Book Recommendation System

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Abstract*— In recent years, as the amount of information available on the internet is growing quickly people need certain tools in order to find and obtain the correct information. To acquire the information without having to look through all the goods or products, we need something called a recommendation system. The development of computing has made it possible to provide users with personalised recommendation lists based on their activities. In comparison to travelling to a store and making their own purchases, internet recommendations give a simpler and faster way to make purchases, and online transactions are quite quick. By offering products that consumers can use right away, this recommendation system makes their lives easier. The top items are usually recommended to customers using a recommendation system. Nowadays, online book selling websites compete with one another in a variety of ways. In this study, we propose a book recommendation system that allows both habitual and infrequent readers to easily obtain results that reflect their interests using their own content of interest as queries. The book recommendation system must suggest books that are of interest to the buyer. A simple and user-friendly book recommendation system that assists readers in selecting the best book to read next. Furthermore, Our discussion is based on the book recommendation system (BRS), which uses content based filtering (CBF), Popularity based filtering, Recommendation using Average weighted Rating and K-Nearest Neighbour algorithm.

Keywords*— Recommendation System, Popularity Based Filtering, Content Based Filtering, KNN

I. Introduction

There are a lot of data available nowadays in the information sector, but none of them are of any use until they are turned into information that is insightful or helpful. Therefore, it is essential to examine this vast volume of data and draw out relevant information. Users are able to make use of data from numerous different dimensions. For this reason, recommendation is one of the helpful tools that suggests a product or object to a user. Recommendation is used in many applications, including those for movies, music, news, books, and other products. With the rapid growth of the online book market, it is a practical challenge to suggest accurate books based on users' past ratings or purchases. Good tailored recommendations can enhance the user experience in new ways. These suggestions largely fall into two categories. Collaboration is the first, and content-based filtering is the second. In collaborative filtering, a user is given product recommendations based on the preferences of other users who share similar tastes. Based on the users' favourite features of other content or the description or content of a specific item, a content-based recommendation engine makes suitable recommendations to the users. KNN algorithm is also used for recommendation. For this, a dataset is used, and some of the aforementioned algorithms are applied to produce recommendations.

II. LITERATURE REVIEW

[1] Developed a system for determining recommended books based on the similarities between the topics and feelings found in books and the interests of users.**[2]** The cold start problem and matrix sparsity are two problems that are almost guaranteed to occur in a recommendation system, and this paper aims to solve the former. This paper focuses on the problem of cold start and attempts to implement personalised book recommendation with students' course selection, which is required for students during their college time. This model employs a user-based collaborative filtering algorithm. **[3]** This paper suggests a collaborative filtering mechanism for a book recommendation system. Based on carefully computed and retrieved reviews from several users, the highest rated books are suggested to the customer. **[4]** A combination of content and collaborative filtering techniques is applied. The system really assesses the quality of the books it recommends based on the ratings provided by the current users. It also uses an association rule mining algorithm to uncover interesting associations and relationships among a big data set of books and to provide effective book recommendations. **[5]** This paper considers two important factors for the collaborative filtering algorithm based on books: user activity and time. The top-k users with the highest similarity are chosen as the recommendation set in this paper. The lowest mean square deviation can be obtained by varying the k value. A hybrid model may improve the performance of the recommendation system by combining different methods. **[6]** In the suggested framework, people are only recommended when K randomly selected individuals are filtered based on how similar they are to each other and collaborative filtering is only used on those users. In order to obtain better performance, this project uses the KNN algorithm and association rule mining to help solve the problem of data sparcity. **[7]** In this paper, we propose a book recommendation that, through collaborative filtering, provides users with recommendations on various genres based on information about their preferences provided during registration. The benefit of this system is its speed and simplicity

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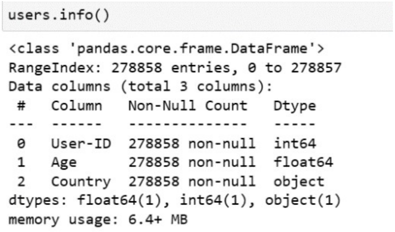
III. METHODOLOGY

A. Dataset Collection/Dataset description

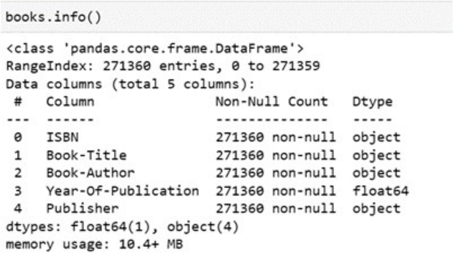
We are using Book-Crossing dataset to train and test our recommendation system. Book-Crossings is a book ratings dataset compiled by Cai-Nicolas Ziegler. It contains 1.1 million ratings of 270,000 books by 90,000 users. The ratings are on a scale from 1 to 10. The Book-Crossing dataset comprises 3 files.

User Dataset: This .csv file contains the users. Note that user IDs (User-ID) have been anonymized and map to integers. Demographic data is provided (Location, Age) if available. Otherwise, these fields contain NULL values.



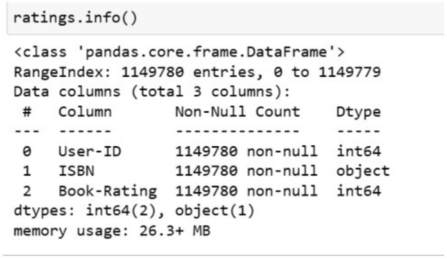
```
users.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 278858 entries, 0 to 278857
Data columns (total 3 columns):
 #   Column    Non-Null Count   Dtype
---  ------    --------------   -----
 0   User-ID   278858 non-null  int64
 1   Age       278858 non-null  float64
 2   Country   278858 non-null  object
dtypes: float64(1), int64(1), object(1)
memory usage: 6.4+ MB
```

Books Dataset: Books are identified by their respective ISBN. Invalid ISBNs have already been removed from the dataset.
Moreover, some content-based information is given (BookTitle, Book-Author, Year-Of-Publication, Publisher), obtained from Amazon Web Services. Note that in the case of several authors, only the first is provided. URLs linking to cover images are also given, appearing in three different flavours (Image-URL-S, Image-URL-M, Image-URL-L), i.e., small, medium, large. These URLs point to the Amazon website.



```
books.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 271360 entries, 0 to 271359
Data columns (total 5 columns):
 #   Column               Non-Null Count   Dtype
---  ------               --------------   -----
 0   ISBN                 271360 non-null  object
 1   Book-Title           271360 non-null  object
 2   Book-Author          271360 non-null  object
 3   Year-Of-Publication  271360 non-null  float64
 4   Publisher            271360 non-null  object
dtypes: float64(1), object(4)
memory usage: 10.4+ MB
```

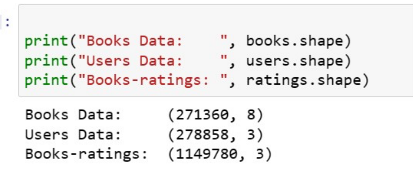
Ratings Dataset: Contains the book rating information. Ratings (Book-Rating) are either explicit, expressed on a scale from 110 (higher values denoting higher appreciation), or implicit, expressed by 0



```
ratings.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1149780 entries, 0 to 1149779
Data columns (total 3 columns):
 #   Column       Non-Null Count    Dtype
---  ------       --------------    -----
 0   User-ID      1149780 non-null  int64
 1   ISBN         1149780 non-null  object
 2   Book-Rating  1149780 non-null  int64
dtypes: int64(2), object(1)
memory usage: 26.3+ MB
```

Dimensions :

Dimensions of datasets



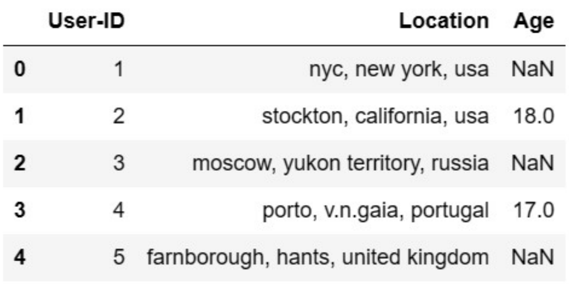
```
print("Books Data:    ", books.shape)
print("Users Data:    ", users.shape)
print("Books-ratings: ", ratings.shape)
```

```
Books Data:      (271360, 8)
Users Data:      (278858, 3)
Books-ratings:   (1149780, 3)
```

B. Data Preprocessing

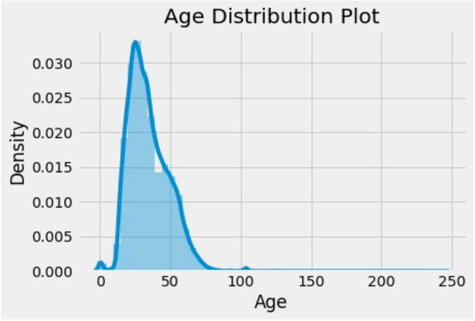
For User dataset, In the users dataset, we have the following feature variables. User ID (unique for each user), Location (contains city, state and country separated by commas) Age.

Out of these features, User-ID is unique for each user, Location contains city, state and country separated by commas and we have Age given across each user.

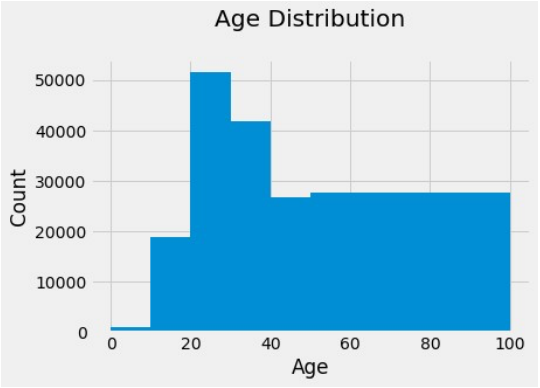


	User-ID	Location	Age
0	1	nyc, new york, usa	NaN
1	2	stockton, california, usa	18.0
2	3	moscow, yukon territory, russia	NaN
3	4	porto, v.n.gaia, portugal	17.0
4	5	farnborough, hants, united kingdom	NaN

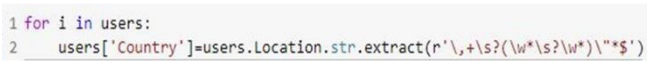
a) *Age :* Let's understand the Age distribution of given user dataset. By using a distplot for the Age column we can get the distribution of ages and the density. Below is the distplot.



From the given distplot we can see that we have outliers in the Age column, we will treat these outliers in the coming section of outlier treatment. Now let's have a look at the age distribution in a range of 0 to 100 by plotting a histogram. From the given histogram plot for age, we see that the distribution is right skewed. This used further in imputing the Null values in the Age information will be coloumn.

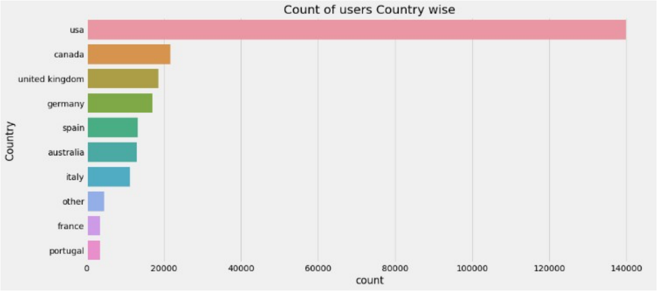


b) *Location :* Now let's deep dive into our location column. This column has city, state and country separated by commas. We will first segregate these into different columns and we will introduce a new column "Country" so that we can analyse on the basis of the country of different users. The following code will separate the Country from the location .



```
for i in users:
    users['Country']=users.Location.str.extract(r'\,+\s?(\w*\s?\w*)\"*$')
```

There are mis-spellings in some of the country names. We will first correct these and then plot the top 10 countries from where we have the maximum number of users. The following countplot shows the top 10 countries, here we analyzed that the maximum number of users belong to the USA.

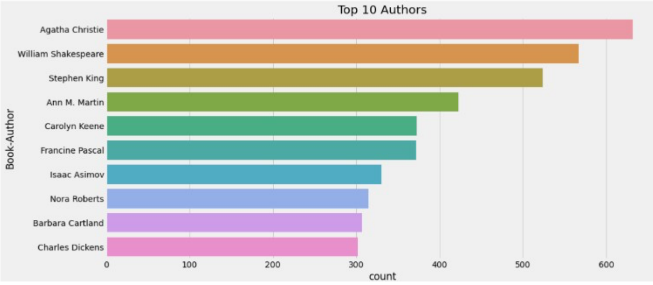


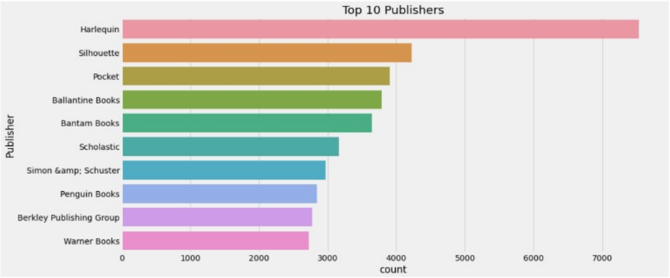
For Books dataset,

In the books dataset we have the following feature variables.

1. ISBN (unique for each book)
2. Book-Title
3. Book-Author
4. Year-Of-Publication
5. Publisher
6. Image-URL-S
7. Image-URL-M
8. Image-URL-L

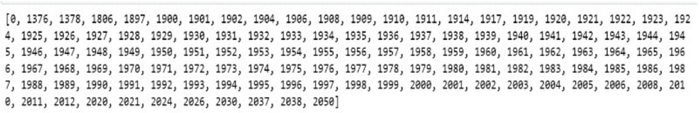
From the count plot, let’s find the top 10 BookAuthor and top 10 Book-Publishers. Further we find that both the plots are skewed and the maximum number of books are from top 10 Book-Authors and top 10 Book-Publishers.





Check for the unique years of publications. Two values in the year column are publishers.

Also, for three tuples name of the author of the book was merged with the title of the book. Manually set the values for these three above obtained tuples for each of their features using the ISBN of the book.



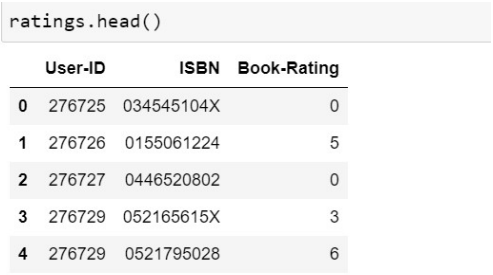
```
[0, 1376, 1378, 1806, 1897, 1900, 1901, 1902, 1904, 1906, 1908, 1909, 1910, 1911, 1914, 1917, 1919, 1920, 1921, 1922, 1923, 192
4, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 194
5, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 196
6, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 198
7, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2008, 201
0, 2011, 2012, 2020, 2021, 2024, 2026, 2030, 2037, 2038, 2050]
```

Dropping last three columns containing image URLs which will not be required for analysis. Convert the type of the years of publications feature to the integer. By keeping the range of valid years as less than 2022 and not 0, replace all invalid years with the mode of the publications that is 2002. By keeping the range of valid years as less than 2022 and not 0, replace all invalid years with the mode of the publications that is 2002.

For Ratings dataset,

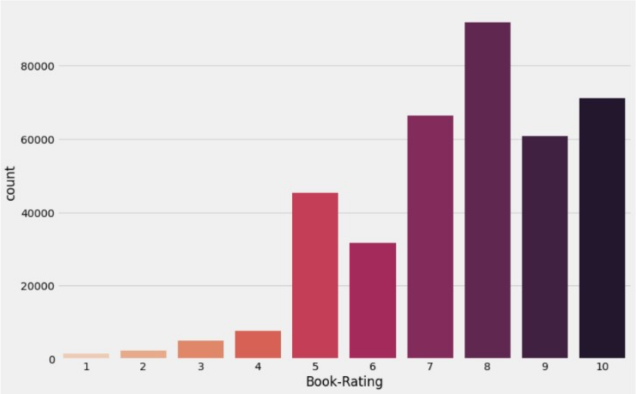
In the ratings dataset we have the following feature variables.

1. User-ID
2. ISBN
3. Book-Rating

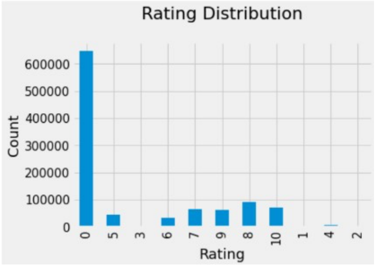


```
ratings.head()
```

	User-ID	ISBN	Book-Rating
0	276725	034545104X	0
1	276726	0155061224	5
2	276727	0446520802	0
3	276729	052165615X	3
4	276729	0521795028	6

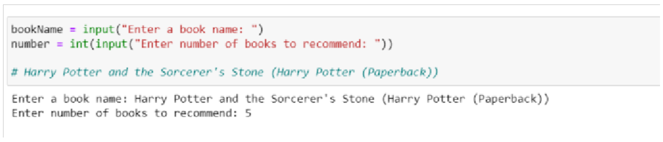


Let’s find the distribution of ratings frequency in our ratings dataset. From the following frequency plot, we find that most of the ratings are 0 which is implicit rating. The following code snippet will give us the frequency distribution.



The ratings are very unevenly distributed, and the vast majority of ratings are 0. As quoted in the description of the dataset - BX-Book-Ratings contains the book rating information. Ratings are either explicit, expressed on a scale from 1-10 higher values denoting higher appreciation, or implicit, expressed by 0. Hence segregating implicit and explicit ratings datasets.

C. Book Required by the User

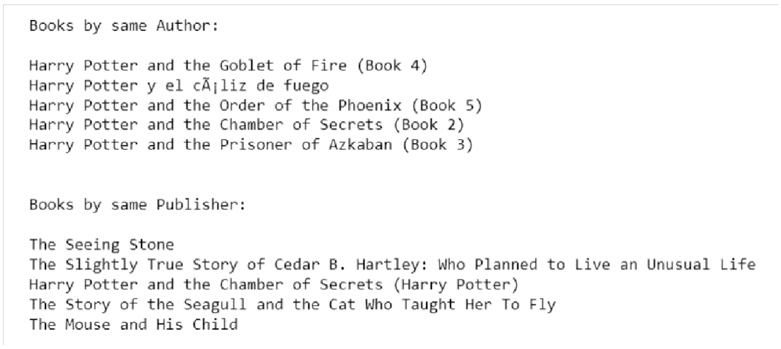


```
bookName = input("Enter a book name: ")
number = int(input("Enter number of books to recommend: "))

# Harry Potter and the Sorcerer's Stone (Harry Potter (Paperback))
```

```
Enter a book name: Harry Potter and the Sorcerer's Stone (Harry Potter (Paperback))
Enter number of books to recommend: 5
```

IV. Recommendation Methods

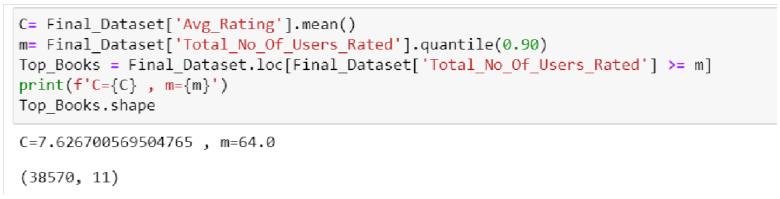
A. *Popularity based filtering*



```
Books by same Author:

Harry Potter and the Goblet of Fire (Book 4)
Harry Potter y el cÃ¡liz de fuego
Harry Potter and the Order of the Phoenix (Book 5)
Harry Potter and the Chamber of Secrets (Book 2)
Harry Potter and the Prisoner of Azkaban (Book 3)


Books by same Publisher:

The Seeing Stone
The Slightly True Story of Cedar B. Hartley: Who Planned to Live an Unusual Life
Harry Potter and the Chamber of Secrets (Harry Potter)
The Story of the Seagull and the Cat Who Taught Her To Fly
The Mouse and His Child
```

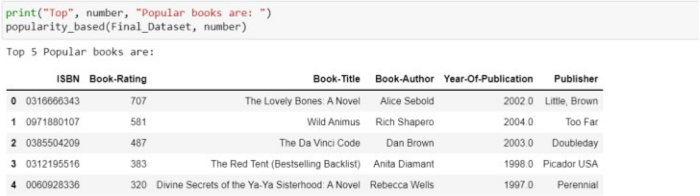
The popularity-based recommendation system, as its name implies, follows trends. In essence, it makes use of current fashion products. For instance, there is a likelihood that it will offer a product to a newly registered user if that product is one that every new user typically purchases. It doesn't have cold start issues, so it can make product recommendations for a variety of different filters right away. The past information about the user is not required. It makes recommendations based on the most popular books across the entire collection, the most popular books by the same author, the publisher of the specified book, and the most popular books by year.

Recommended books by popular in the whole collection.



```
C= Final_Dataset['Avg_Rating'].mean()
m= Final_Dataset['Total_No_Of_Users_Rated'].quantile(0.90)
Top_Books = Final_Dataset.loc[Final_Dataset['Total_No_Of_Users_Rated'] >= m]
print(f'C={C} , m={m}')
Top_Books.shape
```

```
C=7.626700569504765 , m=64.0

(38570, 11)
```



```
print("Top", number, "Popular books are: ")
popularity_based(Final_Dataset, number)
```

```
Top 5 Popular books are:
```

	ISBN	Book-Rating	Book-Title	Book-Author	Year-Of-Publication	Publisher
0	0316666343	707	The Lovely Bones: A Novel	Alice Sebold	2002.0	Little, Brown
1	0971880107	581	Wild Animus	Rich Shapero	2004.0	Too Far
2	0385504209	487	The Da Vinci Code	Dan Brown	2003.0	Doubleday
3	0312195516	383	The Red Tent (Bestselling Backlist)	Anita Diamant	1998.0	Picador USA
4	0060928336	320	Divine Secrets of the Ya-Ya Sisterhood: A Novel	Rebecca Wells	1997.0	Perennial

Recommended Books by same author, publisher of given book name

B. *Average Weighted Rating*

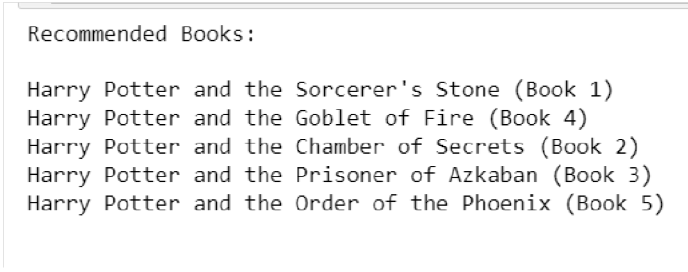
Weighted score can be calculated using the below formula for all the books and recommend the books with the highest score.

score= t/(t+m)∗a + m/(m+t)∗c where, t is the total number of ratings received by the book m is the minimum number of total ratings considered to be included a represents the average rating of the book and, c represents the mean rating of all the books.

Here we used 90th percentile as our cutoff. In other words, for a book to feature in the charts, it must have more votes than at least 90% of the books in the list.

C. *Content Based Recommendation*

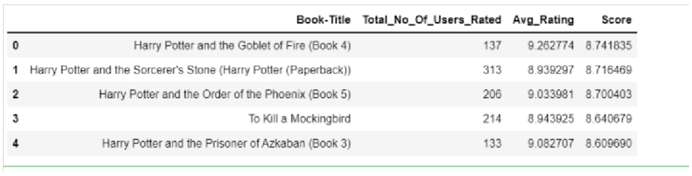
Content-based filtering algorithms are designed to recommend products based on the accumulated knowledge of users. It is crucial to include an important characteristic of products in the system because this technique compares user interest with product attributes. Prior to building a system, choosing each buyer's preferred features should be the top priority. For this filtering, it is necessary to employ these two procedures. The user is first given a list of features from which to choose the most appealing features. Second, the algorithms compile the customer's behavioural data by keeping track of all the products the user has previously selected. Content based recommendation system filter the entire set of books from the dataset based on the content of the book, where buyer is interested to buy.



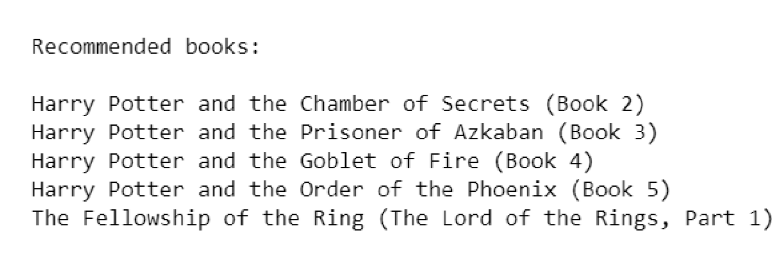
```
Recommended Books:

Harry Potter and the Sorcerer's Stone (Book 1)
Harry Potter and the Goblet of Fire (Book 4)
Harry Potter and the Chamber of Secrets (Book 2)
Harry Potter and the Prisoner of Azkaban (Book 3)
Harry Potter and the Order of the Phoenix (Book 5)
```

Using KNN algorithm,
K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using KNN algorithm.

We see that there are 38570 books which qualify to be in this list. Now, we need to calculate our metric for each qualified book. To do this, we will define a function, weighted_rating() and define a new feature score, of which we’ll calculate the value byapplying this function to our DataFrame of qualified books:



	Book-Title	Total_No_Of_Users_Rated	Avg_Rating	Score
0	Harry Potter and the Goblet of Fire (Book 4)	137	9.262774	8.741835
1	Harry Potter and the Sorcerer's Stone (Harry Potter (Paperback))	313	8.939297	8.716469
2	Harry Potter and the Order of the Phoenix (Book 5)	206	9.033981	8.700403
3	To Kill a Mockingbird	214	8.943925	8.640679
4	Harry Potter and the Prisoner of Azkaban (Book 3)	133	9.082707	8.609690



```
Recommended books:

Harry Potter and the Chamber of Secrets (Book 2)
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)
The Fellowship of the Ring (The Lord of the Rings, Part 1)
```

V. Conclusions And Future Work

The majority of the readers were of the age bracket 20-35 and most of them came from North American and European countries namely the USA, Canada, UK, Germany and Spain. If we look at the rating distribution, most of the books have high ratings with the maximum number of books being rated 8. Ratings below 5 are few in number. Author with the most books was Agatha Christie, William Shakespeare and Stephen King. In conclusion, a book recommendation system is an invaluable tool for readers and bookstores alike. It provides readers with an easy way to find books they may enjoy and bookstores with a way to suggest books to customers that they may be interested in. It also allows stores to keep track of customer preferences, making it easier to promote new releases and special offers. The system's ability to personalize recommendations and tailor them to individual customers is a major advantage, as it allows readers to get the most out of their reading experience.

We can implement collaborative-filtering based recommendation system and compare the results with the existing content-filtering based system. We would like to explore various clustering approaches for clustering the users based on Age, Location etc., and then implement voting algorithms to recommend items to the user depending on the cluster into which it belongs

References

[1] T. Fujimoto and H. Murakami, "A Book Recommendation System Considering Contents and Emotions of User Interests," 2022 12th International Congress on Advanced Applied Informatics (IIAI-AAI), 2022, pp. 154-157, doi: 10.1109/IIAIAAI55812.2022.00039.

[2] J. Qi, S. Liu, Y. Song and X. Liu, "Research on Personalized Book Recommendation Model for New Readers," 2018 3rd International Conference on Information Systems Engineering (ICISE), 2018, pp. 7881, doi: 10.1109/ICISE.2018.00022.

[3] P. Devika, K. Jyothisree, P. Rahul, S. Arjun and J. Narayanan, "Book Recommendation System," 2021 12th International Conference on Computing Communication and Networking Technologies (ICCCNT), 2021, pp. 1-5, doi: 10.1109/ICCCNT51525.2021.9579647.

[4] P. Mathew, B. Kuriakose and V. Hegde, "Book Recommendation System through content based and collaborative filtering method," 2016 International Conference on Data Mining and Advanced Computing (SAPIENCE), 2016, pp. 47-52, doi: 10.1109/SAPIENCE.2016.7684166.

[5] Y. Lu and Y. Lu, "Book recommendation system based on an optimized collaborative filtering algorithm," 2022 3rd International Conference on Computer Vision, Image and Deep Learning & International Conference on Computer Engineering and Applications (CVIDL & ICCEA), 2022, pp. 1-4, doi: 10.1109/CVIDLICCEA56201.2022.9824088.

[6] S. J. Mehta and J. Javia, "Threshold based KNN for fast and more accurate recommendations," 2015 IEEE 2nd International Conference on Recent Trends in Information Systems (ReTIS), 2015, pp. 109-113, doi: 10.1109/ReTIS.2015.7232862.

[7] N. Kurmashov, K. Latuta and A. Nussipbekov, "Online book recommendation system," 2015 Twelve International Conference on Electronics Computer and Computation (ICECCO), 2015, pp. 1-4, doi: 10.1109/ICECCO.2015.7416895.

[8]https://www.ijresm.com/Vol.2_2019/Vol2_Iss6_June 19/IJRESM_V2_I6_91.pdf

[9] https://www.kaggle.com/datasets/arashnic/bookrecommendation-dataset

[10]https://www.youtube.com/watch?v=Eeg1DEeWUjA