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The Hidden Cost of AI: Unveiling and Addressing the Environmental Impact of Digital Consumption

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Abstract

Artificial intelligence (AI) has become an integral part of modern society, influencing every aspect of people's lives, from education, to business, to healthcare, to name a few. However, the widespread adoption of AI carries an environmental cost, as training and using AI generates a significant carbon footprint. The environmental cost of AI should not be disregarded, as the use of AI is increasing exponentially. Yet, in this research I argue that AI users do not seem to recognize this problem. I discuss reasons as to why users might underestimate the carbon footprint of AI. And I highlight possible solutions to this pressing problem. I believe that with more research and collaboration, progress can be made toward reducing the environmental impact of AI.

Keywords

Artificial Intelligence, Environmental Reform, Data Centers and Energy Consumption

1. Introduction: AI's Rapid Expansion and Drawbacks

The rapid expansion of the internet has revolutionized the way people live. In 2005, the number of internet users officially passed the one-billion mark. That number quintupled by 2023 (Statista, 2023). In 2020, the first year of the COVID-19 pandemic, the International Telecommunication Union (ITU) reported a surge in internet users by 10.2%, the largest increase in a decade (International Telecommunication Union, 2021). Today, the internet is more than another way to connect; it is a social intermediary for almost every activity. For example, online shopping is becoming more and more prominent. A researcher in Brazil found that "online shopping intent" has increased significantly since the COVID-19

pandemic, leading to escalating online shopping trends even after the end of the pandemic (Soares et al., 2023).

While the internet has benefited society by expediting communication and making things like shopping easier, it comes with the price tag of environmental degradation. Some of this price can be seen, such as the excessive use of plastic packaging as well as transportation pollution that comes with online shopping. However, part of the environmental cost remains hidden. Data centers, devices, and infrastructure all need electricity to function, which creates carbon dioxide emissions. A comprehensive study done by Renee Obringer concluded that for every gigabyte of data used on the internet, 28 to 63 g of carbon dioxide is generated (U.S. Environmental Protection Agency, 2023). For reference, the average passenger vehicle emits about 400 grams of CO_2 per mile (Obringer et al., 2023). Every activity done online requires a massive amount of data to be processed. In the United States, a standard call with video has a carbon footprint of 157 g of CO_2 per hour (Obringer et al., 2023), which is approximately equivalent to driving 0.39 of a mile (EPA, 2023).

In recent years, artificial intelligence (AI) has become a widely used function of the internet. AI comes in different forms, such as ChatGPT, which is a trained response mechanism, or Alexa, Amazon's helpful at-home robot that responds to voice. However, no matter what type, any AI model has a significant carbon footprint. Researchers at the University of Massachusetts Amherst estimated that training any large language-model has a carbon output of approximately 300,000 kg, which is equal to roughly 125 round-trip flights between New York and Shanghai (Dhar, 2020). This estimate was derived from analyzing the energy costs associated with various natural language processing (NLP) training models, and then converted to carbon output. Furthermore, generating AI responses requires large "compute power", which requires quick data processing in data centers. While there have been estimates of how much carbon dioxide is emitted per response, artificial intelligence is a rapidly evolving field and there isn't an exact number. The exact amount also depends on the complexity of the query and the efficiency of the data center. A recent estimation of the popular AI website "ChatGPT" concluded that 4.5 grams of carbon dioxide is generated per response by inputting the specifications of ChatGPT's efficiency through an online calculator, which incorporated the hardware of the AI model and estimations of the amount of queries received by the AI. However, this estimate may have potential problems as it is still an early estimate without specific information (Piktochart, 2024). This number can multiply exponentially when an image is generated instead of text in response to a query. These claims are also supported by the most recent study in the field, published in July of 2024 (Heikkilä, 2023; Greif et al., 2024).

The environmental impact of AI should not be disregarded, especially since AI is becoming more and more widespread. Yet, people who use AI do not seem to recognize this problem. This phenomenon could result from various reasons, such as the invisible impact of digital consumption, and the lack of education in schools

and online. The present research will investigate the psychological reasons behind the lack of knowledge, as well as explore possible solutions to this pressing problem.

2. Psychological Explanations behind AI's Unrecognized Environmental Impact

While the present research mainly focuses on the environmental damage caused by AI usage, it is important to understand that all climate change is fundamentally hard to understand, contributing to the neglect of AI's environmental impact.

2.1. Lack of Information

Although climate change is hard to understand, recent trends reflect the rapidly increasing threat of global warming and pollution. Education about climate change has also increased in high school and college curriculums over the years (Stevenson et al., 2017), and new generations are acting against climate change more than ever. However, when it comes to digital consumption, especially the use of AI, people are less educated and aware of the environmental harms. As the usage of AI is still an evolving subject, it is difficult to pin estimates and educate people on its environmental effects, especially since different AIs and different digital platforms generate different amounts of CO_2. Therefore, there is a lack of research and analysis on the "invisible" climate threat surrounding AI usage, and the present study aims to bridge that gap.

2.2. Behavioral Constraints and Present Bias

Mental discounting is a psychological phenomenon that says people discount future rewards or consequences relative to immediate ones. It stems from the tendency to prioritize present benefits over future outcomes, often leading to a bias in decision-making.

Psychologically, humans use experience to react to harms, and since in many places, especially developed countries such as the United States, it is "virtually impossible" to detect signals of climate change using past experiences, since threats occur at further locations (Weber & Stern, 2011). Furthermore, the main causes of climate change are invisible, such as greenhouse gasses, and the signals of climate change are hard to detect. This makes it difficult for citizens to pay attention to and understand the threats of climate change, since they do not see the threats themselves. Another reason for the underestimation of the threats of climate change is the multitude of factors that contribute to it. The human mind is wired to associate harms with an "affect-effect" mentality, and most people associate climate change with one or two factors, such as air pollution or deforestation, when it is really caused by many things. Thinking of climate change in terms of only one or two threats can lead to a misunderstanding of the total hazard (Weber & Stern, 2011). Lastly, climate change is a persistent but slow trend, and it is also nonlinear. Humans are good at perceiving linear trends. For example, if someone spends 500

dollars a month on food, it is easy to calculate their expenses for an entire year. However, when something like climate change starts slow and then accelerates, it may cause problems as people "extrapolate that function linearly (Markman, 2018)".

The theory of cognitive dissonance exemplifies the reasons behind inaction. Psychologist Festinger writes that there is a mental discomfort experienced when a person's motivations and actions are conflicting, driving them to reduce this dissonance through either changing their actions or ignoring their motivations. For example, if someone wants to save the climate, but eats steak every meal, cognitive dissonance may cause them to reduce their meat intake (Festinger, 1957).

However, when the motivation to save the planet is not strong enough, or there is a stronger motivation to do an alternative action, the subject may be inclined to ignore the previous urge to help the environment. In the case of digital consumption, even if someone recognizes the environmental harm of using ChatGPT, their mind may ignore it due to the benefits ChatGPT provides to them.

Mental discounting is especially difficult, due to many potential psychological constraints that give individuals vague perceptions of the future and make decision-making more difficult.

These findings are upheld by the "construal level theory". In simple terms, when a danger is close, we perceive it as more concrete and important. When a danger is far, we perceive it as more abstract (Trope & Liberman, 2012). The problem is, even though climate change is rapidly evolving, it still feels far away because of the non-physical nature of the problem, combined with the lack of knowledge about many climate issues. Therefore, people are less inclined to act on the issue, even when educated about it.

The psychological difficulty of understanding climate change is exacerbated when the threat becomes completely untouchable and unseen; although we cannot see the ozone layer depleting, we can see the gasses coming out of vehicles on the street. However, when the cause is digital, it becomes even harder to see the impact, as while computers around the world are causing the destruction, the pollution sites occur at data centers, far away from where electronics are used. This unrecognized threat is especially dangerous because even if we recognize the threat, it is hard to perceive and act against it.

2.3. Sentiment

There is a sense of environmental pessimism throughout the entire world (Swenson-Lengyel, 2017). Pessimism is "a tendency to see the worst aspect of things or believe that the worst will happen (Oxford Languages, n.d.)." When discussing environmental action, pessimism refers to the sentiment that no matter how one acts, environmental degradation will occur because others will not act in the best interest of the population.

People might feel that their actions will not have an impact on the outcome, especially with an issue like digital consumption's environmental effect, since it is

a widely unknown subject. This sentiment is linked to a bigger environmental phenomenon called "tragedy of the commons", which refers to the effect of not being able to exclude users from a common-pool resource (Ostrom, 2008). For example, a community lake has fish, and it is difficult to restrict the number of fish one can take from the pool. As a result of the lack of regulation, residents overfish the lake and eventually there are no more fish in the pool. A similar trend happens with other environmental issues, such as the usage of AI. If the trends of environmental pessimism and the theory of tragedy of the commons are combined, the population becomes unmotivated since they believe nothing will change, and therefore exploit resources recklessly and do not consider the environmental damage of their actions.

2.4. Conclusion

A lack of attention on AI's impact on carbon emissions can arise from a lack of information, behavioral constraints such as present-biased and difficulties with precise mental discounting, and negative externalities. As previously said, there is little research to solidify the damages of AI usage and digital consumption, and most people are not aware of this issue. Due to that, people who are aware of the issue do not act upon it because they lack hope that things will change because of a singular person's action. Therefore, the primary goal today should be to inform people first on the environmental dangers, and then convince people that their actions have an effect.

3. Potential Solutions

To solve this enduring issue, we need to first make the issue known. Currently, there is a lack of research on the environmental impact of AI, since it is a new field with changes coming every day. One initial step that needs to be taken is research: to educate, there needs to be an expansion on society's knowledge of AI. Researchers should devote more resources into finding the true environmental cost of AI as well as how we can mitigate this cost. Companies that produce AI should also become more transparent about their environmental impacts and allow consumers to see the impacts. Governments could also pass policies that would require companies to become more transparent or fund research that would explore the environmental cost of AI. Although there is a lengthy legal process to create laws and policies, people could start from informing others about this rising problem and then gradually, the sentiments will be introduced to governments. As there is still a lack of research, it is hard to indicate what policies could improve the current situation, but one potential solution could be requiring carbon labels for websites. In the status quo, the United States government already has many regulations in place to limit the environmental damage of companies across many fields. For example, the cap-and-trade system in California requires companies that surpass their carbon quota to purchase tokens from other more sustainable companies (Environmental Defense Fund, 2020). There are also quota regulations and carbon

taxes across many different markets, which can be adopted by the artificial intelligence market.

Once there is more understanding of the cost, the second step should be to educate society about the cost. There are a few ways in which this can be achieved. One way would be to collaborate with high schools and colleges to bring education about digital environmental impacts into school curriculums and classes that revolve around environmental science. Environmental organizations can also hold assemblies and educate young people about the environmental impact of AI. It is especially important that the youth are educated because they are the ones that are most likely to act on environmental harms. Younger Generations also tend to use AI more often. This solution is extremely feasible, since high schools often collaborate with local organizations to educate their youth about pressing issues.

Secondly, journalists and news organizations could publish research reports about the environmental cost. This would be effective due to the online nature of this issue: people who use the internet often would be more likely to see these articles and they are the ones that need to become aware of the impact.

Lastly, carbon labels would also be an effective way to solve this issue. There needs to be further research on whether or not carbon labels would effectively shift consumers into using less environmentally damaging products, but carbon labels have been an effective way to influence consumer behavior in the past. Implementing algorithms into AI that would actively report the carbon footprint of a particular user when they are using the platform would incentivize the user to seek more environmentally friendly ways of achieving their goals. Different companies that produce AI could also use this method to gain consumers that care more about the environment by reducing their carbon footprint.

However, even if people are educated about the environmental harms of air, they might not necessarily want to act on new knowledge. As previously mentioned, individuals have incentives to continue using AI even if there are Environmental damages. To solve this, there needs to be a psychological motive for people to not use AI or to limit use of AI. Tracing back to the idea of cognitive dissonance, one approach to motivating people to act would be public commitment. In a previous study, researchers used public commitment to incentivize less water usage by asking participants to sign a petition to stop Water waste and then show them their water usage. Participants who were only shown there what usage or only asked to sign the petition did not save as much water as the participants who performed both tasks (Dickerson et al., 1992). This study effectively triggered the cognitive dissonance of the participants by showing their actions and intense conflict. Similar setups could be used to incentivize more responsible usage of ai.

Secondly, social comparisons could be a good way to advocate for responsible AI usage. This method would be primarily useful in disbanding pessimistic sentiment about AI usage. showing people cases of others being environmentally conscious when using the internet could incentivize them to do the same. Also, stories about the effects of carbon emissions near these data centers would appeal to the

emotions of the General Public and incentivize them to help. Lastly, putting the carbon footprint of their actions into perspective by comparing the emissions to other everyday tasks could showcase the true extent of AIS environmental damage and further cause people to seek healthier alternatives.

The overall goal would be to educate and incentivize individuals and companies and to become more environmentally aware of their actions and help the global movement for change.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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