

# Enhancing Mental Health Support for Depression with LLM and Reflection Agent

Empowering Empathetic Responses and Accessibility



# Table of Content

1. **Project Statement:** The needs of user-centered mental health LLM Application and Chatbot
  1. **Project Proposal:** Enhancing Mental Health Support for Depression
  1. **Solution Architectures:** Building a Personalized LLM App and Chatbot to Bridge the Gap in Timely Mental Health Support for Depression
1. **Optimization and Refinement:** Reflection Prompt Revision & Langchain Semantic Search
1. **AI Agent Algorithm:** Reflection and Langchain Semantic Search
1. **Prompt Tuning:** Mental Health Contexts for Depression
1. **Disclaimer**
1. **Credits / References**

# 1. Project Statement



## **Background:**

Depression is a pervasive mental health disorder affecting millions globally. Characterized by persistent sadness, loss of interest in activities, and functional impairments, it necessitates effective management strategies. The advent of technology has introduced innovative approaches to support mental health, among which depression chatbots hold significant promise. However, creating an effective depression chatbot is complex and requires careful consideration.

## **Problem Statement:**

Despite the potential benefits, many existing depression chatbots fail to meet the needs of users due to a lack of personalization, limited emotional support, and insufficient therapeutic depth. This results in users feeling misunderstood or inadequately supported, exacerbating their condition.

## 2. Project Proposal: Enhancing Mental Health Support for Depression with LLM and Reflection Agent



### Project Proposal: Enhancing Mental Health Support for Depression with LLM and Reflection Agent

Utilizing Advanced AI Techniques

Personalized Mental Health Interventions

Empathetic and Contextually Relevant Responses

Timely Support and Resources

Bridging the Gap in Mental Health Services

## 2. Project Proposal–

### Understanding the Problem: Limited Access to Professional Resources for Depression

Over 264 million people with depression – shortage of psychiatric professionals (as few as 1.5 psychiatrists per 10,000 people)

#### Impact of Depression on Quality of Life

- Pervasive depression affects daily functioning
- Reduced productivity and social interactions
- Increased risk of chronic illnesses

#### Current Challenges

- Limited availability of mental health services
- Stigma associated with seeking help
- Limited human resources for diagnosis and assessment

#### Need for Personalized Support

- Importance of empathetic responses
- Tailored management and referral for individual needs
- Accessibility for diverse populations

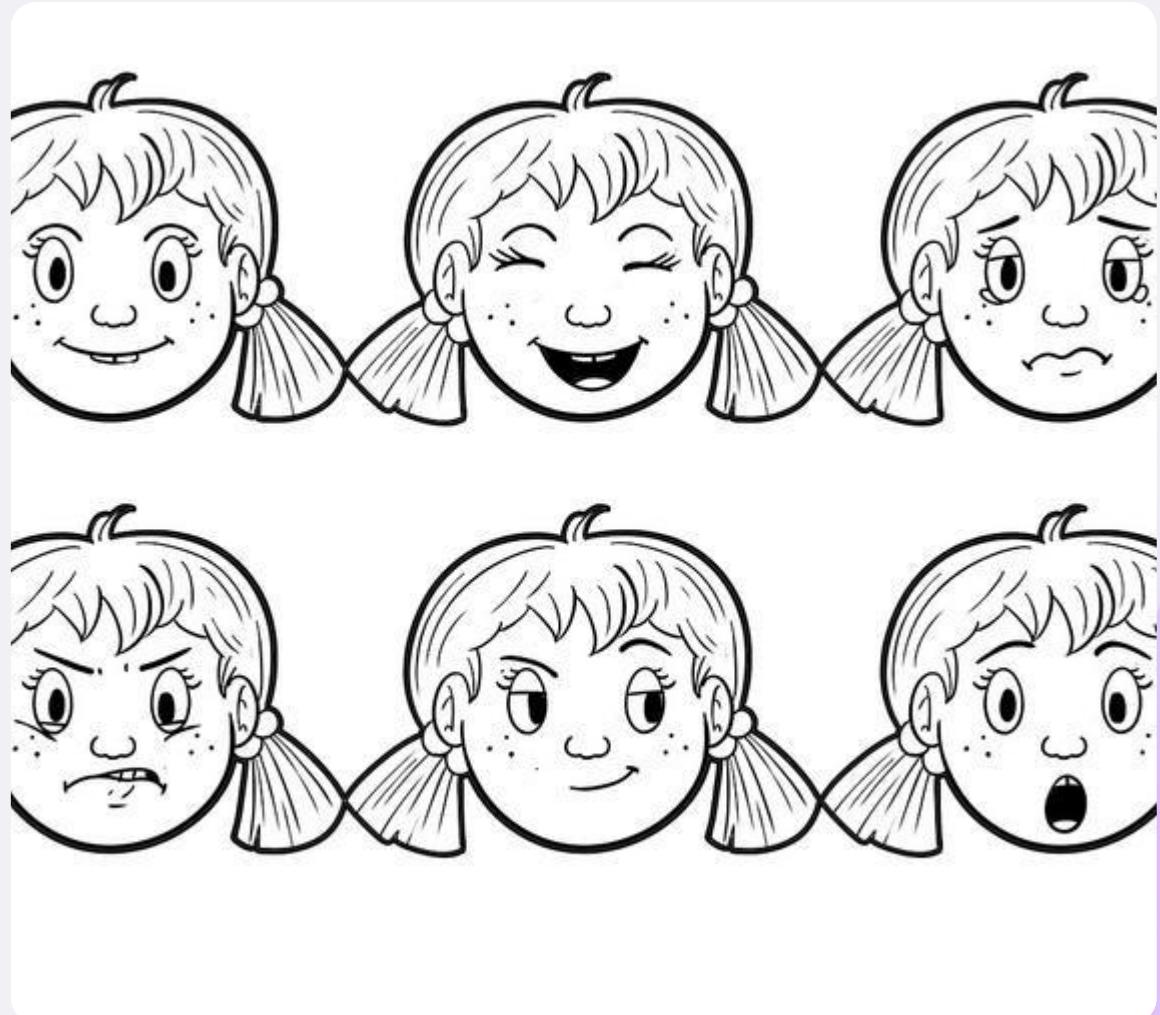
#### Proposed Solution

- Develop a chatbot for timely management
- Provide immediate, affordable, and effective support
- Reduce stigma and increase accessibility

## 2. Project Proposal– Leveraging LLM: The Key to Empathetic Responses

### LLM: Enhancing Empathy

- Human-like responses
- Emotional cues understood
- Diverse mental health issues handled
- Contextual relevance achieved



## 2. Project Proposal– User Stories

### Mental Health Content Delivery

As a patient dealing with stress or anxiety, I want the chatbot to offer mental health support so that I can manage my mental well-being.

### Referral to Mental Health Resources

Online tools for depression assessments

Offer self-help resources and exercises



# **3. Solution Architecture: part 1 of 3**

## **Building a Personalized Chatbot**

### **Streamlit Interface for User Interaction**

- Setting up the user interface
- Handling user inputs
- Displaying chatbot responses

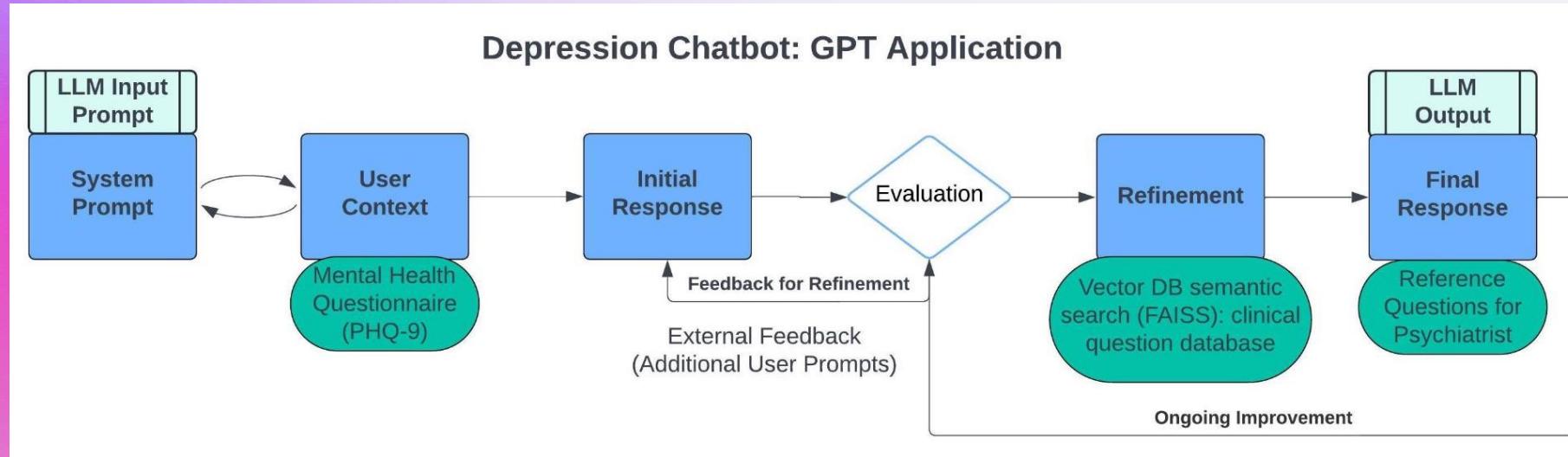
### **Langchain Semantic Querying for Reasoning**

- Setting up semantic querying
- Using Langchain for reasoning

### **Reflection Prompts for Emotional Expression**

- Designing effective prompts
- Incorporating prompts into chatbot
- Benefits for users

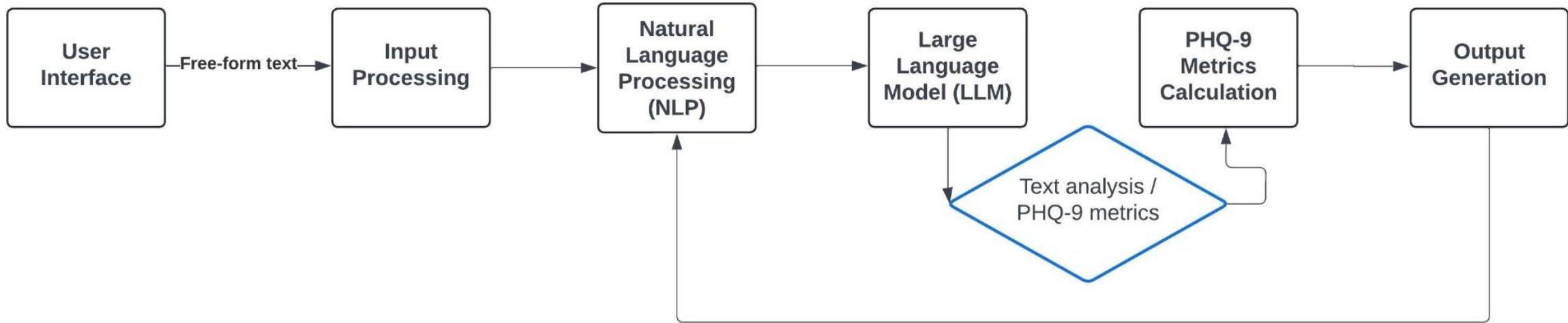
### 3. Solution Architecture 1: Building the Mental Health Chatbot



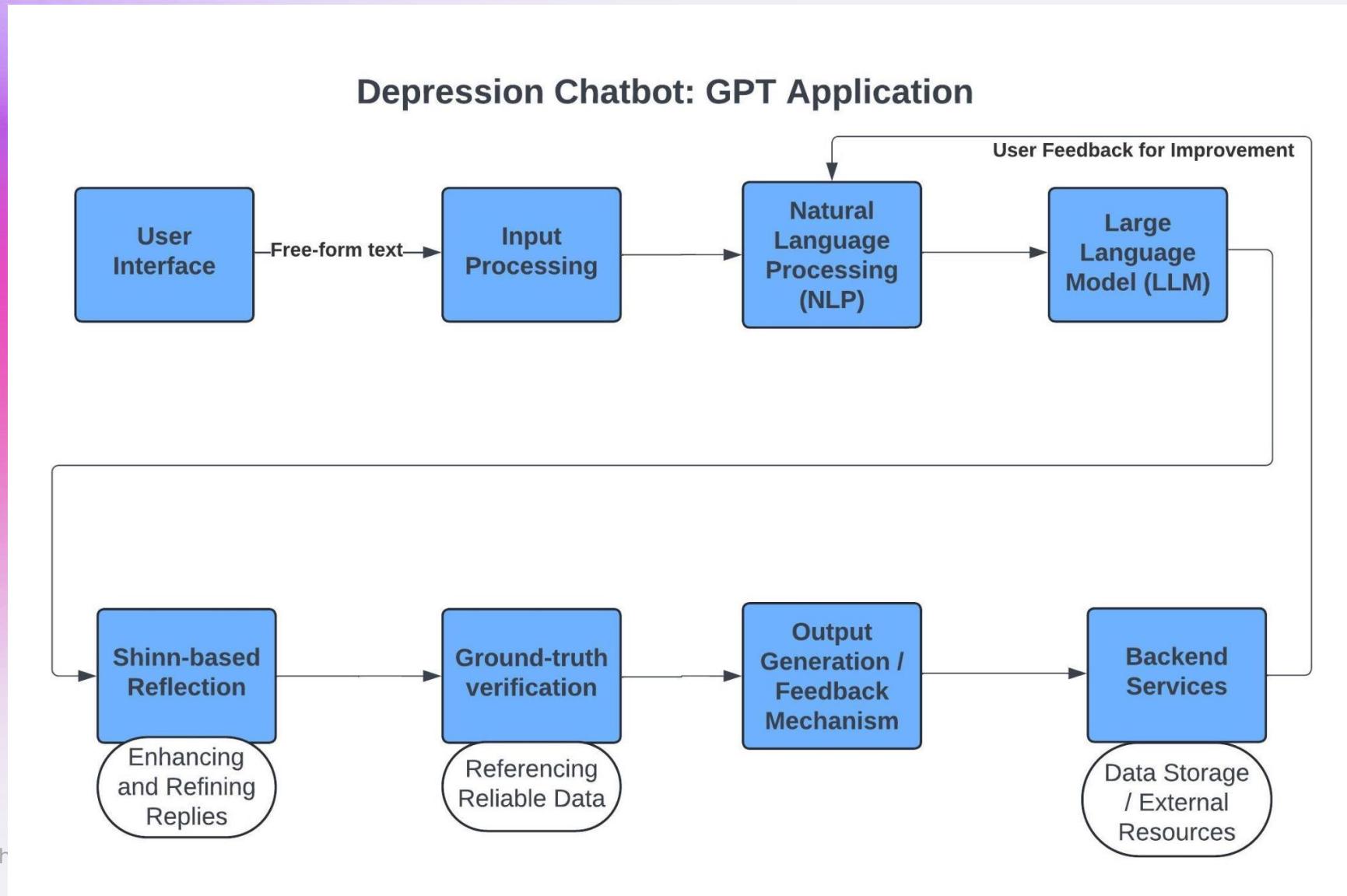
1. **LLM Input Prompt:** The chatbot receives an initial user prompt that initiates the interaction.
2. **System Prompt:** The system generates a prompt based on predefined criteria.
3. **User Context:** The system incorporates the user's context, including information from a **Mental Health Questionnaire (PHQ-9)**, to tailor the response.
4. **Evaluation using Reflection Agent:** The chatbot provides an initial response based on the user's context and input prompt. The initial response is evaluated. Feedback for refinement may be provided either through system evaluation or external feedback from the user.
5. **Refinement:** The response is refined using a **Vector Database (DB) semantic search** with FAISS technology, which includes a clinical question database. This step ensures that the response is as accurate and helpful as possible based on the patient's depression score.
6. **Final Response:** After refinement, the chatbot generates a final response, which may include reference questions for a psychiatrist if needed.
7. **LLM Output:** The refined final response is delivered back to the user. The process includes ongoing improvements based on the feedback and refinement cycle, ensuring that the chatbot continues to learn and improve over time.

### 3. Solution Architecture 2: Building the Mental Health Chatbot

Depression Chatbot: GPT Application



### 3. Solution Architecture 3: Building the Mental Health Chatbot



## 4. Optimization and Refinement

### Importance of User Profiles in Tailoring Responses:

#### Building the Mental Health Chatbot

01

##### Importance of Personalized Responses

Key in enhancing user experience.  
Increase user satisfaction.

02

##### Role of User Profiles

Help tailor responses to individual preferences.  
Enable Conversational AI to provide more relevant and meaningful responses.

03

##### Benefits of Understanding User Profiles

Leads to more engaging interactions.  
Increases user satisfaction.

04

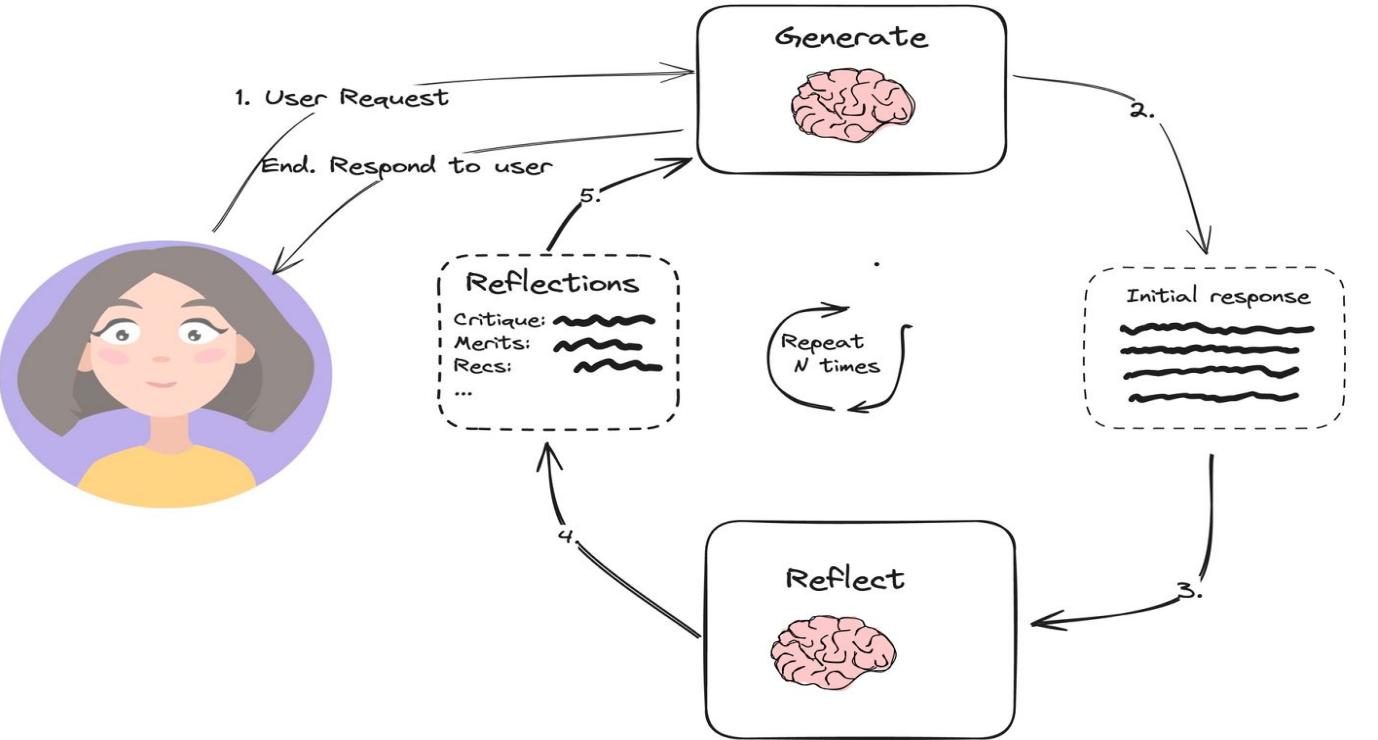
##### Tailoring Responses Based on User Profiles

Enhances user experience.  
Provides more relevant and meaningful responses.

## 4. Optimization and Refinement

### Reflection Prompt Revision: Building the Mental Health Chatbot

#### Basic Reflection



# 4. Optimization and Refinement

## Reflection Prompt Revision: Building the Mental Health Chatbot

01

### Utilizing Reflection Prompt Revision

Langchain Semantic Prompts/Querying LLM

02

### Employing LLM / OpenAI Technology

Collect user profiles  
Generate tailored responses

03

### Generating and Storing Embeddings

For documents and document chunks  
Enhance response accuracy

04

### Using Advanced Language Models

Query for specific information  
Improve response quality

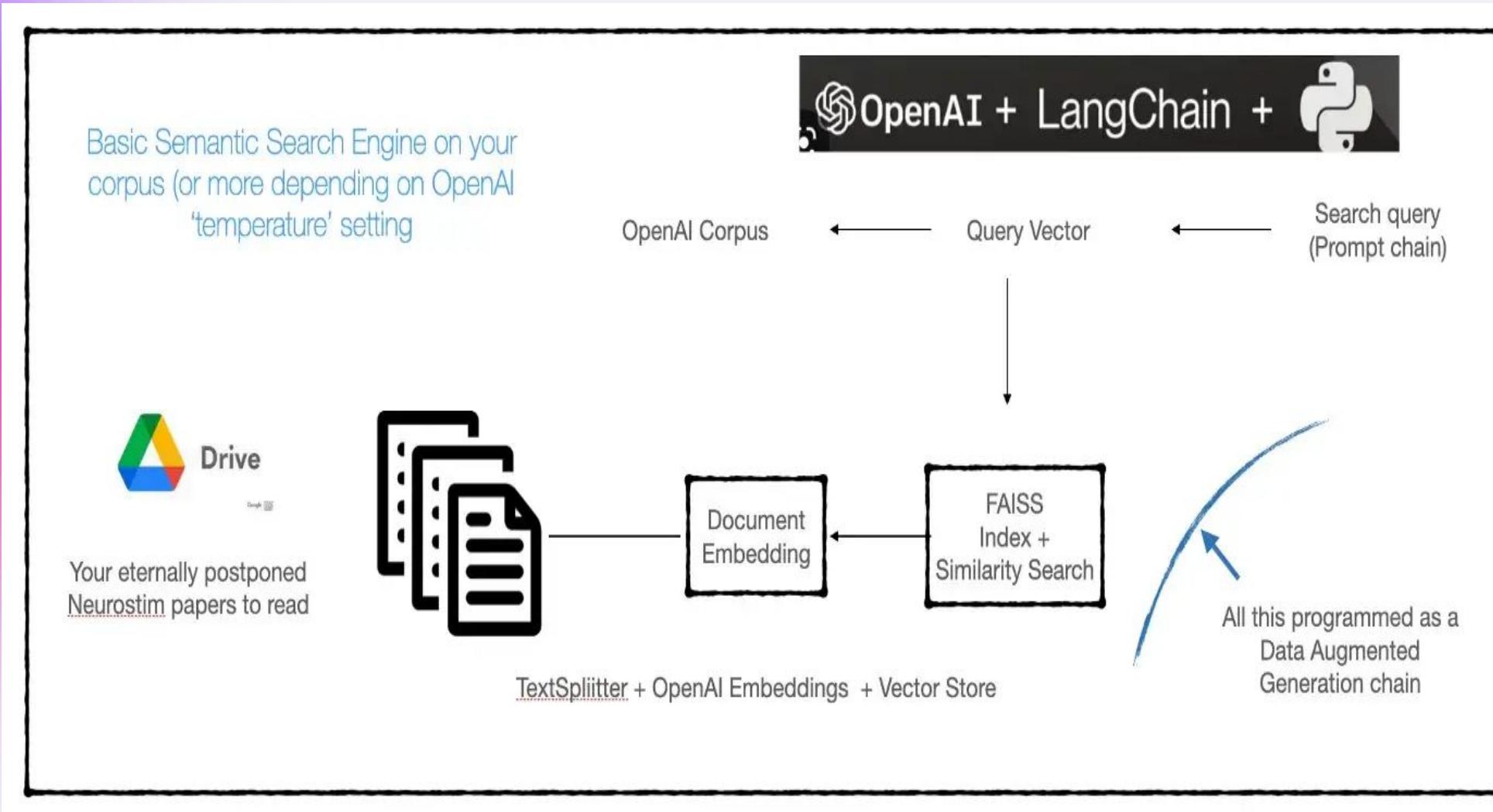
05

### Incorporating User Profiles

Response generation process  
Personalized interactions

## 4. Optimization and Refinement

### Semantic Search: Building the Mental Health Chatbot



# 4. Optimization and Refinement

## Langchain Semantic Search: Building the Mental Health Chatbot

01

### Introduction to Semantic Search Engine

Utilizing OpenAI technology to build a basic semantic search engine on a corpus.

02

### Components Involved

OpenAI Corpus  
Query Vector  
FAISS Index  
Similarity Search Document  
Embedding Neurostim papers

03

### Programming the Search Query Prompt Chain

Programming all components as a search query prompt chain for efficient search functionality.

04

### Generating and Storing Embeddings

Generating and storing embeddings for documents and document chunks to enhance search capabilities.

05

### Using Question Embeddings

Using question embeddings to retrieve relevant document chunk IDs for precise search results.

# Data Flow: Ensuring Timely Support

## User Input via Streamlit

Users provide input through a Streamlit interface (text, audio, or other formats)

Streamlit captures and forwards the input for processing.

## Langchain Semantic Querying and Reasoning Component

Langchain processes the tagged emotions and performs semantic querying to understand the context.

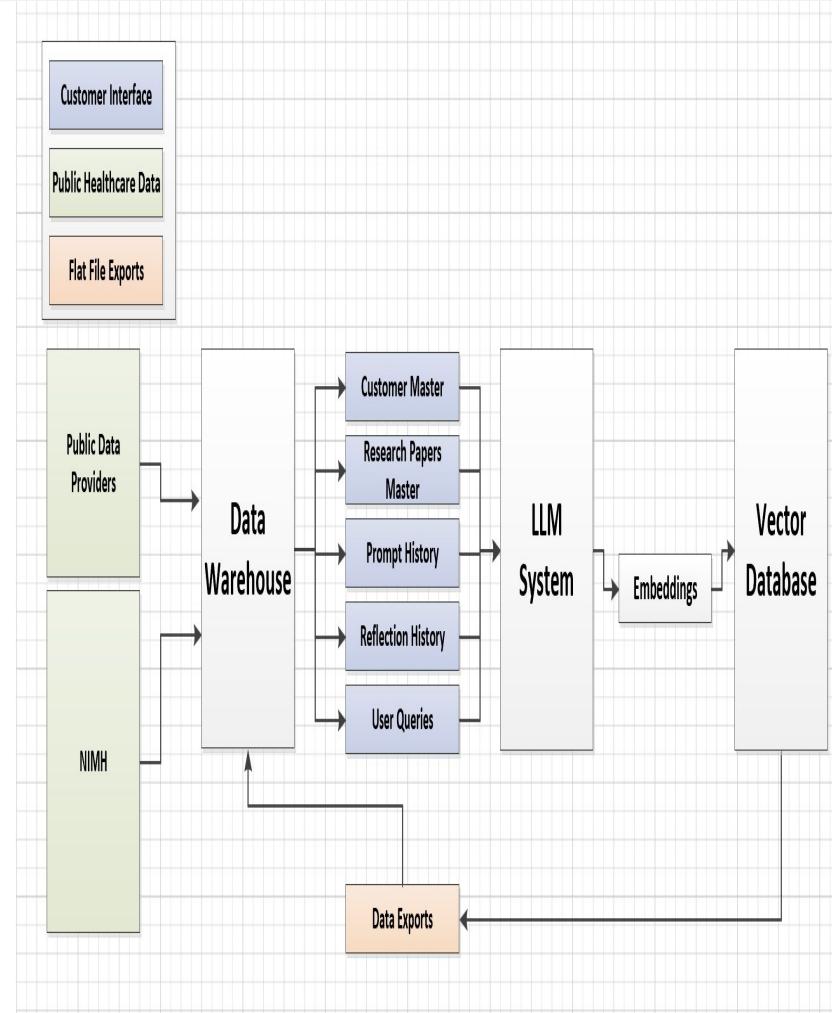
Reasoning algorithms are applied to derive insights.

## Reflection Prompt Revision Component

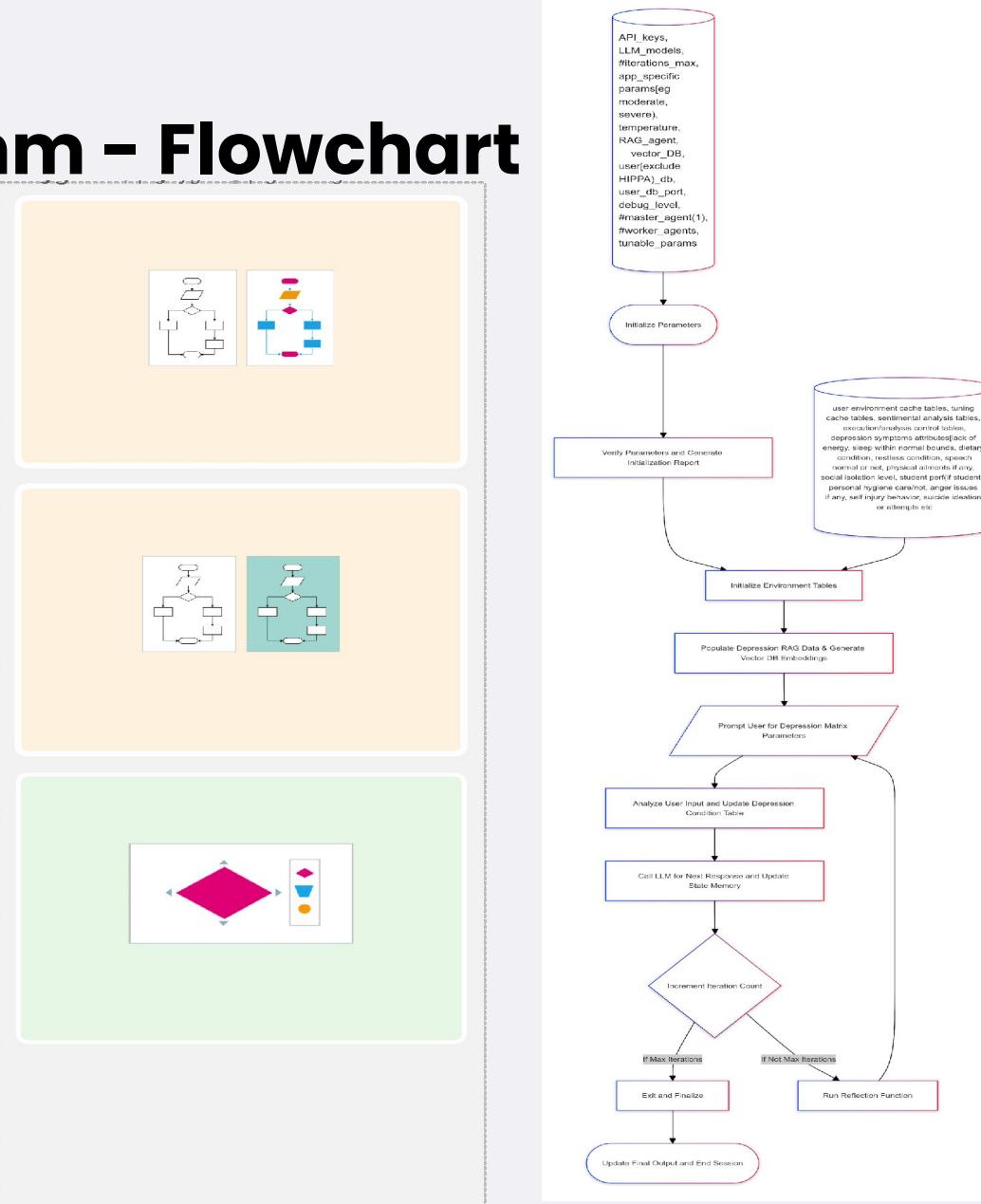
Based on insights, reflection prompts are generated.

Prompts are revised to better suit the user's emotional state.

The component ensures prompts are clear, relevant and empathetic.



# 5. AI Agent Algorithm - Flowchart



# 6. Prompt Tuning for Mental Health Contexts

## Tailoring LLM Prompts for Depression

- Understand the user's emotional state
- Use calming and supportive language
- Incorporate validation and empathy
- Avoid triggering or sensitive topics

## Designing Crisis Response Prompts

- Identify signs of crisis in user input
- Provide resources for follow up
- Use de-escalation technique to ensure user safety

## Fine-Tuning Prompts for Empathetic Interactions

- Train models on empathetic dialogue datasets
- Use active listening techniques
- Reflect the user's feelings and concerns
- Maintain a non-judgmental tone

## Using Prompts to Guide Chatbot Responses

- Create a flowchart of possible user inputs
- Develop prompts for each scenario
- Test and iterate on prompt effectiveness
- Ensure consistency in chatbot behavior



# Part1\_Demonstration – 1

## Mental Health AI Agent Application

Question 1: Little interest or pleasure in doing things?

Several days

Question 2: Feeling down, depressed, or hopeless?

Several days

Question 3: Trouble falling or staying asleep, or sleeping too much?

Several days

Question 4: Feeling tired or having little energy?

Several days

Question 5: Poor appetite or overeating?

Several days

Question 6: Feeling bad about yourself — or that you are a failure or have let yourself or your family down?

Several days

Question 7: Trouble concentrating on things, such as reading the newspaper or watching television?

Not at all

Question 8: Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual?

Not at all

Question 9: Thoughts that you would be better off dead, or of hurting yourself in some way?

Not at all

Submit

# **Part1\_Demonstration – 1 (contd.)**

Please wait while we process your data...

Initial Response

A PHQ-9 score of 6 indicates mild depression. In treating mild depression, a comprehensive approach is typically taken, considering the patient's specific needs and circumstances. Here's a suggested treatment approach:

1. **Psychoeducation:** Educate the patient about depression and its symptoms, emphasizing that mild depression is common and treatable.
2. **Monitoring:** Close monitoring is important to assess any changes in symptoms over time. Regular follow-up appointments can help track mood changes and treatment progress.
3. **Psychotherapy:** Cognitive Behavioral Therapy (CBT) or other forms of psychotherapy may be beneficial. This can help the patient develop coping strategies, challenge negative thought patterns, and promote behavioral activation.
4. **Lifestyle Modifications:** Encourage a healthy lifestyle, including regular physical activity, a balanced diet, adequate sleep, and stress management techniques such as mindfulness or relaxation exercises.
5. **Support Network:** Encourage the patient to engage with social support systems, whether through family, friends, or support groups.
6. **Self-Help Strategies:** Suggest self-help resources, such as books, online programs, or apps focused on mental wellness, which can complement professional treatment.
7. **Medication Consideration:** In cases where symptoms persist or worsen, medication may be evaluated, although it is less common to initiate pharmacotherapy for mild depression.
8. **Gradual Steps:** Emphasize that gradual changes and consistency are key to improvement, and set realistic goals for the patient.
9. **Reassessment:** Schedule regular reassessment to determine if treatment adjustments are needed based on symptom improvement or deterioration.

It's essential to tailor the treatment approach to the individual, as each patient may respond differently to various interventions.

**Note: this is first level response from LLM gpt-4o-mini without use of Reflection, Langchain semantic search**

# Part1\_Demonstration – 2 (with Reflection)

**Note: this is second level response from LLM gpt-4o-mini with use of Reflection and without use of Langchain semantic search**

**Note: How the response language is empathetic**

## Reflection Response

The response provides a comprehensive overview of an approach to treating mild depression according to a PHQ-9 score of 6. However, some improvements and critiques can enhance accuracy, clarity, and relevance. Here are the suggestions along with references for fact-checking:

1. **Clarifying the PHQ-9 Context:** The response should specify that the PHQ-9 is a self-report questionnaire used to assess the severity of depression. While a score of 6 indeed indicates mild depression, it may help to explain the meaning of different score ranges briefly.
  - o Reference: Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2001). "The PHQ-9: Validity of a brief depression severity measure." *Journal of General Internal Medicine*, 16(9), 606-613.
2. **Emphasis on Psychotherapy:** The response rightly emphasizes psychotherapy, particularly Cognitive Behavioral Therapy (CBT). It might be beneficial to mention that other therapeutic modalities, such as interpersonal therapy (IPT) or problem-solving therapy, can also be effective.
  - o Reference: Cuijpers, P., Karyotaki, E., Weitz, E., Andersson, G., Hollon, S. D., van Straten, A. (2016). "The effects of psychotherapies for major depression in adults on remission, recovery and improvement: a meta-analysis." *Journal of Affective Disorders*, 202, 511-515.
3. **Lifestyle Modifications with Evidence:** When discussing lifestyle modifications, it could be more compelling to include specific studies that show their effectiveness in improving mild depression symptoms, such as the impact of exercise on mood.
  - o Reference: Craft, L. L., & Perna, F. M. (2004). "The Benefits of Exercise for the Clinically Depressed." *Primary Care Companion to The Journal of Clinical Psychiatry*, 6(3), 104-111.
4. **Support Network:** More emphasis could be placed on leveraging community resources or mental health support networks, especially since social support is a significant factor in recovery from depression. Suggestions could include local or online support groups for individuals with depression.
  - o Reference: Hosseinpour, M., Sina, K., Aminzadeh, K., & Khosravi, M. (2020). "The impact of social support on the functional recovery of patients with major depressive disorder." *BMC Psychiatry*, 20(1), 1-9.
5. **Medication Consideration:** It's acknowledged that while medication is less common for mild depression, if persistent symptoms arise, a discussion about pharmacotherapy should be nuanced. It's beneficial to mention that the decision to use medication often comes after evaluating factors such as patient history and the presence of comorbid conditions.
  - o Reference: National Institute for Health and Care Excellence (NICE) Guidelines. (2022). "Depression in adults: recognition and management." Available at: <https://www.nice.org.uk/guidance/ng22>.
6. **Actionable Self-Help Strategies:** Providing specifics about self-help resources can add value. For example, referencing validated self-help books or reputable online platforms for mental health could be useful.
  - o Reference: Richards, D. A., & Richardson, T. (2012). "Psychoeducation and self-help for depression: a systematic review." *Journal of Affective Disorders*, 147(1-3), 168-181.
7. **Overall Treatment Context:** It may help to outline that a collaborative treatment approach involving healthcare professionals, including primary care physicians, psychologists, or psychiatrists, is typically effective for managing depression.

By focusing on detailed evidence-based elements and integrating relevant references, the response can enhance its informative value, accuracy, and supportive foundation in addressing mild depression as measured by the PHQ-9.

# Part1\_Demonstration – 3 (with Langchain Semantic Search)

**Note: this is second level Langchain Semantic Search response from LLM gpt-4o-mini with use of Reflection and Langchain semantic search**

**Note: How the response changed to Questions using the context given for Langchain Semantic Search**

## Langchain Search Response

For a PHQ-9 Score of 6, which falls under the category of Mild Depression, the relevant questions to conduct a patient interview would be those associated with the PHQ-9 score of 5-9. While the specific questions are not provided in the context you shared, generally, the PHQ-9 includes questions that assess the following areas:

1. **Interest or Pleasure:** Over the last two weeks, how often have you been bothered by little interest or pleasure in doing things?
2. **Feeling Down:** Over the last two weeks, how often have you felt down, depressed, or hopeless?
3. **Sleep Issues:** Over the last two weeks, how often have you had trouble falling or staying asleep, or sleeping too much?
4. **Energy Levels:** Over the last two weeks, how often have you felt tired or had little energy?
5. **Appetite Changes:** Over the last two weeks, how often have you experienced changes in your appetite or weight?
6. **Self-Perception:** Over the last two weeks, how often have you felt bad about yourself, or that you are a failure or have let yourself or your family down?
7. **Concentration Problems:** Over the last two weeks, how often have you had trouble concentrating on things, such as reading the newspaper or watching television?
8. **Movement or Speech Changes:** Over the last two weeks, how often have you been moving or speaking so slowly that other people could have noticed? Or the opposite—being so fidgety or restless that you have been moving around a lot more than usual?
9. **Thoughts of Self-Harm:** Over the last two weeks, how often have you had thoughts that you would be better off dead, or thoughts of hurting yourself in some way?

These questions can help assess the severity and impact of the patient's symptoms related to mild depression. For the exact phrasing and any additional context-specific questions, you may need to refer to the full PHQ-9 questionnaire.

# Part1\_Demonstration – 4 (Response with both Reflection and Langchain Semantic Search)

Note: this is Final response from LLM gpt-4o-mini with use of Reflection and Langchain semantic search

Note: How the response changed to Questions using the context given for Langchain Semantic Search as well as Reflection

## Questions that can be leveraged for Patient Interview

Here's an improved version of the initial response, incorporating the suggested enhancements for clarity, accuracy, and relevance regarding managing mild depression as indicated by a PHQ-9 score of 6:

For a PHQ-9 score of 6, which falls within the category of **mild depression**, it's essential first to clarify that the PHQ-9 is a self-report questionnaire designed to assess the severity of depressive symptoms. The scoring ranges are as follows: scores from 0-4 indicate no depression, 5-9 indicate mild depression, 10-14 point to moderate depression, and scores of 15 or above reflect moderate to severe depression (Kroenke et al., 2001).

To conduct an effective patient interview related to a PHQ-9 score of 6, the following questions (derived from the PHQ-9) are relevant:

1. **Interest or Pleasure:** Over the last two weeks, how often have you been bothered by little interest or pleasure in doing things?
2. **Feeling Down:** Over the last two weeks, how often have you felt down, depressed, or hopeless?
3. **Sleep Issues:** Over the last two weeks, how often have you had trouble falling or staying asleep, or sleeping too much?
4. **Energy Levels:** Over the last two weeks, how often have you felt tired or had little energy?
5. **Appetite Changes:** Over the last two weeks, how often have you experienced changes in your appetite or weight?
6. **Self-Perception:** Over the last two weeks, how often have you felt bad about yourself, or that you are a failure or have let yourself or your family down?
7. **Concentration Problems:** Over the last two weeks, how often have you had trouble concentrating on things, such as reading the newspaper or watching television?
8. **Movement or Speech Changes:** Over the last two weeks, how often have you been moving or speaking so slowly that others could notice? Or conversely, have you been fidgety or restless?
9. **Thoughts of Self-Harm:** Over the last two weeks, how often have you had thoughts that you would be better off dead, or thoughts of hurting yourself in some way?

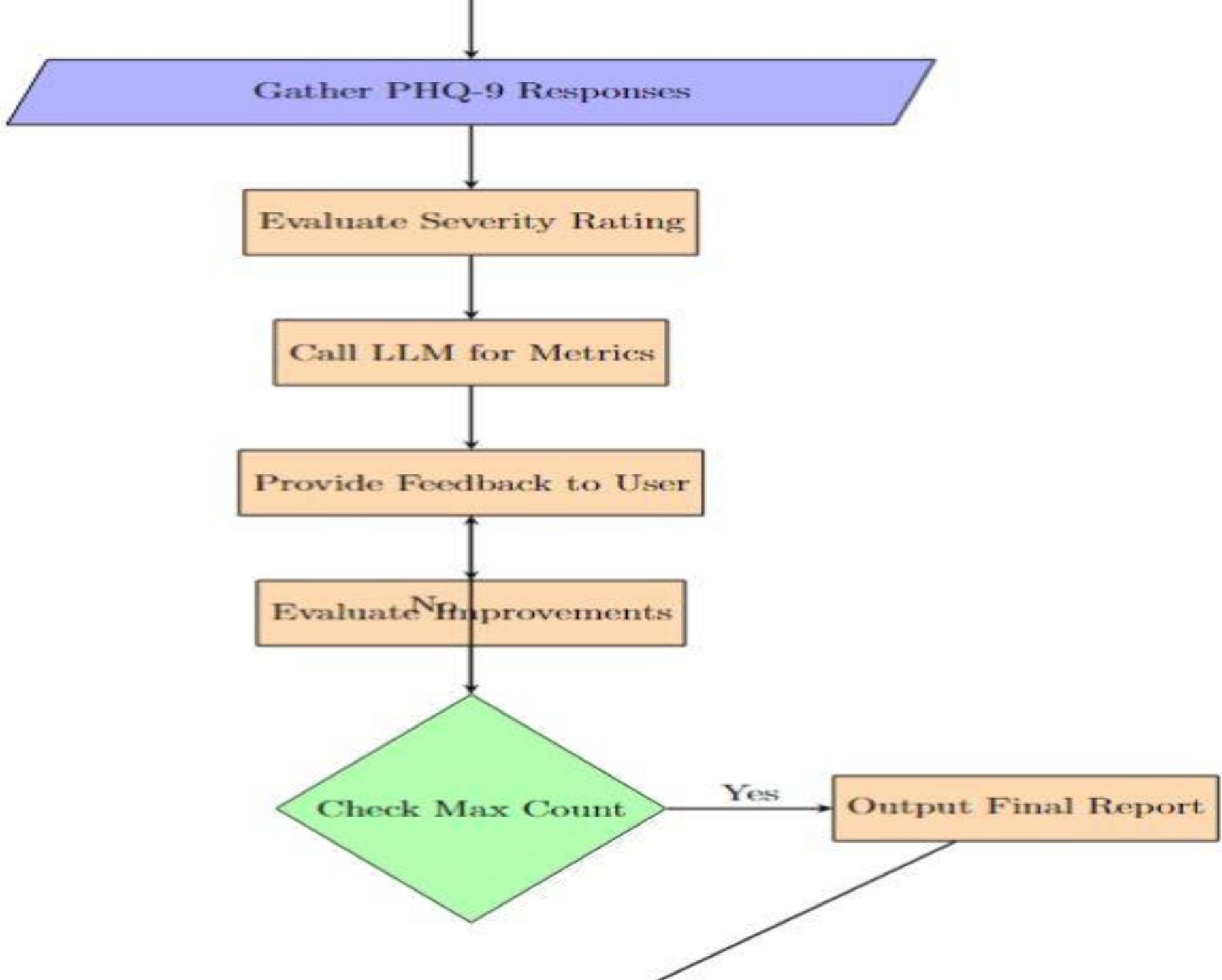
These questions can help assess the severity and impact of the patient's symptoms related to mild depression.

In addition to conducting the interview, it is important to consider various treatment modalities for managing mild depression:

1. **Psychotherapy:** Cognitive Behavioral Therapy (CBT) is highly endorsed, but other therapies, such as interpersonal therapy (IPT) or problem-solving therapy, can also be effective (Cuijpers et al., 2016).
2. **Lifestyle Modifications:** Engaging in regular physical activity has been shown to significantly improve mood and reduce depressive symptoms (Craft & Perna, 2004). Encouraging patients to incorporate exercise into their daily routine can be a beneficial strategy.
3. **Social Support:** Enhancing support networks is crucial, as social support significantly influences recovery from depression. Suggesting involvement in community resources or online support groups can foster this support (Hosseinpour et al., 2020).
4. **Medication Considerations:** While pharmacotherapy is often reserved for more severe presentations, it's crucial to discuss options should symptoms persist. This decision should involve evaluating the patient's history and the presence of any comorbid conditions (NICE Guidelines, 2022).
5. **Self-Help Resources:** Providing specific, validated self-help strategies can empower patients. Recommendations could include reputable mental health websites, self-help books, or online tools that promote coping skills and resilience (Richards & Richardson, 2012).
6. **Collaborative Approach:** A combined treatment approach involving healthcare professionals—such as primary care physicians, psychologists, or psychiatrists—typically yields the best outcomes for managing depression.

By integrating these comprehensive elements into care, the response enhances its informative value for addressing mild depression, offering a supportive and evidence-based foundation for patient management.

This revision aims to provide a thorough and nuanced overview of treating mild depression while clearly outlining the necessary elements of assessment and potential interventions.



## Summary

1. **User Initiation:** User shares feelings.
2. **Free-Form Text Input:** Chatbot processes input.
3. **Text Analysis:** OpenAI LLM analyzes input and provides a PHQ-9 severity score.
4. **Generate PHQ-9 Severity Score:** Output score and details.
5. **Provide Feedback to User:** Explain score and symptom details.
6. **Next Steps and Support:** Suggest further actions or resources.
7. **Follow-Up:** Offer additional help or resources.

This flow ensures the user receives a tailored assessment and support based on their free-form input, leveraging the capabilities of the OpenAI language model to provide a comprehensive evaluation.

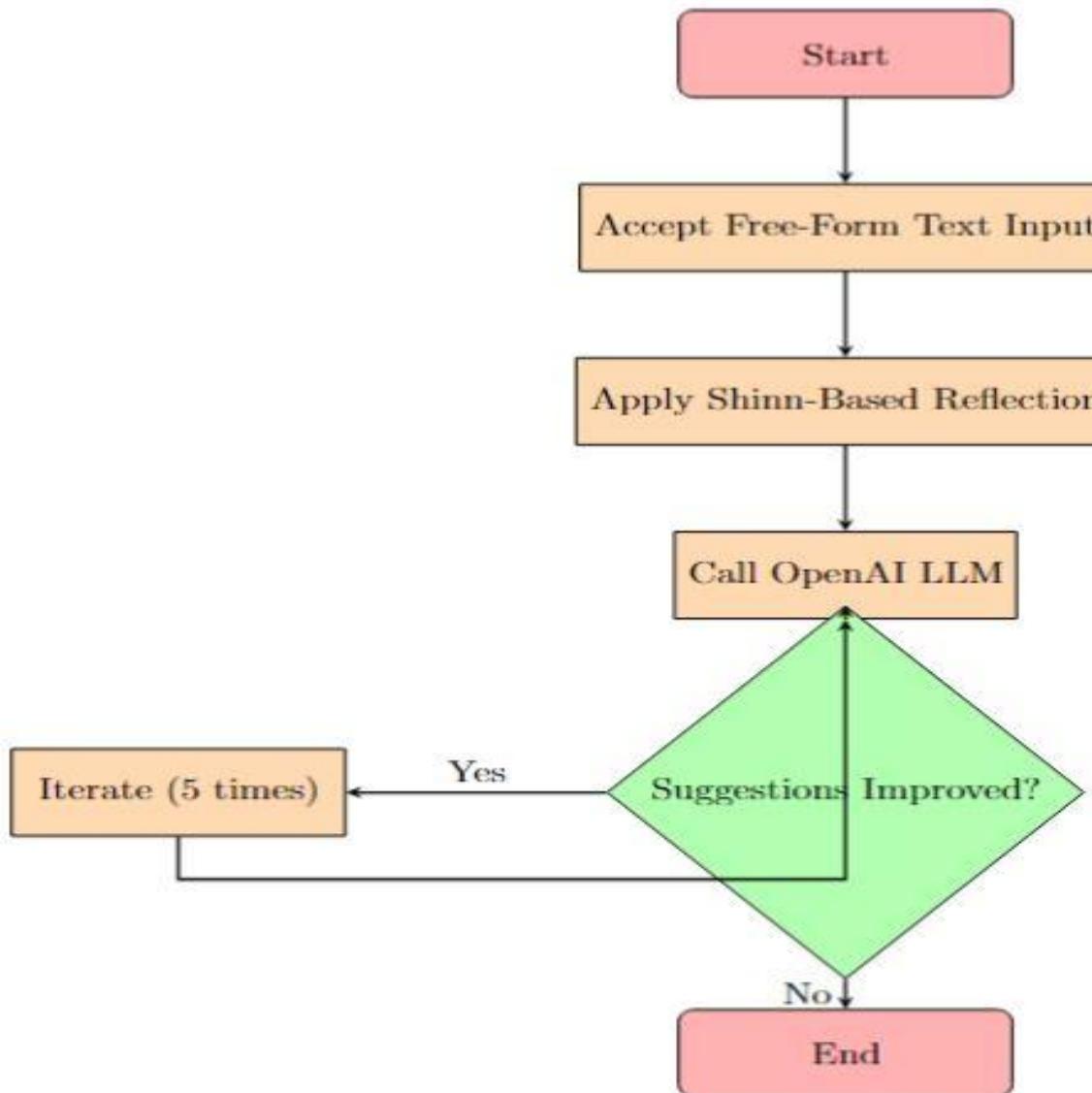


Figure 1: Flowchart for Part 3 of the Depression Chatbot: Accepting User Input, Applying Shinn-Based Reflection, Iterating for Improvement, and Calling OpenAI LLM.

## 6. Disclaimer

- 1. Lack of Professional Mental Health Expertise:** The chatbot has been developed by a team with no formal qualifications in mental health or clinical psychology. The advice and responses generated by this chatbot are based on algorithms, data analysis, and pre-defined programming rather than professional mental health expertise. As such, the information provided should not be considered as a substitute for professional mental health advice, diagnosis, or treatment. The creators and operators of this chatbot make no claims regarding the accuracy,



completeness, or efficacy of the information provided. Users are advised to exercise caution and seek guidance from licensed mental health professionals for any psychological or emotional issues. The chatbot's creators and operators accept no liability for any harm, distress, or adverse consequences that may arise from the use of the information or advice provided.

2. **Compliance with Legal Standards:** This chatbot has been designed to adhere to all applicable legal standards, including but not limited to country, state, county, city, religious institution (such as church or synagogue), and educational institution (such as school district) regulations. There is no intent to promote or engage in any unlawful activities through the use of this chatbot. However, users should be aware that legal standards can vary widely, and it is the user's responsibility to ensure that their use of the chatbot complies with the specific regulations and laws applicable in their jurisdiction. The chatbot's creators and operators do not guarantee compliance with every local law or regulation and disclaim any liability for issues arising from non-compliance.

3. **Content and Sponsorship:** The chatbot may include information or content generated from a variety of sponsoring organizations, such as health providers, hospitals, medical schools, or other related entities. While this content is intended to be helpful and informative, it may include promotional material or content generated for educational purposes. The chatbot is not intended for commercial activities, nor does it serve as an endorsement or recommendation of any particular product, service, or provider. The presence of such content does

not imply an endorsement or guarantee of any products or services, nor does it suggest that the chatbot or its creators are affiliated with any sponsoring organization. The content provided is for general informational purposes only and should not be used for commercial gain or to make decisions regarding specific health services or products.

## 7. Credits / References

1. Prof. Yang Sun – Course Material – Special Topic – GPT Applications
2. Brown, T. B., et al. (2020). Language Models are Few-Shot Learners. arXiv preprint arXiv:2005.14165.
3. Lewis, P., et al. (2020). Retrieval-Augmented Generation for Knowledge-Intensive NLP Tasks. arXiv preprint arXiv:2005.11401.
4. Nguyen, T., et al. (2021). Empathy in Chatbots: An Analysis of Conversational Strategies. Proceedings of the International Conference on Human-Computer Interaction.
5. Spector, A., et al. (2023). Advances in AI for Mental Health: Challenges and Opportunities. Journal of Mental Health Technology.
6. <https://getmarlee.com/blog/mental-health-chatbot>
7. <https://topflightapps.com/ideas/build-mental-health-chatbot/>
8. <https://magazine.sebastianraschka.com/p/finetuning-large-language-models>
9. [https://journals.lww.com/nursing/fulltext/2020/10000/assessing\\_mental\\_health\\_in\\_vulnerable\\_adolescents.12.aspx](https://journals.lww.com/nursing/fulltext/2020/10000/assessing_mental_health_in_vulnerable_adolescents.12.aspx)
10. Implementation / Development
  - Reflection Examples
    - <https://blog.langchain.dev/reflection-agents/>
    - <https://arxiv.org/pdf/2405.06682.pdf>
  - Langchain Semantic Search
    - [https://github.com/venuv/langchain\\_semantic\\_search](https://github.com/venuv/langchain_semantic_search)