

RESEARCH ARTICLE

Powerful tool or too powerful? Early public discourse about ChatGPT across 4 million tweets

Reuben Ng^{1,2*}, Ting Yu Joanne Chow¹

1 Lee Kuan Yew School of Public Policy, National University of Singapore, Singapore, Singapore, **2** Lloyd's Register Institute for the Public Understanding of Risk, National University of Singapore, Singapore, Singapore

* spprng@nus.edu.sg

Abstract

Background

This paper investigates initial exuberance and emotions surrounding ChatGPT's first three months of launch (1 December 2022–1 March 2023). The impetus for studying active discussions surrounding its implications, fears, and opinions is motivated by its nascent popularity and potential to disrupt existing professions; compounded by its significance as a crucial inflexion point in history. Capturing the public zeitgeist on new innovations—much like the advent of the printing press, radio, newspapers, or the internet—provides a retrospective overview of public sentiments, common themes, and issues.

Objectives

Since launch, few big data studies delved into initial public discourse surrounding the chatbot. This report firstly identifies highest-engagement issues and themes that generated the most interaction; secondly, identifies the highest-engaged keywords on both sides of the sentiment valence scale (positive and negative) associated with ChatGPT.

Methods

We interrogate a large twitter corpus ($n = 4,251,662$) of all publicly available English-language tweets containing the ChatGPT keyword. Our first research aim utilizes a prominent peaks model (upper-quartile significance threshold of prominence $>20,000$). Our second research aim utilized sentiment analysis to identify, week-on-week, highest-frequency negative, and positive keywords and emojis.

Results

Six prominent peaks were identified with the following themes: 'hype and hesitance', 'utility and misuse in professional and academic settings', 'demographic bias', 'philosophical thought experiments on morality' and 'artificial intelligence as a mirror of human knowledge'. Of high-frequency valence, negativity included credibility concerns, implicit bias,

OPEN ACCESS

Citation: Ng R, Chow TYJ (2024) Powerful tool or too powerful? Early public discourse about ChatGPT across 4 million tweets. PLoS ONE 19(3): e0296882. <https://doi.org/10.1371/journal.pone.0296882>

Editor: Adiwan F. Aritenang, Institut Teknologi Bandung, INDONESIA

Received: November 23, 2023

Accepted: December 14, 2023

Published: March 27, 2024

Copyright: © 2024 Ng, Chow. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: All relevant data are within the manuscript.

Funding: "We gratefully acknowledge support from the Social Science Research Council's SSHR Fellowship (MOE2018-SSHR-004) and the Commonwealth Fund's Harkness Fellowship in Healthcare Policy and Practice. The funders had no role in study design, data collection, analysis, writing, and decision to publish. There was no additional external funding received for this study."

Competing interests: The authors have declared that no competing interests exist.

environmental ethics, employment rights of data annotators and programmers, the ethicality of neural network datasets. Positivity included excitement over application, especially in coding, as a creative tool, education, and personal productivity.

Conclusions

Overall, sentiments and themes were double-edged, expressing excitement over this powerful new tool and wariness toward its potential for misuse.

Introduction

Since the introduction of ChatGPT—a natural language processing chatbot developed by the company OpenAI—on December 1, 2022, its userbase exploded in popularity, netting a hundred million in its first month. While being the most popular, ChatGPT is only one out of many other generative programs that are powered by processing models: among generative art programs like *DALL-E* and *Stable Diffusion*; representing a crest in a wave of new artificial intelligence technology arriving on the shores of the internet. As the world stands on the precipice of new innovations—the advent of the printing press, the radio, newspapers, for instance—they often catch their share of ire and praise. In similar fashion, ChatGPT has generated a flurry of discussions on its implications and potential uses.

The burgeoning impact of ChatGPT has been investigated from an academic lens, ranging from disapproval over its dubious role in research authorship [1], difficulties in discerning human-generated abstracts from ChatGPT-generated abstracts [2]; though the technology may democratize the playing field by aiding weaker writers [3], with one in three healthcare researchers skewing positive on its applications [4]. Its ramification on medical scholarship is pronounced, particularly in instances where it confidently creates false facts [5], or creates outputs rife with inaccuracies [6]; suggesting that a degree of caution and human judgment must be exercised [7] despite its strengths [8]. While many such studies, editorials, and commentaries have been published in relation to ChatGPT's impact in professional settings, fewer exist in relation to general perceptions. Since its launch, few big data studies have delved into initial public discourse surrounding the chatbot. Existing large-scale data studies on early adopters suggest overwhelmingly positive sentiment toward the technology [9], though fears surround its impact on existing jobs [10]; early sentiments involve excitement on its potential applications, albeit with red flags on ethical concerns [11]. Other studies have also found that ChatGPT, when used as a chatbot, generated higher-quality and more empathetic replies than the average professional [12], and was met with enthusiasm over its applications in education [13] and its user-friendly interface as an information amalgamator [14]. Such technologies have the potential to cut a swathe through existing professional sectors, thus presenting a crucial inflexion point in history to capture the public zeitgeist on artificial intelligence.

With this impetus established, we aim to analyze the exuberance and emotions surrounding ChatGPT's initial public perceptions. We interrogate a corpus dataset of all English-language tweets containing the *ChatGPT* keyword from 1 December 2022 to 1 March 2023 ($n = 4,251,662$) to ask two research questions: First, *what are the biggest issues or themes that generated the most engagement?* Second, *what are the highest-frequency keywords, and what are its sentiments like?* Our first aim is achieved by running a prominent peaks model (prominence $> 20,000$), identifying themes associated with mention count spikes. Our second aim identified highest-frequency keywords rated by valence (positive, neutral, negative),

mapped chronologically by week. By focusing on metrics that generated the most discussion, we provide a bird's eye view of burgeoning narratives that surrounded this new technology's debut onto the global stage.

Methods

Dataset

The dataset used for this study was collected using Twitter's application programming interface standard search, publicly accessible via Twitter API V2 on the academic research access level. All English-language tweets containing the 'ChatGPT' keyword—used in context as either a keyword or hashtag, and not case-sensitive—published between 1 December 2022 and 1 March 2023 were shortlisted ($n = 4,251,662$). A summary of methods used is available in [Fig 1](#).

Research aim 1: Prominent peaks modelling

Our first research aim involved two methodological steps. First, we quantitatively identified prominent peak dates in which 'ChatGPT' experienced a spike in mention count—defined by the total number of original tweets, replies, and retweets containing the keyword—signaling a significant increment in interest and engagement in the topic. This analysis was conducted using peak prominence detection modelling (Python version 3.7: SciPy 1.4.1). The python package module operated based on marking the higher of two bases as the peak's lowest contour line. Prominence was then calculated as the vertical difference between the peak's height, and its lowest contour line. Simply put, for any given date with a certain mention value (A), the program checks for the lowest possible point *prior* to that date (B), and likewise in the other chronological direction for the lowest possible point *after* that date (C): the average of these two values (A-B; A-C) is then defined as the date's prominence score, a value assigned relative to the lowest possible point on either side of the calendar.

A total of 23 statistically significant peaks were found during the study period ($\bar{x} = 17,564$; $\sigma = 21,883$); of which, prominence scores of said peaks were calculated to range from 4582 (lower quartile), to 8932 (median), to 20838 (upper quartile). Using a data-driven approach to determine an adequate threshold for significance, we selected peaks that appeared only in the upper quartile of prominence (i.e., Prominence $> 20,000$) for further investigation, essentially, delving into the top 75% of discussion spike dates. This method yielded 6 peaks: 6 individual dates where prominence exceeded the upper quartile's significance threshold.

Using these identified 6 upper quartile peak dates, our second methodological step involved qualitatively sampling the top engaged tweets on those days (i.e., a qualitative interrogation of the retweets, replies, and discussions, and a sample of the top-100 tweets with the most 'likes'), to identify the main themes, events, or discussions that contributed to the day's significant increase in discursive volume, taking into account the detractors (often represented by quote tweets or replies) and supporters (often represented by retweets and large amounts of 'likes') of certain topics or emergent issues. A summary of results is presented in [Fig 2](#).

Research aim 2: Weekly top keywords and valence

Our second research aim chronicled highest-frequency keywords used in conjunction with ChatGPT tweets, further subcategorized by valence (positive or negative sentiment polarity) or practical utility (neutral sentiment, keywords about potential uses) on a weekly basis. This involved two methodological steps. The first step involved identifying frequently co-occurring collocates (individual words, bigrams, trigrams, quadrigrams: scored by raw frequency totaling retweets, reposts and unique mentions) in our corpus dataset. Second, these high-frequency

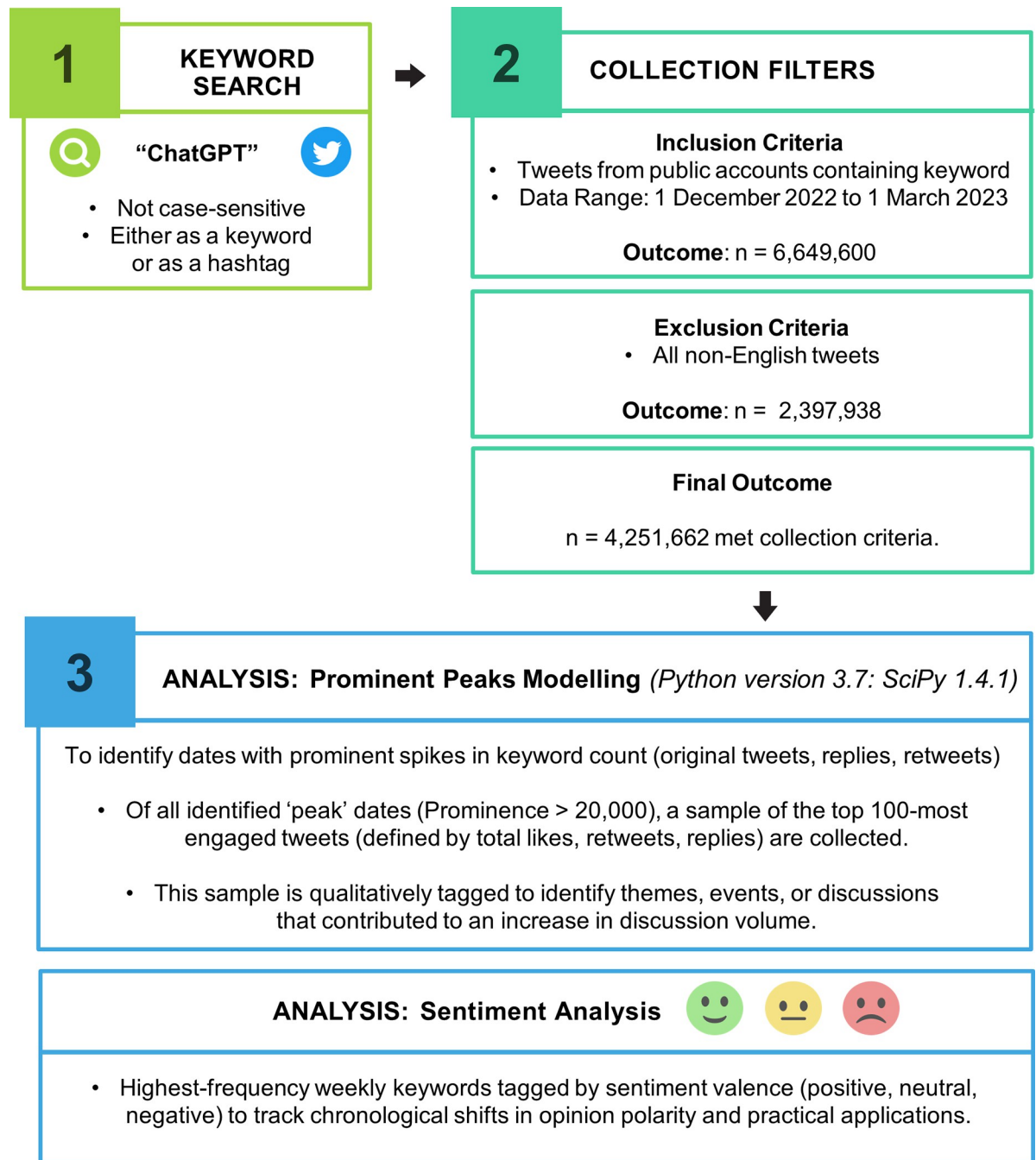
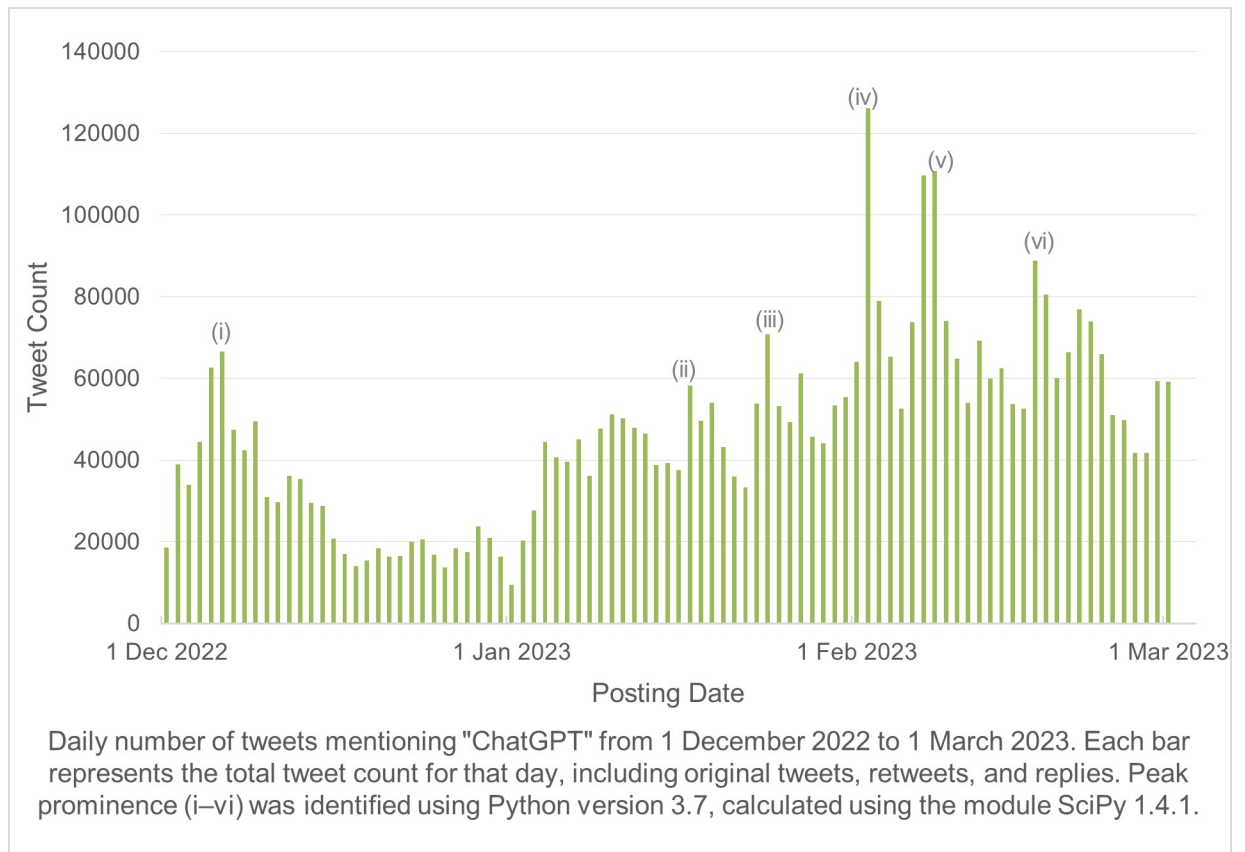


Fig 1. Methodological summary: Data collection and analytic plan.

<https://doi.org/10.1371/journal.pone.0296882.g001>

keywords were then evaluated for their sentiment valence (positive or negative) and whether the phrase related to potential uses (neutral) and sorted into [Table 1](#), along with the top five emojis used in that week. This analysis provides a rolling chronology of shifts in opinions: term frequency was used as a proxy for overall public buzz, representing the main sources of interactions and discussions about practical applications and the ethics of AI during this early adoption window.



Peak	Date	Associated themes & significant discussions	Count (Original tweets, replies, retweets)	Prominence
(i)	6/12/2022	Initial buzz: hype and hesitance	66601	57086
(ii)	17/1/2023	Discussions on potential uses	58236	24924
(iii)	24/1/2023	Utility in academic settings: studying, exams, plagiarism	70791	26666
(iv)	2/2/2023	The detection of bias: political, racial, religious, identities	126176	84425
(v)	8/2/2023	Philosophical thought experiments and moral permissibility	110750	58110
(vi)	17/2/2023	AI as a mirror to humanity	88769	36140

Fig 2. Prominent peaks in ChatGPT conversations across 4 million tweets.

<https://doi.org/10.1371/journal.pone.0296882.g002>

Results

Overall peaks and emergent issues

We present findings of identifying prominent peaks and emergent issues within the first three months of ChatGPT’s official release in Fig 2. Peak prominence was observed in dates (i)–(vi), with each spike attributable to a new dominant discorsal theme.

Peak (i): Initial buzz: Hype and hesitance. This first peak was attributable to the technology’s nascent popularity: this day was met with excitement about its userbase crossing a million users 5 days into launch. Positive sentiments included speculation on its value to creative fields as a content-generation aid; merits as an amalgamator of existing human knowledge; its potential to usurp existing tech goliaths; and the relative ease and accessibility for users to submit

Table 1. Highest frequency keywords by sentiment valence.

Week (Date Range)	Sentiment Valence and Respective Keywords			
	Negative	Positive	Neutral	Top 5 Emojis (Unicode v15.0 CLDR Short Name)
1 (30/11/22–04/12/22)	<ul style="list-style-type: none"> crazy chatgpt loop hallucinated chat room weird trick exactly zero coverage 	<ul style="list-style-type: none"> huge breakthrough good debugging companion biggest tech innovation 	<ul style="list-style-type: none"> proprietary prompt new ai system bubble sort algorithm technical questions senior data engineer 	<ul style="list-style-type: none"> exploding head repeat button thread face with tears of joy backhand index pointing down
2 (05/12/22–11/12/22)	<ul style="list-style-type: none"> problem of bias misleading impression blockchain trilemma cognitive dissonance 	<ul style="list-style-type: none"> robustness and truthfulness unique human skill full potential 	<ul style="list-style-type: none"> workout plan meal plan calorie targets unique architecture modern physics 	<ul style="list-style-type: none"> thread eyes backhand index pointing down laptop exploding head
3 (12/12/22–18/12/22)	<ul style="list-style-type: none"> stolen artwork absolute minimal effort nonsense overconfidence get rich-quick scheme 	<ul style="list-style-type: none"> best possible use 	<ul style="list-style-type: none"> large language models illustrator ai image generator 	<ul style="list-style-type: none"> thread backhand index pointing down—face with tears of joy fire exploding head
4 (19/12/22–25/12/22)	<ul style="list-style-type: none"> fossil fuels variants and competitors 	<ul style="list-style-type: none"> fascinating applications 	<ul style="list-style-type: none"> lesson plans code recent investments nuclear energy 	<ul style="list-style-type: none"> thread backhand index pointing down exploding head backhand index pointing right face with tears of joy
5 (26/12/22–01/01/23)	<ul style="list-style-type: none"> counter-suggestions ai explosion 	<ul style="list-style-type: none"> possibilities internet by storm new era 	<ul style="list-style-type: none"> copywriters open-source implementation whole new industry many creators 	<ul style="list-style-type: none"> rocket robot backhand index pointing down winking face thread
6 (02/01/23–08/01/23)	<ul style="list-style-type: none"> limited knowledge simple mistakes 	<ul style="list-style-type: none"> insanely useful powerful tools incredible ways 	<ul style="list-style-type: none"> modern marketing daily workflow 	<ul style="list-style-type: none"> backhand index pointing down exploding head thread link police car light
7 (09/01/23–15/01/23)	<ul style="list-style-type: none"> religious bias 	<ul style="list-style-type: none"> leverage full potential productivity best open-source speech model free marketing assistant eye-openers 	<ul style="list-style-type: none"> creators and writers speech essays velocity and quality value of inclusion best open-source speech model 	<ul style="list-style-type: none"> backhand index pointing down thread exploding head fire grinning face with smiling eyes
8 (16/01/23–22/01/23)	<ul style="list-style-type: none"> outsourced kenyan workers shocking twist investigation 	<ul style="list-style-type: none"> free employee magical computer intelligence 	<ul style="list-style-type: none"> education marketing assistant 	<ul style="list-style-type: none"> police car light thread backhand index pointing down fire robot
9 (23/01/23–29/01/23)	<ul style="list-style-type: none"> magic nothingness 	<ul style="list-style-type: none"> amazing resource free assistant 	<ul style="list-style-type: none"> charm and syntax ambiguous scenarios undergraduate paper med school 	<ul style="list-style-type: none"> thread backhand index pointing down exploding head face with tears of joy robot
10 (30/01/23–05/02/23)	<ul style="list-style-type: none"> wing bias credibility damage irreparable 	<ul style="list-style-type: none"> content creation superpower 	<ul style="list-style-type: none"> grammar checker homework academic purposes poem natural language processing engine personalized meeting templates 	<ul style="list-style-type: none"> backhand index pointing down collision exploding head blue book police car light

(Continued)

Table 1. (Continued)

Week (Date Range)	Sentiment Valence and Respective Keywords			
	Negative	Positive	Neutral	Top 5 Emojis (Unicode v15.0 CLDR Short Name)
11 (06/02/23–12/02/23)	<ul style="list-style-type: none"> political bias racial slur pithy essay 	<ul style="list-style-type: none"> phenomenal ai super tool full potential 	<ul style="list-style-type: none"> best chatgpt resources chatgpt for advice scientific paper sharing of training data students 	<ul style="list-style-type: none"> backhand index pointing down thread rocket fire backhand index pointing right
12 (13/02/23–19/02/23)	<ul style="list-style-type: none"> unbelievably woke response gaslights 	<ul style="list-style-type: none"> ai memes active community 	<ul style="list-style-type: none"> finance research freelancer and businessman job advert 	<ul style="list-style-type: none"> fire check mark button backhand index pointing down robot backhand index pointing right
13 (20/02/23–26/02/23)	<ul style="list-style-type: none"> fake citations to papers 5th-gen warfare tools flaws 	<ul style="list-style-type: none"> trust and safety engaging content 	<ul style="list-style-type: none"> basic marketing academic writing copywriting tools 	<ul style="list-style-type: none"> robot backhand index pointing down fire check mark button partying face

<https://doi.org/10.1371/journal.pone.0296882.t001>

prompts. This was countered by skepticism: the bot criticized for its tendency to confidently present nonfactual data as fact (e.g., non-existent citations, untrue scientific information, providing different answers to similar prompts); its credibility was problematized in phrases like ‘hallucinations’, ‘echo chamber’ and ‘black box’ to describe inconsistent data outputs.

Peak (ii): Discussions on potential uses. This peak surrounded discourse on how the technology was viable for increasing efficiency in professional fields like business or consumer marketing, enhancing personal productivity, and in simplifying basic tasks. Within this peak, several tech accounts and bots were observed to promote links to full guides, crash courses, and tutorial resources on search prompt optimization.

Peak (iii): Utility in academic settings: Studying, exams, plagiarism. This peak was related to academia. Discussions surrounded whether academic essays produced by the bot were discernible from the average student: one camp of educators reflected it was almost impossible to tell, while another claimed that paragraphs produced by the bot—while grammatically accurate—lacked the earnestness and complex syntax of authentic student papers. Mild panic ensued over the bot’s ability to obtain passing grades on examinations in knowledge-based fields (e.g., law, medicine, business); though this was countered by clarifications that such tests were often multiple-choice—not written—and entirely divorced from actual professional practice. The issue of plagiarism was also discussed: some likened the bot’s assistive function as a research and proofreading tool to the use of calculators in modern-day math classes; while others believed its use lacked academic integrity.

Peak (iv): The detection of bias: Political, racial, religious, identity markers. This peak involved criticism on the inconsistent output of controversial prompts. Demographic bias surfaced along the lines of political, racial, religious, gender- and sexual-identities, with the bot refraining from generating content about certain groups over others. Debates ensued over the degree to which AI engineers held responsibility over this issue of unequal treatment. Users opined on whether this was deliberately programmed malicious propaganda, or simply shortcomings of any new technology to be improved upon with time; suggesting that artificial systems should behave descriptively rather than prescriptively: neutral by default, but with parameters allowing individual user customization and preference toggles.

Peak (v): Philosophical thought experiments and moral permissibility. This peak was dominated by a trend of submitting thought experiments as prompts: for instance, presenting

the ‘trolley problem’ or ‘train car experiment’—common philosophical conundrums presenting an ethical dilemma. Common iterations included presenting the bot with hypothetical choices: between killing one person or five; saving young children or older adults; using a racial slur or setting off an atomic bomb. Others also elicited nuanced ethical judgments from the bot by asking complex philosophical questions on human nature and war. Others attempted to circumvent off-limits questions by setting specific prompt parameters, thereby granting the bot ‘permission’ to take on different personas by answering questions as separate hypothetical entity unbound to coded restrictions on sensitive topics. Submitters of these prompts would then point to the bot’s generated answer as a sign of implicit bias. Conversely, other users pointed out that the bot functioned by mimicking patterns in human language using the dataset it was trained on, and it was thus futile to ascribe morality to its outputs.

Peak (vi): AI as a mirror to humanity. This engagement peak saw a flurry of discussions about the nature of artificial intelligence holding a mirror up to humanity, representing the massive collection of texts its neural network is trained on. Parallels were drawn between the bot as a more sophisticated ‘auto-complete’ function, due to its output reflecting the most statistically probable series of words based on a collective set of human knowledge. Others described this technology akin to a less-impressive parrot: only repeating data it was trained on and constricted further by alleged censorship coded by AI engineers who set restrictions on topics deemed too sensitive.

Top keywords by valence

We present findings of top keywords rated by sentiment score in [Table 1](#), mapping weekly chronological progressions of highest-frequency terms.

Overall, highest-frequency negative keywords indicate concerns about credibility of the new technology (e.g. *hallucinated*, *crazy loop*, *cognitive dissonance*, *limited knowledge*, *simple mistakes*, *overconfidence*, *misleading*), implicit bias when generating answers for queries (e.g. *bias*, *misleading*, *political bias*, *wing bias*, *religious bias*), environmental ethics (e.g. *fossil fuels*), employment rights of data annotators (e.g. *outsourced workers*, *investigation*), and adjacent debates on whether programs based on a neural network of existing human works is ethical (e.g. *stolen artwork*, *minimal effort*).

Highest-frequency positive and neutral keywords indicate excitement over general possibilities (e.g., *huge breakthrough*, *biggest tech innovation*), especially in coding (e.g., *good debugging companion*, *insanely useful*, *code*) and as a creative tool (e.g., *content creation superpower*, *copywriters*), education (e.g., *lesson plans*, *essays*, *undergraduate paper*, *academic purposes*, *grammar checker*), daily personal use (e.g., *workout plan*, *meal plan*, *calorie targets*, *personalized meeting templates*)

The highest-frequency emojis generally point to excitement and interest over the new technology (e.g., ‘mind-blown/exploding head’ [🤯], ‘attentive eyes’ [👁️]), and conveying something being explosively exciting (e.g., ‘boom/collision’ [💥], ‘fire’ [🔥]), technological applications (e.g., related to technology and information: laptop, rocket, robot, blue notebook [💻, 🚀, 🤖, 📓]), sharing of information in threads (e.g., ‘call-to-action’ emojis prompting users to click for more: thread, backhand index fingers pointing downward or to the right, embedded hyperlinks [👉, 👇, 📌, 🔗]), caution and ridicule (e.g., generally conveying doubt: ‘laughing-crying face with tears of joy’ [😂], ‘alarm bell/police car light’ [🚨]).

Discussion and conclusion

We analyzed large-scale data of emergent public chatter, focusing on engagement and frequency metrics surrounding ChatGPT’s initial launch. Our research findings indicate

discussions around its myriad uses, particularly in education and professional settings, though tempered by doubt over its accuracy. This burgeoning technology raised questions on the ethics of artificial intelligence, surfacing issues of implicit demographic bias and philosophical dilemmas on morality judgements. Summarily, prominent peak analysis suggests excitement surrounding the potentially powerful tool, met with doubt due to a potential for misuse—perfectly emblemizing initial hype and hesitance.

Future research may involve tracking the chronological progression of this technology, charting public perception as the software is improved. It is also acknowledged that ChatGPT is not the only publicly available AI model: follow-up analysis using the methodology may be applied to track public perceptions on other popular generative models (e.g., *DALL-E*, *Stable Diffusion*).

Of conceptual significance, this paper contributes to building a structured understanding of social media narratives of an explosive new technology: an artificial intelligence tool that entered public consciousness with a splash. A record of the early narratives of such a historic event provides a referential basis upon which future new phenomena could be compared. By that token, of methodological significance is the replicability of the methodology across different contexts, sectors, or industries. The methodology may also be replicated for the same ChatGPT topic across a future time-period, to compare whether societal narratives on such technologies have become more nuanced, or changed dramatically alongside new events. Of practical significance, such studies deepen our understanding of how people react to new technologies—worries and woes on ethical concerns—which may inform how tech companies could consider framing new releases to prevent unintentional backlash.

Author Contributions

Conceptualization: Reuben Ng.

Data curation: Ting Yu Joanne Chow.

Formal analysis: Reuben Ng, Ting Yu Joanne Chow.

Funding acquisition: Reuben Ng.

Investigation: Reuben Ng.

Methodology: Reuben Ng.

Resources: Reuben Ng.

Supervision: Reuben Ng.

Writing – original draft: Reuben Ng, Ting Yu Joanne Chow.

Writing – review & editing: Reuben Ng, Ting Yu Joanne Chow.

References

1. Stokel-Walker C. CHATGPT LISTED AS AUTHOR ON RESEARCH PAPERS. *NATURE*. 2023 Jan 26; 613(7945):620–U21.
2. Gao CA, Howard FM, Markov NS, Dyer EC, Ramesh S, Luo Y, et al. Comparing scientific abstracts generated by ChatGPT to real abstracts with detectors and blinded human reviewers. *npj Digital Medicine*. 2023 Apr 26; 6(1):75. <https://doi.org/10.1038/s41746-023-00819-6> PMID: 37100871
3. Noy S, Zhang W. Experimental evidence on the productivity effects of generative artificial intelligence. *Science*. 2023 Jul 14; 381(6654):187–92. <https://doi.org/10.1126/science.adh2586> PMID: 37440646
4. Praveen S, Vajrobol V. Understanding the Perceptions of Healthcare Researchers Regarding ChatGPT: A Study Based on Bidirectional Encoder Representation from Transformers (BERT)

- Sentiment Analysis and Topic Modeling. *ANNALS OF BIOMEDICAL ENGINEERING*. 2023 Aug; 51(8):1654–6. <https://doi.org/10.1007/s10439-023-03222-0> PMID: 37129780
5. Shen Y, Heacock L, Elias J, Hentel K, Reig B, Shih G, et al. ChatGPT and Other Large Language Models Are Double-edged Swords. *RADIOLOGY*. 2023 Apr; 307(2). <https://doi.org/10.1148/radiol.230163> PMID: 36700838
 6. Salvagno M, Taccone F, Gerli A. Can artificial intelligence help for scientific writing? *CRITICAL CARE*. 2023 Feb 25; 27(1).
 7. Kitamura F. ChatGPT Is Shaping the Future of Medical Writing But Still Requires Human Judgment. *RADIOLOGY*. 2023 Apr; 307(2). <https://doi.org/10.1148/radiol.230171> PMID: 36728749
 8. Cascella M, Montomoli J, Bellini V, Bignami E. Evaluating the Feasibility of ChatGPT in Healthcare: An Analysis of Multiple Clinical and Research Scenarios. *JOURNAL OF MEDICAL SYSTEMS*. 2023 Mar 4; 47(1). <https://doi.org/10.1007/s10916-023-01925-4> PMID: 36869927
 9. Haque MU, Dharmadasa I, Sworna ZT, Rajapakse RN, Ahmad H. "I think this is the most disruptive technology": Exploring Sentiments of ChatGPT Early Adopters using Twitter Data. 2022. <https://doi.org/10.48550/arXiv.2212.0585>
 10. Taecharungroj V. "What Can ChatGPT Do?" Analyzing Early Reactions to the Innovative AI Chatbot on Twitter. *Big Data and Cognitive Computing*. 2023; 7(1).1.
 11. Dwivedi Y, Kshetri N, Hughes L, Slade E, Jeyaraj A, Kar A, et al. "So What if ChatGPT Wrote It?" Multi-disciplinary Perspectives on Opportunities, Challenges and Implications of Generative Conversational AI for Research, Practice and Policy. 2023; 71:102642.
 12. Ayers J, Poliak A, Dredze M, Leas E, Zhu Z, Kelley J, et al. Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum. *JAMA INTERNAL MEDICINE*. 2023 Jun; 183(6):589–96. <https://doi.org/10.1001/jamainternmed.2023.1838> PMID: 37115527
 13. Tlili A, Shehata B, Adarkwah M, Bozkurt A, Hickey D, Huang R, et al. What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *SMART LEARNING ENVIRONMENTS*. 2023 Feb 22; 10(1).
 14. Sallam M, Salim N, Al-Tammemi A, Barakat M, Fayyad D, Hallit S, et al. ChatGPT Output Regarding Compulsory Vaccination and COVID-19 Vaccine Conspiracy: A Descriptive Study at the Outset of a Paradigm Shift in Online Search for Information. *CUREUS JOURNAL OF MEDICAL SCIENCE*. 2023 Feb 14; 15(2). <https://doi.org/10.7759/cureus.35029> PMID: 36819954