



# MACQUARIE University

## **PROJECT REPORT**

### **Adaptive Emotion-Guided Healthcare Chatbot**

BY-

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## **1. Introduction**

As global healthcare systems evolve, the integration of artificial intelligence (AI) technologies into patient communication and support services is becoming increasingly critical. Healthcare chatbots have gained prominence for their ability to provide timely information, triage symptoms, and support health education, all while alleviating pressure on medical personnel. This project presents a fully functional, adaptive emotion-aware chatbot that leverages Natural Language Processing (NLP) and retrieval-augmented generation (RAG) to offer real-time, contextually relevant health information.

This chatbot operates across three primary modes—Symptom Checker, Prescription Explainer, and Health Literacy Tutor, each designed to handle specific user needs. The underlying architecture is composed of a Streamlit-based user interface, an intermediate processing pipeline for contextual retrieval and prompt formation, and a generative backend powered by LLaMA 3 served via Ollama. The inclusion of emotion-guided responses allows the chatbot to personalize interactions, enhancing user comfort and comprehension.

## **2. Project Objectives**

The project was designed with the following objectives in mind:

- Build a healthcare chatbot capable of handling diverse user needs such as checking symptoms, explaining prescriptions, and enhancing health literacy.
- Integrate user emotions into the dialogue generation process to produce emotionally intelligent and context-sensitive responses.
- Employ retrieval-augmented generation (RAG) to ground chatbot outputs in factual, retrievable information.
- Utilize the LLaMA 3 model through the Ollama backend for local, efficient large language model inference.
- Design an intuitive user interface using Streamlit to facilitate accessibility and interaction.
- Ensure modularity and scalability for future improvements and deployment.

### **3. System Architecture**

The architecture of the chatbot system is composed of three integrated layers:

1. Frontend (User Interface): Developed using Streamlit, the interface provides options for selecting the chatbot mode and emotional tone, entering queries, and viewing both the retrieved context and the generated responses.
2. Processing Pipeline: This layer handles keyword extraction, contextual document retrieval, prompt generation, and emotion-based message templating.
3. Response Generation Layer: The backend integrates with the LLaMA 3 model via Ollama, sending crafted prompts and returning user-specific, informative responses.

These components are loosely coupled, enabling independent updates and easier debugging.

### **4. Chatbot Modes and Functional Overview**

#### **4.1 Symptom Checker**

In this mode, users can describe their symptoms in natural language. The system identifies key health terms using basic keyword-matching techniques and retrieves relevant context from stored health data. This context, along with the user's query and emotional state, is used to form a detailed prompt that is fed to the LLaMA model. The result is an emotionally guided, medically plausible response that helps users understand potential health conditions without providing formal diagnoses.

#### **4.2 Prescription Explainer**

Users input the name of a drug, or a phrase related to medication. The system retrieves textual context from known drug databases such as DrugBank and RxNorm. This includes side effects, usage guidelines, contraindications, and drug interactions. The chatbot then produces a simplified, patient-friendly explanation. Emotionally anxious users receive gentle, reassuring explanations, while confused users get more detailed breakdowns.

#### **4.3 Health Literacy Tutor**

In this educational mode, users can input complex medical terminology or concepts. The system provides layperson-friendly explanations of medical concepts. This feature is useful for patients trying to understand lab reports, diagnoses, or technical literature. Sources such as MedQuad and PubMedQA are intended for contextual grounding.

## **5. Emotion-Aware Interaction**

A core innovation of this chatbot is its ability to adjust tone and explanation depth based on the user's selected emotional state. The user selects their current mood—neutral, anxious, or confused—via a dropdown. This selection maps to a system prompt that sets the chatbot's tone.

For example, a user in an anxious state might receive the prompt: “You are a comforting medical assistant who gently explains things to anxious users.” This is combined with the retrieved context and the user's question to form a comprehensive prompt for LLaMA.

This approach provides a flexible and empathetic framework for dialogue generation, improving user trust and engagement.

## **6. Retrieval-Augmented Generation (RAG) and Prompt Construction**

To support fact-based responses, the chatbot retrieves text snippets related to the user's query using keyword-based matching. While basic in this prototype, this retrieval mimics a real semantic search pipeline and can be upgraded with FAISS or Haystack.

The retrieved context is then used to construct a prompt in the following format:

"""

You are a medical chatbot. Based on the context and the user question, provide an informative answer.

Context: [Retrieved Context]

Emotion: [Retrieved Emotion]

Question: [User Query]

Answer:

"""

This prompt is sent to the LLaMA 3 model running locally via Ollama, ensuring data privacy and low latency. Responses are parsed and presented to the user with the retrieved context shown alongside for transparency.

## **7. Technologies and Libraries**

- Python (backend logic and integration)
- Streamlit (frontend web interface)
- Ollama (lightweight local model inference)
- LLaMA 3 (generative language model)
- PubMedQA / MedQuad (data sources)
- Prompt engineering for emotion and context integration

## **8. Testing and Output Examples**

To validate functionality, the chatbot was tested across all three operational modes using a range of emotional contexts. Key observations include:

- Symptom Checker responses were medically plausible and adjusted in tone based on emotional input.
- Prescription explanations-maintained accuracy and readability, especially under the 'confused' emotion setting.
- Health Literacy explanations were simplified effectively, aiding users in understanding complex medical concepts.

## **9. Evaluation and Limitations**

To objectively assess the quality of the chatbot's generated responses, we implemented an automatic evaluation mechanism using two widely accepted Natural Language Generation (NLG) metrics: ROUGE and BLEU. This function computes:

ROUGE (Recall-Oriented Understudy for Gisting Evaluation): A set of metrics for evaluating automatic summarization and machine translation. It measures the overlap between the generated (prediction) and ground truth (reference) text in terms of n-grams, word sequences, and word pairs.

BLEU (Bilingual Evaluation Understudy): A precision-based metric that evaluates how many n-gram sequences in the predicted output match the reference output. Originally designed for machine translation, it's also used in chatbot response assessment.

Both metrics provide a quantifiable way to compare a predicted answer to a reference (ideal) answer and are helpful during model tuning and benchmarking.

example output:

```
{
  "rouge": {
    "rouge1": {"precision": 0.625, "recall": 0.714, "fmeasure": 0.666},
    ...
  },
  "bleu": {
    "bleu": 0.487
  }
}
```

The system demonstrates strong performance in generating informative, empathetic responses. However, several limitations remain:

- Document retrieval is not semantic or learned—reliant on keyword matches.
- Emotion must be manually selected and is not inferred from user text.
- No persistent memory or multi-turn dialogue handling.
- Only supports English and assumes general medical literacy.
- Real-time updates (e.g., from APIs) are not yet implemented.

## **10. Future Enhancements**

- Replace keyword retrieval with Haystack vector search using sentence embeddings.
- Integrate sentiment analysis (e.g., using BERT or RoBERTa) to auto-detect user emotion.
- Expand to support multi-turn conversations with context tracking.
- Deploy on cloud (e.g., Streamlit Community Cloud or HuggingFace Spaces) with secure access.
- Add support for multilingual queries and responses.

## **11. Conclusion**

This project presents a comprehensive, modular healthcare chatbot prototype capable of interpreting user inputs, adapting responses based on emotional context, and delivering context-rich, understandable answers. With its flexible design and integration of modern NLP techniques, this chatbot serves as a strong foundation for future medical AI tools aimed at improving health communication and education.

## 12. Appendix: Chatbot Logs and Screenshots

Attaching the test results, interaction transcripts, and output screenshots here.

### 1. Symptom Checker Chatbot


Choose a mode:

☒ Symptom Checker

☐ Prescription Explainer


☐ Health Literacy Tutor


Deploy


 **HealthCare Assistant**

A smart medical chatbot for **symptom checking**, **prescription explanation**, and **health literacy**.

**Symptom Checker**

 Hi there! I'm your HealthCare Assistant. How can I help you today?

 I have chest pain

 I'm here for you, and I understand that experiencing chest pain can be incredibly worrying. It's normal to feel concerned about your health, especially when it comes to heart-related issues.

Based on the symptoms you've described, which include sharp stabbing chest pain, pain that usually starts quickly and may radiate to one shoulder, neck, back, or abdomen, I want to acknowledge that this could be a serious condition. It's important to prioritize your well-being and seek medical attention if these symptoms persist or worsen over time.

In the meantime, I'd like to offer some possible causes for your chest pain:

1. **Acute Pericarditis:** As you've mentioned, acute pericarditis is an inflammation of the sac around the heart (pericardium) that can cause sharp stabbing chest pain.

Type your symptoms...


Choose a mode:


☒ Symptom Checker

☐ Prescription Explainer

☐ Health Literacy Tutor

Deploy

 Shortness of breath, and yeah sometimes cold sweats

 I'm here for you! I understand that it can be really unsettling to experience shortness of breath and cold sweats. It's completely normal to feel concerned about what might be causing these symptoms.

Based on the information provided, I want to acknowledge that a chronic cough, especially with mucus production, could be contributing to your shortness of breath. Additionally, the presence of cold sweats adds another layer of complexity.

Given your symptoms, here are some possible causes:

1. **Respiratory conditions:** Chronic bronchitis, pneumonia, or other respiratory issues might be causing your shortness of breath.
2. **Infections:** A bacterial or viral infection could be responsible for your symptoms.
3. **Cardiovascular concerns:** Heart problems or pulmonary embolism (blood clot in the lungs) may also cause shortness of breath and cold sweats.

It's essential to seek medical help if you're experiencing these symptoms, especially since you've mentioned a chronic cough that persists. Your doctor can assess your condition further and provide guidance on how to manage your symptoms.

When to seek medical attention:

- If you experience severe or worsening shortness of breath.
- If you have a persistent and unexplained cough that produces blood-tinged mucus (a rare but serious symptom).
- If you're experiencing chest pain, loss of appetite, weight loss, or fatigue (these can be signs of more significant conditions).

I recommend scheduling an appointment with your doctor to discuss your symptoms further. They will likely perform a physical examination, take a detailed medical history, and potentially order diagnostic tests to determine the underlying cause.

Type your symptoms...



## 2. Prescription Explainer

Choose a mode:

☐

Symptom Checker


☒

Prescription Explainer


☐

Health Literacy Tutor

Deploy

 **HealthCare Assistant**

A smart medical chatbot for symptom checking, prescription explanation, and health literacy.

 **Prescription Explainer**

Enter prescription (e.g., ibuprofen 200mg twice daily)

Sertraline 50mg in the morning

Explain Prescription

As a HealthCare Assistant, I'll provide you with information on Sertraline (Zoloft) 50mg taken in the morning.

**Dosage:** The recommended dosage of Sertraline for adults is 25-200mg per day. In your case, you are taking 50mg once daily in the morning.

**Common Side Effects:**

- Nausea and vomiting
- Insomnia or vivid dreams
- Dizziness or lightheadedness
- Increased sweating
- Dry mouth
- Headache

These side effects are usually mild and temporary. If they persist or worsen, please consult your healthcare provider.

**Important Interactions:**

1. MAOIs (Monoamine Oxidase Inhibitors): Avoid taking Sertraline within 14 days of stopping an MAOI, as this may increase the risk of

## 3. Health Literacy Tutor

Choose a mode:

☐

Symptom Checker


☐

Prescription Explainer


☒

Health Literacy Tutor

Deploy

 **HealthCare Assistant**

A smart medical chatbot for symptom checking, prescription explanation, and health literacy.

 **Health Literacy Tutor**

Ask a health-related question:

What happens if I don't drink enough water?

Explain Concept

I'm so glad you asked!

So, let's talk about what happens when your body doesn't get enough water. As I mentioned earlier, an average person needs around 3 quarts of water per day to keep their body functioning properly.

If you don't drink enough water, your body might start to feel the effects. Some common signs that you're dehydrated include:

- Feeling thirsty
- Urinating less often than usual
- Dark-colored urine (instead of clear or light yellow)
- Dry skin
- Feeling tired and sluggish
- Dizziness or even fainting

For adults, these signs might be a sign that your body needs more water. And for babies and young children, dehydration can cause dry

## 13. Team Contribution

Gouthami Chelluri implemented the Streamlit frontend, integrated the LLaMA 3 backend via Ollama, and developed the chatbot logic.

Niharika Shilamamidi worked on the emotion-aware prompt engineering, retrieval module, and contributed to system testing and evaluation.