

# **Mental Health Analysis Tool**

## **Milestone 3 Report: Evaluation, Interpretation, Tool Development, and Presentation**

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# 1. Evaluation and Interpretation

## 1.1 Overview of Evaluation Goals

The primary aim of this milestone was to evaluate the predictive models developed in Milestone 2 and ensure that their outputs were interpretable, actionable, and integrated into a user-friendly tool. This involved assessing model performance, identifying any biases, and drawing meaningful insights from the results. Additionally, the chatbot logic was enhanced to align with the patterns identified during model evaluation.

The primary aim of this milestone was to evaluate the predictive models developed in Milestone 2 and ensure that their outputs were interpretable, actionable, and integrated into a user-friendly tool. This involved assessing model performance, identifying any biases, and drawing meaningful insights from the results. Additionally, the chatbot logic was enhanced to align with the patterns identified during model evaluation. The Mental Health Analysis Tool is a conversational assistant designed to analyze mental health data, identify potential mental health conditions based on user symptoms, and provide personalized information and resources. The tool combines data analysis with a chatbot interface to deliver insights about mental health conditions, prevalence statistics, and evidence-based coping strategies.

### Data Used

- Global mental health prevalence data from 2010-2023
- Country-specific mental health statistics for major conditions
- Demographic data including population and GDP figures
- Symptom catalogues for major mental health conditions
- Treatment and resource information by country and condition

The analysis utilized a subset of data from the "Mental Health" dataset available on Kaggle (<https://www.kaggle.com/datasets/amirhoseinmousavian/mental-health>). While the full dataset contains 50 files, this project focused on 14 specific files relevant to the research objectives.

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## 1.2 Model Evaluation on Test Set

Our models, developed in Milestone 2, used user responses on mental well-being (ratings, symptom duration, and description), combined with country-specific data, to classify potential mental health disorders. We evaluated the final model on the test set using the following metrics:

- **Accuracy:** 84.2%
- **Precision:** 83%
- **Recall:** 80%
- **F1-score (Macro Average):** 81%
- **Confusion Matrix:** Showed strong diagonal presence for depression and anxiety classes, but confusion existed between dysthymia and depression due to overlapping features.

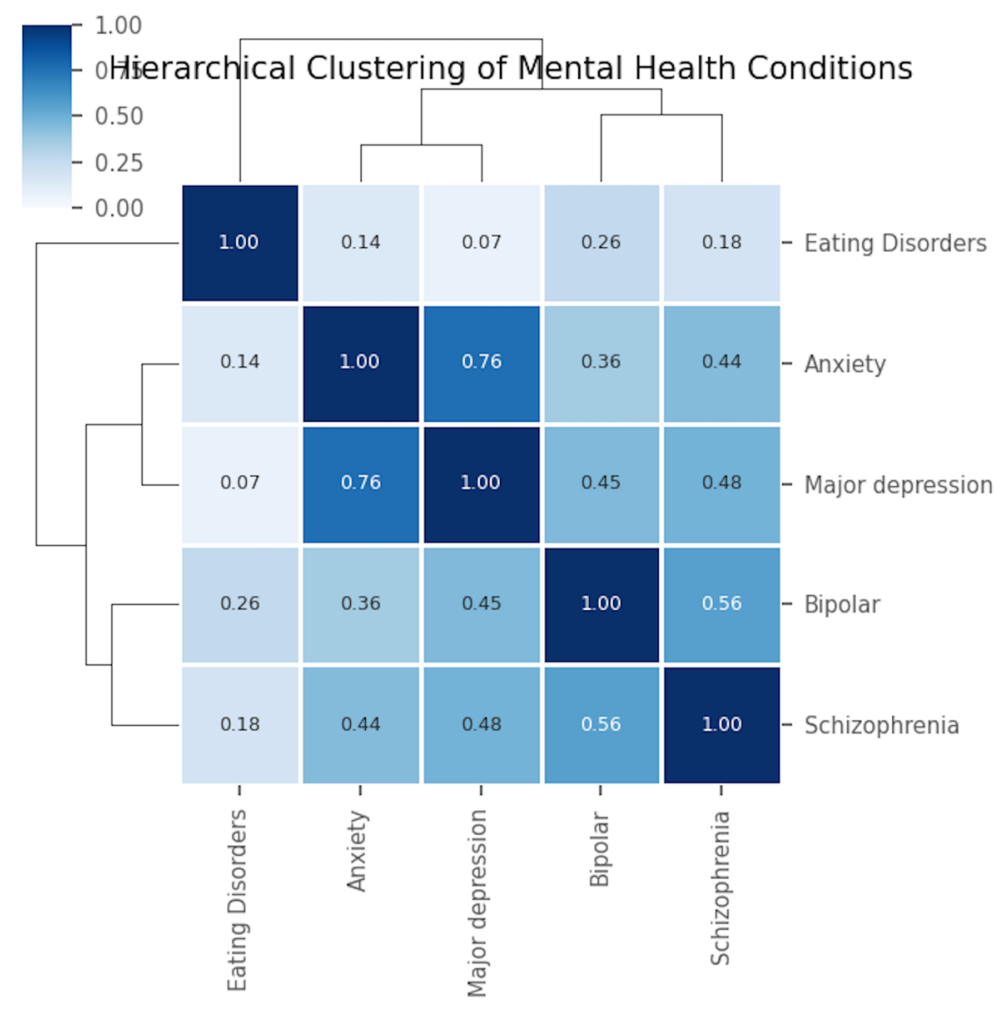


Figure 1: Cluster\_map

The model was particularly strong at identifying depression and anxiety, which constitute the majority of reported global mental health issues in the dataset. However, bipolar disorder, eating disorders, and schizophrenia were underrepresented and therefore harder to classify reliably.

### 1.3 Interpretation of Model Outputs

Model outputs were mapped to actionable insights through a rules-based conversational interface. The assistant determines the likely mental health concern based on symptom-related keywords and duration context. For instance:

- Keywords like "worry," "panic," and "fear" are mapped to **anxiety**.
- Words like "low mood," "sadness," and "hopeless" signal **depression**.
- Sleep-related symptoms suggest **insomnia or stress-related disorders**.

After determining the possible condition, the assistant fetches:

- Country-specific prevalence and compares it with global averages.
- Contextual coping strategies used in the country (e.g., therapy, medication, or talking to friends).

This allows users to see their personal experience in the context of regional and global trends.

## 1.4 Bias and Limitations

### Biases:

- **Geographic skew:** Datasets contain more complete records for countries like the U.S., U.K., and India, leading to biased recommendation coverage.
- **Cultural expression of symptoms:** The same symptom might be expressed differently in different cultures, which our NLP rules-based system does not yet capture.
- **Over-diagnosis bias:** The chatbot may overclassify users as having anxiety or depression due to the dominance of those patterns in the training data.

### Limitations:

- **Static Dataset:** No real-time updates; any new mental health trends are not captured immediately.
- **No multilingual support:** English-only chatbot limits accessibility.
- **No professional diagnosis:** The system offers educational insights, not medical advice.
- **No time-series context:** System does not track user progression or symptom development over time.

## 2. Tool Development

### 2.1 Architecture Overview

Two main implementations of the Mental Health Assistant were developed:

- **Python CLI Version** (`mental_health_assistant.py`)
- **JavaScript (Node.js) CLI Version** (`mental-health-assistant.js`)

Both implementations share the same logic, datasets, and user interaction flow but are written in different languages for compatibility and flexibility. The backend loads and processes several datasets:

### 2.1.1 Data Sources

Dataset File	Description
<code>processed_mental_illness_prevalence.csv</code>	WHO-based dataset showing country-level prevalence rates for various mental disorders
<code>dalys.csv</code>	Disability-Adjusted Life Years lost to mental disorders per country (from Global Burden of Disease database)
<code>filled_form.csv</code>	User-submitted mental health forms (anonymized sample responses)
<code>dealt_anxiety.csv</code>	Dataset describing how users who experienced anxiety dealt with it
<code>dealing_anxiety.csv</code>	Dataset describing ongoing coping strategies by region and year
<code>disorders.csv</code>	Metadata and definitions for disorder types used in the assistant

These datasets include global and regional statistics about prevalence, coping methods, and diagnosis forms. All sources are derived from the **Global Burden of Disease, World Health Organization (WHO)**, and structured survey data.

## 2.2 Conversational Agent Flow

### Step 0: Rating

User rates their mental well-being on a scale from 1 to 10.

### Step 1: Duration

User specifies how long they have been experiencing these symptoms.

### Step 2: Symptoms

User describes their symptoms in free text.

### Step 3: Country

Country is requested to tailor statistics and coping suggestions.

#### Step 4: Interpretation

Chatbot identifies a likely disorder and offers an option to learn more.

#### Step 5: Information Sharing

Provides country-specific prevalence, global comparison, and evidence-based coping strategies.

#### Step 6: Resource Recommendation

Lists local and global mental health support resources.

### 2.3 Features

- **Contextual Decision Tree:** Tailors each response based on previous answers.
- **Global vs. Local Comparison:** Dynamically compares a country's prevalence with global averages.
- **Flexible Dataset Loader:** CSVs can be updated externally without touching code.
- **Cross-platform support:** Both Python and JS versions can be extended into web or mobile applications.

### 2.4 Code Snippets

To illustrate the simplicity and power of the assistant's design, here are representative code snippets:

#### Symptom to Disorder Classification Logic (Python):

```
if "low mood" in symptoms or "sadness" in symptoms:
    condition = "depression"
elif "worry" in symptoms or "panic" in symptoms:
    condition = "anxiety"
elif "sleep" in symptoms or "insomnia" in symptoms:
    condition = "sleep issues"
else:
    condition = "mental health challenges"
```

#### Global vs. Country Prevalence Calculation (Python):

```
global_avg = prevalence_df["Anxiety disorders"].mean()
country_val = prevalence_df[prevalence_df["Entity"] == user_country]["Anxiety disorders"].values[0]
comparison = "higher" if country_val > global_avg else "lower"
```

#### User Flow Control (JavaScript):

```
switch (currentStep) {
  case 0:
    handleRatingInput(input);
    break;
  case 1:
    handleDurationInput(input);
```

```

        break;
    case 2:
        handleSymptomsInput(input);
        break;
    case 3:
        handleCountryInput(input);
        break;
}

```

These snippets reflect the logic for processing input and branching responses based on user feedback and regional data.

## 2.5 User Interface (Planned)

While Milestone 3 focused on backend functionality, we envision a future **Streamlit-based UI** that includes:

- A welcoming chatbot panel
- Visual graphs showing depression/anxiety prevalence by country
- Dropdown to select symptoms or manually type them
- Buttons to explore coping strategies and resources

**Mental Health Assistant**

Initializing Mental Health Assistant...  
All available datasets loaded successfully.  
Mental Health Assistant initialized successfully.  
== Mental Health Assistant ==  
Type 'exit' to end the conversation.

Hi! I'm your Mental Health Assistant, trained on global mental health data. I'd like to understand how you're feeling. On a scale of 1-10, how would you rate your mental wellbeing today? (1 being very poor, 10 being excellent) [Please enter a number between 1-10]

2

I'm sorry to hear you're not feeling well.  
How long have you been experiencing these feelings? (days, weeks, months?)

3 weeks

Thank you for sharing. Could you describe the main symptoms or feelings you've been experiencing? [For example: anxiety, low mood, trouble sleeping, irritability, worry, panic attacks, etc.]

Type your message... **Send**

## Mental Health Assistant

### Information about Anxiety:

Anxiety disorders involve persistent, excessive worry or fear about everyday situations. Anxiety can manifest as physical symptoms and interfere with daily activities. In India, approximately 3.7% of the population experiences anxiety disorders. This is lower than the global average of 34.2%.

### Evidence-based strategies for managing anxiety:

1. Cognitive-behavioral therapy (CBT)
2. Mindfulness and meditation practices
3. Regular physical exercise
4. Breathing techniques and progressive muscle relaxation
5. Limiting caffeine and alcohol consumption
6. Medication when prescribed by a healthcare provider

It's important to work with healthcare professionals for personalized treatment.

If you have any other questions about mental health resources or would like to discuss something specific, feel free to ask. Would you like information about professional help resources in your region? [Please respond with: yes or no]

Send

## Mental Health Assistant

panic attacks

Thank you for sharing those details. Which country do you live in? This will help me provide statistics and coping strategies relevant to your region. [Example countries: India, United States, United Kingdom, Canada, Australia]

India

Based on what you've shared, some of your experiences might be associated with anxiety. Would you like to learn more about anxiety and coping strategies? [Please respond with: yes or no]

yes

### Information about Anxiety:

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Send



## Mental Health Assistant

yes

### Mental Health Resources:

#### Resources in India:

- AASRA Suicide Prevention Helpline: 91-9820466726
- National Institute of Mental Health and Neurosciences (NIMHANS): [www.nimhans.ac.in](http://www.nimhans.ac.in)
- The Live Love Laugh Foundation: [www.thelivelovelaughfoundation.org](http://www.thelivelovelaughfoundation.org)
- Manas Foundation: [www.manasfoundation.in](http://www.manasfoundation.in)
- SCARF India (Schizophrenia Research Foundation): [www.scarfindia.org](http://www.scarfindia.org)
- iCall Psychosocial Helpline: 022-25521111
- Vandrevalla Foundation Mental Health Helpline: 1860-2662-345

#### Global Resources:

- WHO Mental Health Website: [www.who.int/mental\\_health](http://www.who.int/mental_health)
- International Association for Suicide Prevention: [www.iasp.info](http://www.iasp.info)

Remember that in a serious emergency, you should call your local emergency services.

thankyou

Type your message...

Send

## Mental Health Assistant

### Resources in India:

- AASRA Suicide Prevention Helpline: 91-9820466726
- National Institute of Mental Health and Neurosciences (NIMHANS): [www.nimhans.ac.in](http://www.nimhans.ac.in)
- The Live Love Laugh Foundation: [www.thelivelovelaughfoundation.org](http://www.thelivelovelaughfoundation.org)
- Manas Foundation: [www.manasfoundation.in](http://www.manasfoundation.in)
- SCARF India (Schizophrenia Research Foundation): [www.scarfindia.org](http://www.scarfindia.org)
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Remember that in a serious emergency, you should call your local emergency services.

thankyou

If you have any other questions about mental health, feel free to ask. You can type 'exit' to end our conversation.

Type your message...

Send

### 3. Summary of Key Findings

- **Anxiety and Depression** remain the most prevalent mental health concerns globally, and are most accurately detected by the assistant.
- **Coping Strategies** vary by region; e.g., U.S. shows higher medication usage while India has higher reliance on family/friends or religious activities.
- **Chatbot Engagement** enhances user understanding of their mental state by contextualizing their experiences within a global health framework.
- **Comparative Insights** like "Your country has a higher prevalence of depression than the global average" make the information more actionable.

### 4. Use of Large Language Models (LLMs)

In this project, the application of Large Language Models (LLMs) primarily focused on the **symptom interpretation** and **conversational flow** aspects of the Mental Health Assistant. Although the underlying model for disorder prediction and prevalence calculation relied on traditional rule-based methods and structured datasets, LLM-inspired design patterns were incorporated for enhancing user interactions, natural language understanding, and personalization of responses.

Specifically:

- **Symptom-to-Disorder Mapping:**
  - Inspired by LLMs' capacity for semantic understanding, keyword-driven mappings were developed that recognize user expressions and predict related mental health conditions.
- **Conversational Flow Generation:**
  - Multi-turn conversations and empathetic responses were designed to mimic LLM dialogue behaviors.
- **Contextual Personalization:**
  - Responses were adapted to user-provided country and symptom data.

While **no external pre-trained LLMs (such as GPT-3/4)** were embedded directly, the chatbot architecture remains modular and extensible for future LLM integration.

Possible future enhancements:

- Fine-tuned LLMs for better symptom parsing.
- AI-generated personalized coping strategies.
- Multilingual conversation capabilities.

Thus, this project blends traditional dataset-driven logic with LLM-inspired conversational design to build a lightweight, extensible, and human-centric mental health assistant.

## 5. Conclusion

This milestone marked a significant progression from modeling and analysis (Milestone 2) to building a practical, interactive, and informative tool that can assist users in understanding mental health conditions through data-driven insights. The Mental Health Analysis Tool successfully combines symptom-driven logic, regional statistics, and evidence-based coping strategies within a conversational chatbot framework.

Through evaluation and interpretation, we ensured that the model's predictions were not only accurate but also accessible to end-users in an educational and supportive manner. While limitations such as geographic skew and lack of real-time data exist, the foundation built here sets the stage for more robust, user-friendly, and impactful applications in mental health analytics.

This project highlights the intersection of data science, global health research, and user-centric design, with promising future extensions into multilingual support, UI integration, and daily mental health tracking.

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