Helpi – An Automated Healthcare Chatbot

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Abstract. Due to technological advancements, the healthcare industry has witnessed the emergence of innovative solutions, and one such solution is the healthcare Chatbot. The primary objective of this paper is to create a healthcare Chatbot capable of offering medical assistance to patients. The healthcare Chatbot serves as an AI-based conversational program designed to assist both patients and healthcare providers. The proposed Chatbot, named "HELPI," functions as a round-the-clock healthcare provider. It utilizes Natural Language Processing (NLP) and Machine Learning (ML) algorithms such as decision trees to analyze user-provided symptoms and accurately detect specific illnesses or diseases. Subsequently, it offers appropriate healthcare recommendations and suggests relevant medications. This broadens HELPI's capability to address various healthcare-related concerns. In essence, HELPI aims to alleviate the burden on healthcare providers by providing an alternative platform for basic medical advice and support. The success of the HELPI Chatbot lays the foundation for future enhancements. Additional features, such as appointment scheduling, guidance on lifestyle modifications, and medication reminders, could be incorporated to further enhance the Chatbot's functionality.

1 Introduction

Chatbots have found diverse applications across industries such as customer service, e-commerce, healthcare, and finance. Within customer service, Chatbots excel at managing straightforward queries and offering immediate responses, thereby allowing human agents to dedicate their attention to more intricate issues. In the realm of e-commerce, Chatbots prove invaluable in delivering product recommendations, tracking orders, and providing customer support. In healthcare, Chatbots play a vital role by furnishing patients with personalized health guidance and sending reminders for medication schedules and appointments. In the healthcare industry specifically, Chatbots hold tremendous potential for various applications. They contribute to enhancing patient engagement, delivering tailored health advice, and facilitating administrative tasks. These digital assistants can empower patients to actively participate in their healthcare journey, offering personalized

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support and insights. Additionally, Chatbots can aid in streamlining administrative processes, leading to improved efficiency and better overall healthcare experiences.

Chatbots have gained rapid popularity in the healthcare industry, despite their relatively short history, due to their potential to enhance patient engagement and improve outcomes. Several notable milestones mark the progression of Chatbots in healthcare.

- During 2016, the National Health Service (NHS) in the UK introduced "Ask NHS," a Chatbot developed by Sensely, a US-based company. This Chatbot offered health advice and helped patients in locating healthcare providers. Initially, it was available to patients in north London.
- During 2017, Babylon Health, a UK-based healthcare Startup, launched "GP at Hand," an AI-powered Chatbot capable of remotely diagnosing and treating patients.
- During 2018, US Food and Drug Administration (FDA) granted approval for the first AI-powered Chatbot called "Woebot." Woebot employed cognitive-behavioral therapy techniques to deliver personalized support and guidance to individuals with mental health disorders such as depression and anxiety.
- During 2019 Mayo Clinic, a renowned US-based healthcare provider, introduced "Mayo Clinic First-Aid," a Chatbot designed to provide patients with first-aid advice during emergency situations. Additionally, the Chatbot assisted patients in locating nearby emergency medical services.
- During 2020 The COVID-19 pandemic led to an upsurge in the utilization of Chatbots in healthcare. Many healthcare providers launched Chatbots to deliver information about COVID-19, including symptoms and testing locations. Furthermore, Chatbots played a role in screening patients for COVID-19 symptoms and facilitating tele-health consultations.

Building healthcare Chatbot poses several challenges, including data privacy and security, ensuring accuracy and reliability of information, natural language understanding, handling complex scenarios, maintaining user engagement, addressing ethical considerations, integrating with existing systems, and compensating for the lack of human touch and empathy. These challenges necessitate robust privacy measures, up-to-date medical knowledge, sophisticated natural language processing algorithms, adaptable conversational interfaces, responsible AI use, seamless system integration, and a balance between AI and human intervention.

2 Existing methods

HELPI takes symptoms as user input and predicts the disease and provides measures to be taken by the user. By employing natural language processing and machine learning algorithms, the Chatbot can analyze user-entered symptoms and generate potential disease predictions [11]. It then offers tailored measures such as self-care recommendations, home remedies, or guidance on seeking medical attention [12]. This Chatbot enhances accessibility, empowers users to make informed decisions about their health, and contributes to early detection and management of diseases by providing accurate and personalized guidance based on symptom analysis. [13] Highlighted the significance of ML in prediction, pattern recognition and error reduction across diverse fields, emphasizing the impact of AI in broad domain. [14] Suggested data mining techniques to predict disease-prevalence based on symptoms in healthcare data. The appropriate prediction helps healthcare organizations avoid drug shortages and further ensures timely treatment of patients. [15] Discussed the role of Intelligent Decision Support Systems (IDSS) in Healthcare Monitoring, especially for heart disease. Results claimed that IDSS enhances decision-making functionalities in uncertain healthcare scenarios, thereby significantly improving the monitoring and remedial activities. [16] Employs Independent Component
Analysis (ICA) and HDFS-based algorithm to diminish the dimensionality in huge patient datasets, followed by removing irrelevant data and reducing storage and computation time, with superior accuracy compared to Principal Component Analysis (PCA).

**Table 1. Existing approaches.**

<table>
<thead>
<tr>
<th>Ref. No.</th>
<th>Advantages</th>
<th>Drawbacks</th>
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<tbody>
<tr>
<td>[1]</td>
<td>This study analyses various conversational agent types employed in chronic disease management, looking at their underlying communication technologies, evaluation metrics, and AI techniques.</td>
<td>The review lacks a comprehensive analysis of the ethical considerations and potential risks associated with Chatbot interventions in mental healthcare.</td>
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<td>[2]</td>
<td>The study emphasizes the need for adaptability to the new world of Chatbots and AI systems.</td>
<td>The study sample size is relatively small, limiting the generalization of the findings. Further research with a larger and more diverse population is needed.</td>
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<td>[3]</td>
<td>Using a diary and interview study, this article investigated how people perceive Chatbots with different identities for those looking for health information.</td>
<td>The study primarily focuses on user perceptions and lacks objective measurements of the impact of Chatbot interventions on elderly care outcomes.</td>
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<td>[4]</td>
<td>A brief historical review, along with the evolution and design features.</td>
<td>The review does not extensively cover the potential privacy and security concerns associated with Chatbot interactions in managing sensitive health information.</td>
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<td>[5]</td>
<td>The goal of this study was to analyse the existing applications, problems, and gaps in the literature on conversational agents in healthcare</td>
<td>The study duration is relatively short, and the long-term effects of Chatbot-based medication reminders are not fully explored.</td>
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<td>[6]</td>
<td>The Chatbot was effective in assessing the existence and severity of depressed and anxiety symptoms as well as the likelihood of suicide ideation.</td>
<td>The study does not consider the perspectives of healthcare providers, which could provide valuable insights into the feasibility and integration of Chatbot technologies in primary care settings.</td>
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<td>[7]</td>
<td>This study's objective was to assess the ability of existing Chatbot symptom-checkers to collect data.</td>
<td>The study lacks a comparative analysis with human healthcare professionals, making it difficult to determine the true accuracy and reliability.</td>
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<td>[8]</td>
<td>This viewpoint article aims to provide a succinct research overview of Chatbot use in promoting physical activity and a balanced diet.</td>
<td>The study primarily focuses on user engagement and satisfaction, but does not extensively measure the impact of Chatbot interventions on health behaviour change.</td>
</tr>
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<td>[9]</td>
<td>This study examines how conversational agents are used and viewed as trustworthy.</td>
<td>The study is limited to qualitative data and does not provide quantitative insights into the effectiveness of Chatbot interventions during mental health crises.</td>
</tr>
<tr>
<td>[10]</td>
<td>The systematic review approach used in this article is the PRISMA checklist methodology.</td>
<td>The review does not extensively cover the challenges and limitations associated with integrating Chatbots with various health monitoring sensors and technologies.</td>
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3 Proposed method

3.1 Proposed approach

The healthcare industry faces challenges in providing round-the-clock personalized support and advice to patients. Existing resources are often limited, resulting in delays in accessing healthcare services and increased costs. Therefore, there is a need to develop a healthcare Chatbot named HELPI that utilizes the decision tree algorithm to engage patients, reduce healthcare, improve health outcomes, and enhance data collection. With the rapid advancement of technology, innovative solutions have emerged in the healthcare industry, including healthcare Chatbots. The primary objective of this paper is to create a healthcare Chatbot capable of providing medical assistance to patients. The healthcare Chatbot serves as an AI-powered conversational program designed to assist both patients and healthcare providers. By analysing patient inquiries and considering symptoms, medical history, and preferences, the Chatbot aims to offer tailored responses and provide 24/7 support. Utilizing the decision tree algorithm's interpretability and its ability to handle various types of data, HELPI can deliver personalized advice and support to patients.

3.2 Objectives of the proposed approach

1. Design and develop a user-friendly interface for the healthcare Chatbot that allows users to enter their symptoms in a natural language format.
2. Implement natural language processing techniques to accurately interpret and understand user-entered symptoms, considering variations, nuances, and context.
3. Build a machine learning model that leverages symptom data and medical knowledge to predict diseases with a high level of accuracy.

![Connectivity diagram](image.png)

Fig. 1. Connectivity diagram.

3.3 Flow diagram

The following section depicts the description of the flow diagram.
1. The User Interface module receives user input and sends it to the NLP module.
2. The NLP module processes the user input and passes the processed data to the Decision Tree module.
3. The Decision Tree module analyses the data using the CART algorithm and generates appropriate responses.
4. The Decision Tree module may also interact with the Knowledge Base module to retrieve relevant healthcare information.
5. The Personalization module may utilize the outputs from the Decision Tree module and user-specific data to further customize the responses.

The decision-making component considers the structure of the decision tree, the configured hyper-parameters, and the knowledge base to determine the most relevant and accurate response for each user query. Please note that this diagram represents a high-level overview of the connectivity between the modules in healthcare Chatbot system. It highlights how user input progresses through the NLP, Decision Tree, Knowledge Base, and Personalization modules, enabling the Chatbot to provide accurate and personalized responses.

### 3.4 Architecture of proposed method

![Modules framework](image.png)

**Fig. 2.** Modules framework.

The architecture of the HELPI healthcare Chatbot is designed to facilitate seamless communication and intelligent decision-making. It follows a client-server model, where the client represents the user interface or Chatbot application, and the server hosts the backend components responsible for processing user input and generating responses. Here are the key components of the architecture.

- **Client-Side** The client-side component represents the user interface through which users interact with the Chatbot.
- **Server-Side** The server-side component hosts the backend infrastructure of the healthcare Chatbot.
• NLP Processing: Natural Language Processing (NLP) component is a crucial part of the server-side architecture.
• Decision-Making: The decision-making component is responsible for analysing user inquiries and generating appropriate responses.
• Knowledge Base: The knowledge base component acts as a repository of healthcare-related information.
• Personalization: The personalization component focuses on tailoring the Chatbots responses to individual users.

4 Results and discussions

4.1 Description of dataset

The dataset used for building HELPI is “The Disease Symptom Prediction Dataset”, available on Kaggle, provides valuable resource for researchers, data scientists, and healthcare professionals aiming to develop accurate models for predicting disease symptoms. This dataset encompasses a wide range of medical records and symptoms collected from adverse population, enabling the development of robust predictive models. The dataset consists of anonymized patient records, each containing a combination of features such as patient demographics, medical history, and symptoms reported. These features have been carefully curated to capture relevant information that may influence the manifestation of specific disease symptoms. With the growing availability of machine learning algorithms, the Disease Symptom Prediction Dataset offers an opportunity to train models capable of learning complex patterns and associations. Sophisticated methods like decision trees, random forests, logistic regression, support vector machines (SVM), and neural networks can be utilized for dataset analysis and the generation of predictive models.

It contains 4 CSV files:
1. Symptom_severity.csv: It contains 2 columns, symptoms and their count in the dataset
2. Symptom_Description.csv: It contains 2 columns, disease and their descriptions.
3. Symptom_precaution.csv: It contains 5 columns, disease in the first column and the precautions to be taken in the remaining four columns.

The application of disease symptom prediction models built on this dataset extends to various domains within healthcare. Clinicians can benefit from these models by gaining insights into symptom occurrence probabilities, facilitating early intervention and personalized treatment plans. Moreover, researchers can utilize these models to identify high-risk patients, optimize resource allocation, and improve overall healthcare delivery. In summary, the Disease Symptom Prediction Dataset from Kaggle serves as a valuable resource for developing models to predict disease symptoms. By leveraging advanced machine learning algorithms, researchers and healthcare professionals can unlock new insights into the complex relationships between patient attributes and symptom manifestation, leading to improve diagnosis, treatment, and patient outcomes.

4.2 Experimental Results

The proposed healthcare Chatbot - HELPI takes symptoms provided by user as input and displays predicted disease and measures to be taken as the output.
The healthcare Chatbot - HELPI is designed to assist users in identifying potential diseases based on the symptoms they provide. After analysing the user's input, the Chatbot predicts the most likely disease and provides a set of recommended measures to be taken.
The output provided by the Chatbot includes two main components: the predicted disease and the recommended measures. The predicted disease is the result of the Chatbot's analysis of the symptoms provided by the user. It determines the disease that best matches the given symptoms based on a predefined database or algorithm. For example, if the user enters symptoms such as fever, cough, and sore-throat, the Chatbot may predict a possible diagnosis of ‘Common Cold’ or 'Influenza'.

In addition to the predicted disease, the Chatbot also offers a set of recommended measures to be taken. These measures are tailored to the predicted disease and aim to guide the user in managing their condition effectively. The recommended measures may include general advice, specific actions, lifestyle modifications, or medications. For instance, if the Chatbot predicts the user has 'Common Cold', it may suggest measures such as getting plenty of rest, staying hydrated, taking over-the-counter cold medication, and practicing good hygiene to prevent the spread of the virus.

It is important to note that the output provided by the Chatbot is for informational purposes only and should not substitute professional medical advice. It is recommended that users seek advice from healthcare professionals for accurate diagnosis and personalized treatment recommendations based on their specific medical history and condition.

4.3 Significance of proposed work

Healthcare Chatbots are significant as they provide 24/7 availability and instantaneous responses, enabling users to access medical information and assistance at any time without waiting for appointments or helpline calls. They can offer quick guidance, symptom assessment, and reliable medical advice, potentially reducing unnecessary visits to healthcare facilities. The significance of the Personalization module includes:

- Customized Recommendations by considering individual characteristics: the Chatbot offers personalized recommendations and preventive measures, enhancing the relevance and effectiveness of suggestions.
- User Engagement and Motivation: Personalization fosters user engagement by providing information directly relevant to the user's health condition and goals. It can motivate users to adopt healthier behaviours and adhere to recommended treatments.
- Long-term Relationship: The Personalization module enables the Chatbot to establish a long-term relationship with users by providing ongoing support and adapting recommendations based on changing health needs.
- By incorporating these modules into healthcare Chatbot, we created a comprehensive and user-centric solution that effectively assists users in understanding their health conditions, making informed decisions, and promoting overall well-being.

5 Conclusion and future enhancement

HELPI is an automated innovative and user-friendly tool designed to assist individuals in assessing their symptoms, predicting potential diseases, and providing relevant measures to be taken. By simply inputting their symptoms into the Chatbot, users can receive valuable insights and recommendations to better understand their health condition. The Chatbot utilizes machine learning algorithms and a comprehensive medical database to analyze the symptoms provided by the user. It employs a decision tree model, to predict the most probable disease based on the symptoms reported. This predictive capability allows for early detection and intervention, leading to improved health outcomes.

Once the disease is predicted, the Chatbot offers a range of precautionary measures and recommendations to be taken. These measures may include lifestyle modifications,
suggested treatments, self-care practices, and preventive strategies. The Chatbot provides accurate and up-to-date information about the recommended measures, ensuring users have access to reliable healthcare advice. Furthermore, our healthcare Chatbot serves as an educational resource, offering users detailed information about various diseases. It also emphasizes the importance of proactive healthcare management, providing guidance on preventive care, healthy habits, and wellness tips.

References

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