



Intelligent Personalized Book Recommendation System Using Hybrid Machine Learning and User Preference Modelling

Shreya T Harish¹, Varsha P², Divya P³, Dr. Priya R Sankpal⁴, Dr. Ashwini S Savanth⁵

¹ Department of ECE B.N.M. Institute of Technology, Affiliated to VTU Bengaluru, Karnataka, India

shreyatharish@gmail.com

⁴ Associate Professor Department of ECE B.N.M. Institute of Technology, Affiliated to VTU Bengaluru, Karnataka, India

² Department of ECE B.N.M. Institute of Technology, Affiliated to VTU Bengaluru, Karnataka, India

varshaprakashks@gmail.com

⁵ Associate Professor Department of ECE B.N.M. Institute of Technology, Affiliated to VTU Bengaluru, Karnataka, India

³ Department of ECE B.N.M. Institute of Technology, Affiliated to VTU Bengaluru, Karnataka, India

p.divyadivya2006@gmail.com

ABSTRACT –

Book recommendation systems help users discover relevant books from a large collection based on their interests and preferences. However, basic recommendation systems often depend on a single factor such as genre or author, which may not provide sufficiently personalized results. This paper presents an Intelligent Personalized Book Recommendation System that combines user preference modeling with machine learning techniques to provide more relevant recommendations. The proposed system uses TF-IDF and cosine similarity to analyze book content, K-Means clustering to identify similar groups of books, and book ratings along with user preferences for ranking. Users can search based on genre, author, book title, content keywords, or a combination of multiple preferences. The system also provides an explanation for the recommended books and allows users to access them through online book searches. The proposed approach provides a simple and flexible way to improve personalized book discovery by combining multiple recommendation factors.

Keywords - Personalized Book Recommendation, Hybrid Machine Learning, User Preference Modeling, TF-IDF, Cosine Similarity, K-Means Clustering, Content-Based Filtering, Explainable Recommendation System.

INTRODUCTION

With the rapid growth of digital libraries and online reading platforms, users have access to a large number of books covering different genres, authors, and topics. Although this provides a wide range of choices, finding a book that matches a user's specific interests can be difficult. Recommendation systems help address this prob

lem by filtering available books and suggesting items that are more relevant to the user [1], [2].

Traditional book recommendation approaches often rely on a single factor such as genre, author, or rating. While these methods can provide useful suggestions, they may not fully represent the individual preferences of a user. Content-based filtering improves this process by considering information such as book descriptions and keywords to identify books with similar content. Techniques such as TF-IDF and cosine similarity are commonly used for representing and comparing textual information [3], [4].

Machine learning can further improve recommendation by identifying relationships between books and user preferences. Clustering methods such as K-Means can group books with similar characteristics, while combining multiple recommendation factors can provide a more flexible ranking. Hybrid recommendation approaches have therefore been explored to overcome the limitations of using a single recommendation technique [5], [6].

In this work, an Intelligent Personalized Book Recommendation System is developed using a combination of content similarity, user preference modeling, K-Means clustering, and book ratings. The system allows users to search using genre, author, book title, content keywords, or multiple preferences. It also provides recommendation explanations and online access to the selected books. The aim is to provide a simple and personalized approach that helps users discover books according to their specific interests.

RELATED WORK

Different methods have been used in book recommendation systems to help users find books based on their interests. One of the commonly used methods is content-based filtering, where the details of books are compared to find similar books. Anggraeni et al. [1] used TF-IDF and cosine similarity for recommending academic books. Reswara et al. [2] also used TF-IDF and cosine similarity to compare book information and generate recommendations.

Some researchers have focused more on personalization. Lin [3] developed a personalized book recommendation system for university libraries using item-based collaborative filtering. Gupta et al. [4] used deep learning for personalized e-book recommendations in e-commerce platforms. These studies show that considering user preferences can make recommendations more suitable for individual users.

Hybrid methods have also been explored by combining more than one technique. Rahman et al. [5] used adaptive clustering along with a hybrid recommendation approach to handle cold-start problems. Ouanlamai et al. [6] studied content-based filtering for book recommendation using information related to the books. Teng et al. [7] worked on personalized library recommendations using deep learning.

Another area of research is making recommendations easier for users to understand. Attolou et al. [8] studied explainable recommendation using graph-based methods, while Batmani et al. [9] included user reviews to provide more explainable recommendations. Li et al. [10] explored personalized prompt learning for explainable recommendation systems.

From these studies, it can be seen that different techniques such as content similarity, personalization, clustering, and explainability have been used for recommendation systems. In this work, these ideas are combined in a simpler book recommendation framework. The proposed system uses *TF-IDF* and *cosine similarity*, *user preference modeling*, *K-Means clustering*, and *book ratings* to rank books. It also provides explanations for the recommendations and allows users to enter preferences using genre, author, title, content keywords, or multiple preferences.

III. PROPOSED METHODOLOGY

The proposed framework helps users find books based on their interests and available book information. It combines data preprocessing, feature extraction, clustering, user-selected search criteria, and recommendation ranking. The system provides four search options: genre, author, title, and content keyword. Fig. 1 shows the overall workflow of the proposed book recommendation system.

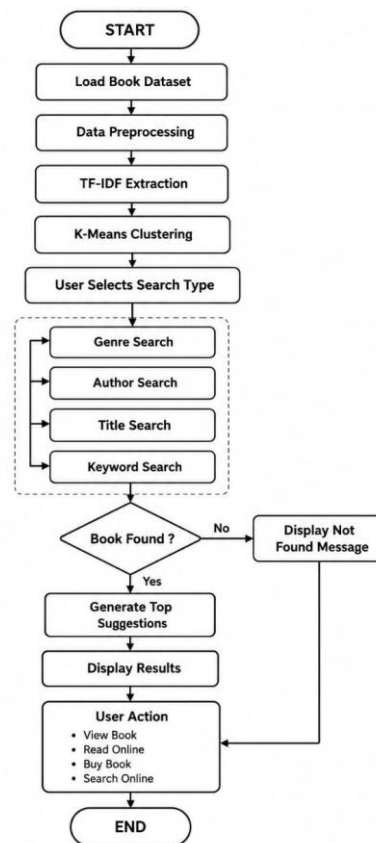


Fig. 1. Book recommendation system flowc

Dataset Loading and Preprocessing

The process begins by loading the book dataset containing information such as book ID, title, author, genre, rating, content keywords, and page reference. The data is checked and organized before it is used by the recommendation system. Preprocessing ensures that the book information is available in a consistent form for searching, comparison, and ranking. This initial step provides the basic information required by the later stages of the recommendation process.

Feature Extraction and Book Representation

After preprocessing, the relevant information from the books is used to represent their characteristics. Textual information such as book titles and content keywords provides useful information about the subject and nature of each book. TF-IDF extraction is used to identify the importance of terms in the available book information. This representation helps the system distinguish between commonly occurring terms and terms that are more useful for identifying a particular book or group of books.

K-Means Clustering

K-Means clustering is used to group books having similar characteristics into clusters. The clustering stage provides an additional way of identifying books that are related to one another based on their extracted features. Instead of treating every book independently, the system can use the similarity between books to support the recommendation process. This is particularly useful when the user provides only a general interest rather than an exact book title.

User Preference and Search Selection

Once the book information has been processed, the user can select how they want to search for a book. The system provides options for genre, author, title, content keyword and multiple preference search. In genre-based search, the user selects a preferred genre from the available choices. In author-based search, the user can enter either the complete author name or a part of the name. Similarly, title search accepts a complete title or a part of a title, while keyword search allows the user to enter a term related to the content they are interested in.

This approach makes the system easier to use because the user does not have to know all the details of a book before searching for it. For example, a user who only knows the genre can directly search by genre, whereas a user who remembers only a part of an author's name can use the author search option.

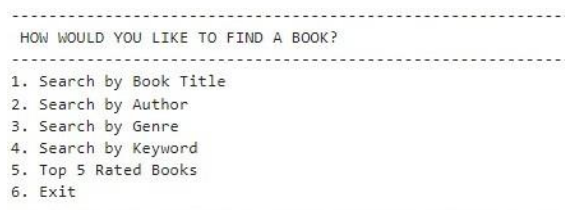


Fig. 2. User preference search option

Recommendation Ranking

After the user provides a search input, the system checks the dataset for matching books. If no suitable match is found, a corresponding message is displayed. When matching books are available, the system ranks the candidates using the recommendation score. The ranking considers the available book information and rating to identify the most suitable results. The highest-ranked books are presented to the user as personalized recommendations. The output includes useful details such as the book title, author, genre, rating, and hybrid score. This allows the user to compare the recommended books before selecting one. The system displays the best available recommendations rather than requiring the user to examine every matching book in the dataset.

Recommendation Output and Online Access

The final stage presents the recommended books to the user. The user can select a book from the displayed list using its corresponding number. After selection, the system provides an online search option for the chosen book and opens the corresponding web search. This allows the user to continue from recommendation to online access without having to manually search for the book again.

The system also handles cases where the entered genre, author, title, or keyword does not match the available dataset. In such cases, the user receives a clear message indicating that no matching result was found. This prevents the system from displaying unrelated recommendations.

Overall, the proposed methodology combines content-based information, clustering, user preferences, and book ratings to provide a simple and flexible recommendation process. The different search options allow users to approach the system according to the information available to them, while the ranking stage helps reduce the number of choices and highlights the most relevant books.

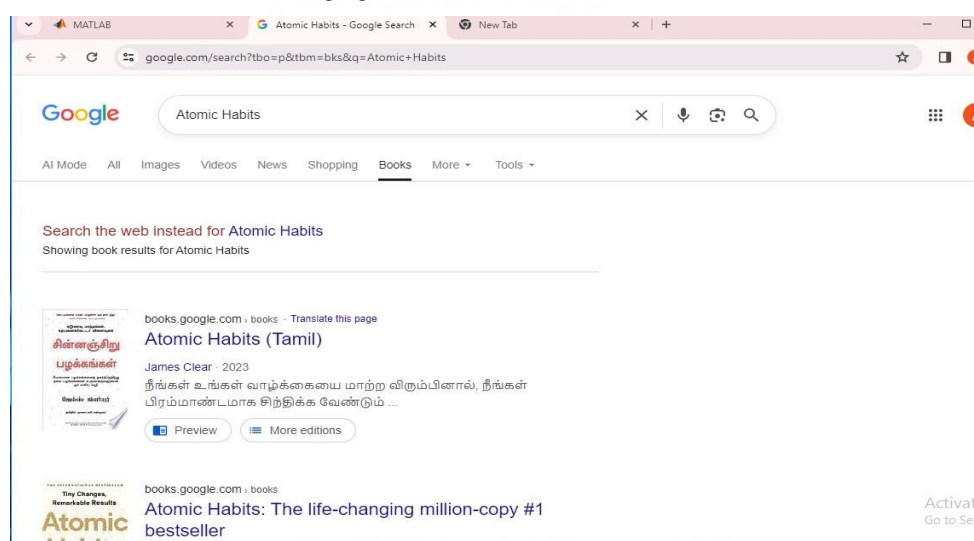


Fig. 3. Online access to the selected book

IV. EXPERIMENTAL SETUP

The experimental setup was prepared to evaluate the working of the proposed book recommendation system using the developed MATLAB implementation. The experiments were carried out using the book dataset and the different search options provided by the system. The system was tested with genre, author, title, and content keyword inputs to observe how effectively it retrieves and ranks suitable books. The recommendation output was then examined based on the information displayed for each selected query.

A. Dataset

The system uses a book dataset containing information such as book title, author, genre, rating, content keywords, and page reference. These attributes provide the basic information required for searching and recommending books. The dataset is used throughout the experiments so that the different recommendation options can be tested under the same conditions.

Experimental Environment

The recommendation system was implemented and tested using *MATLAB*. The program provides a menu-driven interface through which the user can select the required search method and enter the corresponding input. The system processes the input, searches the dataset, and displays the matching books along with their relevant details.

Experimental Procedure

The experiments were performed by selecting the different search options available in the system. For genre-based recommendation, a genre was selected from the available list and the corresponding books were ranked to obtain the top recommendations. For author-based and title-based searches, the user could enter either the complete name/title or a part of it. Content keyword search was tested by providing a keyword related to the desired book content.

The system also checks whether the entered information is available in the dataset. When matching records are found, the results are displayed for selection. If no matching record is available, the system displays an appropriate message instead of returning unrelated books.

Recommendation Output

For each successful search, the system displays the recommended books along with details such as the *book title, author, genre, rating, and hybrid score*, depending on the selected search mode. The recommendations are ranked so that the higher-ranked books appear first. The user can select a book from the displayed results, after which the system provides an option to search for the selected book online.

E. Evaluation Approach

The evaluation mainly focuses on the functionality and recommendation behaviour of the developed system. The different search modes were checked to verify whether the system could retrieve relevant books from the dataset and present them in a ranked form. The experiments also considered the system's ability to handle partial inputs and unmatched searches. The obtained outputs were used to demonstrate the working of the recommendation system and are discussed in the following section.

V. RESULTS AND DISCUSSION

The developed book recommendation system was tested using different search options to understand how the system responds to user preferences and retrieves suitable books from the dataset. The experiments were carried out using genre, author, title, content keyword, and multiple preference searches. The results obtained from these searches were examined based on the relevance of the displayed books and the ranking provided by the system. A representative genre-based recommendation is presented in detail below, while the remaining recommendation modes are summarized to show the overall working of the system.

A. Genre-Based Recommendation

Genre-based recommendation was selected as a representative example to demonstrate the working of the proposed system. In this mode, the user first selects the genre search option and chooses a preferred genre from the available list. The system then searches the dataset for books belonging to the selected genre and ranks the available results. The top three recommendations are displayed to the user along with their relevant details.

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HOW WOULD YOU LIKE TO FIND A BOOK?
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1. Search by Book Title
2. Search by Author
3. Search by Genre
4. Search by Keyword
5. Top 5 Rated Books
6. Exit
-----
Enter your choice: 3

AVAILABLE GENRES:
1. Classic
2. Fantasy
3. Fiction
4. Historical Fiction
5. Mystery
6. Romance
7. Science Fiction
8. Self Help
Select genre number: 1
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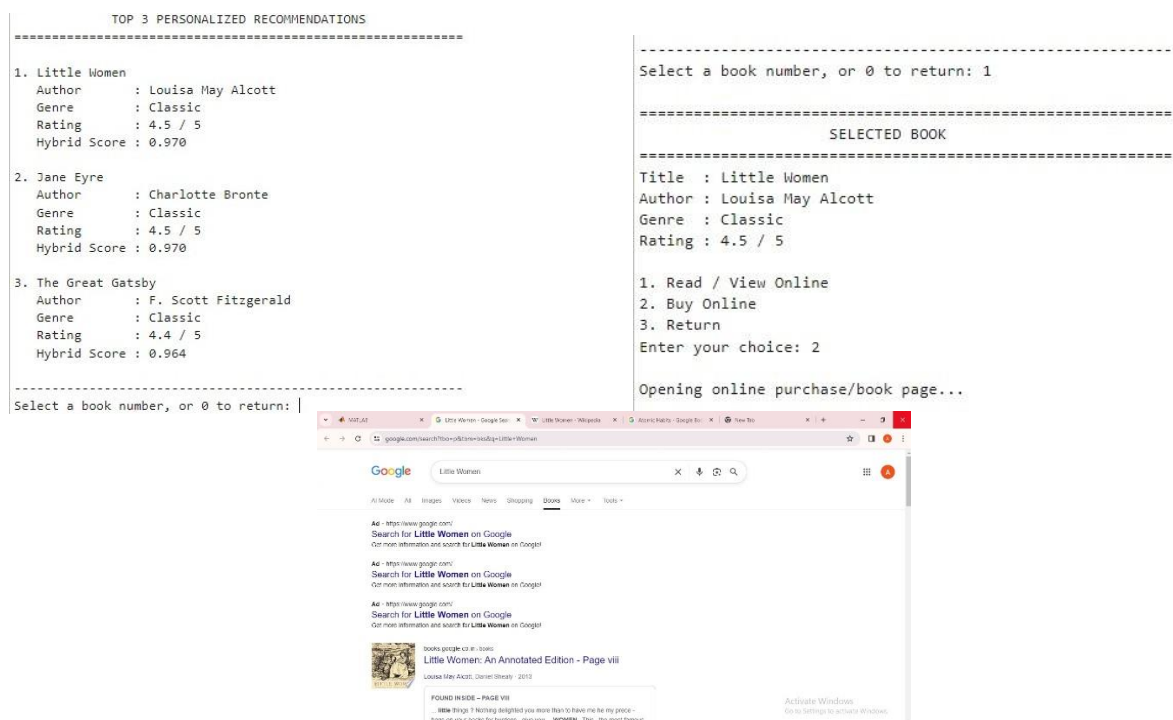


Fig. 4. Genre-based recommendation process and output.

The above figure shows the different stages involved in genre-based recommendation. The process starts with the main menu, where the user selects the required search method, followed by the selection of a preferred genre. After the genre is selected, the system retrieves the corresponding books from the dataset and displays the recommended books in ranked order. Details such as the book title, author, rating, and hybrid score are provided so that the user can compare the recommendations. The user can then select a book from the displayed results and continue with its online search.

After selecting a recommended book, the system provides an online search option for the selected title. This allows the user to continue from the recommendation stage to further information about the book without having to manually enter the book details in a separate search.

Results of Other Recommendation Modes

Apart from genre-based recommendation, the system was also tested with author, title, content keyword, and multiple preference searches. These options allow the user to search for books based on the information they already know about the book or the type of content they are interested in.

TABLE I. SUMMARY OF DIFFERENT RECOMENDATION MODES

<i>Recommendation Mode</i>	<i>User Input</i>	<i>System Output</i>	<i>Ranking / Additional Feature</i>
Author-Based	Full or partial author name	Top three matching books are recommended	Rating-based ranking and Google search link
Title-Based	Full or partial book title	Related books are displayed, with the top three recommended	Title matching and Google search link
Content Keyword	Keyword related to book content	Top three books matching the content keyword are recommended	Content matching and Google search link
Multiple Preference	Genre, author, title, content, and rating preferences	Top three books matching the combined preferences are recommended	Hybrid weighted score and Google search link

The different search modes provide flexibility in the way a user can interact with the recommendation system. In the author-based search, the user can provide either the complete author name or only a part of the name to retrieve relevant books. Similarly, the title-based search can be performed using a complete title or a part of the title. Content keyword search is useful when the user knows the subject or a particular term related to the book but does not know the exact title or author.

The multiple preference option provides a more personalized form of recommendation by considering more than one user preference at the same time. The system combines the selected preferences and uses the resulting score to rank the available books. This helps in reducing the number of results and presenting books that better match the user's overall requirements.

Overall Discussion

The results obtained from the different search modes demonstrate the basic working of the proposed personalized book recommendation system. The genre-based example shows how the system takes a user's selected preference, retrieves suitable books, and presents the top recommendations in ranked order. The other search options provide additional ways to discover books when the user has information such as an author name, part of a title, or a content-related keyword.

The recommendation output also provides useful information such as the title, author, rating, and recommendation score, allowing the user to compare the available books before making a selection. The multiple preference option further extends the system by combining different inputs instead of relying on only one search criterion. The online search feature also provides a simple way for the user to continue exploring the selected book after receiving the recommendation.

Overall, the experimental results show that the developed system provides a simple and flexible approach to book recommendation. Instead of limiting the user to a single type of search, the system allows books to be discovered through different forms of user input. The combination of book information, user preferences, and ranking helps the system present a smaller set of relevant choices to the user and makes the recommendation process more convenient.

LIMITATIONS AND FUTURE WORK

The proposed system provides personalized book recommendations by considering user preferences, book content, authors, genres, and ratings. However, the quality of the recommendations depends on the information available in the dataset. The current system also does not maintain long-term reading history or continuously learn from user feedback. The predefined weights used for different recommendation factors may also affect the final ranking.

The system can be improved by using a larger and more diverse dataset containing detailed book information and user interactions. Incorporating user ratings, reading history, and feedback can help the system understand changing interests and provide more relevant recommendations.

In future work, collaborative filtering and deep learning techniques can be combined with the existing hybrid approach to improve personalization. The system can also be developed into a web or mobile application with a continuously updated database and real-time recommendations, making it more practical and useful for a wider range of readers.

CONCLUSION

The proposed Intelligent Personalized Book Recommendation System provides a flexible approach for helping users discover books according to their interests and preferences. The system combines TF-IDF-based content similarity, user preference modeling, K-Means clustering, and book ratings to generate a hybrid recommendation score. It also supports different search options, including genre, author, book title, and content keywords, allowing users to provide preferences in a way that suits their needs.

The inclusion of multiple preference inputs and recommendation explanations makes the system more personalized and easier to understand. The online book search feature further improves the usability of the system by allowing users to access the selected books through external sources. Overall, the developed system demonstrates the usefulness of combining machine learning techniques with user preferences for personalized book recommendation and provides a foundation for further improvements in recommendation accuracy and user experience.

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