Thesis Project Portfolio

Navigating Large-Scale Development: Lessons from Two Summers at Amazon

Balancing Innovation and Impact: The Environmental Footprint of Artificial Intelligence

An Undergraduate Thesis

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Executive Summary

My portfolio brings together two distinct but personally meaningful projects: my CS 4991 technical report—documenting my summer internships at Amazon—and my STS research paper on the environmental sustainability of AI. Although these deliverables address different domains, they are linked by a common thread: my commitment to building and understanding computing systems that are both technically sound and socially responsible. Together, these works underscore my view that cutting-edge software engineering and reflective policy analysis are both essential to ensure technology serves global communities and ecosystems.

The rapid expansion of cloud services and AI-driven applications has intensified demands on data-center infrastructure and raised critical questions about long-term sustainability. Amazon's global network of warehouses, servers, and monitoring systems supports billions of transactions daily—yet many of the underlying processes still rely on manual intervention or legacy tooling. Meanwhile, AI models powering recommendation engines, fraud detection, and language translation have grown exponentially in size and complexity, driving up energy consumption and carbon output. These trends motivated my dual focus: to streamline essential operational workflows in a production environment, and to interrogate how corporate, non-profit, and governmental actors shape the environmental trajectories of AI technologies.

In my CS 4991 paper, I detail two consecutive summer internships (2023 and 2024) on Amazon's FleetWatch team, responsible for monitoring and alarm management across data-center power and environmental systems. During the first internship, I created Nostradamus, an automated telemetry generator that models and simulates realistic voltage, temperature, and humidity metrics based directly on production system logs. By replacing a manual testing process that previously took days of engineer effort with a fully automated pipeline integrated into AWS CodePipeline, Nostradamus dramatically decreased test setup time, reduced false-positive alarms, and increased coverage of edge-case scenarios. In my second internship, I led the development of the NotificationHistoryService, a distributed logging microservice built on Amazon DynamoDB and SNS. This service ingests raw alert messages, enriches them with metadata such as server identifiers, geolocation, and priority levels, and stores them in a queryable table optimized for time-range scans and ad-hoc analytics. Upon deployment, the service enabled faster anomaly detection and proactive maintenance by providing a comprehensive, real-time view of alarm events across staging and production environments. Throughout both internships, I followed Agile scrum rituals—story mapping, sprint retrospectives, and backlog refinement—while collaborating closely with senior engineers, data scientists, and product managers to deliver production-ready microservices under stringent service-level agreements.

My STS research investigates how technology firms, environmental organizations, and national regulators negotiate the balance between AI innovation and environmental sustainability. To explore this, I conducted a comprehensive literature review of academic articles, corporate white papers, and NGO reports, carried out interviews with practitioners in sustainability and policy roles, and analyzed major regulatory frameworks including the EU AI Act, U.S. Department of Energy efficiency guidelines, and China's power-usage-effectiveness standards. Drawing on Actor-Network Theory, I examine how these diverse actors form coalitions that either accelerate or impede genuine progress in reducing AI's carbon footprint. My analysis reveals that technology companies often frame sustainability initiatives as market differentiators through strategies like renewable-energy credits, while NGOs advocate for standardized reporting protocols and third-party audits to ensure transparency. Regulators worldwide exhibit varying approaches—from mandatory energy-use disclosures in the EU to voluntary guidelines in the U.S.—creating a fragmented policy landscape. I conclude that only harmonized global standards, independent verification mechanisms, and multistakeholder governance models that integrate technical benchmarks with policy incentives can translate efficiency gains into sustained emissions reductions.

By coupling hands-on software engineering at scale with critical sociotechnical inquiry, this portfolio demonstrates the multifaceted challenges and opportunities in building responsible computing systems. The technical report delivers tangible improvements—slashing manual testing time, boosting alarm reliability, and enhancing operational transparency. The STS paper illuminates how institutional incentives and policy frameworks shape AI's environmental footprint. Moving forward, I plan to integrate energy-use telemetry into production microservices, develop dashboards that correlate operational metrics with carbon impact, and collaborate with policymakers to pilot standardized sustainability metrics in cloud services. These efforts aim to ensure that every software deployment and policy decision contributes to a more sustainable technology ecosystem.

I thank my advisor, Professor Kent Wayland, for his invaluable mentorship in STS research; my mentors and teammates on the Amazon FleetWatch team for their guidance, collaboration, and rigorous technical feedback; and my friends and family for their support. I also appreciate the time and insights shared by interview participants and industry experts, whose perspectives enriched the STS analysis.