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A SYSTEM FOR PERSONALIZED BOOK RECOMMENDATIONS BASED ON THE ANALYSIS OF USER ACTIVITY AND TEXT PREFERENCES

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Abstract. This paper presents a personalized book recommendation system that generates suggestions based on a user's reading history and semantic analysis of textual preferences. Unlike conventional genre-based approaches, the proposed system captures implicit preferences by identifying thematic patterns in previously read works and modelling user behavior over time. The system architecture is based on a fine-tuned LLaMA 3.2 language model combined with retrieval-augmented generation (RAG) to dynamically construct query context. Evaluation was conducted on a proprietary dataset of 100 literary works spanning 10 genre categories. Testing results indicate that recommendation accuracy improves as user history accumulates. The system is applicable in educational settings for navigating library collections, including sports universities and sports boarding schools, where students require access to specialized methodological and training literature.

Keywords: recommender systems, personalization, text analysis, language models, retrieval-augmented generation, LLaMA, user history, fiction literature, field of sports.

Introduction. A decline in young people's interest in reading is being observed worldwide. According to the National Literacy Trust, in 2023 only 43% of children and adolescents aged 8 to 18 said they enjoyed reading in their free time, which is the lowest figure recorded in 18 years of data collection [1]. According to the U.S. National Center for Education Statistics, in 2023 only 14% of 13-year-olds read for pleasure almost every day, down from 27% in 2012 [2]. One reason for this trend is competition from digital content, which offers an instant and personalized experience. [10] Book services generally do not provide this level of personalization. This issue is particularly relevant in specialized fields such as sports.

Most existing platforms base their recommendations on genre filters and aggregated ratings. This approach does not take into account the reader's individual preferences and often yields popular but irrelevant results. Meanwhile, research in machine learning shows that systems based on user behavior history and semantic content analysis can provide more accurate recommendations [3] [9].

In recent years, hybrid recommendation systems based on large language models have been actively developed [11]. At the NIPS 2023 conference, the CORE system with a dialogue agent for personalized recommendations was presented, and at NAACL 2024, the InteRecAgent system, which combines an LLM with an interactive interface, was introduced [4]. According to recent research, hybrid approaches combining RAG with fine-tuned models are among the most promising strategies for personalization tasks [5].

The aim of this study is to develop and test a personalized book recommendation system that generates a selection based on the user's reading history and semantic analysis of the text. This paper describes a system that generates personalized book recommendations based on a user's reading history and semantic analysis of the textual characteristics of literary works. The system is implemented as a microservice application with a natural language interface and has been tested on a proprietary fiction dataset.

Materials and ethods. The study was based on a manually curated dataset of fiction compiled by the author. It included 100 works, primarily young adult fiction and classic literature, divided into 10 genre categories: horror, mystery, science fiction, thriller, detective fiction, fantasy,

historical fiction, young adult fiction, adventure, and others. For each work in the dataset, the following are recorded: title, author, genre, summary, and full text in EPUB or PDF format. The limited sample size is due to the pilot nature of the study, which is aimed at testing the personalization algorithm rather than at industrial-scale deployment of the system.

The system is implemented using a microservices architecture. The server-side is built on the FastAPI framework using the Uvicorn web server and data validation via Pydantic. PostgreSQL is used as the database with asynchronous access via the SQLAlchemy and Asyncpg libraries. The client-side is developed using React, and text rendering is implemented via EPUB.js and PDF.js (Figure 1).

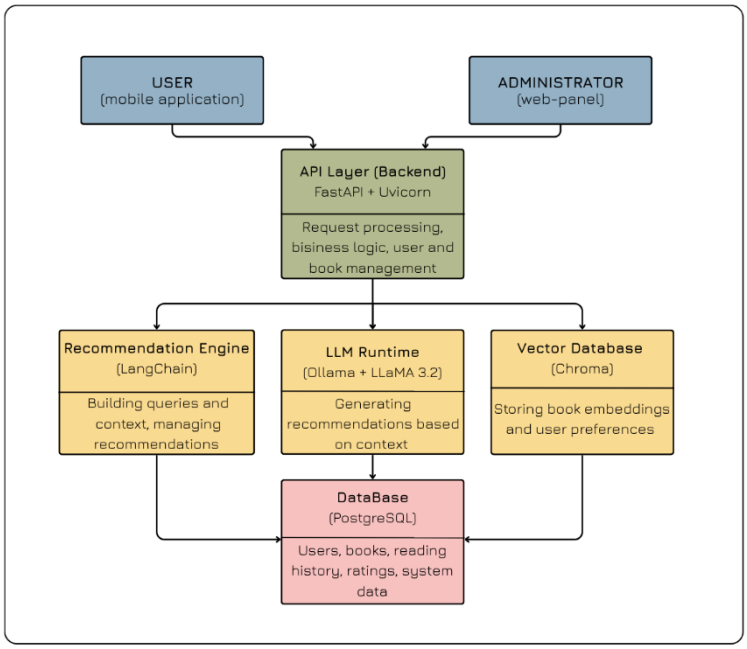

Figure 1. Diagram of a client-server architecture

A key component of the system is the LLaMA 3.2 language model, fine-tuned on a collected dataset using the Unsloth library and the Transformers and PyTorch frameworks [6]. User queries are processed through a LangChain-based RAG pipeline: vector representations of text from works and user preferences are stored in the Chroma database, from which the most relevant fragments are retrieved for each query based on vector cosine similarity [7] [12]. The semantic similarity between a user's profile and a work is calculated using the cosine similarity formula:

$$\text{sim}(A, B) = \frac{A \cdot B}{\|A\|\|B\|} \quad (1)$$

where A and B are vector representations of the book's text and the user's profile, respectively.

The user profile was generated as an average vector of embeddings from previously read works, calculated using the following formula:

$$U = \frac{1}{n}\sum_{i=1}^{n} e_i \quad (2)$$

where U is the vector of user preferences,
e_i is the vector representation of an individual work,
n is the number of books in the user's history.

The final response is generated locally via Ollama, which allows the model to run without calling external APIs. This architecture enables the system to take into account not only the user's current query but also their accumulated reading history (Figure 2).

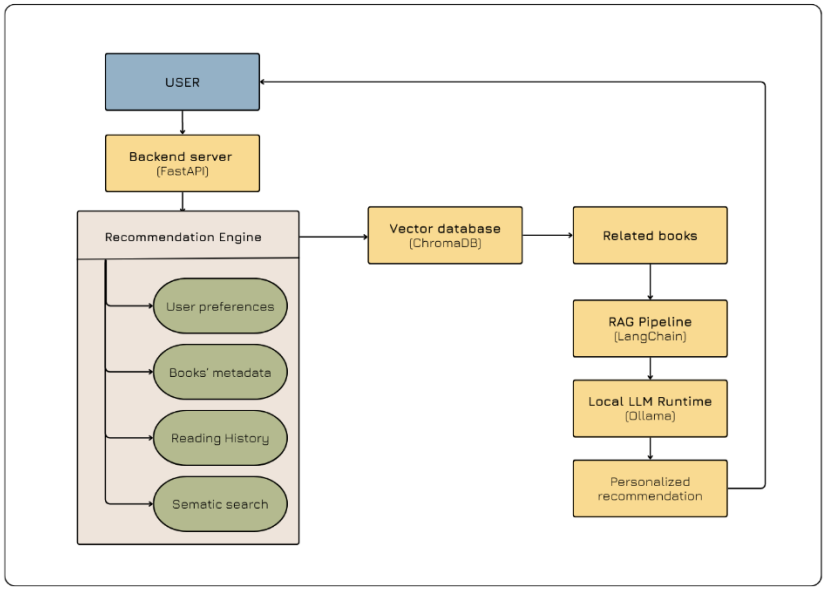

Figure 2. Diagram of the process for generating personalized book recommendations (RAG pipeline)

The system was tested using a test query method: participants formulated queries in natural language, specifying genre, mood, or themes. Participants then evaluated whether the recommendations they received met their expectations. Additionally, the system's ability to exclude from recommendations works containing elements deemed undesirable for a specific user—as identified based on their reading history—was tested.

The architecture of the system is domain-agnostic and can be adapted to specialized catalogs beyond fiction. In sports universities and sports boarding schools, where students and athletes work with a narrowly focused body of literature — training manuals, sports medicine references, and physical education methodology — the system can assist in navigating institutional library collections. The personalization mechanism functions identically regardless of subject domain, requiring only the corresponding dataset.

Results. During testing of the system by two users, three distinct usage patterns were identified, corresponding to different amounts of accumulated reading history (Table 1).

Table 1 – Comparison of recommendation modes based on reading history

Reading History Volume	**Recommendation Quality**
No reading history	Popular works are used
1–5 books	Partial personalization
10+ books	Stable personalized recommendations

Each of these stages is discussed in more detail below.

In the initial stage, when there is no reading history, the system returns the most popular titles from the dataset. This approach ensures that the service works from the very first visit without requiring users to fill out a profile in advance. As users log the books they've read and assign ratings, the system begins to take their accumulated preferences into account when generating recommendations.

During testing, the system was found to be capable of generating a profile of the user's implicit preferences (implicit profiling) based on reading history and thematic patterns in interactions with works [8] (Table 2).

Table 2 – Identified User Patterns

Identified Pattern	**Analyzed Signal**	**System Response**
Preference for dark atmosphere	Frequent interaction with thrillers, mystery, and horror genres	Increased weight of semantically similar works
Avoidance of romantic storylines	Lack of interaction with romantic plots	Reduced probability of similar recommendations
Interest in dynamic plots	Predominance of adventure literature	Recommendation of works with high plot intensity
Interest in young adult fiction	Repeated reading of young adult literature	Formation of recommendations with similar themes
Stable interest in a specific genre	Repeated selection of one genre	Strengthening of genre relevance

For example, if a user consistently avoided works with romantic storylines, the system excluded such books from recommendations even when the user searched for a broad genre (such as fantasy or adventure). This is due to the RAG mechanism: fragments that are semantically close to the user's profile rather than simply matching the request's genre tag are extracted from the Chroma vector database.

According to test participants, there was a trend toward increased recommendation relevance as the user's history grew. With a smaller history, the system had insufficient data for stable profiling. In the experiment, with a history of about ten books, the recommendations matched users' individual preferences in most cases. This trend is consistent with the general findings of research on hybrid recommendation systems.

A comparative analysis of existing platforms (Yandex Books, Litres, Stroki) showed that most of them offer recommendations based on genre classification or aggregated popularity, without taking into account the individual reading patterns of a specific user. The developed system differs in that it forms a preference profile dynamically that is, based on actual reading history and uses it as the primary context when processing a query.

The implementation of the proposed recommendation system in the field of sports education could improve access to specialized methodological and educational literature for students, coaches, and athletes. Personalized recommendations can simplify the search for information in the extensive library collections of sports universities and boarding schools by taking into account individual educational and professional interests. In addition, the use of semantic analysis and user activity history can help increase interest in reading and improve the effective use of educational resources in the field of sports.

The limitation of the current version of the system is the small size of the dataset, which currently consists of 100 works. When the number of suitable books runs out, the system begins to repeat previously suggested recommendations, which reduces its practical value during intensive use. Expanding the catalog to several hundred works will eliminate this limitation without changing the system's architecture.

Conclusion. This study developed a system for personalized book recommendations based on a hybrid approach: the combined use of a user's reading history and semantic analysis of the textual characteristics of literary works. The system was implemented in a microservice architecture using the LLaMA 3.2 language model and a RAG pipeline based on LangChain and Chroma.

Testing confirmed that the quality of personalization depends on the volume of the user's history: once a user had read at least ten works, the recommendations consistently matched individual preferences. The system also correctly accounted for implicit preferences, excluding unwanted thematic elements without explicit user instructions.

The main limitation of the current version is the size of the dataset. With intensive use, the system exhausts relevant options and begins to repeat recommendations. Expanding the catalog to several hundred works will eliminate this limitation without changing the architecture.

The developed approach is applicable in educational institutions, including sports academies and boarding schools, for navigating library collections, on thematic reading platforms, and in other services with a limited but well-structured catalog. Promising directions for the system's development include expanding the dataset, adding user ratings as explicit feedback, and testing the system on a broader audience.

ПАЙДАЛАНУШЫНЫҢ БЕЛСЕНДІЛІГІ МЕН МӘТІН ҚАЛЫПТАУЫН ТАЛДАУҒА НЕГІЗДЕЛГЕН ЖЕКЕШЕЛЕНГЕН КІТАП ҰСЫНУ ЖҮЙЕСІ

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Андатпа. Бұл мақалада пайдаланушының оқу тарихы мен семантикалық мәтін талдауына негізделген таңдау жасайтын жекелендірілген кітап ұсыныс жүйесі талқыланады. Қолданыстағы дәстүрлі тәсілдер жанрлық жіктеуге негізделгенімен, сипатталған жүйе жасырын қалауларды ескереді: бұрын оқылған шығармаларға тән тақырыптық үлгілер және пайдаланушының мінез-құлық үлгілері. Жүйе алынған мәтін үзінділеріне негізделген жауаптар үшін контекстті динамикалық түрде жасайтын іздеу-кеңейтілген генерация (RAG) әдісін қолдана отырып, қайта оқытылған LLaMA 3.2 моделіне негізделген. Жүйе 10 жанрлық санат бойынша таратылған 100 көркем шығармадан тұратын меншікті деректер жиынтығында сыналды. Тестілеу нәтижелердің дәлдігі пайдаланушының оқу тарихының көлемімен артатынын көрсетті. Жүйе білім беру мекемелерінде кітапхана қорлары бойынша навигация үшін, оның ішінде студенттер мен оқушылар мамандандырылған әдістемелік және оқу-жаттығу әдебиеттеріне қол жеткізуі қажет Спорт жоғары оқу орындары мен спорт интернаттарында қолданылуы мүмкін.

Түйінді сөздер: ұсыныс жүйелері, жекешелендіру, мәтіндік талдау, тілдік модельдер, RAG, LLaMA, пайдаланушы тарихы, көркем әдебиет.

СИСТЕМА ПЕРСОНАЛИЗИРОВАННЫХ КНИЖНЫХ РЕКОМЕНДАЦИЙ НА ОСНОВЕ АНАЛИЗА ПОЛЬЗОВАТЕЛЬСКОЙ АКТИВНОСТИ И ТЕКСТОВЫХ ПРЕДПОЧТЕНИЙ

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Аннотация. В статье рассматривается система персонализированных книжных рекомендаций, формирующая подборку на основе истории читательской активности пользователя и семантического анализа текста. Существующие традиционные подходы опираются на жанровую классификацию, в то время как описанная система учитывает неявные предпочтения: тематические паттерны, характерные для прочитанных произведений, и закономерности пользовательского поведения. В основе системы используется дообученная модель LLaMA 3.2 с применением метода retrieval-augmented

generation (RAG), при котором контекст для ответа формируется динамически на основе найденных текстовых фрагментов. Апробация проведена на собственном датасете, включающем 100 произведений художественной литературы, распределённых по 10 жанровым категориям. По результатам тестирования точность результатов возрастает с размером пользовательской истории чтения. Система может применяться в образовательных учреждениях для навигации по библиотечным фондам, в том числе в спортивных вузах и спортивных интернатах, где студентам и учащимся необходим доступ к специализированной методической и учебно-тренировочной литературе.

Ключевые слова: рекомендательные системы, персонализация, анализ текста, языковые модели, RAG, LLaMA, история пользователя, художественная литература.

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