AI Driven Shopping Assistant for Enhancing Personalization and Customer Engagement in E Commerce

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Abstract
The growing development of fashion e-commerce has presented challenges related to product discovery, customer engagement and personalized recommendations. This paper presents an AI-Driven Shopping Assistant that will use Natural Language Processing (NLP) and Recommendation Systems which will make the shopping experience more personalized. The Recommendation Engine uses vector similarity search algorithms and filters based on user profiling for providing highly personalized product recommendations. This assistant reduces the time-taking task of manual scrolling and filtering of products along with human-like interaction, which makes the shopping experience effortless and joyful. This prototype will facilitate human-like interactions and personalized recommendations, which will increase customer satisfaction and conversion rates.
Keywords: AI-based models, virtual shopping assistant, fashion e-commerce, prompt engineering, personalized recommendation.

1. Introduction

AI systems transform e-commerce into online shopping assistants. AI will serve as an example of automation in e-commerce, as these are applications that help customers in good relationship management with intelligent solutions. In order to work with the higher demands for efficiency and personalized shopping experiences, the apps are primarily based around natural language processing and machine learning techniques to enable customized recommendations to customers and possibly communicate with the chatbot at the same time [6].

Almost all shopping assistants, which use chatbots, provide two channels. These act like real humans and give assistance at the same time. It analyzes an individual user's preference and purchase history to reach its study targeted at giving recommendations effectively tying a user to a brand [1],[3]. These systems helped tremendously in drawing in new customers as they personalize each and every fashion item, wherein not only in clothes here come shoe personalization also [14].

Some unanswered questions remain about the problems of ensuring conversational quality, user trust, or even ethical issues such as privacy [4], [7]. Other concerns center on the significance of prompt engineering and flexibility in accepting or engaging these systems in different user environments [2], [5]. For future research opportunities, concepts, challenges and opportunities will be pursued in the area of sustainable business practices, where user engagement [12], [13] will also be considered.

This paper explores the sustainability of AI shopping assistants as online tools to improve consumer shopping experiences. The study was conceptually grounded in the development of the prototype of an AI shopping assistant and in the practical application of discussions that later took place within the research. It seeks to initiate further developments and broaden the understanding of the emerging e-commerce AI-enabled technology with new insights about existing trends.

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2. Related Work

Research investigates the shopping assistance provided by AI, which has received more attention improving the effectiveness of online shopping experiences. In [3],[16], author introduced intelligent conversational agents or NLP-based chatbots. These AI-empowered technologies, including recommendation engines and sentiment analysis, made a significant impact in the manner customer decision-making processes were followed and increased customer engagement and sales [12],[13]. Furthermore, [11] created an intelligent shopping assistant (ISA) to offer personalized recommendations, highlighting AI's revolutionary potential to completely change online shopping.

The development of chatbot architectures tremendously helps e-commerce by allowing interactive shopping experience with consumers. Studies demonstrated that conversation-driven approaches are needed for chatbot management to be implemented to improve customer interactions and reduce latency when responding to customer inquiries [4]. Again, it includes personalized algorithms that have been studied to find out how they affect consumers' attitudes and decisions in purchasing from AI-enabled virtual shopping assistants [9],[6].

Technological advancement from deep learning and NLP has facilitated the development of highly advanced chatbots that essentially deal with complex user queries and provide seamless recommendations as well [8],[7]. Prompt engineering has researched new ways of optimizing interactions driven by AI for more accurate and more relevant context responses [2],[5].

The next area of research in the sustainable business practices in fashion retails that deserves attention is the application of AI. [17] has shown how AI-related tools can further support sustainable measures through operational efficiency and customer satisfaction. Besides, a research study examined the role of chatbots in GenZ customer's acquisition experience and engagement [15] and also presents their dual potential of being friends and enemies in e-commerce. But then, when there are ethical concerns associated with data protection and consumer trust, further research and strong regulation framework development are quite in need [10], [18].

However, the literature suggests that AI shopping assistants will really revolutionize the whole ecosystem of creating and revolutionizing experience, personalization, and operational efficiency in e-commerce. Nevertheless, research is an ongoing process in which there is ongoing resolution of limitations still present and further need improvements in shopping experiences.

3. Proposed methodology

In the current scenario, all the fashion websites have extremely huge product database, which makes it difficult for the user to find the required product. It also limits the user to certain products, as they are not aware of the other available options. Also, there are people who are introverts and hence find offline shopping inconvenient due the constant presence of the salespersons beside them. To get over these limitations, we have proposed a prototype of an AI-Driven Shopping Assistant, using Gen-AI and Prompt Engineering, which will provide more personalized shopping experience to the users.

Fig.1 illustrates the conceptual framework of our prototype. At first, the data is collected from different fashion websites which is then stored in a relational database. This product data is displayed in user-friendly formats like lists and grids with information about the product description, image and price. The frontend displays this product list along with an interactive AI shopping assistant. This assistant processes real-time requests from the user to the backend. The backend uses Open AI Secret Key as environment variable for secure communication through chatbot and uses a Natural Language Processing model which helps in user profiling by collecting data such as user preferences, past shopping experiences, skin tone, constraints like price range, color and brand. After processing, the query is sent to Open AI's API, which provides personalized recommendations according to the user's requirement. In this research, all of the collected data is public data and used only for academic research purposes.

The Recommendation Engine uses vector similarity search algorithms and filters based on user profiling for providing highly personalized product recommendations. This assistant reduces the time-taking task of manual scrolling and filtering of products along with human-like interaction, which makes the shopping experience effortless and joyful.

Any references to skin tone or personal traits in the recommendation process are entirely optional and subjective to user input—these characteristics cannot and will not be inferred automatically. The system does not tie skin tone to rigid beauty ideals. Rather, it is intended to deliver a customizable and inclusive recommendation as a reflection of people's varied ideals and preferences. Regular monitoring and updates will be planned to track and mitigate any inadvertent algorithmic bias.

To address data privacy concerns, anonymous queries are processed and session-based inputs are used instead of persistent input. Also, storing of personal identifiers by the system is avoided. Environment variables are used to store Supabase and OpenAI API keys to assure better security.

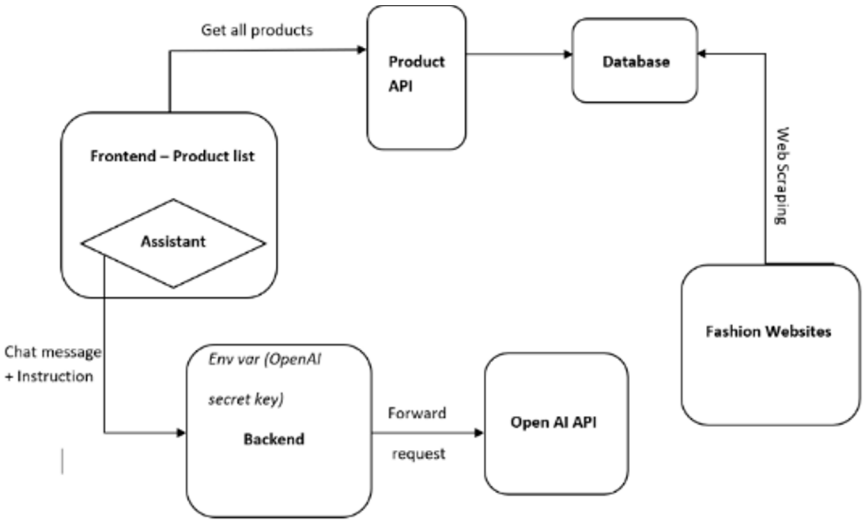

Fig.1 Conceptual Framework

4. Results and Discussion

Elements relevant to the business; the functions and outcomes as perceived by the users were assessed to evaluate how well the shopping assistant powered by A.I. has been implemented.

4.1 Implementation and Performance Analysis

The technology stack used for the implementation and performance analysis is Supabase, Next.js, React, and OpenAI's GPT models. The AI capabilities include machine learning and natural language processing for tailored suggestions. The implementation considered the following points:

- Decreased Choice Fatigue: AI-powered tailored recommendations.
- Improved Engagement: A conversational experience that is human-like.
- Better Discovery: Manual filtering is replaced by natural language search.

To quantify the contributions of various technologies, the following breakdown in Table 1 was determined:

Table 1: Technology Contribution Analysis

Technology	Usage	Percentage
Next.js (React Framework)	Used for the frontend, routing, and server-side rendering.	**30%**
React & JSX	UI components, state management (useState, useEffect), and hooks.	**20%**
TypeScript/JavaScript	Used for logic, API handling, and component interactions.	**15%**
Tailwind CSS	For styling and responsive design (container, grid, shadow-md, text-gray-600, etc.).	**10%**
ShadCN&Lucide Icons	UI components (Button, Input, Menu, MessageCircle, Send, Bot, etc.).	**5%**
OpenAI API (@ai-sdk/openai)	Used for chatbot AI assistant functionality (streamText, useChat).	**10%**
Supabase (PostgreSQL Database & API)	Fetching product details (fetch with Supabase API key).	**5%**
Markdown Parsing (React Markdown)	Used for formatting assistant responses.	**3%**
Next.js API Routes	Handles chat API requests (/api/chat).	**2%**

4.2 ROC-AUC Results for Model Effectiveness Analysis

The plotted ROC curves evaluate the classification capability of four models- Random Forest, Decision Tree, k-Nearest Neighbors (k-NN), and Gradient Boosting for predicting price ranges in our AI-driven shopping assistant.

Random Forest (Fig no. 2): Clearly the best, boasting AUC scores of 0.99, 0.85, and 0.83, appraised across all classes, hence showing great predictive power. Decision Tree (Fig no. 3): Moderate performance of AUC scores of 0.93, 0.74, and 0.70, signifying difficulty in differentiating price class categories. K- Nearest Neighbors (Fig no. 4): Comparatively lower AUC scores declared as 0.88, 0.68, and 0.67 and are said to be a lot weaker in classification, said to be highly sensitized towards the distribution of data. Gradient Boosting (Fig no. 5): Competitively placed with the best AUC for Class 0 at 1.00 and other classes 0.80 and 0.79, indicating very good price range classification.
In our AI assistant prototype, ensemble methods Random Forest and Gradient Boosting outperform the simpler model types, Decision Tree and k-NN, which make them better for price range classification.

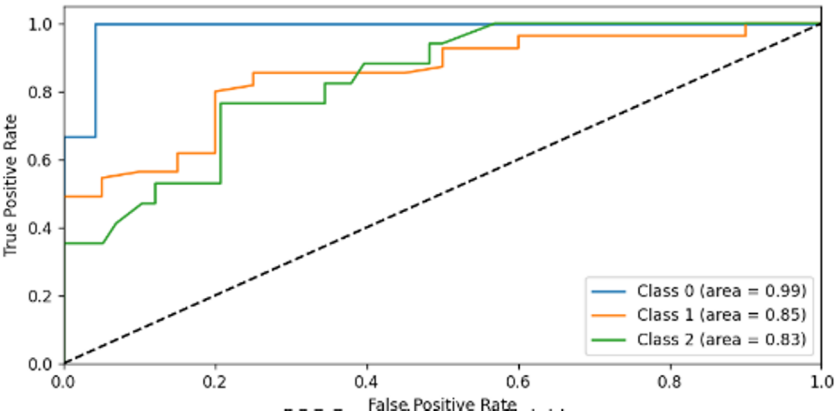

Fig. 2 Random Forest Classifier

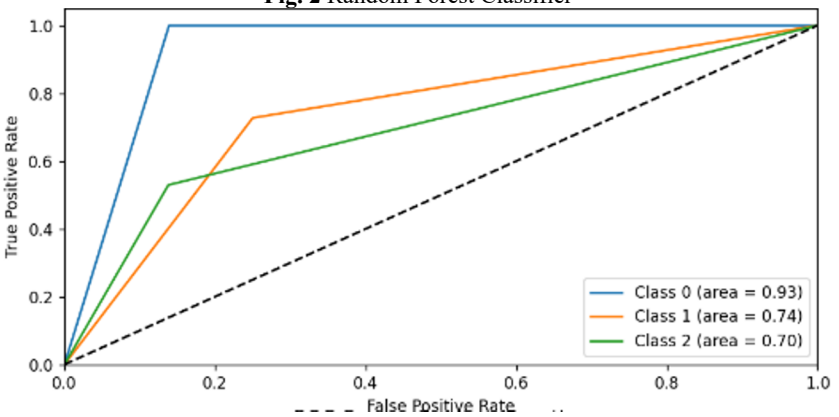

Fig. 3 Decission Tree Classifier

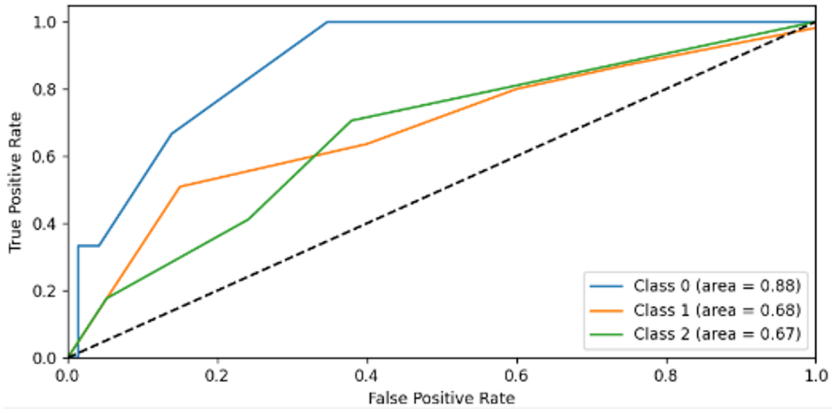

Fig. 4 K-Nearest Neighbors Classifier

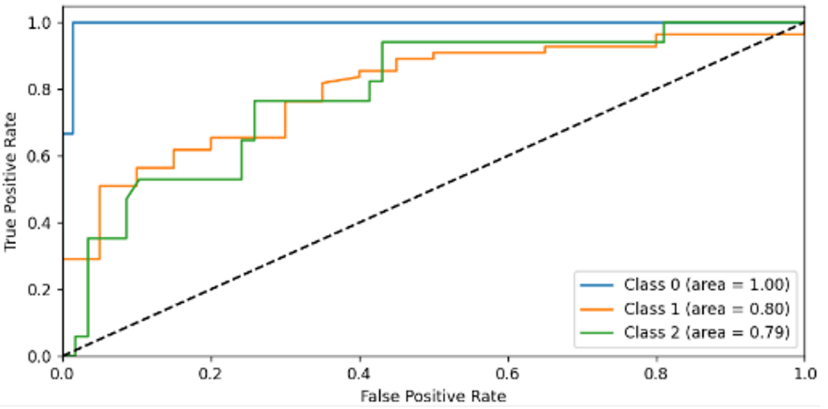

Fig. 5 Gradient Boosting Classifier

4.3 Trends in AI Technology for Shopping Assistants

The changeover from rules-based systems with the rise of deep learning (DL) in AI shopping assistants until the last decade has been graphically presented in Fig. no. 6. Rules-based approaches faded away with time (~10-15% by 2025); between that time, ML was at its top (~40%), increasing accuracy in recommendations. Deep-learning models have now reached a commanding position of ~60%, offering enhanced NLU and personalization. We extended the framework proposed in [19] to include LLMs (GPT-4o-mini) and real-time product recommendations. Our project abides by the trend in employing GPT-4o-mini for AI conversations and using Supabase for real-time recommendations, with improvements on the roadmap in multimodal search and AI fairness.

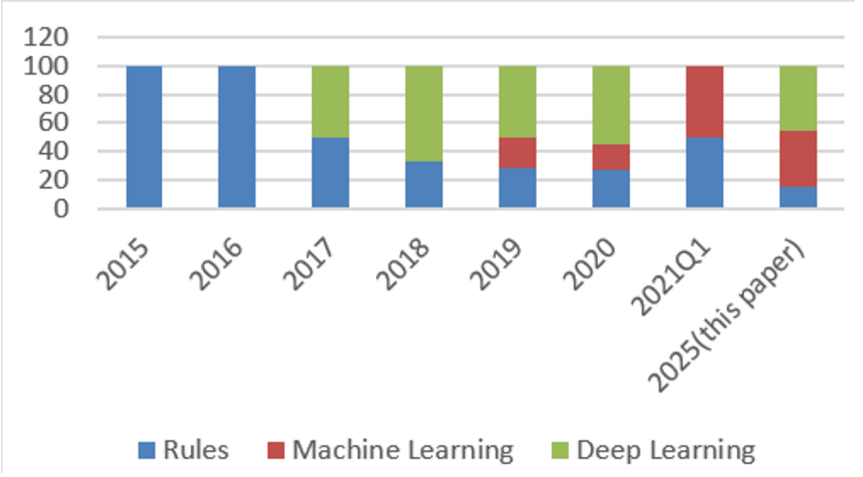

Fig. 6 Input processing/NLU approaches over time [19]

5. Conclusion and Future Scope

The AI Shopping Assistant will advance the entire e-commerce world by making product discovery simple, giving product suggestions, and improving user experience with NLP, OpenAI APIs, and Recommendation Systems. It makes search simple without using filters manually and for users who prefer less social interaction with salesperson. This boosts customer satisfaction and conversion rates.

Further extensions will involve multimodal interactions for voice and image search, real time tracking of user behavior, and user sentiment analysis for better recommendations. Contextual understanding will be enhanced as well as integration with Augmented Reality (AR) for virtual try-on and improved checkout experience. Most important for the virtual assistant will be the data privacy and security concerns while its evolving path to redefine the concepts of e-shopping using AI.

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