Book recommendation system using hybrid filter methods

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Abstract—**A recommender system is an automated system to provide the recommendations based on the user preferences and history of the users search. There are multiple strategies to recommend the products to the users. Recommendation systems improve the user experience and reduce the time of finding the relevant results. Popular methods of recommendation systems are content based filtering and collaborative filtering. Content based filtering shows the results based on the user search. Collaborative filtering shows or displays the results based on the similar user ratings. These two methods have some limitations where the user recommendations after sometime become monotonous. Existing methods recommendations are calculated using cosine similarity, Pearson's correlation coefficient,eucleadian distance and Jaccard's distance. So making the system hybrid and overcoming the challenges thrown by existing systems makes the recommendations interesting. In this paper we are proposing a hybrid filtering method which combines both the existing methods i.e. mixed mode.**

[1] *Index Terms*—**Collaborative filtering,content based filtering, Hybrid recommendation system,cosine similarity and Pearson's correlation coefficient**

I. INTRODUCTION

Recommendation systems are the current popular methods to provide data to the users based on their preferences. Applications for these recommendation systems are Amazon's Alexa, Spotify for generating recommendations for music lovers.These recommendations are generated based on different techniques mainly there are content based recommendations, collaborative recommendation and hybrid systems. Content based filtering methods work on the history of the users with the item but it lacks users personal information. The collaborative filtering model generates recommendations based on the personal info but this lacks the recommendations based on the history of the item. Both the methods have their own limitations.

In the present scenario machine learning based recommendations are used in single recommendation categories like books or movies based using different techniques. In this paper we are using cross content based recommendations using machine learning techniques.For finding the two different types of contents and their descriptions we use TF-IDF vectorizer and K-means clustering for clustering the data

and the performance of the model is evaluated based on the metric cosine similarity. In this paper we are proposing a new recommendation system for recommending the books considering library loan records, book titles, Nippon Decimal Classification, number of books that have been borrowed and publication year. For the experimental analysis we have used SVM(Support Vector Machine), Random Forest and AdaBoost algorithms.In this system we have considered the bibliography also to recommend the books.For the evaluation purpose we have experimented with different techniques i.e. rules based those are title similarities, confidence of support association. In this paper a new model is proposed i.e. user-user recommendations based on the user preferences.For the evaluation various similarity metrics are used.After similarity calculation top 10 recommendations are generated.For this experiment data is collected from kaggle resource and the data is Good reads dataset. Any online platform of selling books or dealing with literature related industries needs a good recommendation system to satisfy the customer needs and retain them.This system proposes a recommendation based on their books bought in the past and their interests . With this system we can recommend the books or products to the new user which are generated based on old user ratings and preferences

In this method we are proposing a model that overcomes the limitations of both the methods collaborative and content based filterings. We are proposing a hybrid model which solves the above problems and makes the recommendations more personalized. One way of implementing the hybrid model is to combine the predictions of both the models i.e. first we need to implement the content based filtering to draw predictions from the model, second implement the collaborative filtering and draw predictions from this model.In the end we need to ensemble the predictions

In this project we explore different Python libraries Keras, Pandas, Numpy,Seaborn and Matplotlib.Since we are implementing both methods of filtering and combining them with ensemble technique.There are two different kinds of metrics to use that measure the quality of the recommendations.In the first case of content based filtering we use similarity measures:
- Cosine similarity
- Pearson's correlation coefficient

- Jaccard's distance
- Euclidean distance
- In the later case collaborative filtering we use predictive metrics:MAE(Mean Absolute Error) and RMSE(Root Mean Squared Error)

Our plan of execution is divided into two tasks. First one is tasks related to the core of the project execution and the second step is to create the overall flow of the project. The first step includes the 4 sub tasks: collecting the reference papers, conducting literature surveys with papers , taking notes and summarizing the approaches mentioned in the papers. Applying multiple machine learning algorithms and conducting comparative analysis.In the second task we create the project workflow and work breakdown structure. After creating the project flow we assign the tasks to the team members. Content based filtering is purely based on the user's explicit or implicit feedback.This kind of recommendation system is purely user centred or item centred. A simple example for this kind of recommendation system is if the user watches thriller movies repeatedly the system recommends the thriller movies. There two types of content based filtering one is user centred and item centred. In the item centred case items are recommended based on the similarity scores of the products the user bought/watched.The similarity scores of the products are calculated using various similarity metrics cosine similarity and Pearson's correlation coefficient are the popular methods. In the item centered method the user's feedback is collected implicitly. In the user centred content based filtering feedback of the user is collected explicitly this could be via a form or a questionnaire.With this information user will get recommendations. For example in a survey or questionnaire the user fills the favourite colors as pink he/she will be get recommendations of pink color apparels as recommendations.

Content based filtering method has limitations which are: The recommendations becomes monotonous and the recommendations are not personalised recommendations. To improve the user experience we need personalised recommendations. To implement that we use collaborative filtering.This recommendation system recommends the products based on the similar user preferences. This is done in two stages in the first stage we find the similar users for the User A.If the User A preferences matches with the preferences of User B then the recommendations are based on the User B.The main advantages of collaborative filtering is there is no need to calculate the similarities manually.This embeddings happens automatically. This method is futher split into memory based and model based methods.

Memory based approaches do not consider machine learning to predict the recommendations for the user. In this method to recommend the items similarity metrics are considered.These similarities are calculated using nearest neighbour algorithms.Using nearest neighboring algorithm userA closest users are identified and their recommendations.

In the model based approach to recommend the items to the users machine learning models used. The machine learning algorithms are matrix factorisation, sparse matrix.These methods divide the sparse uer-item matrix into user-factor and item -factor matrices. In the recent years a lot of research is going on in this area. Researchers are finding the possibility and performance of the neural networks and clustering algorithms.

II. MOTIVATION

In the past shopping used to happen in physical stores. User has to select the products which are available in the store. Nowadays shopping is no more a mundane task with the advent of internet shopping including personal preferences that can be personal brands or choices people are preferring more personalized products to be reviewed.This case is applicable to food, beauty and many more. Recent applications of recommendation systems help the industries to send the recommendations to customers with the history of the customer behavior. The count of avid readers across the world is increasing. The main reason for this increase is the evolution of different reading modes like e-books. To reach out to more readers publishers are looking for best platforms which have a strong book recommender system in built. For the industries mainly for e-commerce vendors huge revenue is generated using recommendation systems. Top industries are investing in building robust recommender systems for the users.

III. OBJECTIVES

Main objectives of this project are:

Book recommendation is a challenging task since the reader picks up the book because of various reasons that could be recommended by a friend, he/she read the same author in the past. Existing methods of content based and collaborative filtering have their own limitations. Recommending the similar items continuously makes the customer choices limited to certain preferences. The objective of the project is to: Building a hybrid recommender system that combines the results of the existing methods

Main features of the project are:

- Building a hybrid recommender system to meet the reader criteria using mixed hybrid recommendation technique
- Main advantage of using mixed type of hybrid recommendation system is it generates the candidates simultaneously and trains to the best model for better performance.

IV. RELATED WORK

Book recommendation system is a modern solution to the library management system. In this paper we are proposing a new recommendation system to recommend the books based on the user preferences and the factors could be number of pages, book genre and so on. This helps the librarians and the readers to select the books of the choices. This system is implemented using various recommendation systems. With the recommended books we calculate the number of pages and copy number. This system helps the bibliographic systems to select the best books for the readers choice [2].

Nowadays the recommendation system has huge demand in various applications. This recommended system is used in

e-commerce sites to recommend the products of various categories apparels, electronics and books. These categories are the top 3 categories which use the recommendation system in the e-commerce site.In the existing system the algorithms are content based filtering and collaborative filtering methods. But these methods have several disadvantages. To mitigate these problems we have implemented the Hybrid recommendation system. Generally, hybrid recommendation systems use the combination of both content based filtering and collaborative filtering. In these methods we have used the K-Fold validation to calculate RMSE. We have used 5-fold cross validation and 10 fold cross validation. In the 5 fold cross validation method 1.2061 and in the 10 fold cross validation the score was 1.224 [1].

Recommendation systems are cropping up everywhere. But the existing systems lack the factor of personalised choices and their recommendations.In the existing system the recommendations are based on the content of the book. But not only the content of the book, other factors also play an important role while purchasing the book. The price of the book and author factors play a pivotal role while purchasing the book.In this proposed system we used the other factors also publisher date, publisher, discount and the customer reviews. To evaluate the task dummy variable regression model. To experiment analysis we have used Amazon books data [20].

Reading has a positive effect on students other than class work. Students need to read the extracurricular activities books as well. Students learn most from the books till a certain time. In this paper we build the cross recommendation system which recommends not only the academic content but also recommends the extracurricular activities content. With these recommendations we can analyse the disciplinary behaviour of the students [8].

With the increase of selling and buying products online there is a strong need for the recommendation systems in the websites. Recommendation systems allow the users to find the preferred items of their choice. In-built recommendation systems in the websites retain the buyers and increase the profit of the business. Online websites nowadays compete with each other in finding the right products in less time. So in our study we are proposing the hybrid recommendation system. Here , the recommendation systems use the combination of collaborative filtering and content based filtering.This method improves the recommendation system efficiency by two times [13].

Customers now choose the most of the products online. One of the product categories is books. There are a plethora of recommendation systems to recommend the books. Traditional algorithms use basic methods like content based filtering and collaborative filtering. These methods have pros and cons. Some people prefer to read books according to their mood. In this research we are proposing a novel approach that recommends books based on facial expressions. If the reader's mood is funny to make him more cheerful we recommend the cheerful and comic genres as recommendations. If the reader's mood is sad then also it recommends the comics and

philosophy books to read. To extract the facial expressions we have used the CNN model. Convolutional Neural Network extracts the facial features. To recommend the books we used a hybrid recommendation system. This model achieved moderate accuracy in future further tuning of the model improves the accuracy and recommendations and can be implemented as library robots [21].

In spite of having massive recommendation systems for books, there is novelty in the recommendations and use cases. The existing systems use the keywords and search results to provide the recommendations. In this novel approach we combine the recommendations of the habitual reader emotions through the reviews.The emotion based recommendation parameters are calculated using similarity metrics which are applied on the user reviews [18].

Book recommendation systems are widely popular on books selling websites like Amazon and other sites. Books available on this site are recommended using traditional methods like content based filtering and collaborative filtering. These methods have drawbacks like data sparsity and scalability. To overcome these problems we are implementing CNN algorithms to reduce the sparsity of the matrices and improve the scalability. To experiment with the various kernel size, filter size and epochs we have used the Amazon dataset. And the accuracy metrics are calculated using the MAE, MAPE and MSE [16].

Reading is an effective habit in all age groups. Reading improves the cognition in the students. There are a lot of researchers who have proved that reading is an effective habit. Some countries are trying to improve the reading habits of youngsters by conducting book fairs. A book fair hosts the different publishers' books at one place and the interesting thing about these bookfairs is that they exhibit rare books. Countries like India and Sudi Arabia are the countries that host book fairs every year to draw readers across the country. Though these fairs are conducted for a reasonable number of days, few people may miss these exhibitions. With an intention of providing the book fair online we host a website where the users can search and find the preferred book. But the challenging part is these online websites won't be as interactive as offline fairs. To make the website user friendly we are embedding a recommendation system to find the rare books and preferences as well. In this system robust recommendations are done using user behaviour and popular in the fair.The system analysis is done using DataFlow diagram, class diagram and activity diagrams [7]. With the increase of online purchases the user searches for the products to find the matched product or item. People are opting for online purchases due to the hassle free purchases like automated recommendation systems. In this paper we are proposing the existing methods and their functioning. We explore the existing methods of collaborative filtering and content based filtering. In this paper we mainly focused on User Based Collaborative Filtering(UBCF) [11].

For recommendation systems machine learning is the current popular method. In machine learning we have multiple

types to recommend the items. Most popular methods are memory based and model based approaches. In the memory based approach we need the user past data in this type. The information needed for the recommendation of the products requires huge memory. So in this paper we are proposing the state of the art algorithm to recommend the products. To recommend the products we proposed association based rules and this method allowed us to individualise the items and in turn produce the personalised information [19].

There are different types of readers, one is a habitual type of reader who reads the books on a regular basis and the other one is an occasional reader. Occasional readers look for the best reviews and suggestions to read the books. In this paper we are proposing a mechanism to recommend the books mainly focusing on the occasional readers. To recommend the books we combined the multiple methods collaborative filtering, content based filtering and association rules [15].

Existing recommendation systems in machine learning recommend books based on the one aspect it could be ratings, author or publisher. But the readers sometimes look for multiple attributes or aspects to recommend the books. In this paper we are proposing a hybrid filtering method where the products are recommended based on the multiple attributes of the book's language, author and content of the book. In this paper we are proposing a hybrid recommendation where the user gets the recommendations that is combination of the classification algorithms ,collaborative filtering and association based rules [22].

In the digital libraries there is a lot of information about mass-circulation. This kind of information is seen in the Universities and educational institutions. To design a personal recommendation system we used the association based rules but the efficiency of the algorithm is not satisfactory. To recommend books be better recommendations for the user. In this paper we are proposing a better algorithm based on association rules we used the Apriori algorithm. New algorithm results are satisfactory and the algorithm can be embedded on to the websites of various platforms like recommending books and any product recommendations [17].

Machine learning provides the recommendations for the users of their own choice. These recommendations are designed according to the user preference and the factors that affect the recommendations are ratings, reviews , price of the book and author or publisher. But in this recommendation system we are implementing the novel approach to recommend the books to the new users. In this system we recommend the books to the users in the educational institutions who have never bought or picked the books. These people will recommend the books based on their course curriculum and existing borrowing data [12].

In countries like Indonesia there is an increasing number of readers. In Indonesia mainly the users or the readers in the University needs a recommendation system to recommend the books since the library database system is huge. To recommend the books from this huge corpus is a challenging task. In this paper we are proposing a recommendation system based on data mining association rules. There are two methods in the association rules, one is frequent items list and infrequent items list. Two methods are tested on the University of Indonesia data. Two methods gave two different results. Using comparative study we picked the best method to recommend the books [3].

Books have prominence in various fields. In this paper we are proposing a book recommendation system using Neo4j which is a graphical database. In this method we are designing a user interface using Neo4j database and the programming language we used is cypher language.To display the results we have used the Bibtex metadata. To process the metadata and to display the results it took 180-184 milliseconds. This paper conducts a comparative study to show the results of the recommendation system with manual procedure. And the automated system provides the best results compared to the manual procedure [4].

The exponential growth of readers across the country demands the best recommendation systems. This system requires knowledge of 3 different domains Artificial Intelligence, Machine learning and data mining. In this paper we are proposing the Book recommendation system retrospection in which we recommend the books by overcoming the barriers like religion, race and ethnicity. These taboos are the barriers while recommending the books. Another barrier like new users since the past history makes the recommendations work we propose a recommendations for the new users [9].

The existing algorithms have many drawbacks, few of them are: sparsity and training time. The sparsity in the data leads to incorrect or inaccurate predictions. To overcome this problem we are proposing a new recommendation system optimisation technique. To optimise the existing algorithms we used the user past data.In this case we have built a book recommendation system for an e-commerce website. To optimise the algorithm we used top-k best results.Here,the k represents the top k ratings or top-k method shows the reduced training time and reduced sparsity in the data. With the reduced sparsity the performance of the algorithm is improved and the accuracy parameter Root Mean Square Error is improved [5].

In the existing methods we have a recommendation system with sophisticated methods. The recommendations from these systems are monotonous and sometimes out of context. Existing methods use the aspects of ratings, reviews and price of the books as top attributes. But in this paper we are proposing the linguistic parameters and language semantics to recommend the books.To perform this task we proposed a SOLE-R which considers the lexical parameters of the content.This method recommendations go beyond the other attributes of the book. The performance of the method is evaluated on the publicly available benchmark dataset [10].

One of the important aspects of online purchases is the user's privacy. In this paper we are proposing a book recommendation system that uses multiple recommendation systems at the same time it preserves the privacy of the user. The basic mechanism behind the recommendations are content based filtering and collaborative filtering methods. There are multiple

works proposed in the past but the user's privacy aspect is new in this system. The model performance is tested on the public dataset [6].

Habitual readers always maintain a reading list, but the occasional reader always depends on the suggestions and emotions. What to read next is a big question. So to simplify the answer we are building a simple recommendation system keeping in mind. To recommend the books first we have built the basic techniques like content based filtering and collaborative filtering. Content based and collaborative filterings are the best recommendations . In this paper we are proposing a web based recommendation which only uses the basic recommendation system but also the different aspects of the users like demographics, age and gender also considered to provide the personalised recommendations. To conduct experimental analysis we have scraped the data from publicly available resources. After scraping the data from the resources we have cleaned the data of the book titles and reviews. The demographics of the user are collected in the different dataset. Usernames and User ids like personal information are anonymized. We have conducted exploratory data analysis to understand the underlying structure of the data. In the EDA we have observed the semantics of the data by analysing the data in word level and sentence level. Finally we have built the recommendation systems to recommend the books. This experiment is conducted based on the publicly available benchmark dataset [14].

V. DATA DESCRIPTION

Book recommendation system uses 3 files: books.csv, users.csv and ratings.csv files. Books files contain ISBN of each book, title of the book, book author, year of publication, publisher of the book and image URLs.Since ISBN is unique column to identify the book invalid ISBNs are removed from the data.The original source of the data is collected from the Amazon web services.In the user file demographic information of the user is mentioned age and location along with the user id which is anonymised as integers. Ratings file contains the ratings information of the book.These ratings are reviewed on the scale of 1-10. Higher ratings are considered as higher appreciation which is known as explicit ratings whereas "0" ratings are implicit ratings.

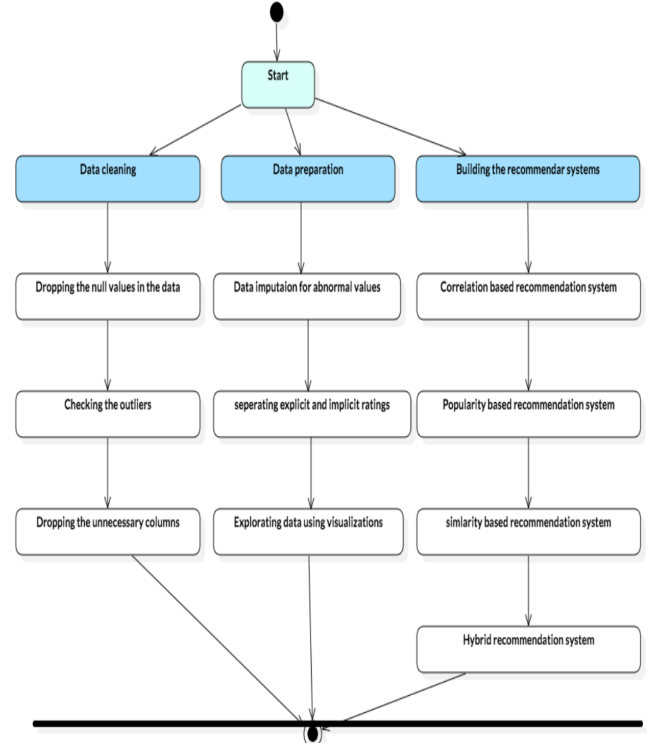## VI. PROPOSED FRAMEWORK

Figure 1. Workflow

Implementation of book recommendation systems is divided into stages: data cleaning, data preparation and building recommendation systems. Since the dataset consists of 3 files of information each file needs to be cleaned separately. Data cleaning includes removing the null values, examining the distribution numerical columns to check any abnormalities in the data. In this stage we retain the necessary features and remove the unnecessary features. We have dropped the image url columns. At the stage of data cleaning we have identified some abnormal values in age and publishing year columns. The age column contains a considerable amount of 0 values in the data so we have ignored the rows with age range 0-80 as normal range and ignored the other values in the dataset. Another column with abnormal values is the publishing year which is greater than the current year and the range is between 0-2050 which is abnormal. We have considered an imputation method to fill the abnormal values that are mean.Ratings column also divided into implicit and explicit we have built the recommendation system on explicit ratings and ignored the implicit ratings.

- After the data preparation various recommender systems are built on the final data.
- The first method is popularity based recommendation system: All the ratings are summed up and based on the user preference top n number of books are displayed the popular books to read

- Similar author recommendation system displays the books of same authors from the popular books
- Similar publisher recommendation system displays the books of same publisher from the popular books
- User-item collaborative filtering system recommends the books based on the cosine similarity
- Correlation based recommendation system recommends the books based on the Pearson's correlation
- Content based recommendation system recommends the list of books which are higher than the set threshold of popular ratings.
- Hybrid recommender system recommends the list of books by combining content based filtering and collaborative filtering suggestions.

A. Hybrid filtering

The basic approaches of recommender systems have pros and cons. Content and collaborative filtering methods are not considered as strong when we consider the recommendations individually.So here we are proposing a mixed hybrid recommendation system which gives the results based on the mixed method which is robust compared to the individual methods. Hybrid recommendation system overcomes the challenges of the content and collaborative filtering methods. Hybrid filtering method is implemented in two different ways.One way is just implementing content based filtering and collaborating and then combining the results of both the methods. In the second approach we implement a completely new approach based on the availability of the user data. If there is a new user first we recommend content based filtering and as we gradually collect the data we implement the collaberative filtering.
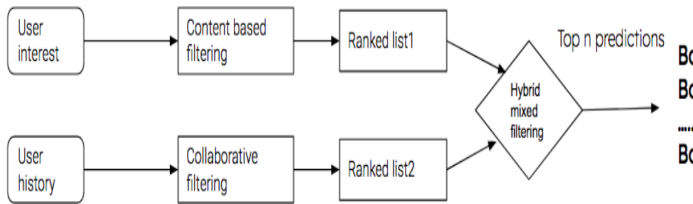

Figure 2. Hybrid filtering block diagram

Figure 3. comparison of existing methods

VII. RESULTS ANALYSIS

Under preliminary results we explored the data in different dimentions.

A. Content based filtering

In our project content based filtering is applied to get the top n recommendations of authors , publishers and highest ratings books. These recommendations are suggested based on the
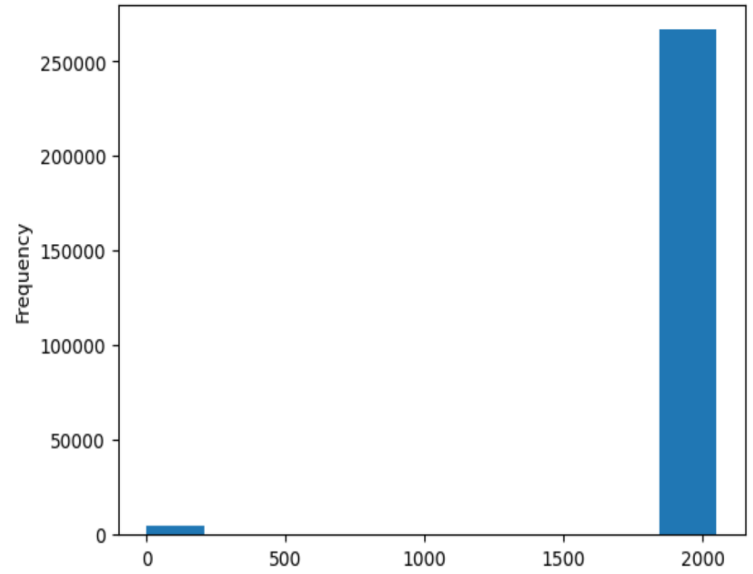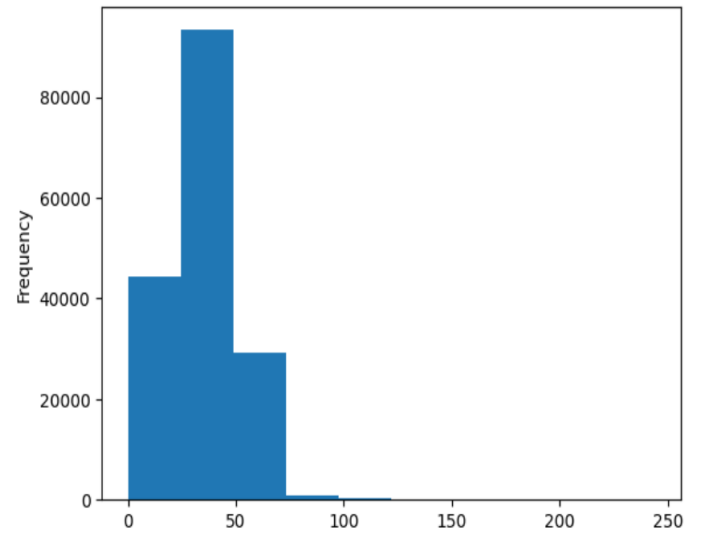

Figure 4. Hybrid filtering block diagram

Figure 5. Hybrid filtering block diagram

user ratings.Here in the project we displayed the top 5 books as recommendations.

B. Collaborative filtering

Collaborative filtering is applied to find the user-item based filtering and correlation based filtering. In the correlation based filtering we used the Pearson's correlation coefficient the metric and in the similarity based recommendation we used the cosine similarity as the metric
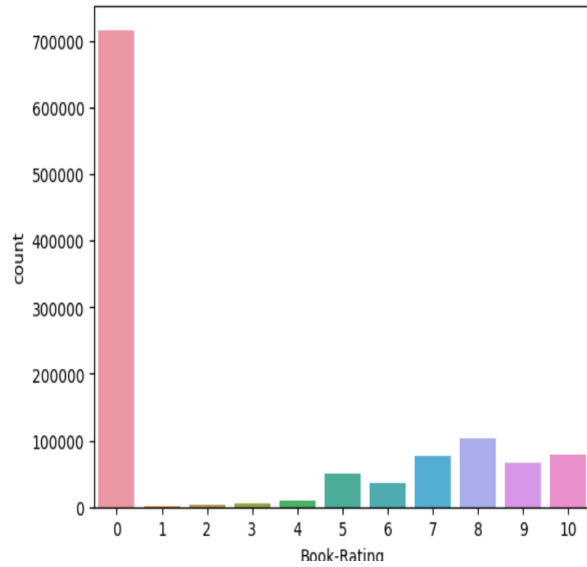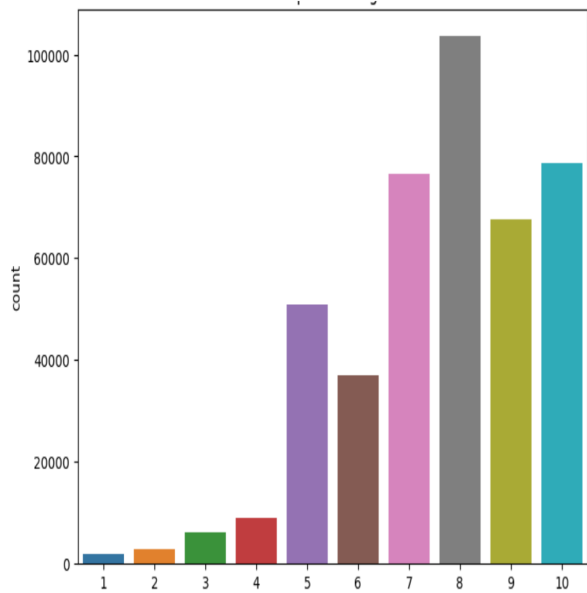
Figure 6. Hybrid filtering block diagram

Figure 7. Hybrid filtering block diagram

C. Exploratory Data Analysis

In the exploratory data analysis we have observed the underlying structure of the data. To proceed with the models we need to understand the distribution of each category. In the ratings distribution what are the valid ratings and what are the invalid ratings since some the ratings were 0. When we look at the distribution of the tragets graph it is a normal curve and the distribution is normal.This is an important observation to note because applying the algorithms depends on the distribution of the data. In this section we have explored the data distributions using various visualization packages. In project

we used matplotlib and seaborn to plot the graphs. These visualizations gives the understanding of the data whether the data contains outliers and it is following normal distribution or the data is skewed. In this we have visualized the target values or dependent variables. With the visualization we can differentiate the valid values and the outliers in the data.

VIII. Results summary

Nowadays recommender systems are everywhere be it online grocery shopping , apparels and many more. In the past we have implemented content based filtering and collaborative filtering to avoid the shortcomings of individual methods. We are deploying hybrid filter methods. There are multiple types of hybrid recommendation systems namely: switching, weighted and mixed etc., Mixed approach selects the best model and fits the training set to that model. This process is automatic which is an advantage of mixed hybrid method.

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Books by same Author:

Harry Potter and the Goblet of Fire (Book 4)
Harry Potter and the Order of the Phoenix (Book 5)
Harry Potter and the Sorcerer's Stone (Book 1)


Books by same Publisher:

The Seeing Stone
The Story of the Seagull and the Cat Who Taught Her To Fly
The Slightly True Story of Cedar B. Hartley: Who Planned to Live an Unusual Life
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Figure 8. Results of collaberative filtering

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Input Book:
Harry Potter and the Sorcerer's Stone (Harry Potter (Paperback))

RECOMMENDATIONS:

Harry Potter and the Prisoner of Azkaban (Book 3)
Harry Potter and the Goblet of Fire (Book 4)
Harry Potter and the Order of the Phoenix (Book 5)
```

Figure 9. Results of hybrid filtering

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