

Sovereign AI and Sustainable Computation for Indigenous Communities

Submitted to the UCSD GEMSTONES Program on behalf of Prof. Keolu Fox and the Native BioData Consortium (NBDC) and Indigenous Futures Institute (IFI).

Introduction: Indigenous communities worldwide have long faced challenges related to technological dependence, environmental degradation, and lack of data sovereignty. The rapid expansion of artificial intelligence (AI) and computational technologies has exacerbated these disparities, creating a digital divide and contributing to unsustainable practices such as e-waste (*See, Figure 1*). This proposal leverages the concept of Earth Friendly Computation (EFC) to build technological independence for Indigenous communities through the decentralization of micro-data centers powered by reanimated Zombie GPUs (ZGPUs).

The primary goal is to empower underserved communities by creating localized, energy-efficient computational systems while preserving cultural knowledge and promoting environmental stewardship. This initiative aligns perfectly with the GEMSTONES Program’s mission of addressing community-defined needs through innovative, interdisciplinary, and community-based solutions.

Unmet Need I: E-Waste and the Environmental Burden: E-waste has reached over 50 million tons annually, with discarded GPUs comprising a significant portion. Companies like NVIDIA continually refresh hardware, leaving millions of functional GPUs deemed obsolete despite their computational potential. These “Zombie GPUs” (ZGPUs) are an untapped resource that can be reanimated and redeployed sustainably.

Unmet Need II: Technological Dependence and Data Sovereignty: Indigenous communities often rely on external, centralized systems for computational needs, limiting their autonomy and leaving their data vulnerable to exploitation. Sovereignty and sustainability are inseparable in these contexts. By reclaiming control over data infrastructure, communities can assert their right to govern their own data and shape their technological futures.

Project Goals & Approach:

- 1. Reanimating Zombie GPUs:** This initiative will recycle and optimize discarded GPUs, creating a secondhand market to support low-cost micro-data centers. Open-source frameworks will enable communities to repurpose these GPUs for modern workloads such as AI and machine learning.
- 2. Decentralized Micro-Data Centers:** The project will develop renewable-powered, localized data ecosystems—referred to as “data terrariums.” These centers, costing under \$10,000 per unit, will process and store data locally, reducing dependency on centralized infrastructure while minimizing environmental impact.
- 3. Little Language Models for Indigenous Communities:** To address the unique needs of Indigenous populations, the project will develop small, efficient AI models trained on culturally relevant and community-curated datasets. These Little Language Models (LLMs) will serve applications such as language preservation, healthcare, and education.
- 4. Community-Centric Design and Training:** By integrating Indigenous knowledge systems and engaging community members in the design process, the project will foster technological independence. Training programs will equip students and community leaders with skills to manage, maintain, and innovate within this new infrastructure.

Proposed Activities & Deliverables:



Figure 1. On the left side of the image, we see a graveyard of “Zombie GPUs”—four stacked GeForce GTX graphics processing units (GPUs) sitting inside a decommissioned computer rig. These GPUs, while still functional, are likely considered obsolete by current standards, yet they retain significant computational potential. On the right side, a worker sorts through a large pile of e-waste in an industrial facility, highlighting the environmental impact of discarded electronics.

1. **Community Engagement:**
 - Conduct workshops with Indigenous communities to co-design micro-data centers and LLM applications.
 - Partner with organizations like the Native BioData Consortium to ensure alignment with community needs.
2. **ZGPU Optimization and Deployment:**
 - Develop open-source tools for optimizing ZGPUs.
 - Deploy pilot micro-data centers in underserved Indigenous communities.
3. **Training and Capacity Building:**
 - Create training programs to educate students and community leaders on managing sustainable data infrastructure.
 - Provide hands-on workshops on developing LLMs and integrating renewable energy solutions.
4. **Outreach and Advocacy:**
 - Host public forums and presentations to highlight the intersection of technology, sustainability, and sovereignty.
 - Collaborate with policymakers to advocate for sustainable, decentralized computational systems.

Expected Impact and Success Metrics:

Immediate Outcomes:

- Deployment of at least two micro-data centers in Indigenous communities within 12 months.
- Training of 10+ community leaders and students in sustainable computational practices.

Medium-Term Goals:

- Creation of scalable, open-source tools for ZGPU reanimation and micro-data center deployment.
- Development of culturally relevant LLMs tailored to specific community needs.

Long-Term Vision:

- Establishment of a decentralized network of micro-data centers across sovereign lands, promoting data sovereignty and technological independence.
- Reduction in e-waste and carbon emissions associated with GPU disposal.

Budget and Justification:

Requested Amount: \$10,000

1. **Community Engagement and Outreach (\$2,500)**
 - Costs associated with workshops, travel, and collaboration with Indigenous communities.
2. **Hardware and Software Development (\$4,000)**
 - Procurement and refurbishment of ZGPUs.
 - Development of open-source frameworks and training materials.
3. **Training Programs (\$2,500)**
 - Design and implementation of hands-on workshops and training modules.
4. **Operational Support (\$1,000)**
 - Miscellaneous costs, including logistical support and data collection for project evaluation.

Sustainability and Future Funding: This project's focus on open-source tools and community-driven innovation ensures its scalability and longevity. Success will position the project for future funding opportunities through federal grants (e.g., NSF, DOE), private foundations, and collaborations with tech companies committed to sustainability and equity.

Conclusion: By integrating Indigenous knowledge systems with cutting-edge computational science, this project advances the twin goals of sovereignty and sustainability. It offers a replicable model for reducing e-waste, decentralizing data infrastructure, and empowering underserved communities to lead in the era of AI. With support from the GEMSTONES Program, this initiative will serve as a transformative step toward equitable and sustainable technological futures.

Glossary & Definitions:

- 1. Zombie GPUs:** Graphics Processing Units (GPUs) that are no longer considered cutting-edge by manufacturers or mainstream users but still retain significant computational power for AI and parallel computing tasks.
- 2. Little Language Models (LLMs):** Small, efficient artificial intelligence models designed to perform specific tasks with focused datasets. Unlike large-scale language models, LLMs are optimized for lower computational requirements, making them ideal for localized applications, such as preserving Indigenous languages, addressing community-specific needs, and operating sustainably in low-resource environments. These models prioritize accessibility, cultural relevance, and energy efficiency.
- 3. Decentralized Cloud Clusters:** Distributed computational networks that leverage multiple localized cloud resources (e.g., repurposed GPUs) to provide scalable and cost-effective AI development environments without relying on centralized data centers.
- 4. E-Waste (Electronic Waste):** Discarded electronic devices and components, such as outdated or broken GPUs, that contribute to environmental degradation if not properly recycled or repurposed.
- 5. Circular Economy:** An economic model aimed at minimizing waste and making the most of resources by reusing, repairing, refurbishing, and recycling existing materials and products, extending their lifecycle.
- 6. Open-Source Framework:** A software platform whose source code is publicly available, allowing anyone to inspect, modify, and enhance it. Used here to adapt Zombie GPUs for AI and parallel computing workloads.
- 7. Parallel Computing:** A type of computation where many calculations or processes are carried out simultaneously, leveraging the power of multiple processors (or GPUs) to solve complex problems more efficiently.
- 8. Sovereign Tribal Lands:** Lands under the legal jurisdiction of Indigenous tribes, recognized by the U.S. government, where tribes hold autonomy and governance rights, including decisions related to resource management and technology deployment.
- 9. Earth Friendly Computation (EFC):** The development and use of computational technologies that prioritize environmental sustainability by minimizing energy consumption, reducing electronic waste, and promoting renewable energy sources. EFC aims to align technological advancements with ecological principles, ensuring that digital infrastructure contributes positively to the health of the planet.
- 10. Indigenous Data Sovereignty (IDSov):** The right of Indigenous peoples to control the collection, ownership, and application of data related to their communities, lands, and cultures. It emphasizes that Indigenous groups should govern their own data in ways that align with their values, laws, and traditional knowledge systems, ensuring self-determination in the digital space.

Keolu Fox, Ph.D.

Assistant Professor, Department of Anthropology, UC San Diego

Contact: pkfox@ucsd.edu

Education:

- **Ph.D. in Genome Sciences** – University of Washington, Seattle, WA (2016)
 - **B.A. in Anthropology (High Honors)** – University of Maryland, College Park, MD (2008)
-

Professional Appointments:

- **Assistant Professor** – UC San Diego, Department of Anthropology (2019–Present)
 - **UCSD Chancellor’s Postdoctoral Fellow** – UC San Diego (2016–2019)
-

Key Research Areas:

1. **Indigenous Data Sovereignty:** Ethical genomics and data governance.
 2. **Human Evolutionary Genetics:** Investigating mutations in underrepresented populations.
 3. **Sustainable AI:** Exploring environmentally friendly computation systems.
-

Selected Honors & Awards:

- **TED Fellow** (2016)
 - **National Geographic Emerging Explorer** (2017)
 - **MIT Solve Indigenous Communities Fellowship Finalist** (2020)
 - **FootPrint Coalition Science Lead** (2023)
-

Selected Grants:

- **Robert Wood Johnson Foundation** – Safeguarding Tribal Genomic Data (\$490,000, Co-PI)
 - **Schmidt Family Foundation** – Breathing Life Back into Zombie GPUs (\$125,000, PI)
 - **Hawaii Community Foundation** – Genomic Medicine Perceptions (\$60,000, Co-PI)
-

Teaching & Mentorship:

- Courses Taught: ANBI 102, ANBI 121, ANTH 223.
 - Supervised over **14 Ph.D. candidates**, **6 Master’s students**, and **2 Postdocs**.
-

Selected Publications:

1. **Fox, K.** et al. (2019). Use Ancient Remains More Wisely. *Nature*.
 2. **Fox, K.** et al. (2020). The Illusion of Inclusion — The “All of Us” Research Program and Indigenous Peoples’ DNA. *New England Journal of Medicine*.
 3. **Fox, K.** et al. (2025). Earth Friendly Computation: Applying Indigenous Data Lifecycles in Medical and Sovereign AI. *Biocomputing 2025: Proceedings of the Pacific Symposium*.
-

Key Leadership Roles:

- **Co-Founder:** UCSD Indigenous Futures Institute (2020–Present)
 - **Council Member:** World Economic Forum – Synthetic Biology (2020–2023)
-

Invited Talks:

- **TED 2016:** *Why Genetic Research Needs to Be More Diverse*.
 - **Cambridge University (2025):** *Darwin Lecture – Wayfinding Through the Human Genome*.
-

Media Features:

- Featured in **National Geographic, The New York Times, Nature, and Science Magazine**.
 - Podcast Appearances: *Science Friday, Technically Optimistic, National Geographic Overheard*.
-

Professional Memberships:

- American Society for Human Genetics (ASHG)
 - Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)
 - National Congress of American Indians (NCAI)
-

Contact:

Patrick Keolu Ozer Fox

Email: pkfox@ucsd.edu
