An Approach to Incorporate Textual Reviews in Book Recommender System

Anil Kumar

Department of Computer Science, G.G.D.S.D. College, Hariana, Hoshiarpur, Punjab, India

Sonal Chawla

Department of Computer Science and Applications, Panjab University, Chandigarh, India

Corresponding author: Anil Kumar, Email: anil.dadhwal@gmail.com

Recommender systems are widely accepted by internet users to find suitable products in various domains. In the academic domain, the book recommender system provides personalized books to the learner to retain his interest in the learning environment. It also helps in reducing cognitive stress faced by learners due to non-personalized recommendations and information overload. The existing recommender systems recommend books to the learner based on the learner's preferences yet the learner struggles in retrieving tailored recommendations. This leads to an increase in learner's stress and anxiety. To relieve stress and anxiety, appropriate recommendations can be provided to the learner by considering the textual reviews of books given by peer learners. Sentiments of the textual reviews can be used to complement the explicit ratings of books to achieve higher recommendation reliability. So the objective of this paper is to propose and elaborate the framework for a book recommender system that integrates sentiment analysis with collaborative filtering to improve the predicted ratings. The proposed recommendation system is based on KNN and lexicon-based sentiment analysis. The results of the evaluation and testing of the proposed framework show that there is a significant improvement in the performance of the recommender system.

Keywords: Hybrid Book Recommender System, Book Recommender System, Sentiment Analysis, Collaborative Filtering.

2021. In Rahul Srivastava & Aditya Kumar Singh Pundir (eds.), *New Frontiers in Communication and Intelligent Systems*, 635–647. Computing & Intelligent Systems, SCRS, India. https://doi.org/10.52458/978-81-95502-00-4-65

1 Introduction

The huge availability of books on the internet has raised the problem of identifying the book that discusses the learner's needs and desires. Examining each book manually in the search results and choosing one of them is a cumbersome, tedious, and time-consuming task for learners [1]. So there exists an information filtering process to deal with this task efficiently. Book recommender system is a subclass of information filtering which can filter and recommend books as per learner's requirement. Book recommender systems accomplish this task by monitoring the data of the learner, such as profile, likes, dislikes and browsing history to provide customized and personalized recommendations [2]. Giving exposure to non-personalized books may reduce the confidence of the learner in the book recommender system. To preserve this confidence, the book recommender system must consider textual reviews along with the above-mentioned inputs to suggest the books. Moreover, online textual reviews and comments are growing day by day and a large portion of internet users rely on reviews to make decisions.

Existing recommender systems use recommendation techniques like collaborative filtering, content-based, ontology-based, association rule mining, and hybrid techniques. These available techniques can be applied to ratings, ranking, and implicit information to calculate similarity among users or items to generate recommendations [3]. Among these techniques, the hybrid technique is the most popular in recommender systems due to its feature of utilizing the strength of different techniques which results in improved performance [4]. Therefore, the proposed book recommender framework implements the hybrid technique of collaborative filtering and sentiment analysis to generate recommendations for computer science books only. The final recommendation list includes the books based on user interest which is calculated with the help of collaborative filtering and sentiment analysis of the reviews.

The rest of the paper is organized as follows, in section 2, related work in sentiment analysis and collaborative filtering is discussed. Section 3 discusses the methodology followed to create the framework. In the next sections, experimental work and result is discussed. Finally in section 6, conclusion and the future task of the research is discussed.

2 Related Work

Book recommender systems mainly deal with the problem of identifying the similarity among books to predict ratings and recommending books. Implicit and explicit inputs are used for rating prediction to provide recommendations. There are attempts to use implicit inputs i.e. textual reviews in recommender systems using sentiment analysis. Leung et al. [5] tried to determine the sentiment orientation and strength of opinion words. They proposed a relative-frequency-based method to determine the sentiment orientation and strength of opinion words. Kumar et al. [1] attempted to include internal feed-back from the users and external feedback from social media like Twitter to improve the recommendation system that was based on user-based and item-based collaborative filtering. Singh et al. [2] combines content-based and sentiment analysis technique for recommendation by considering positive and negative sentiments. Sohail et al. [6][7] presents an opinion mining-based recommendation technique that takes into account both expert and reader's opinions and addresses the issue of recommending books as per the university syllabus. The proposed algorithm takes into the reciprocal meaning of interpretation terms with the help of human intelligence for final recommendation. Tiwari and Priyanka [8] attempt to suggest the list of books whose features are similar to what the user had posted in the reviews about those features, in the past, for different books. Mounika and Saraswathi [9] use a four-level process that includes document-level sentiment analysis and KNN to recommend the books. Miguel et al. [10] categorized the users based on the

average polarity of their textual reviews and these categories are used as attributes in collaborative filtering algorithms. Dubey et al. [11] created a dictionary of sentiment scores which is calculated by finding the probability of the review to be positive. This sentiment score is used by item-based collaborative filtering system to improve the recommendation and filter out items with overall negative user opinion. Sundari and Subaji [12] applied lexicon-based sentiment analysis on tags, not on the textual reviews and integrated it with collaborative filtering to recommend books. Ramzan et. al [13] proposed hybridization of opinion based sentiment analysis with CF for hotel recommendation system. The proposed system is based on sentiments towards hotel features and guest type using fuzzy rules.

Researchers also attempt to use hybrid techniques without inclusion of sentiment analysis. Ali et al. [14] presents a hybrid book recommender system based on content-based and collaborative filtering along with Table of Contents and association rule mining to consider the book content along with metadata of books. Ekstrand et al. [15] present a recommendation system that handles the issue of bias, discrimination, and stereotyping. The author measures the distribution of genders of the authors of the books in user rating profiles and recommends a list using publicly available book rating data. Yiu [16] integrated the collaborative and content-based filtering technique to provide a hybrid book recommender system i.e. CBRec to recommend grade-level books for the children. It makes use of ReLAT to infer the readability level of the user. User profiles are created based on user ratings i.e. collaborative filtering approach is used to create user profiles based on user ratings while the Content-Based approach is applied using the description of the books rated by a user in the past.

As per the literature review, the hybrid recommendation technique has been applied to many of the recommender systems. It is found to be the most famous technique among researchers and collaborative filtering is found in the majority of hybridization in recommender systems. The main motive of the researchers is to include the user's feed-back either implicitly or explicitly while providing recommendations. Collaborative filtering helps to include explicit user feedback while sentiment analysis provides implicit user feedback which is found to play an important role in recommendations and can improve user satisfaction levels [7]. Fusion of reviews with collaborative filtering can be efficient inpredicting user's preferences rather than using single system [17].

Therefore, the proposed framework for the book recommender system is based on the hybrid technique of collaborative filtering and sentiment analysis.

2.1 Collaborative Filtering

It is a domain independent in nature [18]. It helps to enhance the user's experience and make it more fruitful. In this, the system looks for neighbors, which are having similar interests to the target user, based on the ratings. It can be of two types:

User-Based or Memory Based: In this the user profile is compared with other users to look for overlapping of interest [14]. The items are recommended to the target user based on the preference of a set of users, which are similar to the target user. It is like taking suggestions about an item from friends who have similar interests and have already used that item.

Item Based or Model Based: It calculates the similarity in ratings among different items and determines the set of similar items.

To calculate the similarity, various similarity calculation algorithms like Cosine Similarity, Adjusted cosine similarity, Pearson Similarity, Jaccard Similarity, Euclidean Similarity are used [7]. After similarity calculation, a prediction algorithm is used to predict the rating for the selected item.

2.2 Sentiment Analysis

It is a technique of identifying the sentiments behind the text i.e. the polarity of the text which is measured as positive, negative, or neutral. Text is preprocessed before identifying the sentiments. Preprocessing includes stemming, stop word removal, opinion word extraction, and converting data into lowercase. The sentiment behind the extracted opinion words is identified based on the following two approaches.

Machine Learning Approach: It helps to detect the sentiments based on the selection and extraction of features. The techniques used in the machine learning approach are SVM, Naïve Bayes, and Maximum Entropy [19].

Lexicon Based Approach: This technique depends upon the predetermined set of sentiment terms, phrases. It can be of further two types dictionary-based and corpus-based. Both use the predetermined set of annotated words, the difference is that the corpus-based provides domain-specific dictionaries [19].

3 Framework for Hybrid Book Recommender System

This section explains the framework which is based on the architecture of the data-base systems as proposed by ANSI-SPARC. The framework (Figure 1) is divided into three levels i.e. external level, conceptual level and internal level. External level is an interface for the end-user. Conceptual level consists of database schema and recommendation engine. Internal level consists of database only.

3.1 External level

The external level is the user interface for the learner wherein the learner gets himself registered by filling out the basic details and can search for a particular book. The search sentence is broken into individual keywords and all the books that match with the keywords appear. After selecting the required book, the details of the book along with the recommendations are provided to the learner. This level allows the learner to provide the feedback of the books in terms of rating and comments.

3.2 Conceptual level

The conceptual level consists of schemas that contain the information related to books, authors, and learners. Actual processing is done at this level to generate the recommendation using recommendation engine.

3.2.1 Recommendation Engine

The recommendation engine implements collaborative filtering and sentiment analysis. In the proposed framework item based collaborative filtering using KNN (K nearest neighbors) is used on explicit ratings. Cosine similarity was applied to identify the similarity between two books based on their ratings to identify the neighbors.

The cosine similarity among two books (A, B) was calculated as below:

$$\text{Similarity} = \cos(\theta) = \frac{A \cdot B}{\|A\|\|B\|} = \frac{\sum_{k=1}^{n} A_k B_k}{\sqrt{\sum_{k=1}^{n} A_k^2}\sqrt{\sum_{k=1}^{n} B_k^2}}$$

The value of the cosine similarity of the two books is in the range of 0 to 1 [20] . The high similarity is indicated by a value close to 1 while the weak similarity is indicated by a value close to 0 [21].

Once similarity calculation is done then top K neighbors are considered experts to predict the rating. A group of ten nearest neighbors is used which is cited as the ideal group size for predicting user ratings [16]. The engine predicted the rating of a book i for a user u, based on earlier ratings of u on books similar to i. The rating for the target item i for active user u was predicted by a simple weighted average.

$$p_{u,i} = \frac{\Sigma_{j \in K} r_{u,j} w_{i,j}}{\Sigma_{j \in K} |w_{i,j}|} \qquad \ldots\ldots (1)$$

Here K was the neighborhood of most similar items which are rated by user u and wi,j is the similarity between book i and j. The value of pu,i is calculated in the range of (0, 5).

A list of ten books is recommended using collaborative Filtering. This list is passed on to the Sentiment Analysis part of the recommendation engine.

Sentiment Analysis is done using a dictionary-based approach which is one of the types of Lexicon-based approach. The dictionary of predetermined positive and negative words for calculating sentiments of the reviews is taken from https://www.cs.uic.edu/~liub/FBS/sentiment-analysis.html. Generally, the book with more positive reviews is likely to be preferred by a learner as compared to the one with negative reviews. To calculate the polarity of book reviews, sentences are firstly split into tokens i.e. individual words. Positive and Negative words from the dictionary are also split into tokens. The extracted tokens from the learner reviews are then compared with positive and negative words to count the number of positive and negative tokens. The final sentiment score of the sentence is calculated as the difference between total positive and negative tokens. Below pseudo code explains that how the system calculates the final scores of a sentence as positive or negative.

Algorithm: To calculate the sentiment score of a Sentence

Input: Sentence

Output: Sentiment Score of Sentence.

Step 1. Pass the sentence to function calculate.

Step 2. Count positive words

Num_Positive_words=0

If extracted_words in Positive_Dictonary_words

Num_Positive_words = Num_Positive_words+1

Step 3. Count Negative words

Num_ negative_words=0

If extracted_words in negative_Dictonary_words

Num_negative_words = Num_negative_words+1

Step 4.Calculate Final_Score of sentence = Num_Positive_words -Num_Negative_words

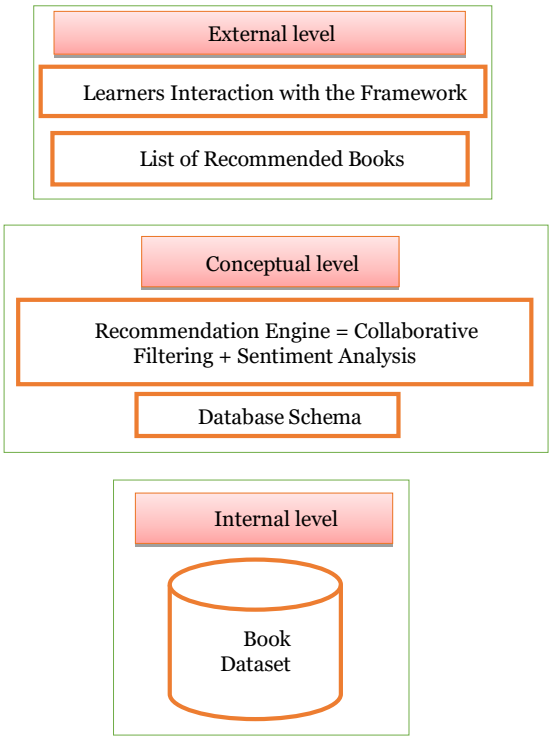


Fig. 1. Framework for hybrid book recommender system

Using the above pseudo-code, sentiment score is calculated for each book in the recommendation list generated by collaborative filtering. Finally, the framework displays two recommendation lists. The first list is generated by collaborative Filtering while the second list is generated using hybridization of collaborative filtering and sentiment analysis. The books in the first list are arranged in the descending order of predicted rating while in the second list they are arranged in such a way that learners got the book with the most positive reviews as the first item and the book with the least positive reviews as the last item.

3.3 Internal View

It is meant for physically representation of the database

4 Implementation of Framework for Hybrid Book Recommender System

The proposed framework for hybrid book recommender system is implemented as mobile friendly website http://anildadhwal.pythonanywhere.com. External view of the proposed framework is

implemented using HTML5, JAVAScript, PHP, JQuery, BootStrap 4.1 and the internal view is implemented with the help of Django 2.0.7 and Python 3.6.

For testing of the proposed framework, the reviews of books are taken from Amazon Book Review dataset, which is available for academic researchers. This framework is not restricted to a particular dataset rather it will work for any book datasets.

Following are the step-by-step screenshots for accessing the framework:

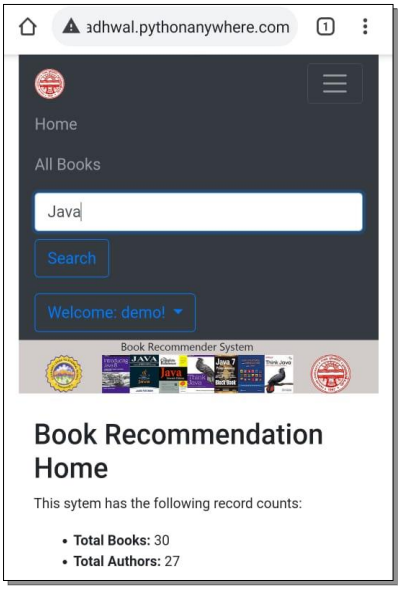


Fig. 2. External view wherein user can search for book after successful login in the system

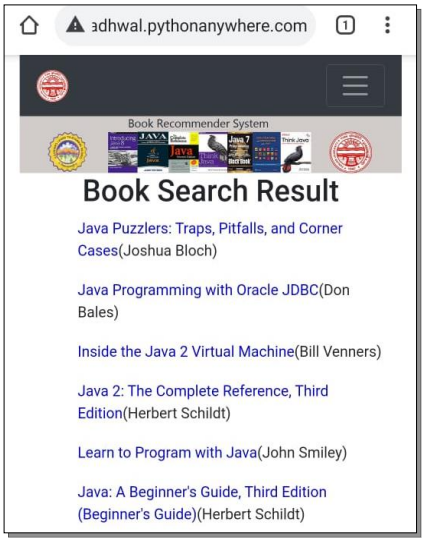


Fig. 3. Result of the User Query

5 Results and Discussion

This section represents the experimental results of the evaluation of the proposed framework. The results are compared with the existing state of art algorithm i.e. collaborative filtering technique only. Two experiments are conducted to evaluate the proposed framework. In the first experiment, evaluation metrics such as accuracy, precision, recall, and F1 score are used, whereas the statistical techniques are employed in the second experiment to reflect the learner's behavior.

5.1 Experimental Setup 1

In this experimental setup, evaluation metrics such as accuracy, precision, recall, and F1 Score are calculated based on below confusion matrix to measure the performance of both the techniques i.e. collaborative filtering and hybridization of collaborative filtering and sentiment analysis.

		Recommended	
		Positive	Negative
Actual	Positive	True Positive (TP)	False Negative (FN)
	Negative	False Positive (FP)	True Negative(TN)

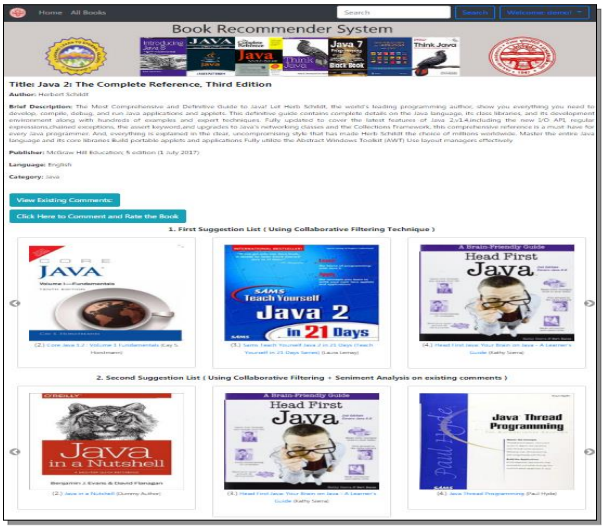


Fig. 4. Details of the book selected by user along with the two recommendation lists

Accuracy [22] measure the efficiency with which system can generate list of recommendations and is calculated as:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

Precision [23] is the ratio of correctly positive recommended to total positive recommendations.

$$Precision = \frac{TP}{TP + FP}$$

Recall [23] measure the presence of correctly positive to actual positive recommendations

$$Recall = \frac{TP}{TP + FN}$$

F1 [23] Score is a harmonic mean of Precision and Recall.

$$F1 = 2 * \frac{Precision * Recall}{Precision + Recall}$$

For this experiment, the proposed algorithm is implemented and executed using Google Colab. A static dataset consists of 30 books, 801 learners, 873 reviews are taken from

http://anildadhwal.pythonanywhere.com. In this dataset, learners have rated the book on a scale of 1 to 5. A publicly available lexical resource SentiWordNet [24] which provides positive, negative, and objectivity scores to a particular word, is used to do the sentiment analysis. SentiWordNet is chosen as it is widely used in literature for conducting sentiment analysis.

For comparative analysis, proposed technique is compared with state-of-art algorithm i.e. item based collaborative filtering

Firstly, item-based collaborating filtering is used to generate the prediction matrix for each user and book on a scale of 1 to 5. The prediction matrix along with the actual rating matrix is used to calculate the above said evaluation metrics.

Secondly, the prediction matrix already generated by item based collaborative filtering is modified using sentiment analysis. In this, the positive score of the reviews of every book is calculated using SentiWordNet. SentiWordNet returns the positive score for every word and overall score of the review is calculated by adding the positive score of individual word. The positive score is then normalized to a scale of 0 to 5 using below standard formula:-

$$x_{inor} = (b - a)\left[\frac{x - \min(x)}{\max(x) - \min(x)}\right] + a \qquad \ldots\ldots(2)$$

where in x_{inor} was the normalized value of positive score in the range of (a, b) i.e. (0, 5) for i^{th} book.

Hybridization of collaborative Filtering and sentiment analysis is done by adding the normalized positive score of book review is to the prediction matrix generated by item based collaborative filtering to predict the final modified predictionvalue.

$$mp_{u,i} = p_{u,i} + x_{inor}$$

where $mp_{u,i}$ is the modified prediction based on $p_{u,i}$ calculated in equation (1) and x_{inor} in equation (2). If the final value of $mp_{u,i}$ comes out to be negative, it is considered as 0 and if it comes out to be more than 5 then it is considered as 5. Evaluation metrics were again calculated for $mp_{u,i}$.

For the proposed framework, while calculating the confusion matrix,3 is the threshold value which means a rating is considered as positive if its value is greater than or equal to 3 otherwise it is considered as negative.

Table 1: Values of accuracy, precision, recall, and F1 for both the techniques

Technique	Accuracy	Precision	Recall	F1
Collaborative Filtering (state-of-art Algorithm)	0.959759	0.048110	0.019886	0.028141
Hybridization of Collaborative Filtering and Sentiment Analysis	0.831669	0.073961	0.411932	0.125405

From table 1 and figure 5, it can be seen that the hybrid technique outperforms the state of art technique i.e. collaborative filtering technique in all the evaluation metrics except accuracy. This result indicates that the hybridization of sentiment analysis with collaborative filtering contributes to the improvement of evaluation metrics and is better than collaborative filtering.

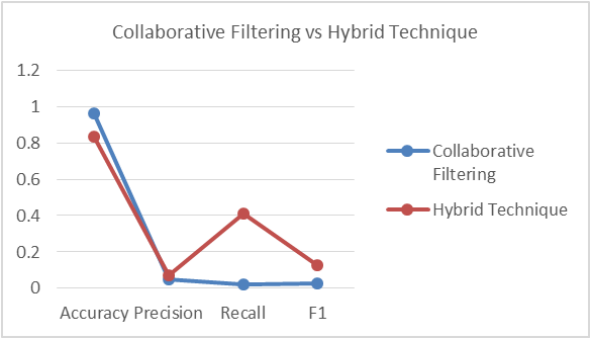


Fig. 5.

5.2 Experimental Setup 2

In the second experimental setup, statistical techniques are employed to study the learner's behavior and satisfaction level. For this, a closed-ended questionnaire of nine questions (Figure 6) is filled out by the learners. Only a registered interactive learner on http://anildadhwal.pythonanywhere.com could submit the questionnaire. 109 learners of graduate and postgraduate courses of five different institutes participated in this experiment. As discussed in section 3 learners are provided with two recommendation lists i.e. based on the collaborative filtering technique only and based on Hybridization of collaborative filtering and sentiment analysis. Learners are asked to rate these individual recommendation lists on a Likert scale (Strongly Disagree, Disagree, Satisfied, Agree, and Strongly Agree) in the questionnaire (Figure 6).

To test the effectiveness of the system following null hypotheses were framed:

H1: There is no difference between the ratings given by learners to individual recommendation lists.

To check the null hypothesis Paired Sample Test is conducted

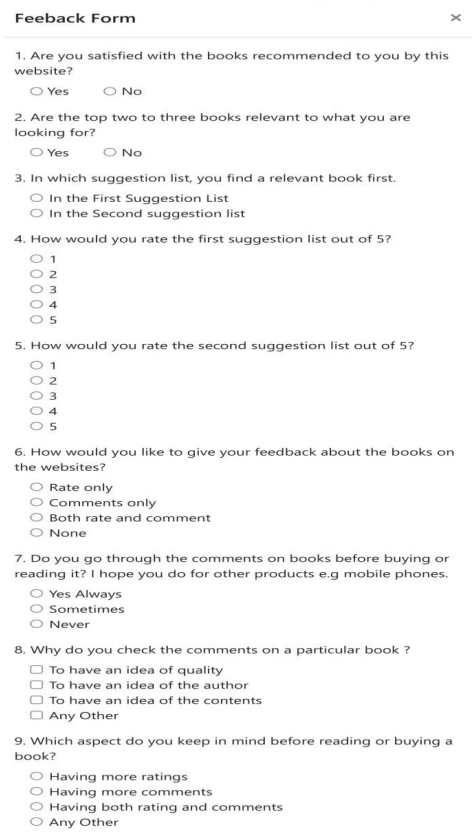
The result of the test is as $t(108) = -5.226$, $p < 0.0005$). Due to the means of the two ratings and the direction of the t-value, null hypothesis is rejected and it can be concluded that there is difference between the ratings given by learners to individual recommendation list. It is also found that there is a statistically significant improvement in rating from 3.55 ± 1.07 to 4.15 ± 0.85 ($p < 0.0005$). Improvement in ratings clearly shows that the learner find the second list based on hybridization of collaborative filtering and sentiment analysis to be more appealing rather than the first list based on collaborative filtering only. This leads to increased satisfaction of the learner.

H2: There is no association between the list chosen by the learner as satisfactory and the rating given learner to the individual lists.

Chi-Square Statistical test is employed to evaluate this hypothesis. Based on result of $\chi^2(4) = .0001^{**}$, $p = .0001^{**}$ for first recommendation list i.e. based on collaborative filtering technique and $\chi^2(4) = .006^{**}$, $p = .006^{**}$ for second recommendation list i.e. based on hybrid technique, null hypothesis is rejected and based on it can be stated that ratings given by learners are in strong association with the list chosen as satisfactory by the learner, which means that learners are more satisfied with proposed hybrid technique rather than collaborative filtering technique.

From the learners' responses, some other facts are also noticed that support the importance of introducing sentiment analysis of reviews in process of recommending books. It is found that 60.6% of the learners' preferto give feedback in terms of "both ratings and comments" while only 2.8% of the learners didn't prefer to give feedback in form of either ratings or comments. 97.2 % of the learners go through the comments and 72.5% of the learners rely on both ratings and comments while buying or reading a book.

The above facts also encourage the researchers to use textual reviews along with ratings for recommender systems to increase the learner's satisfaction.


Feeback Form

1. Are you satisfied with the books recommended to you by this website?
○ Yes ○ No

2. Are the top two to three books relevant to what you are looking for?
○ Yes ○ No

3. In which suggestion list, you find a relevant book first.
○ In the First Suggestion List
○ In the Second suggestion list

4. How would you rate the first suggestion list out of 5?
○ 1
○ 2
○ 3
○ 4
○ 5

5. How would you rate the second suggestion list out of 5?
○ 1
○ 2
○ 3
○ 4
○ 5

6. How would you like to give your feedback about the books on the websites?
○ Rate only
○ Comments only
○ Both rate and comment
○ None

7. Do you go through the comments on books before buying or reading it? I hope you do for other products e.g mobile phones.
○ Yes Always
○ Sometimes
○ Never

8. Why do you check the comments on a particular book ?
☐ To have an idea of quality
☐ To have an idea of the author
☐ To have an idea of the contents
☐ Any Other

9. Which aspect do you keep in mind before reading or buying a book?
○ Having more ratings
○ Having more comments
○ Having both rating and comments
○ Any Other

Fig. 6. Questionnaire for measuring learner's satisfaction

6 Conclusions

This paper presents a generic framework for a hybrid book recommender system. Evaluation and comparison of the framework is done using standard parameters and found that hybridization of collaborative filtering and sentiment analysis outperforms the state of art algorithm i.e. collaborative filtering. However, the values of the parameters come out to be small which might be because of the

small nonstandard sparse dataset under consideration. The empirical study of the framework reveals that on the same dataset learners find the second recommendation list based on a hybrid technique to be more satisfactory than the first one based on collaborative filtering only. It is also found that the learners prefer to give feedback on the book recommender systems and go through the reviews to check the quality of the book. Also to check the quality of books, learner relies on both ratings and reviews. So both ratings and reviews should be considered for hybridization in book recommender systems. Future work will focus on integrating other technologies and conducting more evaluation techniques to check the performance and accuracy of the book recommender system.

References

[1] Kavinkumar, V. et al. (2015). A hybrid approach for recommendation system with added feedback component. in *International Conference on Advances in Computing, Communications and Informatics*, 745–752.

[2] Singh, V. K., Mukherjee, M. and Mehta, G. K. (2011). Combining a content filtering heuristic and sentiment analysis for movie recommendations. *Communications in Computer and Information Science*, 659–664.

[3] Kumar, A. and Chawla, S. (2019). Framework for Hybrid Book Recommender System based on Opinion Mining. *International Journal of Recent Technology and Engineering*, 8(4):914–919.

[4] Cui, B. and Chen, X. (2009). An online book recommendation system based on web service. In *6th International Conference on Fuzzy Systems and Knowledge Discovery*, 7:520–524.

[5] Leung, C. W., Chan, S. C. and Chung, F. (2006). Integrating Collaborative Filtering and Sentiment Analysis : A Rating Inference Approach. In *Proceedings of the ECAI 2006 workshop on recommender systems*.

[6] Sohail, S. S., Siddiqui, J. and Ali, R. (2013). Book recommendation system using opinion mining technique. In *Proceedings of the International Conference on Advances in Computing, Communications and Informatics*, 1609–1614.

[7] Sohail, S. S., Siddiqui, J. and Ali, R. (2018). Feature-Based Opinion Mining Approach (FOMA) for Improved Book Recommendation. *Arabian Journal for Science and Engineering*, 43(12): 8029–8048.

[8] Tewari, A. S. and Priyanka, K. (2014). Book recommendation system based on collaborative filtering and association rule mining for college students. In *Proceedings of International Conference on Contemporary Computing and Informatics*, 135–138.

[9] Mounika, A. and Saraswathi, S. (2021). Design of book recommendation system using sentiment analysis. *Lecture Notes on Data Engineering and Communications Technologies*, 53: 95–101.

[10] García-Cumbreras, M. Á., Montejo-Ráez, A. and Díaz-Galiano, M. C. (2013). Pessimists and optimists: Improving collaborative filtering through sentiment analysis. *Expert Systems with Applications*, 40(17): 6758–6765.

[11] Dubey, A. et al. (2019). Item-based collaborative filtering using sentiment analysis of user reviews. In book: *Applications of Computing and Communication Technologies*, 899: 77-87.

[12] Shanmuga Sundari, P. and Subaji, M. (2020). Integrating Sentiment Analysis on Hybrid Collaborative Filtering Method in a Big Data Environment. *International Journal of Information Technology and Decision Making*, 19(2):385–412.

[13] Ramzan, B. et al. (2019). An Intelligent Data Analysis for Recommendation Systems Using Machine Learning. *Scientific Programming*, 2019: 5941096.

[14] Ali, Z., Khusro, S. and Ullah, I. (2016). A hybrid book recommender system based on Table of Contents (ToC) and association rule mining. In *ACM International Conference Proceeding Series*, 68–74.

[15] Ekstrand, M. D. et al. (2018). Exploring author gender in book rating and recommendation. In *12th ACM*

Conference on Recommender Systems, 242–250.

[16] Ng, Y.-K. (2016). Recommending Books for Children Based on the Collaborative and Content-Based Filtering Approaches. *O. Gervasi et al. (Eds.): ICCSA 2016, Part IV, LNCS 9789*, 302–317.

[17] Srifi, M. et al. (2020). Recommender systems based on collaborative filtering using review texts-A survey. *Information (Switzerland)*, 11(6): 1–21.

[18] Parhi, P., Pal, A. and Aggarwal, M. (2017). A survey of methods of collaborative filtering techniques. In *Proceedings of the International Conference on Inventive Systems and Control*, 1–7.

[19] Serrano-Guerrero, J. et al. (2015). Sentiment analysis: A review and comparative analysis of web services. *Information Sciences*, 311: 18–38.

[20] Cobos, C. et al. (2013). A hybrid system of pedagogical pattern recommendations based on singular value decomposition and variable data attributes. *Information Processing and Management*, 49(3): 607–625.

[21] Duma, M. and Twala, B. (2018). Optimising latent features using artificial immune system in collaborative filtering for recommender systems. *Applied Soft Computing Journal*, 71: 183–198.

[22] Chandak, M., Girase, S. and Mukhopadhyay, D. (2015). Introducing Hybrid Technique for Optimization of Book Recommender System. *Procedia Computer Science*, 45: 23–31.

[23] Anwar, T. and Uma, V. (2019). CD-SPM: Cross-domain book recommendation using sequential pattern mining and rule mining. *Journal of King Saud University - Computer and Information Sciences*. https://doi.org/10.1016/j.jksuci.2019.01.012.

[24] Baccianella, S., Esuli, A. and Sebastiani, F. (2008). SENTIWORDNET: A Publicly Available Lexical Resource for Opinion Mining. In *Proceedings of the 7th Conference on Language Resources and Evaluation LREC10*, 2200–2204.