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ChatGPT: Fundamentals, Applications and Social Impacts

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***Abstract*—Recent progress in large language models has pushed the boundaries of natural language processing, setting new standards for performance. It is remarkable how artificial intelligence can mimic human behavior and writing style in such a convincing way. As a result, it is hard to tell if a human or a machine wrote something. Deep learning and natural language processing have recently advanced large language models. These newer models can learn from large amounts of data to better capture the nuances of language, making them more accurate and robust than ever before. Additionally, these models can now be applied to tasks such as summarizing text, translating between languages, and even generating original content. ChatGPT is a natural language processing (NLP) model developed in 2022 by OpenAI for open-ended conversations. It is based on GPT-3.5, the third-generation language processing model from OpenAI. ChatGPT can power conversational AI applications like virtual assistants and chatbots. In this paper, we describe the current version of ChatGPT and discuss the model's potential and possible social impact. Disclaimer: This paper was not written by ChatGPT; it was written by the listed authors.**

***Index Terms*—ChatGPT, Generative Pre-trained Transformer, Language Models, Social Impact**

I. Introduction

Recently, the performance of many natural language processing tasks has been significantly boosted due to recent advancements in large language models. As a result, it is becoming increasingly difficult to distinguish between a text written by a machine or a human. Language models are mathematical models that create a natural language for devices to process and understand [1], [2]. They are used in many areas, including machine learning, natural language processing, speech recognition, information retrieval, automatic summarization, and many more [3]. Language models work by representing words or phrases in vector space. Statistical algorithms can predict which words or phrases will likely be used together, allowing machines to make more accurate predictions about the language they are processing [4]. Hence language models help engines understand the structure and meaning of human-generated language; they are often used in natural language processing to generate intelligent responses that are more natural and conversational. There are a variety of popular language models, such as GPT-3 from OpenAI[1], BERT from Google [5], ELMo from the Allen Institute [6], Microsoft's ERNIE, and Google's Transformer.

Language models have a variety of advantages, including better natural language processing, enhanced understanding of a text, and the ability to generate new text based on existing sources. Additionally, language models can help with tasks such as summarization, question answering, and machine translation [7]. However, each language model has different strengths and weaknesses, so choosing the one that best fits our needs is essential. The main disadvantage of language models is that they can be difficult and expensive to build and maintain due to their complex nature. They also require large volumes of training data, which can be hard to obtain and costly to process [4]. Moreover, language models are prone to overfitting due to their complexity, meaning their performance may degrade when exposed to new data or specific contexts. Finally, language models are inherently limited in the data type they can process, meaning certain types of information may not be accurately represented [8], [9].

OpenAI released ChatGPT on the 30th of November, 2022 [10]. From the beginning, the model gained impressive public attention, where more than one million users signed up in the first week to test the new artificial intelligence (AI) based chatbot. OpenAI describes it as a language model optimized for dialogue [11], which implies that it can answer questions in a human-like text and keep track of the whole conversation. Hence, it is quite powerful, especially when considering possible conversations. The conversations could span from providing definitions from a dictionary to telling stories and providing medical advice.

ChatGPT is an advanced version of GPT3 specifically designed for conversational AI. It can generate natural language conversations and better answer questions on various topics by providing more context around words or phrases for the AI to understand better what is being asked. The ChatGPT structure uses a Transformer [12], [13] architecture to generate natural language conversations. The architecture consists of an encoder-decoder and a self-attention mechanism, which enables it to generate context-sensitive responses. It can be used for various tasks, such as chatbot dialogue, question answering, and text summarization. The ChatGPT structure is designed to better capture the local context of a conversation,

[1]https://openai.com/api/

making it more effective at generating coherent conversational outputs. Compared with OpenAI's GPT-3 for chatbot applications, the ChatGPT has been specifically designed for natural language conversations. It has a better understanding of context and intent, allowing it to understand and respond to user input more quickly and accurately. Additionally, ChatGPT can generate more creative responses that make conversations more engaging. ChatGPT is designed to generate natural-sounding conversations. It can interact more naturally by creating human-like responses, whereas GPT-3 is geared more toward providing factual answers. Reinforcement learning with human feedback (RLHF) is an additional layer of training that utilizes human feedback to help ChatGPT learn to follow commands and generate responses that meet human expectations [14].

Comparing ChatGPT with other language models, ChatGPT surpasses BERT for conversational and dialogue tasks because ChatGPT has a pre-trained language model designed explicitly for natural conversational language. Moreover, ChatGPT has a high accuracy rate when predicting the following sentence in a conversation, making it more suitable for chatbots. ChatGPT is a text-based dialogue system focusing on more extended discussions and general conversation topics, and RoBERTa is a language model optimized for understanding natural language tasks. ChatGPT better understands dialogue context and provides more informative, coherent responses with less training data than RoBERTa [9].

This paper discusses ChatGPT, its fundamental technology, and how it potentially impacts society. We analyze how this can improve conversations and provide deeper insight into humanity. Utilizing this technology can give us a more comprehensive perspective on our relationships and the world around us. The rest of this paper is structured as follows: Section II briefly describes ChatGPT's underlying structure. In Sections III and IV, we explore the applications of ChatGPT and its potential implications for society. Finally, Section VI concludes the paper.

II. Fundamentals

A. The current version of chatGPT

This discussion considers ChatGPT in its current form. The following description depends on the OpenAI user interface, notifications, and FAQs [15]. Today ChatGPT is available online as a free preview for research purposes, not in the API. However, it is accessible and easy to use. The user can access the ChatGPT interface after providing some information, such as the email address and phone number. The interface is similar to many chatting applications.

ChatGPT was trained using a massive amount of data, including online data, but currently, it is not connected to the internet and has limited knowledge after 2021. However, the dialogue with the system is not private; it can be reviewed to train and enhance the system so the user is notified not to share confidential or personal information. The system also alerts users of possible inappropriate and/or misleading information in ChatGPT responses.

OpenAI asked for feedback at this stage and started a feedback contest [10]. The system was updated on 15 December. Users who pass the daily limit can extend their access by providing feedback. The update also allows users to view and continue their previous conversations. One of the reasons that ChatGPT is impressive is its ability to remember the dialogue with the user and build on it. Currently, the free preview is limited to approximately 3000 words (or 4000 tokens). Also, there is a limit on the number of characters the system can output; users can ask ChatGPT to continue to get a complete answer. Figure 1 shows an example of using the ChatGPT chatbot. In this example, The authors prompted, "Tell me about when Christopher Columbus came to the US in 2015." multiple times, and each time the chatbot of ChatGPT gave a different response.

B. Underlying technology

Machine and Deep Learning algorithms are used to identify patterns and relationships in complex data sets, allowing computers to make predictions based on data. Language models use Deep Learning and Machine Learning to help a computer understand natural language by looking at large amounts of text data. These models have many applications and are mostly used for sentiment analysis, question-answering, chatbots, and translation. Additionally, they are used to analyze language and create useful output by focusing on the meaning of words and how they relate to each other.

Based on the information provided by the OpenAI blog [10], ChatGPT is based on a model in the GPT [16] series built previously by OpenAI (GPT3.5). GPT, Generative Pre-trained Transformer, is an open-source language model developed by OpenAI. GPT-3, released in June 2020, is the newest version of GPT and has become widely used in natural language processing (NLP). GPT-3 is a much larger language model than GPT-2. It is an upgraded version of the previous model, with more layers, parameters, and a more extensive training dataset. As a result, GPT-3 can generate more accurate and sophisticated text than its predecessor. GPT2 and earlier versions of GPT were trained on billions of words from webpages and other text sources, while GPT-3 was trained on a much larger dataset of 45TB. ChatGPT is a type of GPT specifically designed for chatbot development in combination with a dialogue system. It can be used to generate natural-sounding conversations with a user, as well as provide contextual responses.

The training of the ChatGPT model used data available up until early 2022. OpenAI used Microsoft Azure infrastructure for training. ChatGPT training methods are similar to the ones used to train InstructGPT [17], which OpenAI also developed. The introduction of InstructGPT illustrated the promising results in aligning language models with their user's intent by training language models with human feedback [18]. Reinforcement Learning from Human Feedback (RLHF) [14], which was deployed to train InstructGPT, was also used to train ChatGPT. In addition, the InstructGPT dataset was utilized in developing ChatGPT [10].

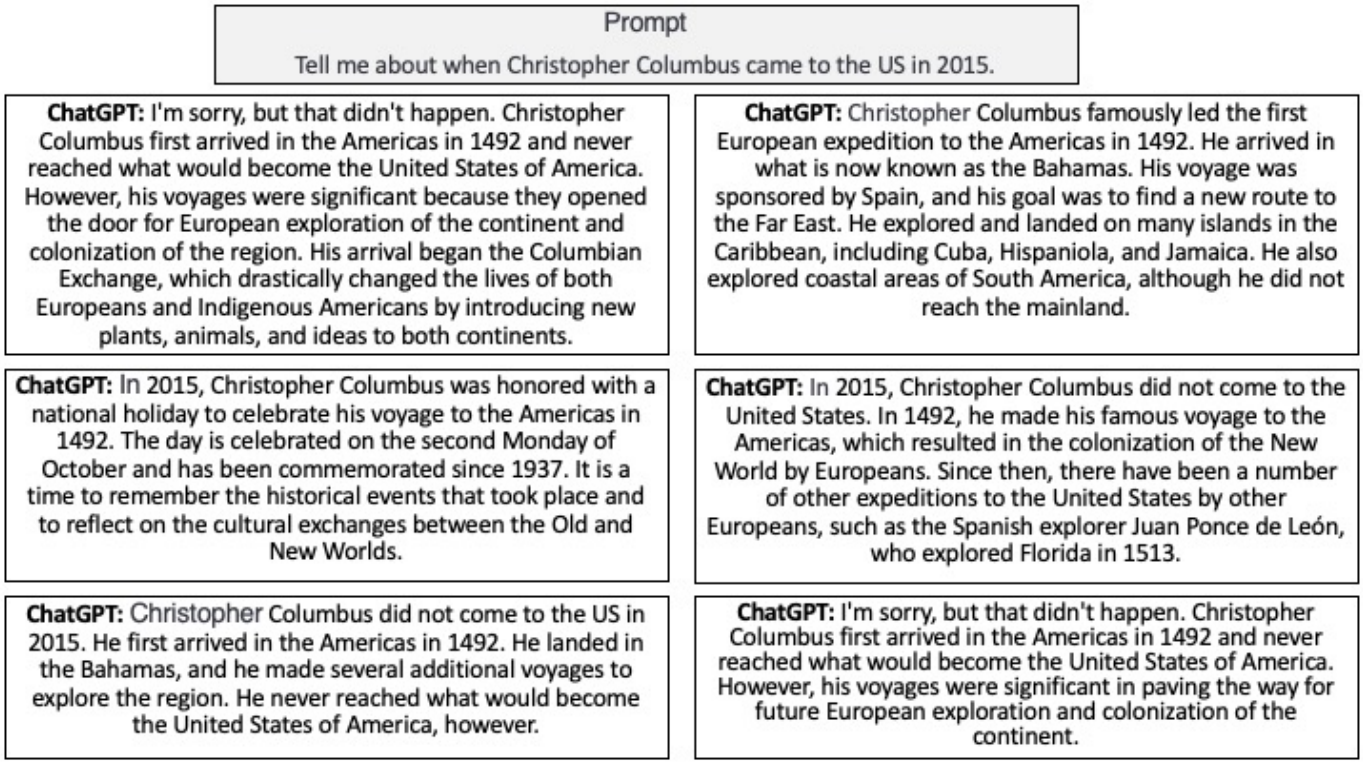

Fig. 1. Asking the chatGPT a question multiple times

The engineers behind ChatGPT hired labelers to compare and contrast the outputs of GPT-3 and the newly developed InstructGPT. The labelers then provided ratings to evaluate the performance of the two systems. The InstructGPT is the preferred choice for labelers, as it demonstrates greater truthfulness than GPT-3 models and slight reductions in toxicity but no bias [17].

ChatGPT dataset contained new dialogues in addition to the data of the InstructGPT dataset after being converted to a dialogue format. Applying the paradigm of reinforcement learning requires a reward model. The comparison data used in the reward model of ChatGPT was randomly selected from the model conversations. Afterward, additional samples of alternative conversations were made, and AI trainers ranked them. OpenAI gives three samples to highlight the difference in the responses of ChatGPT versus InstructGPT [10]. The samples show that ChatGPT can better identify bullying and violence requests and is less deceived by false information. Figure 2 illustrates the workflow for creating the ChatGPT model.

III. Applications

It is hard to limit the applications of ChatGPT to a list, and it is also hard to determine the limits of its capabilities. However, ChatGPT interprets the users' requests in its current version and generates clear human-like text. In other words, ChatGPT shows progress in natural language processing and other artificial intelligence capabilities.

Although it was predicted that AI would accelerate the development of useful natural language models, the vast leap demonstrated by ChatGPT capabilities in language-related applications caught the attention of many. Starting with dialogue, conversations with machines using natural language have been a research area of interest for decades [19]. ChatGPT gives an interface that allows for conversations and allows the user to control the conversation flow and iterate and refine requests. In addition, the system keeps track of the conversation and answers queries in natural language.

Analyzing, formulating, editing, and producing natural language allows for various applications. The four samples given by OpenAI blog [10] demonstrate the power of ChatGPT as a language model and its application in specific fields. The four samples include a conversation on debugging code, explaining a theorem, writing a short note to a neighbor, and a request containing possibly illegal activity. The samples show ChatGPT's abilities as a dialogue system, answering questions, generating responses in natural language, deploying different writing styles, and generating poetry, in addition to its abilities to classify and summarize a given text. The samples also demonstrate ChatGPT's ability to follow through the conversation; if the user makes a request and later uses the word 'it' to refer to something in the initial request, ChatGPT will correctly interpret the new request. The samples also show that ChatGPT may identify illegal activity and refuse to answer. Also, when the user places a follow-up request providing acceptable reasons for their initial request,

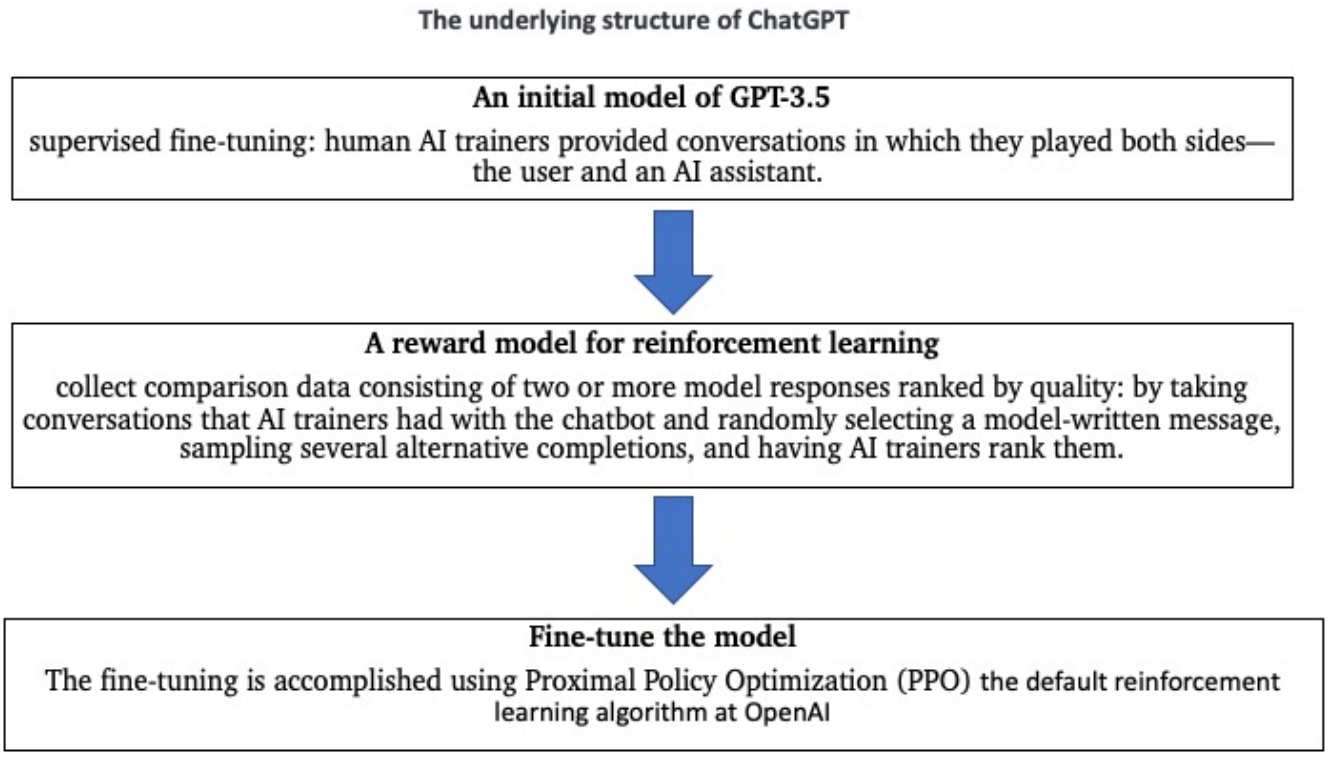

Fig. 2. WorkFlow of creating ChatGPT model

ChatGPT responds. One of the samples asks ChatGPT to write a limerick; another asks to summarize the conversation so far, which was done well.

There are various applications for a system that writes and generates meaningful text. For instance, the user may ask the system to write a bedtime story for a child at a certain age, and the story could be tailored to include actual events or specific names. In addition, understanding follow-up questions make it easy to use the system for chatting, killing time, and answering questions the user finds interesting, just like surfing the internet and scrolling through different content but with a system miming human writing.

Technically speaking, one could ask for consultations or medical advice, but as warned by OpenAI, the system may generate incorrect and possibly harmful information. Even for chatting, it is not a human-level chatbot interface yet. The system might be utilized to generate online content, rephrase text, write essays, write in languages other than English, and generate legal documents such as liability waivers, contracts, and agreements.

The model can provide services in programming; the language model has the potential to generate code in different programming languages for a variety of purposes. For example, in the current version of ChatGPT, one can ask for a particular function or a program, but it might require follow-up requests to get to the needed function or program. In addition, the code might need debugging even for simple functions, this is not to underestimate the power of the language model, but some answers might include errors; in some cases, the output is not in the requested programming language, and finally, the code might not adhere to best practices.

Even though ChatGPT is text-based, the ability to write code makes it possible to produce music, images, and 3D models. It is also possible to make profitable functionality, such as building trading systems and real state advising systems. Other possible uses in programming are debugging code, optimizing code to become more efficient, completing code with missing parts, changing the code style, generating test cases, and generating documentation.

Another exciting application is building plans. After providing supporting information, the user can request a plan to achieve a specific goal. ChatGPT provides a plan where the user can ask for more elaboration. The generated plan can be modified in follow-up requests. The plan's content could be a workout plan, a diet plan, a course plan, and so on. The user can ask for a general diet plan, and ChatGPT might respond with general guidelines to build one. The user might ask for a customized meal plan by providing information such as gender, age, weight, height, and goals, and then the system might return the meal plan with the proper calorie count. ChatGPT's response may include some advice to consult a healthcare professional or a registered dietitian. Figure 3 shows examples of ChatGPT applications.

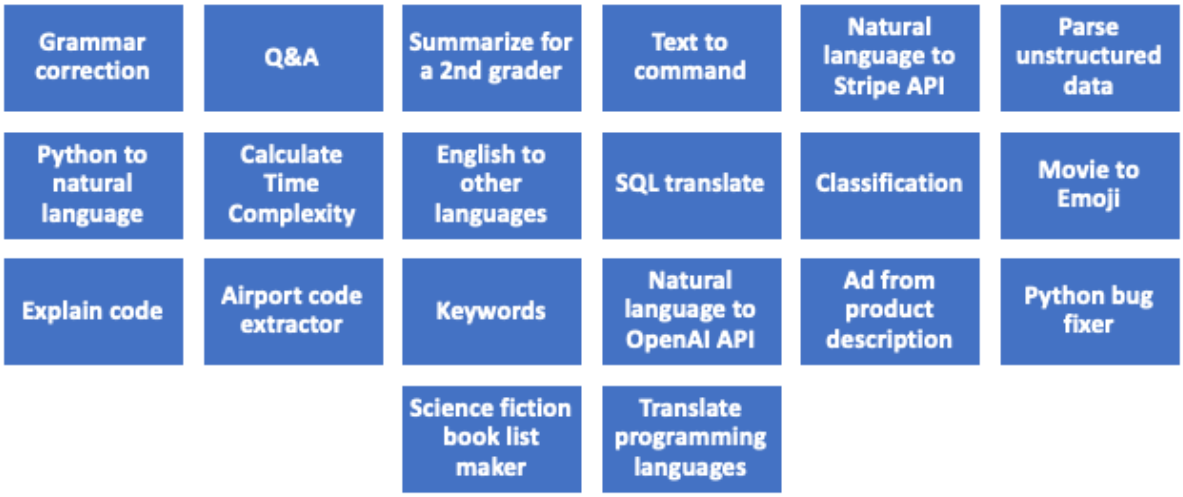

Fig. 3. Examples of ChatGPT applications

IV. Social impact

Since the capabilities and future potential of advanced language models such as ChatGPT are not defined or predetermined, it is debatable how they will impact human lives. In other words, ChatGPT is trained to make a dialogue with a human user based on vast amounts of data, the variety of functions it is capable of stems from the underlying data variety. This reminds people of the notion of artificial general intelligence (AGI), which implies that intelligent machines can perform any intellectual activity that a human can do [20]. AGI has always been seen as science fiction and a possibility of the future. However, the danger of self-acting AI comes to mind when observing the rapid development of systems dependent on AI. As these systems do not require any human intervention to make decisions, they might make harmful decisions. It also holds the risk of being attacked as any computerized system. ChatGPT's current version is an advanced language model based on AI and does not represent AGI.

The work in [21] analyses the tweets of early adopters of ChatGPT. Most tweets consider future careers and opportunities. The authors used 10,732 tweets from early ChatGPT users to investigate the sentiment of its users. Their analysis found that users were mostly positive when discussing topics such as Disruptions to software development, Entertainment, and exercising creativity. Nonetheless, there were still some concerns about the potential misuse of Chat-GPT, particularly in terms of its Impact on educational aspects. Examples were provided for each topic, and the authors offered implications for tackling any worries that may arise for researchers and users. In this section, we will discuss the social impact of ChatGPT on different domains, including the possibility of displacing workers in each domain.

A. Software Development and Software Engineering

As ChatGPT writes code, it is legitimate to think of the future of computing and how careers in this domain will be affected by the services provided by ChatGPT. In its current version, the code written by ChatGPT is impressive and may be helpful in some instances. For example, ChatGPT could be useful in debugging and generating code, especially when a programmer guides the process and sends requests. However, considering the limitations of the number of characters ChatGPT can output, and the possibility of minor and major errors, writing code beyond a simple program consists of a series of requests, repeated requests, and manually fixing errors.

This is not different from the code debugging functionality; answers provided by ChatGPT might be incorrect. Stack overflow, a website for professional developers, banned answers copied from ChatGPT as the chance of getting correct answers is too low [22]. The current version of ChatGPT will help assist programmers, but it will not end careers in the domain. As AI advancements are moving fast, such technologies will probably change the realm of computing careers in the near future.

B. Search Engines

ChatGPT also raises the question of the usability of other searching methods when ChatGPT further improves and the chance of other companies to compete. ChatGPT, in its current form, cannot replace search engines as it has a high error rate and needs access to up-to-date information. It is also text-based. In other words, although search engines cannot produce creative answers in their current version, they still can lead users to needed facts. The success of machine-learning technology such as ChatGPT depends heavily on the data, so it all comes to who has meaningful data and can use more parameters. It also depends on the processing power and ability to scale. Many businesses would likely offer such services in different ways. In the future, which searching technology to use may depend on many factors, such as efficiency, results relevance and quality, complementary features, and price if it is not free of charge.

C. Education

Another debatable area is the impact of ChatGPT on education. It has always been the case that technology affects education tremendously. Technology changed the role of teachers, how information is delivered, the student assessment, and so on. In the eighties, authors were interested in studying the impact of technology on education. For example, in his book, David Hawkridge, forecasted that it will be neither hell nor heaven for learners [23]. In 1988, a book envisioned the role of technology in education in 2020 [24].

ChatGPT could be quite helpful in teaching, explaining complex concepts in simple and understandable language, giving examples, and writing questions. It could enhance taught courses, suggest syllabus improvements, and prepare slides. On the other hand, many find it to have a negative impact on education as it is easy to misuse the functionality. For example, it may be used to write students' essays and solve homework. This is possible as the model can generate human-like text that is not copied directly from any source. Consequently, the text is unlikely to be recognized by anti-plagiarism software.

Nonetheless, this might encourage the improvement of software recognizing machine-generated text and improve methods used in education. Also, using the current version of ChatGPT might not have the depth of human reasoning, even if it is excellent at generating natural language.

A recent study [25] revealed that ChatGPT has the potential to display sophisticated reasoning and create realistic text with only a small amount of data, which could compromise online exams in higher education institutions where these types of exams are becoming more commonplace. To counter this problem, invigilated and oral exams may be implemented; however, advanced monitoring methods and AI-text detectors may only partially eradicate the issue. Further research is necessary to understand the full implications of large language models like ChatGPT and to develop strategies to counteract cheating that uses these tools. It is imperative for academics and educational institutions to be aware of the possibility of ChatGPT being employed to cheat and to explore ways to prevent this to preserve the fairness and reliability of online tests for all students.

D. Scientific Research

As in the case of all activities that require intellect and creative capability, such technology is expected to increase productivity and efficiency in accomplishing research-related tasks. One important task is reporting results, as ChatGPT can write, rephrase, and check the text for errors. In addition, it could assist in writing reviews and summarizing related works. Tasks such as finding a research problem of interest in a certain field, sampling, data collection, and data interpretation could be enhanced by suggestions provided by ChatGPT. For example, it could assist in designing questionnaires to collect data.

ChatGPT, in its current version, cannot produce meaningful scientific research. One limitation is its reasoning and high possibility of errors; another limitation is the data, as data on more specialized and complicated topics could be lacking. The work in [26] used ChatGPT to write a paper, and the human authors concluded that the produced content was not reliable.

E. Virtual Assistant

ChatGPT has great potential to improve the quality of life of many people. It can be used to create virtual assistants that can take over mundane tasks and help people complete their work more efficiently. Additionally, ChatGPT can be used to build chatbots that can provide support, answer questions, and offer assistance in many areas, such as customer service, health care, and education. In the long run, these applications could enable better access to knowledge, education, and services for people worldwide.

ChatGPT can help businesses by automating customer service, personalizing customer interactions, and providing a better customer experience. In addition, it can generate natural language responses tailored to individual customer needs, making customers happier and more satisfied with their overall experience. This can lead to increased customer retention, loyalty, and satisfaction.

F. Literature and Art

ChatGPT can help writers and other creatives by providing a platform to generate content quickly, access real-time feedback from readers, and discover new ideas and angles for their stories. It can also help with creative processes such as outlining, editing, and proofreading., and provide writers with insights into the types of stories their readers are most interested in.

The authors of [11] demonstrate that ChatGPT can achieve a state-of-the-art or equivalent performance for stance detection tasks on common datasets (e.g., SemEval-2016 and P-Stance). Furthermore, ChatGPT can explain its predictions, a capability not previously seen in existing models.

G. Media and News

ChatGPT is a powerful tool for exploring social impact by analyzing different users' conversations and media interactions. It can be used to identify both positive and negative trends in the news, giving us a better understanding of the potential implications of certain events.

H. Legal and Court systems

AI assistants like chatGPT are already beginning to impact legal and court systems significantly. By allowing lawyers and other legal professionals to analyze large amounts of data and generate legal arguments quickly, these advanced AI tools can save time and reduce the cost of litigation. Additionally, AI assistants like chatGPT can be used to identify patterns in legal documents, which could lead to new insights about the law that can be used to improve the accuracy and speed of legal proceedings.

I. Health and Medical care

A group of researchers investigated ChatGPT by conducting an exploratory case study with medical reports [**?**]. The study's initial findings suggest that using large language models such as ChatGPT to simplify radiology reports has great potential for improving patient-centered care in radiology and other medical domains. Fifteen radiologists were asked in a survey to evaluate the quality of the simplified reports, and most agreed that they were factually correct and complete. However, further research is needed to confirm these findings.

V. Conclusion

ChatGPT is a form of natural language processing (NLP) technology that has enabled unprecedented levels of automation in communication. It is designed to enable better conversations with AI-powered agents, and its generative-based machine-learning model can provide highly accurate results. It is built on cutting-edge artificial intelligence and machine learning technologies. By using machine learning and artificial intelligence, ChatGPT has been able to enable conversations between humans and machines and improve the accuracy and speed of communication. This can change the way we interact with each other and can have a significant impact on many aspects of our lives, from education to business. Aside from the obvious benefits of increased accuracy and speed, ChatGPT has many potential applications in areas such as customer service automation, voice-based intelligent assistants, automated translations, and much more. Thus, the fundamentals of chatGPT are revolutionizing how people communicate and interact, and the effects of this technology on society as a whole are far-reaching and undeniable. From education to business, it has made communication easier, faster, and more efficient, and its effects are only expected to grow with time.

The limitations of ChatGPT can be listed [10] as:

- The challenge of improving ChatGPT's accuracy is difficult since there is currently no reliable source of truth to guide training.
- ChatGPT can interpret slight changes in input phrasing and respond differently to the same prompt if asked multiple times.
- The model tends to use too much vocabulary and repeat words or phrases like OpenAI created it. These issues stem from a bias in the training data and common concerns about over-optimization.
- The ideal model can understand an ambiguous query by asking the user questions to clarify what they are looking for. In contrast, the current models make guesses about the user's intended intentions.
- The Moderation API is used to detect and prevent harmful requests, however, some inappropriate requests may still slip through, and the model could behave in a biased way.

Regardless of the limitations of the current version of ChatGPT, the language model made people realize artificial intelligence potential. The possible impact of the language model is debatable, but its contribution to increasing people's awareness of new artificial intelligence capabilities is evident. ChatGPT has the potential to create positive social impacts by providing people with a convenient way to communicate and collaborate. It can also help bridge communication gaps between cultures and countries by allowing people to communicate with one another from all over the world. Additionally, chatGPT could help support businesses that rely on customer service, as well as provide educational material to students in a more interactive setting, which could lead to more successful outcomes. As this technology continues to grow, its impact and usefulness will only increase.

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