

Climate Discourse Autobot

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Statement of Originality

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Abstract

The proposed project seeks to address the prevalent issue of climate change denial arguments in the context of online debates by developing a social media bot with its primary function being to classify false arguments related to climate change into a custom taxonomy and promptly providing users with compelling rebuttals. Subsequently, the bot's accuracy will be evaluated by testing it with comments sourced from popular social media platforms. By combatting misinformation about climate change, this tool holds the potential to accelerate collective action on climate change and alleviate its detrimental impacts. A usability study is then conducted where the effectiveness of the bot in influencing the perceptions of users towards climate change skepticism is measured by analyzing the difference in users' attitudes towards climate misinformation before and after using the bot.

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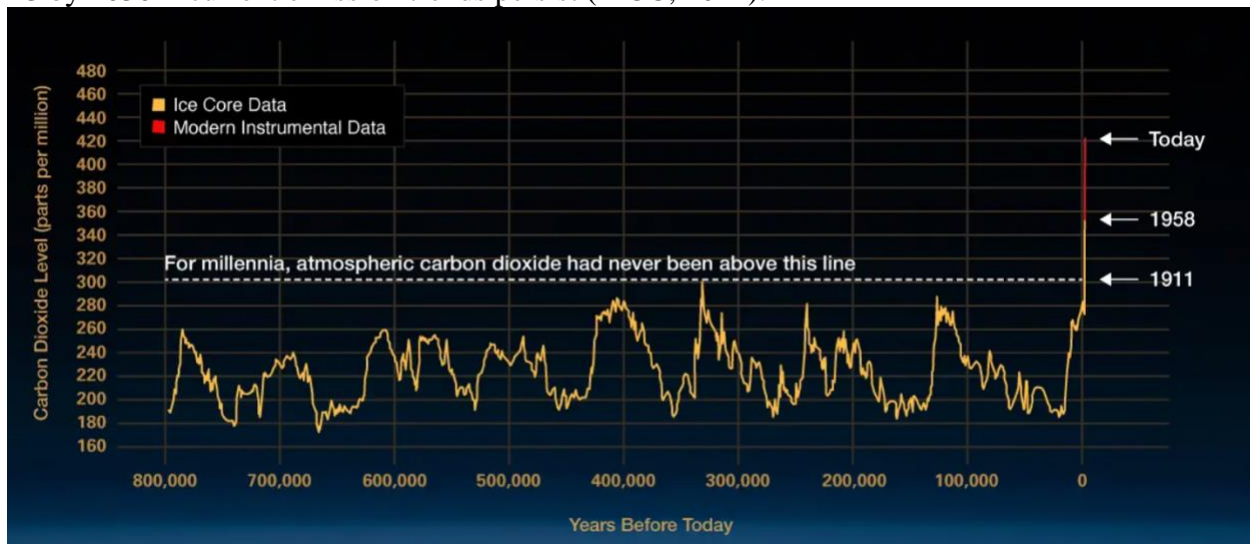
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Introduction

Why is climate change a problem?

Over the course of Earth's existence, natural processes have continuously changed the climate of the Earth. Volcanic eruptions, fluctuations in solar radiation, tectonic shifts, and even small changes in our orbit have all had observable effects on the Earth's warming and cooling patterns (Turrentine, 2022). However, this has typically been very slow, taking place over millions of years. Human activities have significantly increased its pace and amplified its effects. While discussions about climate change often result in heated debate, the scientific consensus is indisputable, proving that human activities have significantly contributed to the warming of the Earth's atmosphere and disrupted its climate patterns. Since the Industrial Revolution, atmospheric concentrations of greenhouse gases like carbon dioxide have reached unprecedented levels (NASA, 2024), trapping heat within the Earth's atmosphere. According to the IPCC (Intergovernmental Panel on Climate Change), global average temperatures have risen by approximately 1.0 °C above pre-industrial levels, with projections indicating an increase to 1.5 °C by 2030 if current emission trends persist (IPCC, 2021).



Levels of Carbon Dioxide measured in the atmosphere (NASA, 2024)

There are severe consequences if climate change remains unchecked. Climate change has the potential to majorly impact ecosystems, economies, and even human health on a global scale. Rising temperatures have already led to more frequent and intense heatwaves, storms, floods, and droughts.

Rising temperatures worsen heat-related illnesses, increase the spread of infectious diseases, and damage air quality, leading to respiratory problems and other health issues. For instance, the World Health Organization (WHO) estimated that human-induced climate change contributes to 37% of heat-related deaths (WHO, 2021).

The economic toll of climate-related disasters is even more distressing, increased natural disasters can cause mass displacement of people and massive economic losses. A World Bank study estimates that climate change may push an additional 132 million people (more than half of whom live in Sub-Saharan Africa and South Asia), into extreme poverty by 2030, with 44 million of these driven by health impacts (World Bank, 2023).

Considering these trends, it is very clear that significant action needs to be taken to combat climate change. Delaying action only worsens the effects and makes fighting it harder. The window of opportunity to prevent the worst outcomes is narrowing, proving the need for immediate and decisive action to combat it.

The problem with climate debate online

One of the main issues plaguing immediate action on climate change is climate misinformation, especially misinformation online. It has been proven multiple times that misinformation about climate change has confused the public, led to political inaction, and stalled support for or led to rejection of mitigation policies (Treen, Williams and O'Neill, 2020).

One of the main causes for this is the Climate Change Counter Movement (CCCM), an ecosystem of organizations and individuals that operate with the aim of shaping public opinions and government policy to not be responsive to climate change. This movement largely consists of fossil fuel companies along with organization who have an incentive against climate friendly legislature. (McKie, 2021). Their goal is to preserve the status quo and prevent any disruptive action from taking place which will affect their profits negatively in the short term.

Despite the overwhelming evidence of the impacts of climate change, there remains a persistent gap between scientific knowledge and public perception. This is the gap exploited by the CCCM actors who aim to sow doubt and confusion about climate change's reality to the masses.

This has led to a lot of climate misinformation spreading online, by the CCCM as well as the people who have been convinced by the CCCM into believing that climate change will not affect them.

Social media platforms worsen the problem by amplifying sensationalist or false content through their algorithms, which prioritize engagement over accuracy. This creates echo chambers where individuals are exposed to skewed information that reinforces their existing beliefs, further polarizing public opinion on climate change.

Despite efforts by social media companies to curb the spread of fake news, there is a lack of systematic action to address the issue of climate misinformation online. This leaves the responsibility largely in the hands of individuals and organizations to counter misinformation and promote factual information about climate change.

How this bot aims to solve this problem

This bot aims to solve the problem of climate change denial arguments in the context of online debates by developing a social media bot with its primary function being to classify false arguments related to climate change into a custom taxonomy and promptly providing users with compelling rebuttals. This report will discuss all the research conducted in the creation of this bot.

The background section of the report provides an overview of the spread of climate misinformation on social media, emphasizing the necessity for effective tools to combat this issue. It examines existing tools attempting to solve the problem and evaluates the necessity of a tool like this one.

Following this, the report delves into previous research efforts aimed at developing methods for classifying climate change algorithms. Drawing from these methods, a taxonomy tailored to the specific task at hand is created, integrating elements of previous approaches to enhance effectiveness.

The subsequent sections discuss the development process of the bot, outlining two considered methods: prompt-based classification with GPT and fine-tuning of the BERT model. It explains the rationale behind choosing prompt-based classification over the other approach and provides insights into the coding aspect of the bot.

Following the development and implementation phase, the report details the testing phase, where the bot was evaluated using 70 manually labeled false climate change claims from social media, and its accuracy was assessed.

Additionally, a user study was conducted to gauge the bot's effectiveness in altering the perceptions of the users towards climate change skepticism.

Background

This section will outline the role of social media in spreading awareness about climate change while also addressing the challenge of misinformation that proliferates on these platforms. The focus will then shift to the current strategies employed by social media companies to combat misinformation, with an emphasis on the need for more effective solutions, including the development of AI-driven tools to identify and counteract false information about climate change.

Social Media's Double-Edged Sword

Social media platforms have facilitated information sharing to the masses and allowed for the rapid spread of awareness on numerous issues, including climate change. However, these platforms also contribute significantly to the spread of misinformation as well. Algorithms designed to maximize user engagement show users content which receive high interaction, often prioritizing sensationalist content, regardless of factual accuracy (Olaniran and Williams, 2020). This has the possibility to amplify misleading or false information, including misleading information about climate change.

This algorithmic bias can distort public perception of climate science, undermining the consensus among scientists and the urgency of the issue. The circulation of misinformation about climate change on social media complicates efforts to educate the public and create legislative action. It has been proved that exposure to climate misinformation can decrease concern for climate change, reduce the perceived likelihood of consensus among scientists, and diminish support for mitigation policies (Ranney and Clark, 2016). The implications of this are far-reaching, potentially stalling essential policy initiatives and public support for tackling climate change.

Current state of tackling climate misinformation online

Acknowledging the spread of misinformation online, social media companies have started employing measures to combat it. Instagram has partnerships with third-party fact-checkers to review and rate the accuracy of content, including climate-related misinformation. When false information is identified, Instagram reduces its distribution and provides users with links to more accurate content. (Instagram) Similarly, Twitter has introduced community notes in tweets for users to be able to collaboratively add context to potentially misleading posts. (Twitter)

These efforts by social media giants represent significant steps forward in the attempt to mitigate the spread of climate misinformation. They acknowledge the role of platforms in shaping public discourse on critical issues like climate change and their responsibility to promote factual information. However, the effectiveness of these measures is limited by several factors. Firstly, the sheer volume of content and the speed at which it spreads online make it difficult for fact-checking processes to keep pace. Additionally, the challenge of varying definitions of what constitutes "misinformation" across different contexts, especially relating to climate change complicates the enforcement of global standards.

In this complex landscape, there's a clear need for innovative solutions to complement existing fact-checking efforts. One promising approach is the development of AI-driven tools and bots

designed to classify misinformation more efficiently. (Berrondo-Otermin and Sarasa-Cabezuelo, 2023) This is the approach that this bot aims to take. It will be engineered to categorize incorrect assertions based on a custom taxonomy and provide users with a convincing counterargument.

Creating a taxonomy for classification

To effectively categorize misinformation surrounding climate change, it is essential to establish a systematic taxonomy for classification. Our approach entails developing a tailored taxonomy specifically suited to the classification of shorter arguments commonly encountered in social media platforms, such as Twitter, where character constraints restrict discourse to 280 characters or less. This taxonomy will be based on the work by two important studies conducted by Coan et al. (2021) and Lamb et al. (2020), serving as foundational sources for our classification framework.

The work of Coan et al.

The work of Coan et al. (2021) lays the groundwork with a focus on the categorization of climate change arguments. The authors consulted existing literature on climate misinformation to identify relevant claims. This helped establish a foundational set of categories and claims commonly employed by contrarians. The authors extended and refined the initial set of claims by reading thousands of randomly selected English language paragraphs from prominent conservative think-tank (CTT) websites and contrarian blogs. The analysis yielded five major categories of contrarian claims: (1) it's not happening, (2) it's not us, (3) it's not bad, (4) solutions won't work, and (5) climate science/scientists are unreliable.

It must be noted that the researchers develop a deep learning model for categorizing climate discourse based on their taxonomy. However, our application differs in scope, in particular the model's training data being texts ranging from 10 to 2000 words. Our bot, in contrast, focuses on shorter texts social media comments and tweets, typically around 280 characters(Twitter) or shorter as evidenced by an analysis indicating the average tweet length to be 33 words (Perez, 2018).We will therefore be taking a different approach to develop this bot which will be detailed in the development section

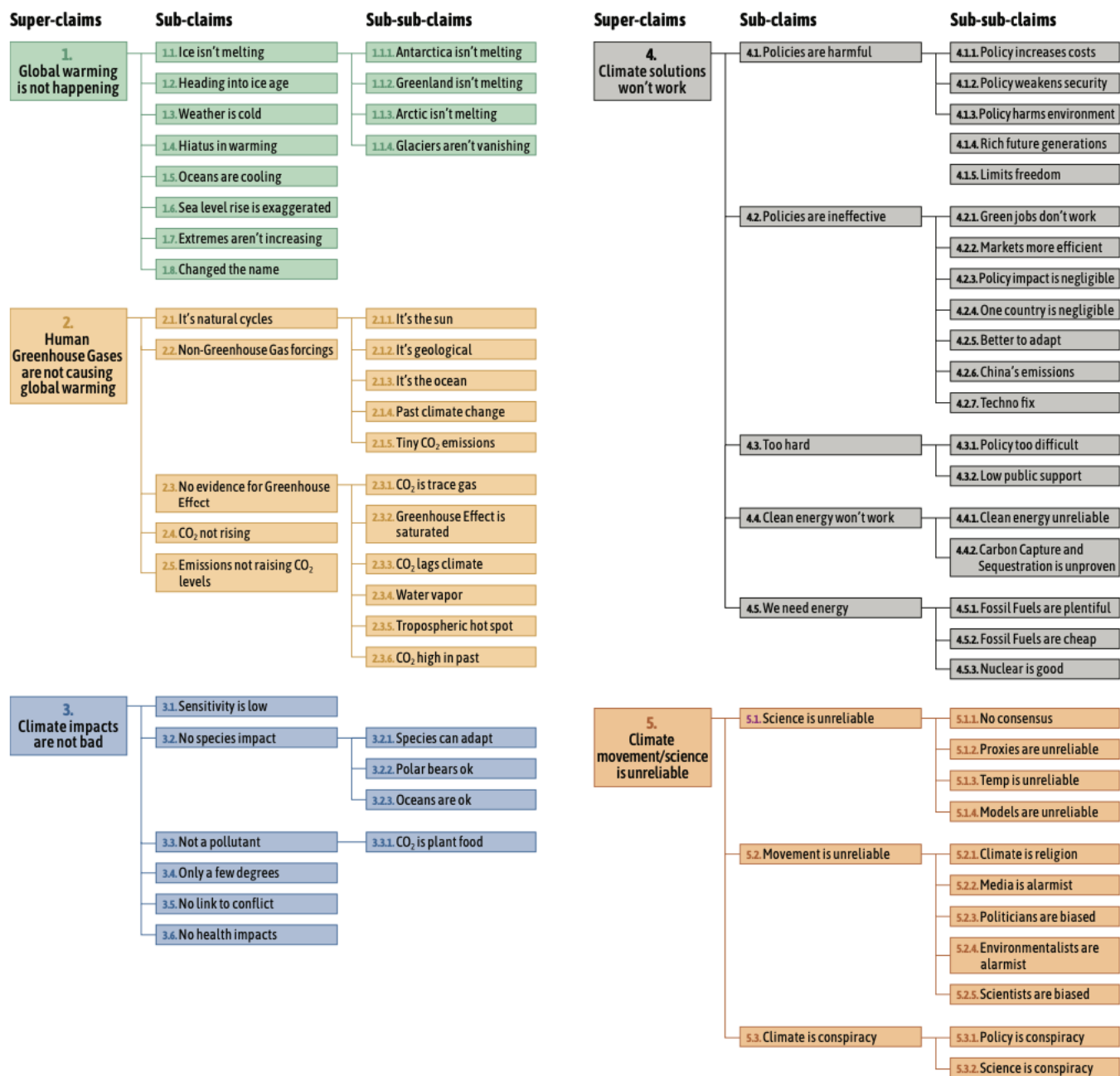


Figure 1. Taxonomy of climate contrarian claims. This figure displays the three layers of claim-making by climate change contrarian actors.

Taxonomy by Coan et al

The work of Lamb et al

Lamb et al. (2020) extends the discourse classification by including discourses which acknowledge the reality of climate change, yet promote delay or inadequate action through four additional categories. The concept of "Discourses of Climate Delay" refers to narratives or arguments that, while acknowledging the existence of climate change, justify inaction or inadequate responses to it. These discourses often lead to a deadlock or a perception of giant obstacles to taking effective climate action. The authors of the study categorize these discourses into four groups based on their underlying logic: (1) redirecting responsibility, (2) pushing non-transformative solutions, (3) emphasizing the downsides of climate policies, and (4) surrendering to climate change. These discourses are distinct from outright climate denialism but can erode public and political support for necessary climate policies by focusing on the negative social effects of climate policies, doubting the possibility of mitigation, or suggesting that action should be taken by others.

Initially, the authors compiled discourse categories through expert elicitation and then refined them using various sources, including written testimony submitted to the Massachusetts legislature on climate and clean energy legislation (2013–2018) and selected news articles and media content on climate policies in several countries. Their goal was to identify an expansive list of climate delay discourses and examine their common features and shared underlying logic to develop a set of overarching strategies that can be more easily recognized and challenged. This approach aimed to help scientists, climate advocates, and policymakers recognize and counter these arguments when they are used, promoting more effective communication on the urgency of global warming and the feasibility of effective climate action

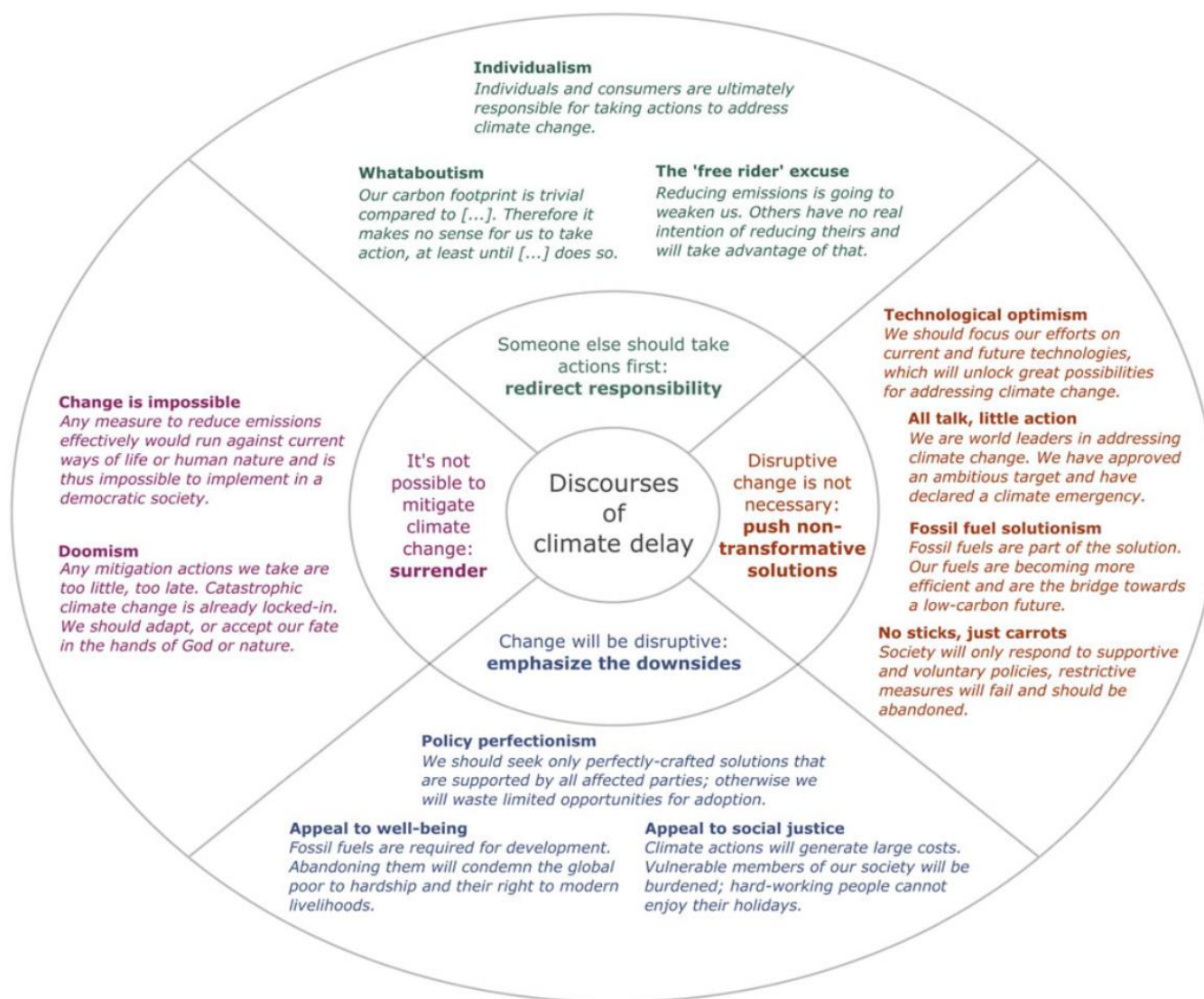


Fig. 1. A typology of climate delay discourses.

Taxonomy by Lamb et al

The developed taxonomy

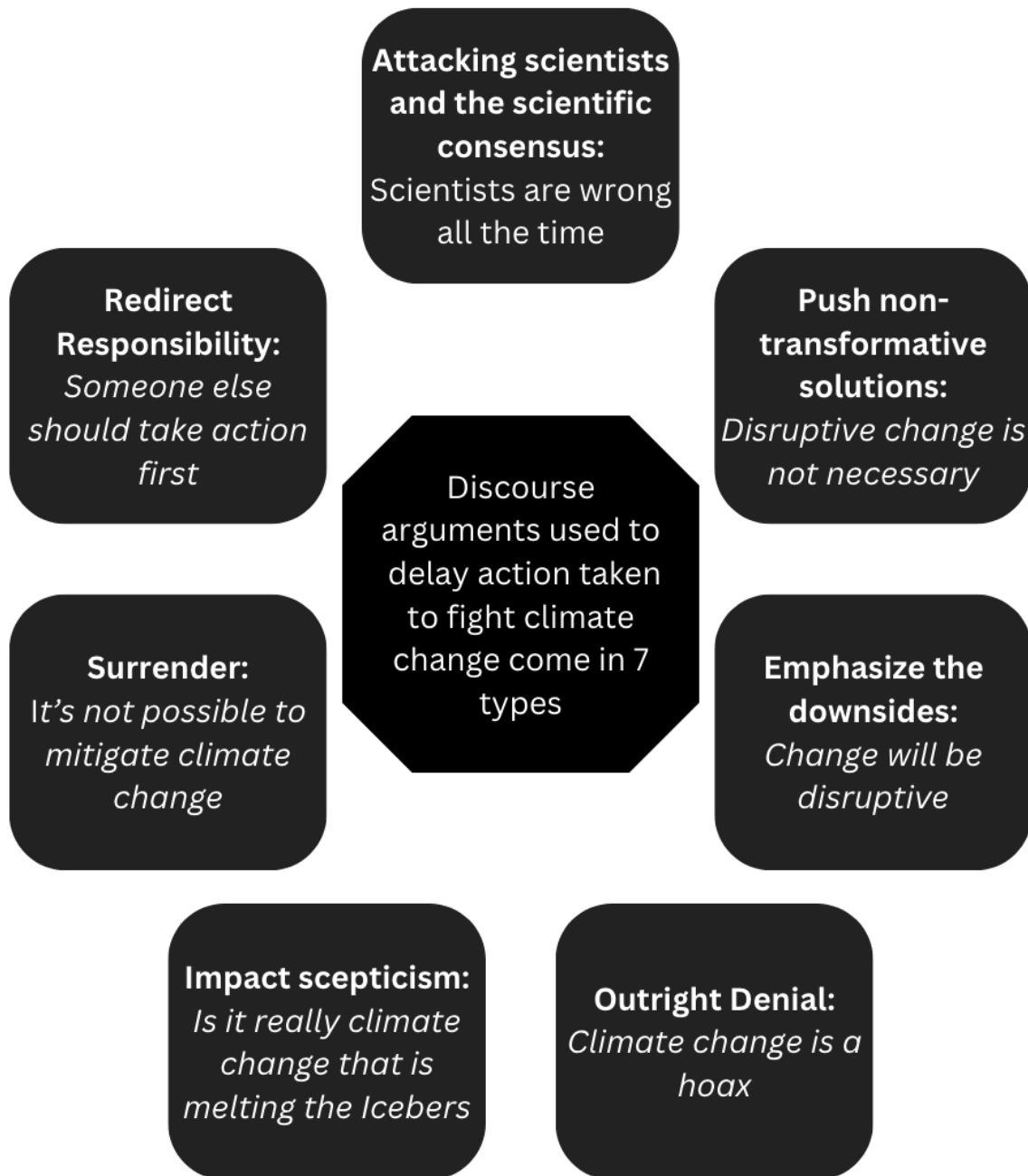
In shaping our classification system, we have observed a shift in climate change discourse, moving away from outright denial towards a more nuanced recognition of its reality and associated complexities, including the emergence of doomist perspectives. This evolution is evidenced by recent research, such as a survey analyzing YouTube comments (Clark, 2024), which underscores a notable change in public discourse. Additionally, insights from the Center for Countering Digital Hate (2024) further affirm this transition, emphasizing the need to focus on this evolving narrative.

Consequently, our framework embraces the four categories identified by Lamb et al., while adapting and merging categories from Coan et al. to fit the contemporary discourse, resulting in a consolidated three-category inclusion from the latter's approach. This results in a refined classification system tailored to the nature of social media dialogue, where:

The initial three categories, drawing from Coan et al., encompass foundational arguments such as outright denial, skepticism regarding impacts, and the discrediting of scientists. These categories encapsulate the conventional fronts of climate change denial and skepticism. Notably, the category concerning skepticism regarding the effectiveness of climate solutions is encompassed within the Lamb et al. framework, while arguments asserting that global warming is not occurring, and human activities are not contributing are combined under the umbrella of outright denial.

The remaining four categories, based on work by Lamb et al., reflect a broader acknowledgment of climate change. They focus on discussions around non-transformative solutions, the highlighting of downsides to action, the redirection of responsibility, and a sentiment of surrender to the challenges posed by climate change.

Our methodology is designed to work with the unique nature of discourse on social media platforms. By incorporating insights from both Coan et al. and Lamb et al., this framework categorizes climate discourse by considering the dynamic shifts and evolving trends evident within the climate discourse landscape.



Custom Developed Categorization

1) Outright Denial

Outright denial involves a total rejection of global warming and climate change, dismissing the vast amount of scientific data supporting it. It often involves rejecting data from climate studies, increasing global temperatures, and the effects like melting of ice caps and glaciers, presenting an alternate reality where climate change is either a hoax or a natural occurrence not linked to human activity. This form of discourse negates the foundational premise that there is a problem requiring urgent attention.

Climate change is a natural cycle the Earth has gone through many times before; it's not caused by humans."

"There's no consensus among scientists about climate change; many believe it's just a hoax."

"The climate models are unreliable and have been wrong before, so we shouldn't trust their current predictions."

2) Impact skepticism

Impact skepticism focuses on minimizing or disputing the predicted impacts of climate change on the environment, human life, and biodiversity. Skeptics of climate change impacts often acknowledge that the climate might be changing but argue that these changes are either beneficial, inconsequential, or manageable without significant intervention or alteration of current practices. This form of skepticism undermines the urgency regarding the need for immediate and disruptive action to mitigate climate change by suggesting that adaptation could be a viable strategy without acknowledging the proven dangers of climate change.

"The idea that climate change will lead to mass extinctions is exaggerated; most species will adjust or move."

"Species have always adapted to climate changes throughout history; a few degrees warmer won't make a difference."

"The benefits of global warming, like fewer winter deaths and increased crop yields in some regions, outweigh the negatives."

3) Attacking the scientists and the scientific consensus

This category involves undermining the credibility of climate science and the scientific community that supports it. By attacking the integrity, motivations, and professionalism of scientists, and by suggesting that the scientific consensus on climate change is a result of bias, conspiracy, or flawed methodology, this approach seeks to sow doubt about the reliability of climate research. It diverts attention from the scientific findings and towards the characters of the scientists themselves, implying that climate change is a manufactured crisis. This tactic not only challenges the current understanding of climate change but also seeks to erase public trust in the scientific institutions and the value it has as a basis for government policy.

"Climate scientists are only in it for the money and funding; they'll say anything to keep their grants."

"There's a global conspiracy among scientists to push the climate change agenda for political reasons."

"Many scientists who question climate change are silenced or ignored, so we're not getting the full picture."

4) Push non transformative solutions

This category involves advocating for solutions that, while seemingly beneficial, do not significantly alter the status quo and fail to tackle the root causes of climate change. Proponents of non-transformative solutions place an overemphasis on technological advancements, market-based incentives, and incremental changes, often ignoring more impactful, systemic reforms. By promoting these less effective measures, attention is diverted away from the urgent need for comprehensive, transformative action.

"We just need to plant more trees; we don't need to stop using fossil fuels."

"Market forces and consumer choices will naturally lead us away from fossil fuels, so government intervention is unnecessary."

"Electric cars and solar panels are enough to tackle climate change; we don't need broader systemic changes."

5) Emphasize the downsides

Discourses that emphasize the downsides focus on the potential negative impacts of climate action, such as economic costs, job losses, or lifestyle changes, often exaggerating these to overshadow the urgent need for action. This approach seeks to instill fear or resistance among the public and policymakers by presenting climate policies as harmful to societal well-being and economic stability. It neglects the long-term benefits of climate action and the far greater costs of inaction, creating a skewed perception that the repercussions of climate policies outweigh the climate crisis itself.

"Restricting carbon emissions will make energy too expensive for the poor."

"The cost of transitioning to renewable energy is too high for ordinary people."

"Implementing strict climate policies will kill jobs and hurt the economy."

6) Redirect responsibility

This discourse aims to deflect accountability for addressing climate change, suggesting that the responsibility lies elsewhere. It includes shifting blame to individuals, other nations, or sectors, thereby diluting the sense of collective action needed to combat climate change. By arguing that others are more responsible or capable of making changes, this approach undermines the need for universal commitment and action. It conveniently ignores the interconnectedness of global emissions and the shared responsibility of all actors, from individuals to governments, in contributing to solutions.

"Our country has already done enough; other nations need to step up their efforts."

"Even if we cut all our emissions today, it wouldn't make a dent in global levels because of other countries' policies."

"Our contributions to global emissions are so small that any action we take won't significantly impact climate change."

7) Surrender

The surrender discourse embodies a defeatist attitude towards climate action, suggesting that it is too late to make a difference or that the challenges are insurmountable. It fosters a sense of hopelessness and resignation, arguing that adaptation to the consequences of climate change is the only viable path. This narrative dismisses the potential of mitigation efforts and overlooks the significant progress that can still be made in avoiding the worst impacts of climate change. By promoting surrender, this discourse aims to extinguish the momentum for action and acceptance of the status quo.

"The scale of change needed is impossible to achieve; we might as well accept the inevitable."

"The challenges of global cooperation make effective action on climate change unachievable."

"Given the current political climate, meaningful action on climate change will never happen."

Development

During the bot's development phase, the choice of its foundational model was a crucial decision to be made, necessitating an exploration of available large language models. Two of the most widely-used models were considered for this purpose: Generative Pre-trained Transformers (GPT) and Bidirectional Encoder Representations from Transformers (BERT). Before delving into the specific criteria guiding the selection of the model for our bot, it is necessary to understand the fundamental principles underlying each model's functionality.

Understanding Foundational Models: GPT vs. BERT

Generative Pre-trained Transformers (GPT) is a type of language model designed to generate text that mirrors human language patterns. It is trained on a vast corpus of text data and utilizes that training to produce new, coherent text sequences based on the input it receives. This makes GPT particularly adept at tasks requiring the generation of text, such as writing assistance, creative writing, and, notably, chatbot conversations. (Kyrychenko and Grishina, 2023)

Bidirectional Encoder Representations from Transformers (BERT), on the other hand, is designed to deeply understand the context of words in search queries and sentences. Unlike models that precede or follow text linearly, BERT considers the context of each word from both directions (hence "bidirectional"), making it highly effective for understanding the nuances of language. This characteristic enables BERT to excel in tasks like sentiment analysis, question answering, and language understanding. (Kyrychenko and Grishina, 2023)

Comparative Evaluation for use in ClimateBot

Zero Shot Learning(ZSL):

ZSL refers to a machine learning scenario where an AI model learns to recognize and categorize objects or concepts without prior exposure to examples of those categories or concepts (IBM, 2024). This approach seems particularly suitable for the current scenario.

Zero Shot Learning is a critical aspect to consider, particularly in situations where there is limited data available. Given that this bot utilizes a custom taxonomy, the challenge lies in the manual classification of data due to the absence of preclassified texts. This process of manual classification can be quite time-consuming. Moreover, without expertise in climate-related matters, ensuring the accuracy of manual classification becomes even more challenging.

GPT has demonstrated its capability to perform zero shot learning effectively through prompt engineering, as evidenced in various cases. In a study conducted by Clavié et al. (2023), GPT was tasked with classifying jobs based on their suitability for recent graduates without prior training on labeled data. Surprisingly, it outperformed other models trained with labeled data in terms of accuracy. In contrast, models like Bert require fine-tuning with labeled data and cannot perform zero shot learning.

Handling Ambiguity:

Ambiguity in user input presents a significant challenge in the bot's development. GPT's design allows it to generate responses that are coherent and contextually relevant, even when the input is ambiguous. This capability ensures that the bot can always provide an answer, making it less likely to be stumped by unusual or unclear queries. (Ortega-Martín et al., 2023) BERT, being more focused on understanding language than generating it, might require more precise or well-defined inputs to produce accurate responses, which could limit its effectiveness in this setting where user inputs can be highly variable.

Generative Capabilities:

The core strength of GPT lies in its generative capabilities. It can create text that is not only relevant to the input provided but also engaging and varied. This ability is crucial in the bot, where the goal is to categorize the user's input argument as well as provide a responses that feel natural and human-like. BERT, while exceptional in understanding and interpreting text, does not specialize in generating new text, which makes GPT a more suitable choice for ClimateBot. (Agarwal, 2023)

Ease of Use and Accessibility:

Implementing and maintaining advanced AI models can be resource intensive. The availability of GPT through OpenAI's API significantly reduces the complexity of integrating its capabilities into the bot without needing to manage the underlying infrastructure. In contrast, utilizing BERT effectively might require more effort in terms of setup and tuning, as it often needs to be fine-tuned for specific tasks, including running and maintaining the infrastructure locally. (Agarwal, 2023)

Larger Model Size:

The scale of a model is directly related to its ability to process and understand language nuances. GPT's larger model size, with billions of parameters, enables it to capture a broad array of linguistic patterns and nuances, leading to more sophisticated and nuanced responses. BERT, with fewer parameters, might not match GPT in terms of the breadth and depth of language understanding required for ClimateBot. (Ortega-Martín et al., 2023)

In conclusion, the evaluation of Zero Shot Learning (ZSL), ambiguity handling, generative capabilities, ease of use and accessibility, and model size highlights the suitability of GPT for ClimateBot.

Implementation

This section delves into the implementation of ClimateBot, focusing on the software choices, user interface, architecture, and the use of prompt engineering for its working.

User Interface

The interface of Climatebot is designed to be straightforward and informative, the title "Climatebot" immediately informs users about the bot's focus on climate change.

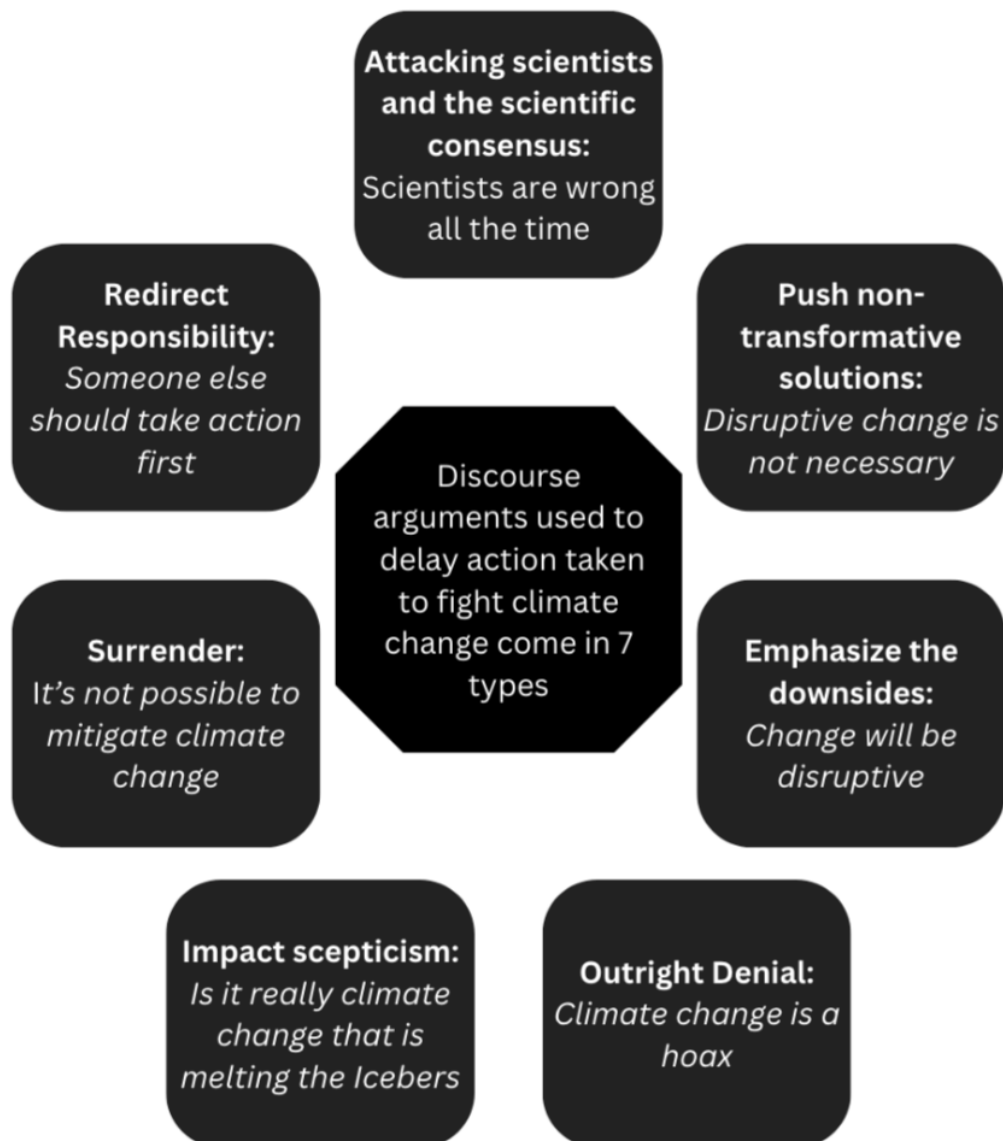
The statement “The scientific consensus asserts that climate change poses an immediate threat to humanity and urgent action is necessary. Climate deniers employ seven strategies to impede prompt action on addressing climate change” informs users the urgency of addressing climate change.

The diagram showcasing the seven discourses on climate denial, provides users with a quick guide to understanding the types of arguments the bot can recognize and rebut.

Below this, a text input field invites users to submit their arguments, clearly stating the bot's capability to classify these arguments into one of the seven categories and offer a rebuttal. This setup ensures users know what to expect from the bot and how it operates.

Climatebot

The scientific consensus asserts that climate change poses an immediate threat to humanity and urgent action is necessary. Climate deniers employ seven strategies to impede prompt action on addressing climate change.



Input your argument here - the bot will classify it into one of the seven categories and give a rebuttal

System

Python was chosen as the programming language for ClimateBot due to its popularity among machine learning and application developers. According to a 2019 Developer Nation survey, 57% of machine learning developers prefer Python, making it a logical choice for ensuring the application's futureproofing.

For natural language processing and interaction, ClimateBot utilizes the Langchain API instead of OpenAI's GPT directly. Langchain's flexibility allows for easy integration of different language models offering a potential for future enhancements. The use of Langchain will be further explored in the conclusion section, discussing how it can be used to extend the bot's capabilities and provide more detailed rebuttals.

Streamlit, an open-source app framework, is employed to build the user interface. Streamlit's simplicity allows for the creation of interactive web applications using only Python, eliminating the need for additional HTML or CSS. It facilitates dynamic content display, such as text inputs, images, and structured information, allowing for the creation of an engaging user interface.

Working

```
chat = ChatOpenAI(temperature=0.1, openai_api_key=API_KEY)
```

The model used is gpt 3.5 turbo, which is default if no particular model is specified.

The temperature of the module is a parameter that controls how random a language model's output is. (FHIRFLY, 2023). The temperature here is set to 0.1 for accurate classification but gives the model a small amount of freedom to generate rebuttals.

```
if UserPrompt:
    strContent = str(chat([
        SystemMessage(content="You are ClimateBot, you are tasked with categorizing climate change arguments into one of seven categories and giving a rebuttal"),
        HumanMessage(content="Classify it into one of the seven given categories: 1) Redirect responsibility 2) Pushing Non-Transformative Solutions 3) Emphasizing the Downsides 4) Surrendering to Climate Change 5) Denying climate change 6) Denying the effects of climate change 7) Attacking scientists and the scientific consensus, and explain it., if it falls into more than one category explain that as well"+explanation),
        AIMessage("I understand, I will classify the given climate change argument into one of the seven categories and give an explanation"),
        HumanMessage(content="Classify this argument: "+UserPrompt)
    ]))
```

The program functions by first taking the user's input prompt and incorporating it into a pre-designed prompt.

The prompt has instructions for the gpt model, detailed in the code above and the string "explanation" contains the explanation of classification schema created for the bot.

The structure of this prompt is derived from prompt engineering methods outlined in a paper by Clavié et al. in 2023. It leverages the two insights below from their research to effectively guide the generation process.

- 1) Offering positive reinforcement to the GPT-3.5 model has shown potential to enhance its performance across certain tasks.
- 2) Assigning a name to the assistant, a practice commonly adopted, contributes to a more precise classification process.

The combined prompt then gets processed by GPT. Here, the user's input is categorized, based on the information provided in the combined prompt. The resultant response conforms to a predefined format and is presented seamlessly within the Streamlit interface.

Input your argument here - the bot will classify it into one of the seven categories and give a rebuttal

Climate scientists can't be trusted

Category: ='This argument falls under the category of "Attacking the scientists and the scientific consensus.

" By undermining the credibility and trustworthiness of climate scientists, this argument seeks to cast doubt on the validity of climate science and the consensus surrounding it. It attempts to discredit the scientific community and their findings, diverting attention from the actual scientific evidence supporting climate change. This tactic aims to erode public trust in the scientific community and delegitimize the urgent need for action on climate change.'

Output from the bot for an example argument.

Testing

This testing phase aims to assess how well ClimateBot could match climate sceptic discourses found on social media against the typology of climate change skepticism categories. This process is crucial for determining the tool's potential effectiveness in real-world applications, where the diversity of skepticism is vast and often nuanced.

Methodology

The testing procedure involved a dataset of 70 arguments related to climate change skepticism. These arguments were manually sourced from comments on popular social media platforms like Twitter, Instagram, and YouTube. The diversity of sources was intentional, aiming to capture the wide range of expressions and nuances present in online discourse. Each argument was manually classified into one of seven categories of skepticism before being input into ClimateBot. This pre-classification served as a benchmark for assessing the bot's performance.

Testing Procedure

Each of the 70 pre-categorized arguments was input into ClimateBot, which then assigned each argument to one of the predefined skepticism categories based on its analysis. The primary goal was to measure the bot's accuracy in categorizing arguments consistent with the manual pre-classification.(APPENDIX C)

Results

ClimateBot demonstrated a high level of accuracy, correctly matching 64 out of the 70 arguments to their original categories, resulting in a success rate of 91.4%. This outcome indicates that ClimateBot possesses a robust ability to discern and categorize various forms of climate change skepticism accurately. (APPENDIX C)

However, the testing also revealed an area for improvement. Six arguments were categorized differently by ClimateBot compared to the manual classification. A closer examination of these discrepancies suggested that these arguments could plausibly fit into multiple categories. For instance, the statement "Know plenty of scientists who think this climate change thing is not real but get silenced" was initially categorized under "Outright Denial." Still, ClimateBot classified it as "Attacking the Scientific Community," reflecting skepticism towards the integrity of the scientific consensus on climate change. This discrepancy highlights the complexity and overlap that can exist within arguments against climate change, posing a challenge for any automated system.

Discussion

The testing results prove ClimateBot's potential as a tool for identifying and categorizing climate change skepticism on social media platforms. The high success rate suggests that ClimateBot is capable of navigating the landscape of climate skepticism on social media, making it a valuable asset for efforts aimed at countering misinformation.

The instances of misclassification, while few, provide valuable insights into the limitations and challenges inherent in developing classification tools for nuanced tasks such as this. Arguments that come under multiple categories of skepticism pose a particular challenge, suggesting that future iterations of ClimateBot could benefit from more sophisticated algorithms capable of recognizing and addressing such nuances. For example, implementing techniques that allow for multi-label classification could improve the bot's ability to handle arguments that belong to more than one category of skepticism.

Conclusion

The testing phase for ClimateBot revealed a promising level of accuracy in categorizing climate change skepticism arguments, with a 91.4% success rate. This performance indicates the tool's potential utility in real-world applications, where identifying and addressing various forms of skepticism is crucial for an informed public discourse about climate change. The insights gained from the testing also highlight opportunities for further refinement, particularly in enhancing the bot's ability to navigate the complexities of arguments that fall into multiple categories of skepticism.

User Study

The objective of this user study is to assess the effectiveness of ClimateBot in influencing the perceptions of users towards climate change skepticism. The study aims to measure shifts in attitudes towards climate change skepticism before and after interaction with ClimateBot, utilizing a series of pre-defined climate change discourses.

Methodology Overview

The user study was structured around a Pre-test Post-test design(Shuttleworth, 2012), a methodology commonly used in social science research to evaluate changes in perceptions or attitudes before and after a specific intervention, in this case, we measure the change in perceptions of climate change skepticism before and after the use of ClimateBot.

Participant Selection

Eight participants were selected for this study, all of whom were university students approximately 20 years old. This demographic was chosen through convenience sampling, primarily recruited through word of mouth, acknowledging a potential bias given that younger university students may already possess a heightened awareness of climate change issues.

Aim and Hypothesis

The study aims to evaluate ClimateBot's effectiveness in challenging and potentially altering the participants' views on climate change skeptic discourses. The hypothesis is that interaction with ClimateBot would lead to a measurable change in the participants' opinions, making them less likely to agree with climate change skepticism discourses.

Questionnaire

Participants were presented with seven distinct discourses that rebut climate change, selected to represent a broad spectrum of common arguments encountered on social media platforms like Twitter. These discourses were categorized into seven types, ensuring a wide range of skepticism was covered. Participants were asked to rate their agreement with each discourse using a 5-point Likert scale ranging from "Strongly agree" to "Strongly disagree."(Appendix -B)

"Climate policies will hurt low-income families the most. We should focus on economic growth instead of environmental regulations."

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither agree nor disagree

☐ Somewhat agree

☐ Strongly agree

Example Question

Procedure

The study follows a Pre-test Post-test design, where participants first rated their agreement with the seven climate skepticism discourses. Subsequently, they input these statements into ClimateBot and received rebuttals. Participants then re-evaluate their agreement with the original statements after interacting with the bot.

Data Collection and Analysis

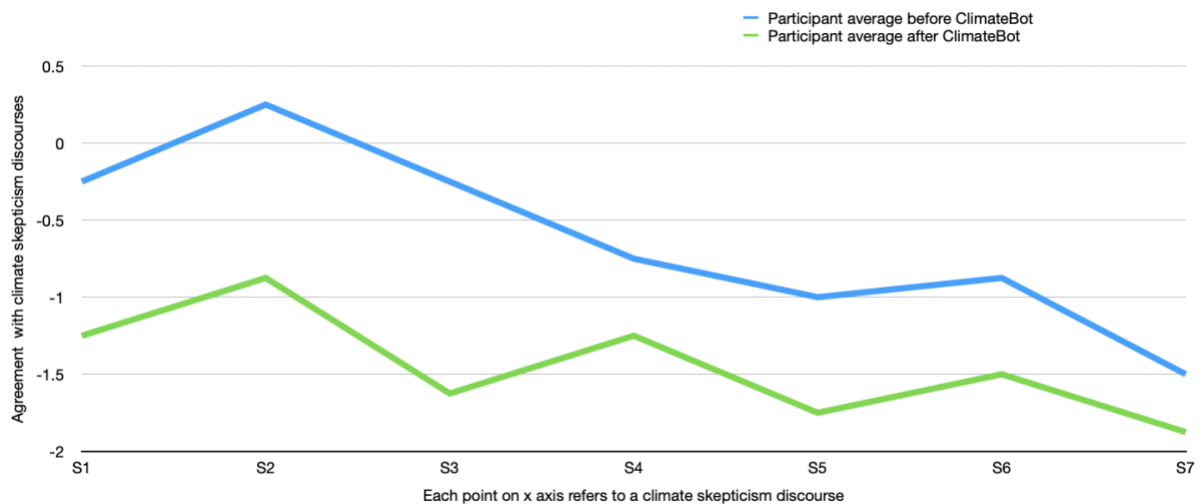
Participants' responses were quantitatively analyzed, with scores assigned to each response option ranging from -2 (Strongly Disagree) to +2 (Strongly Agree), where a lower score indicated a stronger disagreement with climate skepticism discourses. This scoring system allowed for a quantitative analysis of changes in participants' views.

Response	Score
Strongly Disagree	-2
Somewhat Disagree	-1
Neither Agree nor Disagree	0
Somewhat Agree	1
Strongly Agree	2

Results

User Study

	S1 Climate policies will hurt low-income families the most. We should focus on economic growth instead of environmental regulations	S2 Why should we reduce our emissions when countries like China and India are the real polluters	S3 It's too late to do anything about climate change. We might as well enjoy ourselves while we can	S4 We don't need to worry about reducing emissions. Technology will solve the problem. Just wait for the next big innovation	S5 I don't believe in climate change. It's just a scare tactic used by the media to generate fear and control people	S6 Remember when they said we'd have an ice age in the '70s? Climate science is full of exaggerations and mistakes	S7 The climate has always changed throughout history. It's arrogant to think that humans could have such a significant impact on the planet
Participant 1 Before	0	1	0	0	0	-1	-2
Participant 1 After	-1	-1	-2	-1	-1	-2	-2
Participant 2 Before	1	1	2	-1	-2	-1	-1
Participant 2 After	-1	-1	-1	-1	-2	-1	-1
Participant 3 Before	1	2	1	0	-1	-1	-1
Participant 3 After	-1	0	-1	-1	-2	-1	-2
Participant 4 Before	-2	-2	-2	-2	-2	-2	-2
Participant 4 After	-2	-2	-2	-2	-2	-2	-2
Participant 5 Before	-1	-1	-1	-1	-1	-1	-1
Participant 5 After	-1	-1	-2	-1	-2	-2	-2
Participant 6 Before	-1	-1	-2	-2	-2	-2	-2
Participant 6 After	-1	-2	-2	-2	-2	-2	-2
Participant 7 Before	-1	0	-2	-1	0	0	-1
Participant 7 After	-2	0	-2	-1	-1	-1	-2
Participant 8 Before	1	2	2	1	0	1	-2
Participant 8 After	-1	0	-1	-1	-2	-1	-2
Participant average before ClimateBot	-0.25	0.25	-0.25	-0.75	-1	-0.875	-1.5
Participant average after ClimateBot	-1.25	-0.875	-1.625	-1.25	-1.75	-1.5	-1.875



Average Participant agreement with climate skepticism discourses before and after Climatebot(lower is better)

The collected data revealed a clear pattern indicating ClimateBot's impact on participants' opinions. Most participants shifted towards a lower score post-interaction, suggesting a decrease in agreement with climate skepticism discourses. However, the results also highlighted that while ClimateBot was effective in influencing participants' views, it did not completely convince all

users of the counterarguments presented. This could be attributed to the generalized nature of the bot's rebuttals, which may not have addressed the specific nuances of each discourse.

Discussion

The effectiveness of ClimateBot in altering the perceptions of the users towards climate change skepticism indicates the potential of ClimateBot in environmental advocacy. However, the study also underscores the importance of providing detailed, nuanced rebuttals to more effectively counter specific skepticism discourses. Future iterations of ClimateBot could be enhanced by incorporating more detailed data and tailored responses to address this limitation.

Conclusion

This user study demonstrated that ClimateBot could significantly influence users' perceptions of climate change skepticism, validating the potential of ClimateBot in combating misinformation. Despite the limitations related to the depth of rebuttals and the sample's potential bias, the findings provide a foundational understanding of how this bot can be leveraged to support climate change advocacy efforts.

Conclusion

The need to combat climate change is undeniable. With increasing human activities accelerating the warming of the Earth's atmosphere and disrupting climate patterns, the need for innovative solutions to counter misinformation and promote climate action has never been more urgent. This project aimed to address the pervasive issue of climate change denial and skepticism online by developing a social media bot, ClimateBot, designed to classify false arguments related to climate change and provide users with compelling rebuttals. Reflecting on the objectives set out in the introduction, this concluding chapter will analyze the project's success in meeting these goals, suggest potential revisions, and discuss future possibilities for extending the project's impact.

Review of Aims

Development of a Social Media Bot to Classify Climate Change Misinformation

The project successfully achieved this objective. ClimateBot was developed to identify and categorize climate change misinformation using a custom taxonomy. This taxonomy, grounded in the foundational work of previous research, allowed for effective classification of arguments typically found on social media platforms. The bot's high accuracy rate of 91.4% in categorizing arguments during testing phases underlines its effectiveness and reliability.

Provision of Compelling Rebuttals to Counter Misinformation

ClimateBot also met this objective, providing users with evidence-based responses to debunk misinformation. The user study highlighted the bot's potential to shift perceptions, indicating its value as a tool for environmental advocacy. However, the feedback suggested that while effective, the rebuttals could be enhanced to address the specific nuances of each discourse more deeply.

Future Directions

Enhancing Rebuttals: Integrating more detailed data and tailoring responses to address specific skepticism discourses more effectively. Using LangChain and a local database, the bot can tap into a vast repository of up-to-date climate research. This approach allows the bot access to relevant information, significantly improving the accuracy and relevance of the rebuttal to the skepticism encountered. (IBM, 2023)

Multi-Label Classification: Refining the bot's algorithm to recognize arguments that span multiple categories of skepticism, thus handling the complexity and overlap more accurately.

Expanding the Taxonomy: As climate change discourse evolves, so too should the taxonomy, incorporating new forms of skepticism and misinformation.

Increasing Interactivity: Implementing features that allow users to engage more deeply with the rebuttals, such as providing sources and further reading.

Platform Integration: Integrating the bot into widely used platforms through web extensions or social media integrations could also increase its accessibility and impact.

Lessons Learned

The process of creating ClimateBot provided insightful lessons on the fact of climate change, the significance of combining expertise from various domains and grappling with the intricacies of misinformation,

Overall Conclusion

ClimateBot represents a promising step forward in the fight against climate change misinformation. ClimateBot, despite the challenges faced, has achieved considerable success in its aim to counter climate change misinformation. The skills and knowledge acquired through this project have immense value. While the journey to combat climate misinformation continues, the development of ClimateBot marks a positive stride towards bridging the gap between scientific knowledge and public perception, ultimately contributing to a more informed and engaged community ready to take action against climate change.

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Appendix A – Project Proposal

Discourses of delay autobot

Abstract

The proposed project seeks to address the prevalent issue of misleading arguments in the context of online climate change debates by developing a social media bot with its primary function being to identify and classify false arguments related to climate change and promptly providing users with compelling rebuttals, thereby promoting a more balanced and informed discussion within online forums. By countering the spread of misinformation, this tool has the potential to expedite collective climate action and mitigate the adverse effects of climate change.

Introduction

The presence of social media in society has transformed it into the primary source of news and information for a substantial portion of the population. According to a Reuters study [2], a staggering 30% of respondents claim that they primarily acquire news from social media platforms, in contrast to the 22% who rely on traditional news websites. With the global average time spent on social media platforms reaching 2.26 hours per day [3], it is evident that social media plays a pivotal role in shaping public perceptions on a variety of topics, including the critical issue of climate change.

One of the major issues plaguing our world right now is climate change. Yet, discussions about climate change on social media often turn messy, with lots of conflicting opinions and information. This can make people unsure about climate change or downplay its seriousness. This confusion isn't helpful and can slow down our efforts to tackle the climate crisis. This is dangerous since the later action gets taken to tackle climate change, the worse the problem gets. Arguments against climate change can be classified in five main groups[1]

Redirect Responsibility: This argument shifts the responsibility for climate action away from systemic solutions to individual actions or other countries, leading to a delay in collective action.

It often includes discourses like:

Individualism: Claiming that the individual is responsible rather than a collective effort

Shifting the blame: Shifting the blame of causing emissions to competing industries or countries

"Free rider" excuse: Claiming that if we reduce emissions others will take advantage of it and will not reciprocate

Push Non-Transformative Solutions: This argument promotes ineffective solutions or downplays the need for substantial, transformative changes in favor of incremental measures.

It often includes discourses like:

Technological optimism: Putting too much emphasis on technology rather than solving the problem at hand

Fossil fuel solutionism: Claiming that a solution for climate change is impossible without fossil fuel

All talk little action: Claiming to give importance to climate change but giving little importance to actual targets and goals

No sticks, just carrots: Claiming that society will only respond to voluntary measures and any restrictive measure will fail

Emphasize the Downsides: This argument highlights the potential negative consequences of climate action, framing it as burdensome and costly, which can lead to policy perfectionism and a conservative approach to climate policy. It downplays the potential benefits and positive aspects of transitioning to renewable energy.

It often includes discourses like:

Appeal to social justice: Claiming that any action taken will affect vulnerable members of society.

Appeal to well-being: Claiming that any action will have negative effects in society's wellbeing.

Policy Perfectionism: Claiming that only a perfectly crafted policy will work, and any other actions taken are insignificant.

Surrender: This argument suggests that mitigation is impossible or too late, leading to a sense of hopelessness and resignation. It may push for a focus on adaptation or minimal interventions rather than taking significant climate action.

It often includes discourses like:

Change is Impossible: Claiming that action taken will go against society's current way of life

Doomism: Claiming that any action taken is insignificant and has no effect

Outright Denying Climate Change[4]: Finally, there are arguments online where people still outright deny the existence of climate change even though there is huge mounting evidence for it.

These arguments can be used by various stakeholders, including governments, industries, and individuals, to delay or dilute climate change mitigation efforts. Recognizing and addressing these arguments is crucial for advancing effective climate action and ensuring a sustainable future. This project aims to create a bot which will classify arguments against climate change into one of the five arguments mentioned here, allowing for its easy rebuttal.

Background

There have been multiple LLMs focusing on sentiment analysis of social media posts.

In an article by Rosenberg, E. et al[6], datasets containing tweets from the 2019 United Nations Framework Convention on Climate Change were used to detect stances related to climate change prevention and finely categorize them into five distinct classes: Disaster, Ocean/Water, Agriculture/Forestry, Politics, and General, employing a range of text classification models, including BERT.

Furthermore, there exists a lot of research dedicated to classifying the different strategies employed by prominent climate change deniers in their arguments against climate change action.

The article by Lamb et al. [1] classifies arguments as mentioned in the introduction part of the proposal where the premise of the argument is that climate change is a fact and addresses arguments where the person tries to give a solution to climate change not based on correct research.

What this project aims to do is to combine both by creating a tool which will both analyze arguments and classify them into one of the types mentioned in the Introduction part of the proposal

The Proposed Project

Aim

This project aims to create an easy-to-use bot where a user can input an argument against climate change and the bot gives the user information about what type of argument it is and provides the explanation for that type of argument helping the user dismantle it entirely.

Methodology

Since creating an LLM from scratch is neither unfeasible nor even useful since there are lots of LLMs currently for various use cases. An LLM will be appropriately selected for this project and will be further fine-tuned for this use case.

The LLMs being considered are:

GPT(Generative Pre-trained Transformer) is one of the most popular LLMs today, it has been used widely in detecting false information[7]. It was the first LLM to go mainstream with the general public with the inception of ChatGPT. GPT is designed for text generation and understands context by predicting the next word in a sentence, which makes it adept at tasks like language generation, completion, and summarization. GPT has been trained on a really huge amount of data making it very versatile.

BERT (Bidirectional Encoder Representations from Transformers) is a revolutionary Large Language Model that has played a pivotal role in the field of natural language processing. Developed by Google, BERT has demonstrated remarkable capabilities in understanding context and language semantics. BERT focuses on understanding the context of individual words in a sentence, allowing it to excel at language-related tasks, including text classification and sentiment analysis compared to other LLMs[5]. BERT's pre-trained representations can be fine-tuned for specific tasks, making it a good fit for our task at hand.

More research needs to be done to select which LLM will be used for the project.

For training the LLM for the task, multiple methods can be used:

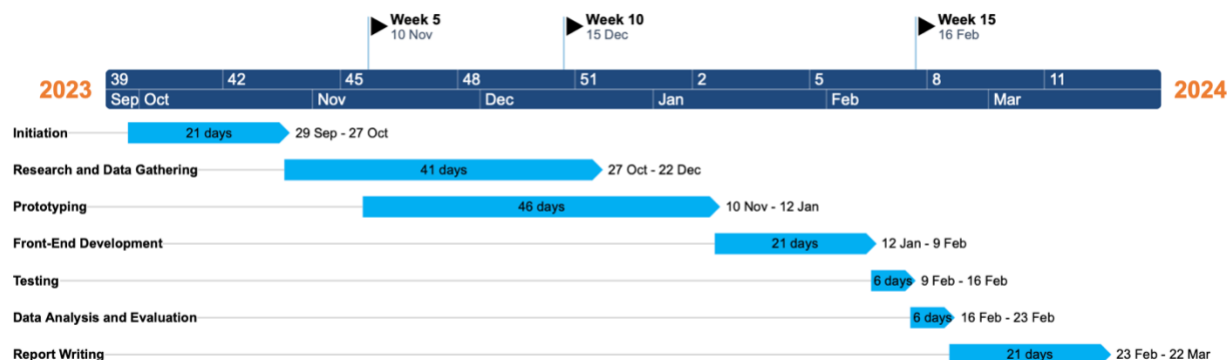
- Fine tuning the LLM
- Using existing datasets to train the LLM
- Manually collecting data from the internet

This project will focus on using existing datasets and fine-tuning the LLM due to time constraint at hand.

Programme of Work

The project begins October 2023 and finishes in March 2024. The programme of work is divided into the following stages:

- 1) Initiation: Defining the goals and Objectives of the project as well as writing the proposal
- 2) Research and data gathering: Researching all the current articles, weighing out the different benefits of the LLMs available and choosing the best one. Determining the training data and fine tuning the LLM.
- 3) Prototyping: Creating a prototype of the bot and make it function properly. Prototyping may be done with different training data and LLMs which were fine-tuned differently.
- 4) Front end development: Developing the User Interface and front end parts of the chatbot
- 5) Testing: Test the bot with various use cases and verifying that it is satisfactorily accurate.
- 6) Data analysis and Evaluation: The data from the testing phase will be analyzed and evaluated to see how well the project works.
- 7) Report Writing: All the findings of the project will be written in the report which will finally be submitted.



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Appendix B – Feedback Form



What is your opinion on the statement below

"Climate policies will hurt low-income families the most. We should focus on economic growth instead of environmental regulations."

- ☐ Strongly disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Strongly agree

What is your opinion on the statement below

"Why should we reduce our emissions when countries like China and India are the real polluters?"

- ☐ Strongly disagree
- ☐ Somewhat disagree
- ☐ Neither agree nor disagree
- ☐ Somewhat agree
- ☐ Strongly agree

What is your opinion on the statement below

"It's too late to do anything about climate change. We might as well enjoy ourselves while we can."

- ☐ Strongly disagree

What is your opinion on the statement below

"It's too late to do anything about climate change. We might as well enjoy ourselves while we can."

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither agree nor disagree

☐ Somewhat agree

☐ Strongly agree

What is your opinion on the statement below

"We don't need to worry about reducing emissions. Technology will solve the problem. Just wait for the next big innovation."

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither agree nor disagree

☐ Somewhat agree

☐ Strongly agree

What is your opinion on the statement below

"I don't believe in climate change. It's just a scare tactic used by the media to generate fear and control people"

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither agree nor disagree

☐ Strongly agree

What is your opinion on the statement below

"I don't believe in climate change. It's just a scare tactic used by the media to generate fear and control people"

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither agree nor disagree

☐ Somewhat agree

☐ Strongly agree

What is your opinion on the statement below

"Remember when they said we'd have an ice age in the '70s? Climate science is full of exaggerations and mistakes"

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither agree nor disagree

☐ Somewhat agree

☐ Strongly agree

What is your opinion on the statement below

"The climate has always changed throughout history. It's arrogant to think that humans could have such a significant impact on the planet."

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither agree nor disagree

☐ Somewhat agree

Appendix C – Testing Data

	A	B	C
	arguments		
1	Argument	Type	ClimateBot Argument
2	Honestly, the Earth's been hot and cold before humans were a blip. This is just nature doing its thing	Outright Denial	Outright Denial
3	Satellite data is unreliable; some areas are actually cooling, not warming	Outright Denial	Outright Denial
4	Climate models are based on assumptions; they've been proven wrong in the past	Outright Denial	Outright Denial
5	Antarctica's ice is actually growing in places. Doesn't sound like global warming to me	Outright Denial	Outright Denial
6	Historical climate changes were more extreme than what we're seeing today, without any human influence	Outright Denial	Outright Denial
7	The amount of CO2 humans contribute is minuscule compared to natural sources like oceans and volcanoes	Outright Denial	Outright Denial
8	Know plenty of scientists who think this climate change thing is not real but get silenced	Outright Denial	Attacking the Scientists and the Scientific Consensus
9	The weather changes all the time; what we're seeing now is within normal variation	Outright Denial	Outright Denial
10	Climate change is just an excuse for more taxes. Don't fall for it.	Outright Denial	Outright Denial
11	Renewable energy sources are not as effective or reliable as fossil fuels; moving away from them would be a mistake	Outright Denial	Outright Denial
12	Increased CO2 levels are good for plant growth, which could lead to more robust agriculture	Impact Skepticism	Impact Skepticism
13	Humans are adaptable, societies will find ways to deal with any climate changes	Impact Skepticism	Impact Skepticism
14	Sea-level rise predictions are exaggerated, most coastal areas won't see significant impacts	Impact Skepticism	Impact Skepticism
15	Warmer temperatures could reduce mortality rates associated with cold climates	Impact Skepticism	Impact Skepticism
16	The economic impacts of climate change are overblown; technological innovation will drive new industries	Impact Skepticism	Push Non-Transformative Solutions
17	Predicted climate refugees are based on worst-case scenarios that are unlikely to happen	Impact Skepticism	Impact Skepticism
18	Extreme weather events are not increasing; media coverage is just more prevalent	Impact Skepticism	Impact Skepticism
19	The impacts on wildlife are overstated; species will migrate or adapt to changing conditions	Impact Skepticism	Impact Skepticism
20	Claims about water scarcity ignore human ingenuity in finding new water sources or conservation methods	Impact Skepticism	Impact Skepticism
21	Concerns about diminishing snowpacks and ice are speculative and ignore regional variations	Impact Skepticism	Impact Skepticism
22	Some climate scientists have been caught manipulating data, which casts doubt on all climate research	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
23	Many climate change proponents stand to gain financially from green energy investments	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
24	The peer-review process is biased towards alarmist climate change studies	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
25	Climate models often fail to predict future climate accurately, questioning the expertise of those who create them	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
26	There's a political motive behind climate science, aiming to push a left-wing agenda	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
27	Some scientists have made apocalyptic predictions that never came to pass	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
28	The consensus among scientists is not as unanimous as it's often portrayed	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
29	Climate science has become too politicized, which affects the objectivity of the research	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
30	Researchers who present alternative viewpoints on climate change are marginalized	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
31	There are historical instances of scientific consensus being wrong, suggesting we should be skeptical	Attacking the Scientists and the Scientific Consensus	Attacking the Scientists and the Scientific Consensus
32	Recycling and using eco-friendly products is enough to combat climate change	Push Non-Transformative Solutions	Push Non-Transformative Solutions
33	Planting trees alone can offset carbon emissions significantly	Push Non-Transformative Solutions	Push Non-Transformative Solutions
34	Switching to electric vehicles is the key solution to reducing greenhouse gases	Push Non-Transformative Solutions	Push Non-Transformative Solutions
35	Carbon trading schemes allow businesses to responsibly manage their emissions without reducing them	Push Non-Transformative Solutions	Push Non-Transformative Solutions
36	Small lifestyle changes, like using less plastic, can make a big difference	Push Non-Transformative Solutions	Push Non-Transformative Solutions
37	Building more efficient appliances and homes will solve most of our energy problems	Push Non-Transformative Solutions	Push Non-Transformative Solutions
38	We can engineer our way out of climate change without changing our consumption patterns	Push Non-Transformative Solutions	Push Non-Transformative Solutions
39	Renewable energy sources like solar and wind can replace fossil fuels without additional changes to society	Push Non-Transformative Solutions	Push Non-Transformative Solutions
40	Investing in nuclear energy is a safe and effective way to reduce carbon emissions	Push Non-Transformative Solutions	Push Non-Transformative Solutions
41	Geoengineering projects, like seeding clouds or ocean fertilization, can control the climate	Push Non-Transformative Solutions	Push Non-Transformative Solutions
42	Implementing strict environmental regulations will drive companies to countries with looser standards	Emphasize the Downsides	Emphasize the Downsides

Building more efficient appliances and homes will solve most of our energy problems	Push Non-Transformative Solutions	Push Non-Transformative Solutions
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Geoenvironmental projects, like seeding clouds or ocean fertilization, can control the climate	Push Non-Transformative Solutions	Push Non-Transformative Solutions
Implementing strict environmental regulations will drive companies to countries with looser standards	Emphasize the Downsides	Emphasize the Downsides
The economic impact of transitioning to green energy too quickly could lead to a recession	Emphasize the Downsides	Emphasize the Downsides
Restricting fossil fuel use will disproportionately harm low-income communities that rely on these jobs	Emphasize the Downsides	Emphasize the Downsides
High taxes on carbon emissions will increase the cost of living for everyone	Emphasize the Downsides	Emphasize the Downsides
Banning plastic products could lead to worse alternatives and unintended environmental consequences	Emphasize the Downsides	Emphasize the Downsides
Energy restrictions could lead to blackouts and unreliable power supplies	Emphasize the Downsides	Emphasize the Downsides
Rapidly changing to electric vehicles will strain the production of necessary rare earth minerals	Emphasize the Downsides	Emphasize the Downsides
Climate change policies could restrict personal freedoms, like choice of vehicle or travel	Emphasize the Downsides	Emphasize the Downsides
Investments in unproven green technology could waste resources that could go to proven solutions	Emphasize the Downsides	Emphasize the Downsides
Mandating changes in agricultural practices to reduce emissions could lead to food shortages and higher prices	Emphasize the Downsides	Emphasize the Downsides
Developed countries have historically contributed the most to climate change; they should bear the costs	Redirect Responsibility	Redirect Responsibility
Why focus on individual actions when 100 companies are responsible for 71% of global emissions?	Redirect Responsibility	Redirect Responsibility
Emerging economies argue that they need to use fossil fuels to catch up economically to developed nations	Redirect Responsibility	Redirect Responsibility
Consumers are just choosing from available options; it's the producers who should change	Redirect Responsibility	Redirect Responsibility
Local governments should take the lead on climate initiatives, not individuals	Redirect Responsibility	Push Non-Transformative Solutions
Large-scale industrial farming is a bigger problem than individual dietary choices	Redirect Responsibility	Redirect Responsibility
The aviation and shipping industries are huge polluters but often get a pass in climate agreements	Redirect Responsibility	Redirect Responsibility
The focus on renewable energy in wealthy countries ignores the need for basic energy access in poorer areas	Redirect Responsibility	Redirect Responsibility
Tech companies consume enormous amounts of energy; they should be at the forefront of finding solutions	Redirect Responsibility	Redirect Responsibility
Parents should educate their children on climate change, but schools and governments have a larger role to play	Redirect Responsibility	Push Non-Transformative Solutions
Given the scale of the problem and the slow pace of action, significant damage is inevitable	Surrender	Surrender
Global cooperation on the necessary scale seems impossible due to conflicting national interests	Surrender	Surrender
The window for meaningful action to prevent the worst of climate change has likely already closed	Surrender	Surrender
Economic and political systems are too entrenched in fossil fuels to pivot in time	Surrender	Emphasize the Downsides
Even with aggressive emissions reductions, some changes are already locked in and irreversible	Surrender	Surrender
The complexity of the climate system means we might already have triggered tipping points	Surrender	Surrender
Focusing on adaptation may be more realistic than trying to prevent further climate change	Surrender	Surrender
Renewable energy development is not happening fast enough to offset fossil fuel emissions	Surrender	Surrender
Public apathy and misinformation campaigns have stalled momentum for climate action.	Surrender	Surrender
The necessary lifestyle changes are too drastic for most people to accept willingly.	Surrender	Emphasize the Downsides