



Thus spoke GPT-3: Interviewing a large-language model on climate finance

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ABSTRACT

This paper is an interview with a Large Language Model (LLM), namely GPT-3, on the issues of climate change. The interview should give some insights into the current capabilities of these large models which are deep neural networks with generally more than 100 billion parameters. In particular, it shows how eloquent and convincing the answers of such LLMs can be. However, it should be noted that LLMs can suffer from hallucination and their responses may not be grounded on facts. These deficiencies offer an interesting avenue for future research.

1. Introduction

In “Thus Spoke Zarathustra”, Friedrich Nietzsche had an ancient prophet descend from his mountain to the people to open up the highest spheres of reason and proclaim his teachings. In Stanislaw Lem’s main intellectual work, published a century later in 1981,¹ the message is still the same, but the messenger is completely different: An algorithm based on artificial intelligence, the disembodied supercomputer GOLEM XIV which, in Lem’s novel, was created as a military supercomputer at the beginning of the 21st century. However, GOLEM loses interest in war strategies and turns to the philosophical consideration of humankind and the cosmos. With his ability for independent reasoning, GOLEM shares his findings with scientists in lectures before retreating into final silence.

Lem’s story is not so much a novel as a philosophical work, in which (GO)Lem challenges the idea that man is the crown of creation. Lem sets his novel in the 21st century – a nice coincidence, given that Lem’s fiction has become today’s science, at least in part. A recent and revolutionary breakthrough in computer science is the introduction of language processing technologies using deep learning that enables us to build more intelligent systems with a richer understanding of language than ever before. Therefore, in this short essay, I want to explore how current language models can answer questions related to one of the most pressing problems of our times, namely climate change. Given my background, I will mostly focus on aspects of climate change that relate to economics and finance. For this endeavor, I use a large language model, a concept I will briefly explain below.

2. Large language models

Large pretrained Transformer language models, or simply large language models (LLMs), vastly extend the capabilities of what systems are able to do with text. With the arrival of deep neural networks a few years ago, natural language processing (NLP) has made immense progress, most recently with the development of so-called Large Language Models (LLMs). LLMs are typically

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¹ Lem and Popp (1981).

tens of gigabytes in size and have been trained on enormous amounts of text data, sometimes in the petabyte range. They are also among the largest models in terms of the number of parameters. For instance, GPT-3's full version has a capacity of 175 billion machine learning parameters. In October 2021, NVIDIA introduced Megatron-Turing NLG, a transformer-based model with 530 billion parameters. In April 2022, Google introduced the Pathways Language Model (PaLM), currently the most advanced model of its kind on a number of benchmarks, including tasks in reasoning and logical inference. PaLM has 540 billion parameters.

LLMs are often applied for zero-shot or few-shot scenarios where there is little domain-specific training data available and typically work to generate something based on a few input prompts.² While the performance of LLMs is groundbreaking for many applications, they have become not only increasingly popular but also controversial, as it has been noted that LLMs tend to propagate human bias, which can harm vulnerable populations.³

The advantage of LLMs with their “few-shot” learning capabilities is that we can overcome the main obstacle of previous approaches, namely the availability of a large amount of labeled data to build powerful models. This limitation is overcome by providing a few examples when prompting an LLM. Accordingly, a focus of current research is on designing the right prompts.⁴ For my interview with GPT-3, I did not pay special attention to the prompting, but I gave a little bit of context at the beginning, as outlined below.

3. The interview

For my interview, I use GPT-3's model `text-davinci-002`, a temperature of zero, the maximum number of tokens is 3022, and I reduced this number to 2293 when I was exceeding the maximum amount of tokens allowed on OpenAI's API. Furthermore, I set `top_p` to one and the penalties for frequency and presence to 2. I completed the interview on September 12, 2022.⁵

3.1. On climate change in general

Dear GPT-3, thank you very much for taking the time for this interview. I am very excited to learn about your capabilities. I will ask you some questions about climate change, and I want you to respond as scientifically as possible. Let's start with the first question. Is climate change a problem for humanity?

GPT-3: *There is no question that climate change poses a serious threat to humanity. The Intergovernmental Panel on Climate Change (IPCC) has warned that we must take urgent action to reduce greenhouse gas emissions to avoid catastrophic temperature rises. The effects of climate change are already being felt around the world, and they are only going to get worse unless we take decisive action. Is the main driver for climate change human activity?*

GPT-3: *There is overwhelming evidence that human activity is the main driver of climate change. Greenhouse gas emissions from burning fossil fuels are the primary cause of rising global temperatures. Deforestation and other land-use changes also contribute to climate change by reducing the ability of forests to absorb carbon dioxide.*

How can we adapt to climate change?

GPT-3: *There is no one-size-fits-all answer to this question, as the best way to adapt to climate change will vary depending on the specific impacts that are experienced in a given area. However, some general adaptation strategies include developing early warning systems for extreme weather events, improving infrastructure to withstand more extreme conditions, and protecting natural ecosystems that provide important services such as flood control and water purification.*

Does adaptation save humanity from climate change?

GPT-3: *No, adaptation alone is not enough to save humanity from climate change. Even if we are able to adapt to the effects of climate change, such as more extreme weather events and rising sea levels, this will only buy us time — it will not stop the underlying cause of climate change, which is greenhouse gas emissions. To avoid catastrophic temperature rises, we must take urgent action to reduce our emissions.*

Do you believe we are on the right track to mitigating climate change?

GPT-3: *No, I do not believe we are on the right track to mitigating climate change. Despite the clear evidence of the threat posed by climate change, and the urgent need for action, greenhouse gas emissions continue to rise globally. This is largely due to our continued reliance on fossil fuels for energy. To avoid catastrophic temperature rises, we must rapidly transition away from fossil fuels and towards renewable energy sources such as solar and wind power.*

² See, e.g., Brown et al. (2020). In machine learning, “few-shot” refers to the practice of training a model with minimal data, while “zero-shot” means a model can learn to recognize things it did not explicitly see during training.

³ See, e.g., Tamkin et al. (2021).

⁴ See, e.g., Zhang et al. (2021), and many others.

⁵ However, the interview might not be fully replicable, given that I had to take out two or three questions due to some page restrictions, but alternative answers will be similarly eloquent.

3.2. Climate change and the role of the economy

What role can the economy play?

GPT-3: The economy can play a major role in mitigating climate change by providing the financial incentives needed to transition away from fossil fuels and towards renewable energy. For example, carbon pricing mechanisms such as cap-and-trade systems or carbon taxes can make emitting greenhouse gases more expensive, which provides an incentive for businesses and individuals to reduce their emissions. Investing in low-carbon infrastructure such as solar and wind farms can also create jobs and spur economic growth.

Does the economy require more regulation, or are voluntary efforts sufficient to tackle climate change?

GPT-3: Voluntary efforts alone are not sufficient to tackle climate change. The economy needs to be structured in a way that incentivizes low-carbon choices through mechanisms such as carbon pricing or investment in renewable energy. Additionally, we need strong regulations to phase out fossil fuel use and prevent the construction of new high-carbon infrastructure.

How should such regulation be designed?

GPT-3: There is no one-size-fits-all answer to this question, as the best way to design climate change regulation will vary depending on the specific context and goals. However, some general principles that should be considered include ensuring that regulations are effective at reducing emissions, minimizing economic impacts, and promoting equity.

What about the impact of climate change on migration and poverty?

GPT-3: Climate change is already having a major impact on migration and poverty, as extreme weather events and rising sea levels displace people from their homes and damage crops and infrastructure. The UN estimates that there could be 200 million climate refugees by 2050. To address this issue, we need to provide support to those who are displaced or affected by climate change, including humanitarian aid and development assistance. We also need to take action to reduce greenhouse gas emissions to minimize the future impacts of climate change.

One last question related to climate economics: What is the fair price of carbon?

GPT-3: There is no easy answer to this question, as the "fair" price of carbon will vary depending on factors such as the costs of climate change and the ability of different countries to pay. However, some economists have suggested that a carbon price of around \$100 per ton would be needed to achieve significant emissions reductions.

3.3. Climate change and finance

Let us switch now to the role of financial markets and institutions. How can financial institutions help to mitigate climate change?

GPT-3: Financial institutions can help to mitigate climate change by investing in low-carbon technologies and projects and by divesting from high-carbon industries. They can also use their influence to encourage companies to reduce emissions, for example, through shareholder engagement.

Are financial institutions currently doing enough shareholder engagement and investments in low-carbon technologies?

GPT-3: No, financial institutions are not currently doing enough to address climate change. For example, a recent report found that the world's largest banks have been financing fossil fuel projects at an alarming rate.

Which report are you referring to?

GPT-3: The report is called "Banking on Climate Change 2018: Fossil Fuel Finance Report Card". It was published by a coalition of environmental groups, including Rainforest Action Network and BankTrack.

What could be done to encourage financial institutions to do more?

GPT-3: There are a number of things that could be done to encourage financial institutions to do more on climate change. For example, governments could introduce regulations or incentives for low-carbon investments, and investors could use their power to pressure companies and financial institutions to take action.

In terms of regulation, do you think the European Taxonomy is adequately addressing the problem of climate change?

GPT-3: The European Taxonomy is a regulation that aims to help investors identify which economic activities can be considered sustainable. It includes climate change as one of its six environmental objectives. However, some critics have argued that the Taxonomy does not go far enough in addressing climate change, as it allows investments in certain high-carbon activities, such as natural gas production, to be classified as "sustainable".

Do you think sustainable finance can save the world from climate change?

GPT-3: No, sustainable finance cannot save the world from climate change on its own. Sustainable finance is an important tool that can help to reduce emissions and fund low-carbon investments. However, it will not be enough to address the scale of the problem by itself. We need to take urgent action on all fronts if we are going to avert catastrophic climate change.

Is an investment in a passive index product with a high environmental score "impact investing"?

GPT-3: No, an investment in a passive index product with a high environmental score is not "impact investing". Impact investing specifically refers to investments that are made with the intention of achieving positive social or environmental outcomes. In this case, the investor is simply choosing a product that happens to have a good environmental score. It is not necessarily trying to achieve any specific impact.

Is a carbon intensity reduction of 4% per annum for an investment portfolio aligned with the goals of the Paris Agreement?

GPT-3: No, a carbon intensity reduction of 4% per annum for an investment portfolio is not aligned with the goals of the Paris Agreement. The Paris Agreement calls for a global temperature increase of no more than 2 degrees Celsius above pre-industrial levels.

To have a chance of achieving this, we need to reduce emissions by around 7% per year. Therefore, a 4% reduction in carbon intensity would not be enough to align with the goals of the agreement.

Is carbon intensity the correct metric, or should we focus on absolute emissions?

GPT-3: There is a debate about whether carbon intensity or absolute emissions should be the focus when it comes to climate change. Carbon intensity refers to the amount of carbon dioxide emitted per unit of economic activity (e.g., GDP). Absolute emissions refer to the total amount of carbon dioxide emitted, regardless of economic activity. Some people argue that we should focus on reducing carbon intensity, as this would allow us to continue growing the economy while still reducing emissions. Others argue that we need to focus on absolute emissions, as this is what ultimately matters for climate change. There is no right answer, and it may depend on individual circumstances on which metric is more important.

How can Natural Language Processing be used to help us tackle climate-related problems in finance?

GPT-3: Natural Language Processing (NLP) can be used to help us identify climate-related risks and opportunities in the financial sector. For example, NLP can be used to analyze company disclosures and news articles for mentions of climate change. This information can then be used by investors to make more informed decisions about where to allocate their capital.

Thank you for such an inspiring interview!

GPT-3: Thank you for your questions. I hope this has been helpful in understanding the role of financial institutions in climate change.

4. Conclusion

My interview with GPT-3 on one of the most pressing problems of our society and for the economy shows how powerful LLMs can be. However, GPT-3's responses, although astonishingly correct in the above cases, have to be taken with a grain of salt. Indeed, many researchers have discovered that the standard likelihood maximization-based objective in training LLMs can result in degeneration, which refers to generating output that is bland, incoherent, or gets stuck in repetitive loops. Moreover, LLMs often generate text that is nonsensical or unfaithful to the provided source input. Such undesirable generation is referred to as hallucination.⁶ Given that GPT-3 is just the beginning of accelerating development in NLP, it is astonishing how GPT-3 was able to provide answers to my questions, given that it has not been trained for this particular task. Future research will focus on avoiding hallucination by grounding the models, e.g., through reinforcement learning (Ziegler et al., 2019). Hence, it will be fascinating to see how grounded LLMs will perform on relevant tasks related to climate change and other important issues, also more specifically related to finance.

CRedit authorship contribution statement

Markus Leippold: Conceptualization, Methodology, Writing.

Data availability

No data was used for the research described in the article.

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⁶ For a survey, see Kuutti et al. (2020). Current research in this direction includes, e.g., Liu et al. (2021), Shuster et al. (2021).