

# CS 505 Final Project - Milestone Report

## Team Members

- Haniel Edward Jacob Thomson - U61342617
- Jeya Varshini Bharath - U79028725
- Pranesh Jayasundar - U08334002

## Overview

### Title of the Project

AI-Powered Health Assistant and Emotional Support Chatbot

### Brief Description

The project's primary objective is to develop an advanced AI-powered chatbot designed to serve as both a knowledgeable health assistant and a source of emotional support. This innovative chatbot will harness the capabilities of cutting-edge Natural Language Processing (NLP) models to deliver accurate, reliable medical information and empathetic support for users experiencing various emotional states, particularly focusing on stress and depression.

To achieve this we plan to explore two technological pathways:

**Utilizing Ollama and Langchain:** These advanced NLP tools offer specialized functionalities for sentiment analysis and response generation. Ollama is adept at analyzing emotions and sentiments from user inputs, making it ideal for understanding and addressing user's emotional states. Langchain, on the other hand, excels in leveraging language models for generating appropriate and contextually relevant responses. The integration of these technologies promises a chatbot that is not only responsive to user's emotional needs but also equipped with a robust medical knowledge base.

**Employing Traditional Models like GPT-NeoX and BERT:** Alternatively, we are considering the use of well-established models such as GPT (Generative Pretrained Transformer) for response generation and BERT (Bidirectional Encoder Representations from Transformers) for sentiment analysis and depression detection. GPT's ability to generate coherent and contextually relevant text makes it suitable for crafting responses in conversational settings. BERT's effectiveness in understanding the nuances of language can be leveraged for accurately gauging user sentiments. This approach would involve fine-tuning these models on specific datasets tailored to the chatbot's dual functionalities.

**Importance:**

- 1) **Health Information Accessibility:** Many people face challenges in accessing timely and accurate health information. We aim to bridge this gap by providing a knowledgeable health assistant.
- 2) **Emotional Support:** Stress and depression are prevalent mental health issues. Integrating emotional support into a chatbot addresses the growing need for mental health resources.

**Relevance:** Our project aligns with concepts covered in the class, specifically in sentiment analysis and response generation. Sentiment analysis plays a crucial role in understanding user's emotional states, contributing to analysing the emotional state of the user at the start and end of the conversation. This project also resonates with our personal interests in leveraging technology to help individuals cope with stress and depression. If someone seeks emotional support, our chatbot aims to engage in lighthearted conversation to help the person feel more at ease and uplifted.

**User Interface**

Additionally, we plan to use **Gradio** as the user interface for our chatbot. Gradio will allow us to create a user-friendly and interactive interface, making the chatbot easily accessible and convenient for users. It will enable real-time interactions and provide a platform for users to directly communicate with the chatbot, enhancing their experience and engagement.

## Project Plan

### Restatement of the Problem:

The project addresses the need for accessible health information and emotional support. It solves the problem of providing immediate, reliable medical guidance and empathetic interaction for individuals seeking help in these areas.

### Data Wrangling:

- Extraction and organization of medical information into a queryable format.
- Preprocessing of conversational data, including sentiment analysis and emotion detection.

### Methods/Algorithms:

1. Sentiment/Emotion Analysis

**BERT:** Fine-tuning a pre-trained BERT model for sentiment and emotion analysis. This involves training BERT on a dataset labeled with various emotional states to accurately detect user sentiments.

**Ollama:** Leveraging Ollama's built-in sentiment analysis capabilities to supplement BERT's analysis, ensuring a more nuanced understanding of user emotions.

## 2. Response Generation

**GPT-NeoX:** Employing GPT-2 for generating contextually relevant and coherent responses in the chatbot's conversations. Fine-tuning GPT-2 on domain-specific data ensures the responses are tailored to the health-related topics.

**Langchain:** Utilizing Langchain's conversational AI tools to manage and enhance the response generation process, ensuring the responses align with the sentiments/emotions identified.

## 3. Health-Related Queries

**BERT:** Adapting BERT for the specific task of understanding and responding to health-related inquiries, fine-tuning it on medical datasets to handle a wide range of health topics accurately.

**Langchain:** Integrating Langchain's information retrieval capabilities of effectively source and present medical information, complementing BERT's language understanding.

## 4. Emoji Analysis

**Ollama:** Using Ollama for the interpretation and analysis of emojis within user interactions.

Ollama can contextualize emojis within the conversation, providing additional insights into user sentiments.

## Implementation Plan:

**Data Processing:** Managing the extraction, cleaning, and preparation of data from various medical and conversational datasets to train out models.

**Development:** Establish a robust dev environment including Python, the Transformers library(HuggingFace), torch and other relevant NLP tools, along with version control systems(GIT).

**Model Training and Testing:** Leveraging Google Colab for its GPU capabilities to efficiently train complex NLP models. We might use Shared Computing Cluster(SCC) or Google Cloud Platform(GCP) to handle large-scale computations.

## Evaluation Strategy:

- **Performance Metrics:** Evaluating NLP models using metrics such as accuracy, precision, recall, F1-score to measure effectiveness of sentiment/emotion analysis and response accuracy in health-related queries.
- **Response Time:** Additionally, the response time of the chatbot will be measured to ensure it is responding within an acceptable timeframe.
- **Human Evaluation:** Our team will manually evaluate the chatbot's responses, focusing on both NLP accuracy and medical relevance. We will systematically assess a representative sample of interactions, scrutinizing the chatbot's comprehension, the precision of its responses, and the relevance to the user's queries.

- **Real-World Testing:** The chatbot will be exposed to a group of beta testers who represent our target user base. They will interact with the chatbot in real-world scenarios, providing insights into the user experience.
- **AB Testing:** Implementing different versions of response algorithms or conversation flows to see which performs better in terms of user engagement and satisfaction.

## Work Division

- **Data Management**  
Pranesh Jayasundar, Haniel Edward Jacob Thomson, Jeya Varshini Bharath: Collaborative handling of data sourcing and preparation.
- **Model Development**  
Pranesh Jayasundar, Jeya Varshini Bharath: Jointly responsible for model development and fine-tuning.
- **Testing and Quality Assurance**  
Haniel Edward Jacob Thomson, Jeya Varshini Bharath: Overseeing testing and ensuring the chatbot's quality.
- **Documentation**  
Pranesh Jayasundar, Haniel Edward Jacob Thomson: Responsible for all project documentation and reporting.

## References

- Academic Papers:
  - 1) ChatCounselor: A Large Language Models for Mental Health Support.  
<https://arxiv.org/pdf/2309.15461.pdf>
  - 2) Development and Evaluation of Three Chatbots for Postpartum Mood and Anxiety Disorders.  
<https://arxiv.org/pdf/2308.07407.pdf>
  - 3) ChatDoctor: A Medical Chat Model Fine-Tuned on a Large Language Model Meta-AI (LLaMA) Using Medical Domain Knowledge  
<https://arxiv.org/abs/2303.14070>
  - 4) Calibration of Transformer-based Models for Identifying Stress and Depression in Social Media  
<https://arxiv.org/abs/2305.16797>
- Data Sources:
  - <https://huggingface.co/datasets/DouglasPontes/emoji-sentiment-analysis-tweets>
  - <https://www.kaggle.com/datasets/elvis23/mental-health-conversational-data>
  - [https://huggingface.co/datasets/knowrohit07/know\\_medical\\_dialogue\\_v2](https://huggingface.co/datasets/knowrohit07/know_medical_dialogue_v2)
  - <https://huggingface.co/datasets/lavita/ChatDoctor-HealthCareMagic-100k>