Actors Which Inform Uses of Machine Learning Models for Sustainability at Amazon Compared to Academia

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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1- Introduction

How do actors impact the creation of different machine learning models for environmental sustainability at Amazon vs in Academia? In this paper, I will analyze the actor networks involved in the creation of machine learning models for sustainability both within Amazon and within academia. Amazon was picked because according to Amazon's sustainability website, they co-founded The Climate Pledge with an organization named Global Optimism, the same organization that oversaw the delivery of the Paris Climate Accord. The Climate Pledge says that Amazon will reduce its carbon emissions to net zero by 2040, 10 years before the Paris Climate Accord. In Amazon's 2021 Sustainability Report it is stated that since creating this pledge, 300+ companies have followed Amazon's lead by signing the pledge (Amazon.com inc, n.d.). Further, Amazon has announced many initiatives toward meeting this goal, including 274 renewable energy projects (Amazon.com inc, 2021, 8).

However, despite their initiative, Amazon is still a long way from reaching its lofty goal and most companies in the world have not even committed to increase their sustainability through similar pledges. It is easy to say that companies not achieving or attempting lofty sustainability goals is a natural result of their for-profit nature or decisions pushed down by their CEOs and boards. In spite of that reasoning however, it doesn't seem that there is a good grasp of all the smaller actors which also drive these decisions. As a result, this paper will attempt to recognize the network of actors involved in adopting a small subset of technology that could be powerful for sustainability efforts, machine learning. This will be achieved by contrasting the actor network in academia with the differing network at Amazon to find differences in areas including personnel, motivations, and organization. Ultimately, actor network theory analysis could help improve sustainability by allowing us to understand what actors help Amazon to be a

sustainability leader. This information should not only help us understand how to continue moving sustainability objectives forward at Amazon, but also help in enacting the same changes at other companies. Machine learning was the technology selected for this paper because it is a useful sustainability technology that increases efficiency and reduces waste. As a result, machine learning helps companies to be more efficient while also being more environmentally friendly. Using a technology that is multipurpose in this way could make it easier to see the business objectives or lack thereof underlying the decision to make sustainable machine learning technology.

Actor-network theory is the primary framework used in this paper and the research will employ a document-based approach of finding, reading, and synthesizing previous literature. It will look at several different published uses of machine learning for sustainability in academia and at Amazon. Then it will attempt to identify the important actors involved in both to recognize the different actors involved in the two situations. The paper will start by going through background information and motivations for this topic before diving into the methodology used for the research, a discussion of the research results, and finally a short conclusion with a summary of the results.

2- Background Information/Significance

Machine learning is a subset of artificial intelligence within computer science which focuses on teaching computers to understand trends from data sets in order to make decisions. This means that machine learning often takes large datasets which humans may have a hard time deriving conclusions from and synthesizes them into trends that can be used to make better decisions. In the past this field has been used for many purposes, including beating the best players of both Chess and Go and creating ChatGPT, a near-human chatbot released last year

with seemingly near-human intelligence. This shows that ML is already being used today to outperform humans in a number of tasks. As a result of its potential, ML has also begun to see use for environmental sustainability. Current examples from my research include: predicting Amazon rainforest deforestation (Dominguez & Rodriguez et. al, 2022), reducing food waste at convenience stores (Cheng, 2022), and automating wind farm maintenance with drones (Gozluklu, 2021). However, in the future, it has the potential to revolutionize environmental sustainability in a number of different industries. Last year, an article titled *Tackling Climate Change with Machine Learning* outlined a range of ways ML might be used to combat climate change in 13 different industries, including everything from electricity systems to education. In the conclusion of the paper they stated a few examples of MLs potential uses:

> ML can enable automatic monitoring through remote sensing (e.g., by pinpointing deforestation, gathering data on buildings, and assessing damage after disasters). It can accelerate the process of scientific discovery (e.g., by suggesting new materials for batteries, construction, and carbon capture). ML can optimize systems to improve efficiency (e.g., by consolidating freight, designing carbon markets, and reducing food waste) (Rolnick et. al, 2022, 15).

However, despite machine learning's recent rise in popularity and its astounding potential, this article also shows that ML has not reached anywhere near its full potential for climate change prevention efforts.

As a result, the motivation for this research is to increase the usage of machine learning for sustainability at companies. The long term goal of this increased usage is that machine learning can have a prominent role in achieving net zero carbon emissions in our world without relying on government oversight and academic research. This is important because even

Amazon, one the most environmentally conscious companies, is struggling to reduce their carbon footprint. According to Amazon's 2021 Sustainability report, in 2021 Amazon had only a 1.9% decrease in the intensity of their carbon footprint while also logging a 18% increase in absolute carbon footprint due to the growth of their business (Amazon.com inc, 2021, 7). This shows that not enough is being done yet to move companies towards net zero carbon emissions. Therefore, the secondary goal of this paper would be to find out how to motivate companies to use machine learning to enact and follow through on climate pledges. If advocates for environmental sustainability know what actors to navigate around in order to reach their goals, they may find more success in increasing the adoption of ML models for sustainability. Additionally, it is likely that these models are created for different purposes in academia in comparison to in companies. As a result, this paper analyzes both to find meaningful differences between the two. Finding these differences should help us pinpoint the actors which are important to the adoption of machine learning models for sustainability within industry.

3- Methodology

I explored the topic of this paper by gathering evidence through document analysis. I chose document analysis for three reasons. First of all, I believe that studying primary sources on how both Amazon and academia perceive sustainability in machine learning is the best way to analyze their self-perceived motives and actors. Second, many of the articles on sustainability at Amazon from secondary sources were too general to be useful in making a strong argument for the development of machine learning models for sustainability. These articles would give an outside view, however their views were based mostly on Amazon primary sources and they were generally not focused entirely on machine learning. Therefore they didn't seem helpful in

identifying additional actors or adding evidence for the impact of specific actors. Finally, doing interviews would have been tough since Amazon employees would likely have to use Amazon PR controlled resources. This means I would receive similar information about Amazon even if I did interviews. Further, since I felt document analysis was best for Amazon research, I decided to do the same with academic research since I believed that would draw a better comparison between the two.

The academic references gathered for this paper were found by scanning through UVA library databases to find examples of ML sustainability models in academia. Once I collected a number of articles on different usages for ML in sustainability within academia I analyzed it by taking each paper and trying to determine who wrote it, why they wrote it, and how/why they think it will help people or businesses. The focus for determining the actors networks involved in each paper was to look at secondary reasons besides pure sustainability. I chose to do this because I found that many of the Amazon resources outside their sustainability report highlighted the benefits to consumers or businesses as a primary motivation rather than sustainability. For Amazon references most were found by finding blog posts on success stories for the use of ML within Amazon or using AWS (Amazon Web Services). I then went through the same process of trying to identify who the authors were and what primary motivations seemed to be present in the projects.

Since this paper aims to identify the interlinked influencers on the development of machine learning models for sustainability, I will be using Actor-Network theory as a way to look at how those actors shape the development of ML models. Although ML for machine learning is ultimately developed by data scientists or computer scientists, there are a wide range of motivations and people involved in the decision to make these models in both business and

academia. Each of these actors have their own influence upon the shape and frequency of development for these models. Therefore I am convinced that there needs to be an understanding of all the influencers which have led to the current state of machine learning for sustainability. Finding all of these actors could help us to understand how to motivate companies to work harder to increase their own sustainability through the use of machine learning.

4- Discussion / Results

It seems that machine learning models for sustainability differ greatly within business as compared to academia due to a number of different actors. These actors include business goals, company culture, partner companies, employees, and customer demands. First, machine learning models for businesses are generally built to achieve a business goal. Many times this means that the models are not built for the sole purpose of improving the environment, but rather in order to reduce waste, simplify tasks, and save money. For example, at Amazon one blog post for sustainability in machine learning was on reducing food waste at a Chinese convenience store chain by predicting how stocked the stores need to be on a particular day (Cheng, 2022). The goal of this ML model was not to improve the environment, but rather to reduce costs and food waste at this chain, which helps that company to keep their costs down and just so happens to also prevent a large amount of food waste. Therefore a byproduct of the model is that it improves the environment by reducing food waste. This is great because it helps the environment while giving the company a tangible, non-altruistic reason to become more sustainable. In contrast, many of the sustainability models built within academia seemed much more directly focused on helping the environment without achieving any secondary goals. For example, *An exploratory DEA and Machine Learning Framework for the evaluation and analysis of sustainability*

composite indicators in the EU was an article on creating a machine learning model which could more accurately analyze the sustainability of countries in the EU (Tsaples et al., 2022). This model can be interesting and help governments and citizens to analyze how their nation stacks up, however there is no business case for a model like this. It will not convince a business to further develop it nor will it likely make a consumer change their consumption habits, and as a result it seems that it is less likely to be developed by a business. This is also likely a major problem for improving sustainability at companies with few incentives like gas companies or computer hardware companies. In *Tackling Climate Change with Machine Learning* the author of the electricity systems section says that in order to improve our systems we must move away from GHG producing fuels (Rolnick et. al, 2022, 15). Further, he says that ML could be a major tool in creating smart electrical systems and helping in the research and deployment of new law carbon electric systems (Rolnick et. al, 2022, 15). Gas companies could use machine learning models to help research and deploy alternative fuel solutions, however they have legitimate business goals which rely upon society remaining at our status quo.

Second, company culture might be a major actor in their decision to make models for sustainability. At the bottom of the executive summary of Amazon's 2021 Sustainability report it says "Amazon is guided by four principles: customer obsession rather than competitor focus, passion for invention, commitment to operational excellence, and long-term thinking" (Amazon.com inc, 2021, 19). In my experience at Amazon, most decisions at Amazon were made by finding justification within their leadership principles. Since sustainability models line up well with "passion for invention", "commitment to operational excellence", and "long-term thinking" it may simply be easier to make these decisions viable for the company with a company culture like Amazon's.

Thirdly, it seems that Amazon is heavily impacted by their partner companies. Most of the PR materials and blogs I could find boasted more about the usage of AWS resources to help other organizations achieve their business objectives. For instance, three uses I found were: Reducing food waste at convenience stores (Cheng, 2022), automating wind farm maintenance (Gozluklu, 2021), and restoring ecosystems (Wanser, 2020). For these examples, each model was developed using AWS Cloud software to help their partners become more sustainable, giving examples of how other companies can do the same and how Amazon can use their software internally. Furthermore, one of AWS' reported drivers for enterprises to move to their cloud is their environmental sustainability. In one AWS research paper Amazon states that "Climate change and its effects direct more attention at resource efficiency as a key part of sustainability responsibility, which is of growing importance to businesses" (Bizo, 2019, 3). This in turn requires Amazon and other partner companies to become sustainable in order to keep their partnerships. As a result, companies can exert pressures on each other to keep up in sustainability numbers. In contrast, the articles I found within academia had no noted corporate influences. Although there can be a large amount of corporate influence on academia through funding, this seemed to not be the case for my topic area.

Fourth, ultimately all sustainability decisions at a company have to be made by employees at the company. There are a number of sustainability related job listings for the company who can impact the company and there are internal groups within the company of people who are passionate about sustainability and advancing sustainability initiatives within the company. In 2018 Amazon launched their Sustainability Ambassadors program specifically to help amplify "...amplify global, companywide efforts at the local level." (Amazon.com inc, n.d.). These ambassadors lead projects on Amazon campuses and create virtual engagement events to

inspire fellow employees to be more sustainable. For example, one example of employee inspired work from the sustainability site was "In Italy, an Ambassador spearheaded an effort to include sustainability information in new hire orientation programming for thousands of new Amazon employees" (Amazon.com inc, n.d.). Another example of employee lead sustainability is Amazon's sustainability summit, a new internal virtual event led by ambassadors which allows other employees to learn about corporate sustainability programs and partnerships.

Fifth, despite there being no active movements to force Amazon into sustainable practices, Amazon is increasingly convinced to use sustainable practices by their customers. There is an increasingly high number of consumers who are expecting more sustainable packaging and delivery of more sustainable products, and Amazon has been showing increasing efforts to reach these consumers. For example, over the past year Amazon has used machine learning for sustainability internally for packaging their boxes:

> In 2021, we deployed data-science algorithms to optimize the number and size of boxes used for 12 geographies around the world. These algorithms—which help our fulfillment centers maintain the right mix of box sizes—now cover 65% of global box shipments, with plans to scale to 97% in 2022 (Amazon.com inc, 2021, 9).

This effort lines well with the 2021 Cross-Border E-Commerce Shopper Survey which found that 49% of ecommerce consumers want their packaging to be carbon neutral and 70% would like it to be recyclable. Moreover, Amazon released the Amazon's Climate Pledge Friendly products program in 2020 and expanded it to new certifications in 2021. This program tags Amazon store products with sustainability certifications to let consumers know they are buying a more sustainable product. The release of this program and its subsequent expansion shows that there is a desire by consumers to receive more sustainable products when they shop. Ultimately

companies must appease their customers to succeed and it seems like Amazon is increasingly lining up with their sustainability objectives.

Therefore it seems that the actors which are most likely to account for the differences in model usage are: business objectives, company culture, partner companies, employees, and customers. These collectively account for a large number of the differences between academia and industry and might be the actors within the network that are most important to take into account when trying to make a company more sustainable.

5- Conclusion

In conclusion, in this paper literature review was used to identify the differences in actor networks for machine learning models in sustainability between academia and Amazon. Through this analysis it was found that the most notable actor differences in the two networks were: business objectives, company culture, partner companies, employees, and customers. These actors together are the primary differences between academia and industry which may or may not account for differences in size or type of development for sustainability-focused machine learning models. Some people might argue that governments should be the main drivers of environmental sustainability or that companies should be motivated by being green purely. However, it is hard to force people with opposing alternative personal motivations or pressures to make the right decision for the sake of the right decision despite its obvious negative consequences for their own circumstances. If we want the companies in our world to become more green we need to find out how to push companies to pressure their partners, make sustainability an important business objective, change company cultures, have employees work on internal change, and ask more out of companies as consumers. Luckily, as sustainability has

become more and more pertinent to society, companies have responded by increasing sustainability efforts. AWS's paper on the carbon reduction of moving to AWS stated that " In 2018, 86% of the companies in the S&P 500 index published a sustainability report, up from only 20% in 2011…" (Bizo, 2019, 3).

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