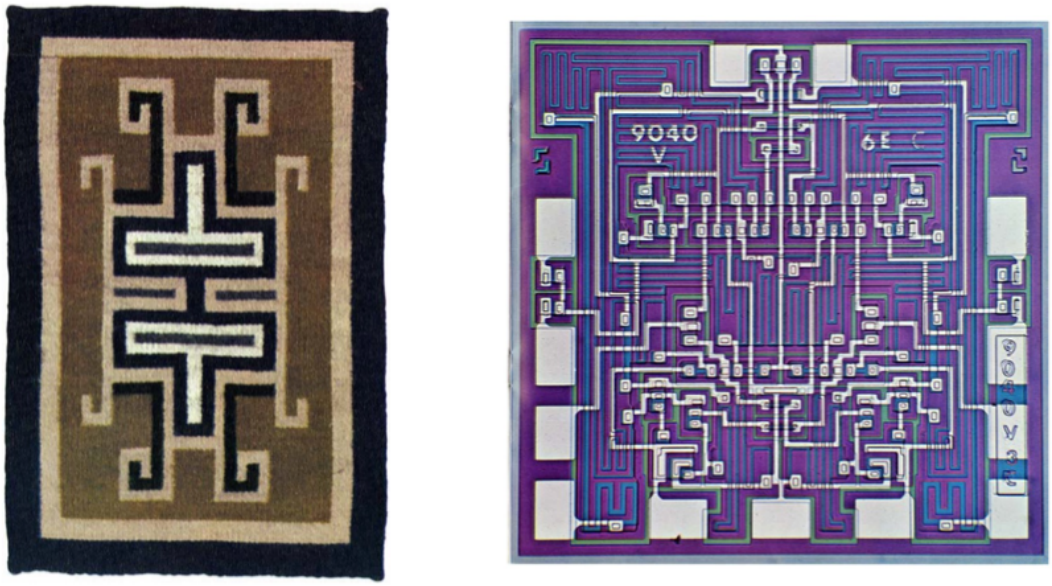

Fig 1. Left: A traditional Navajo rug; Right: the die layout of a Fairchild 9040 integrated circuit. These images are adapted from a Fairchild commemorative brochure for the 1965 opening of a new manufacturing plant on the Navajo Nation Reservation in Shiprock, NM. At this facility, Navajo women were specifically recruited to assemble early integrated circuits because their exceptional dexterity and precision, developed through generations of intricate rug-weaving, were invaluable for handling delicate components. The rug-weaving traditions, which involved complex pattern recognition and fine motor skills, directly translated into their ability to work with early microelectronics.

3. Earth Friendly Computation 574: Indigenous Data Sovereignty, Circular Systems, and Solarpunk Solutions for a Sustainable Future

Indigenous communities are not only envisioning but actively leading efforts to reshape AI through Earth-friendly principles. *Alipio et al.* present a policy and technology development proposal rooted in the idea of Indigenous Data Sovereignty and the establishment of decentralized, sustainable computing systems built on sovereign Indigenous lands. The number "574" refers to the 574 federally recognized Indigenous tribes in the United States, each uniquely positioned to lead this initiative.

This approach draws inspiration from Indigenous knowledge systems that promote circular economies and sustainable land stewardship, integrating these values with modern technology solutions. For example, the Hawaiian ahupua'a land management system, which operates on closed-loop cycles of resource renewal, provides a model for designing data centers that reuse resources, minimize waste, and generate less heat.

Here are some key recommendations for the development of policy and technology to decentralize sustainable access to machine intelligence among Indigenous communities:
- *Indigenous Data Sovereignty:* EFC 574 empowers the 574 federally recognized tribal nations to build and maintain control over their own data infrastructure, ensuring data governance that aligns with cultural values, autonomy, and the unique legal frameworks of sovereign tribal lands.
- *Sustainable Data Center Development:* This initiative focuses on creating environmentally sustainable data centers on tribal lands by integrating renewable energy sources like solar, wind,

and hydroelectric power. These centers will serve as models for climate-resilient and sovereign data management.
- *GIS-Based App for Sustainable Planning:* EFC 574 will develop an app that overlays GIS data onto Indigenous reservation topography and coordinate data, combined with renewable energy availability (solar, wind, hydroelectric), megawatt capacity, and biodiversity data. This tool will determine the most sustainable locations for data center architecture on sovereign tribal lands, promoting responsible and efficient development.

By leveraging ideas from *Solarpunk*—a speculative genre that imagines harmonious relationships between humans, technology, and the environment—Indigenous-led initiatives can guide the development of *circular data systems*. These systems would recycle electronic components, repurpose waste heat for energy generation, and use renewable power sources like solar and wind energy to fuel AI development.

4. AI in Point-of-Care: A Sustainable Healthcare Revolution at the Edge

AI-enhanced *Point-of-Care Testing (POCT)* is transforming healthcare by bringing diagnostics closer to patients, particularly in underserved areas. AI-driven POCT offers rapid, real-time diagnostic insights, reducing the need for centralized laboratory testing and improving healthcare outcomes in regions with limited access to medical infrastructure. However, this progress comes with a cost: the increased use of AI in healthcare systems exacerbates energy consumption and contributes to e-waste through the frequent upgrading of diagnostic devices.

To address these concerns, *Rajput et al.* present *edge computing* as a promising solution. By processing data locally on devices closer to the point of care—rather than relying on cloud-based infrastructure—edge computing reduces energy consumption and lowers the environmental impact of AI-driven healthcare technologies. This localized processing significantly reduces latency and energy costs associated with transmitting large amounts of data to distant data centers.

Here are some key recommendations for the utilization of AI in edge computing settings:
- *AI-Enhanced POCT:* AI reduces diagnostic latency in hospitals, delivering real-time results crucial for urgent care and improving access in underserved areas.
- *Scalability vs. Sustainability:* Balancing AI scalability with sustainability is key, favoring energy-efficient models over large, resource-intensive LLMs.
- *LLM Limitations:* LLMs aren't always ideal for point-of-care; careful selection of AI models is necessary to meet healthcare needs without increasing environmental impact.

In healthcare settings, edge computing can support *AI-driven genome sequencing*, *disease diagnostics*, and *patient monitoring systems*, enabling faster and more accurate medical decisions while minimizing energy use. For instance, edge-powered AI devices have shown success in reducing diagnostic times for infectious diseases like COVID-19 and improving personalized care in intensive care units (ICUs). These innovations illustrate that sustainable AI is not only possible but can also enhance healthcare delivery, making it more accessible, eco-friendly, and efficient.

5. Conclusion: The Future of Earth Friendly Computation

The future of Earth-friendly computation is one where AI development coexists with environmental sustainability and technological sovereignty. Indigenous communities, leading with principles of data sovereignty, circular systems, and land stewardship, are charting a path toward a

more sustainable digital future. From reducing the carbon footprint of algorithms to promoting secondhand markets for GPUs, these innovative solutions offer a blueprint for mitigating the environmental impact of AI.

In the coming years, it is essential to prioritize the development of green algorithms, sustainable hardware, and decentralized computing systems that emphasize energy efficiency and waste reduction. By incorporating Indigenous knowledge and practices into the fabric of AI development, the world can harness the power of AI for the greater good, while preserving the health of the planet. Sovereign AI should be informed by the knowledge hard-won by Indigenous data scholars over many generations.

The integration of edge computing into healthcare systems, the expansion of secondhand GPU markets, and the implementation of policies like Earth Friendly Computation 574 represent critical steps in achieving this vision. As demand for AI, its technological capabilities, and the systems available to train and use these tools continue to grow, so too must our commitment to ensuring that this growth aligns with the needs of both the planet and future generations. Aligning AI development and deployment with Indigenous data lifecycles and principles makes it possible to advance these technologies while preserving our planet's past, present, and future (*See, figure 2*).

Fig 2. Art by Wally Dion (Canadian and Yellow Quill First Nation/Saulteaux, born 1976). Left: "*Green Star Quilt* (*2019)*." E-waste, circuit boards, brass wire, copper tube. Right: "*Caterpillar, Egg, Chrysalis, Moth (2018).*" E-waste, circuit boards on plywood, nails. Serves as a powerful commentary on humanity's hidden environmental toll, symbolizing the lifecycle of AI and data-driven technologies. The artwork, crafted from discarded e-waste and circuit boards, evokes the transformation of a moth, paralleling the unseen extraction of rare earth metals and natural resources required to sustain our addiction to data centers, AI, and cloud computation. It highlights the environmental cost and the unsustainable hunger for energy that drives the digital age.

6. Acknowledgments

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