Разработка на прототип на чатбот, базиран на RAG, за административна помощ в образователните системи

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A RAG-Based Chatbot Prototype for Administrative Support in Educational Systems

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Abstract:

Artificial Intelligence (AI) is rapidly transforming educational environments, with increasing attention from both users and institutional authorities. In this context, an intelligent chatbot is proposed to support administrative tasks in schools and educational institutions. The system is designed to deliver fast and accurate responses to queries related to regulations, guidelines, and curricula, relying exclusively on official documents and authoritative sources.

The solution is based on a Retrieval-Augmented Generation (RAG) architecture, integrating document retrieval with language model–driven response generation. It supports multiple document formats, including PDF, Word, and scanned files through Optical Character Recognition (OCR). The prototype is implemented using .NET and Visual Studio, with the flexibility to operate using either local AI models or cloud-based solutions, and can be deployed both locally and on platforms such as Azure.

The proposed approach aims to improve administrative efficiency, streamline workflows, and ensure reliable access to up-to-date regulatory information. The expected outcome is a web-based chatbot providing responses grounded in official documentation and supported by appropriate citations.

Keywords: artificial intelligence, chatbot, large language models, education

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INTRODUCTION

Administrative processes in modern organizations and educational institutions often involve large amounts of unstructured data, including PDF files, Word documents, Excel spreadsheets, scanned materials, regulations, and internal guidelines. Retrieving information from these heterogeneous sources is frequently performed manually, which is time-consuming, inefficient, and prone to human error [1, 2]. The lack of centralized access to administrative documentation can further complicate communication and delay everyday operational tasks.

Intelligent chatbot systems have emerged as a promising solution for improving information accessibility and automating administrative support processes. By combining natural language interaction with advanced retrieval mechanisms, chatbots can provide fast and context-aware responses to user queries, improving efficiency and reducing repetitive manual work [3]. Such systems are especially valuable in educational environments, where access to accurate and up-to-date information is essential for students, teachers, and administrative staff.

While many chatbot solutions rely on cloud-based AI services, educational institutions often require closed-domain systems in which knowledge is restricted to official documents to ensure data privacy and regulatory compliance [4]. This motivates the development of a RAG-based chatbot prototype, implemented as a .NET API, capable of integration into educational platforms and serving as a centralized knowledge access point.

CHATBOT PROTOTYPE FOR ADMINISTRATIVE SUPPORT

Educational institutions operate with a large volume of administrative documentation, including regulations, curricula, internal policies, and procedural guidelines. Accessing this information efficiently is essential for both staff and students, yet traditional methods rely heavily on manual search and fragmented data sources.

The proposed chatbot prototype addresses this challenge by providing a centralized and structured mechanism for accessing institutional knowledge. By consolidating heterogeneous document formats into a unified knowledge base, the system enables faster and more consistent retrieval of information [2, 5]. A key characteristic of the solution is its closed-domain design, which ensures that responses are generated exclusively from approved and institution-specific documents. This approach minimizes the risk of misinformation and aligns with data protection requirements in educational environments [4].

The system is further designed as a RESTful API, allowing seamless integration with school websites, administrative portals, and other digital platforms. In addition, it supports automated document processing, including scanned materials through OCR, ensuring comprehensive coverage of available information sources [6]. Recent studies highlight that successful adoption of AI systems in education depends not only on functionality but also on trust, transparency, and ease of access, all of which are addressed by the proposed approach [10].

The chatbot prototype is implemented using ASP.NET Core, a modern framework that provides flexibility, scalability, and ease of integration with external systems and services. The use of ASP.NET Core allows the system to support cross-platform deployment and modular development, making it suitable for integration into different educational and administrative environments. In addition, the framework enables efficient handling of HTTP requests and supports the development of secure and maintainable RESTful APIs. The system follows a layered architecture, where user queries are processed through an HTTP interface and routed to dedicated components responsible for document ingestion, knowledge storage, retrieval, and response generation. This separation of functionalities improves maintainability and allows individual modules to be independently updated or extended without affecting the overall system operation.

At the ingestion stage, documents in formats such as PDF, Word, Excel, and scanned text are processed and transformed into machine-readable text. This information is stored in a knowledge base that combines textual content with vector embeddings, enabling both keyword-based and semantic search capabilities. The query engine retrieves relevant document fragments using a hybrid search approach and forwards them to a local language model, which generates context-aware responses. This design ensures that answers remain grounded in the underlying documents, reducing the likelihood of hallucinations. The modular structure allows individual components to be independently extended or replaced, supporting future improvements. Such architectural decisions are consistent with contemporary frameworks for AI chatbot systems in educational environments, which emphasize modularity and domain-specific control [9].

Document processing is a critical step in ensuring the quality and reliability of the system. Structured documents, including PDF, DOCX, and XLSX files, are parsed using

established libraries, enabling accurate extraction of textual information. For scanned or image-based documents, the system employs Optical Character Recognition (OCR) techniques to convert visual content into text [6]. The extracted data is then normalized and transformed into semantic embeddings, which facilitate advanced retrieval mechanisms beyond simple keyword matching [7]. This process ensures that all relevant information, regardless of its original format, becomes accessible through the chatbot interface. The system implements a Retrieval-Augmented Generation (RAG) approach, combining information retrieval with language model–based answer generation [4]. Initially, relevant document segments are identified through a hybrid search mechanism that integrates keyword-based indexing with semantic vector search [7].

These retrieved fragments are then provided as context to a local language model, which generates responses that are both coherent and grounded in the source material. This significantly improves answer accuracy and reduces the risk of generating unsupported or incorrect information. Such hybrid retrieval strategies are widely recognized as an effective approach for domain-specific question-answering systems, particularly when working with unstructured data [8].

The chatbot utilizes local large language models for response generation, enabling secure and efficient processing without reliance on external cloud services. This approach ensures that sensitive institutional data remains within the organization, which is particularly important in educational contexts. In addition to enhancing data security, local deployment reduces operational costs and allows tighter integration with the system architecture. However, it also requires careful consideration of model capabilities, as smaller local models may have limitations compared to large-scale cloud-based alternatives [8]. Despite these constraints, the use of retrieval-based context significantly improves the reliability of generated responses, making the approach suitable for administrative support scenarios.

The API-based design of the system enables flexible integration with various educational platforms, including school websites, administrative systems, and internal portals. Through standardized endpoints for document management and query processing, the chatbot can be easily incorporated into existing digital infrastructures. This flexibility supports different deployment scenarios, including local installations within institutional networks or cloud-based hosting solutions. Such adaptability is essential for addressing the diverse technological capabilities of educational institutions [9].

The proposed RAG-based chatbot prototype offers several key advantages. It ensures data privacy through its closed-domain design, provides high-quality responses by combining semantic search with language models, and supports integration across multiple platforms through its API architecture. Furthermore, the modular design allows for future extensions, such as the inclusion of additional document types or improved language models. These characteristics make the system a practical and scalable solution for administrative support in educational environments.

Despite its benefits, the system faces several challenges. OCR accuracy can affect the quality of extracted text, particularly for low-quality scanned documents [6]. Additionally, local language models may have limited performance compared to larger cloud-based models, which can impact response quality in complex scenarios [8]. Scalability is another consideration, as large document collections require efficient

indexing and storage strategies. Finally, user trust remains a critical factor, as successful adoption depends on the perceived reliability and transparency of the system [10].

CONCLUSIONS

A RAG-based chatbot prototype designed to support administrative processes in educational systems. By combining document processing, semantic retrieval, and local language models, the system provides a secure and efficient solution for accessing institutional knowledge.

The proposed architecture enables integration with existing platforms, supports real-time knowledge updates, and ensures that responses are grounded in official documentation. These characteristics make the system a promising approach for improving administrative efficiency and information accessibility in educational environments, in line with current research on AI chatbot adoption and design [9, 10].

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