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Book Recommender System ¶

Based on Ratings

Purpose

Create a book recommender system using data from the “Book Recommendation Dataset” (https://www.kaggle.com/datasets/arashnic/book-recommendation-datasetUsing (https://www.kaggle.com/datasets/arashnic/book-recommendation-datasetUsing). The system will allow users to input a book they like (limited to the titles within the data set) and recommends other book for them to add to their reading list.

In [1]:

```python
# Import libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

# Hide warnings
import warnings
warnings.filterwarnings('ignore')
```

Data Import

In [2]:

```python
# Import data from the Books.csv into a dataframe and then display
books = pd.read_csv (r'/Users/kimberlyadams/Documents/GitHub/Portf
books.head()
```

Out[2]:

	ISBN	Book-Title	Book-Author	Year-Of-Publication	Publisher	
0	0195153448	Classical Mythology	Mark P. O. Morford	2002	Oxford University Press	http://images.amazon.com/image
1	0002005018	Clara Callan	Richard Bruce Wright	2001	HarperFlamingo Canada	http://images.amazon.com/image
2	0060973129	Decision in Normandy	Carlo D'Este	1991	HarperPerennial	http://images.amazon.com/image
3	0374157065	Flu: The Story of the Great Influenza Pandemic...	Gina Bari Kolata	1999	Farrar Straus Giroux	http://images.amazon.com/image
4	0393045218	The Mummies of Urumchi	E. J. W. Barber	1999	W. W. Norton &amp; Company	http://images.amazon.com/image

In [3]:

```python
# Import data from the Ratings.csv into a dataframe and then displ
ratings = pd.read_csv (r'/Users/kimberlyadams/Documents/GitHub/Por
ratings.head()
```

Out[3]:

	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

Exploration and Cleanup

In [4]:
```python
# Determine number of values in each column
books.count(axis=0)
```
Out[4]:
```
ISBN                   271360
Book-Title             271360
Book-Author            271359
Year-Of-Publication    271360
Publisher              271358
Image-URL-S            271360
Image-URL-M            271360
Image-URL-L            271357
dtype: int64
```

In [5]:
```python
# Determine number of unique values in each column
books.nunique(axis=0)
```
Out[5]:
```
ISBN                   271360
Book-Title             242135
Book-Author            102023
Year-Of-Publication       202
Publisher               16807
Image-URL-S            271044
Image-URL-M            271044
Image-URL-L            271041
dtype: int64
```

Note that the counts of the ISBN and Book-Title are the same, but the unique values number is different. This indicates that a book title might have multiple ISBN numbers.

In [6]:
```python
# Count how many Title-Author combinations are unique
books.groupby(['Book-Title', 'Book-Author']).ngroups
```
Out[6]:
```
251184
```

Looks like there are 251,184 unique books in the dataset based on Title and Author combinations. I will add a column combining these columns so I can avoid duplicates later on. I can't just assume that each title is unique since multiple authors can write books with the same title and unlikely as it is, some authors might even share names.

In [7]:
```python
# Concatenate Title and Author text into a new column
books["TitleAuthor"] = books["Book-Title"] + " by " + books["Book-
```

In [8]:
```python
# Merge the two dataframe based on the 'ISBN' column to get book a
BookRatings= pd.merge(books, ratings, on= 'ISBN')
BookRatings.head()
```

Out[8]:

	ISBN	Book-Title	Book-Author	Year-Of-Publication	Publisher	
0	0195153448	Classical Mythology	Mark P. O. Morford	2002	Oxford University Press	http://images.amazon.com/imag
1	0002005018	Clara Callan	Richard Bruce Wright	2001	HarperFlamingo Canada	http://images.amazon.com/imag
2	0002005018	Clara Callan	Richard Bruce Wright	2001	HarperFlamingo Canada	http://images.amazon.com/imag
			Richard			

My computer also started having issues with the larger dataset, so I also trimmed out users that had not rated at least 9 books so as to only view the "active" users. Normally I would NOT have done this step, but the computer crashed non-stop until I did.

In [9]:
```python
# Creating a dictionary using value_counts()
items = BookRatings['User-ID'].value_counts().to_dict().items()

# Filtering only those rows where duplicate entries occur more tha
n = 9
BookRatingsActiveUsers = BookRatings[BookRatings['User-ID'].isin([
```

Many books have a rating of 0. Since most rating system will only let you rate as low as 1 star, I am going to assume that 0 means the user did not rate the book and thereby I am going to replace the 0s with null values.

In [10]:
```python
# Replace 0 book rating scores with null.
BookRatings['Book-Rating'].replace(0, np.nan, inplace=True)
```

In [11]:
```
# Create new dataframe with active user ratings that are greater t
BookRatings = BookRatingsActiveUsers[BookRatingsActiveUsers['Book-
BookRatings.head()
```

Out[11]:

	ISBN	Book-Title	Book-Author	Year-Of-Publication	Publisher	
1	0002005018	Clara Callan	Richard Bruce Wright	2001	HarperFlamingo Canada	http://images.amazon.com/images/
3	0002005018	Clara Callan	Richard Bruce Wright	2001	HarperFlamingo Canada	http://images.amazon.com/images/
5	0002005018	Clara Callan	Richard Bruce Wright	2001	HarperFlamingo Canada	http://images.amazon.com/images/

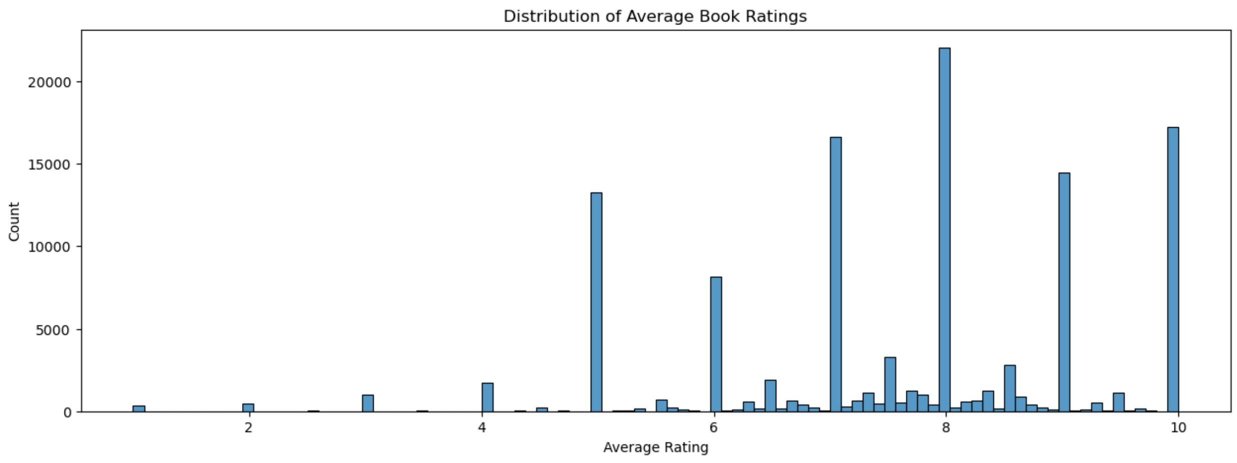
Looks like there are multiple listings now for each book so we might need to average the ratings to get an overall score and then remove the duplicates.

In [12]:
```
# Group the rows by the book's ISBN to get all the reviews for eac
# Get the average rating for the book from all the user ratings
# Sort the resulting dataframe by rating
Summary = BookRatings.groupby('TitleAuthor').agg({'Book-Rating':'m
```

In [13]:
```
# Group the combined dataframe rows by the book's title/author com
# Put count values into new column
Summary['RatingsNum'] = pd.DataFrame(BookRatings.groupby('TitleAut
```

In [14]:
```python
# Plot distribution of the ratings to see the shape of the data
plt.figure(figsize=(15,5))
sns.histplot(Summary['Book-Rating'])
plt.title("Distribution of Average Book Ratings")
plt.xlabel('Average Rating')
plt.ylabel('Count')
```

Out[14]:
```
Text(0, 0.5, 'Count')
```

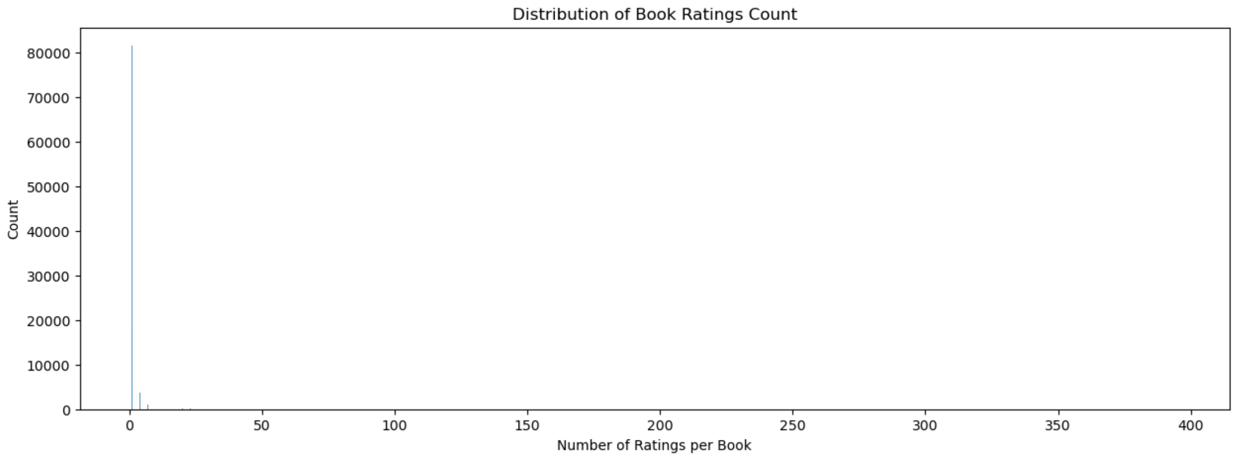


From this distribution we can see that most of the ratings are 5-10 so overall users are rating books they liked. There are a few lower ratings so occasionally users indicated they did not like a book, but these are rare.

In addition to the overall skew towards higher values, there is still a large number of 5 ratings that would potentially keep this from an otherwise normal distribution (when only looking at the higher values).

In [15]:
```python
# Plot distribution of the number of ratings per book to see the s
plt.figure(figsize=(15,5))
sns.histplot(Summary['RatingsNum'])
plt.title("Distribution of Book Ratings Count")
plt.xlabel('Number of Ratings per Book')
plt.ylabel('Count')
```

Out[15]:
```
Text(0, 0.5, 'Count')
```



That's a little hard to see anything. Let's look at the data itself.

In [16]:
```python
# Allow all rows of dataframe to show
pd.set_option('display.max_rows', None)

# Display the number of books with each number of ratings
Summary.RatingsNum.value_counts().sort_index()
```

Out[16]:
```
1      81590
2      17492
3       6935
4       3671
5       2226
6       1513
7       1092
8        805
9        566
10       487
11       356
12       297
13       287
14       269
15       219
16       158
17       157
18       122
19       119
```

In [17]:
```python
# What is the highest number of ratings on a single book?
print(max(Summary['RatingsNum']))
```

```
395
```

In [18]:
```python
# What is the average number of ratings?
print(Summary[['RatingsNum']].mean(axis=0))
```

```
RatingsNum    2.412841
dtype: float64
```

From this plot and table we can see that most books are not rated and after that most have only 1 or 2 ratings. The book with the highest number of ratings has only 707. On average books have only 2.75 ratings so that isn't very high.

The recommender will need to take into account movies that just have a single rating may not be accurately portrayed by that rating as that is a single person's opinion. However, since there is not much data available on each book, any rating is better than none.

Recommendation

In [19]:
```python
# Create a pivot table with each user's ratings for all books with
recommend = BookRatings.pivot_table(index='User-ID', columns='Titl
recommend.head()
```

Out[19]:

TitleAuthor	A Light in the Storm: The Civil War Diary of Amelia Martin, Fenwick Island, Delaware, 1861 (Dear America) by Karen Hesse	Ask Lily (Young Women of Faith: Lily Series, Book 5) by Nancy N. Rue	Dark Justice by Jack Higgins	Earth Prayers From around the World: 365 Prayers, Poems, and Invocations for Honoring the Earth by Elizabeth Roberts	Final Fantasy Anthology: Official Strategy Guide (Brady Games) by David Cassady	Flight of Fancy: American Heiresses (Zebra Ballad Romance) by Tracy Cozzens	Garfield Bigger and Better (Garfield (Numbered Paperback)) by Jim Davis	P B
User-ID								

This table is mostly NaNs because not every user has seen every movie or at very least submitted a rating for it.

In [20]:
```python
# Type in book and author combination from database to search for.
# Note: If this were a stanealone app, the user would ideally have
search = 'The Da Vinci Code by Dan Brown'

# Lookup rating for the searched book
Rating_Lookup = recommend[search]

# Find similar book ratings from the `recommend` pivot_table based
# Create a dataframe with results as a Correlation column
correlation = pd.DataFrame(recommend.corrwith(Rating_Lookup), colu

# Drop the empty values
correlation.dropna(inplace=True)

# Add the number of users who rated that book to the dataframe
correlation = correlation.join(Summary['RatingsNum'])

# Get recommendations by looking for high correlation values betwe
# Only consider books that over 25 users have read to weed out les
# Print out top 10 recommendations
correlation[correlation['RatingsNum']>25].sort_values(by='Correlat
```

Out[20]:

	Correlation	RatingsNum
TitleAuthor		
Let Me Call You Sweetheart by Mary Higgins Clark	1.0	28
On the Road (Penguin 20th Century Classics) by Jack Kerouac	1.0	26
The Lion, the Witch, and the Wardrobe (The Chronicles of Narnia, Book 2) by C. S. Lewis	1.0	37
Foucault's Pendulum by Umberto Eco	1.0	30
The Da Vinci Code by Dan Brown	1.0	314
The Mulberry Tree by Jude Deveraux	1.0	41
Open House (Oprah's Book Club (Paperback)) by Elizabeth Berg	1.0	34
Shell Seekers by Rosamunde Pilcher	1.0	26
Speak by Laurie Halse Anderson	1.0	26
Milkrun by Sarah Mlynowski	1.0	30

In [21]:
```python
# Running again with a different book to compare results

# Type in book and author combination from database to search for.
# Note: If this were a stanealone app, the user would ideally have
search = 'A Christmas Carol by Charles Dickens'

# Lookup rating for the searched book
Rating_Lookup = recommend[search]

# Find similar book ratings from the `recommend` pivot_table basec
# Create a dataframe with results as a Correlation column
correlation = pd.DataFrame(recommend.corrwith(Rating_Lookup), colu

# Drop the empty values
correlation.dropna(inplace=True)

# Add the number of users who rated that book to the dataframe
correlation = correlation.join(Summary['RatingsNum'])

# Get recommendations by looking for high correlation values betwe
# Only consider books that over 25 users have read to weed out les
# Print out top 10 recommendations
correlation[correlation['RatingsNum']>25].sort_values(by='Correlat
```

Out[21]:

	Correlation	RatingsNum
TitleAuthor		
Fried Green Tomatoes at the Whistle Stop Cafe by Fannie Flagg	-1.0	97

Overall, this recommendation system only seems to be recommending similarly rated books without taking anything else into account. This makes sense as this is the only data we fed the model. However, this approach returns a lot of titles that would likely not interest the user due to other characteristics of the book such as distasteful genres. Or in the case of A Christmas Carol, barely returned any suggestions at all.

I feel like there is a better way to take more details about the book into account.

Based on Content

Purpose

Create a book recommender system using data from the “Goodreads' Best Books Ever” dataset found on Kaggle (https://www.kaggle.com/datasets/meetnaren/goodreads-best-books (https://www.kaggle.com/datasets/meetnaren/goodreads-best-books)).

The system will allow users to input a book they like (limited to the titles within the data set) and recommends other books for them to add to their reading list. Recommendations are based on the similarity of the books' descriptions and thus is more tailored to individual tastes than a flat rating system. By factoring in the actual content of the book, we can avoid recommending something in a completely different genre that just happened to be highly rated.

Data Import

In [22]:
```python
# Import libraries
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

from sklearn.feature_extraction import text
from sklearn.metrics.pairwise import linear_kernel
```

In [23]:
```
# Import data from the book_data.csv into a dataframe and then dis
books = pd.read_csv (r'/Users/kimberlyadams/Documents/GitHub/Portf
books.head()
```

Out[23]:

	book_authors	book_desc	book_edition	book_format	book_isbn	book_pages	book_
0	Suzanne Collins	Winning will make you famous. Losing means cer...	NaN	Hardcover	9.78044E+12	374 pages	
1	J.K. Rowling|Mary GrandPré	There is a door at the end of a silent corrido...	US Edition	Paperback	9.78044E+12	870 pages	
2	Harper Lee	The unforgettable novel of a childhood in a sl...	50th Anniversary	Paperback	9.78006E+12	324 pages	
3	Jane Austen|Anna Quindlen|Mrs. Oliphant|George...	«È cosa ormai risaputa che a uno scapolo in po...	Modern Library Classics, USA / CAN	Paperback	9.78068E+12	279 pages	
4	Stephenie Meyer	About three things I was absolutely positive.F...	NaN	Paperback	9.78032E+12	498 pages	

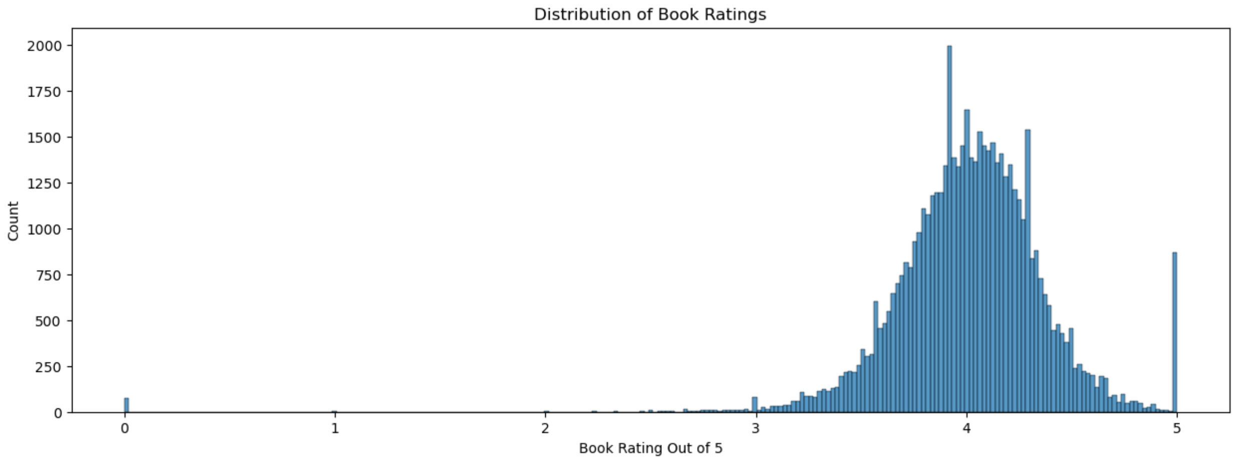
Data Exploration

In [24]:
```
# Determine number of unique values in each column
books.nunique(axis=0)
```

Out[24]:
```
book_authors         27159
book_desc            51781
book_edition          2134
book_format            147
book_isbn              548
book_pages            1403
book_rating            259
book_rating_count    21860
book_review_count     6895
book_title           48483
genres               30094
image_url            53618
dtype: int64
```

In [25]:
```python
# Plot distribution of the number of ratings per book to see the s
plt.figure(figsize=(15,5))
sns.histplot(books['book_rating'])
plt.title("Distribution of Book Ratings")
plt.xlabel('Book Rating Out of 5')
plt.ylabel('Count')
```

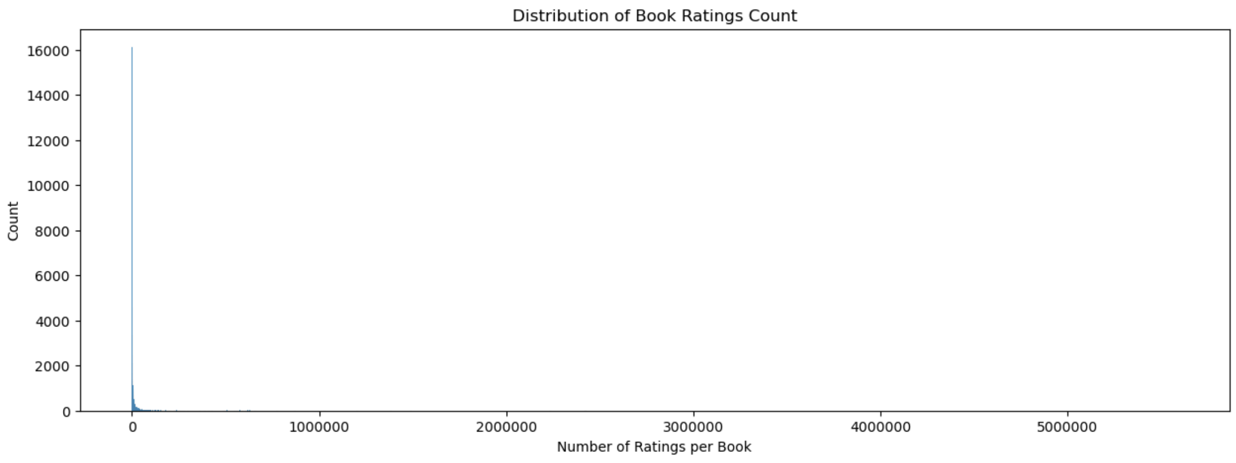
Out[25]:
```
Text(0, 0.5, 'Count')
```



The graph shows a nicely normal distribution centered around 4 but it quickly tapers off to 3 and 5, effectively cutting off anything below a 3 rating. This shows that the users who rate books enjoyed them and that users are unlikely to put the effort into rating a book they did not enjoy.There is also a fun little spike at 5 which shows people love to rate their favorite books.

In [26]:
```python
# Plot distribution of the number of ratings per book to see the s
plt.figure(figsize=(15,5))
sns.histplot(books['book_rating_count'])
plt.title("Distribution of Book Ratings Count")
plt.xlabel('Number of Ratings per Book')
plt.ticklabel_format(style='plain', axis='x')
plt.ylabel('Count')
```

Out[26]:
```
Text(0, 0.5, 'Count')
```



When looking at the number of ratings each book had, a graph just was no showing much so a table is a better visual here. There are some books (like The Hunger Games) that were rated by over 550,000 users, while 75 books in the database have no ratings and 357 only have 1 rating. Such a difference made the scale of the graph so large, the data was invisible on it.

Overall there is fairly good showing of ratings for the books in the database. Based on the count earlier though, only 259 books in the database have a rating, so probably not going to be useful for this recommendation system as the data is too sparse to take into meaningful account.

In [27]:
```
# Allow all rows of dataframe to show
pd.set_option('display.max_rows', None)

# Display the number of ratings and the number of books with that
books.book_rating_count.value_counts().sort_index()
```

Out[27]:
```
0          75
1         357
2         373
3         353
4         278
5         218
6         209
7         180
8         187
9         179
10        157
11        165
12        162
13        143
14        156
15        135
16        110
17        106
18        101
```

Data Cleaning and Processing

In [28]:
```
# Trim dataframe to needed columns for book title, description, ar
books = books[["book_title", "book_authors", "book_desc", "genres"
```

In [29]:
```
# Count null values in each column.
books.isna().sum()
```
Out[29]:
```
book_title              0
book_authors            0
book_desc            1331
genres               3242
book_rating_count       0
dtype: int64
```
In [30]:
```
# Drop rows with missing data
books = books.dropna()
```
In [31]:
```
# Group same named books together to avoid duplicated results
# Grab the description and rating count from first encountered lir
books = books.groupby("book_title", as_index=False).agg({"book_tit
```
In [32]:
```
# Re-determine number of unique values in each column after trimmi
books.nunique(axis=0)
```
Out[32]:
```
book_title           44526
book_authors         23552
book_desc            44129
genres               28423
book_rating_count    19316
dtype: int64
```
In [33]:
```
# Add quotes to beginning and end of book description
books["book_desc"] = books["book_desc"].apply(lambda x: "'" + str(
```
Set Up Model and Access Function

In [34]:
```
# Define characteristic feature and vectorizing model
feature = books["book_desc"].tolist()
tfidf = text.TfidfVectorizer(stop_words="english")
```
In [35]:
```
# Form matrix from model and calculate simularity
tfidf_matrix = tfidf.fit_transform(feature)
similarity = linear_kernel(tfidf_matrix, tfidf_matrix)
```
In [36]:
```
# Set book title as search parameter
indices = pd.Series(books.index,
                    index=books['book_title']).drop_duplicates()
```

In [37]:
```
# Define a function to return up to 20 recommended titles
# Sort based on similarity to entered title
def book_recommendations(title, similarity = similarity):
    index = indices[title]
    similarity_scores = list(enumerate(similarity[index]))
    similarity_scores = sorted(similarity_scores, key=lambda x: x[
    similarity_scores = similarity_scores[0:20]
    bookindices = [i[0] for i in similarity_scores]
    recommendations = pd.DataFrame(books[['book_title','book_autho
    return recommendations
```

Perform Query and Return Results

In [38]:

```
# Enter book to search for recommendations within quotes
# Results will be displayed in a dataframe with corresponding genr
book_recommendations("The Da Vinci Code")
```

Out[38]:

	book_title	book_authors	genres
30961	The Da Vinci Code	Dan Brown	Fiction|Mystery|Thriller
2783	Angels and Demons / The Da Vinci Code	Dan Brown	Fiction|Mystery|Thriller|Historical|Historical...
34365	The Lost Symbol	Dan Brown	Fiction|Mystery|Thriller
22419	Oprindelse	Dan Brown	Fiction|Thriller|Mystery|Thriller|Mystery Thri...
2774	Angels & Demons	Dan Brown	Fiction|Mystery|Thriller
2775	Angels & Demons - Malaikat dan Iblis	Dan Brown|Isma B. Koesalamwardi	Fiction|Mystery|Thriller
21792	O Código Da Vinci	Dan Brown|Celina Cavalcante Falck-Cook	Fiction|Mystery|Thriller
31282	The Devil's Chord	Alex Archer|Michele Hauf	Fantasy|Fiction|Fantasy|Urban Fantasy|Action|A...
37127	The Smile	Donna Jo Napoli	Historical|Historical Fiction|Young Adult|Hist...
10645	Evil in the Beginning	Gary Williams|Vicky Knerly	Mystery|Thriller|Adventure|Fiction
17844	Leonardo da Vinci	Walter Isaacson	Biography|Nonfiction|History|Art|Science
16681	King Dork	Frank Portman	Young Adult|Fiction|Humor|Young Adult|Teen|Mus...
3790	Be Great!: 365 Inspirational Quotes from the W...	Daniel Willey	Classics
17846	Leonardo, the Terrible Monster	Mo Willems	Childrens|Picture Books|Childrens|Childrens|St...
8831	Digital Fortress	Dan Brown	Fiction|Thriller|Mystery|Suspense
17845	Leonardo's Notebooks	Leonardo da Vinci|H. Anna Suh	Art|Nonfiction|History|Science|Classics|Biography
38082	The Uncanny	Sigmund Freud|Adam Phillips|David McLintock|Hu...	Nonfiction|Psychology|Philosophy|Philosophy|Th...
40473	Unbreakable	Kami Garcia	Young Adult|Fantasy|Paranormal|Fantasy|Paranor...
33190	The Hourglass Door	Lisa Mangum	Young Adult|Fantasy|Romance|Science Fiction|Ti...
29410	The Aylesford Skull	James P. Blaylock	Science Fiction|Steampunk|Fantasy|Science Fict...

In [39]:

```
# Running again with a different book to verify different results
book_recommendations("A Christmas Carol")
```

Out[39]:

	book_title	book_authors	genres
416	A Christmas Carol	Charles Dickens|Joe L. Wheeler	Classics|Fiction|Holiday|Christmas|Fantasy|Lit...
417	A Christmas Carol and Other Christmas Writings	Charles Dickens|Michael Slater	Classics|Fiction|Holiday|Christmas|Short Stori...
418	A Christmas Carol, The Chimes and The Cricket ...	Charles Dickens|Katharine Kroeber Wiley	Classics|Fiction|Holiday|Christmas|Literature
95	12 Stocking Stuffers	Beverly Barton|Helen Bianchin|Janelle Denison|...	Romance|Contemporary|Holiday|Christmas|Antholo...
30393	The Christmas Box	Richard Paul Evans	Holiday|Christmas|Fiction|Holiday|Inspirational
11309	Finding Noel	Richard Paul Evans	Holiday|Christmas|Fiction|Romance|Holiday
400	A Charlie Brown Christmas	Charles M. Schulz	Holiday|Christmas|Childrens|Childrens|Picture ...
4101	Belstarr The Lost Toymaker	David Jacks|Daniel S. Morrow	Holiday|Christmas|Childrens|Picture Books
30391	The Christmas Basket	Debbie Macomber	Holiday|Christmas|Romance|Holiday|Fiction|Wome...
6321	Christine Kringle	Lynn Brittney	Holiday|Christmas
21604	North Pole Reform School	Jaimie Admans	Young Adult|Holiday|Christmas|Fantasy|Romance|...
32142	The First Christmas Carol	Marianne Jordan	Holiday|Christmas|Christian Fiction|Christian|...
34124	The Life and Times of Scrooge McDuck	Don Rosa	Sequential Art|Comics|Sequential Art|Graphic N...
30394	The Christmas Box Collection: The Christmas Bo...	Richard Paul Evans	Holiday|Christmas|Fiction|Romance
12878	Grace	Richard Paul Evans	Holiday|Christmas|Fiction|Romance|Holiday|Youn...
16799	Kissing Under the Mistletoe	Bella Andre	Romance|Romance|Contemporary Romance|Contempor...
21603	North Pole High: A Rebel Without a Claus	Candace Jane Kringle	Holiday|Christmas|Romance|Young Adult|Humor|Fi...
30392	The Christmas Books, Volume 1: A Christmas Car...	Charles Dickens|Michael Slater	Classics|Fiction|Holiday|Christmas|Short Stories
1674	A wartime Christmas	Carol Rivers	Historical|Historical Fiction|Holiday|Christma...

40496	Uncle Scrooge: Only a Poor Old Man	Carl Barks|Gary Groth|George Lucas	Sequential Art|Comics|Sequential Art|Graphic N...

The results of this model are much nicer than the previous approach, but it too has some drawbacks. The recommendations often include the title submitted and variations there of. This makes sense as there is nothing preventing it from doing so and the variations would be similar to the original from the descriptions.

References

Aman Kharwal. July 19, 2022. *Book Recommendation System using Python.* https://thecleverprogrammer.com/2022/07/19/book-recommendation-system-using-python/ (https://thecleverprogrammer.com/2022/07/19/book-recommendation-system-using-python/)

Book Recommendation Dataset. (2024, February 9). https://www.kaggle.com/datasets/arashnic/book-recommendation-dataset (https://www.kaggle.com/datasets/arashnic/book-recommendation-dataset)

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