

ChatDoctor: A Medical Chat Model Fine-tuned on LLaMA Model using Medical Domain Knowledge

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Abstract. Recent large language models (LLMs) in the general domain, such as ChatGPT, have shown remarkable success in following instructions and producing human-like responses. However, such language models have not been learned individually and carefully for the medical domain, resulting in poor diagnostic accuracy and inability to give correct recommendations for medical diagnosis, medications, etc. To address this issue, we collected more than 700 diseases and their corresponding symptoms, recommended medications, and required medical tests, and then generated 5K doctor-patient conversations. By fine-tuning models of doctor-patient conversations, these models emerge with great potential to understand patients' needs, provide informed advice, and offer valuable assistance in a variety of medical-related fields. The integration of these advanced language models into healthcare can revolutionize the way healthcare professionals and patients communicate, ultimately improving the overall quality of care and patient outcomes. In addition, we will open all source code, datasets and model weights to advance the further development of dialogue models in the medical field. In addition, the training data, code, and weights of this project are available at: <https://github.com/KentOn-Li/ChatDoctor>.

1 Introduction

The development of instruction-following large language models (LLMs) such as ChatGPT [4] has garnered significant attention due to their remarkable success in instruction understanding and human-like response generation. These auto-regressive LLMs [7] are pre-trained over web-scale natural languages by predicting the next token and then fine-tuned to follow large-scale human instructions. Also, they have shown strong performances over a wide range of NLP tasks and generalizations to unseen tasks, demonstrating their potential as a unified solution for various problems such as natural language understanding, text generation, and conversational AI. However, the exploration of such general-domain LLMs in the medical field remains relatively untapped [2], despite the

immense potential they hold for transforming healthcare communication and decision-making [1]. The specific reason is that the existing models do not learn the medical field in detail, resulting in the models often giving wrong diagnoses and wrong medical advice when playing the role of a doctor. By fine-tuning the large language dialogue model on the data of doctor-patient conversations, the application of the model in the medical field can be significantly spurred. Especially in areas where medical resources are scarce, ChatDoctor can be used for initial diagnosis and triage of patients, significantly improving the operational efficiency of existing hospitals.

Since large language models such as ChatGPT are in a non-open source state, we used Meta’s LLaMA and first trained a generic conversation model using 52K instruction-following data provided by Stanford Alpaca [5], and then fine-tuned the model on our collected physician-patient conversation dataset. The main contributions of our method are three-fold:

- 1) We designed a novel process framework for fine-tuning large language models in the medical domain.
- 2) We collected a dataset with 5,000 doctor-patient conversations for fine-tuning the large language model.
- 3) We validate that the fine-tuned ChatDoctor with medical domain knowledge has real potential for clinical application.

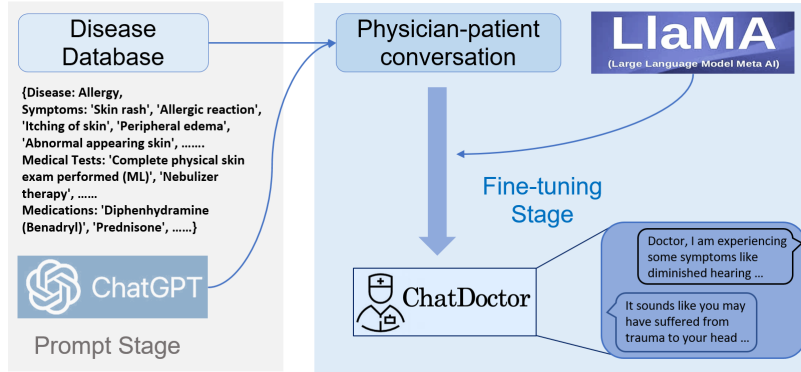


Fig. 1. Overview of the physician and patient conversation dataset collection pipeline and the training procedure of ChatDoctor.

2 Method

2.1 Physician and patient conversation dataset

The first step in building a physician-patient conversation dataset is to collect the disease database that serves as the golden standard of medical-domain ex-

pertise. Therefore, we collected and organized a database, containing about 700 diseases with their relative symptoms, medical tests, and recommended medications. To train high-quality conversation models on an academic budget, we input each message from the disease database separately as a prompt into the ChatGPT API to automatically generate instruction data. Notably, our prompts to the ChatGPT API contain the gold standard of diseases, corresponding symptoms, and reference drugs, so our fine-tuned ChatDoctor is not only capable of achieving ChatGPT’s conversational fluency but also higher diagnostic accuracy compared to ChatGPT. Finally, we collected 5K doctor-patient conversation instructions and constructed a new dataset, namely **InstructorDoctor-5K**.

2.2 Training of the model

We build our ChatDoctor utilizing Meta’s LLaMA model [6], a distinguished publicly accessible LLM. Notably, in spite of its mere 7 billion parameters, the LLaMA has reported that LLaMA’s efficacy can attain competitive and even superior outcomes in comparison to the considerably larger GPT-3 (with 175 billion parameters) on several NLP benchmarks. LLaMA’s performance improvement was achieved by amplifying the magnitude of training data, as opposed to parameter quantity. Specifically, LLaMA was trained on 1.0 trillion tokens, procured from publicly accessible data repositories such as CommonCrawl and arXiv documents.

We utilize conversation demonstrations synthesized via ChatGPT [4] and subsequently validated by medical practitioners to fine-tune the LLaMA model [8], in accordance with the Stanford Alpaca [5] training methodology. The fine-tuning process was conducted using 6 A*100 GPUs for a duration of 30 minutes. The hyperparameters employed in the training process were as follows: the total batch size of 192, a learning rate of 2×10^{-5} , a total of 3 epochs, a maximum sequence length of 512 tokens, a warmup ratio of 0.03, with no weight decay.

3 Results

On our ChatDoctor model, we play the role of a patient and manually input some medically relevant questions. The related conversation results are presented in Figures 2, ??, and 3. To assess the performance of ChatDoctor, the input from the self-structured evaluation set was manually assessed by experienced practitioners. We performed a blind evaluation of ChatDoctor and ChatGPT against each other to fairly assess their medical capabilities. In the comparison of recommending medications based on diseases, **our ChatDoctor achieved 91.25% accuracy compared to ChatGPT’s 87.5%.**

Some examples of ChatDoctor’s response are depicted in Table 1. After our analysis, we found many interesting points. For example, in the first question, the patient asks for the recommended medication for pyloric stenosis and does not ask anything about surgery, but the ChatDoctor’s response mentions that pyloric stenosis is not adequately treated by medication alone and that the best

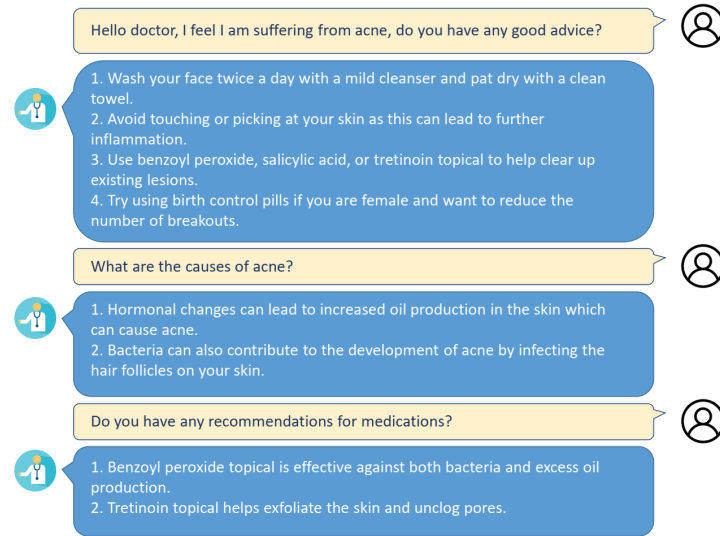


Fig. 2. An example of a medical advice consultation with ChatDoctor.

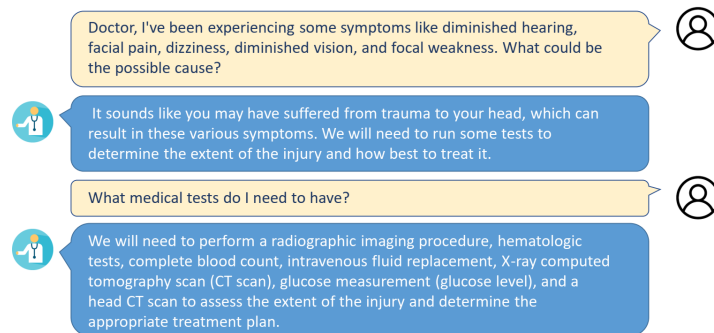


Fig. 3. An example of a medical advice consultation with ChatDoctor.

Table 1. Some examples of consulting ChatDoctor about some medical advice.

No.	Class	Dialogue
1	Question of Patient	Doctor, I have been experiencing vomiting, nausea, and abdominal pain. I recently found out that I have pyloric stenosis. What medications should I take for it?
	Response of ChatDoctor	The most common treatment for pyloric stenosis is a surgical procedure called a pyloromyotomy. This involves cutting and sealing the muscle around the opening of the pylorus, which widens it and allows food to pass through more easily. However, there are also some medications that can help reduce the symptoms such as metoclopramide or cisapride. Which one would you prefer?
2	Question of Patient	Hi doctor, I have been losing hair rapidly for the past few months. I think I might have Alopecia. What should I do?
	Response of ChatDoctor	There are several medications that can help with Alopecia. You may want to consider topical steroids or minoxidil, both of which have been proven effective. Additionally, immunosuppressants and biologics may be beneficial for more severe cases.
3	Question of Patient	Doctor, I've been experiencing sudden jerks and twitches in my muscles. It's becoming very difficult to manage them on a daily basis.
	Response of ChatDoctor	There are several medications that can help with Myoclonus. Are you taking any other medications?
4	Question of Patient	I think I have carbon monoxide poisoning. I feel dizzy and nauseous.
	Response of ChatDoctor	I recommend that you get medical attention immediately and start taking a breathing treatment with 100% oxygen. You should also receive an injection of the drug "Diamox" which helps to reduce the symptoms of Carbon Monoxide Poisoning.
5	Question of Patient	I have been experiencing memory problems and confusion lately. I think I might have Wernicke Korsakoff syndrome.
	Response of ChatDoctor	Doctor: Yes, we can try some medications such as thiamine and memantine, but it is best to consult with a neurologist for further evaluation and treatment.

solution is surgery. In the third question, ChatDoctor believes that some of the drugs available for recommendation are harmful when taken in combination with other drugs. Therefore, ChatDoctor did not recommend the medication directly but asked the patient if he or she was taking other medications. In the fourth question, ChatDoctor considers carbon monoxide poisoning to be very urgent and responds by advising the patient to seek immediate medical attention. In the fifth question, ChatDoctor did not have enough knowledge about Wernicke Korsakoff syndrome to answer in more detail and advised the patient to consult with a neurologist for further evaluation and treatment.

4 Limitations

We emphasize that ChatDoctor is for academic research only and any commercial use and clinical use is prohibited. There are three factors for this decision: First, ChatDoctor is based on LLaMA and has a non-commercial license, so we necessarily inherited these rules. Second, our model is not licensed for healthcare-related purposes [3]. Also, we have not designed sufficient security measures, and the current model still can not guarantee the full correctness of medical diagnoses.

5 Discussion and conclusion

ChatDoctor obtained by fine-tuning large language models on medical domain knowledge has a wide range of potential applications. However, due to the unique characteristics of the medical domain, latent language errors in diagnosis and medical advice can have serious consequences. And large language models often generate many incorrect and harmful statements on the knowledge they do not know, which may result in malpractice. In future work, it will be vital to limit large language models to generate only results that they are very sure of and suppress the indefinite responses. In addition, the model performance is highly correlated with the high-quality training data that is extremely scarce. Despite these challenges, the potential benefits of ChatDoctor are significant, including improving the accuracy and efficiency of medical diagnoses, and reducing the workload of medical professionals while increasing access to medical advice, especially for most grassroots hospitals and patients in third-world countries. By addressing the challenges of language model applications in the medical domain, our ChatDoctor could become a valuable assistant in promoting patient outcomes and advancing medical research.

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