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# Personalized Book Recommendation System

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**ABSTRACT:** Existing book-related websites primarily focus on isolated functionalities such as selling or renting books, often neglecting comprehensive recommendation systems and additional features like mood-based recommendations, voice search, and feedback management. Users lack a single platform that offers an integrated solution combining all these functionalities with a responsive and user-friendly interface. This project aims to build a comprehensive E-commerce platform for books, equipped with a state-of-the-art recommendation system. The platform offers multiple functionalities, including user registration and authentication, collaborative filtering for similar book suggestions, content-based filtering, popularity-based filtering, and reader mood and preference based recommendation. Additional features include voice-based search functionality, responsive design, notifications, and a library. The platform prioritizes user data privacy and content moderation to maintain a safe and efficient environment. By leveraging modern web technologies and machine learning techniques, this project bridges the gap in existing systems and offers an all-encompassing solution for book enthusiasts.

**KEYWORDS:** Book recommendation system, Collaborative filtering, Content-based filtering, Popularity-based filtering, mood and preference based recommendation, Machine Learning.

## I. INTRODUCTION

The rapid growth of digital technology has transformed the way readers discover and access books. Traditional book-related platforms primarily focus on isolated functionalities such as selling, renting, or providing generic recommendations, often failing to deliver a personalized and engaging experience. Users frequently struggle to find books that align with their preferences, moods, and reading habits due to the absence of an integrated recommendation system.

To bridge this gap, this project aims to develop a comprehensive E-commerce platform for books, incorporating a state-of-the-art personalized book recommendation system. The system leverages multiple recommendation techniques, including collaborative filtering, content-based filtering, and popularity-based filtering, ensuring accurate and user-specific suggestions. Additionally, reader mood analysis enhances the personalization process by analysing user interactions and preferences.

Beyond recommendation capabilities, the platform introduces advanced functionalities such as voice-based search, feedback moderation, notifications, and a virtual library, making it a one-stop solution for book enthusiasts. A responsive and user-friendly interface ensures seamless navigation across devices, while data privacy and content moderation are prioritized to create a secure and efficient reading environment.

By integrating machine learning techniques and modern web technologies, this platform revolutionizes book discovery and enhances the user experience. The proposed system not only addresses the limitations of existing platforms but also establishes a dynamic, intelligent, and adaptive approach to book recommendations, catering to diverse reader preferences.

## II. LITERATURE SURVEY

In paper [1] Esmael Ahmed and Adane Letta proposed a matrix factorization collaborative filtering model to tackle the cold start problem in book recommendation. Their study compared memory-based and model-based approaches, with Singular Value Decomposition (SVD) outperforming KNN in accuracy.

In paper [2] E. Uko Okon, B. O. Eke, and P. O. Asagba developed an Improved Online Book Recommender System using Collaborative Filtering and Firebase NoSQL databases, ensuring scalability and performance improvements.

In paper [3] Onur Dogan, Emre Yalcin and Ourania Areta Hizirolu introduced a Web-Based Hybrid Intelligent Book Recommender System (W\_HybridBook) that integrates collaborative filtering, content-based filtering, and genre-oriented user profiles. This approach improved similarity calculations, reducing the sparsity problem and enhancing user satisfaction.

In paper [4] Aqsa Maryum and Fawad Nasim implemented a genetic algorithm-enhanced hybrid book recommendation system, using Amazon's dataset from Kaggle to refine book ratings and measure similarity between users.

In paper [5] Sewar Khalifeh and Amjed Al-Mousa implemented User-Based and Item-Based Collaborative Filtering, along with Matrix Factorization using SVD, to improve accuracy in book recommendations. Their study compared KNN-based algorithms with matrix factorization, highlighting that SVD yielded higher accuracy, while KNN was faster in fitting and testing time.

In paper [6] Binge Cui, Xin Chen introduced an online book recommendation system based on Web Services. Their model allowed readers to recommend books when they couldn't find a book in a library's catalog. The study proposed formulas to compute book value and the optimal number of copies for purchase, improving book availability and user satisfaction.

In paper [7] Anandaraj, Yeshwanth Ram P, Sri Ram Kumar K, Revanth M, Praveen R proposed a Book Recommendation System using TensorFlow, integrating deep learning and collaborative filtering to refine recommendations. Their study emphasized the advantages of TensorFlow-based models in handling large datasets efficiently.

In paper [8] Ms. Praveena Mathew, Ms. Bincy Kuriakose, Mr. Vinayak Hegde proposed a hybrid system combining collaborative filtering, content-based filtering, and association rule mining to improve book recommendations.

In paper [9] Shailesh D. Kalkar, Prof. Pramila M. Chawan implemented an improved collaborative filtering model using Firebase for real-time data storage to enhance accuracy.

In paper [10] Prof. S. R. Hiray, Mr. Atish Bhosale, Ms. Komal Patil, Ms. Amruta Gaikwad, Mr. Riddhesh Deshmukh applied Support Vector Machine (SVM) to classify books based on subject and user preferences.

## III. PROPOSED SYSTEM

The proposed system for the personalized book recommendation platform integrates multiple advanced features to enhance user experience and engagement. It begins with User Registration and Authentication, allowing both general users and students to create secure accounts with protected login credentials. The system employs Collaborative

Filtering to suggest books based on the preferences of similar users, while Content-Based Filtering recommends books by analyzing the user's search and reading history. Additionally, a Popularity-Based Filtering approach highlights top-rated and frequently recommended books.

To provide a more personalized experience, the system incorporates Reader Mood and Preference Analysis, enabling tailored book suggestions based on user emotions and interests. Users can also utilize Voice-Based Search to find books effortlessly through voice commands. The Feedback Management feature allows users to submit reviews, ensuring a safe and constructive community. Notifications keep users updated about book reviews and ratings.

Furthermore, the system includes a Library Feature, which organizes purchased or rented books into a virtual library for easy access. Emphasizing user trust, Data Privacy measures are implemented to ensure secure handling of personal information. Lastly, a Responsive Design guarantees seamless accessibility across multiple devices, making the platform user-friendly and highly functional across desktops, tablets, and mobile phones.

The proposed system consists of

#### **USER:**

##### **1. User Management**

Users should be able to register and log in to the system. The system should store user interactions with books (e.g., likes, browsing, ratings, history). Users can able to view the recommendations with the help of collaborative, content and popularity based recommendation techniques. Users are able to get the book recommendations based on reader mood.

##### **2. Home Page**

Home page consists of current mood based filtering predictions output which are predicted in mood based filtering. It also consists of the list of book that user has rated and given feedback.

##### **3. Browse Books**

##### **4. Voice Search**

##### **5. Collaborative Filtering**

Collaborative Filtering (CF) is a popular technique for personalized book recommendations. It predicts a user's preferences based on the behavior and interests of similar users.

User-Based Collaborative Filtering (UBCF) is a personalized recommendation technique that suggests items (e.g., books, movies, or products) based on the preferences of similar users. It operates on the assumption that users who have shown similar interests in the past will likely have similar preferences in the future. Instead of analyzing item characteristics, UBCF focuses on user interactions, behaviors, and ratings to make recommendations.

##### **6. Content-based Filtering**

Content-based filtering recommends books by analyzing their features (e.g., title, author, genre, publisher). The system: Extracts text-based attributes of books.

Converts them into numerical vectors using TF-IDF.

Computes cosine similarity between books.

Recommends books that are most similar to those a user has interacted with.

##### **7. Popularity Filtering**

Popularity filtering is a simple and effective recommendation technique that suggests **top-rated or most-read books** to users, regardless of their personal preferences. It does not rely on user history but instead ranks books based on overall popularity metrics.

##### **8. Mood-Based Filtering**

Mood-based filtering is a personalized recommendation technique that suggests books based on the user's current mood. This approach considers emotional states like happiness, sadness, excitement, or relaxation and recommends books that match those moods.

### 9. History

It consists of the wishlisted book by the user.

### 10. Logout

After the user interaction with the interface the user can logout from the website.

### ADMIN

Admin can view the list of users, ratings and feedbacks given by users and can perform operations like activating the user , deleting the user, ratings and feedbacks given by the users.

## IV. METHODOLOGY

### Collaborative Filtering Methodology

In Collaborative Filtering the techniques used are User-Based Collaborative Filtering (UBCF) and Memory-Based Filtering (using similarity calculations between users).

The algorithm used is **k-Nearest Neighbors (KNN) with Cosine Similarity**. The system employs **KNN (k-Nearest Neighbors)** with a **Cosine Similarity metric** to find users with similar reading preferences.

### IMPLEMENTATION

#### 1. Data Collection:

- Fetches books and ratings from the database.
- Converts data into a User-Item Rating Matrix (users as rows, books as columns, ratings as values).

#### 2. Preprocessing:

- If a user has not provided ratings, it falls back to Popularity-Based Recommendations.
- Converts the matrix into a sparse format (to optimize memory usage).

#### 3. Training the Model:

- Uses Scipy's Sparse Matrix Representation (`csr_matrix`) to store ratings efficiently.
- Fits a KNN model (`NearestNeighbors`) with Cosine Similarity as the metric.

### Calculate Similarity Using Cosine Similarity

KNN uses **Cosine Similarity** to compare users based on their rating vectors.

The **Cosine Similarity** between two users **A** and **B** is calculated as:

$$\text{Similarity} = \frac{A \cdot B}{\|A\| \times \|B\|}$$

If **similarity**  $\approx 1$ , users have very similar preferences.

If **similarity**  $\approx 0$ , they have no common preferences.

#### 4. Making Recommendations:

- Finds similar users by computing the nearest neighbors of the target user.
- Retrieves books rated highly by those similar users.
- Returns the top N recommended books.

Example:

User	Book A	Book B	Book C	Book D
U1	5	4	0	3
U2	4	0	5	4
U3	0	5	4	0

### Compute Similarity between U1 and U2

$$U1 = (5, 4, 0, 3), \quad U2 = (4, 0, 5, 4)$$

$$\text{Dot Product} = (5 \times 4) + (4 \times 0) + (0 \times 5) + (3 \times 4) = 20 + 0 + 0 + 12 = 32$$

$$\|U1\| = \sqrt{5^2 + 4^2 + 0^2 + 3^2} = \sqrt{25 + 16 + 0 + 9} = \sqrt{50} \approx 7.07$$

$$\|U2\| = \sqrt{4^2 + 0^2 + 5^2 + 4^2} = \sqrt{16 + 0 + 25 + 16} = \sqrt{57} \approx 7.55$$

$$\text{Similarity}(U1, U2) = \frac{32}{7.07 \times 7.55} = \frac{32}{53.38} \approx 0.599$$

### Compute Similarity between U1 and U3

$$U1 = (5, 4, 0, 3), \quad U3 = (0, 5, 4, 0)$$

$$\text{Dot Product} = (5 \times 0) + (4 \times 5) + (0 \times 4) + (3 \times 0) = 0 + 20 + 0 + 0 = 20$$

$$\|U3\| = \sqrt{0^2 + 5^2 + 4^2 + 0^2} = \sqrt{0 + 25 + 16 + 0} = \sqrt{41} \approx 6.40$$

$$\text{Similarity}(U1, U3) = \frac{20}{7.07 \times 6.40} = \frac{20}{45.25} \approx 0.442$$

### Compute Similarity between U2 and U3

$$U2 = (4, 0, 5, 4), \quad U3 = (0, 5, 4, 0)$$

$$\text{Dot Product} = (4 \times 0) + (0 \times 5) + (5 \times 4) + (4 \times 0) = 0 + 0 + 20 + 0 = 20$$

$$\text{Similarity}(U2, U3) = \frac{20}{7.55 \times 6.40} = \frac{20}{48.32} \approx 0.414$$

### User U1's Nearest Neighbor:

- U2 (0.599) is more similar than U3 (0.442).
- So, U2 is the closest neighbor to U1.
- └ U1 has not rated Book C (Rating = 0).
- └ U2 has rated Book C as 5.
- └ Since U2 is the closest neighbor, Book C is recommended to U1.

### Content-Based Filtering

The algorithm Used in Content-Based Filtering is the **TF-IDF (Term Frequency-Inverse Document Frequency) Algorithm** is commonly used to extract important features from book descriptions or metadata.

#### 1 TF-IDF (Term Frequency-Inverse Document Frequency)

- **TF (Term Frequency):** Measures how often a term appears in a document (book description).
- **IDF (Inverse Document Frequency):** Reduces the weight of terms that appear frequently across all books.
- Formula:

$$\text{TF-IDF} = \text{TF} \times \text{IDF}$$

where:

- **TF (Term Frequency):** Measures how frequently a term appears in a document.

$$TF(t, d) = \frac{\text{Number of times term } t \text{ appears in document } d}{\text{Total number of terms in document } d}$$

**IDF (Inverse Document Frequency):** Reduces the weight of commonly used words across all documents.

$$IDF(t) = \log \left( \frac{N}{df(t)} \right)$$

where:

- $N$  = Total number of documents in the corpus
- $df(t)$  = Number of documents containing the term  $t$

Example:



**Book Dataset:**

Book	Genre
Book A	"Fantasy, Magic, Adventure"
Book B	"Fantasy, Mythology"
Book C	"Sci-Fi, Space, Adventure"

**Step 1: Convert to TF-IDF Vectors**

- Book A → (Fantasy: **0.7**, Magic: **0.5**, Adventure: **0.6**)
- Book B → (Fantasy: **0.8**, Mythology: **0.7**, Adventure: **0.2**)
- Book C → (Sci-Fi: **0.9**, Space: **0.8**, Adventure: **0.6**)

**Step 2: Compute Cosine Similarity**

- Similarity(Book A, Book B) ≈ **0.85**  (Highly Similar)
- Similarity(Book A, Book C) ≈ **0.45**  (Less Similar)

**Step 3: Recommend Similar Books**

- If a user reads **Book A**, the system recommends **Book B** (since it has the highest similarity).

**POPULARITY FILTERING**

The system follows a Sorting & Ranking Algorithm:

1. Counts the number of ratings per book.
2. Orders books in descending order of rating count.
3. Allows filtering by genre (optional).
4. Returns the top N popular books.

**Mood-Based Filtering:**

This implementation follows a Rule-Based Classification Algorithm combined with String Matching & Keyword Filtering.

Steps in the Algorithm

1. User Input Handling
  - a. The user selects up to 5 mood-related preferences via a form.
  - b. Each selection is mapped to a general mood category (e.g., Cheerful → Happy).

2. Mood Classification & Selection
  - a. Counts the frequency of each mood selection.
  - b. Identifies the most dominant mood.
  - c. If multiple moods have the highest count, a random tie-breaker selects one.
3. Keyword-Based Filtering
  - a. Maps the identified mood to genre-based keywords:
    - i. Happy → adventure, fun, joy
    - ii. Sad → nostalgic, reflective, deep
    - iii. Calm → peaceful, relaxing, soothing
    - iv. Tired → light, easy, gentle
  - b. Filters books from the database whose genre contains mood-related keywords.
4. Book Recommendation Generation
  - a. If books matching the mood keywords are found, they are ranked & returned.
  - b. If no matches are found, the system randomly selects books as a fallback.

Example:

**User Input:**

- Selected moods:
  1. Laugh and have fun → **Happy**
  2. Go on an adventure → **Happy**
  3. Reflect and relax → **Sad**
  4. High energy → **Happy**
  5. Short and light reads → **Tired**

**Mood Classification:**

- **Happy (3), Sad (1), Tired (1)**
- **Most common mood:** Happy

**Recommendation Process:**

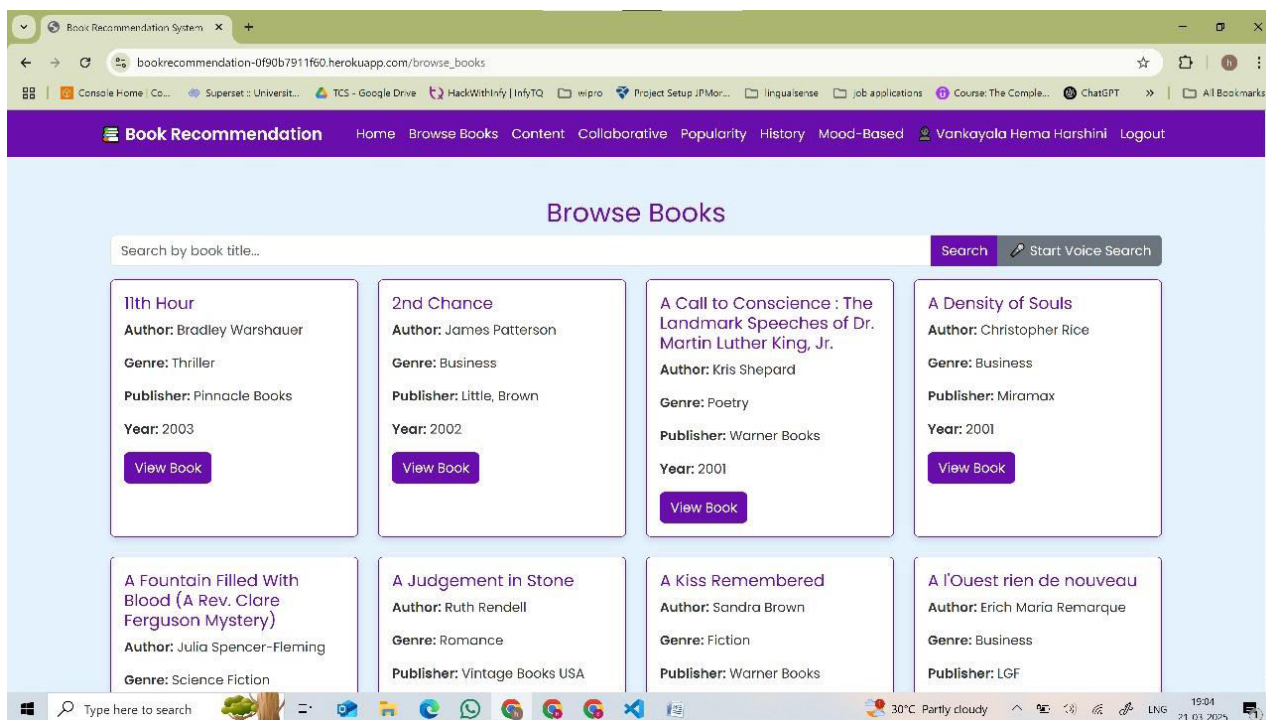
1. The system looks for books with genres containing adventure, fun, joy, excitement.
2. If no such books are found, it picks **random books** from the database.

Recommended Books (Mood: Happy)

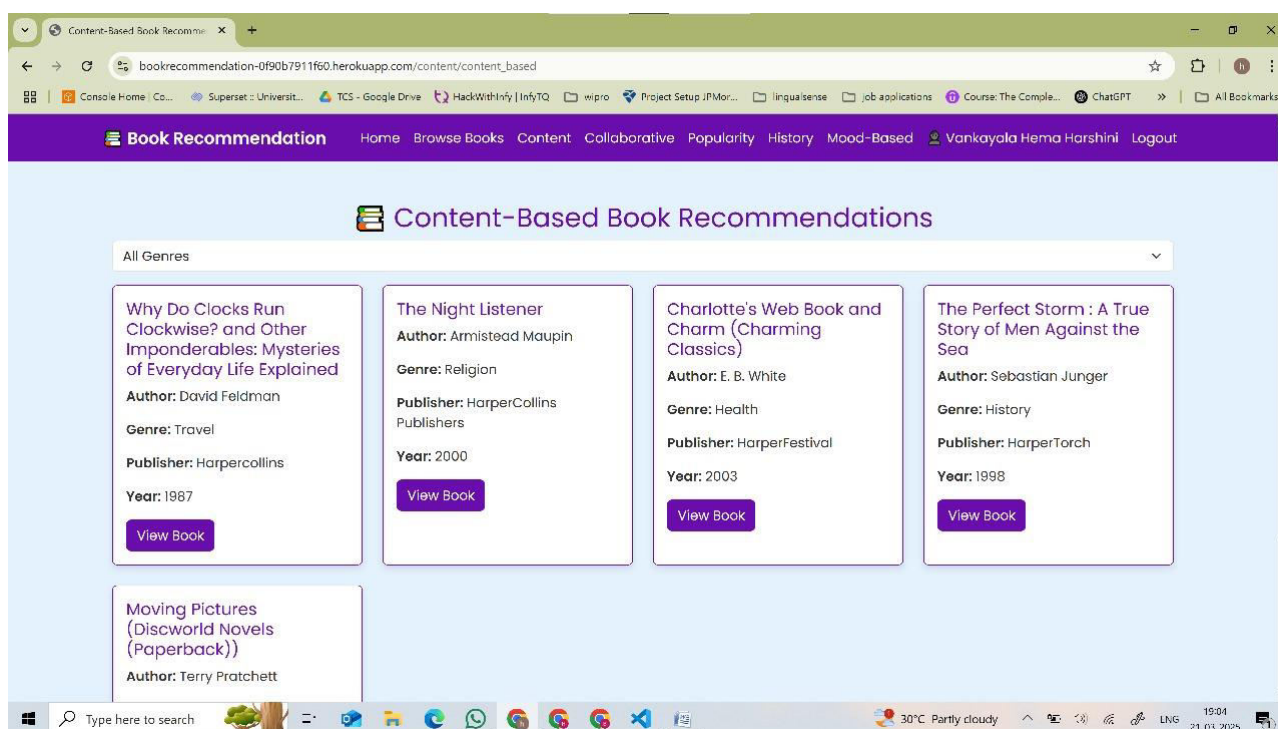
- 1 "The Hobbit" - Adventure
- 2 "Percy Jackson" - Mythology & Fun
- 3 "Harry Potter" - Fantasy Adventure
- 4 "The Alchemist" - Journey & Motivation
- 5 "The Lightning Thief" - High Energy Adventure



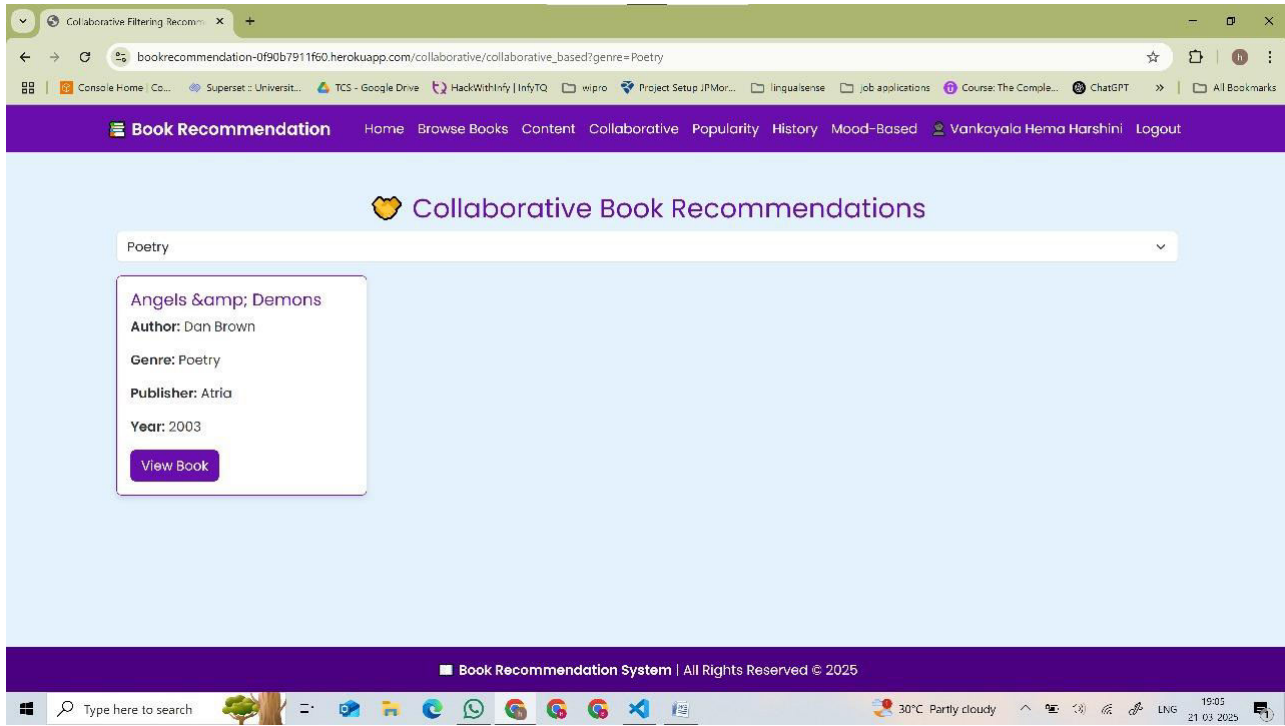
V. EXPERIMENTAL RESULTS



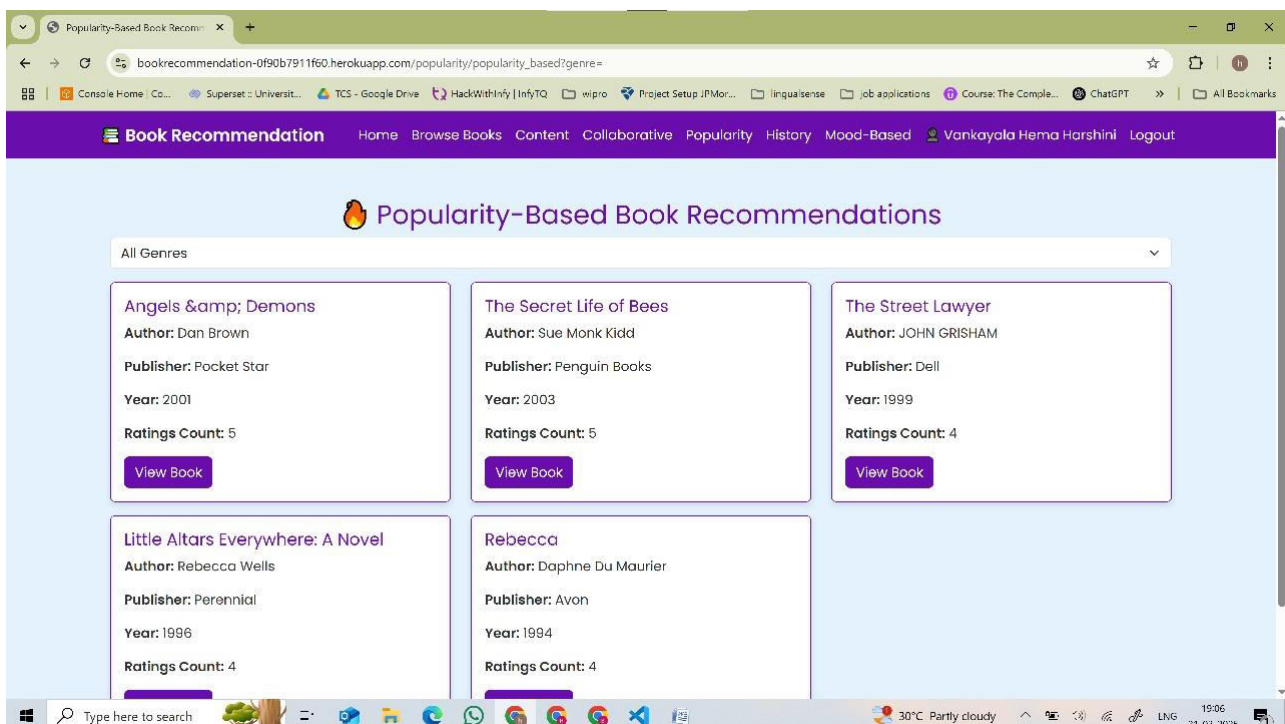
Fig(1): Browse books



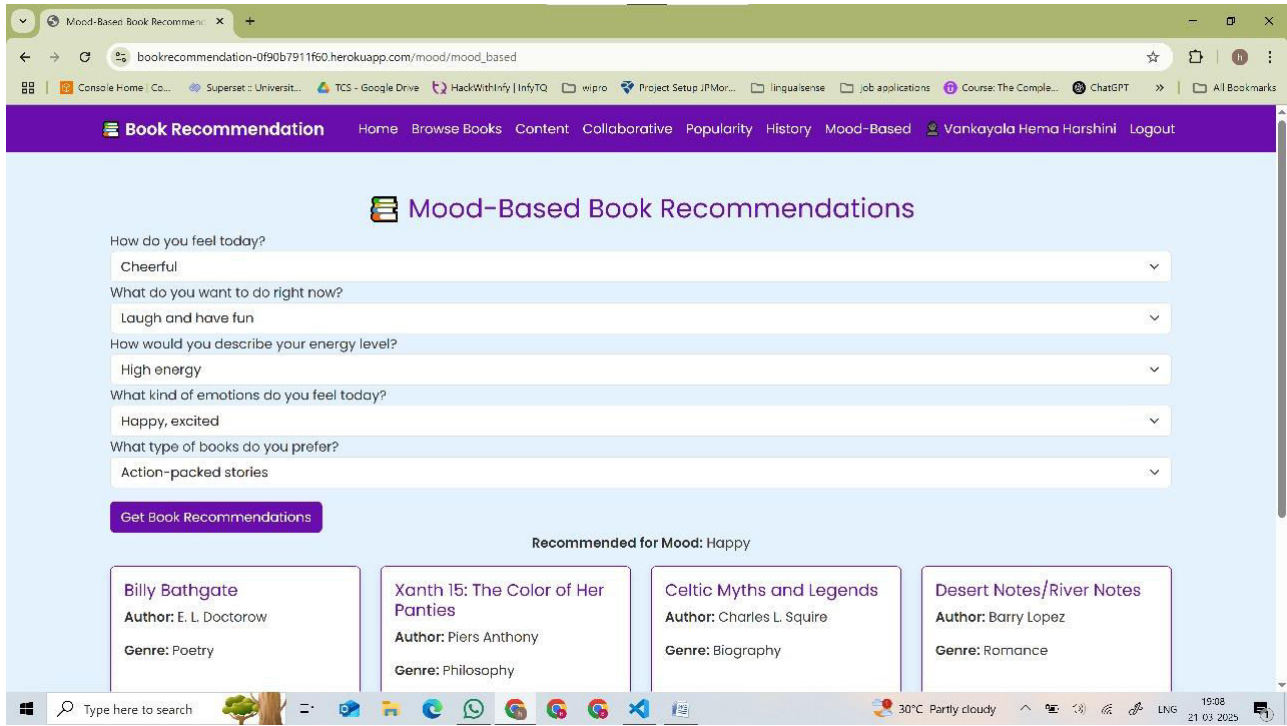
Fig(2): Content-based filtering



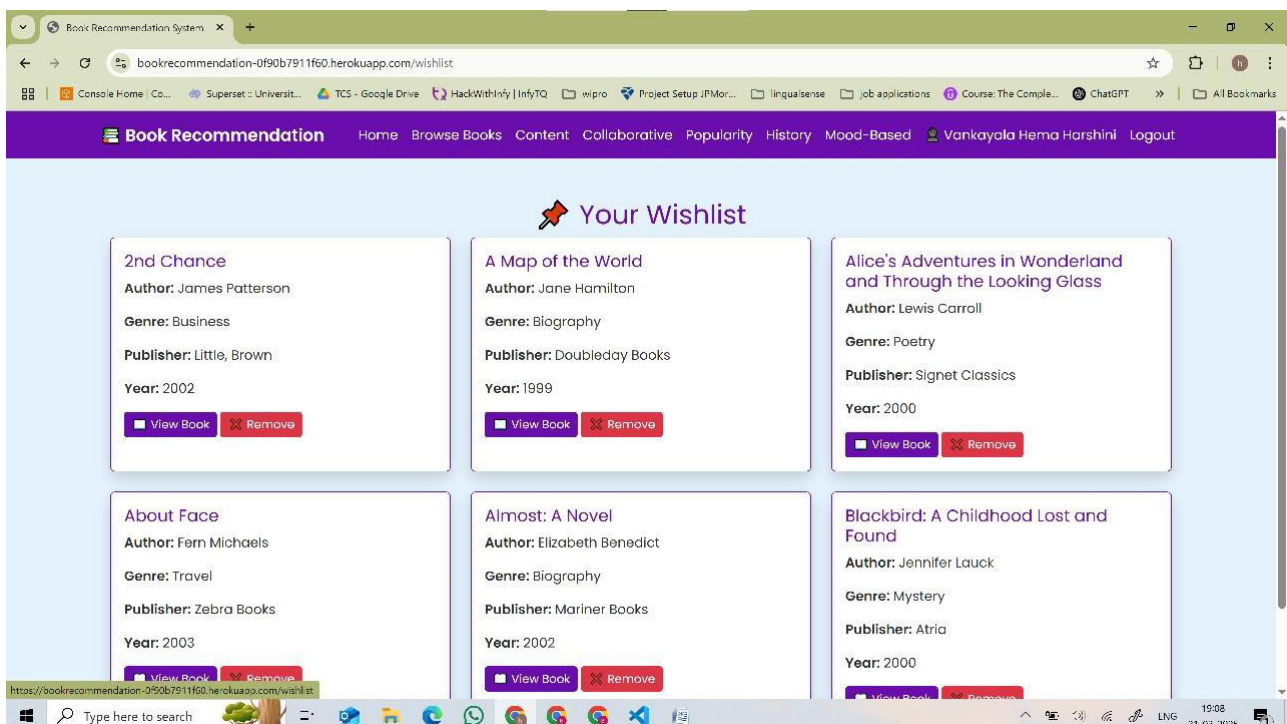
Fig(3): Collaborative filtering



Fig(4): Popularity based filtering



Fig(5): Mood based filtering



Fig(6): Whishlist

## VI. CONCLUSION

The Personalized Book Recommendation System successfully enhances the reading experience by providing customized book suggestions based on different filtering techniques, including Collaborative Filtering, Content-Based Filtering, Popularity Filtering, and Mood-Based Filtering. The system effectively integrates machine learning algorithms like K-Nearest Neighbors (KNN) and TF-IDF to recommend books based on user preferences, reading history, and emotions.

By leveraging Flask for web development and a structured database for book and user data storage, the system ensures seamless user interaction and efficient data retrieval. The mood-based filtering approach adds a unique feature, allowing users to get recommendations based on their emotional state.

Some features that could be added in the future includes

1. **Deep Learning for Better Recommendations** – Implementing **Neural Networks** and **Deep Learning models** (like Autoencoders) can refine recommendations based on more complex patterns in user behavior.
2. **Natural Language Processing (NLP) for Sentiment Analysis** – Analyzing book descriptions and user reviews can further personalize recommendations.
3. **AI Chatbot** – Integrating an AI-based chatbot to provide book recommendations based on user queries.
4. **Gamification & Reward System** – Introducing features like **badges, leaderboards, and challenges** to encourage users to explore and review books.
5. **Audiobook & E-Book Integration** – Including **audiobook and e-book** recommendations.

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