Thesis Project Portfolio

Automating UVA Nitrogen Footprint Tracking with Python

(Technical Report)

Ethical Considerations of Applying AI to Sustainability: An Analysis of the Environmental Impact of Data Centers in Northern Virginia

(STS Research Paper)

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Executive Summary

As climate change worsens and engineers search for ways to apply technology to climate solutions, it is critical that the ethics and environmental impact of technology itself is carefully considered. In my Capstone Project, I used Python to automate data processing needed to calculate the University of Virginia (UVA)'s nitrogen (N) footprint. My application processes data crucial for UVA's success in accomplishing sustainability initiatives and saves the Nitrogen Working Group (NWG) hundreds of hours of manual work. In my STS research paper, I explore the ethics of applying artificial intelligence (AI) to sustainability through a utilitarian analysis of the environmental impact of data centers in Northern Virginia. Given that AI itself has a large environmental footprint, it is important to weigh whether applications with environmentally benevolent intentions ameliorate or worsen the climate crisis. My Capstone Project is an example of applying technology to sustainable development. My STS paper explores whether applications that aim to advance sustainability, yet inherently cause their own environmental damage (such as my Capstone) are ethical.

My Capstone Project presents my work using Python for sustainable development at the Nitrogen Working Group. UVA's Nitrogen Working Group tracks, validates, and establishes strategies to reduce UVA's nitrogen footprint to meet the 30% reduction goal by 2030 (UVA Sustainability, 2024). Nitrogen footprint calculations at institutions across the country are often performed manually, slowing environmental sustainability initiatives and progress. As an intern with the NWG, I authored a Python program to automate the processing of UVA Dine food consumption data needed for nitrogen footprint calculations. I used Python Pandas and fuzzy string matching to automatically perform processing.

My Capstone successfully processes data crucial for UVA's success in accomplishing sustainability initiatives. Optimizing weight calculations improved processing efficiency from roughly four semesters to one semester to complete one calendar year of data. When I started as an NWG intern, the N footprint tracking team was three years behind on data processing. Improved efficiency in weight calculations has allowed the team to catch up on backlogged data and focus energy on expanding the NWG's reach. By saving hundreds of hours of manual data processing, NWG interns now have time to focus on new projects. The NWG now partners with Morven, UVA's Sustainability Lab, to calculate N footprints and is in the process of expanding footprint calculations to students who live off-Grounds.

In my STS Paper, I analyze the morality of applying AI for sustainability through the lens of utilitarianism. I perform a case study on the environmental impact of data centers in Northern Virginia. Given that large data centers are needed to train AI models, understanding the effect of data centers helps illuminate the environmental consequences of artificial intelligence. With the rise of AI, it is important to apply AI for societal good, such as fighting the most pressing environmental challenges. However, it is also crucial to understand AI's environmental ramifications. In my paper, I weigh the benefit of using AI to solve sustainability issues considering the environmental drawbacks of the data centers needed to train AI models.

When considering the ethics of using artificial intelligence for sustainable development, it is important to examine both environmental and economic impacts. AI for climate can help advance sustainability initiatives, but data center use for training contributes significantly to climate change, the very cause it hopes to solve. I concluded that through the lens of utilitarianism, applying AI for sustainability is ethical as long as the environmental and economic benefits outweigh the environmental harm caused by data centers needed for model training.