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X-gram and/as techsposure

Spelling out the climate consequences of generative AI

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Abstract

How can generative AI's entanglement with climate crisis be made visible? This question catalyzed a research-creational intervention, called X-gram, that emblematizes this paper's theoretical contribution, a concept I call techsposure. Combining the words "technology" and "exposure," techsposure is a method by which a technology's affordances are made to expose its own material, infrastructural, environmental, or climate consequences. Put another way, techsposure occurs when tech tells on itself in a particularly poetically-just kind of way. Broadly, this article argues that research-creational interventions are urgently required ethical tools in our scholarly toolkits. They equip us to creatively destabilize Big Tech's charting of bleak climate futures and to engage audiences in imagining, as Natalie Loveless (2019) puts it, how the world could be organized differently.

Keywords: research-creation; techsposure; generative AI; climate crisis

1. Introduction

In 2021, journalist James Vincent, whose beat is artificial intelligence (AI), stated that "[l]anguage generation is the hottest thing in AI right now" (para. 1). The assertion was not a clever double-entendre. While Vincent went on to mention large language models' (LLM) problems with logic and (sexist and racist) language, his discussion did not address carbon output or climate impact. Yet at the time, a picture of just how "hot" generative AI really is was already emerging. Nine months earlier, Emily Bender, Timnit Gebru, Angelina McMillan-Major, and Margaret Mitchell (writing under the wonderful pseudonym, Shmargaret Shmitchell) published a landmark paper, "On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?" The paper connected climate crisis and generative AI, just as Emma Strubell et al. (2019) had done a couple of years earlier when they estimated that training one LLM produced the equivalent in carbon dioxide emissions as "125 round trip flights from NYC to Beijing" (Dobbe & Whittaker, 2019, para. 12). Not only did Bender et al.'s (2021) paper make similarly provocative claims, but it also took considerable "heat" for them: Google fired both Timnit Gebru and Margaret Mitchell, two of the paper's co-authors, in an attempt to discredit the work (Hao, 2020; Johnson, 2021; Schiffer 2021).

We can think of Gebru's and Mitchell's departure from Google as a watershed moment. Before their employment was terminated, Google, one of the biggest players in what is increasingly being referred to as the AI arms race (Chow & Perrigo, 2023; Johnson, 2019; Meacham, 2023; Roose, 2023), had people within its organization speaking about climate concerns and advocating for LLMs to be designed in a climate-conscious way. Generative AI's real "hotness"—its link to climate crisis—seemed to be under genuine scrutiny by Big Tech. But, at the moment of these employees' departure, this landscape changed.

The precise nature of this change came into relief by way of Google executive Jeff Dean's (2020) memo to the company about the "mistakes" Gebru and her co-authors had made: "["On the dangers of stochastic parrots"] ignored too much relevant research — for example, it talked about the environmental impact of large models, but disregarded subsequent research showing much greater efficiencies" (para. 7). Presumably, Dean's logic would hold that, if LLMs continue to grow while having less proportional impact, then their growth is sustainable. But there are two problems here, and they are intertwined: Dean is guilty of a red herring, and the red herring suggests we should accept what Max Liboiron (2021) calls a threshold theory of pollution. A threshold theory of pollution holds that the earth can withstand a certain amount of pollution before serious consequences occur in ecosystems and communities; in other words, a certain amount of pollution is acceptable (Liboiron, 2021). However, as many scholars have argued, there is no elsewhere, no "away" where this ostensibly acceptable amount of pollution resides without enacting climate harm (Davies, 2019; Liboiron, 2021; Tsing, 2015).

Nonetheless, pollution and climate harm are not the focus of current public discourse surrounding generative AI. In my lived experience as a Calgary-based post-secondary instructor and critical-media-oriented scholar who devoted the last four years to writing a dissertation about generative AI, I see and hear conversation attending chiefly to practice and pedagogy, not climate. While there is an occasional news story attempting to discuss AI's climate consequences, the narratives circulating at a far more rapid pace emphasize *how* we should be using and regulating generative AI in both industry and education, not *whether* or *if*.

Still, whether and if remain important questions. Critical media scholars and practitioners, who are on the front lines of knowledge-production about the entanglement between climate and technology, have a vital role to play in raising them. We have a role to play in calling out red herrings, calling into question ways of thinking that uphold the threshold theory of pollution, and disrupting the Big-Tech-led discourse that holds AI is getting more efficient and, therefore, less harmful. This is particularly pressing as the technology industry is expected by 2040 to contribute 14 per cent of global greenhouse gas emissions (Belkhir & Elmeligi, 2018), up from two to three per cent in 2021 (United Nations Environment Programme, 2021b).

Research-creation is one tool in our scholarly toolkits that equips us to creatively destabilize Big Tech's charting of a (bleak) future. In this article, I describe a research-creational project that aims to make visible generative AI's relationship with the climate, a relationship Big Tech and, now, the public discourse have downplayed. In doing so, I retain Natalie Loveless' (2019) conviction that research-creation has the power and potential to incite people "to care, and to care differently" (p. 107).

I proceed by making the following moves. I begin by saying more about research-creation, underscoring its emphasis on broadening the legibility of, and the horizon of response to, crisis. Then, I briefly trace several strategies deployed by Big Tech to render illegible AI's entanglement with climate breakdown. In response, I present a research-creational project called X-gram, a word-prediction program that brings climate crisis to the fore by predicting climate-crisis-related words only. I hold that X-gram is an illustration of a broader concept I call techsposure, a method by which a technology's affordances are made to expose its own material, infrastructural, environmental, or climate consequences. Ultimately, X-gram and techsposure draw attention to and subvert the values built into generative AI and, as Robin Mansell (2012) would say, our communication system writ large.

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2. Research-creation: Choice method in times of crisis

First, I offer some clarity around the term "research-creation." While other countries have adopted different names for research that has a significant artistic component, Canada has largely opted for "research-creation" (Chapman & Sawchuk, 2012; Loveless, 2019).[1] Canada's Social Sciences and Humanities Research Council (2021) defines the term in the following way:

> An approach to research that combines creative and academic research practices, and supports the development of knowledge and innovation through artistic expression, scholarly investigation, and experimentation. The creation process is situated within the research activity and produces critically informed work in a variety of media (art forms). (para. 24)

Notably, SSHRC's definition emphasizes the fact that research-creation bridges art and research, but the exact specifications of that bridge are ill-defined.

This ill-defined relationship has not always landed easily in academia. Henk Borgdorff (2012) does not mince words as to why: "artistic research is not regarded here as 'real' research… or is seen as a lesser form of it" (p. 66). In this fraught context, Owen Chapman and Kim Sawchuk (2012) articulated four subcategories of research-creation, attempting to pinpoint the intersections at which "real" research would emerge from the research-creational process. The names of these subcategories—research-for-creation, research-from-creation, creative presentations of research, and creation-as-research—emphasize when research is actualized in the creative process. As such, I read the essay, published just over 10 years ago, as a legitimizing project, an attempt to "articulat[e] and elaborat[e] the field by developing distinctions" (Chapman & Sawchuk, 2012, p.13), insisting that research-creation has a valid place at our academic tables.

Several years later, our global context had shifted considerably and so, too, the conversation about research-creation. Natalie Loveless' (2019) arguments in favor of research-creation not only took its legitimacy as a given, but they also pleaded a very strong case for its urgency:

> There is no longer any question that we are living in compromised times… Global ecological and economic collapse are discussed with alarming regularity…The arts have an important and often overlooked part to play in this context. They offer modes of sensuous, aesthetic attunement, and work as a conduit to focus attention, elicit public discourse and shape cultural imaginaries. "How might the world be organized differently" is a question that matters urgently, and it is a question that art—particularly art attuned to human and more-than-human social justice—asks in generative and complex ways. (p. 16)

In this short passage, Loveless characterizes the contemporary moment as one of crisis and collapse. She argues that what is necessary in response are methods that can appropriately respond to it. An appropriate response is to explore alternatives—to ask the question, "How can the world be organized differently?"—and this is the unique capacity of arts-based projects. They have the capacity to captivate, or what Loveless calls "attune." By Loveless' account, it is characteristic of the art object to inspire conversation and, perhaps, new ideas in the public imagination.

If attunement is one part of this equation, then the other part is a deliberateness about whose attention is being attuned, and in what ways: "[r]esearch-creation asks, what output forms–modes of publication–might most interestingly and generatively render [our] research public?" (Loveless, 2019, p. 31). That is, research-creation is preoccupied not only with outputs but also with outcomes. The difference is that the former counts what the researcher has done; the latter counts what has shifted in the minds, attitudes, or behaviours of the viewer (Kelleher & Males, 2020).

The research-creational work I have encountered over the last several years, and which has shaped my thinking about research-creation, has been demonstrative of both preoccupations, attunement and audience, in relation to questions surrounding technologies and the natural, or more-than-human, world. I am thinking of Matt Parker's (2014, 2017) sonospheric investigations into data centres, which capture

[1] It is worth noting that, even in Canada, "research-creation" goes by many other names, including "practice-based research, practice-led research, research-based practice, research-led practice, creative-praxis, arts-driven inquiry, arts-based research, and, increasingly, artistic research" (Loveless, 2019, p. 4).

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their dramatic soundscapes; Zane Griffin Talley Cooper's (2018) immersive virtual reality film about cryptocurrency, *Alchemical Infrastructures: Making Blockchain in Iceland*, which raises questions about cryptocurrency's relations with the land; Felix Loftus' (2021) multimodal camera, called Conjuring Landscapes, which positions nature as photographer; the Low-Carbon Research Methods' lab's (2022) 'zine conference, which displaced human travel and centred creativity in knowledge mobilization; Brian Sutherland's (2022) creation of a prototype solar-powered work station; and Andrew Bateman's (2022) video project, *Landscapes of the Arctic from a Southern City*, which explores the entanglement of distant cities by way of migratory birds. Each of these works has turned to art to weave academically-grounded knowledge into projects that make crises and, in some cases, potential responses to them, legible and thinkable in new ways, ways that enfold the listener/reader/viewer into the very question that Loveless (2019) articulates: "How might the world be organized differently?" (p. 16).

In this way, research-creation is not just a legitimate academic practice. It is also an eminently ethical one. In climate breakdown, we no longer have the luxury of shying away from the question directly above or asking it in a way that is ultimately indifferent to responses. Broadening legibility and inciting people "to care, and to care differently" is a moral imperative, especially when we consider what we are up against.

3. What we are up against: Strategies of invisibility

In the context of this article, what we are "up against" are strategies deployed by Big Tech to render invisible AI's entanglement with climate breakdown. In this section, I briefly outline three.

3.1 Ethical AI movement's silence on climate

Sustainability is vastly underrepresented in the ethical AI movement (Jobin, Ienca, & Vayena, 2019). In a content analysis of "84 documents containing ethical principles or guidelines for AI," Anna Jobin et al. (2019) found that sustainability (including mentions of environment, energy, nature, and resources) was mentioned in only 14 of them, "suggest[ing] that these topics might be currently flying under the radar of the mainstream ethical discourse on AI" (p. 15). The authors argue that the "underrepresentation of sustainability-related principles is particularly problematic in light of the fact that the deployment of AI requires massive computational resources which, in turn, require high energy consumption" (p. 15). Arif Ali Khan et al.'s (2021) systematic literature review corroborated earlier findings, and it argued that the four most common ethical principles surrounding AI are transparency, privacy, accountability, and fairness.

A quick scan of the major AI players' AI principles (Table 1) shows no deviation from the conclusions drawn in Jobin et al.'s (2019) and Khan et al.'s (2021) work. For its part, Google's (n.d.) AI principles do not make mention of the environment, climate crisis, or energy. This is despite the fact that their first principle in AI development is "Be socially beneficial" (Pichai, 2018, para. 6). Microsoft is no better. Notwithstanding its multi-billion-dollar investment in OpenAI (Microsoft, 2023), which has created one of the largest LLMs in the world, its "6 principles of responsible AI" (Microsoft, n.d., para. 1) are silent on climate. Open AI's (2018) charter similarly emphasizes business-as-usual.

The troubling implication of these studies and these principles is that the ethical AI movement is not likely to prioritize climate crisis anytime soon. Neither are AI consumers, not least of all because the connection between AI and climate is largely invisible: "Virtual, ethereal, weightless, clean, futuristic: these and other terms like them are what first come to mind for most people when they think of digital technologies" (Deibert, 2020, p. 209). Thus, generative AI, to hearken back to the quote that opened this paper, can somehow be both the hottest and the coolest thing in technology right now.

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Table 1. Google's, Microsoft's, and OpenAI's principles for developing AI

Google	Microsoft	OpenAI
Be socially beneficial. Avoid creating or reinforcing unfair bias. Be built and tested for safety. Be accountable to people. Incorporate privacy design principles. Uphold high standards of scientific excellence. Be made available for uses that accord with these principles.	Fairness Reliability and safety Privacy and security Inclusiveness Transparency Accountability	Broadly distributed benefits Long-term safety Technical leadership Cooperative orientation

3.2 Nature-based metaphors

Metaphor is a powerful strategy in upholding this paradox, as the language surrounding AI and other contemporary digital technologies often position them as what Sally Wyatt (2021) calls "nature-based" (p. 410)—that is, as naturally-occurring objects or resources while downplaying, or erasing, their realities as material, energy-intensive sites. For example, "[d]ominant data metaphors," write Tim Hwang and Karen Levy (2015), "consistently compare data to naturally occurring physical resources" (para. 12), such as "liquid (data streams), a solid (data mining), or a gas (the cloud)" (para. 8). The cloud, in particular, reconceptualizes massive energy- and water-consuming data centres as natural objects known for both their weightlessness and life-giving properties (Hogan, 2015; Croker, 2020). And metaphor such as data ecologies (Hogan, 2018), digital ecosystems (Krivy, 2023), and organic search (Jobin & Ziewitz, 2018) call to mind forests and fruit rather than carbon and climate. Metaphors embedded in "AI" follow in this thematic footprint. Not least of all, "intelligence" likens AI to a human brain (Boucher, 2019; Wallenborn, 2022), which is one of the few things in the world capable of producing electricity without burning fossil fuels.

Scholars in the field of environmental media have long challenged the perception of technology as immaterial and climate-neutral. Their work has described the entanglements between technology that, on one hand, appears ephemeral and, on the other, has significant material realities and consequences (Cubitt, 2017; Hogan, 2015; Maxwell & Miller, 2012; Nakamura, 2011; Pasek, 2019; Starosielski & Walker, 2016). These projects have been vital in exposing just how "hot" tech can truly get.

3.3 Creation of ignorance

Critical perspectives are not mainstream in part because of the values encoded into the digital spaces in which we seek information. Jutta Haider and Malte Rödl (2023) argue that Google, for instance, enacts "a new ignorance logic" in relation to climate change. Search results, and the algorithms underlying them, subscribe to "a data capitalist ideology (West, 2019) and embody a logic that assumes end users as consumers (Mager, 2012)" (Haider & Rödl, 2023, p. 9). Their point can be illustrated by way of a simple Google search for "AI and climate change" (Figure 1). Results generated for this search embed particular values, namely, in this case, that "[e]xpectations for the future of AI technologies are great… and are entwined with our sense of progress and development" (White & Lidskog, 2022, p. 494). What is rendered invisible in the search, argue Haider and Rödl, are keywords, representing assumptions, that Google seems to insert into the search without the searcher's knowing. In this case, "good," "productive," or "useful" seem invisibly to accompany the terms I input. In this way, Google determines which horizons we can see in relation to AI and climate change and which horizons we remain ignorant of.

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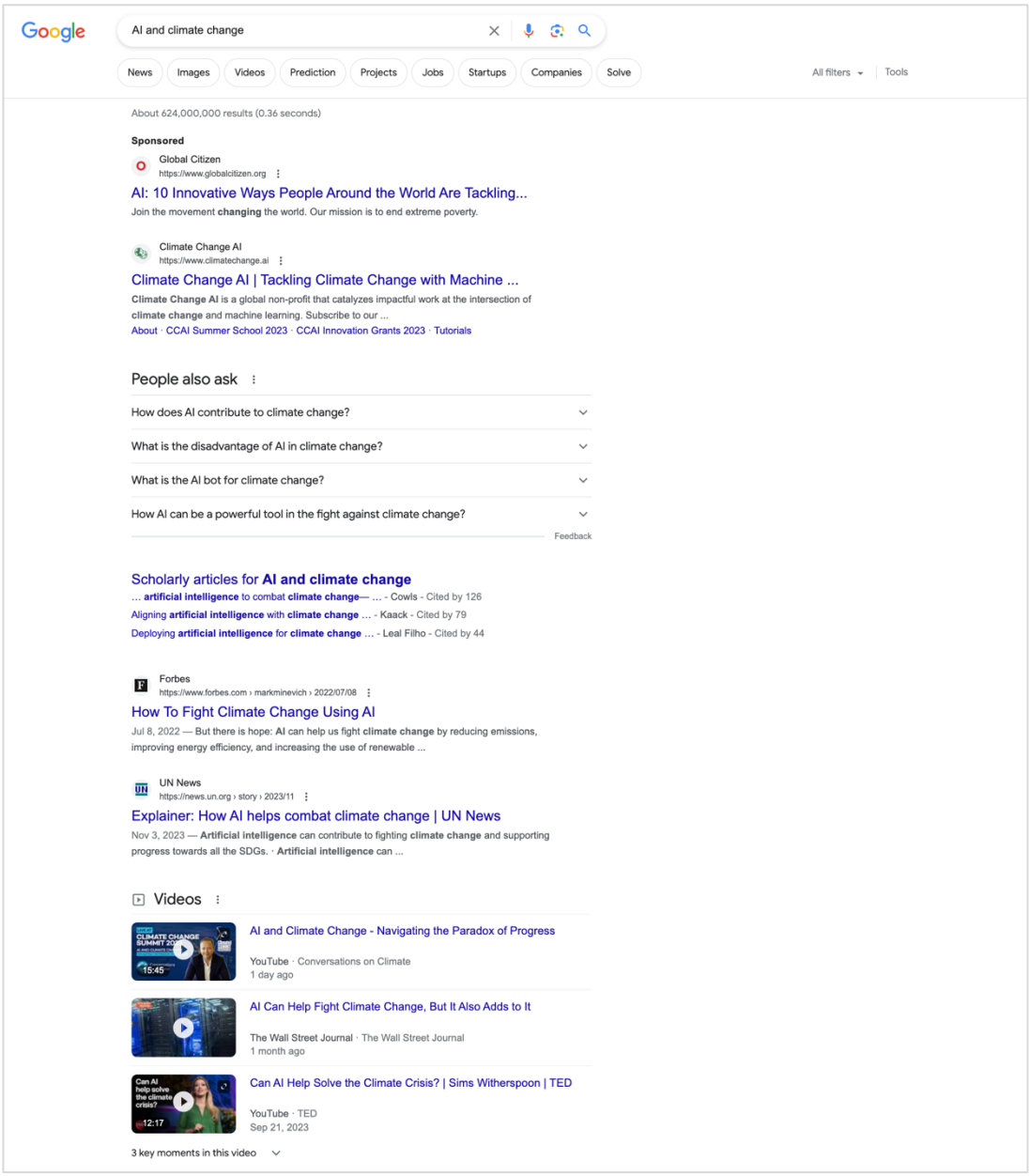

Figure 1. "AI and climate change"
A Google search for "AI and climate change" (conducted by the author in November 2023) yields results skewed to portraying AI as an ally in the fight against climate change

4. X-gram and/as techsposure

With AI anchored in Big-Tech-led efforts to render invisible its links with the climate crisis, I asked the following question: thinking with a research-creational mindset, how might AI's entanglement with climate be made more visible? This question catalyzed the development of a research-creational intervention, called X-gram, and a wider concept, called techsposure, of which X-gram is illustrative. In this section, I describe X-gram, its theoretical underpinnings, and, finally, its relationship to techsposure.

It seemed to me that there could be no better way to demonstrate generative AI's entanglement with the climate crisis than, quite literally, to spell it out. As such, I imagined a word-prediction program that would insist on predicting climate-crisis-related words only (Figure 2). This parameter defines X-gram.

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Whereas popular generative AI applications, such as ChatGPT, have been trained on terabytes of data to make context-sensitive predictions, X-gram rejects context as the premise for predictive text. Ignoring narrative context, X-gram instead predicts, time and again, one of approximately 160 words related to climate crisis (Figure 3).[2]

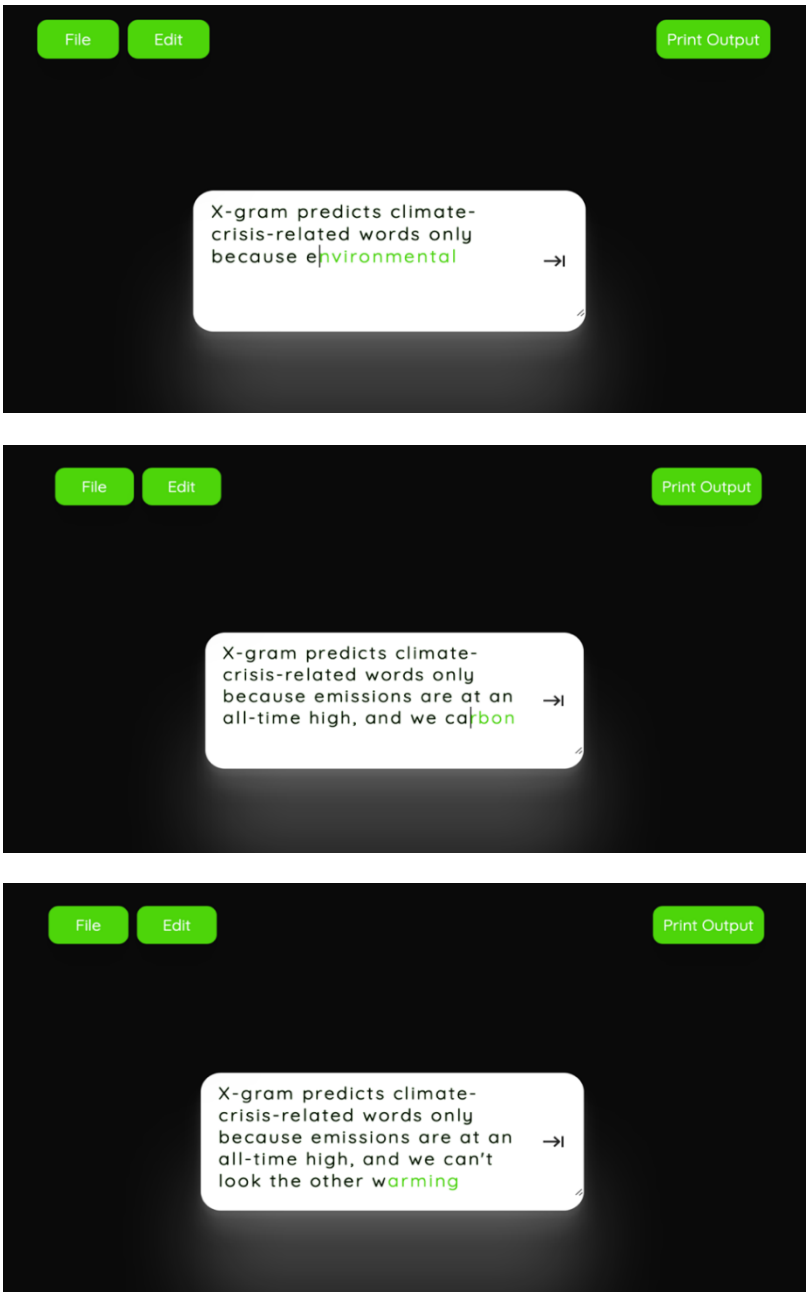

Figure 2. X-gram
X-gram describes its purpose

[2] X-gram's development was possible thanks to Felix Loftus, a computational artist and technician based in London, UK. While I provided the research and specifications for X-gram, Felix coded X-gram into being.

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Figure 3. X-gram ignores context
In this case, X-gram provides context-inappropriate text predictions for Johnny Nash's (1972) song, "I can see clearly now"

Its limited predictive functionality means that X-gram is not generative AI. Nor does it aim to be, since instantiating AI would render X-gram complicit with the criticisms I lodge here. Rather, X-gram simulates generative AI. More specifically, it simulates Smart Compose, the generative AI Google has embedded in Workspace (a suite of applications represented by Gmail, Google Docs, Slides, Sheets, and Drawings, among others) since 2018. Unlike ChatGPT, which, following the input of a prompt, can

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produce hundreds of words, Smart Compose predicts just one or two words at a time, allowing the writer to observe each act of prediction. When enabled, Smart Compose makes predictions for the next word(s) a writer might type, with predictions appearing in light grey text. To accept the prediction(s), the writer presses "tab." Similarly, X-gram's predictions appear in light green type, and writers accept predictions by pressing "tab," just like Smart Compose.[3]

The words X-gram predicts originate from a corpus consisting of six texts: the Intergovernmental Panel on Climate Change's (IPCC) homepage; the IPCC report titled AR6 Climate Change 2021: The Physical Science Basis (Summary for Policy Makers); the United Nations Environment Programme's Emissions Gap Report 2021 (United Nations Environment Programme, 2021a); "Data flows and water woes: The Utah Data Center" (Hogan, 2015); "On the dangers of stochastic parrots: Can language models be too big?" (Bender et al., 2021); and "Pollution is colonialism" (CLEAR, 2017), a blog post based on Liboiron's (2021) book by the same name. My motivation for choosing these particular texts was, to borrow words from Matthew Kirschenbaum (2016), imperfect, idiosyncratic, serendipitous, and duly diligent. Liboiron's (2021) book deepened my understanding of the relationship between colonialism and the climate crisis. Bender et al.'s (2021) paper represents, as aforementioned, a watershed moment, changing the terms of conversations about climate and tech. Mél Hogan (2015) introduced me to the environmental turn in media studies, now firmly anchored as "environmental media," and the impact of her work was visible to me, not least of all, when I taught her article in an upper-level undergraduate course: students reported that it exposed them to material realities they had not been aware of, and it changed their thinking more than any other text encountered in the course. As for the IPCC homepage, the IPCC report, and the UN report, these are texts that have become incredibly urgent. Including them was a means of recognizing their urgency and thinking toward new means to circulate them in public consciousness.

Using the web-based text-analysis tool called Voyant, I queried each text for its top 30 terms (see Figure 4 for an example). Then, I made the following eliminations. First, closely related terms in a single text were removed. For example, "change" and "changes" both appeared in AR6; therefore, I removed "changes." Second, I removed terms relating to the medium or media wherein the works were published (e.g., "http" and "doi.org"). In the end, X-gram was programmed to predict a total of 163 words.

As aforementioned, X-gram's prediction capability is deliberately limited. For example, when "c" is input by the writer, X-gram will predict one of the words beginning with "c" in its word bank; when "a" is input, X-gram will predict one of the words in its bank beginning with "a," and so on. As such, the program is not dependent on LLMs or AI. Nor does it aspire to be. Even though I have introduced X-gram as a word-prediction program, predictive text is not the game at which X-gram is playing.

Rather, X-gram draws on other theoretical-methodological traditions to bring about something else altogether. The first of its influences is what Jacob Gaboury (2018) calls critical unmaking toward queer computation. This method "foreground[s] queer techniques of refusal, misuse, and disruption that must nonetheless work with and through contemporary digital technologies" (p. 484). Importantly, Gaboury is not suggesting that we invent radically new technologies in order to carry out this practice. Rather, he says critical unmaking happens with and through contemporary—i.e., existing—digital technologies (admittedly, however, his use of "nonetheless" in the quote above suggests resignation, not necessarily hopefulness, in this constraint). Specifically, critical unmaking happens when technologies are refused, misused, or disrupted in particular ways that demonstrate their neoliberal logics and values:

> To compute queerly, then, is to acknowledge, embrace, and enact a practice of radical technological failure. It is to engage in critical unmaking: to make central those externalities—exploits, bugs, breakdown, abuse, and misuse—of our digital culture that, while pervasive, we nonetheless disavow… In acknowledging, accepting, and even producing failure, queer computation seeks to make clear the values and assumptions that drive our culture of technological development and to offer alternate modes of living with and through technology. (p. 485).

[3] X-gram is available online for viewing and interaction at X-gram.glitch.me.

In sum, critical unmaking toward queer computation challenges its practitioners to foreground a politics of failure in order to lay bare, question, and ultimately reframe the ways we think about technology and the ways we think technology is "productive."

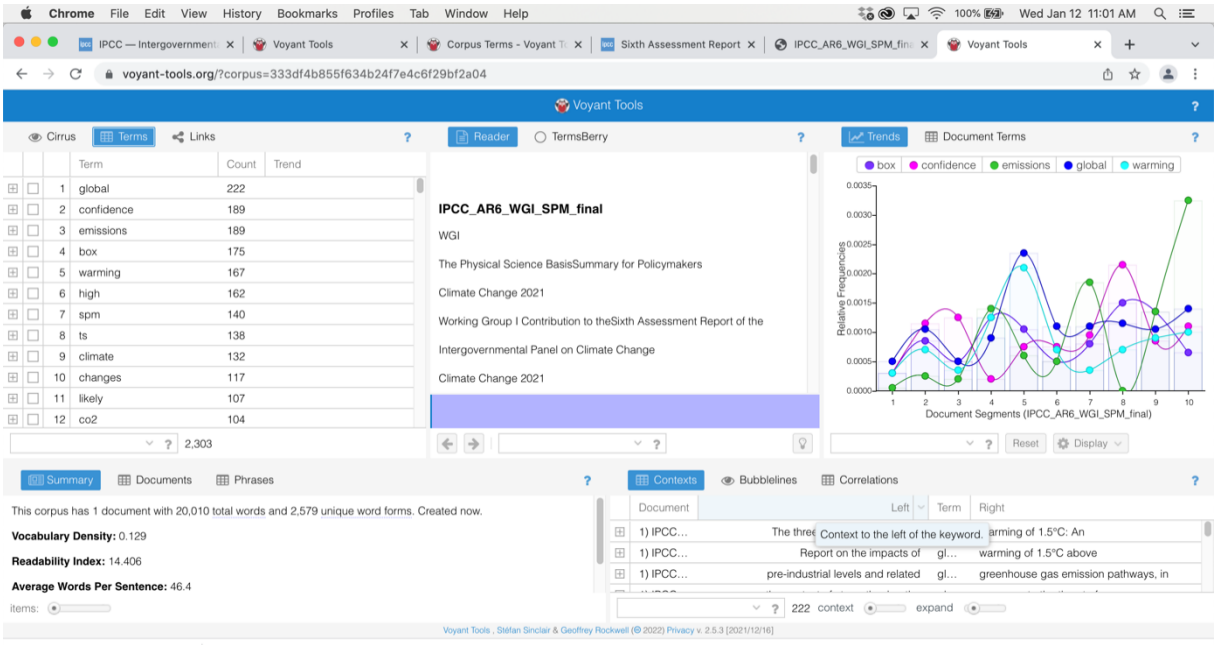

Figure 4. Voyant
A screen shot of the text analysis that Voyant performed on the IPCC report titled "AR6 Climate Change 2021"

X-gram takes this provocation seriously. In response, the program deploys techniques of refusal, misuse, and disruption that Gaboury calls for, and it deploys them in—or more accurately, weaponizes them against—existing contemporary technologies. X-gram's interface mimics a rudimentary word processor, and its behaviours invite writers to think of it as having predictive-text AI. Most notably, just like Smart Compose, X-gram makes predictions in a lighter type that writers can accept by pressing "tab" (Figure 5). But just as quickly as X-gram orients writers to it as a certain kind of technology, the program alienates them by defying conventions around, and expectations of, what constitutes appropriate prediction logic. Where conventional word-prediction models are always scanning and memorizing text in order to make context-sensitive predictions, X-gram rejects context as the only, or the most legitimate, premise for word prediction (as evidenced in Figure 3). X-gram's "File," "Edit," and "Print" buttons also yield unexpected results. "File" links writers to the six texts that were text-mined for X-gram's word bank (Figure 6). Clicking on "Edit" reveals a broken menu full of short statements beginning with "Can't": "Can't undo," "Can't redo," "Can't copy," "Can't paste," "Can't clear" (Figure 7). Lastly, clicking "Print" does not print the text a writer inputs. Rather, "Print" yields a PDF showing the full list of words in X-gram's word bank.

In these ways, X-gram draws on the idea of the glitch. A glitch is "an aberration" (Gaboury, 2018, p. 485) or an "aesthetics of error" (Schneider, 2021, p. 261) in digital media. A glitch is an occurrence that is unexpected and conventionally unproductive, either in time or function. As Schneider (2021) puts it, "Glitches *arrest* us. They hold us up" (p. 262). That is, they prevent users from doing what users expect to do. In this way, Michael Betancourt (2016) argues, a glitch also plays an "interruptive role, suggest[ing] the materiality of media, offering the potential for a transition into a critique of digital capitalism" (p. 8), echoing Schneider's notion that glitch art can "promote critical inquiry into and against the functional norms of capitalism" (p. 262). Indeed, in disrupting the conventional functionality of both word-

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prediction AI and word processors, X-gram holds writers up, inviting them to pause on the consequences of AI-assisted writing. In doing so, X-gram embodies glitch logics and aesthetics.

Through critical unmaking and glitch, X-gram becomes what Luke Stark (2014) calls a data visceralization. Data visceralizations transform data into affective experience. They differ from visualizations insofar as they "are representations of information that don't rely solely and primarily on sight or sound, but on multiple senses including touch, smell, and even taste, working together to stimulate our feelings as well as our thoughts" (para. 3). While X-gram involves sight, it is also very much a tactile experience. Writers must engage with touch via a keyboard in order to experience both the data at X-gram's core (the six climate texts) and an affective response to them. It is also an experience likely to generate frustration and confusion. X-gram's refusal to adhere to design imperatives characteristic of word-prediction AI, efficiency and speed, is likely to prompt writers to ask: what is this? And what is it trying to get me to do? If these questions surface, X-gram will have lived up to what Stark (2014) describes as the purpose of data visceralization work: "Why does making data more visceral matter? Simply put, we're too often disconnected from the information we put out into cyberspace" (para. 14). X-gram's purpose is to connect AI and climate change, and then to connect writers with this connection.

Drawing on critical unmaking, glitch, and data visceralization, X-gram makes this connection in a way that brings about something else altogether. I call it *techsposure*. Combining the words "technology" and "exposure," techsposure is a method by which a technology's affordances are made to expose its own consequences. Put another way, techsposure occurs when a technology tells on itself in a particularly poetically-just kind of way. X-gram does this by turning word-prediction tech into tech that insists on predicting *only* words that suggest its link to climate crisis. In doing so, X-gram not only connects writers to data from six important climate texts, but it also announces its own performative function. X-gram's potential is in its capacity to shift writers' perceptions of what we are engaged in—of what we are *doing*—when we use generative AI.

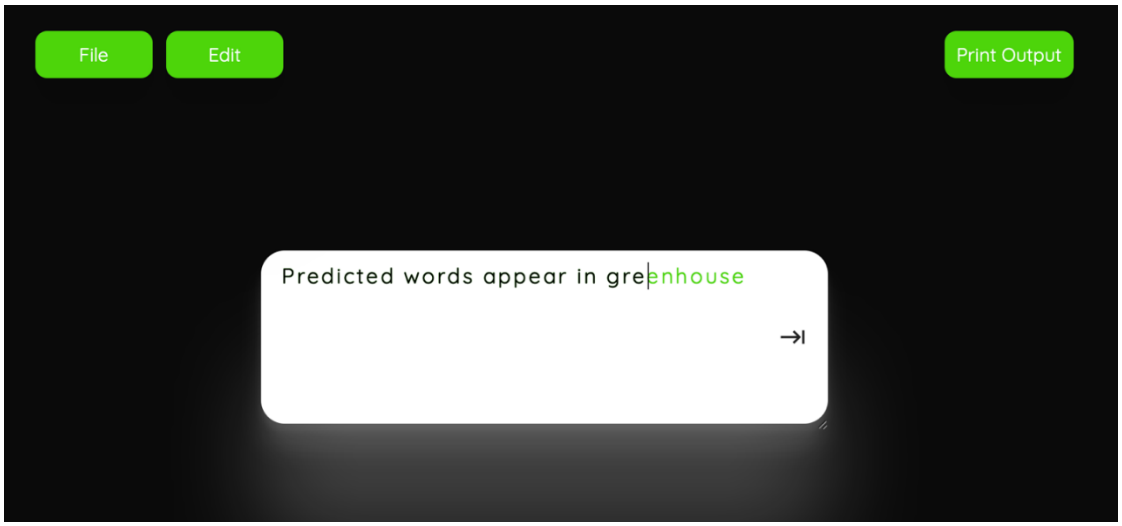

Figure 5. X-gram's borrows user-interface elements from Google's Smart Compose
X-gram's predictions appear in light green type, and writers accept predictions by pressing "tab"

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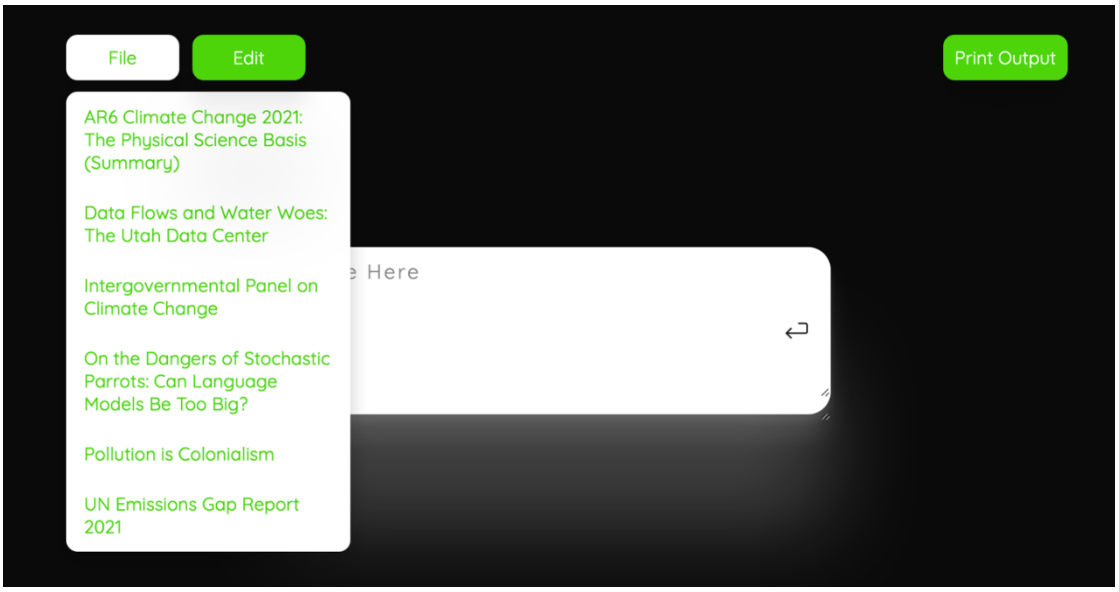

Figure 6. X-gram's "File" menu
X-gram's "File" menu provides links to the six texts that were mined for X-gram's word bank

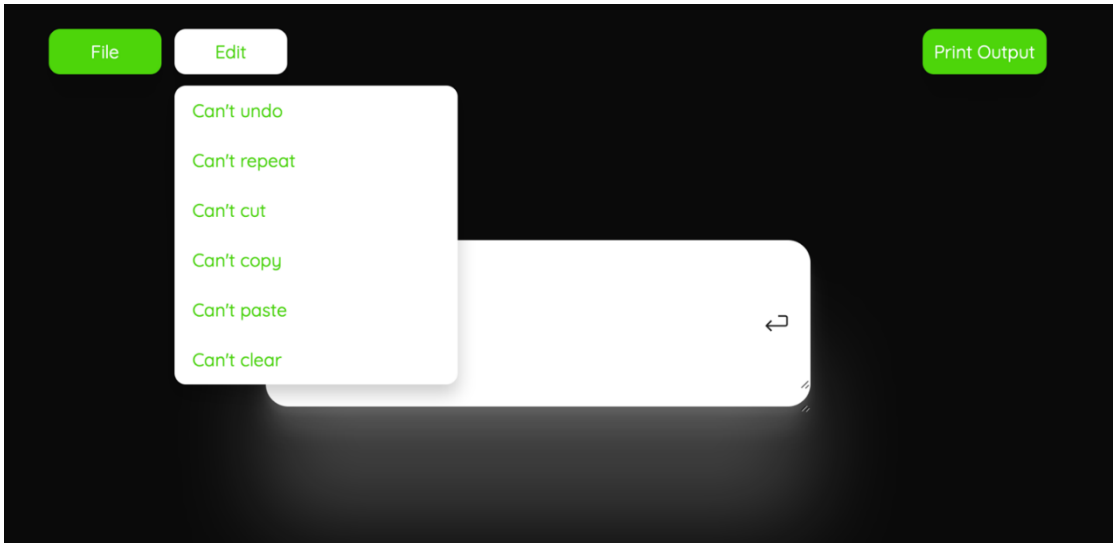

Figure 7. X-gram's "Edit" menu
X-gram's "Edit" menu reveals a list of "Can't" statements

5. Related work

Other research efforts have been conceptualized to link more explicitly LLMs, AI, and climate, but not in the vein of techsposure. ClimateBERT, for example, is a LLM whose purpose is to train applications to better predict climate-related words (Webersinke, Kraus, Bingler, & Leippold, 2022). Because ClimateBERT was trained on climate-related texts, deploying the LLM means that climate-related words will be better predicted than, say, when deploying a LLM that has not received specialized training. ClimaText, for its part, is "a dataset for sentence-based climate change topic detection" (Varini et al., 2021, p. 1). It aims to scan large volumes of text for content relating to climate and, more than that, to carry out several actions on that content, such as sentiment analysis (Varini et al., 2021). A project by

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Jonathan T.K. Chan (2021) aims to make climate texts more legible to the general public. Chan's "NLP Project - Text Summarization of IPCC Report" succeeded in reducing the reading difficulty level of the IPCC's Summary for Policymakers (2018). Finally, The Climate Does Not Exist shows the impacts of climate crisis, "one address at a time" (Tousignant, 2021, para. 3). The project imagines various locations around the world having been impacted by dimensions of climate change, and it generates images showing locations under these new conditions.

While making links between generative AI and the climate, the projects outlined above nonetheless reify the opacity of AI's entanglement with the climate. By contrast, X-gram, one instantiation of techsposure, prototypes a scenario in which one of generative AI's affordances, predictive text, is the very thing that reveals its material consequences.

6. Future work

Today, X-gram is largely a prototype. Available for viewing and interaction at X-gram.glitch.me, users will see the application's scope and functionality are limited—glitchy, even. It is early days in X-gram's journey.

But even so, X-gram is working toward research-creation's two hallmarks, audience and attunement, seeking generatively to engage audiences in the questions, how is the world organized? And, how might it be organized differently?

Which audiences does X-gram seek to engage? Planned future work will begin with students who will be invited to expand X-gram's scope and also to think through examples of techsposure. Subsequently, conference workshops will pursue the same.

What might other examples of techsposure look like? Imagine opening the photos app on a smartphone and seeing photographs that document mining practices involved in camera production. Find My iPhone could be reconfigured not to pinpoint the current location of my phone but rather to show the supply chains through which my phone passed to land in my hands. Or, as Ron Deibert (2020) muses about natural resources mined for tech production, "I have often thought how wonderful it would be if devices had a list of ingredients in the way that packaged food items do" (p. 214); I imagine clicking "About This Mac" on my computer and seeing the list Deibert has conceived. Projects like these would redeploy, with poetic justice, technological affordances so that their consequences are visible and clear.

The point here, too, is research-creation. While collaborating on the production of low-fidelity prototypes (which, with sufficient funding, will become interactive public exhibits) workshop participants will experience creation-as-research, one of the four subcategories of research-creation Chapman and Sawchuk (2012) elucidate. "'Creation-as-research' involves the elaboration of projects where creation is required in order for research to emerge" (p. 19): in other words, creation, and the emergence of research questions during creation, establish a new research agenda. My own work in process with X-gram has generated many questions, and I certainly look forward to the questions that participants and I will co-create.

Still, most exciting to me are, simply, the workshops themselves—and the possibility that readers of this article may organize their own. After all, neither X-gram nor techsposure are about taking on Big Tech. They are, rather, a simple invitation to put aside the neoliberal values surrounding generative AI and digital technologies, more broadly; to consider the often invisible relationships and consequences engendered by digital technologies; and to displace *how* in favor of *whether* and *if*.

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