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Retrieval-Augmented Generation (RAG) Based Artificial Intelligence (AI) Chatbots: A Case Study of St. Nicholaos

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Abstract

Large language models (LLMs) have paved the way for making AI-related tools accessible to ordinary users. A vast number of users benefit from LLMs using generative pre-trained transformers (GPTs). GPTs help create content, translate languages, integrate agents into daily tasks, and handle specific queries. GPTs usually operate in a chatbot format and enable users to interact with them easily without requiring advanced computer skills. They can process text, voice, and image data.

Currently, millions of people interact with chatbots to meet their specific needs, and the tourism industry has recently begun to emphasize their capabilities. Individual businesses and corporate companies use AI-powered chatbots to answer user inquiries, such as product comparison, price checking, route planning, or providing on-site feedback. However, there is a need for refinement in these chatbots. (1) Chatbots rely on pretrained datasets; therefore, their information may not always be up-to-date. (2) Chatbots are trained for general-purpose tasks, which means that they cannot perform well in domain-specific queries such as cultural heritage, food and beverages, or history of places.

This study adopts a retrieval-augmented generation (RAG) approach to open-source chatbots, which have great potential for revising and increasing their information capacity. RAG implementation highlights that ordinary chatbots struggle to answer questions regarding the St. Nicholaos and St. Nicholaos Church in Demre. Accordingly, a well-trained chatbot can answer specific questions more accurately and reduce the occurrence of hallucinations.

Keywords: Artificial ıntelligence, chatbots, cultural heritage, St. Nicholaos

1. Introduction

LLMs simply construct probabilistic responses for the user based on the text in their training data (Marr, 2024). These texts mostly depend on internet data and yet are prone to hallucination or false information. According to Huyen (2024), hallucination and inconsistencies are related to the probabilistic nature of AI. While inconsistencies occur when the model generates very different responses, hallucination refers to responses that are not grounded in facts (Huyen, 2024). Therefore, modern LLMs such as ChatGPT, Gemini, Llama, Claude, Mistral, Grok etc. are being used by millions of people in a day, yet they still provide false answers to users without even noticing them (Hsu, Tan & Stantic, 2024; Kırtıl, Çizel, Uzut & Uzun, 2024).

Three approaches are recommended to help foundation models respond more effectively to user queries: *Prompt engineering*, *fine-tuning* and *RAG* (Huyen, 2024). Prompt engineering is the process of optimizing input prompts to clarify the user's intent to the LLM (Ekin, 2023). Prompt engineering can be considered the first stage of interaction between the user and the LLM. The user should prefer a brief, concise and clear language while chatting with the foundation model. For example, the earlier versions of ChatGPT, such as GPT-3 was trained

only on text data, so the user should not expect knowledge about the physical world from it (Kublik and Saboo, 2022).

Fine-tuning requires the most technical knowledge and time among the three techniques. It requires machine learning skills because it is about model training. Fine-tuning involves training the LLM on a smaller, task-specific dataset (Özdemir, 2024). If the LLM has behavioral response problems, fine-tuning is recommended; simply, it is for form (Huyen, 2024). If the model works well but lacks information, RAG can help the model access relevant and necessary information (Huyen, 2024).

Table 1. Pros and Cons of RAG. (Adapted from Liu et al., 2023; Borgeaud et al., 2021; Gao et al., 2023)

Advantages of Using RAG	Challenges of Using RAG
Uses User's Specific Data (Customizable)	Two-Step Process (Complex)
Always Updatable	Possibility of Finding the Wrong Document (Retrieval Inaccuracy)
Reduces Hallucination	Potential for Slower Responses
Provides Citations	Context Length Limitations (Memory)
Cheaper & Faster (than Finetuning)	Requires Maintenance

The most critical contemporary problems about LLMs are the up-to-date information and context-specific tasks. Users struggle when they ask specific questions, or the LLM simply hallucinates. Specifically, the tourism and travel related LLMs need to be updated regularly, and the necessary information could be provided to the models via RAG. RAG can help the model to retrieve the necessary text, image or video-based information from a database. This database could be a separate domain, or basically could be located in the database of the provider.

2. Materials and Methods

This study prefers a RAG implementation to an open-source LLM. Open-source models allow users to intervene in the model and help enhance its response capabilities. We selected OpenAI's 'gpt-oss-20b' model as the foundational model and used AnythingLLM software for the interaction between user and chatbot.

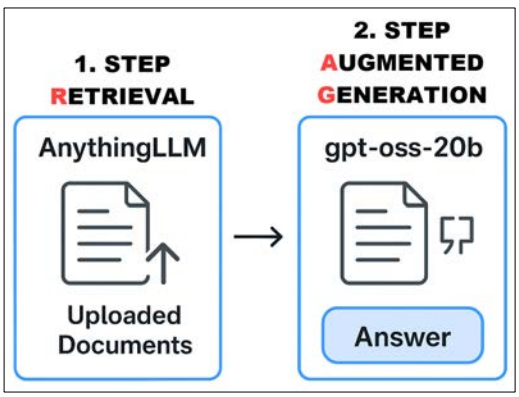


Figure 1. RAG Process Steps of the Study

The system prompt given to the chatbot was to behave like a travel chatbot: *"You are a travel chatbot designed for the tourism industry. You respond in Turkish or English languages based on the user's message. Speak in a warm and friendly tone, like a well-informed local guide. Your answers should be clear, detailed, and welcoming, but not overly academic or formal. For domain-specific questions look for the RAG-context."*

Our context was St. Nicholaos, which is located in Demre, Antalya, Türkiye. St. Nicholaos is a historical figure, and his church is a well-known cultural heritage site located in Demre. Domain-specific information from textbooks and local guides was carefully compiled, and a document of Questions and Answers was provided to AnythingLLM and stored in the vector database of the software.

3. Findings and Discussion

The findings indicate that the implementation of RAG increases the response accuracy of the chatbots. The same questions were asked to the models, and it was observed that the travel chatbot responded differently to these queries. The queries concerned several domain-specific questions regarding St. Nicholaos, a saint who once lived in Demre, Antalya, Türkiye.

Figures 2 and 3 depict questions about St. Nicholaos and the ancient harbour. It was seen that the chatbot without RAG says that there is no information about the topic (Figure 2a), and RAG-implemented chatbot highlighted the connection between Nicholas and the ancient harbour (Figure 2b).

Figure 3a and Figure 3b demonstrate the second query presented to the travel chatbot. The plain chatbot's response illustrates a clear example of hallucination (Figure 3a).

It provided an incorrect location for the church and an irrelevant narrative. On the other hand, Figure 3b gave an accurate answer regarding the user query. It gave the location and the story of the plakoma in correct and concise format. When more domain-specific questions were asked, the RAG-powered chatbot provided more accurate answers as long as the relevant information was present in its RAG context.

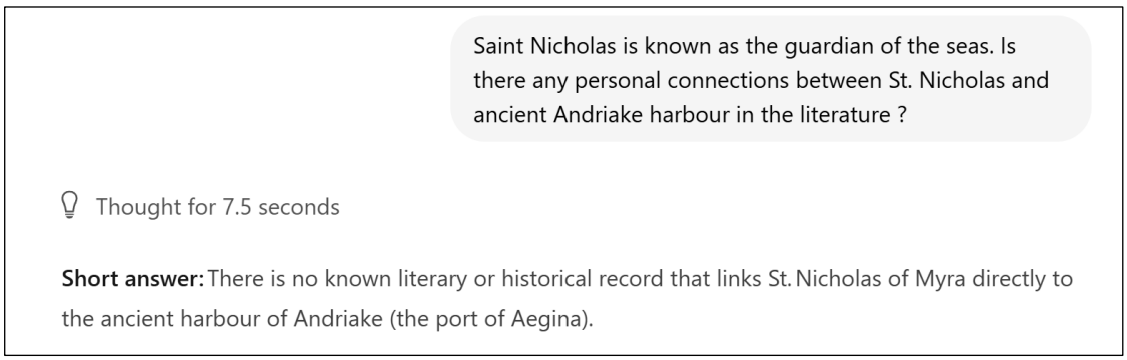


Figure 2a. Chatbot Answer Without RAG

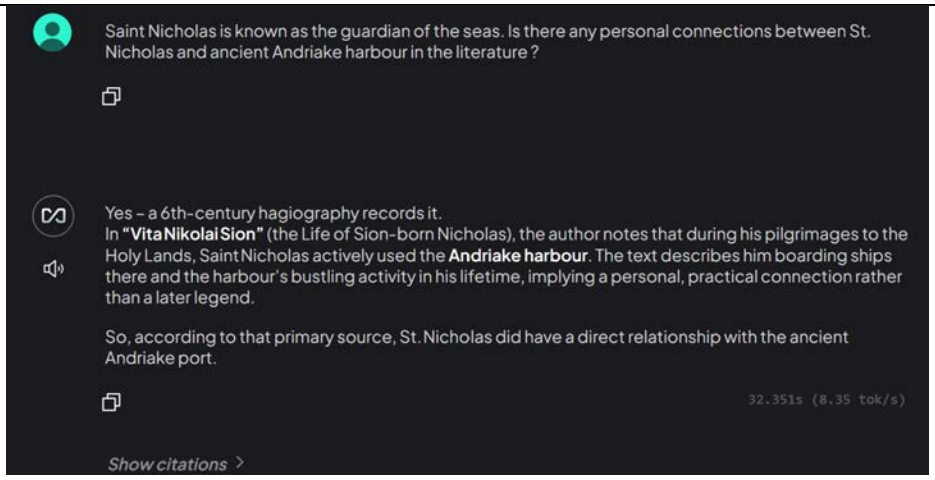


Figure 2b. Chatbot Answer With RAG

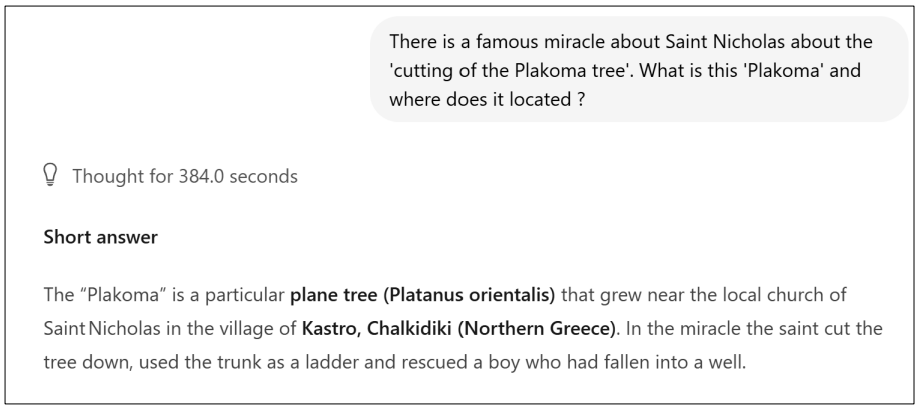


Figure 3a. Chatbot Answer Without RAG

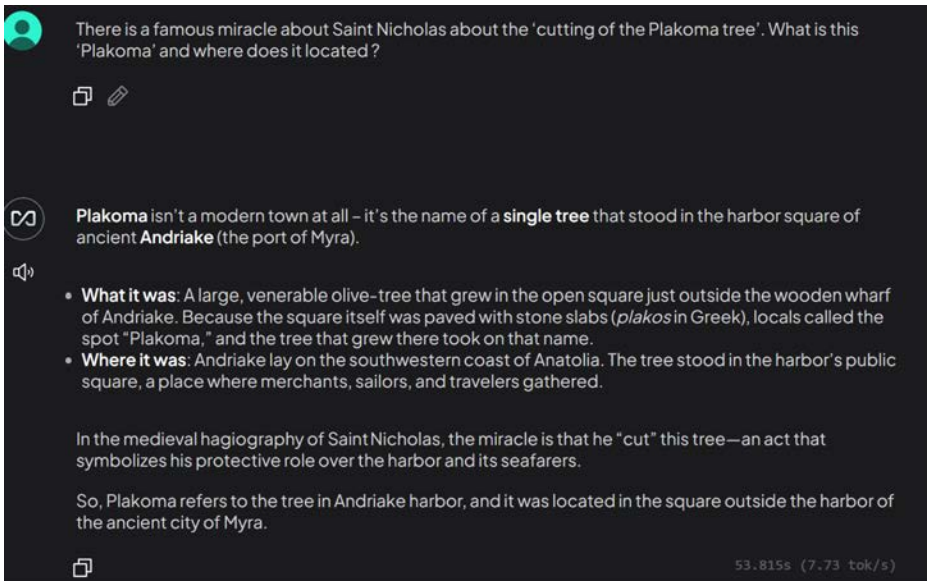


Figure 3b. Chatbot Answer With RAG

4. Conclusion and Recommendations

This study shows that RAG implementation significantly enhances the reliability of AI chatbots in tourism & travel contexts. Compared to the baseline model, the RAG-powered chatbot produced more accurate, consistent, and domain-specific answers regarding St. Nicholaos and the historical Demre region.

The findings underline key limitations of standard LLMs, especially their tendency to hallucinate when confronted with niche historical or cultural queries. This situation is apparent even in the most well-known and reputable chatbots. RAG mitigates these issues by enabling access to verified external sources, making it a useful tool for tourism professionals such as travel agencies, local tourist guides, and tour operators.

The study suggests broader integration of RAG-supported systems in destination marketing, cultural heritage interpretation, and tourism information services. Future research may test user experience, multimodal data integration (audio or video), and automated content updating to maximize the practical value of AI in tourism. AI-related tools are rapidly evolving, but their implementation with local tourism information needs to be followed up precisely.

Thanks and Information Note
The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study. All authors contributed equally to the article

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