

UNIVERSITY OF FLORIDA
DEPARTMENT OF ENGINEERING EDUCATION
TECHNICAL REPORT
ON
AI POWERED MENTAL HEALTH CHATBOT

SUBMITTED BY

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Science in Applied Data Science

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Objective of the Project

Mental health is a significant component of overall wellness, yet many lack access to trained mental health professionals. This project will develop an **AI-driven Mental Health Chatbot** that answers Mental health-related queries, provides emotional support and detects user sentiment through Natural language processing (NLP) techniques.

The chatbot will be trained on real life mental health counseling conversation, FAQs, and sentiment analysis data to generate empathetic, context-specific, and correct responses. With the integration of retrieval-based response generation and sentiment-aware interaction, the chatbot will be able to guide users to appropriate mental health resources and respond empathetically according to the user's emotional state.

This chatbot is designed to be deployed into Universities, the Workplace, and Healthcare environments to provide an easily accessible and scalable mental health support tool. This project aims to assist in raising mental health awareness, reducing stigma, and providing on-demand support to those who need it.

Type of Tool

This project involves the development of a **Conversational AI Chatbot** designed specifically for **Mental health support**. The chatbot will function as an interactive, text-based virtual assistant that can engage in conversations with users, provide mental health-related information, and offer personalized responses based on sentiment analysis.

The chatbot will utilize retrieval-based and sentiment-aware response generation to enhance its effectiveness:

- **Retrieval-Based System:** The chatbot will leverage a structured FAQ knowledge base to retrieve pre-existing responses to frequently asked mental health questions. This ensures factual accuracy and consistency in responses.
- **Therapy-Informed Conversational AI:** The chatbot will be trained using real counseling conversations, enabling it to provide contextually appropriate responses that align with professional mental health guidance.
- **Sentiment-Aware Interaction:** By analyzing user sentiment while in conversation, the chatbot can adjust the tone and content of its responses to better support users experiencing stress, anxiety, or emotional distress.

The chatbot will be designed for deployment in websites ensuring accessibility for users in need of mental health guidance and support.

Data to Be Used

This project utilizes **Three** key datasets to train and improve the chatbot's ability to provide accurate and context-aware responses. The datasets cover mental health counseling conversations, structured FAQs, and sentiment analysis for emotion detection. Each dataset has been **acquired from a reliable source** and has been **verified for accessibility and compliance** with licensing restrictions.

❖ Dataset 1: Mental Health Counseling Conversations

Source: Hugging Face

- **Dataset Name:** Amod/Mental Health Counseling Conversations
- **URL:** https://huggingface.co/datasets/Amod/mental_health_counseling_conversations
- **License:** Permitted for academic use, sourced from online therapy platforms.

Content: This dataset contains question & answer pairs sourced from online counseling and therapy platforms. It features real mental health queries and psychologist responses, making it ideal for training a chatbot that provides context-aware therapy guidance.

Dataset Properties:

- **Number of Entries:** 3512 entries.
- **Columns:** Context (User's question or concern) & Response (Professional therapist's answer).

Use Case in Chatbot: It helps in training the chatbot to generate contextually relevant therapy responses by providing a knowledge base of professional advice, ensuring chatbot responses align with expert guidance.

❖ Dataset 2: Mental Health FAQ for Chatbot

Source: Kaggle

- **Dataset Name:** Mental Health FAQ for Chatbot
- **URL:** <https://www.kaggle.com/datasets/narendrageek/mental-health-faq-for-chatbot>
- **License:** Available for academic use, sourced from mental health organizations.

Content: This dataset consists of frequently asked questions (FAQs) about mental health, collected from reliable mental health sources. It serves as a structured knowledge base that the chatbot can use to retrieve factual, pre-defined answers to user queries.

Dataset Properties:

- **Number of Entries:** 98 entries.
- **Columns:** Questions (Commonly asked mental health-related queries) & Answers (Expert responses to those queries).

Use Case in Chatbot: It enhances the chatbot's FAQ-based retrieval system, allowing users to get quick answers to common mental health questions that are factually accurate and based on trusted mental health sources.

❖ Dataset 3: Sentiment Analysis for Mental Health

Source: Kaggle

- Dataset Name: Sentiment Analysis for Mental Health
- URL: <https://www.kaggle.com/datasets/suchintikasarkar/sentiment-analysis-for-mental-health>
- License: Available for academic use, sourced from various social media and mental health forums.

Content: This dataset is a curated collection of mental health-related user statements, labeled with different mental health conditions from multiple sources such as Reddit posts, Twitter discussions, and Online forums, making it a rich resource for sentiment analysis and mental health trend detection.

Dataset Properties:

- **Number of Entries:** 53043 entries.
- **Columns:** Statement (Text data or user-generated post) & Status (Mental health condition label - Normal, Depression, Suicidal, Anxiety, Stress, Bipolar, Personality Disorder).

Use Case in Chatbot: This Dataset enables the chatbot to analyze User Sentiment and adjust responses accordingly.

Expected Tech Stack

The development of this AI-powered mental health chatbot requires a combination of Natural Language Processing (NLP), Machine learning, Database management, and Web deployment technologies. The following tech stack has been selected to ensure efficient data processing, accurate chatbot responses and seamless deployment.

1. Programming Language

- Python - Used for data preprocessing, model training, chatbot development, and Integration.

2. Data Processing & Analysis

- Pandas, NumPy - Handling datasets, performing data preprocessing and feature engineering.
- Matplotlib, Seaborn, WordCloud - Exploratory Data Analysis (EDA) and data visualization.

3. Natural Language Processing (NLP)

- NLTK, SpaCy - Tokenization, stopwords removal, lemmatization, and text cleaning.
- Hugging Face Transformers (BERT, RoBERTa) - Sentiment analysis and text embeddings for chatbot training.
- TF-IDF, Word2Vec - Feature extraction techniques to enhance chatbot response quality.

4. Machine Learning & Sentiment Analysis

- Scikit-Learn, TensorFlow, PyTorch - Training models for sentiment detection and chatbot response generation.
- Pretrained NLP models - Used for understanding user intent and generating context-aware responses.

5. Database & Knowledge Retrieval

- PostgreSQL, SQLite, DuckDB - Storing and retrieving FAQs, chatbot responses, and user interaction data.
- pgvector (PostgreSQL extension) - For semantic search and vector-based response retrieval.

6. Chatbot Development & Deployment

- DialogFlow, LangChain - Building and managing chatbot conversation logic.
- FastAPI, Flask - Creating API endpoints to integrate the chatbot with applications.
- Streamlit - Web-based frontend for chatbot interaction and testing.

Project Timeline

❖ The project is structured into two remaining milestones:

- **Milestone 2: Feature Engineering, Model Training & Chatbot Integration**

Timeline: February 24, 2025 – March 21, 2025

Planned Accomplishments:

- Feature Engineering & Text Representation – Extract text features using TF-IDF, Word2Vec, or Transformer embeddings to improve chatbot response generation.
- Sentiment Classification Model Training – Train a machine learning model (BERT/LSTM) on the sentiment dataset to detect emotional tone in user queries.
- Chatbot Knowledge Retrieval System – Store FAQs and counseling responses in PostgreSQL/SQLite for efficient chatbot response retrieval.
- Web-Based Chatbot Interface – Integrate the chatbot with a Streamlit-based UI for interactive testing.

- **Milestone 3: Evaluation, Deployment & Final Presentation**

Timeline: March 24, 2025 – April 23, 2025

Planned Accomplishments:

- Performance Evaluation & Optimization – Assess chatbot accuracy using precision, recall, and F1-score, and refine model performance based on feedback.
- Deployment & API Integration – Deploy the chatbot using FastAPI/Flask.
- Interactive Dashboard for Monitoring – Create a dashboard in Streamlit or Power BI to track chatbot interactions and sentiment trends.
- Final Report & Presentation – Document the development process, challenges, and results, and prepare a project presentation for submission.

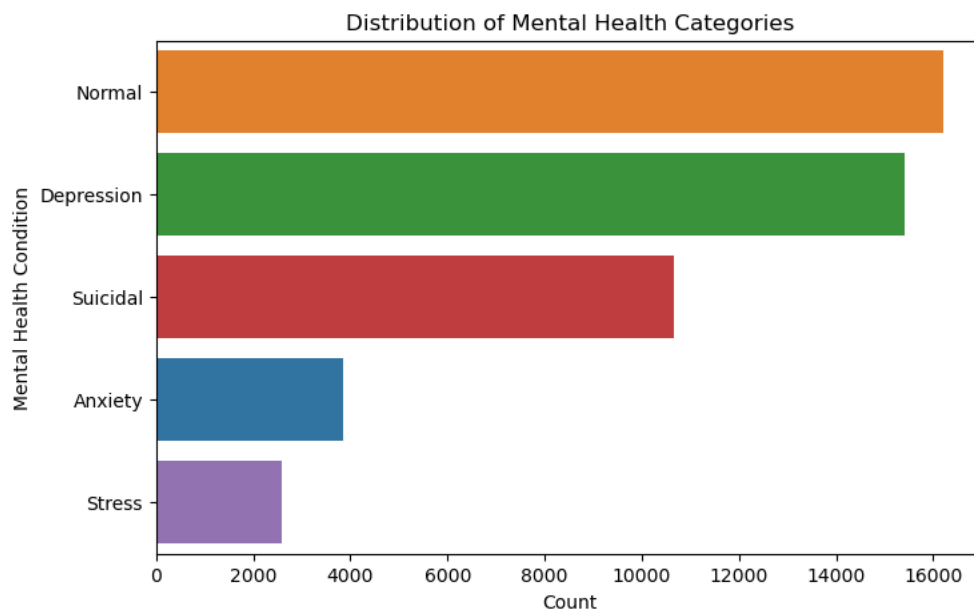
Exploratory Data Analysis (EDA) Report

- The purpose of Exploratory Data Analysis (EDA) is to gain insights from the datasets that will be used to develop the AI-powered mental health chatbot.
- This project utilizes three datasets & performing EDA on these three datasets can help significantly in building a Well-performing chatbot.

Key Plots & Visualizations:

❖ Distribution of Mental Health Categories – Bar Chart

Objective: To analyze the frequency of different mental health conditions.



Key Observations:

- **Class Imbalance:** The dataset is dominated by the "Normal" category, followed by Depression and Suicidal, indicating that a significant portion of statements discuss mental health distress. Anxiety and Stress are underrepresented, suggesting the need for balancing techniques (oversampling, synthetic data generation) during model training.
- **Mental Health Intervention Perspective:** The presence of a substantial number of Suicidal statements highlights the critical need for intervention-based chatbot responses. The chatbot should be designed to prioritize empathetic interactions and guide high-risk users toward appropriate resources or professional support.

Objective: To visualize common words associated with different mental health conditions.

[illegible]

- Depression & Suicidal statements frequently contain words like "feel," "life," "think," and "time," indicating deep emotional expression requiring empathetic intervention, while Stress & Anxiety discussions focus on situational stressors like "work," "time," and "symptoms."
- Normal conversations contain casual words like "I'm," "want," and "really," reflecting day-to-day topics rather than distress signals which requires just casual engagement.

Objective: To analyze whether some mental health conditions are associated with longer user statements.

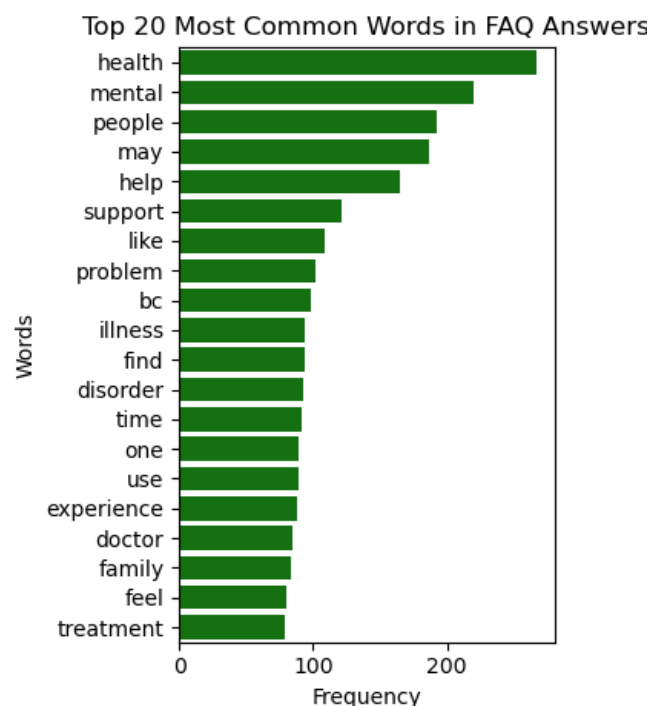
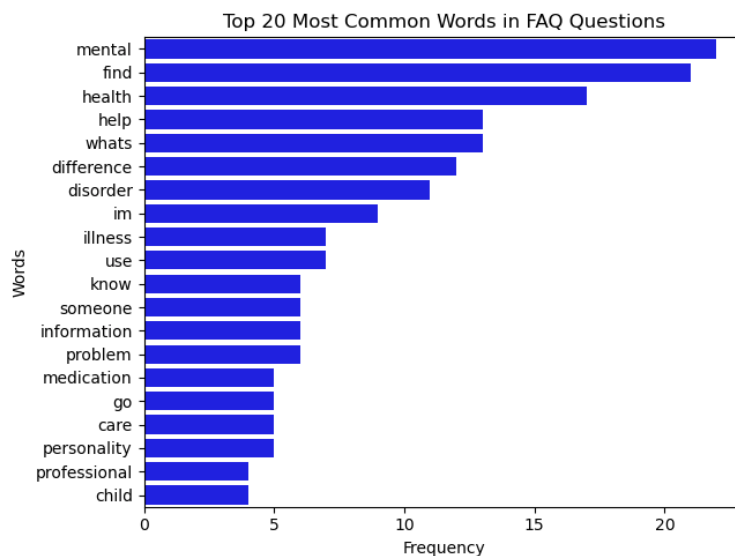


Key Observations:

- Most statements have Low word counts, as indicated by the compressed interquartile range (IQR) and median values close to zero across all categories.
- Some individuals express longer, detailed thoughts, with outliers highlighting the need for chatbot adaptation to handle both short and long messages effectively.

❖ Most Common Words in FAQ Questions & Answers – Bar Chart

Objective: To analyze frequently asked mental health-related questions and response themes.

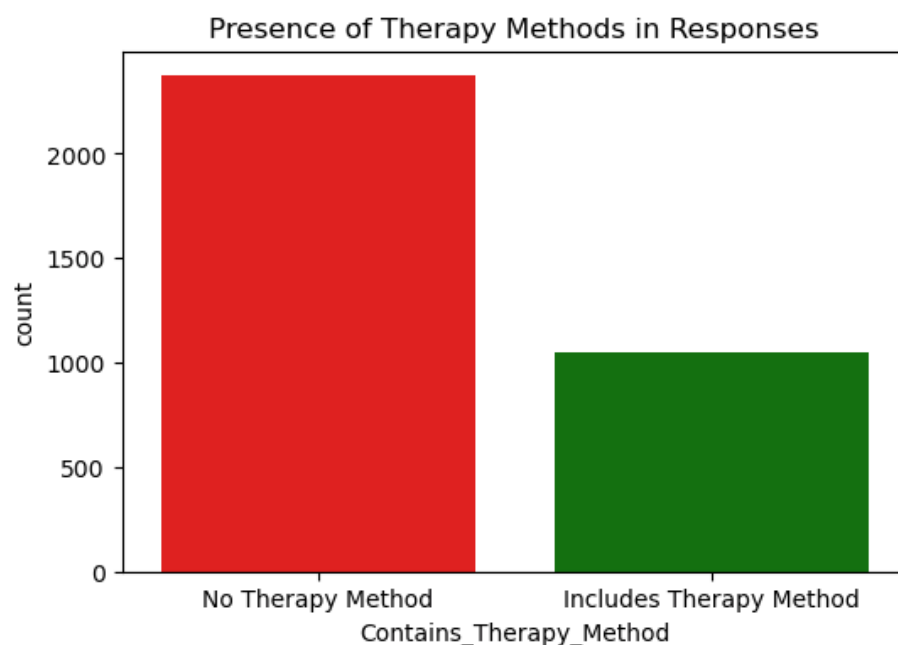


Key Observations:

- FAQ Questions frequently include terms like "mental," "health," "find," "help," "difference," "disorder," and "problem," indicating that users often seek clarification on mental health concepts and symptoms.
- FAQ Answers emphasize words like "health," "mental," "support," "treatment," "doctor," and "experience," suggesting that responses focus on providing medical guidance, emotional support, and structured treatments.

❖ Presence of Therapy Techniques in Therapist Responses– Bar Chart

Objective: To check the presence of therapy-based guidance in chatbot training data.



Key Observations:

- Most responses do not explicitly mention therapy techniques (e.g., CBT, mindfulness, deep breathing), indicating that many replies are general support-based rather than structured therapy-driven.
- A smaller portion of responses do include therapy-related methods, suggesting that while therapeutic guidance is present, it is not the dominant approach in the dataset.

Conclusion

This EDA provides significant insights towards the development of a **Sentiment-aware mental health chatbot**, ranging from mental health category imbalances to word usage patterns and therapy-based interventions. Depression & Suicidal comments dominate the dataset, necessitating balanced training to avoid bias. Stress & Anxiety discussions are more situational, necessitating context-aware responses.

Most of the responses are devoid of therapy-based methods, proposing that the chatbot must include CBT, mindfulness, and coping skills for guided assistance. Variations in statement lengths affirm the necessity of adaptive responses to provide short questions with brief reassurance and longer distress signals with empathetic multi-turn dialogue.

These results will guide chatbot development to detect distress, prioritize high-risk scenarios, learn to respond based on sentiment, and integrate therapy-informed approaches for effective mental health intervention.