



ChatGPT and Open-AI Models: A Preliminary Review

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Abstract: According to numerous reports, ChatGPT represents a significant breakthrough in the field of artificial intelligence. ChatGPT is a pre-trained AI model designed to engage in natural language conversations, utilizing sophisticated techniques from Natural Language Processing (NLP), Supervised Learning, and Reinforcement Learning to comprehend and generate text comparable to human-generated text. This article provides an overview of the training process and fundamental functionality of ChatGPT, accompanied by a preliminary review of the relevant literature. Notably, this article presents the first comprehensive literature review of this technology at the time of publication, aiming to aggregate all the available pertinent articles to facilitate further developments in the field. Ultimately, the authors aim to offer an appraisal of the technology's potential implications on existing knowledge and technology, along with potential challenges that must be addressed.

Keywords: ChatGPT; ChatGPT review; GPT-4; natural language processing; generative pre-trained transformer



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1. Introduction

ChatGPT is a state-of-the-art language model that has revolutionized natural language processing by generating human-like text with context and coherence, enabling new possibilities for human-AI interaction [1]. Its impressive performance in various language tasks and benchmarks has established it as one of the leading language models in the world [2]. ChatGPT's advanced language modeling capabilities have the potential to transform the way we interact with computers and machines by enabling more natural and intuitive communication [3]. Pre-training on massive amounts of text data has equipped ChatGPT with the ability to understand the nuances of language and generate highly accurate responses, even in complex and ambiguous contexts [4]. Additionally, ChatGPT's ability to learn from both structured and unstructured data makes it a highly flexible and versatile conversational AI tool [5]. Its advanced neural architecture allows it to handle multiple inputs and generate highly personalized responses, leading to a more engaging and satisfying user experience [6].

Moreover, ChatGPT's ability to learn and adapt to user preferences and conversational styles over time makes it a highly effective tool for building long-term relationships with customers and clients [7]. ChatGPT's ability to generate coherent and contextually relevant responses in multiple languages has the potential to break down language barriers and promote cross-cultural communication [8]. Its impressive performance in generating creative and novel text has opened up new possibilities for applications in fields such as creative writing, marketing, and advertising [9]. Finally, ChatGPT's ability to generate highly realistic and convincing conversational responses can transform the way we learn, interact, and communicate with each other in the digital age [10].

ChatGPT was developed through a two-phase process involving unsupervised pre-training followed by supervised fine-tuning [4]. During the pre-training phase, the model was trained on a massive corpus of text utilizing unsupervised learning techniques, including language modeling and masked language modeling. The primary objective of this

phase was to enable the model to acquire a comprehensive understanding of the structure of natural language and the complex interrelationships between words and sentences.

Following the pre-training phase, the model was subject to fine-tuning various downstream tasks such as text completion, question-answering, and dialogue generation. The fine-tuning process encompassed the model's training on labeled datasets comprising task-specific input-output pairs. The model's parameters were iteratively adjusted to minimize the discrepancies between the model's predicted outputs and the proper labels for the given tasks [11].

The outcome was a versatile language model that could proficiently execute diverse natural language processing tasks and generate human-like responses to user inputs [4]. ChatGPT has undergone extensive training on a substantial corpus of data and encompasses many parameters that contribute to its exceptional performance on numerous benchmarks evaluating natural language processing.

ChatGPT is a generative AI model that utilizes deep learning methods to process and produce natural language text. Initially launched as a prototype on 30 November 2022, it became available to the public on 30 January 2023 [12]. The model is trained on vast amounts of text data, enabling it to capture human language patterns, nuances, and complexities. The training corpus includes various sources, such as books, articles, reviews, online conversations, and human-generated data, allowing the model to engage in non-trivial dialogues and provide accurate information on diverse topics [13]. By leveraging the GPT (Generative Pretrained Model [14]) as its foundation, ChatGPT not only expands upon its predecessor but also illuminates a promising trajectory for future research endeavors within this field.

The core advantages of such extensive language models are their ability to understand the context of a given input and produce the correct output [15]. This improvement is significant compared to earlier models because earlier models could not interpret the context of the piece of text. Additionally, the text generated by GPT models is of high quality and is difficult to distinguish from human text. The model can provide answers to questions that cannot be obtained from a search on the web. The responses can also be trusted because the model has been trained from extensive input data [13].

This article presents a preliminary exposition of ChatGPT (scoping review). Section 2 expounds a concise history of ChatGPT, elaborating on the system's genesis. Furthermore, the system's training process is explicated in detail, drawing on the existing literature. In Section 3, an extensive review of the literature is presented, compiling all relevant research publications to date. The literature review was conducted by sourcing the most recent 47 academic articles. Despite the technology's recent stable release on 13 February 2023, the literature on ChatGPT is rapidly expanding with novel ideas and potential applications. Section 3 provides an all-encompassing synopsis of the most recent research advancements in ChatGPT. To enhance comprehensibility and facilitate a structured analysis, the reviewed articles were methodically classified into eleven distinct research categories based on the articles' topic. Moreover, a designated indicator (citation indicator) was employed to evaluate the significance and impact of each paper. The order of presentation was determined by the magnitude of their contribution, with the most pivotal papers accorded priority. In the context of research articles, strong statements were systematically extracted and organized in a tabulated structure, along with the articles' domain and the number of citations. Finally, Section 4 discovers the advantages and disadvantages of ChatGPT, along with the authors' thoughts on crucial topics that should be further addressed and their effect on existing knowledge and technology.

This article aims to conduct a preliminary assessment of the available research literature on ChatGPT. The objective is to identify the nature and extent of research evidence, extract strong statements, and provide a foundation for future researchers to build upon.

2. ChatGPT Training Process

ChatGPT is a sophisticated large-scale, pre-trained language model developed by OpenAI. It has performed exceptionally on various natural language processing tasks, from language modeling and classification to text generation [12]. The success of ChatGPT stems from its unique training process, which involves using a large amount of unlabeled text data and an innovative training algorithm strategically designed to optimize the model's capacity to generate coherent and contextually suitable responses to natural language input.

ChatGPT was introduced in November 2022, and its primary purpose is to provide accurate responses to users' questions. As mentioned, it consists of different deep learning and reinforcement algorithms trained in the content of over 150 billion human-generated items, such as books, articles, blog posts, conversations, and reviews [16]. The platform has one million users and counting in just the first week, and it came out as an emerging technology in AI and natural language processing [17].

The foundation of ChatGPT goes back to the development of GPT, an AI language model developed by OpenAI in 2018. GPT was designed to guess the next word or complete a sentence in a human-generated text, and an immense number of human-generated texts trained its model. The technology was considered a successful and handy tool for several applications, including machine learning, language generation, text prediction in smartphone typing, and many more.

The OpenAI API utilizes various models with distinct capabilities. Among these models, GPT-3.5 is an upgraded version of GPT-3 and can comprehend and produce natural language and code. Meanwhile, DALL·E is a model that generates and modifies images based on a natural language input [18]. On the other hand, Whisper is a model that converts audio to text [19]. Embedding is a model group that transforms text into a numerical representation [20]. Codex is a collection of models that can interpret and produce code, including translating natural language into code [21]. Additionally, Moderation is a fine-tuned model that identifies potentially sensitive or unsafe text [22]. Lastly, GPT-3 is a set of models that can both comprehend and produce natural language [23].

OpenAI's models have applications in both research and production for developers. The GPT-3.5 series comprises a suite of models trained on a heterogeneous amalgam of text and code data predating Q4 2021. The code-DaVinci-002 model is primarily suitable for tasks that require pure code completion. Meanwhile, the text-DaVinci-002 model is an InstructGPT model that builds upon the code-DaVinci-002 model. Finally, the text-DaVinci-003 model advances upon the text-DaVinci-002 model [24].

This chapter presents an extensive exposition of the ChatGPT training process. The discussion entails the essential constituents of the training process, encompassing the model's architecture, text data pre-processing, and training algorithm.

2.1. The Architecture of the Model

The ChatGPT model's architecture design is grounded in a transformer-based neural network, expressly crafted to manipulate and generate natural language text. The transformer architecture, introduced by Vaswani et al. in 2017 [25], constitutes the state-of-the-art methodology for accomplishing natural language processing tasks.

The transformer architecture is renowned for its aptitude for apprehending extended-range dependencies in text data, which is indispensable for tasks such as language modeling and text generation [25]. The architecture embodies a series of transformer blocks, each encompassing a self-attention mechanism alongside a feedforward neural network. The self-attention mechanism confers the model with the faculty to focus on diverse parts of the input text. At the same time, the feedforward network enables the model to comprehend non-linear correlations between the input and output [26].

The ChatGPT model employs a specific variant of the transformer architecture known as the GPT-2 architecture, as introduced by Radford et al. [4] in 2019. The GPT-2 architecture is a multi-layer transformer model that features a large number of parameters, enabling it to capture complex relationships between the input and output [25]. The ChatGPT model, a variant of the GPT-2 architecture, possesses an even more significant number of layers and parameters, enhancing its potency and enabling it to generate highly realistic and coherent responses to natural language input.

2.2. Pre-Processing of Text Data

The pre-processing of text data constitutes a critical aspect of the ChatGPT training process as it plays a significant role in determining the quality and suitability of the input data for the model [27]. To this end, the pre-processing stage of text data for ChatGPT involves a sequence of procedures comprising tokenization, subword encoding, and data cleaning.

- Tokenization is a fundamental step in natural language processing that involves segmenting text into discrete units of meaning, known as tokens [27]. The purpose of tokenization is to facilitate the subsequent processing of text by the model. In the case of ChatGPT, tokenization is performed using a pre-trained tokenizer designed explicitly for natural language processing tasks. This tokenizer converts the input text into a sequence of tokens, where each token represents a specific word or subword unit. The resulting token sequence is then used as input for the model in further processing.
- Subword encoding is a widely used technique in natural language processing to handle rare or out-of-vocabulary words in the input text. It involves breaking down the input text into smaller units or subwords, which the model can then process. Subword encoding has been shown to improve the performance of language models on various natural language processing tasks. In the case of ChatGPT, subword encoding is performed using a pre-trained subword encoder, such as the Byte Pair Encoding (BPE) algorithm, specifically designed for natural language processing tasks [27,28].
- Data cleaning is a crucial step in pre-processing text data as it aims to eliminate irrelevant or noisy information from the input text, ultimately improving the quality and suitability of the input data for the model [29]. It involves a series of steps, such as removing punctuation, numbers, and special characters and correcting spelling and grammatical errors, among others. Data cleaning transforms the input text into a more coherent and standardized form, thereby enhancing the model's ability to capture meaningful patterns in the data.

2.3. Training Algorithm

The ChatGPT training algorithm employs a variant of the unsupervised pre-training technique based on transformer-based language modeling [25]. The model is trained to predict the next word in a text sequence, with the preceding words serving as input. This objective is accomplished by minimizing the anticipated word's negative log-likelihood, given the preceding words' contextual information. The training process comprises essential steps such as initialization, pre-training, and fine-tuning, which are critical in optimizing the model's performance.

The initialization phase of the ChatGPT training algorithm involves the random assignment of weights to the transformer-based neural network. The weights are initialized based on a normal distribution with a mean of zero and a standard deviation of 0.02, following the recommendations of the GPT-2 paper [4].

2.3.1. Pre-Training Phase

In the pre-training stage, the transformer-based neural network is trained on a large corpus of unlabeled text data to learn general features and patterns of natural language. The pre-training process involves two stages: unsupervised and supervised [27]. The former consists of training the model on unlabeled text data using the transformer-based language modeling approach. The latter involves fine-tuning the model on a smaller corpus of labeled data for specific natural language processing tasks, such as text classification or question answering. Both stages aim to enhance the model's performance in generating coherent and contextually appropriate responses to natural language input.

The pre-training process utilizes the Adam algorithm, a variant of stochastic gradient descent, to update the model weights more efficiently and stably [30].

2.3.2. Fine-Tuning Phase

The fine-tuning step in the training process of ChatGPT involves further optimizing the model's performance on specific natural language processing tasks by training it on a smaller corpus of labeled data. This step typically involves several vital processes, including data preparation, architecture modification, and parameter optimization [31].

During the data preparation process, the labeled data undergoes the same pre-processing steps as the unlabeled data, including tokenization, subword encoding, and data cleaning [27]. The model's architecture may be modified to better suit the specific task at hand, such as by replacing the final layer with a softmax layer for classification tasks [4]. The model's parameters are then optimized using the Adam algorithm to minimize the loss function of the specific task [30].

During fine-tuning, the model is trained on a smaller dataset of labeled data tailored to the particular natural language processing task. This ensures that the model's performance is optimized for the specific task while preserving its capacity to generate relevant and meaningful responses to natural language input [31].

3. Literature Review

In the previous sections, we have presented a detailed discussion on ChatGPT and its training process. The current section offers a comprehensive overview of the latest research findings on ChatGPT. To facilitate a structured analysis, the forty-seven reviewed articles were systematically divided into eleven distinct research topics (sub-sections) based on the domain of their inquiry. Additionally, a designated indicator (citation indicator) was implemented to ascertain the relevance and impact of each paper, with the order of presentation reflecting the significance of the article and the most crucial papers appearing first. In the context of research articles, strong statements were methodically derived and arranged in a structured tabular format, together with the domain of the articles and their corresponding citation counts. Table 1 provides a comprehensive summary of the papers utilized for the literature review. This includes relevant details such as the Research Topic, Strong Statements, Capabilities Examined, and Citation Indicator.

Due to the dynamic nature of ChatGPT as a nascent technology, multiple sources were employed to collate the articles. Initially, articles with the term "ChatGPT" in their title were retrieved via Google Scholar. Furthermore, articles from reputable publishers such as MDPI, Elsevier, and IEEE were included. It should be noted that certain articles, due to their newness, had not been indexed by Google Scholar at the time of data collection.

Table 1. Summary of the papers sorted by Research Topic and Citation Indicator.

Research Topic	Strong Statements	Capabilities Examined	Citation Indicator
Healthcare/Exams	ChatGPT can produce understandable reasoning and provide relevant clinical insights, increasing confidence in its trustworthiness and comprehensibility [32].	Reasoning/Logical Reasoning	140
Healthcare	ChatGPT does not produce original texts after paraphrasing [33].	Research/Paraphrasing/Academic Writing	63
Healthcare/Vaccine Effectiveness	ChatGPT could be an excellent research tool for conducting analyses and drafting research articles, but it could not be trusted to find article references [34].	Research/Academic Writing	18
Healthcare/Healthcare Education and Research	The proactive embrace of LLM technologies, with careful consideration of ethical and legal issues, can expedite innovation in healthcare [35].	-	11
Healthcare	ChatGPT lacks context, inaccuracy, bias, and understanding of the nuances of medical sciences and language [36].	-	8
Healthcare/Education	ChatGPT commits errors in basic reasoning, logic, mathematics, and presenting factual information [37].	Research/Reasoning/Calculations	8
Healthcare/Biomedical	Even though ChatGPT's responses were methodical, accurate, and innovative, they lacked the quality expected of scholarly writing [38].	Research/Reasoning/Academic Writing	8
Healthcare/Dentistry	ChatGPT can be used to oversee the telemonitoring of patients, furnish virtual training settings, and enhance evaluations of students and the care of patients [39].	Reasoning/Critical Thinking	7
Healthcare/Diagnosis	ChatGPT provided correct diagnoses with more than 90% accuracy [40].	Research	4
Healthcare/Orthodontics/Diagnosis	ChatGPT could monitor more patients simultaneously compared to traditional treatment management methods [41].	Research	3
Healthcare/Pharmacy	ChatGPT could provide only general knowledge regarding the chosen topic and is incapable of providing a comprehensive analysis [42].	Research/Reasoning/Academic Writing	2
Healthcare/Diagnosis	ChatGPT achieved an impressive level of accuracy in clinical decision-making, but it might face difficulties in making a diagnosis based on a canonical presentation [43].	Research/Understanding/Reasoning	0
Healthcare/Drug Discovery	ChatGPT's model's performance is directly linked to the data quality used for its training [44].	Reasoning/Research	0
Healthcare/Orthodontic	ChatGPT can be used to enhance patient care and outcomes [45].	-	0
Healthcare/Pediatric	While there are challenges associated with the use of ChatGPT in pediatric research, there are also opportunities for language models to make significant contributions to the field [46].	-	0
Education/Teaching	ChatGPT could assist teachers by automating various tasks such as assessment, plagiarism detection, administration, and feedback mechanisms [47].	-	58

Table 1. Cont.

Research Topic	Strong Statements	Capabilities Examined	Citation Indicator
Education/Exams	Responses given by ChatGPT were on-topic and relevant, achieving high scores on precision, relevance, depth, and originality [15].	Research/Critical Thinking	52
Education/Chatbots	ChatGPT is extremely important and valuable for transforming education [48].	-	19
Education/Teaching	It is crucial to provide resources and training for educators to use ChatGPT effectively [49].	Teaching Assistance	0
Education/Teaching	Educators should guide students on effective questioning techniques and the validation of responses while developers improve the accuracy of ChatGPT [50].	Teaching Assistance/Reasoning	0
Education/Academic Writing	Should be created ethical guidelines to ensure the responsible use of AI language models in scientific publishing [51].	Research/Academic Writing	0
General	ChatGPT demonstrates greater proficiency in deductive and abductive reasoning as opposed to inductive reasoning [52].	Reasoning/Logical Reasoning	49
General	ChatGPT's ability to fix bugs significantly surpasses the outcomes achieved by conventional program repair approaches [53].	Code Debugging	21
General	Current benchmarks on ChatGPT cannot adequately address a significant proportion of ethical concerns [54].	Ethics	27
General	ChatGPT outperformed the RoBERTa-large model on various tasks. ChatGPT achieves a similar level of comprehension as some BERT-style models. Falls short of outperforming the current top models on specific natural language understanding tasks [55].	Linguistics/Paraphrasing/Understanding	12
Finance/Cryptocurrency	ChatGPT's public data outperform private data [16].	Research/Academic Writing	44
Finance	ChatGPT's responses were compared against students' answers outperforming the average college student [56].	Understanding/Reasoning	5
Machine Learning/AI/Natural Language Processing	ChatGPT performs superior to GPT-3.5, highlighting its remarkable arithmetic reasoning ability [57].	Reasoning/Calculations	32
Machine Learning/AI	The text generated by ChatGPT has less coherence and feelings than the text generated by a human [58].	Research	5
Machine Learning/Data Science	ChatGPT enhances the productivity and accuracy of data science workflows [59].	-	5
Machine Learning/AI/Chatbots	From the perspective of the development objectives of conversational chatbots, the main objective was not only to improve technical aspects by providing accurate responses but to ensure that users' needs are met through context maintenance [60].	Dialogue System/Logical Reasoning	0

Table 1. Cont.

Research Topic	Strong Statements	Capabilities Examined	Citation Indicator
Machine Learning/Frameworks	There is a great need for a framework to bridge the gap between artificial and natural systems [61].	-	0
Translation	ChatGPT competes favorably with commercially available translation products. Its performance lags significantly behind on low-resource or foreign languages [62].	Translation	40
Mathematics	ChatGPT's mathematical skills are noticeably worse than those of a typical mathematics graduate student [63].	Calculations	24
Social/Early Reactions	Concerns arose about the next evolution of jobs, the new technological landscape, the quest for artificial general intelligence, and the ethics-progress conundrum [64].	-	17
Social/Megatrends	The AI model did not entirely comply with the word count specifications. There was a minor software error in the GPT-3 generated code during the debugging process [65].	Research/Classification/Academic Writing	7
Social/Politics	ChatGPT's responses are left-leaning political viewpoints [66].	Research/Ethics	1
Social/Social Impact	Although ChatGPT's usefulness, there are potential risks associated with its use [67].	-	1
Social/Security	ChatGPT can be used for social engineering attacks [68].	Security	0
Industry/Robotics	Involving a human in the loop is essential to oversee and step in if ChatGPT produces unexpected behaviors [69].	Application	6
Industry/Intelligent Vehicles	ChatGPT lacks updated data [70].	Understanding/Reasoning	4
Industry/Intelligent Vehicles	There are potential conflicts between legal requirements and user intentions that could affect ChatGPT's integration into smart vehicles [71].	-	2
Industry/Construction	ChatGPT can be used to generate a construction schedule for a simple construction project [72].	Application	2
Industry/Automation	While ChatGPT's understanding of Industries 5.0 is basic and shallow [73].	Understanding/Research	1
Industry/Supply Chain	ChatGPT may support, but not replace, the ability of supply chain experts in decision-making [74].	-	0
Art	ChatGPT can improve the creativity and productivity of parallel art [75].	Understanding/Art	2
Marketing	ChatGPT has the potential to revolutionize marketing if ethical considerations are taken into account [76].	-	0

3.1. Healthcare Topics

Kung T et al. conducted a study to evaluate the performance of ChatGPT compared to the USMLE [32]. The authors formulated open-ended questions, which were converted into multiple-choice, single-answer questions. The study found that ChatGPT was accurate in more than 60% of its responses without requiring specific guidance from human trainers. ChatGPT produced understandable reasoning and provided relevant clinical insights, which increased confidence in its trustworthiness and comprehensibility. The authors proposed using ChatGPT to aid human learners in medical education and integrate it into clinical decision-making processes. Overall, the study highlights the potential of ChatGPT as a tool to enhance medical education and improve clinical decision-making.

Aydın Ö et al. used ChatGPT to generate a literature review on “Digital Twin in Healthcare” by rephrasing abstracts from Google Scholar’s most cited papers on the topic [33]. On-topic questions were asked to ChatGPT to evaluate its comprehension of the topic. Using an authenticated plagiarism tool, the authors manually compared the plagiarism rates of the texts produced by ChatGPT with the corresponding texts on the web and in academic libraries. ChatGPT’s paraphrasing showed high plagiarism rates, while its answers to on-topic questions showed low plagiarism rates. The authors concluded that ChatGPT’s paraphrasing did not produce original texts and suggested that future academic publishing processes may require less human labor, allowing researchers to focus on their research. The authors plan to track citations to their work in future research to evaluate the theoretical validity of the information produced by ChatGPT.

The study conducted by Macdonald et al. involved the use of ChatGPT to produce a research article on vaccine effectiveness [34]. The authors generated a simulated dataset containing the diverse characteristics of 100,000 healthcare workers, which ChatGPT then utilized to analyze vaccine efficacy and develop a research paper. The study results demonstrate the potential of ChatGPT as a helpful research tool for conducting analyses and generating articles in various fields. However, the study also highlights the need for improvement in ChatGPT’s ability to locate article references, which needs to be revised.

In a literature review, Sallam examined the potential and valid concerns of using ChatGPT in healthcare education and research [35]. ChatGPT has the potential to overcome language barriers and promote equity and diversity in research. However, guidelines and regulations are urgently needed to ensure the safe and responsible use of ChatGPT to limit future complications. Sallam recommended a risk-based approach to assess the impact of ChatGPT from a healthcare perspective before its widespread adoption. The author concluded that the proactive embrace of LLM technologies, with careful consideration of ethical and legal issues, can expedite innovation in healthcare.

The article by Dahmen J et al. presents a comprehensive evaluation of the pros and cons of using ChatGPT [36]. The researchers identified its ability to efficiently analyze vast amounts of data, extract relevant information, and organize it systematically as a significant advantage. However, they also raised several concerns, including the lack of context, inaccuracy, bias, and inadequate knowledge of medical sciences and language. These limitations of ChatGPT may impede its effectiveness in certain areas, so careful consideration is necessary when employing it for research or other purposes.

Shahriar S et al. presented a comprehensive historical and technical analysis of ChatGPT, highlighting its potential applications in various domains, such as healthcare, education, and research [37]. The authors also discussed the limitations of ChatGPT, including its tendency to make errors in basic reasoning, logic, mathematics, and in presenting factual information. The study further revealed that ChatGPT’s input processing capacity is limited to a maximum of 5000 text tokens. The authors also raised critical concerns regarding ChatGPT’s ability to provide up-to-date information and its potential unethical use in education, which poses ethical issues related to copyright and plagiarism. Overall, the article underscores the importance of careful consideration of the advantages and limitations of ChatGPT in diverse settings.

The study by Kumar A assessed the efficacy and significance of ChatGPT in the context of academic writing in the biomedical sciences [38]. ChatGPT was evaluated based on its response time, content quality, and reliability by responding to five randomly selected topics from a pool of queries. While ChatGPT's responses were methodical, accurate, and innovative, they lacked the quality expected in scholarly writing. The author suggested that AI tools like ChatGPT should be utilized to educate and train students in academic writing skills rather than focusing on their potential misuse of plagiarism and cheating. Overall, the study highlights the potential of AI in enhancing academic writing education and underscores the need for further research in this area.

The study by Thurzo A et al. provided an overview of the applications of AI in dental education and assessed the accuracy of ChatGPT in answering dental-related questions [39]. The authors found that AI could enhance dental education in both theoretical and practical domains. AI can analyze patient data and generate plans and simulations for academic education while aiding in remote patient monitoring, virtual training environments, and student evaluations in practical applications. However, the authors also expressed ethical concerns regarding the use of ChatGPT. Overall, the study highlights the potential of AI in dental education and underscores the importance of ethical considerations in its application.

In their study, Hirose T et al. evaluated the diagnostic precision of differential-diagnosis lists generated by ChatGPT-3 for common clinical cases [40]. The authors found that ChatGPT could provide more than 90% accurate diagnoses, although the physicians' answers were still superior. They suggested further refining the test lists to include more complex cases and exploring AI's potential in healthcare, particularly in eHealth, while emphasizing the need for collaboration between physicians, patients, and AI.

Strunga et al. conducted a study to compare the effectiveness and efficiency of AI-based technology, such as ChatGPT, versus conventional methods for diagnosing, assessing progress, and monitoring stability during orthodontic treatment [41]. The authors reviewed the literature on AI in orthodontics. They found that AI technology allowed orthodontists to treat more patients without compromising the quality of care, and issues could be identified before the next appointment. Additionally, using AI software expedited the complex process of orthognathic surgery treatment planning compared to traditional diagnostic methods. However, there are concerns regarding the reliability of AI software due to potential errors and biases that could lead to treatment errors or complications. The study suggests that AI technology has significantly impacted orthodontics, but further research is necessary to address the limitations of AI-based orthodontic diagnosis and treatment planning.

In their study, Zhu Y et al. trained ChatGPT through conversational methods to generate a concise summary of the topic of "lipid-based drug delivery systems" [42]. The authors commented on the reliability of each ChatGPT response, and the findings showed that ChatGPT could generate a reasonable overview of the topic with conclusive sentences, which could provide valuable insights to readers. However, the accuracy and consistency of the review could not be entirely guaranteed due to the lack of reliable references. Thus, the authors concluded that ChatGPT is limited to providing general knowledge on the selected subject matter and cannot provide an exhaustive analysis.

In the study by Nastasi A, the effectiveness of ChatGPT in providing continuous clinical decision support was evaluated by analyzing the accuracy of its responses to standardized clinical vignettes [43]. ChatGPT achieved an impressive level of accuracy of 71.7% in clinical decision-making. However, it faced difficulties in specific clinical scenarios with an established standard of care and more ambiguous situations. The study suggests that ChatGPT can be used as a complementary tool in clinical decision-making but should not be relied upon as the only decision-making tool.

Sharma et al. examined ChatGPT's performance in the drug discovery process, which is a time-consuming and arduous task [44]. The authors evaluated ChatGPT's responses to various queries. They noted some disadvantages, such as the model's dependence on high-quality training data, the need for experimental validation, and its limited comprehension

of complex biological systems. However, the authors believed that ChatGPT could serve as a valuable starting point to simplify the initial stages of research and increase productivity. They viewed ChatGPT as a promising area for further investigation, as it has the potential to accelerate and improve the drug development process as technology advances.

Surovková et al. investigated the impact of AI, particularly ChatGPT, on the roles of dental assistants and nurses in orthodontic practices by presenting an AI-powered orthodontic workflow and evaluating its benefits and drawbacks over three years [45]. The authors found that AI had the potential to improve dental practice by providing more precise and personalized treatment. Still, it brought new responsibilities for trained medical professionals and raised new ethical and legal issues for dental procedures. The study highlights the need for further research on the impact of AI on healthcare workflows and the need for guidelines to address ethical and legal concerns. The authors suggested that AI and ChatGPT could be used to enhance patient care and outcomes and that it is essential for healthcare professionals to understand and adapt to the changing landscape of AI in healthcare.

Corsello et al. discussed the potential implications of ChatGPT on future pediatric research, considering both the positive impacts, such as improved clinical decision-making, faster drug development, and better research outcomes, as well as the negative implications, such as bias, safety concerns, and ethical considerations [46]. The authors suggested that while there are challenges associated with the use of AI in pediatric research, there are also opportunities for language models to make significant contributions to the field. By collaborating across disciplines, pediatricians, researchers, and AI experts can address these challenges and work towards realizing the full potential of AI in improving pediatric health.

3.2. Education Topics

The study by Rudolph J et al. examined the impact of AI chatbots, including ChatGPT, on higher education and its potential developments and implications [47]. The benefits of using student-facing AI applications were analyzed, including improving intelligent student support systems. The use of teacher-facing AI applications was also explored, which could automate tasks such as assessment, plagiarism detection, and feedback mechanisms. The authors suggested recommendations for higher education institutions and students to mitigate the potential drawbacks of using AI tools such as ChatGPT.

In a study, Susnjak T. explored the potential threat of ChatGPT to online examinations and highlighted the importance of exam integrity [15]. The study revealed that ChatGPT could produce highly authentic text with advanced reasoning capabilities, raising concerns about cheating. The author employed a three-step methodology to examine ChatGPT's higher-order thinking abilities, and the generated responses were on-topic and relevant. The author suggested designing test questions that are not readily accessible via cheating resources, returning to oral exams, and utilizing GPT output detection models as potential solutions to reduce cheating. Overall, the study emphasizes the need to address the potential risks of ChatGPT in academic integrity and calls for further research to develop effective measures to prevent cheating.

Tlili A et al. explored the concerns related to ChatGPT's implementation in education [48]. The study used three data analysis stages: social network analysis of tweets, content analysis of interviews, and investigation of user experiences. The findings showed that users perceived ChatGPT as valuable for transforming education, but they also had several concerns related to cheating prevention, content quality, and fair access for all users. The authors suggested integrating ChatGPT into teaching practices and providing recommendations for future research to address the identified concerns. Overall, the study highlights the importance of considering AI-based technologies' potential risks and benefits in education.

Kovačević suggested that ChatGPT could be used as a tool to teach English for Specific Purposes (ESP) and proposed various ways to utilize ChatGPT in creating instructional materials, such as generating textual content, vocabulary and grammar exercises, virtual teaching assistants, and interactive educational resources [49]. The author believed that

ChatGPT has excellent potential in the educational sector but acknowledged that it could be challenging for educators who lack programming language and machine learning knowledge to utilize ChatGPT for ESP instruction. Therefore, Kovačević suggested providing resources and training for educators to use ChatGPT effectively.

Shoufan A. conducted a two-stage study to explore how students perceive ChatGPT and its potential educational challenges [50]. The study involved senior computer engineering students who evaluated ChatGPT using their own words after completing a learning activity. The results were analyzed to create a questionnaire, which the students responded to in the second stage. The study found that students generally had a favorable view of ChatGPT, finding it exciting and admiring its capabilities but also expressing concerns about its accuracy. The students noted that ChatGPT's responses may not always be precise and that effective use of the tool requires prior knowledge. The author recommended that educators guide students on effective questioning techniques and the validation of responses while developers improve the accuracy of ChatGPT.

Castellanos-Gomez's article discussed the use of ChatGPT in scientific article writing and the potential risks and benefits associated with its use [51]. The author highlighted the dangers of misusing ChatGPT to produce low-quality papers and emphasized the potential benefits for non-native English speakers regarding language and grammar checks and drafting paragraphs. The article called for establishing ethical guidelines and best practices to ensure the responsible use of AI language models in scientific publishing.

3.3. General Topics

Bang Y. et al. explored the capabilities and limitations of ChatGPT in reasoning, factuality, hallucinations, and interactivity and compared it to earlier language models [52]. ChatGPT exhibited proficiency in deductive and abductive reasoning but faced limitations in addressing semantic reasoning tasks that were non-textual in nature. It generated invented information, but accuracy could be improved by developing an interface to an external knowledge source. ChatGPT's interactive capability has improved compared to earlier language models, and it surpassed LLMs with zero-shot learning on most tasks. However, it struggled to generate non-Latin script languages, and its accuracy in logical reasoning, non-textual reasoning, and commonsense reasoning was 64.33%. The study suggests that ChatGPT is not a dependable reasoner, and similar to other LLMs, it experienced hallucination issues.

Sobania et al., 2023 investigated the efficacy of ChatGPT for automated bug fixing [53]. The study assessed ChatGPT's performance on QuixBugs, a frequently utilized benchmark dataset for bug fixing, and compared its outcomes with those of diverse methods documented in the extant literature. The results indicate that ChatGPT's bug-fixing capabilities are comparable to those of typical deep-learning approaches, such as CoCoNut and Codex, and significantly exceed the results of conventional program repair methods.

Zhuo et al. conducted a qualitative study on the ethical concerns associated with ChatGPT and other advanced language models (LLMs) [54]. They argued that although LLMs have influenced various industries, including copywriting and summarizing software, they may produce social biases and toxicity that pose moral and societal risks [77]. The authors examined ChatGPT's ethical dimensions, including biases, dependability, toxicity, and robustness, through experimental evaluations on multiple sample datasets. They found that current benchmarks could not adequately address a significant proportion of the ethical concerns, providing additional case studies to highlight them. The authors emphasized the importance of their findings on ChatGPT's AI ethics and offered potential future concerns and practical design considerations for LLMs. Ultimately, the authors concluded that their research provides valuable insights into future endeavors to identify and mitigate ethical risks associated with LLM applications.

Zhong Q et al. assessed ChatGPT's comprehension capabilities by evaluating its responses against a benchmark tool known as GLUE [55]. The GLUE benchmark tool was called on to examine ChatGPT's responses to various NLU tasks, such as linguistic accept-

ability, sentiment analysis, paraphrasing, textual similarity, and more. The researchers compared ChatGPT with four BERT-style, fine-tuned models and found that ChatGPT demonstrated superior performance compared to the RoBERTa-large model in various tasks. In this study, ChatGPT achieved a similar level of comprehension as some BERT-style models that have been fine-tuned. However, the study also revealed that ChatGPT did not outperform the existing top models in specific natural language understanding tasks.

3.4. Finance Topics

Dowling et al. investigated the use of ChatGPT for generating academic articles in finance, specifically focusing on cryptocurrency [16]. The authors used ChatGPT to generate three versions of the same research idea, including a research idea, a condensed literature review, a description of relevant data, and a testing framework. Thirty-two reviewers then rated the generated text based on its likelihood of acceptance for a minimum ABS2-level finance journal. The results indicate that ChatGPT is a highly effective tool for generating research ideas due to its access to an extensive corpus of parameters and texts. However, the outcomes of the literature reviews and testing frameworks could have been more satisfactory, and expert input is required to produce high-quality text. The study highlights the importance of utilizing ChatGPT by trained individuals with expertise in the relevant domain, and caution should be exercised in relying solely on the generated text without expert guidance.

Geerling et al. utilized ChatGPT to conduct the Understanding Test in College Economics (TUCE), which assesses fundamental-level comprehension of economic principles through a standardized multiple-choice format [56]. ChatGPT's responses were compared against the average college student and were found to outperform them. The authors suggested that ChatGPT's ability to perform well on the test is due to its access to vast amounts of knowledge on texts that are difficult for students to retrieve. However, the authors caution that assessments should include conventional approaches, such as supervised tests or written tasks during class and practical learning opportunities.

3.5. Machine Learning/AI Topics

Qin C et al. empirically analyzed ChatGPT's zero-shot learning abilities, evaluating its performance on twenty frequently used NLP datasets covering seven primary task categories [57]. The authors found that ChatGPT outperformed GPT-3.5 in arithmetic reasoning and produced precise responses for natural language inference. ChatGPT also performed better than GPT-3.5 in question answering despite not always complying with the instruction to provide only "yes or no" answers. ChatGPT excels in dialogue, while GPT-3.5 needs improvement in this area. The authors suggested that ChatGPT has excellent potential in the field of NLP and could be further developed to achieve even better results.

Mitrović et al. aimed to investigate the development of a machine-learning model using Transformers to differentiate between human-authored text and text generated by ChatGPT [58]. The study focused on short texts, presenting a more challenging ML model task. The authors conducted two experiments focusing on brief internet reviews, using text produced by ChatGPT and humans. The researchers refined a Transformer-based model, utilized it to generate predictions, and applied Shapley Additive exPlanations (SHAP) to explain them. The findings revealed that the ML model struggled to differentiate between human-generated text and ChatGPT-generated text that had been rephrased when compared to a score-based method. Additionally, the text generated by ChatGPT exhibited less coherence and emotionality than the text generated by humans.

Hassani et al. explained how ChatGPT could aid data scientists in automating various tasks in their workflow, such as data cleaning, model training, and result interpretation. The authors also highlighted its potential in analyzing unstructured data and providing new insights to improve decision-making processes [59]. While ChatGPT has many advantages, it may only perform well on specific tasks if it has been specifically trained for them, and its output may be challenging to interpret. However, the benefits of ChatGPT outweigh

the costs, and it has the potential to significantly enhance the productivity and accuracy of data science workflows, becoming an increasingly important tool for intelligence augmentation. The authors emphasized the importance of addressing concerns about bias and plagiarism and suggested further research to establish ethical guidelines for using ChatGPT in data science.

Lin C et al. reviewed thirty-two papers to investigate the development of conversational chatbots from three perspectives: construction goals, algorithms used, and outcomes and challenges [60]. They found a trend in using Natural Language Processing (NLP) technologies for constructing conversational chatbots, particularly in architecture, to emulate human conversational abilities. Open-domain chatbots lack pre-defined dialogue contexts and need to establish coherence in conversations. In contrast, closed-domain chatbots focus on accurate information provision and emphasize creating dialogue systems that express emotions and empathy. The study highlights the need for developing conversational chatbots with natural language processing abilities that can express emotions and empathy and maintain coherence in their conversations.

Miao et al. examined machine learning paradigms and advocated for adopting the HANOI framework, which integrates human factors and leverages knowledge through integrating artificial systems and the natural world [61]. The authors provided a taxonomy of paradigms and a review of intermediate and advanced machine learning paradigms. They proposed the HANOI framework, which consists of Human, Artificial systems and the Natural world, and Organizational Intelligence, to automate the knowledge for establishing sustainable and intelligent societies. The framework sought to incorporate the human element in machine learning systems and bridge the gap between artificial and natural systems. Finally, the authors highlighted the significance of machine learning paradigms in developing intelligent systems that could contribute to a more sustainable future.

3.6. Translation Topics

Jiao et al. evaluated the machine translation capabilities of ChatGPT in comparison to three commercial translation products: Google Translate, DeepL Translate, and Tencent TranSmart [62]. Three different translation prompts were created to prompt ChatGPT to return the appropriate results. ChatGPT competed favorably with commercially available translation products, such as Google Translate, in European languages but lagged significantly behind in low-resource or foreign languages. For these foreign languages, the authors explored a technique called “pivot prompting.” ChatGPT’s performance in handling biomedical abstracts or Reddit comments was inferior to commercial systems. However, the study highlights the potential of ChatGPT as a translator for spoken language.

3.7. Mathematical Topics

In their study, Frieder et al. examined the mathematical capabilities of ChatGPT and evaluated its performance on exam-like mathematical questions using a new dataset called GHOSTS, the first natural language dataset created and maintained by practicing mathematics researchers [63]. The authors concluded that ChatGPT’s mathematical abilities were considerably inferior to those of an average graduate student in mathematics. Still, its strength lies in its capacity to search for mathematical entities based on information provided about them. The study highlights ChatGPT’s potential to complement human expertise in mathematical problem-solving and provides a new dataset for comparison with other language models in sophisticated mathematics comprehension. The authors finally noted the importance of continued research and development of AI systems in mathematical domains.

3.8. Social Topics

Taecharungroj analyzed the early reactions to ChatGPT on Twitter by obtaining a dataset of 33,914 tweets containing the question “What can ChatGPT do?” and using Dirichlet allocation (LDA) to discover the topics discussed [64]. The author removed

irrelevant content, tokenized the tweets, and removed stop words and frequently occurring words. The study aimed to map initial perceptions of ChatGPT on social media and identified four critical issues of using chatbot AI technologies: the next evolution of jobs, the new technological landscape, the quest for artificial general intelligence, and the ethics-progress conundrum.

Haluza et al. investigated the potential of ChatGPT in identifying and understanding megatrends, which are overarching developments that persist over an extended period [65]. They used GPT-3 to detect the top ten megatrends in today's society and generate answers to questions about each trend. The authors expressed concerns about using AI in academia but noted that leveraging ChatGPT to analyze extensive data sets could enable rapid and accurate knowledge extraction. The study revealed ten megatrends: digitalization, urbanization, globalization, climate change, automation, mobility, global health issues, aging population, emerging markets, and sustainability. However, the AI model did not entirely comply with the word count specifications, and there was a minor software error in the GPT-3 generated code during the debugging process.

Rozado D's article examined the possibility of political bias in ChatGPT's responses to political orientation tests [66]. ChatGPT's responses to fifteen political orientation tests were analyzed, and it was found that 14 out of 15 tests identified its responses as leaning toward the left. The author emphasized that AI systems must remain impartial and provide unbiased information to users, especially concerning normative inquiries. The article concludes that AI systems that profess political impartiality while exhibiting political bias may significantly impact human perspectives and society and, therefore, must be viewed as problematic.

Abdullah et al. explored the potential social impact of ChatGPT and future applications [67]. The author noted that there is much debate regarding the effects of sophisticated language models similar to ChatGPT on human existence, as they can make decisions without human involvement and are susceptible to attack. In addition, the author provided an in-depth analysis of the potential social impact of ChatGPT on various domains, highlighting its usefulness and the potential risks associated with its use. The study emphasizes the importance of understanding the social implications of advanced language models, such as ChatGPT, and developing strategies to mitigate adverse effects.

Grbic D.V. et al. proposed using ChatGPT to create environments for social engineering attacks [68]. ChatGPT's capabilities, such as generating text templates on specific topics and producing code, can be easily leveraged to obtain all the necessary components for phishing attacks. The authors proposed a methodology for creating a phishing attack using ChatGPT and outlined social engineering attacks along with preventive measures. Using ChatGPT prompts, the authors developed an HTML login page similar to Facebook's interface and a phishing email enticing recipients to provide their personal information. The authors provided guidelines for protecting email accounts against social engineering attacks and expressed their concerns about the potential misuse of ChatGPT.

3.9. Industry Topics

Vemprala S et al. conducted an experimental study on using ChatGPT in robotics applications by proposing a four-step framework [69]. The authors defined a high-level robot function library, created a prompt to guide ChatGPT on its objective, and permitted high-level functions. Users evaluated the output code to assess its quality and safety, and ChatGPT's capacity to solve robotics problems was investigated. The study found that involving a human in the loop was essential to oversee and step in if ChatGPT produced unexpected behaviors. Additionally, the authors presented PromptCraft, a platform to share examples of prompt engineering strategies within different robotics categories.

Du et al. explored the potential applications of ChatGPT in the field of intelligent vehicles, particularly in autonomous driving, human-vehicle interaction, and intelligent transportation systems [70]. The authors evaluated ChatGPT's accuracy in answering technical questions related to these areas and highlighted a need for updated data as

a limitation. They discussed the challenges and opportunities of ChatGPT's potential applications in these fields and the uncertainties and limitations of this emerging technology. The paper presents a preliminary investigation of ChatGPT's potential for intelligent vehicle research, laying the foundation for further study.

Gao et al. explored the possible applications of ChatGPT in intelligent vehicles and investigated its implementation challenges [71]. They suggested that ChatGPT could enhance the intelligence level of automobiles' human-machine interaction systems, providing a more efficient, safe, and personalized user experience. However, the authors also identified various challenges associated with ChatGPT's practical application in intelligent vehicles, such as its inability to generate truthful and non-redundant responses and seek clarifications for ambiguous prompts. They also discussed issues related to computational capability and potential conflicts between legal requirements and user intentions that could affect ChatGPT's integration into intelligent vehicles.

Prieto et al. demonstrated how ChatGPT could generate a construction schedule for a simple construction project [72]. While ChatGPT as a technology still has limitations, this study highlights the advantages of using large language models and Natural Language Processing (NLP) techniques in the construction industry. Further development is needed before it can be widely adopted, and the authors suggested that future research should focus on refining the approach and addressing limitations to improve its effectiveness.

Wang et al. suggested that ChatGPT could be used to investigate the impact and significance of industrial development, especially control and automation in manufacturing and production for Industry 5.0 [73]. According to the authors, ChatGPT effectively provided comprehensive information and knowledge on established terms, such as Industry 5.0, but its responses to creative concepts, such as Industries 5.0, may only occasionally be accurate. In addition, the authors highlighted that ChatGPT's limitation was that it requires specific information and may not understand implied cues. While ChatGPT's understanding of Industries 5.0 is essential and shallow, its answers are still helpful. The authors emphasized that continued research is required to explore the learning and decision-making technologies for intelligent industries, which would require a joint effort between academia and industry.

Frederico, G.F. provided an overview of the applications and issues related to ChatGPT in supply chains [74]. The author aimed to assist practitioners in supply chain activities who seek structured content related to the impact and applications of ChatGPT. Quality results indicated that although the technology has yet to mature, it could be applied in different areas of supply chain management, leading to significant benefits, such as cost reduction and performance improvement. ChatGPT may support, but not replace, supply chain experts' decision-making abilities.

3.10. Art Topics

Guo et al. investigated the potential of ChatGPT in enhancing artistic creation by providing linguistics-based artistic knowledge and text-based, human-machine interaction interfaces in the field of parallel art [75]. The authors proposed that ChatGPT could provide solutions based on linguistics-based artistic knowledge learned from the web, enhancing the diversity and accuracy of painting computational experiments. Furthermore, the study presented a case study of text-based painting imagination using ChatGPT, demonstrating the model's ability to provide explicit and detailed guidance on painting content and the organization of painting elements and its understanding of abstract artistic expressions, such as painting styles and emotions. The authors concluded that ChatGPT could provide clear and reasonable control over painting content and potentially improve the creativity and productivity of parallel art.

3.11. Marketing Topics

Rivas et al. discussed the impact of ChatGPT on the future of marketing, emphasizing the potential for ChatGPT-based tools to help marketers create content faster and conduct

more efficient research [76]. However, they also highlighted ethical considerations, such as avoiding bias and ensuring transparency in using ChatGPT. The authors suggested that ChatGPT could assist in automating customer service and improving efficiency, but it is crucial to balance automation with human interaction. The paper concluded that ChatGPT has the potential to revolutionize marketing if ethical considerations are taken into account, which will ultimately benefit both marketers and consumers.

4. Discussion

The previous sections presented a brief history of ChatGPT along with its training process. They also conducted an extensive literature review bringing together all of the academic knowledge regarding the applications and implications of ChatGPT on future technology advancements.

This article presents a classification table (Table 1) summarizing the publications reviewed based on their research topic, strong statements, capabilities examined, and citation indicator. Despite its potential applicability in various industries, the literature review suggests a significant focus on utilizing ChatGPT for healthcare-related purposes. However, the table also reveals a need for more academic exploration into the ethical implications of ChatGPT and integration into existing applications. Additionally, our analysis highlights a research gap in the ability of ChatGPT to handle machine-learning tasks effectively.

Given the constituent elements that comprise ChatGPT, a tabular overview consisting of twenty significant advantages and twenty pivotal disadvantages was generated and presented in Appendix A, specifically in Table A1.

Bellow, the authors offer a condensed summary of their observations, with a research and programming emphasis, subsequent to their utilization of ChatGPT.

- **Research:** Observations gleaned from the utilization of ChatGPT suggest that the platform can identify and proffer academic references that pertain to specific sentences or paragraphs, thereby facilitating the work of prospective researchers in their search for relevant sources. However, it was noted that most of the proposed references, while related to the topic, must be more present in academic databases and often feature errors in author names or digital object identifiers (DOIs). Following the identification of such errors, ChatGPT endeavored to rectify the situation by suggesting alternative sources, but these, too, were found to be erroneous upon scrutiny. In response to these repeated instances of inaccuracy, ChatGPT expressed regret at its inability to offer suitable alternatives. The genesis of this particular issue could be attributed to an error that occurred during the training phase of the model, an anomaly that the developers have yet to uncover. Ultimately, it is imperative to emphasize that researchers should exercise extreme caution and refrain from relying solely on tools such as ChatGPT to procure references to pertinent scholarly articles.
- **Programming:** In an attempt to confirm the rumors about the programming proficiencies of ChatGPT, the researchers provided the platform with a prompt describing the desired program features. The output in the Python programming language was remarkable. However, it was observed that composing an appropriate prompt effectively conveying the desired request to ChatGPT necessitates a certain degree of programming knowledge. Furthermore, while the output was impressive, comprehending and adapting it to meet the specific demands of a project also requires programming expertise. To summarize, ChatGPT can be a valuable tool in aiding developers in the generation of code, but it cannot supplant the developer's role, at least not at present.

Subsequently, some key authors' thoughts and concerns regarding ChatGPT are succinctly deliberated through pressing queries.

- To what extent will the advancement of science be expedited and streamlined by empowering scientists with instantaneous access to information by posing relevant queries to ChatGPT?
- The primary objective of this research is to generate knowledge for future applications. However, the process of a new scientist gathering information from existing literature and using it to expand the field can lead to significant delays in time. While this time is not necessarily wasted, it may impede the discovery of fresh ideas that could more expeditiously solve pressing human problems. AI tools, such as ChatGPT, could enable new scientists to read the fundamental concepts of a field and pose pertinent questions within a few hours. Nevertheless, AI tools must evolve to offer knowledge commensurate with the level of expertise expected by scientists. In this vein, neophyte scientists could commence the development of the technology from the outset, drawing upon prior research in the field. A compelling example of this pertains to the potential acceleration and efficiency with which novel medical treatments can be devised for emerging diseases.
- Does the continued existence of search engines, as we have known them thus far, remain justified?
- To date, the conventional approach to utilizing search engines has involved posing search queries and awaiting the corresponding search results. Subsequently, individuals browse through a plethora of websites suggested by search engines in hopes of obtaining the requisite knowledge. Yet, how often have we altered the search term (i.e., keyword) due to unrepresentative outcomes? The advent of AI tools such as ChatGPT will transform the conventional search methodology. By conversing with the AI tool and enabling it to filter information on our behalf, the most suitable outcomes will be instantly accessible without any time wastage (Microsoft Bing: Reinventing search with a new AI-powered). Nonetheless, it is critical to underscore that the searcher's capacity for critical thinking is likely to be significantly reduced.
- Does the emergence of ChatGPT and other AI tools signal the demise of eCommerce as we know it today?
- The integration of ChatGPT and other AI tools into eCommerce platforms may disrupt the traditional way of online shopping. Previously, consumers reached online stores through search engines or third-party platforms, selecting products that align with their needs using built-in eCommerce filters. However, with the integration of ChatGPT in searches, specific products, and online stores may be suggested, which may not necessarily be the most cost-effective or highest-quality options. There is a potential threat of specific recommended products being prioritized to bring more significant benefits to the company that created the AI tool. As such, the introduction of AI tools in eCommerce platforms raises concerns about the potential impact on consumer choice and the overall integrity of the online shopping experience.
- To what extent will individuals utilize ChatGPT or comparable AI tools for disease diagnosis and treatment?
- Although ChatGPT does not provide direct answers to such inquiries, numerous articles, particularly in online publications, promote the use of ChatGPT as a tool capable of delivering answers that can aid in diagnosing a disease or even providing treatment. The authors of some articles have asked ChatGPT about diagnosing and treating diseases. Even though the OpenAI FAQ clearly states that cure or treatment questions violate the terms of use [78], ChatGPT provides treatment-related information. To maintain objectivity, the following statement was appended to the response: "It is important to talk to a healthcare professional. Your healthcare provider can help you determine the best treatment option for your specific needs". Nonetheless, ChatGPT has the potential to be a promising technology for identifying diseases in their early stages through symptoms before they become advanced. Therefore, both humans and AI tools should exercise caution when reading and responding to the

results. Specifically, for disease prevention, similar technologies could prevent disease progression by identifying symptoms and referring patients to a doctor.

In summarizing the results of our study, it is evident that ChatGPT offers both benefits and drawbacks across a range of domains. Notably, in the fields of healthcare and research/science, ChatGPT can enhance productivity and efficiency. Furthermore, ChatGPT can assist with educational and programming endeavors. However, ethical concerns and uncertainties surrounding potential job displacement are among the negative consequences that arise from this technology. As such, governments need to establish regulatory frameworks to mitigate any adverse effects that may occur from the adoption of ChatGPT. Ultimately, this technology can potentially revolutionize existing domains, ranging from positive to negative.

5. Conclusions

ChatGPT is an advanced form of AI generative model that is capable of producing human-like text responses to user queries. This technology has undergone extensive training with vast amounts of data and can also be used to generate code and algorithms to fix code errors. Although ChatGPT was officially released in February 2023, the literature on this technology is rapidly expanding with fresh ideas and potential applications. To provide an overview of ChatGPT, this article delves into its history and training process, followed by an extensive literature review analyzing forty-seven academic articles on the technology. The reviewed articles were categorized into eleven distinct research domains and presented based on their contribution. Furthermore, this article systematically extracted and tabulated strong statements along with the articles' domain and citation count. In conclusion, this article offers insights into the advantages and disadvantages of ChatGPT and suggests areas for further research to enhance existing knowledge and technology. Overall, this article serves as an informative starting point for researchers and practitioners seeking to deepen their understanding of ChatGPT.

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Appendix A

Table A1. Advantages and disadvantages of ChatGPT.

Advantages	Disadvantages
ChatGPT can generate human-like responses, improving the quality of chatbot interactions [1].	Biases in the training data: Language models similar to ChatGPT rely heavily on the data they are trained on, and if that data is biased in some way (e.g., if it contains more examples of certain types of language or perspectives), the model may reproduce those biases in its responses [79].
ChatGPT can understand and respond to complex and nuanced user inputs, allowing for more natural and effective communication [4].	Lack of understanding of context: Although ChatGPT can generate responses based on the preceding conversation, it does not have a deep understanding of context or the larger discourse in which a conversation takes place. This can lead to responses that are inappropriate or nonsensical [4].
ChatGPT can be trained on large datasets, improving its ability to generate high-quality responses [1].	Difficulty with sarcasm and irony: Because ChatGPT does not have a full understanding of human emotions and intentions, it may have difficulty recognizing sarcasm or irony and may respond inappropriately as a result [80].

Table A1. Cont.

Advantages	Disadvantages
ChatGPT can be fine-tuned on specific domains, allowing for more specialized and accurate responses [81].	Limited knowledge of the physical world: ChatGPT does not have direct access to the physical world and, therefore, may not be able to answer questions that require knowledge of the physical environment (e.g., “What’s the weather like outside?”) [4].
ChatGPT can handle multiple languages, improving accessibility for users across different countries and regions [27].	Difficulty with long-term memory: While ChatGPT is able to generate responses based on previous statements in a conversation, it may not be able to remember specific details from earlier in the conversation or from previous conversations [82].
ChatGPT can generate coherent and contextually appropriate responses, improving the overall chatbot user experience [4].	Inability to generate truly creative responses: While ChatGPT is capable of generating novel responses, it may struggle to produce truly creative responses that go beyond what it has seen in the training data [83].
ChatGPT can learn from user feedback and improve over time, leading to better performance and user satisfaction [1].	Difficulty with multi-party conversations: ChatGPT is primarily designed to handle two-party conversations and may struggle to keep track of multiple speakers or to distinguish between different speakers in a multi-party conversation [84].
ChatGPT can be used for a variety of applications beyond chatbots, such as natural language processing and text generation [4].	Difficulty with non-standard English: ChatGPT has been trained primarily on standard English text and may have difficulty with non-standard varieties of English, such as regional dialects or slang [85].
ChatGPT can be used for tasks such as summarization, translation, and question-answering, improving efficiency and productivity in various fields [1].	Difficulty with complex sentence structures: ChatGPT may struggle with complex sentence structures, particularly those involving nested clauses or unusual grammatical constructions [86].
ChatGPT can be used for research purposes, allowing for new insights and discoveries in the field of natural language processing [4].	Limited ability to reason abstractly: While ChatGPT is able to generate responses based on patterns in the training data, it may not be able to reason abstractly or understand complex logical relationships [87].
ChatGPT can be fine-tuned on smaller datasets, allowing for more accessible and cost-effective applications [81].	Inability to recognize or understand images: While ChatGPT is capable of processing text, it does not have the ability to recognize or understand images, which can limit its usefulness in certain applications [88].
ChatGPT can be used for educational purposes, such as teaching language skills and improving language proficiency [1].	Limited ability to generate coherent narratives: While ChatGPT is able to generate text that follows logically from previous statements in a conversation, it may struggle to generate coherent narratives that have a clear beginning, middle, and end [89].
ChatGPT can be used for creative applications, such as generating poetry or other forms of creative writing [4].	Inability to distinguish between fact and fiction: ChatGPT is not able to distinguish between statements that are factually true and those that are fictional or speculative, which can lead to inappropriate or inaccurate responses [90].
ChatGPT can be used for data augmentation, improving the performance of machine learning models in various applications [1].	Difficulty with social and cultural nuances: ChatGPT may not have a full understanding of social and cultural nuances, such as sarcasm or humor, and may respond inappropriately as a result [88].
ChatGPT can be used for generating chatbot training data, reducing the need for human annotation, and improving efficiency [81].	Lack of human-like empathy: ChatGPT does not have the ability to understand human emotions in the same way that humans do, which can limit its ability to provide appropriate emotional support or responses [91].
ChatGPT can be used for generating natural language queries for databases, improving accessibility and ease of use [1].	Limited ability to handle complex tasks: While ChatGPT can perform a range of tasks, its ability to handle complex tasks, such as problem-solving or decision-making, may be limited [92].
ChatGPT can be used to improve search engine results by generating more natural and accurate search queries [27].	Dependence on large amounts of data: ChatGPT relies heavily on large amounts of training data, which can be difficult and expensive to obtain and may lead to challenges in terms of scalability and generalizability [90].

Table A1. Cont.

Advantages	Disadvantages
ChatGPT can be used for generating product descriptions or reviews and improving the efficiency and quality of e-commerce websites [1].	Lack of transparency: The inner workings of ChatGPT are opaque to most users, which can make it difficult to understand why it generates certain responses and can limit trust in the system [93].
ChatGPT can be used to improve social media marketing by generating engaging and natural language responses to customer inquiries [1].	Vulnerability to adversarial attacks: Language models similar to ChatGPT are vulnerable to adversarial attacks, in which an attacker deliberately manipulates input data in order to produce unexpected or malicious output [94].
ChatGPT can be used to improve customer service in various industries by providing more effective and personalized responses to customer inquiries [4].	Environmental impact: Training large language models similar to ChatGPT requires significant amounts of computational power and energy, which can have a significant environmental impact [95].

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