

Ramavath Suresh

IIT Kharagpur

[ramavathsuresh@iitkgp.ac.in](mailto:ramavathsuresh@iitkgp.ac.in)

+919553563919

### **Chatbot Development Report**

The chatbot system, as implemented, begins by configuring access to Google's Generative AI services, utilizing an API key for authentication. Following this setup, it initializes the 'gemini-pro' pre-trained model for generating responses to user queries. For PDF parsing, the system leverages PyMuPDF and NLTK, employing the 'extract\_sentences\_from\_pdf' function to divide the text into individual sentences. Utilizing the 'all-mpnet-base-v2' sentence transformer model, sentences are encoded into embeddings, enabling semantic comparison based on vector representations. Vector database integration involves converting PDF sentences into embeddings and employing cosine similarity to identify semantically similar sentences. Within the chatbot framework, additional context is concatenated to user queries, enriching response generation. The system alternates between providing responses with and without this additional context, derived from nearest neighbor sentences extracted from the PDF, ensuring comprehensive and contextually relevant interactions, as demonstrated.

## System Setup

Dependencies:

google-generativeai for accessing pre-trained models.

PyMuPDF for PDF parsing.

NLTK for natural language processing tasks.

sentence\_transformers for generating and utilizing sentence embeddings.

Install the required libraries using pip:

```
pip install google-generativeai PyMuPDF nltk sentence_transformers
```

## Initial Knowledge Base

The chatbot's knowledge base consists of a pdf (Mark Zuckerberg Biography).

## System Architecture

1. **User Interface:** A simple console-based interface where users can input queries and receive responses.
2. **Query Processor:** Enhances user queries with additional context before passing them to the generative model.
3. **PDF Parser:** Extracts and tokenizes sentences from PDF documents to serve as part of the knowledge base.
4. **Sentence Embedding Generator:** Converts sentences from the PDFs into vector representations.
5. **Semantic Similarity Matcher:** Finds sentences in the knowledge base that are semantically similar to the user's query.
6. **Response Generator:** Utilizes a pre-trained model to generate responses based on the enhanced query.

### **Hallucination Mitigation Strategy:**

Integrates contextually relevant information from the knowledge base into the query.

Uses semantic similarity to ensure that the information being integrated is closely related to the user's query.

Limits the scope of the response generation to the context provided, reducing the generative model's tendency to extrapolate beyond the provided information.

### **Testing Methodology and Results**

#### **Results Summary:**

**Query 1:** Educational Institutions with Initial Access to 'Facebook'

#### **Gemini with Prompt:**

- Response: The educational institutions that initially had access to Facebook were:
- Harvard University
- Yale
- Dartmouth
- Stanford
- Columbia

**Relevance:** Highly relevant and comprehensive.

**Accuracy:** Provides specific educational institutions mentioned in the query.

#### **Gemini without Prompt:**

Response: Ivy League universities

**Relevance:** Partially relevant but lacks specificity.

**Accuracy:** Generalizes the answer to a broader category.

Query 2: Name of File-Sharing Program Introduced by Zuckerberg in 2004

**Gemini with Prompt:**

Response: Wirehog

**Relevance:** Highly relevant and accurate.

**Accuracy:** Provides the correct name of the file-sharing program.

**Gemini without Prompt:**

Response: Facemash

**Relevance:** Partially relevant but incorrect.

**Accuracy:** Provides an incorrect answer.

Query 3: Year Mark Zuckerberg Received the Person of the Year Title

**Gemini with Prompt:**

Response: 2010

Relevance: Highly relevant and accurate.

Accuracy: Provides the correct year.

**Gemini without Prompt:**

Response: 2008

**Relevance:** Partially relevant but incorrect.

**Accuracy:** Provides an incorrect year.

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Welcome to the Chatbot console!

You can start chatting. Type 'exit' to quit.

You: Which educational institutions initially had access to 'Facebook'?

Gemini\_withprompt: The educational institutions that initially had access to Facebook were:

- Harvard University
- Yale
- Dartmouth
- Stanford
- Columbia

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Gemini\_withoutprompt: Ivy League universities

You: What was the name of the file-sharing program introduced by Zuckerberg in 2004?

Gemini\_withprompt: Wirehog

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Gemini\_withoutprompt: Facemash

You: In which year mark got the person of the year title ?

Gemini\_withprompt: 2010

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Gemini\_withoutprompt: 2008

You:

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## **Insights and Challenges**

**Contextual Relevance:** Ensuring responses were not only accurate but contextually relevant to the user's query was challenging. Fine-tuning the similarity threshold and embedding strategies was crucial.

**Performance Optimization:** Processing large PDFs and generating embeddings in real-time introduced latency. Implementing caching and optimizing the PDF parsing process may mitigate this.

**Hallucination Mitigation:** While improvements were made, completely eliminating inaccurate generative responses remains a challenge. Continuous monitoring and iterative refinement of the mitigation strategy are necessary.