AI4media

ARTIFICIAL INTELLIGENCE FOR THE MEDIA AND SOCIETY

ROADMAP ON AI TECHNOLOGIES & APPLICATIONS FOR THE MEDIA INDUSTRY

SECTION: "CLIMATE CRISIS AND AI"

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Climate crisis and AI

According to the United Nations, "*climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas. Burning fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat and raising temperatures. […] Energy, industry, transport, buildings, agriculture and land use are among the main emitters.*"[1] Greenhouse emissions are at their highest levels in 2 million years and continue to rise, resulting in Earth's temperature rising about 1.1°C since the 1800s. According to the same UN article, the consequences of this rise are enormous and dire: intense droughts, water scarcity, severe fires, rising sea levels, flooding, melting polar ice, catastrophic storms and declining biodiversity that can affect our health, safety, housing, ability to grow food. People in many places around the world, especially in developing countries, are already facing the disastrous effects of climate change and experts expect that the number of climate refugees will be on the rise in the coming decades.

Climate change is forcing governments, industries and citizens to adapt and take action before it is too late, going into emergency mode against climate crisis. Global frameworks and agreements have been set in place to guide progress in cutting emissions, adopting alternative solutions and adapting to change, including the Paris Agreement[2], UN's Sustainable Development Goals[3], the UN Framework Convention on Climate Change[4] and the Paris Agreement.

The media and entertainment industry are not cut out of this reality. In fact, media is part of the problem since it consists of physical infrastructure (data centers, content delivery networks, access networks, etc.) that obviously require gigantic amounts of energy to operate. Some interesting statistics are presented below:

- The carbon footprint of the Internet (incl. infrastructure, our devices and supporting services) accounts for 3.7% of global greenhouse emissions, similarly to those of the airline industry, and is expected to double by 2025. Considering that Netflix and YouTube combined represent more than 50% of Internet traffic at peak times in North America, audio and video streaming make more than 60% of the global Internet traffic, and online gaming increases by 19% per year, it is obvious that the media industry contributes significantly to the problem[5].

[1] United Nations, What Is Climate Change?: https://www.un.org/en/climatechange/what-is-climate-change
[2] The Paris Agreement: https://www.un.org/en/climatechange/paris-agreement
[3] United Nations' Sustainable Development Goals: https://www.un.org/sustainabledevelopment/sustainable-development-goals/
[4] United Nations' Framework Convention on Climate Change: https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change
[5] Climate Care, Infographic: The Carbon Footprint of the Internet (2021): https://www.climatecare.org/resources/news/infographic-carbon-footprint-internet/

- A report[6] published by Carbon Trust in 2021 shows that the media and entertainment industry accounts for about 46% of the carbon footprint of ICT[7]. The same report estimates that average carbon emissions per hour of video streaming in Europe for 2020 were 56g CO2 e per hour of video streaming while the equivalent energy consumption is 188Wh per hour of streaming.
- Netflix reported that fans spent more than 6 billion hours watching the top 10 shows in the first 28 days after each show was released in 2021. Based on the estimation above for the average carbon emissions per hour of video streaming, this translates to 1.8bn km of travel in a car – the current distance between Earth and Saturn[8].
- A report by the Shift Project[9], estimates that in 2018 online video viewing generated more than 300 Mt CO_2, i.e. 1% of global emissions or as much as Spain emits, while video on demand services by streaming giants produced more than 100 Mt CO_2e/year or 0.3% of world emissions. Given that since 2018 online video viewing and streaming have witnessed an unprecedented growth, also fuelled by the pandemic, we can safely assume that greenhouse gas emissions have increased even more since then.
- When a global brand displays 40 billion 200kB ad impressions, this can generate up to 8,000 tons of CO_2[10]. A typical online ad campaign would emit 5.4 tonnes of CO_2, which is the equivalent of 43% of the average annual carbon footprint of a person in the United Kingdom[11].
- Movies with a budget of $50 million dollars typically produce the equivalent of around 4,000 Mt of CO_2[12]. Blockbuster films' average carbon footprint is 3,370 Mt (or about 33 Mt per shooting day) while one-hour scripted dramas for TV had 77 Mt of CO_2 emissions per episode[13].

[6] Carbon Trust, Carbon impact of video streaming: https://www.carbontrust.com/resources/carbon-impact-of-video-streaming

[7] The following narrow definition of the carbon footprint of the media & entertainment industry is adopted: Media & entertainment comprises all electronic equipment utilised for media and entertainment purposes, including: TVs, cameras, and other E&M consumer electronics, as well as physical paper media and printing. The definition excludes cinemas, theatres, and other arenas or physical site events (e.g., sports), and content creation such as film and TV production.

[8] M. Sweney, Guardian, Streaming's dirty secret: how viewing Netflix top 10 creates vast quantity of CO2 (2021): https://www.theguardian.com/tv-and-radio/2021/oct/29/streamings-dirty-secret-how-viewing-netflix-top-10-creates-vast-quantity-of-co2

[9] The Shift Project, Climate crisis: the unsustainable use of online video – The practical case for digital sobriety (2019): https://theshiftproject.org/wp-content/uploads/2019/07/2019-02.pdf

[10] J. Benon, The Drum, How the media industry is in a unique position to reduce the internet's CO2 impact (2022): https://www.thedrum.com/industryinsights/2022/01/05/how-the-media-industry-unique-position-reduce-the-internet-s-co2-impact

[11] O. Oakes, Mediatel Nees, Carbon footprint of digital ads laid bare by Good-Loop tool (2021): https://mediatel.co.uk/news/2021/06/03/carbon-footprint-of-digital-ads-laid-bare-by-good-loop-tool/

[12] Columbia Climate School, Cut! How the Entertainment Industry is Reducing Environmental Impacts (2018): https://news.climate.columbia.edu/2018/03/29/entertainment-industry-sustainability/

[13] T. Spangler, Variety, Hollywood Studios Release Carbon-Emissions Report, Showing Wide Variance Among Productions (2021): https://variety.com/2021/film/news/sustainable-production-alliance-carbon-emissions-report-1234942580/

There are already a lot of new and promising initiatives that can help the media industry calculate, manage and reduce carbon emissions, like Albert[14], Ad Net Zero[15], the AdGreen calculator[16], and the IPA carbon calculator[17].

There are a lot of ways in which AI could help the media industry reduce its carbon footprint. For example, automation of film and music production processes and workflows that traditionally require human presence could reduce direct emissions such as those from fuel used by production vehicles and generators but also indirect emissions from travel and accommodations[13]. Similarly, automatic generation of new content (news summaries, visuals, game assets, movie trailers, etc.) reduces significantly the time and work effort required to produce the content and thus related emissions from human professional activity, buildings, equipment, commute etc. Targeted advertisement that knows when and where to find the user could reduce the number of online advertisements and thus relevant traffic, which nowadays is far from negligible. AI at the edge running on the user's or professional's device can significantly reduce processing power and reduce the volume of data being sent across networks while quantum computing is set to go even further. And AI can help the media and entertainment industry calculate and predict carbon footprint of its different processes and optimise them, thus enabling resource management focused on sustainability.

Since AI is making everything faster and more efficient, it is not unreasonable to expect that it can help reduce the industry's environmental footprint. But that assumption oversees a very basic fact. AI is not something intangible that somehow just happens in a void. It requires huge computational power and physical resources to be able to deliver all the amazing applications discussed in the previous sections of this Roadmap, from recommender systems, to smart visual search, to automatic content creation, to personalised services. AI is by definition a data hungry technology that requires enormous amounts of data to train models that exhibit high accuracy in different tasks like image classification, natural language processing, or prediction analytics.

To grasp the problem let us consider a simple example, presented in the essay "*Anatomy of an AI system*"[18]: for Amazon's Alexa to be able to answer a question, play a song or switch on a device, continuous learning from the interactions between Alexa and the user is required; the computational resources for this however are much higher than the energy and labor it would take for a human to flick a switch.

Training AI models requires large amounts of compute resources. In 2018, OpenAI released an analysis[19] showing that since 2012, the year deep neural networks were introduced, the amount of compute used in AI training has been increasing exponentially with a doubling time of 3.4 months (compared to the two years of Moore's law), increasing by an astounding 300,000 times by 2018 (see Figure 1). An even sharper rise was observed in training NLP models, especially

[14] Albert: https://wearealbert.org/
[15] Ad Net Zero: https://adassoc.org.uk/ad-net-zero/
[16] The AdGreen Carbon Calculator: https://weareadgreen.org/carbon-calculator
[17] IPA Media Carbon Calculator: https://ipamediaclimatecharter.co.uk/media-carbon-calculator/how-to-use-the-calculator/
[18] K. Crawford and V. Joler, "Anatomy of an AI System: The Amazon Echo As An Anatomical Map of Human Labor, Data and Planetary Resources," AI Now Institute and Share Lab (2018): https://anatomyof.ai
[19] OpenAI, AI and Compute (2018): https://openai.com/blog/ai-and-compute/

with the development of BERTs. As discussed in a recent report by Google and Berkeley researchers[20], OpenAI's GPT-3 language model (trained on almost 500 billion words and using 175 billion parameters) produced the equivalent of 552 metric tons of CO_2 during its training, which is the equivalent of driving 120 passenger cars for a year[21] or driving to the moon and back. Google's chatbot Meena consumed 96 metric tons of CO_2e, which is almost the same as powering 17 houses for a year.

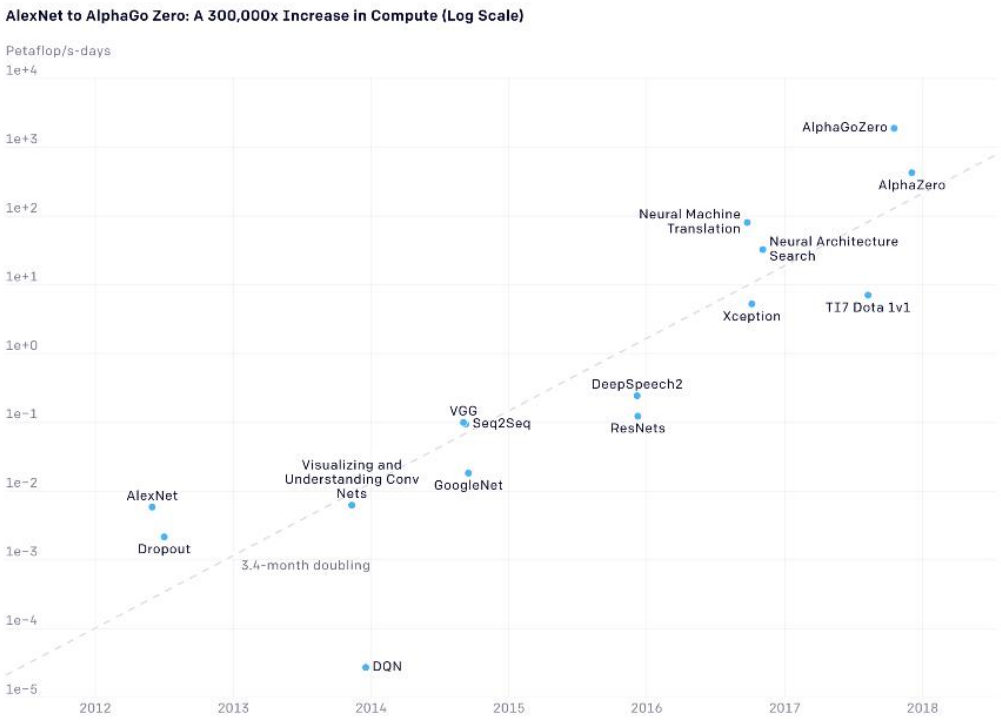

Figure 1: Increase in AI training compute from 2012 to 2018[22].

The same study identified several factors that contribute to the carbon footprint of AI training: i) algorithm improvement (e.g. optimised architectures that require less rounds of training and less data); ii) processor improvement (e.g. building AI chips that accelerate model training and serving, instead of using GPUs); iii) datacenter improvement (e.g. getting access to energy-optimised datacenters, powered by green energy).

A recent paper examines the environmental impact of AI from a holistic perspective, presenting challenges and opportunities for sustainable AI computing the ML development process — Data, Experimentation, Training, and Inference — for a variety of AI use cases at Facebook, including recommendation, computer vision and NLP. The study shows that the AI algorithm used affects significantly the carbon footprint: for example, training the Switch Transformer that has 1.5

[20] D. Patterson, J. Gonzalez, Q. Le, C. Liang, L.-M. Munguia, D. Rothchild, D. So, M. Texier, and J. Dean, Carbon Emissions and Large Neural Network Training (2021): https://arxiv.org/abs/2104.10350

[21] J. Kahn, A.I.'s carbon footprint is big, but easy to reduce, Google researchers say (2021): https://fortune.com/2021/04/21/ai-carbon-footprint-reduce-environmental-impact-of-tech-google-research-study/

[22] Image source: OpenAI - https://openai.com/blog/ai-and-compute/

trillion parameters produces significantly less carbon emission than GPT-3 (750 billion parameters), highlighting the environmental advantage of network architectures. The success of an AI system should be measured in terms of its overall impact. This will help us select the correct levels of complexity for a particular problem, which can lead to a significant reduction in energy consumption, cost and time[23].

Data centers are also an important part of the equation. Used for the storage and processing of the data required to train AI algorithms, data centers comprise millions of machines that consume huge amounts of energy. To understand the size of their environmental impact, with the current growth rate Ireland's data center sector is projected to consume about 23% of the country's total energy demand by 2030, forcing the Irish Government to consider placing restrictions on data center building or even banning it, in order to meet targets for emissions and renewable energy[24]. A data center's efficiency and regional placement may have a major impact on emissions. For example, a server in Quebec (which is dominated by low-carbon hydroelectricity) may emit as many as 35 times less CO_2 per KWh as a server in Iowa (where, after wind energy, coal is the most common electricity source)[25].

The increase in AI training compute was mainly motivated by the need for more accurate models. A new term has been introduced by Schwartz et al.[26] to describe the phenomenon: ***Red AI***. Red AI is AI seeking to obtain state-of-the-art results in accuracy through the use of massive computational power. On contrast, ***green AI*** aims to be more environmentally friendly, interested not only in better models but also more sustainable ones, seeking to achieve great performance without increasing, or even decreasing, computational cost.

To truly benefit from AI's great potential, we need a better understanding of AI's growing carbon footprint so that we are able to find the balance between transformative applications for media professionals and users, on one hand, and impact of those applications in the deteriorating climate crisis, on the other.

Leaders in the media industry must be proactive in making sure that the AI technologies they adopt take environmental considerations into account while AI researchers and developers should make sure that a green AI approach is adopted to address these concerns. An understanding of the costs of building and deploying AI models not only financially but also in terms of environmental impact must be developed across the board[27]. The mentality that more data or bigger models is always better should be reexamined while technologies such as evolutionary learning that adapt a model based on new information rather than retraining it from scratch can help reduce computational costs.

[23] B. Mullins, Time to tackle AI's impact on the environment (2021): https://sifted.eu/articles/ai-environmental-impact/c

[24] P. Judge, Data Centre Dynamics, Irish government could restrict data center building (2021): https://www.datacenterdynamics.com/en/news/irish-government-could-restrict-data-center-building/

[25] F. Rice, Greening AI: Rebooting the environmental harms of machine learning (2021): https://www.corporateknights.com/clean-technology/greening-ai/

[26] R. Schwartz, J. Dodge, N. Smith, and O. Etzioni, Green AI (2109): https://arxiv.org/pdf/1907.10597.pdf

[27] B. Mullins, Time to tackle AI's impact on the environment (2021): https://sifted.eu/articles/ai-environmental-impact/

To this end, environmental standards should be developed to ensure the mitigation of environmental impacts while green AI certifications could be introduced to promote green AI development by AI researchers and tech companies. At the same time, media companies deploying AI technologies should develop industrial guidelines promoting the procurement of green AI[28]. Ensuring that AI for media is developed not only transparently and responsibly but also sustainably, the media and entertainment industry can reap the benefits of AI, without its adoption being counterproductive in the fight against climate change.

[28] P. Dhar, The carbon impact of artificial intelligence (2020), https://www.nature.com/articles/s42256-020-0219-9

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