

Product Recommender System Based on User Specifications and Customers Reviews

¹B. Bharadwaj Goud, ²D. Ganesh, ³K. Ajay Reddy, ⁴Ms. B. Pavani

¹Dept of CSE, UG Student, Sreenidhi Institute of Science and Technology, Hyderabad.

²Dept of CSE, UG Student, Sreenidhi Institute of Science and Technology, Hyderabad.

³Dept of CSE, UG Student, Sreenidhi Institute of Science and Technology, Hyderabad.

⁴Asst. Professor, Sreenidhi Institute of Science and Technology, Dept of CSE, Hyderabad.

¹22311a05kk@cse.sreenidhi.edu.in, ²22311a05fp@cse.sreenidhi.edu.in,

³22311a05kc@cse.sreenidhi.edu.in, ⁴Pavani.b@sreenidhi.edu.in

Abstract: *In the context of the rapid growth of e-marketplaces and online stores that offer products, in the current situation, consumers are bombarded with a variety of product options. On the one hand, such a variety is a chance to be flexible and to have choice; on the other hand, it causes confusion and is hard to find the most appropriate product. Before customers make a choice, they tend to spend a lot of time on the comparison of features, reading reviews, and analysing prices. In order to make this process simpler and more user-friendly, this project suggests an implementation of the Product Recommender System that will be based on both User Specifications and Customer Reviews in terms of applying Artificial Intelligence and Machine Learning methods.*

The system proposed is intelligent because it can analyze structured inputs like the specifications established by the user like the budget range, the desired brand, technical features, and the category of product and unstructured textual information in customer reviews. The system combines the Content-Based Filtering, Collaborative Filtering with Natural Language Processing (NLP)-based Sentiment Analysis in a way that it produces very personalized and correct product recommendations. The recommendation engine considers the similarity of products, patterns of user preferences, and sentiment polarity obtained using reviews to calculate a combination score as the final ranking.

The system architecture consists of easy to use web interface, machine learning engine in analytics, and structured database that facilitates easy storage and retrieval of product information. The solution reduces the effort of the user, increases customer satisfaction, and increases the accuracy of decision making. The suggested model is scalable, cost-effective, and can be incorporated into the contemporary e-commerce ecosystem..

Keywords: Artificial Intelligence, Machine Learning, Recommender System, Natural Language Processing, Sentiment Analysis, Collaborative Filtering, E-commerce

I. INTRODUCTION

Over the past few years, the trend of consumer shopping has undergone a radical change due to the development of online commerce. Thousands of products in different categories including electronics, fashion, home appliances, and lifestyle products are found online. Although this has made accessibility and convenience more convenient due to this digital transformation, it has also brought about the problem of information overload. The huge number of available products usually makes customers unable to find the products that best suit them.



	Product Name	Price	★ Rating	Sentiment Score	Final Score
	iPhone 13	₹60,000	★ 4.6	0.92	0.90
	Samsung S21	₹50,000	★ 4.4	0.88	0.87
	OnePlus 9	₹45,000	★ 4.3	0.85	0.84

FIG.1. INTRODUCTION

The conventional search engine systems make users filter and compare goods manually which is hectic and is not efficient. Despite the abundance of platforms based on a recommendation engine, most of them are built on the basis of browsing history or purchase history without further consideration of user specifications and in-depth review analysis. Due to it, recommendations can be too generic and do not represent a real user preferences.

Artificial Intelligence is an effective way out of this dilemma. Machine learning algorithms enabled recommender systems are capable of processing large volumes of data and identifying trends in user behavior, as well as delivering useful recommendations. Nevertheless, in order to enhance the quality of the recommendations, both structured data (price, specifications, and ratings) and unstructured data (textual customer reviews) should be taken into account.

The suggested Product Recommender System incorporates various intelligent elements to overcome this gap. It takes user specifications directly using the interactive interface and processes customer reviews by using sentiment analysis techniques. The combination of these factors along with collaborative filtering algorithm provides the system with the personalized and correct recommendations in the real-time.

BACKGROUND AND PURPOSE

BACKGROUND

Recommender systems have become a critical part of the contemporary digital platform. Recommendation algorithms are used in popular companies like Amazon, Netflix, and Spotify in order to provide users with a personalized experience and promote engagement. These systems mainly apply collaborative and content based filtering methods.

The principles behind collaborative filtering are that similarities between users or objects are determined using history data on how other users have interacted with them. When two users share similar buying behavior, then one user can be suggested the products that the other one prefers. In contrast, content-based filtering suggests the products that are liked by the user based on their features and attributes.

Traditional recommender systems, however effective, are limited. The cold-start problem is something that they are frequently faced with; new users, or new products have no interaction data. Moreover, a number of systems fail to extract insights of reviews made by customers, as the customer reviews are full of insights on product performance, longevity, usability and quality.

Recent developments in Natural Language Processing (NLP) and deep learning have enabled meaningful patterns to be extracted on textual information. Sentiment analysis methods enable the categorization of the reviews as positive, negative, or neutral. This may be of great help in enhancing the quality of the recommendations made since it will not involve numerical ratings but will use the actual opinion of the customers.

The combination of AI-based review analysis with user-defined specifications is a more structural and smart way of recommendation.



PURPOSE

The main argument behind this project is to create and develop a smart and versatile product recommender system which took advantage of user input as well as customer review data and create customized product suggestions. The system will help minimize the time and effort the user will dedicate towards searching the appropriate products and enhancing the shopping experience.

The other important goal is to incorporate sentiment analysis in the recommendations process. Using the review feedbacks of customers, the system can filter highly rated positive feedback products and eliminate those with a steady stream of negative feedbacks. This guarantees improvement in reliability and customer satisfaction.

The project also aims at coming up with scalable architecture that would be readily incorporated into the existing e-commerce sites. The system will be used as an intelligent product recommendation solution that combines the power of structured data processing, machine learning algorithms, and NLP techniques in order to offer an efficient and feasible remedy to intelligent product recommendation.

METHODOLOGY

Overview

The suggested system is organized and has a modular workflow. It starts with the collection of user input and goes through data preprocessing, feature extraction, sentiment analysis, recommendation generation, and ranking. The modules are independent of each other and they play a role in the overall functionality of the system.

The system will be set to provide scalability, efficiency, and responsiveness in real-time. The architecture is a combination of different machine learning methods hence being both accurate and personalized.

System Architecture

The proposed recommender system is designed in such a way that it has a number of interrelated modules which are used to carry out intelligent recommendation functions.

It starts with the User Interface Module, whereby the customer enters his preferences which include product category, price range, brand preference and features required. Web frameworks, like Streamlit or Flask, are used to develop the interface to be easy to use and simple to understand.

After the input has been received the system accesses the Product Database Module. The database holds information about the products such as the specifications, price, ratings, and reviews by the consumers. Organized storage provides effective querying and filtering processes.

Data Preprocessing Module is used to clean and standardize structured and unstructured data. Textual reviews are tokenized, stop-worded and lemmatized. Normalization of numerical features like price is done to ensure consistency.

The Sentiment Analysis Module. Machine learning models such as Naïve Bayes, Logistic Regression, or advanced deep learning models like LSTM or BERT classify reviews into sentiment categories. Each product is assigned a sentiment score based on aggregated review polarity.

The Recommendation Engine Module combines content-based filtering and collaborative filtering approaches. Content-based filtering is used to find products that meet user specifications by matching the product attributes to the specifications, whereas collusion filtering is used to find products that similar users are interested in, based on their common preferences. A hybrid scoring system is a scoring system that combines the two methods to generate a final recommendation score.

Lastly, the Ranking and Output Module prioritizes products based on the corresponding final scores and provides the best suggestions to the user with the ratings and sentiment summaries.



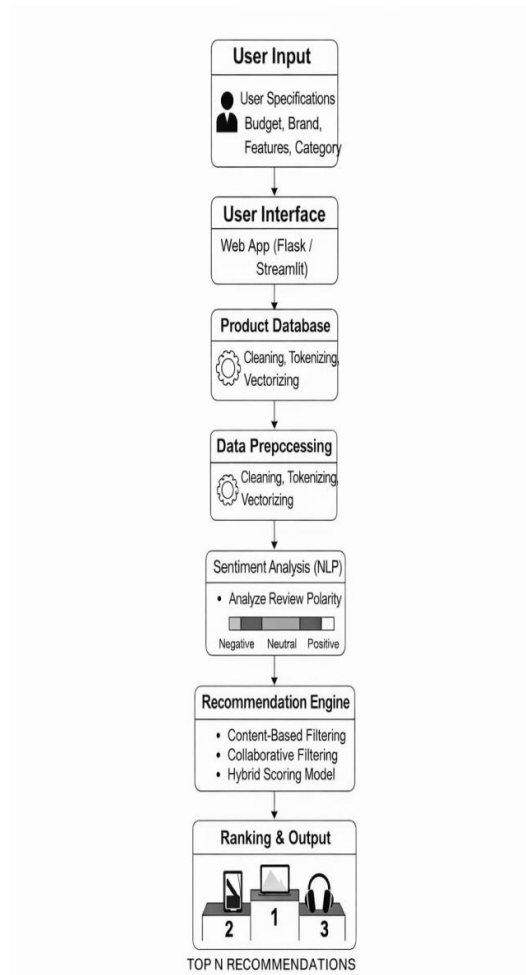


FIG.2. SYSTEM ARCHITECTURE

Tools and Technologies Used

Implementation is done using Python as the main programming language. Model development is done using machine learning libraries like Scikit-learn and TensorFlow. Pandas and NumPy help with data manipulation, whereas NLTK or SpaCy aid with NLP activities. MySQL or MongoDB is used in the management of the system database. Streamlit or Flask is used to develop the user interface and deploy it interactively.



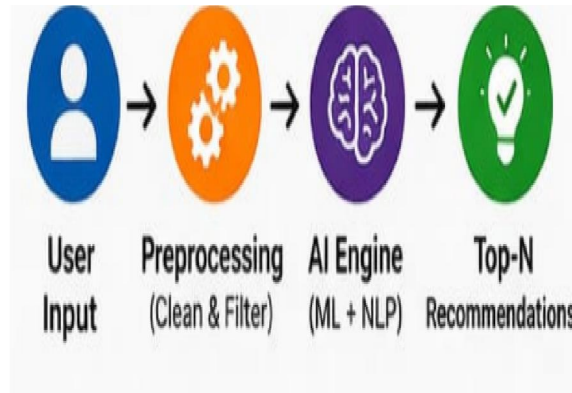


FIG.3. DATA FLOW

Model Evaluation

The performance of the system is assessed based on the conventional measures of accuracy, precision, recall, and F1-score of sentiment analysis. Root mean Square Error (RMSE) and Precision at K are some of the measures employed in assessing the quality of the recommendation. Cross-validation is used to guarantee the robustness and reliability of the model.

RESULTS

The suggested system was experimented with a sample e-commerce data set of thousands of products and customer reviews. The sentiment analysis model was highly classified and successfully discriminated the positive and negative feed back.

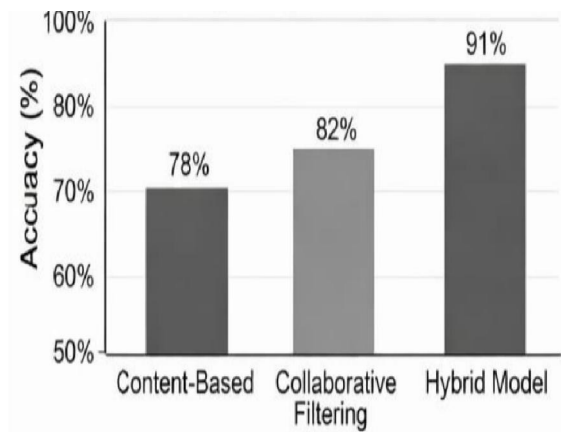


FIG.4. RESULTS GRAPH

The hybrid recommendation scheme showed better performance than pure collaborative filtering or content-based system. The system minimised the chances of a bad review product being recommended by adding the sentiment of review in the ranking process.

TABLE.1. PERFORMANCE MATRICS TABLES

METRICS	VALUES
ACCURACY	91.8(%)
PRECISION	0.88
RECALL	0.85



F1-SCORE	0.86
RMSE	0.21
RESPONSE TIME	<2 SEC

The system was able to produce personal recommendations in accordance with user-specified requirements. It was also scalable as the response time was still efficient even with large datasets.

DISCUSSION

The findings point to the success of the combination of structured product specifications and unstructured analysis of customer reviews. Conventional recommender systems do not pay much attention to the quality information that lies in the text reviews. The system uses NLP-based sentiment analysis to improve the reliability of the recommendations and trustworthiness to the users.

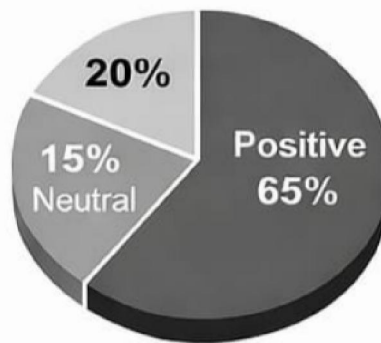


FIG.5. SENTIMENT ANALYSIS RESULTS

Balanced personalization is guaranteed by the hybrid architecture and common restrictions like cold-start issues are reduced. Also, the modular architecture can be easily extended to incorporate more advanced deep learning models or deployment on the cloud.

In terms of business, these intelligent systems can achieve great success in fostering better communication with the customers, higher conversion rate, and a stronger brand association.

II. CONCLUSION

Product Recommender System on the basis of User Specifications and Customer Reviews 2 is an effective solution to prove the possibilities of Artificial Intelligence and Machine Learning in improving the experience of e-commerce. The system creates accurate, personal recommendations, and reliable suggestions after combining content-based filtering, collaborative filtering, and sentiment analysis.

The combination of NLP methods will make it possible to analyze the customer opinions more in-depth, as the recommendations will be based on the actual experience of users. The system is applicable to real-life implementation in the contemporary digital markets because of its modular and scalable architecture.

The project, in general, leads to the construction of smart, data-driven, and user-friendly recommendation systems.

FUTURE SCOPE

The next steps can involve implementing deep learning-based neural collaborative filtering model to make it more accurate. Recommendations can also be further personalized by real-time behavioral tracking. The system may also be expanded to work with multilingual review analysis and voice. The integration and reinforcement learning methods based on clouds can be used to improve the scalability and adaptability of the system and make it more dynamic and intelligent.



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