

# Framework for Hybrid Book Recommender System based on Opinion Mining



Anil Kumar, Sonal Chawla

**Abstract:** Recommender system plays an important role in automatic filtering out the important and personalized information for the intended user from a large amount of available information on internet. Recommender systems for books provide personalized recommendations to the readers for reading and to the librarians for book acquisition process. The objective of this research paper is four folds. Firstly, it conducts an extensive literature review pertaining to book recommender systems, secondly it specifies the popular recommendation techniques being used in specific application area of books, thirdly the paper reflects on the methodology followed and evaluation techniques being used based on the techniques discussed. Lastly, the paper proposes a framework for a book recommender system using best-suited recommendation techniques.

**Keywords :** Book Recommendation System, Hybrid recommendation technique, Recommendation System, Recommendation techniques.

## I. INTRODUCTION

Recommendation System is a subclass of Information Filtering, Data Mining and Machine learning. The recommender systems are gaining popularity due to the need of personalized recommendations for internet users. Recommender systems provides the personalized recommendations automatically to user by using some algorithm to ensure that user is interested in those apart from the current search that user is doing. Wang (1998) defined recommender systems as “A system that has as its main task, choosing certain objects that meet the requirements of users, where each of these objects are stored in a computer system and characterized by a set of attributes.”[1].

Applications of recommenders systems are in various fields such as in recommending movies, products, learning material, books, music etc. A lot of development and research is being done in various application of recommender system, still the book recommender systems needs much more research work to be done.

Book recommender system can be used commercially or in academic domain. It is mainly used in two folds. Firstly, it can suggest the books to the reader directly either for reading

or buying. Readers can have different characteristics like competence level, background knowledge, age group, gender etc, which needs to be considered during recommendation in order to provide personalized recommendation. By the Personalized means the books are tailored for specific user as per his interest [2]. Secondly, it can recommend books to the librarian for book acquisition so that library can be updated and readers interest can be kept in library. Librarians are restricted by their own knowledge and couldn't pick the books that satisfy the reader demands. So there is a need for a system that automatically gathers books information from various websites without librarian's intervention and suggest the books to acquire [3].

## A) Literature Review

This section provides a review of the existing literature with focus on overview of existing book recommendation system. Ahu Sieg et al. [4] Build context sensitive collaborative recommendation by incorporating semantic knowledge in the form of Domain Ontology. Reference Ontology is used instead of developing Ontology. Euclidean Distance is used to measure semantic neighborhood while variation of Resnick Standard Prediction Formula is used for prediction. Maria Soledad Pera and Yiu-Kai Ng [5] developed a PReF a personalized recommendation system that relies on social friendship on librarythings to make tailored recommendations to users. Word Correlation Factor is used to measure the degree of resemblance.

Shih-Ting Yang and Ming-Chien Hung [6] build a book acquisition recommendation model based on text mining, it first collects the history of those book enquiry cases, where in borrowers could not found the books they were looking for. The keywords are extracted from this history and are then matched with the book database of booksellers in order to obtain the list of books to be recommended. The librarians are then able to buy books based on this list.

Maria Soledad Pera and Yiu-Kai Ng [7] proposes Rabbit(Readers advisory based book recommendation tool) a Book Recommender System. It captures reading ability, preference and interest of its readers to suggest books to k-12 readers. TRoLL(Tool for regression analysis of literacy level) tool was used to compute readability level while ABET (appeal based extraction tool) was used to extract appeal term automatically from description of books. Content Similarity using bag of words using cosine similarity measured based on WCF(word Correlation Factor)

Manisha Chandak et al. [8] proposes a hybrid technique that uses the recommendation given by Collaborative Filtering and filter the users who rated the books in recommendation. Further filtration is done based on demographic features.

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\* Correspondence Author

Anil Kumar\*, Department of Computer Science, GGSDS College, Haryana, Hoshiarpur, Punjab, India. Email: anil.dadhwal@gmail.com

Dr. Sonal Chawla, Department of Computer Science and Applications, Panjab University, Chandigarh, India. Email: sonal\_chawla@yahoo.com

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These filtered users are then checked for similarity with the current user using Content Based Filtering to give the final recommendations.

Zafar Ali et al. [9] presents a hybrid book recommender using book's table of content along with association rule mining and opinions of similar users.

It preprocess the books for extracting features using PDF parser in PHP Language and then calculates the adjusted cosine similarity to give CF Recommendations, TF-IDF is used for content based recommendations. Association rule mining is then combined with CB and CF scores to give final recommendation to user

P Devika et al. [10] Proposes a novel pattern mining algorithm called Frequent Pattern Intersect Algorithm(FPIIntersect algorithm). Polarity of user comments is calculated using Naïve Bayes Text Classifier and product rating is also used to score the products and list of best products is generated for recommendation.

Edward Rolando Nunez-Valdez et al. [11] Author tried to focus on defining a mathematical model that allowed us to develop an algorithm for converting implicit into explicit feedback in an e-book platform. Nine implicit actions were evaluated as positive by twelve popular machine learning algorithm

Tamara Alvarez-Lopez et al.[12] In this paper new schemas are proposed that were useful for improving the quality of book recommendation by extracting the most important aspect expressed along with associated sentiment in reviews by experts and informal ones .

Chaloemphon Sirikayon et al. [13] In this experiment Matrix Factorization is adopted to solve the sparsity of rating Matrix. Different Similarity Calculations are compared. Book It shows Pearson similarity measure performs best among itself, Cosine and Euclidean Similarity.

Taushif Anwar and V. Uma[14] proposes a new approach of CD-SPM(Cross Domain – Sequential Pattern Mining) to recommend the preferred items by combining WPath, Collaborative Filtering and SPM Technique. The idea was to combine two different domains i.e. movies and books and recommend the books for a given movie.

## II. RECOMMENDATION TECHNIQUES

This section provides the overview of the recommendation techniques and problems faced in Book Recommendation system. [15] distinguish between different types of recommendation techniques. Each approach has its strengths as well as limitations. In the literature following techniques are specifically used in book recommender system.

### A. Collaborative Filtering

Goldberg in 1992 proposes the first ever collaborative recommender system named Tapestry, which was a research based email recommendation system [16]. Collaborative Filtering technique is used for filtering the items based on user interest. It predicts the rating based on user's past rating or ratings given by other users similar to target user. This is the reason why recommendation systems are sometimes called as rating prediction problem [17]. Two types of Collaborative Filtering:-

*User Based or Memory Based:* A user-based collaborative Filtering algorithm first searches the users who share same rating pattern as that of active user and then rating from these

similar users are used to calculate a predicted rating for the active user [18],[19]. Computational complexity of user based approach increases with the increase in the number of users and items [9].

*Item Based or Model Based:* It calculates the similarity among the items that user has liked in past with those items which user has not liked before. It recommends and selects top N items that matches with user previously liked items and meet user needs [9].

Similarity calculation algorithms like Adjusted cosine similarity[14], Slope One algorithm for prediction of Rating [8], Pearson Similarity[20], Jaccard Similarity[21], Euclidean Similarity[22], Cosine Similarity[22] are used. Once the similarity weights are calculated, top-K users with maximum weights are treated as experts to predict ratings.

Collaborative Filtering suffers from Cold start problem which occurs when the user or item is new to the system and has very less information about it and the system is unable to provide recommendations [23],[22]. In other words this is the case when nobody has rated any item both explicitly or implicitly. Sparsity problems indicates the insufficient amount of available data for identifying the similarity among users [24]. Popularity bias problem states that system is not able to recommend different items to a user with a unique taste [24]. Gray Sheep Problem represents a set of users which are having varied interest hence difficult to provide them the recommendation [23].

**B. Content Based :** Items are recommended by comparing its features with user profiles. Techniques used in content based filtering includes LSH/MinHash[8], TFIDF(Term Frequency inverse document frequency) [14],[9], Bayesian classifier, Decision Tree, Relevance Feedback [25]. Content based systems can give explanation why a particular recommendation is provided which can increase the user confidence [26]. Content Based recommendations are user independent, transparent and system can recommend unrated items as well. Content-based recommender system are difficult to implement on data formats like audio, video or images. It suffers from Overspecialized problem[17] that tends to recommend over similar items from already rated items.

**C. Ontology based:** Ontology based recommender systems are knowledge based recommender systems that kept the knowledge of user, item and relationship between them for recommendations. Similarity is found between users using user's profiles [8]. Wpath technique is used to calculate the semantic similarity between concepts of Ontology [14].

**D. Association rule mining:** It is a subpart of data mining technique which include association rule, clustering and decision tree [27]. It identifies the similarity between book titles based on confidence and support. It tries to find out the relationship between items that occur synchronously in Database [9].

**E. Hybrid Technique:** Hybrid systems hybridizes the features of two or more recommendation techniques to utilize the strength of each techniques to improve the performance [3],[8]. This technique helps in overcoming the limitations of individual recommendation technique by combining them.

Apart from above discussed techniques, the various other techniques which are not so popular among the researchers are Demographic Based that provide the recommendations to end user based on demographic classes like age, gender, location [3],[8].

Fuzzy Based that generate the recommendations based on the vague information where user expressed its interest in linguistic terms like 'most', 'at least half' and 'as many as possible' etc [28]. Group Based where in Recommendations are provided for group of users instead of individuals [18]. Social Recommender system generates the recommendation based on users social information like social tags, trust ratings used on social networking sites [29]. Aspect Based Sentiment Analysis [30] generates the recommendations based on sentiments. Few researchers try to recommend the books to the user based on their age and gender which is identified through real time video, while the reader is entering in the library [31]. SVM( Support Vector Machine) is also used for recommending books [32],[12]. Sequential Pattern Mining algorithms like PreFix Span algorithm and TopSeq SPM is applied to recommend the most similar and preferred items to the user [14].

Based on the literature review of book recommender system, recommendation techniques are popularly applied on one of the following type of data for calculating similarity and predictions.

**A. Rating Score or Explicit Information:** In this, user gives rating to books mainly on five point scale from 1 to 5 based on his own quality assessment parameters. Rating score is used for similarity calculation among user or books. Once the similarity is calculated, rating for the target user is predicted and the books with highest ratings are recommended to the user.

**B. Ranking Based:** Ranking based algorithm use ranking information rather than rating scores. It is of two types, SRM (similarity ranking method) and MRM (model-ranking method). SRM addresses the problem by a set of neighbors who have taste similar to the target user. The difference between SRM and Collaborative Filtering is the measure of the pair-wise user-to-user similarity. MRM is a machine learning-based approach which consists of two phases, model learning and rank generating [33].

**C. Library Loan records:** Books can be recommended to user based on library loan records using NDC(Nippon Decimal Classifier) categories [32]. Library Loan records can either be converted into numeric value based on some assumption like the more the time user kept the book with him the more the rating the book will get[13] or one can directly apply Association rule mining technique for recommending books.

**D. Implicit information:** Explicit feedback cause inconvenience to user as user has to stop his work and need to provide explicit feedback in terms of ratings. While implicit information related to user profile like Duration of session, no. of clicks, reading time, no. of visits, no. of comments etc can be collected without disturbing the user to measure user's interest [6] [34].

### III. EVALUATION TECHNIQUES FOR RECOMMENDER SYSTEMS

Results of different recommendation techniques further needs to be evaluated by either comparing in an online environment where system predicted rating are compared with actual user ratings or by using Splitting method [17] in which few of users latest rating are removed from database and then the predicted ratings are compared with these latest ratings that were already removed. Following evaluation techniques are used in literature:

**Accuracy:** is the fraction of relevant recommendations to all possible recommendations [8],[26]. It measures how efficiently the system generates a list of recommendations.

**Precision:** It describes the ratio of correctly recommended books and total recommendation. It indicates how many recommendations were useful to the user [7],[12],[14],[16],[22],[26],[30],[35].

**Recall:** It measures the presence of preferred and relevant items in the sequence of recommended items. It is defined as the ratio of correctly recommended books to the relevant books [4],[7],[12],[14],[16],[22], [25], [26],[30],[35].

**F1 Score:** It is the weighted average and harmonic mean of precision and recall [7],[12],[14],[17],[26]. The accuracy and recall of the algorithm changes with change in size of recommendation set. If the size of recommendation set increases, the recall rate will increase and the accuracy may decrease. So F1 measure is used for comprehensive and balanced assessment algorithm efficiency.  
F1 Score =  $2 * \text{precision} * \text{recall} / (\text{precision} + \text{recall})$  [18]

**MAE(Mean Absolute Error):** The result of recommendations are compared with true value of rating and an error value is calculated based on their difference. Error value is calculated as an average of sum of all mean absolute error [4]. The lower the MAE the better the results are.

**Questionnaires:** Questionnaire is an offline mechanism to evaluate the book recommender system in which predefined questions are asked to user [36]. After analyzing the answers one conclude whether user like the recommender system or not.

**RMSE ( Root Mean Square Error):** RMSE is used to measure the deviation between predicted and actual rating. It can be calculated using following formula [14], [37]. RMSE increases quickly with fall in no. of ratings that an item has received [10]. The Lower the RMSE the better the Algorithm [38].

**ZScore measure:** It is used to identify the most salient words belonging to the specific classes [12]. It measures the importance of different terms in a dataset.

**MAP(Mean Average Precision)** It defined as the mean of all the user's average precision [33].

**Mean Reciprocal Rank (MRR):** It computes the average ranking position of the first relevant book suggested by a recommendation system [5], [35].

**Area under the ROC curve (AUC):** It measures the probability that a system ranks a positive instance higher than a negative one [39].

**Spearman's rank :** Spearman's rank correlation coefficient is also used to evaluate the correlation coefficients for different rankings of the recommender system [40].

**IV. RESEARCH GAPS**

As per above discussed literature review, following limitations have been drawn:

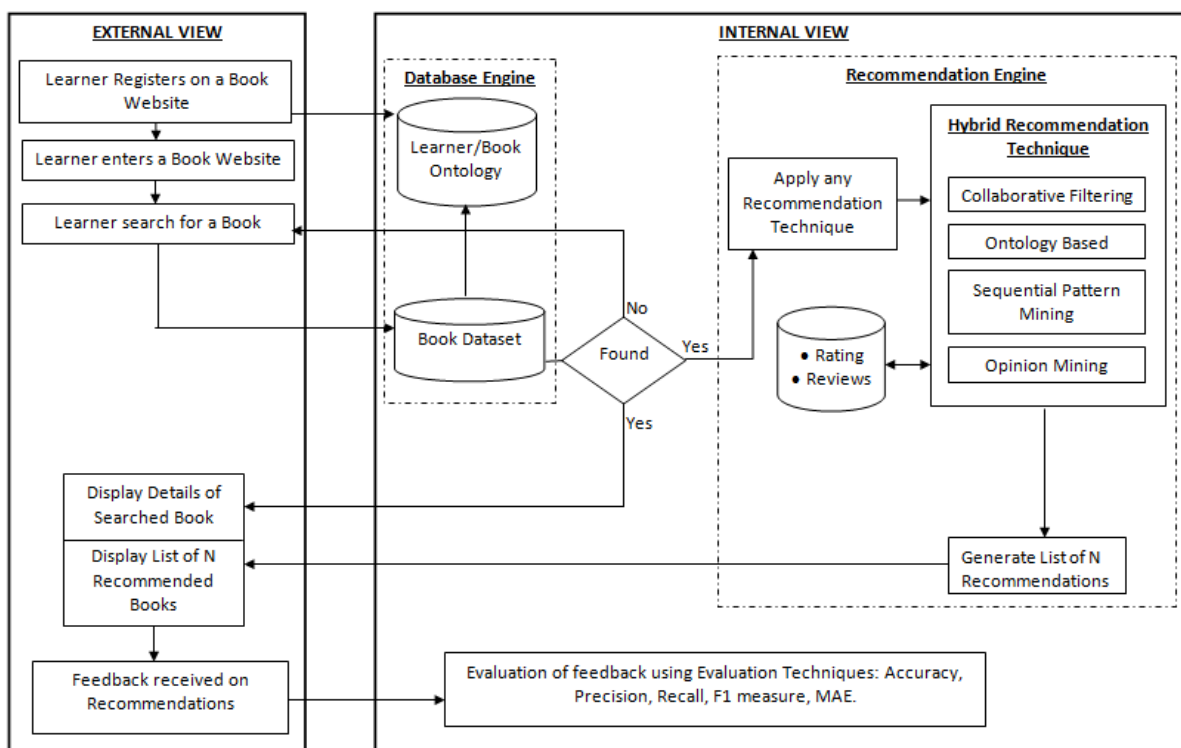
1. Hybrid recommendation technique is the most popular technique and researchers those have used hybrid technique includes the collaborative technique in it. Moreover, the best choice of algorithm is dataset dependant [19].

performance of Amazon data with the one they have used.

3. For evaluating the book recommender system Precision, Recall, F1 and MAE are most popular techniques.
4. Most of the researchers test on small data but not on large data set which can actually fill the validity generality of experiment [19].

**V. PROPOSED FRAMEWORK**

Various recommendation techniques with a special focus on book recommender system have been identified and explained in this research paper. Similar kind of tools and techniques for Recommendation Systems with a special focus on Academic Domain were also identified and compared in [41]. Therefore, the objective of the paper is to propose a book recommendation framework based on identified techniques and research gaps found in literature. So, If a book recommendation system has to be evolved then following framework for a book recommender system shall



2. There is no benchmark dataset available for book recommender system still most of the researchers use Amazon book data either directly to build up book recommender system or indirectly to compare the

act more suitable way of recommending a book. The proposed Framework is broadly divided into two main views:

**Fig.-I: Proposed Framework for Book Recommender System**

**External View:** This view represents the front-end view of the system. It is the user interface of the system where in the learner register himself by providing his basic personal information. Learner can login into the system and can search for books. In External view, learner is able to view the result of searched books along with the book recommendations generated by the system. Learner provides feedback regarding the system-generated recommendations in terms of ratings or written comments.

**Internal View:** This view is the back end of the system where in the actual processing is done on database to generate the recommendations. This view consists of Database Engine

and Recommendation Engine.

**Database Engine:** It is responsible for managing the database and ontology related to learner and books.

**Recommendation Engine:** Here any of the recommendation techniques discussed in this paper is applied on implicit and explicit data to generate the recommendations. Proposed framework implements the best-suited recommendation



technique i.e. hybrid recommendation technique to use the strength of Collaborative Filtering, Ontology, Sequential Pattern Mining, Opinion Mining to improve the system performance.

Evaluation of the feedback provided by Learner about the recommendation list is also evaluated using various statistical techniques in Internal View.

**Algorithm: Book recommender system based on Hybrid recommendation technique**

**Input:** Learner, Books Rating and Learner’s Comment from Database

**Output:** Recommendations related to Searched Book.

- Step 1. Read the Book\_id, Book\_ratings and User\_id.
- Step 2. Apply Collaborative Filtering on Book\_ratings.
- Step 3. Read Learner’s comments related to list of books generated in Step 2.
- Step 4. Preprocess the learner’s comments to remove stop words and punctuation.
- Step 5. Apply Opinion Mining to calculate polarity of comments i.e. positive or negative comments
- Step 6. Arrange the books in descending order based on calculated polarity.
- Step 7. Display the recommendations.

Overall the proposed framework will works as follows:-

1. Learner first register in book website by entering his basic details like Name, age, email id, class etc. The Ontology for the learner and book is created to represent the relationship among them.
2. Registered learner login the book website by entering his login credentials and searches for a particular book.
3. Entered Book is searched in book database i.e. Amazon Book Review Database.
4. If the book is not found learner will again search for book and If the book is found, its details are shown to the user. Simultaneously, Hybrid technique is applied to generate the book recommendations.
  - a. Collaborative filtering is applied on book ratings to generate a list of recommended books based on Ontological similarity and prediction calculation.
  - b. Apply sequential pattern mining to mine the history of learner to look for patterns.
  - c. Preprocessing of the user reviews related to the books in recommendation list to perform opinion mining. Preprocessing includes tokenization, removal of stop words and punctuation.
  - d. Mine the user reviews by using dictionary based sentiment analysis to identify the positive and negative reviews.
  - e. After opinion mining, book with most positive reviews will come first in recommendation list and so on in descending order. This final recommendation list is displayed to the user along with the details of actual searched book.
5. The proposed system will be evaluated using Precision, Recall, F1 & MAE statistical techniques. The learner’s satisfaction will be measured with the help of questionnaires.

**VI. CONCLUSION**

This research paper attempts to conduct a systematic literature review as well as analyzes the existing recommendation techniques being used specifically in area of book recommender system. Hybrid recommendation technique is found to be most popular recommendation technique for book recommender systems. Therefore, this research work proposes a framework for a book recommender system to incorporate the qualitative information found in learner’s comments to be considered during recommendation process. The proposed system is based on hybrid recommendation technique by combining the aspects of Collaborative Filtering and Opinion mining. We will continue investigating the proposed the system for its outcome and evaluation.

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### AUTHORS PROFILE



**MR. ANIL KUMAR** is working as an Assistant Professor in GGDSD College, Haryana, Hoshiarpur, Punjab, India. He is currently pursuing Ph.D. from Department of Computer Science and Applications, Panjab University, Chandigarh, India. His research work mainly focuses on Recommendation Systems, and Sentiment Analysis. He has 3 years of teaching experience and research experience



**DR. SONAL CHAWLA** is working as Professor in Department of Computer Science and Applications, Panjab University, Chandigarh, India. She has published more than 25 research papers in reputed international journals including Thomson Reuters (SCI & Web of Science) and conferences. Her areas of research are Software Engineering, Operating Systems, E-Learning, Semantic Web Applications. She has 21 years of teaching experience and research experience