

Original Article

The Effect of Artificial Intelligence on Environment and Society

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This paper examines the dual effect of Artificial Intelligence (AI) on environmental sustainability and societal structures. AI technology, while rapidly transforming sectors like healthcare, education, and manufacturing, poses both promising advancements and significant environmental and ethical challenges. On the positive side, AI contributes to environmental sustainability by optimizing energy usage, supporting precision farming, and enabling enhanced biodiversity monitoring. These applications help reduce carbon footprints, conserve resources, and protect ecosystems. However, the rise of AI also brings environmental concerns, notably due to the energy demands of data centers, which contribute to carbon emissions, and the production of specialized hardware that results in substantial electronic waste and ecological damage.

From a societal perspective, AI enhances healthcare diagnostics, personalizes educational experiences, and drives economic growth by increasing productivity. Yet, it also leads to challenges like job displacement, economic inequality, and privacy risks. The paper delves into the ethical considerations associated with AI, such as biases in decision-making algorithms and surveillance concerns, emphasizing the need for fairness and accountability.

The discussion extends to the role of regulatory frameworks and ethical AI practices in mitigating these risks, advocating for policies that ensure sustainable and responsible AI development. The paper suggests that adopting sustainable AI practices, such as energy-efficient model training and recycling programs for AI hardware, difficult reducing AI's environmental footprint. It also highlights the importance of transparent and fair AI applications to prevent biases and uphold human rights. By addressing both the environmental and societal impacts of AI, this research highlights the need for a balanced approach to harness AI's potential while minimizing its risks, ensuring that AI contributes positively to a sustainable future.

Keywords: - Artificial Intelligence (AI), Environmental Sustainability, Ethical AI Practices, Societal Impact

Introduction

1. Definition of Artificial Intelligence (AI)

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines, allowing them to perform tasks that typically require human reasoning, such as decision-making, pattern recognition, and learning. The idea of AI has its roots in the 1950s, when pioneering scientists like Alan Turing began exploring whether machines could “think” and if they could eventually replicate cognitive processes. Early AI research focused on rule-based systems and symbolic reasoning, and while these early systems were limited, they laid the groundwork for what would become modern AI.

Today, AI is woven into the fabric of modern society, influencing a vast range of applications from everyday conveniences to global industries. In our daily lives, AI is present in virtual assistants like Siri and Alexa, recommendation engines on streaming platforms, and even



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personalized advertising on social media. On a larger scale, AI is transforming industries, including healthcare, finance, education, and manufacturing. In these sectors,

2. Significance of Studying AI's Impact

Studying the effect of AI is essential because, as AI climbs to evolve, its influence will be felt across almost every aspect of human life. The proliferation of AI technology brings not only advancements but also new challenges, requiring a balanced examination of both its positive and negative consequences. From an environmental perspective, understanding the effect of AI is crucial as the technology relies heavily on data processing and computing power, which require considerable energy resources. Data centers and hardware production contribute to a significant carbon footprint, raising concerns about sustainability. At the same time, AI offers promising solutions for environmental challenges, such as optimizing energy use, enabling precision farming, and enhancing resource management. Recognizing both sides of this equation helps us leverage AI's potential for environmental benefit while mitigating its negative effects.

From a societal perspective, AI has the power to reshape economies, influence job markets, and transform the way people live and work. AI can drive economic growth by automating tasks, increasing efficiency, and creating new job sectors. However, it also poses challenges, such as the potential for job displacement and shifts in employment structures. Understanding these dynamics is essential for policymakers, businesses, and communities to navigate the economic transitions AI may bring. Ethical concerns also play a central role in AI's societal impact, as issues such as privacy, bias, and accountability emerge with the increasing autonomy of AI systems. Studying AI's societal impact helps us ensure that its integration into daily life is responsible, equitable, and beneficial.

Review of Literature

Recent research has delved into the multifaceted effect of AI on the environment and society. Studies have highlighted the potential of AI to optimize resource consumption, reduce waste, and drive sustainable practices. AI-powered solutions have been explored in areas like energy efficiency, transportation systems, and waste management, aiming to minimize environmental footprint. For instance, AI algorithms can optimize energy grids, leading to reduced carbon emissions. In the realm of transportation, AI-driven autonomous vehicles have the potential to reduce traffic congestion and accidents.

However, the environmental cost of AI development and deployment cannot be overlooked. Training AI models requires significant computational power, which often relies on energy-intensive data centers. Additionally, the production and disposal of AI hardware contribute to electronic waste.

Societal implications of AI are equally profound. While AI has the potential to automate tasks and improve productivity, concerns about job displacement and economic inequality persist. Ethical considerations, such as algorithmic bias and privacy concerns, have gained prominence. Ensuring fairness and transparency in AI systems is crucial to mitigate potential social harms. Moreover, the use of AI in surveillance and decision-making raises questions about individual privacy and the potential for misuse. Striking a balance between innovation and ethical considerations is essential to harness the benefits of AI while minimizing its negative consequences.

Research Gap:

A critical research problem in examining the effect of Artificial Intelligence (AI) on the environment and society is understanding and mitigating its dual-edge effects. While AI offers transformative solutions to global challenges, such as optimizing energy consumption, improving waste management, and enhancing disaster response, its rapid adoption also poses significant environmental and societal risks. The high computational demands of AI systems contribute to escalating carbon emissions, exacerbating environmental degradation. Simultaneously, societal challenges emerge, including ethical concerns, job displacement, algorithmic biases, and the potential widening of socioeconomic inequalities. Research is needed to balance these impacts, exploring sustainable AI development frameworks that minimize energy consumption, promote social equity, and ensure ethical decision-making. This dual challenge of leveraging AI for societal good while addressing its unintended consequences demands interdisciplinary approaches and innovative solutions.

Objectives:

1. To Explore Environmental Impacts of AI
 - a. Analyze the carbon footprint and energy consumption associated with AI technologies, particularly data centers and machine learning models.
 - b. Investigate AI's potential in environmental conservation, such as monitoring biodiversity, optimizing renewable energy, and reducing waste.
2. To Assess AI's Influence on Society
 - a. Examine how AI reshapes industries, employment, and the workforce, including opportunities and challenges related to job automation.

- b. Study the societal implications of AI, such as privacy concerns, ethical dilemmas, and decision-making transparency.
3. To Identify Opportunities for Sustainable Development
 - a. Highlight the role of AI in achieving Sustainable Development Goals (SDGs), such as improving healthcare, education, and urban planning.
4. To Evaluate Risks and Challenges
 - a. Assess risks such as bias in AI algorithms, unequal access to AI technologies, and potential misuse.
5. To Recommend Policy and Governance Measures
 - a. Propose guidelines and frameworks to ensure the ethical and sustainable use of AI.
 - b. Advocate for regulatory policies to balance innovation with environmental and societal safeguards.

Hypothesis:

The integration of artificial intelligence (AI) into various sectors has the potential to significantly influence environmental sustainability and societal structures, with both positive and negative outcomes. On one hand, AI can drive advancements in environmental monitoring, resource management, and energy efficiency, reducing carbon footprints and promoting eco-friendly practices. It can also enhance societal well-being through improved healthcare, education, and economic opportunities. On the other hand, the rapid adoption of AI may exacerbate environmental degradation through increased energy consumption in data centers and manufacturing of AI-enabled devices, while also intensifying social challenges such as job displacement, privacy concerns, and economic inequality. Thus, the overall effect of AI on the environment and society will depend on how its development and application are managed and regulated to maximize benefits while minimizing risks.

Methodology

To explore the effect of artificial intelligence (AI) on the environment and society, a mixed-methods approach can be adopted. The methodology involves a combination of qualitative and quantitative research techniques to ensure a comprehensive analysis. First, a literature review will be conducted to examine existing studies and theoretical frameworks related to AI's environmental and societal impacts. This will provide a foundational understanding of key issues, including energy consumption, resource usage, and social implications such as employment and ethics. Second, quantitative data on AI's energy usage and carbon footprint will be collected and analysed using statistical tools to assess its environmental impact. For societal aspects, surveys and interviews will be conducted with stakeholders such as policymakers, industry experts, and the public to gather diverse perspectives. Additionally, case studies of AI applications in sectors like healthcare, transportation, and agriculture will illustrate real-world impacts. Finally, the findings will be synthesized to identify patterns, challenges, and opportunities, enabling a balanced discussion on AI's dual role as a driver of innovation and a potential source of ecological and social concerns.

Data Analysis and Interpretation

1.. Energy Consumption of AI Models

The development and deployment of AI models are highly energy-intensive, particularly for large language models and deep neural networks that require vast computational resources. The training of such models involves processing massive datasets through complex algorithms, often necessitating multiple iterations to optimize performance. This process consumes significant amounts of energy, with models like OpenAI's GPT and Google's BERT requiring thousands of GPUs or TPUs running for days, if not weeks.

Data centers, which serve as the backbone for AI model training and operation, consume large quantities of electricity. Although some data centers utilize renewable energy sources, a considerable number still rely on fossil fuels, particularly in regions where clean energy is less accessible. This reliance on non-renewable energy contributes to greenhouse gas emissions, exacerbating climate change. For instance, Google and Facebook have made strides in powering their data centers with renewables, but many smaller facilities worldwide continue to depend on coal and natural gas. As AI continues to evolve, with increasingly complex models being developed, the associated energy consumption is projected to rise. Efforts are being made to create more energy-efficient AI systems and training processes, such as using distributed computing to optimize power usage. Nevertheless, the high energy demands of training large AI models remain a considerable environmental concern that requires ongoing innovation and regulatory attention to mitigate their carbon footprint.

2. Electronic Waste and Hardware Production

The growing demand for AI capabilities is driving an increase in computing power, leading to accelerated hardware production cycles and, consequently, more electronic waste (e-waste). The development of AI relies on specialized hardware, such as GPUs, TPUs, and advanced processors, which enable faster computations and higher efficiency. However, the rapid pace of technological advancement in AI means that hardware becomes obsolete quickly, as new and more powerful components are required to support the next generation of AI models. This

obsolescence contributes to an accumulation of e-waste, which poses serious environmental risks if not properly managed.

In addition to the problem of e-waste, the production of AI hardware has significant environmental costs. Manufacturing these devices requires rare earth metals, such as lithium, cobalt, and nickel, which are essential for creating components with high processing capabilities. Mining these metals is resource-intensive and often associated with ecological damage, including deforestation, soil degradation, and water pollution.

The environmental effect of hardware production for AI is compounded by the challenges of recycling e-waste. Many electronic components contain hazardous materials, and the complexity of recycling them often leads to improper disposal, especially in developing countries where e-waste is frequently shipped for dismantling. This issue underscores the importance of developing more sustainable supply chains for AI hardware, as well as recycling programs that can mitigate the environmental effect of the rapid growth in AI-related technologies.

3. Carbon Footprint of AI-driven Automation

AI-driven automation is being rapidly adopted for tasks such as assembly, packaging, and logistics. These automated systems can run continuously, reducing downtime and optimizing production processes, which theoretically improves efficiency. However, automated systems require significant power, and without a clean energy source, the increased electricity demand can contribute to higher greenhouse gas emissions. For example, the extensive use of AI-powered robotics in factories can create additional strain on the power grid, especially if energy demands rise as a result of 24/7 operation. This increased power usage, if not sourced from renewables, could heighten industrial carbon footprints.

The training and implementation of AI models today requires vast amounts of energy, and this is directly proportional to the growth and complexity of the respective datasets and associated models. This increase in the energy consumption cuts across greenhouse gas emissions which fossil fuel utilization exacerbates. A report from the researchers at OpenAI indicates that the power capacity required to train state of art AI models has been increasing exponentially for every 3.4 months, this growth was noted from 2012

Recently, a study was conducted by researchers at the University of Massachusetts to determine how much energy is used to train certain popular large AI models. According to the results, training can produce about 626,000 pounds of carbon dioxide, or the equivalent of around 300 round-trip flights between New York and San Francisco – nearly 5 times the lifetime emissions of the average car. Fig(1)

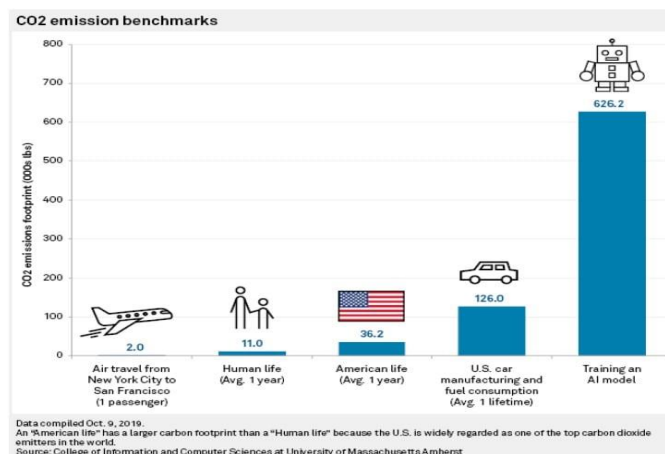


Fig 1: The contrast between the carbon footprint produced by training an AI model and the average life of people and automobiles

Findings and Suggestions

2.1 Positive Impacts of AI on Society

1. Healthcare Advancements

AI is transforming healthcare by enhancing the accuracy of diagnostics, personalizing treatment, and enabling predictive analytics that improve patient outcomes. In diagnostics, AI algorithms can analyze complex medical data, such as medical images and patient records, to detect patterns and anomalies that might go unnoticed by human clinicians. Machine learning models, for example, can scan X-rays, MRIs, and CT scans to identify signs of diseases like cancer, heart disease, and neurological disorders with remarkable accuracy. IBM Watson has been instrumental in oncology, assisting doctors by rapidly analyzing large volumes of medical literature and patient data to suggest potential treatment options. This tool has empowered healthcare providers to make more informed decisions, especially in complex cases where time is critical.

2. Education and Accessibility

AI is playing a crucial role in transforming education by providing personalized learning experiences and expanding accessibility to quality education. Traditional education systems often follow a one-size-fits-all approach, which may not cater to the diverse learning needs of individual students. AI-powered platforms, however, enable customized learning experiences by adapting to each student's learning style, pace, and strengths. For instance, platforms like Dream Box and Smart Sparrow use adaptive learning technology to assess students' progress in real-time, offering targeted exercises to reinforce concepts where students may be struggling. This tailored approach not only helps students learn more effectively but also empowers teachers with data-driven insights into each student's needs, enabling more focused instruction.

3. Economic Growth and Efficiency

AI is a driving force behind economic growth, enabling organizations to increase productivity, innovate new industries, and optimize resources. One of AI's most significant contributions to the economy is its ability to automate routine and mundane tasks, allowing employees to focus on higher-value activities that enhance job satisfaction. In sectors like finance, customer service, and manufacturing, AI systems handle repetitive tasks, such as data entry, transaction processing, and quality control, with speed and precision. By reducing human effort on these tasks, AI frees employees to engage in creative problem-solving and strategic decision-making, leading to higher productivity and more fulfilling work.

The rise of AI has also created new industries and job roles, from data science and machine learning engineering to AI ethics and algorithm auditing. As organizations increasingly rely on AI, they need skilled professionals to design, implement, and maintain these systems. This demand is generating employment opportunities and fostering innovation across technology sectors.

Part 3: Bridging the Divide - Responsible and Sustainable AI Development

1. Sustainable Development of AI

As AI systems become more advanced, the environmental footprint of AI model training has grown substantially due to the energy-intensive processes involved. One way to address this is by adopting strategies that reduce energy consumption during model training and deployment. For example, researchers are developing low-energy algorithms that require less computational power to operate efficiently. Federated learning is another promising approach, allowing AI models to be trained locally on devices instead of central data servers, reducing energy costs associated with data transmission and processing. Additionally, green computing practices in data centers, such as improved cooling systems, optimizing server utilization, and transitioning to alternative energy sources like solar or wind, can significantly reduce the carbon footprint of data-heavy AI operations. Companies and research institutions are increasingly exploring these strategies, recognizing that sustainable

2. Policy and Regulatory Frameworks

Effective policies and regulatory frameworks are essential to guide the responsible development of AI, addressing its ethical, environmental, and societal impacts. Policymakers worldwide are recognizing the need to establish rules that govern AI applications, ensuring that they prioritize human rights, privacy, and fairness. For example, the European Union's AI Act aims to set global standards for safe and ethical AI, classifying AI applications based on their risk levels and requiring stricter oversight for high-risk systems. This approach encourages transparency and accountability, protecting users from harmful AI applications while fostering innovation within safe boundaries. Globally, organizations such as the OECD and UNESCO are promoting principles for trustworthy AI, advocating for international cooperation in AI regulation. These frameworks call for ethical guidelines, environmental considerations, and the need for explainable AI, ensuring that AI systems operate in ways that are fair, understandable, and accountable. As nations work together to align on these standards, regulatory frameworks can help create a balanced environment where AI's benefits can be realized without compromising ethical values or environmental sustainability.

3. Ethical AI and Fair AI Practices

To create AI systems that are fair, transparent, and accountable, ethical considerations must be embedded at every stage of AI development. Building ethical AI begins with ensuring diversity in development teams and training datasets, as varied perspectives help to mitigate biases that can otherwise be overlooked. Diverse representation ensures that AI systems are more inclusive and accurately reflect the experiences of different demographic groups, reducing the risk of unintentional discrimination. Moreover, transparency in AI algorithms is essential for accountability, enabling users to understand how decisions are made and promoting trust in AI applications. Many organizations are now adopting "Explainable AI" principles, developing models that clarify how inputs lead to outputs, which is crucial in high-stakes fields like healthcare and criminal justice.

Conclusion:

Artificial intelligence (AI) stands as a powerful force reshaping various sectors, offering both transformative benefits and significant challenges for the environment and society. AI has propelled advancements in critical fields

like healthcare, where it aids in accurate diagnostics and personalized treatment, and in education, where it supports customized learning experiences and expands accessibility. In the economic realm, Furthermore, societal concerns, including job displacement due to automation, economic inequality, and ethical biases embedded within AI systems, underscore the complexities of integrating AI responsibly into daily life. AI's benefits, such as improved energy efficiency and enhanced conservation efforts, illustrate its potential as a tool for sustainability, yet the environmental effect of its computational demands highlights an urgent need for more sustainable development practices in AI.

Scope of the future research

1.1 Positive Impacts of AI on the Environment

1. Energy Efficiency and Reduction in Carbon Emission

AI has emerged as a key player in optimizing energy usage, which is essential for reducing carbon emissions and combating climate change. One significant area where AI is making strides is in power grid optimization. Traditional power grids are often inefficient and struggle to accommodate the increasing integration of renewable energy sources, which have variable outputs due to their dependence on weather conditions.

A well-known example of AI's role in energy efficiency is Google's DeepMind, which has developed energy-saving algorithms for data centers. These algorithms analyze real-time data to automatically adjust cooling systems, thereby reducing energy consumption. By implementing DeepMind's AI solutions, Google achieved a 40% reduction in the energy required for cooling its data centers. This example underscores AI's potential to significantly reduce the environmental effect of large-scale digital infrastructure, which is becoming increasingly energy-intensive with the rise of cloud computing and big data analytics.

2. Environmental Monitoring and Conservation

AI has become a valuable tool for environmental monitoring and conservation, helping scientists and environmentalists protect ecosystems and wildlife. AI-powered sensors and drones are used extensively in biodiversity monitoring, enabling researchers to gather real-time data on animal populations, detect changes in vegetation cover, and assess habitat health. For example, drones equipped with AI-driven image recognition software can autonomously track animal populations, reducing the need for invasive monitoring methods and allowing conservationists to better understand species' behavior and migration patterns. This non-intrusive approach helps protect endangered species and ensures that habitats remain undisturbed. This information is crucial for developing conservation strategies tailored to the needs of specific species.

3. Agriculture and Precision Farming

AI has brought transformative changes to agriculture, particularly in the area of precision farming, which focuses on optimizing crop yields and reducing resource waste. Traditional farming methods often lead to over-farming, soil depletion, and excessive water and pesticide usage, all of which can harm the environment. By integrating AI, farmers can implement data-driven techniques that tailor farming practices to specific environmental and crop needs, resulting in higher efficiency and reduced environmental impact.

Machine learning models in precision farming analyze data on weather patterns, soil moisture, nutrient levels, and crop health, allowing farmers to make informed decisions on when to plant, water, and harvest. These models help optimize crop yields by identifying the best conditions for growth and detecting early signs of disease or nutrient deficiency. For example, AI-driven sensors embedded in soil can monitor moisture levels and activate irrigation systems only when needed, significantly reducing water consumption. This approach not only conserves water but also ensures crops receive adequate hydration, leading to more sustainable farming practices.

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