ML-Based Product Recommendation System Using Browsing History, Purchase Data, and Seasonal Trends

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Abstract — This paper presents the development of a machine-learning–based recommendation system that predicts and suggests products to users based on browsing history, purchase patterns, and seasonal buying trends. The system analyses user–item interactions, extracts meaningful behavioural features, and recommends products through similarity-based ML techniques. Seasonal demand is included to enhance prediction accuracy. The proposed model demonstrates that even a lightweight, interpretable ML approach can generate relevant and personalized product recommendations suitable for small e-commerce datasets.

Keywords: Recommendation System, Machine Learning, User Behavior Analysis, Product Recommendation, Similarity-Based Filtering, Seasonal Demand Analysis

I. Introduction

Online shopping platforms generate large volumes of user interaction data, including clicks, searches, page visits, and previous purchases. Recommendation systems process this data to deliver personalized product suggestions that improve user experience and increase business revenue. Traditional rule-based systems provide limited personalization, while modern machine-learning approaches offer higher accuracy by analysing user behaviour and item attributes.

This work proposes an ML-based recommendation engine that combines browsing history, purchase patterns, and seasonal trends to suggest relevant products. The method enhances real-world applicability, as seasonality greatly influences customer buying behaviour. The system implements similarity-based ranking to deliver recommendations through a simple and intuitive interface.

II. Related Work

Early foundational work on collaborative filtering was introduced by Resnick et al., followed by Sarwar et al. with item-based filtering. Hybrid systems combining collaborative and content-based methods were later studied by Burke to improve sparsity and cold-start issues.

Recent studies explore deep learning, sequential models, and context-aware recommendation techniques. Temporal user modelling and seasonal behaviours have also been emphasized in modern time-aware recommender systems.

This project adopts concepts from these works but implements a simplified hybrid approach suited for lightweight academic prototypes.

III. Methodology

A. System Architecture

The architecture consists of:

1) User Interface Layer: Captures browsing actions, clicks, and search queries.
2) Data Collection Layer: Extracts browsing history, purchase logs, and seasonal context.
3) Database Layer: Stores structured user and product information.
4) Feature Engineering Layer: Converts raw logs into features such as frequently viewed categories and time-based seasonal weights.
5) ML Recommendation Engine: Uses similarity matching, weighted scoring, and hybrid filtering logic.
6) Recommendation Delivery Layer: Displays ranked product suggestions to the end user.

B. Data Description

- Browsing history: clicked items, viewed pages
- Purchase history: previously bought products, categories
- Product catalog: price, category, description
- Seasonal data: month-wise buying patterns
- Interaction data: Wishlist items, cart activity

C. Model Logic

The recommendation score is computed using:

- Item similarity (category, keywords)
- User behaviour patterns
- Frequency and recency of interactions
- Seasonal demand weighting

The final ranked list is displayed to the user.

IV. Results and Discussion

The system generates personalized recommendations based on browsing patterns and past purchases. Users who frequently searched electronics were recommended related gadgets and accessories. Seasonal boosting improved relevance—for instance, winter wear was prioritized during colder months.

Although the system uses a small dataset and basic ML logic, results remained consistent across different user profiles. The interface effectively displayed recommended products, search history, and items added to the cart or Wishlist.

Limitations include reduced accuracy for new users and dependence on limited data. However, the lightweight design makes it suitable for academic and prototype applications.

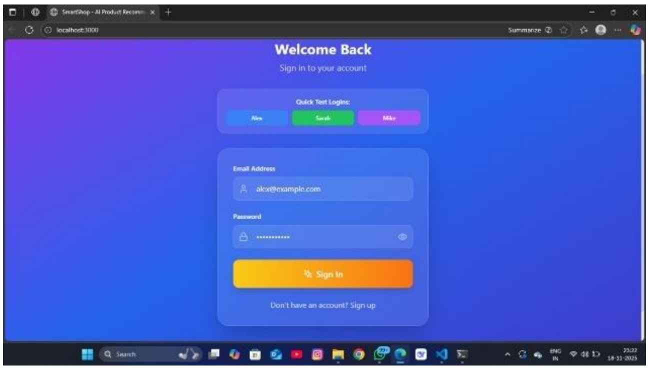

Fig. 1: Login Interface

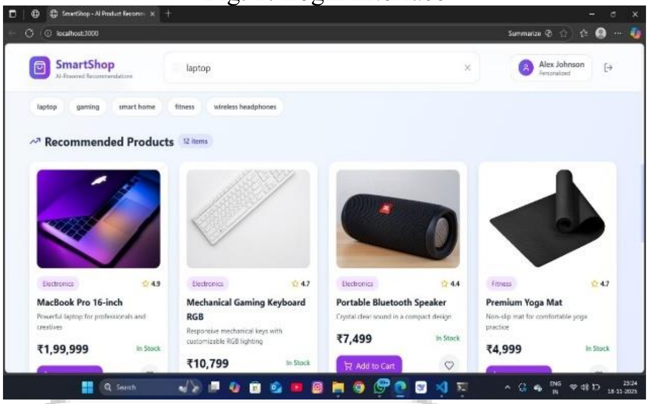

Fig. 2: Recommendation Items (Laptop)

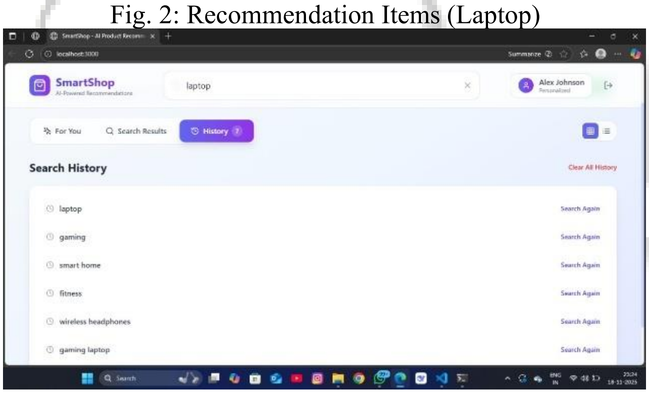

Fig. 3: Search History

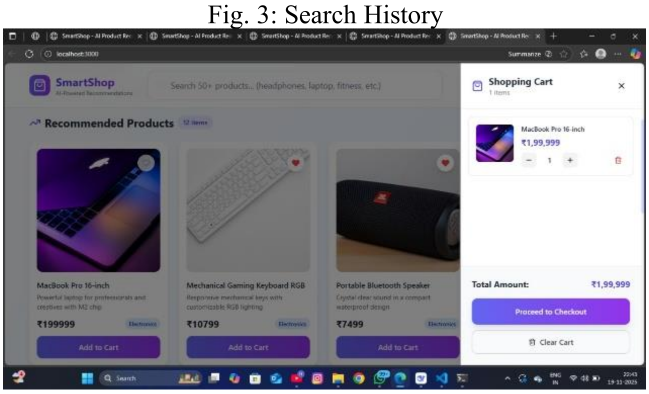

Fig. 4: Items Added to Cart

V. Conclusion

This paper demonstrates a functional ML-based recommendation system that predicts product preferences using browsing history, purchase data, and seasonal trends. The model offers personalized recommendations, reduces search effort, and enhances user satisfaction. Despite using simple ML techniques, the system performs effectively and can be expanded for real-world e-commerce applications.

VI. Future Scope

– Integration of deep learning models
– Dynamic user profiling
– NLP-based product description analysis
– Automated seasonal trend detection
– Large-scale deployment with real-time updates

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