

The State-of-art Applications of NLP: Evidence from ChatGPT

Yuming Zhao *

Department of Computer Science and Technology, Tianjin University of Technology, Tianjin, China

* Corresponding Author Email: zym5164@stud.tjut.edu.cn

Abstract. Contemporarily, ChatGPT, one of the latest applications of natural language processing (NLP) based on a popular deep learning model developed by OpenAI, has attracted tremendous attention of researchers. On this basis, this study takes NLP as an example to provide a basic introduction to the development history and application of NLP, and lists some models in the development process. These are valuable knowledge that is still used in OpenAI applications. Before in-depth study of the components and models of ChatGPT, this paper also mentioned the basic introduction of chat robots. According to the analysis, it is shown that people are increasingly interested in the use of ChatGPT in various applications, including language translation and question answering. However, it also lists several limitations of ChatGPT, e.g., its tendency to generate biased or inappropriate responses. The future prospects of ChatGPT or similar products are also mentioned later. Moreover, the main findings of the paper and proposes potential avenues for future research are presented. Overall, these results shed light on guiding further exploration of NLP.S.

Keywords: Natural Language Processing; OpenAI; ChatGPT; Machine learning.

1. Introduction

NLP researchers are keen on learning about how people interpret and use language in order to develop the appropriate tools and methods that will allow computer systems to comprehend and manipulate natural languages in order to accomplish the intended tasks [1]. Many transfer learning techniques and architectures have emerged in the field of Natural Language Processing (NLP), greatly advancing the state-of-the-art for a variety of NLP problems [2]. NLP involves a wide range of applications, which can be divided into the following six categories: (1) Text mining (2) Information retrieval (3) Syntactic semantic analysis (4) MT (5) Q&A system (6) Dialogue system.

The research has steadily eliminated the disorder of the conventional word bag representation method, further enhancing the expression capability of the representation vector, from the embedded word vector representation in 2001 to the word2vec in 2013. The usage of several neural network models in NLP rapidly increased between 2013 and 2014, with convolutional neural networks (CNN), recurrent neural networks (RNN), and recursive neural networks being the most popular models. Sequence-to-sequence learning is a framework model that Sutskever et al. proposed in 2014. It uses neural networks to map one sequence to another. A representation vector is created by encoding the input text, and a sequence of output texts is created by decoding the representation vector. Once proposed, this structure was quickly applied to machine translation and gradually replaced the phrase-based whole sentence machine translation model. Influenced by image learning, pre-trained language models were first introduced in 2015, but only in 2018 did major progress occur, and pre-trained language models represented by BERT proposed by Google were proven to be effective on a large number of NLP tasks (ELMO, XLNet, GPT, RoBERTa, ALBERT, etc.). These pre-trained language models are unsupervised, enabling the model to gain generic language modeling capabilities from unlabeled corpus. The model may then execute task-oriented fine-tuning based on a little quantity of labeled data, enabling it to produce satisfactory results without a huge amount of training data and significantly reducing the requirement for many labelled data points for low-resource tasks. Nowadays, NLP research has advanced quickly. It still falls short of expectations, though, and there is a lot of opportunity for development across the board.

Here are some examples of application of NLP in Open AI. The next generation of NLP systems, which should be capable of processing generic material rather effectively and account for much of a language's complexity and confusion, is currently under development by NLP researchers [3]. An

autoregressive language model called Generative Pre-trained Transformer 3 (GPT-3) mainly uses learning techniques to generate text that simulates natural communication. Open AI developed the GPT-n series in the research facility. It is a Natural Language Processing (NLP) technology that works well [4]. UFT One, an AI-driven test automation product, enabling customers to test earlier and more frequently. The three AI features that UFT One and UFT Developer have are Translator (NLP), Mind (Neural Networks), and Vision (Computer Vision). By creating tests in essentially plain English, users can use the Translator to speed up test creation and make test management easier [5].

The aim of this paper is to better understand the detailed introduction of the current OpenAI based on the development of NLP. The remainder of the essay is structured as follows. The Sec. 2 will introduce Basic Descriptions of Chatbot. The Sec. 3 will introduce Components of ChatGPT. The Sec. 4 will introduce Models of ChatGPT. The Sec. 5 will introduce Potential Applications based on ChatGPT. The Sec. 6 will introduce the limitations and future outlooks of ChatGPT.

2. Basic Descriptions of Chatbot

A chatbot is a software program that communicates through text or dialogue. It is able to mimic human speech and pass the Turing test. The purpose of ChatBot, a character-based DGA, is to demonstrate how well a simple DGA based on minor perturbations can avoid being detected by modern classifiers [7]. Chat robots are usually used for various purposes in conversation systems, including customer service, request routing or information collection. Some chat robot programmers just scan common keywords and generate responses using common phrases retrieved from the related library or database, in contrast to some chat robot systems that use a variety of word categorization techniques, natural language processors, and complicated AI.

The majority of chatbots today may be accessed online via pop-up windows on websites, virtual assistants (e.g., Google Assistant and Amazon Alexa), or messaging apps (e.g., Facebook Messenger or WeChat). Business (e-commerce through conversation), education, entertainment, finance, health, news, and productivity are some of the use areas for chat robots. Naive Bayes, Decision Trees, Support Vector Machines, Recurrent Neural Networks (RNN), Markov Chains, Long Short Term Memory (LSTM), and Natural Language Processing are some of the most prominent algorithms utilized by typical Chatbots (NLP). Chatbots commonly utilize categorization algorithms to assess phrase intent [8].

One of the most used classification algorithms is naive Bayes. It is a classifier technique built on the independent assumption of feature conditions and Bayesian definition. The naive Bayesian technique has a strong mathematical foundation and stable classification efficiency because it is calculated using the Bayesian formula. The Naive Bayes model has a simple procedure, few estimated parameters, and is not sensitive to missing data. Support vector machines excel in generalizing classification problems because its major focus is to establish an ideal decision hyperplane that maximizes the distance between the two classes of samples that are closest to the plane on either side of the plane. A hyperplane is randomly created for a multidimensional sample set, moved around, and the samples are then categorized until sample points from the training sets that correspond to multiple categories are dispersed on both sides of the hyperplane. There could be a number of hyperplanes that satisfy this condition, SVM officially finds such a hyperplane. SVM is a supervised learning technique that is primarily used to identify, categories, and forecast data from small samples. Decision tree induction technique is one example of a similar learning strategy based on samples.

Now-essential technologies for a range of tasks like speech recognition, image classification, and natural language processing include deep neural networks and other algorithms for machine learning [9]. Convolutional neural network (CNN), recurrent neural network (RNN), deep confidence network (DBN), deep automatic coder (Auto Encoder), generating antagonism network (GAN), and others are the most widely utilized deep neural network models now. The previous multi-layer neural network's limitation in supervised learning is that it is simple to fall into local extreme points. The learnt multi-layer weights can be effectively utilized to forecast the new test samples if the training samples are

sufficient to cover the future samples. However, it can be challenging to collect enough samples with labels for many activities. In this situation, straightforward models, such linear regression, or decision trees, frequently produce exceptional results to multi-layer neural networks (better generalization, worse training error). A typical example of CNN and FNN are given in Fig. 1 and Fig. 2 [10].

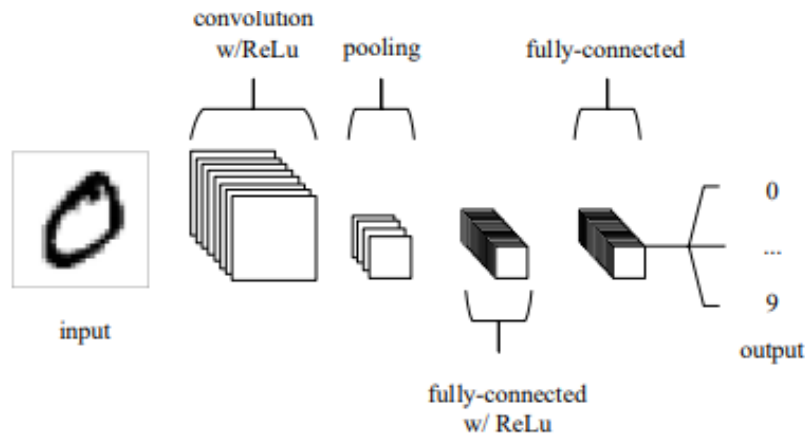


Fig 1. a straightforward CNN architecture with only five layers.

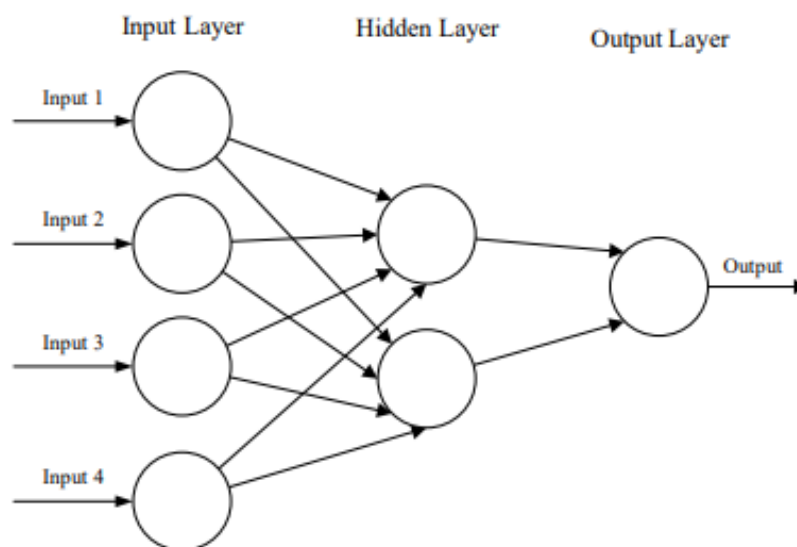


Fig 2. A simple feedforward neural network (FNN) with three layers: input, hidden layer, and output.

3. Components of ChatGPT

The reason for the name “ChatGPT” is that this model is pre-trained, designed for dialogue and text generation, and uses the Transformer architecture. Therefore, "Chat" means that it is a dialogue model, and "GPT" means that it is built with the architecture of the Generic Pretrained Transformer. Originally introduced for the task of natural language translation, transformers are a significant, recently formed class of deep learning models that now monopolies the state-of-the-art performance across nearly all NLP tasks [11]. Transformer architecture is a deep neural network architecture for natural language processing tasks. It adopts attention mechanism, which can solve the problem of long dependence in sequence data. The Transformer architecture has achieved remarkable success in the NLP field and has become the preferred architecture for most NLP tasks. They can be used for emotional analysis, machine translation, speech recognition and other tasks.

Based on artificial intelligence (AI) technology, ChatGPT has been taught using data from the internet that has been written by people, including discussions. An AI-powered chatbot can write

essays, poems, solve coding problems, and explain difficult concepts, among many other things [12]. It is a conversational AI system introduced by OpenAI, a business engaged in AI development. Several of ChatGPT's features are shared with the GPT-3.5, one of the largest LLMs (>175 billion parameters) to yet. Moreover, ChatGPT has been optimised for conversational tasks [13]. The basic principle of LLMs is to use deep learning algorithm for training, and learn the structure and rules of language through many language data. In the training process, LLMs generate some new texts similar to the corpus by learning the probability distribution and grammatical structure of the text. The advantage of LLMs is that they can automatically generate many high-quality texts, and can improve the quality of the generated text through continuous training.

It was first presented as a conversational AI system by the OpenAI AI research and application company. GPT-3.5, which has more than 175 billion parameters and is one of the largest LLMs to date, is the basis for ChatGPT. Furthermore, ChatGPT is optimized for conversational activities [13]. RHLF technology is the main difference between ChatGPT and other conversation robots. The training process of RLHF can be divided into three core steps:

The first step is Pretraining Language Model (LM): training a language model using the classical pre-training target. For the model in this step, OpenAI uses the smaller version of GPT-3 in its first popular RLHF model, InstructGPT. This step is similar to other language training. And then collect data and train reward model RM's training is the beginning of the difference between RLHF and the old paradigm. It receives a series of texts and returns a scalar reward, which numerically corresponds to people's preferences. Then, one will use LM modeling in an end-to-end way, or use modular system modeling (such as ranking the output, and then converting the ranking into rewards). This reward value will be crucial for the subsequent seamless access to the existing RL algorithm. The last step is to fine tune LM through reinforcement learning, using reinforcement learning algorithm to continuously optimize, which uses a reinforcement learning algorithm called PPO (Proximal Policy Optimization). The early reinforcement learning algorithm has a high training cost and is very complex. It is rarely used outside the game AI. The PPO algorithm proposed by OpenAI later greatly simplifies the complexity of the algorithm under the same or even better effect. The framework of the procedure is given in Fig. 3 [14].

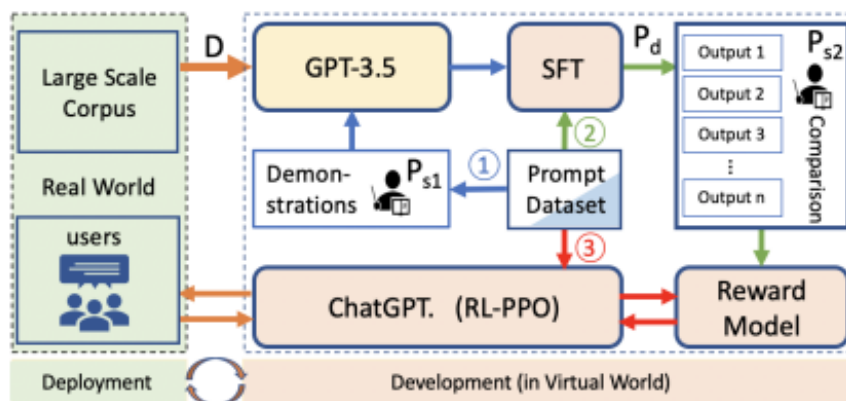


Fig 3. Principles of ChatGPT from a Parallel Learning perspective.

4. Models of ChatGPT

ChatGPT can be viewed as the whole in a true sense as compared to the prior chat robots. It is widely acknowledged that one of the most difficult tasks in the world of AI is natural language processing. Three different learning types, i.e., descriptive, predictive, and prescriptive, are used in a double-loop pipeline as part of the ChatGPT approach [14]. Language is often full of ambiguity and highly dependent on context. In addition, all parties in common language communication need to have a lot of common background knowledge. ChatGPT can produce text that resembles human speech without the need for further tinkering on a particular job or dataset because it has already been

pre-trained on a vast amount of conversational data [15]. Training the ChatGPT requires the following steps. First is data preparation, it needs to prepare enough chat conversation samples, which can be real human conversations or virtual conversations generated by programs. These dialogues help the ChatGPT model learn the context of the language, thus it can generate more natural and logical responses. Then the second step is model construction. The foundation of ChatGPT model is a language model, which is based on a bi-directional circulator-decoder. This model can capture context information to achieve more accurate semantic understanding. The third is the training process, ChatGPT model uses the following text of the dialogue to predict the content of the next sentence. It will predict the content of a sentence and its relationship with other sentences according to the context information in the training data. The training process will continue to improve the model until the model performance reaches the expected level. Period effect. In addition, ChatGPT also adopts the technology based on dynamic mask, which can dynamically select which parts of the model to participate in the calculation, thus improving the efficiency and accuracy of the model. ChatGPT also uses residual connection and Layer Normalization technologies, which can effectively solve the problems of gradient disappearance and gradient explosion, thus improving the training effect and stability of the model. The next step is model evaluation. After training, the model will be evaluated to evaluate the accuracy and performance of the model. During the evaluation process, the performance of the model on a series of tasks will be given, and the evaluation results will be given according to the performance. The last one is deployment. After the ChatGPT model is deployed, it can start to communicate with users. Users can create natural dialogues and interact with the model with the help of this model.

In the process of training and evaluation, a large amount of computing resources will be used, while the deployment process requires less resources. In addition, the deployed model can also be adjusted and optimized to improve performance. In short, ChatGPT, as an advanced natural language processing model, has high interpretability and scalability in terms of its training mode and technical principles. With the continuous improvement and application of ChatGPT, it will also play an increasingly important role in more natural language processing tasks.

5. Applications

Intelligent and conversational AI systems that can revolutionise the way people interact with technology can be developed by combining the conversational capabilities of ChatGPT with the physical and visual capabilities of computer vision and robotics [16]. For example, ChatGPT can be connected with smart home system to realize home control and automation. ChatGPT can control the opening, closing and adjustment of home devices through voice or visual recognition. It can automate some operations in the home (automatically turning off the lights, automatically adjusting the temperature, etc.). Thereby, users can enjoy a better life experience. It can become a learning assistant for students, and realize the explanation and answering service of knowledge points through dialogue. Through the analysis of users' learning content, it can provide users with personalized course recommendations and learning plan recommendations. It can also review knowledge points in the form of flashcards to improve the efficiency and quality of students.

The capacity to help with social media chores is one of ChatGPT-3's core characteristics, making it a useful tool for marketers, organisations, and individuals [17]. ChatGPT is expected to have a huge impact on the operation, management, product marketing and customer service of the financial industry. In recent years, financial institutions have a strong desire for digital construction under the influence of stricter compliance, rising labor costs and other factors. Considering the outstanding performance of ChatGPT in content generation, It is expected to take the lead in providing external customer service and internal investment and research support. Taking the banking industry as an example, electronic customer service is still in the AB judgment stage, and the introduction of ChatGPT will better serve customer needs. In the securities and fund industries, a large number of doubts of individual investors can be solved through ChatGPT, and institutional investors will also

get cooperation from GPT in investment research. ChatGPT is expected to reconstruct the customer service end of the financial industry, and to further enhance the investment and research capabilities within the institution, to help improve operational efficiency and optimize costs.

ChatGPT is expected to change the content production mode in the field of image and video, and improve the richness of information output through multimodality. The image and video industry are intertwined with the old and new formats, and has a relatively diverse composition. It exists in the form of production and dissemination of words, images, art, images, sounds, and other forms, including newspapers, books, radio, films, television, animation, and many other subdivisions. From the perspective of the industrial chain, the image and video industry mainly involve information collection, production, distribution, dissemination, etc. ChatGPT will mainly affect the collection and production of the front end of the industrial chain. In fact, GPT 4 has achieved these functions.

6. Limitations & Future outlooks

Although ChatGPT has more powerful performance and learning ability than the previous GPT-3 / GPT 3.5, it cannot think like humans, so there are inevitable limitations. The first aspect is about logical reasoning, ChatGPT's ability is not enough to deal with logic problems accurately. For example, for mathematics or first-order logic, it often gives wrong answers, because the answers to such questions are deterministic rather than probabilistic. The second is about reliability, it will still produce factual incorrect or biased answers. Although this is an inherent problem of the generative AI model, it is not so good at solving this problem. The authenticity of generated information is still the main cornerstone of this kind of generative chat robot. And the third is Knowledge learning, ChatGPT does not have the real-time search function of the website, and cannot learn new knowledge and update the knowledge reserve. In addition, it is difficult to rewrite and revise the knowledge in the model. Knowledge acquired from large-scale corpus is stored in a model with distributed representation. These models are black boxes, which are difficult to operate or interpret. The last aspect is about robustness. Although it is strong in generating safe and harmless responses, there are still some ways to attack the system, including instruction attack (making the model follow wrong instructions to do illegal or immoral things) and prompt injection. In addition, it does a good job in English and respecting American culture, but for other languages and cultures, it is necessary to develop other versions based on the background of relevant data sets.

For future studies in ChatGPT, there several achievable development trends. First: More intelligent and adaptive, one of the future development trends of it is to be more intelligent and adaptive. With the continuous development of AI technology, the model and algorithm are also being improved and upgraded. In the future, ChatGPT will be more intelligent, able to understand human language more accurately, and able to automatically learn and adapt itself. This will enable it to play a more important role in all fields. Second: More personalized and customized. The third development trend of in the future is to be more personalized and customized. With the increasing demand for personalized services, it will pay more attention to personalized and customized services. In the future, ChatGPT will be able to provide more accurate services according to different needs and habits of users. This will make it closer to the needs of users, so as to better meet the needs of users. Third: More humanized and emotional. The fourth development trend in the future is more humanized and emotional. Although ChatGPT can now understand and process human language, it still lacks human emotion and understanding ability. In the future, it will pay more attention to humanized and emotional services. It will learn and imitate human emotion and language characteristics, so as to better understand human language and provide more considerate services.

7. Conclusion

In summary, this study discusses evidence from ChatGPT based on the state-of-art Applications of NLP. The research successfully outlines the development of its predecessor, the development of

NLP, and the development of Chatbot. This article focuses on discussing the structure, composition, and usage model of ChatGPT. It also discusses the scenarios and ways in which humans will use similar products in the future, and describes some potential applications. The limitations and future expectations were mentioned. Firstly, its ability to accurately handle logical questions was not sufficient, secondly, the reliability of the answers was also important. Thirdly, ChatGPT did not have the real-time search function of the website, and finally, its robustness. However, this article did not mention its lack of social ethics due to space issues. In the future, it can become more intelligent and have better adaptability, and can be customized and personalized for different needs of different users. The research significance of this article is to provide scholars with a preliminary understanding of future research and development of similar products, and to help those who want to understand artificial intelligence introduce such knowledge. Currently, the more powerful GPT4 has been released, and this article can serve as a reference for further research on GPT4 in the future.

References

- [1] Chowdhary K R, Chowdhary K R. Natural language processing. *Fundamentals of artificial intelligence*, 2020: 603-649.
- [2] Ruder S, Peters M E, Swayamdipta S, et al. Transfer learning in natural language processing. *Proceedings of the 2019 conference of the North American chapter of the association for computational linguistics: Tutorials*. 2019: 15-18.
- [3] Joseph S R, Hlomani H, Letsholo K, et al. Natural language processing: A review. *International Journal of Research in Engineering and Applied Sciences*, 2016, 6(3): 207-210.
- [4] Desai V P, Oza K S. Fine Tuning Modeling Through Open AI. *Progression in Science, Technology and Smart Computing*, PRARUP, 2021.
- [5] Pham K, Nguyen V, Nguyen T. Application of Natural Language Processing Towards Autonomous Software Testing. *37th IEEE/ACM International Conference on Automated Software Engineering*. 2022: 1-4.
- [6] Peck J, Nie C, Sivaguru R, et al. CharBot: A simple and effective method for evading DGA classifiers. *IEEE Access*, 2019, 7: 91759-91771.
- [7] Lokman A S, Aamedeen M A. Modern chatbot systems: A technical review. *Proceedings of the Future Technologies Conference (FTC) 2018: Volume 2*. Springer International Publishing, 2019: 1012-1023.
- [8] Montavon G, Samek W, Müller K R. Methods for interpreting and understanding deep neural networks. *Digital signal processing*, 2018, 73: 1-15.
- [9] Zerveas G, Jayaraman S, Patel D, et al. A transformer-based framework for multivariate time series representation learning. *Proceedings of the 27th ACM SIGKDD Conference on Knowledge Discovery & Data Mining*. 2021: 2114-2124.
- [10] O'Shea K, Nash R. An introduction to convolutional neural networks. *arXiv preprint arXiv:1511.08458*, 2015.
- [11] Patel S B, Lam K. ChatGPT: the future of discharge summaries?. *The Lancet Digital Health*, 2023.
- [12] Shen Y, Heacock L, Elias J, et al. ChatGPT and other large language models are double-edged swords. *Radiology*, 2023: 230163.
- [13] Munn L, Magee L, Arora V. Truth Machines: Synthesizing Veracity in AI Language Models. *arXiv preprint arXiv:2301.12066*, 2023.
- [14] Wang F Y, Miao Q, Li X, et al. What does chatGPT say: the DAO from algorithmic intelligence to linguistic intelligence. *IEEE/CAA Journal of Automatica Sinica*, 2023, 10(3): 575-579.
- [15] Mijwil M, Aljanabi M, Ali A H. ChatGPT: Exploring the Role of Cybersecurity in the Protection of Medical Information. *Mesopotamian journal of cybersecurity*, 2023, 2023: 18-21.
- [16] Aljanabi M. ChatGPT: Future Directions and Open possibilities. *Mesopotamian Journal of CyberSecurity*, 2023, 2023: 16-17.
- [17] Aljanabi M, Ghazi M, Ali A H, et al. ChatGpt: Open Possibilities. *Iraqi Journal For Computer Science and Mathematics*, 2023, 4(1): 62-64.