```
!pip install seaborn wordcloud spacy kneed
!python -m spacy download en_core_web_sm
!pip install kneed

# data manipulation
import pandas as pd
import numpy as np

# data visualization
import seaborn as sns
from matplotlib import pyplot as plt
from wordcloud import WordCloud
sns.set_style('whitegrid')

# data preprocessing
import re
import json
import string
import spacy
from nltk.corpus import stopwords
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics.pairwise import cosine_similarity

# modeling
from sklearn.cluster import KMeans
from kneed import KneeLocator

# utility
from collections import Counter
from itertools import chain
import warnings
from IPython.display import clear_output
warnings.filterwarnings("ignore")
```

```
Requirement already satisfied: thinc<8.4.0,>=8.3.4 in /usr/local/lib/python3.11/dist-packages (from spacy) (8.3.6)
Requirement already satisfied: wasabi<1.2.0,>=0.9.1 in /usr/local/lib/python3.11/dist-packages (from spacy) (1.1.3)
Requirement already satisfied: srsly<3.0.0,>=2.4.3 in /usr/local/lib/python3.11/dist-packages (from spacy) (2.5.1)
Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in /usr/local/lib/python3.11/dist-packages (from spacy) (2.0.10)
Requirement already satisfied: weasel<0.5.0,>=0.1.0 in /usr/local/lib/python3.11/dist-packages (from spacy) (0.4.1)
Requirement already satisfied: typer<1.0.0,>=0.3.0 in /usr/local/lib/python3.11/dist-packages (from spacy) (0.15.3)
Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in /usr/local/lib/python3.11/dist-packages (from spacy) (4.67.1)
Requirement already satisfied: requests<3.0.0,>=2.13.0 in /usr/local/lib/python3.11/dist-packages (from spacy) (2.32.3)
Requirement already satisfied: pydantic!=1.8,!=1.8.1,<3.0.0,>=1.7.4 in /usr/local/lib/python3.11/dist-packages (from spacy) (2.11.4)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.11/dist-packages (from spacy) (3.1.6)
Requirement already satisfied: setuptools in /usr/local/lib/python3.11/dist-packages (from spacy) (75.2.0)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.11/dist-packages (from spacy) (24.2)
Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in /usr/local/lib/python3.11/dist-packages (from spacy) (3.5.0)
Requirement already satisfied: scipy>=1.0.0 in /usr/local/lib/python3.11/dist-packages (from kneed) (1.15.3)
Requirement already satisfied: language-data>=1.2 in /usr/local/lib/python3.11/dist-packages (from langcodes<4.0.0,>=3.2.0->spacy) (1
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib!=3.6.1,>=3.4->seaborn) (1
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.11/dist-packages (from matplotlib!=3.6.1,>=3.4->seaborn) (0.12.
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.11/dist-packages (from matplotlib!=3.6.1,>=3.4->seaborn) (
Requirement already satisfied: kiwisolver>=1.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib!=3.6.1,>=3.4->seaborn) (
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib!=3.6.1,>=3.4->seaborn) (3
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.11/dist-packages (from matplotlib!=3.6.1,>=3.4->seaborn
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.11/dist-packages (from pandas>=1.2->seaborn) (2025.2)
Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.11/dist-packages (from pandas>=1.2->seaborn) (2025.2)
Requirement already satisfied: annotated-types>=0.6.0 in /usr/local/lib/python3.11/dist-packages (from pydantic!=1.8,!=1.8.1,<3.0.0,>
Requirement already satisfied: pydantic-core==2.33.2 in /usr/local/lib/python3.11/dist-packages (from pydantic!=1.8,!=1.8.1,<3.0.0,>=
Requirement already satisfied: typing-extensions>=4.12.2 in /usr/local/lib/python3.11/dist-packages (from pydantic!=1.8,!=1.8.1,<3.0.
Requirement already satisfied: typing-inspection>=0.4.0 in /usr/local/lib/python3.11/dist-packages (from pydantic!=1.8,!=1.8.1,<3.0.0
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.11/dist-packages (from requests<3.0.0,>=2.13.0->spa
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.11/dist-packages (from requests<3.0.0,>=2.13.0->spacy) (3.10)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.11/dist-packages (from requests<3.0.0,>=2.13.0->spacy) (2
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.11/dist-packages (from requests<3.0.0,>=2.13.0->spacy) (2
Requirement already satisfied: blis<1.4.0,>=1.3.0 in /usr/local/lib/python3.11/dist-packages (from thinc<8.4.0,>=8.3.4->spacy) (1.3.0
Requirement already satisfied: confection<1.0.0,>=0.0.1 in /usr/local/lib/python3.11/dist-packages (from thinc<8.4.0,>=8.3.4->spacy)
```

Downloading https://github.com/explosion/spacy-models/releases/download/en_core_web_sm-3.8.0/en_core_web_sm-3.8.0-py3-none-any.whl

```
Downloading https://github.com/explosion/spacy-models/releases/download/en_core_web_sm-3.8.0/en_core_web_sm-3.8.0-py3-none-any.whl
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 12.8/12.8 MB 72.0 MB/s eta 0:00:00
✓ Download and installation successful
You can now load the package via spacy.load('en_core_web_sm')
⚠ Restart to reload dependencies
If you are in a Jupyter or Colab notebook, you may need to restart Python in
order to load all the package's dependencies. You can do this by selecting the
'Restart kernel' or 'Restart runtime' option.
Requirement already satisfied: kneed in /usr/local/lib/python3.11/dist-packages (0.8.5)
Requirement already satisfied: numpy>=1.14.2 in /usr/local/lib/python3.11/dist-packages (from kneed) (2.0.2)
Requirement already satisfied: scipy>=1.0.0 in /usr/local/lib/python3.11/dist-packages (from kneed) (1.15.3)
```

```
import nltk
nltk.download('stopwords')

# global variable
dataset = 'goodreads.csv'
stopwords = set(stopwords.words('english'))
punctuation = string.punctuation + '—'
min_rating = 2000000
nlp = spacy.load("en_core_web_sm")
vectorizer = TfidfVectorizer()
kmeans_params = {
    'init': 'random',
    'n_init': 10,
    'max_iter': 300,
    'random_state': 42
}
sse = []
n_k = range(1, 41)
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

Data Loading

```
df = pd.read_csv(dataset) \
    .drop(['web-scraper-order', 'web-scraper-start-url', 'genre', 'genre-href', 'book', 'book-href'], axis=1)
df.head()
```

	title	author	description	rating	total_rating	list_genre
0	Insurgent	Veronica Roth	One choice can transform you—or it can destroy you. But every choice has consequences, and as unrest surges in the factions all around her, Tris Prior must continue trying to save those she loves—and herself—while grappling with haunting questions of grief and forgiveness, identity and loyalty, politics and love.\n\nTris's initiation day should have been marked by celebration and victory with her chosen faction; instead, the day ended with unspeakable horrors. War now looms as conflict between the factions and their ideologies grows. And in times of war, sides must be chosen, secrets will emerge, and choices will become even more irrevocable—and even more powerful. Transformed by her own decisions but also by haunting grief and guilt, radical new discoveries, and shifting relationships, Tris must fully embrace her Divergence, even if she does not know what she may lose by doing so.\n\nNew York Times bestselling author Veronica Roth's much-anticipated second book of the dystopian DIVERGENT series is another intoxicating thrill ride of a story, rich with hallmark twists, heartbreaks, romance, and powerful insights about human nature.	3.99	1,375,098 ratings	[{"list_genre":"Young Adult"},{"list_genre":"Dystopia"},{"list_genre":"Fiction"},{"list_genre":"Fantasy"},{"list_genre":"Science Fiction"},{"list_genre":"Romance"},{"list_genre":"Adventure"},{"list_genre":"...more"}]
1	New Moon	Stephenie Meyer	There is an alternate cover edition for ISBN13 9780316160193 here. \n\nI knew we were both in mortal danger. Still, in that instant, I felt well. Whole. I could feel my heart racing in my chest, the blood pulsing hot and fast through my veins again. My lungs filled deep with the sweet scent that came off his skin. It was like there had never been any hole in my chest. I was perfect - not healed, but as if there had never been a wound in the first place. \n\nI FELT LIKE I WAS TRAPPED IN ONE OF THOSE TERRIFYING NIGHTMARES, the one where you have to run, run till your lungs burst, but you can't make your body move fast enough.... But this was no dream, and, unlike the nightmare, I wasn't running for my life; I was racing to save something infinitely more precious. My own life meant little to me today. \n\nFOR BELLA SWAN THERE IS ONE THING more important than life itself: Edward Cullen. But being in love with a vampire is even more dangerous than Bella could ever have imagined. Edward has already rescued Bella from the clutches of one evil vampire, but now, as their daring relationship threatens all that is near and dear to them, they realize their troubles may be just beginning....\n\nLEGIONS OF READERS ENTRANCED BY THE New York Times bestseller Twilight are hungry for the continuing story of star-crossed lovers Bell and Edward. In New Moon, Stephanie Meyer delivers another irresistible combination of romance and suspense with a supernatural spin. passionate, riveting, and full of surprising twists and turns, this vampire love saga is well on its way to literary immortality.	3.58	1,747,095 ratings	[{"list_genre":"Young Adult"},{"list_genre":"Fantasy"},{"list_genre":"Romance"},{"list_genre":"Vampires"},{"list_genre":"Fiction"},{"list_genre":"Paranormal"},{"list_genre":"Paranormal Romance"},{"list_genre":"...more"}]
2	Harry Potter and the Half-	J.K. Rowling	It is the middle of the summer, but there is an unseasonal mist pressing against the windowpanes. Harry Potter is waiting nervously in his bedroom at the Dursleys' house in Privet Drive for a visit from Professor Dumbledore himself. One of the last times he saw the Headmaster was in a fierce one-to-one duel with Lord Voldemort, and Harry can't quite believe that Professor Dumbledore will actually appear at the Dursleys' of all places. Why is the	4.58	2,939,820 ratings	[{"list_genre":"Fantasy"},{"list_genre":"Young Adult"},{"list_genre":"Fiction"},{"list_genre":"Magic"},{"list_genre":"Childrens"},

Next steps: Generate code with df | View recommended plots | New interactive sheet

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1121 entries, 0 to 1120
Data columns (total 6 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   title         1121 non-null   object 
 1   author        1121 non-null   object 
 2   description   1120 non-null   object 
 3   rating        1121 non-null   float64
 4   total_rating  1121 non-null   object 
 5   list_genre    1121 non-null   object 
dtypes: float64(1), object(5)
memory usage: 52.7+ KB
```

Data Cleaning

Since we can't visualize with dirty data, we need to clean the data first so we can do EDA with ease. First we need to clean the *total_rating* columns and convert to int.

```
df.dropna(inplace=True)
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 1120 entries, 0 to 1120
Data columns (total 6 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   title         1120 non-null   object 
 1   author        1120 non-null   object 
 2   description   1120 non-null   object 
 3   rating        1120 non-null   float64
 4   total_rating  1120 non-null   object 
 5   list_genre    1120 non-null   object 
dtypes: float64(1), object(5)
memory usage: 61.2+ KB
```

```
# clean the rating column by removing "ratings" and convert to int
df['total_rating_clean'] = df['total_rating'].apply(lambda x: re.sub(',(?!\s+\d$)', '', x[:-8])).astype(np.int64)
df.head()
```

	title	author	description	rating	total_rating	list_genre	total_rating_clean
0	Insurgent	Veronica Roth	One choice can transform you—or it can destroy you. But every choice has consequences, and as unrest surges in the factions all around her, Tris Prior must continue trying to save those she loves—and herself—while grappling with haunting questions of grief and forgiveness, identity and loyalty, politics and love.\n\nTris's initiation day should have been marked by celebration and victory with her chosen faction; instead, the day ended with unspeakable horrors. War now looms as conflict between the factions and their ideologies grows. And in times of war, sides must be chosen, secrets will emerge, and choices will become even more irrevocable—and even more powerful. Transformed by her own decisions but also by haunting grief and guilt, radical new discoveries, and shifting relationships, Tris must fully embrace her Divergence, even if she does not know what she may lose by doing so.\n\nNew York Times bestselling author Veronica Roth's much-anticipated second book of the dystopian DIVERGENT series is another intoxicating thrill ride of a story, rich with hallmark twists, heartbreaks, romance, and powerful insights about human nature.	3.99	1,375,098 ratings	[{"list_genre":"Young Adult"}, {"list_genre":"Dystopia"}, {"list_genre":"Fiction"}, {"list_genre":"Fantasy"}, {"list_genre":"Science Fiction"}, {"list_genre":"Romance"}, {"list_genre":"Adventure"}, {"list_genre":"...more"}]	1375098
1	New Moon	Stephenie Meyer	There is an alternate cover edition for ISBN13 9780316160193 here. \n\nI knew we were both in mortal danger. Still, in that instant, I felt well. Whole. I could feel my heart racing in my chest, the blood pulsing hot and fast through my veins again. My lungs filled deep with the sweet scent that came off his skin. It was like there had never been any hole in my chest. I was perfect - not healed, but as if there had never been a wound in the first place. \n\nI FELT LIKE I WAS TRAPPED IN ONE OF THOSE TERRIFYING NIGHTMARES, the one where you have to run, run till your lungs burst, but you can't make your body move fast enough.... But this was no dream, and, unlike the nightmare, I wasn't running for my life; I was racing to save something infinitely more precious. My own life meant little to me today. \n\nFOR BELLA SWAN THERE IS ONE THING more important than life itself: Edward Cullen. But being in love with a vampire is even more dangerous than Bella could ever have imagined. Edward has already rescued Bella from the clutches of one evil vampire, but now, as their daring relationship threatens all that is near and dear to them, they realize their troubles may be just	3.58	1,747,095 ratings	[{"list_genre":"Young Adult"}, {"list_genre":"Fantasy"}, {"list_genre":"Romance"}, {"list_genre":"Vampires"}, {"list_genre":"Fiction"}, {"list_genre":"Paranormal"}, {"list_genre":"Paranormal Romance"}, {"list_genre":"...more"}]	1747095

Next steps: Generate code with df | View recommended plots | New interactive sheet

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 1120 entries, 0 to 1120
Data columns (total 7 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   title               1120 non-null   object 
 1   author              1120 non-null   object 
 2   description         1120 non-null   object 
 3   rating              1120 non-null   float64
 4   total_rating        1120 non-null   object 
 5   list_genre          1120 non-null   object 
 6   total_rating_clean  1120 non-null   int64  
dtypes: float64(1), int64(1), object(5)
memory usage: 70.0+ KB
```

Next lets move to *list_genre* columns. We need to convert from json object to list of genre

```
# clean the genre from json object to dictionary and convert to list
df['list_genre_clean'] = df['list_genre'].apply(lambda x: [dict_genre['list_genre'] for dict_genre in json.loads(x)])
df['list_genre_clean'] = df['list_genre_clean'].apply(lambda x: ['-'.join(genre.split()) for genre in x[:-1]])
df.head()
```

	title	author	description	rating	total_rating	list_genre	total_rating_clean	list_genre_clean
0	Insurgent	Veronica Roth	One choice can transform you—or it can destroy you. But every choice has consequences, and as unrest surges in the factions all around her, Tris Prior must continue trying to save those she loves—and herself—while grappling with haunting questions of grief and forgiveness, identity and loyalty, politics and love.\n\nTris's initiation day should have been marked by celebration and victory with her chosen faction; instead, the day ended with unspeakable horrors. War now looms as conflict between the factions and their ideologies grows. And in times of war, sides must be chosen, secrets will emerge, and choices will become even more irrevocable—and even more powerful. Transformed by her own decisions but also by haunting grief and guilt, radical new discoveries, and shifting relationships, Tris must fully embrace her Divergence, even if she does not know what she may lose by doing so.\n\nNew York Times bestselling author Veronica Roth's much-anticipated second book of the dystopian DIVERGENT series is another intoxicating thrill ride of a story, rich with hallmark twists, heartbreaks, romance, and powerful insights about human nature. There is an alternate cover edition for ISBN13 9780316160193 here. \n\nI knew we were both in mortal danger. Still, in that instant, I felt well. Whole. I could feel my heart racing in my chest, the blood pulsing hot and fast through my veins again. My lungs filled deep with the sweet scent that came off his skin. It was like there had never been any hole in my chest. I was perfect - not healed, but as if there had never been a wound in the first place. \n\nI FELT LIKE I WAS TRAPPED IN ONE OF	3.99	1,375,098 ratings	[{"list_genre":"Young Adult"},{"list_genre":"Dystopia"},{"list_genre":"Fiction"},{"list_genre":"Fantasy"},{"list_genre":"Science Fiction"},{"list_genre":"Romance"},{"list_genre":"Adventure"},{"list_genre":"...more"}]	1375098	[Young-Adult, Dystopia, Fiction, Fantasy, Science-Fiction, Romance, Adventure]

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```
#removing useless columns

df.drop(['list_genre','total_rating'], axis=1, inplace=True)
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 1120 entries, 0 to 1120
Data columns (total 6 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   title               1120 non-null   object
 1   author              1120 non-null   object
 2   description         1120 non-null   object
 3   rating              1120 non-null   float64
 4   total_rating_clean  1120 non-null   int64
 5   list_genre_clean    1120 non-null   object
dtypes: float64(1), int64(1), object(4)
memory usage: 61.2+ KB
```

Exploratory Data Analysis

```
print(f'The goodreads dataset contains {df.shape[0]} rows and {df.shape[1]} columns')
```

```
The goodreads dataset contains 1120 rows and 6 columns
```

```
print('Book unique value:', len(df['title'].unique()))
print('Author unique value:', len(df['author'].unique()))
```

```
Book unique value: 1120
Author unique value: 898
```

This means some authors have multiple books.

Now, checking min, max, mean, std deviation etc for rating and total ratings.

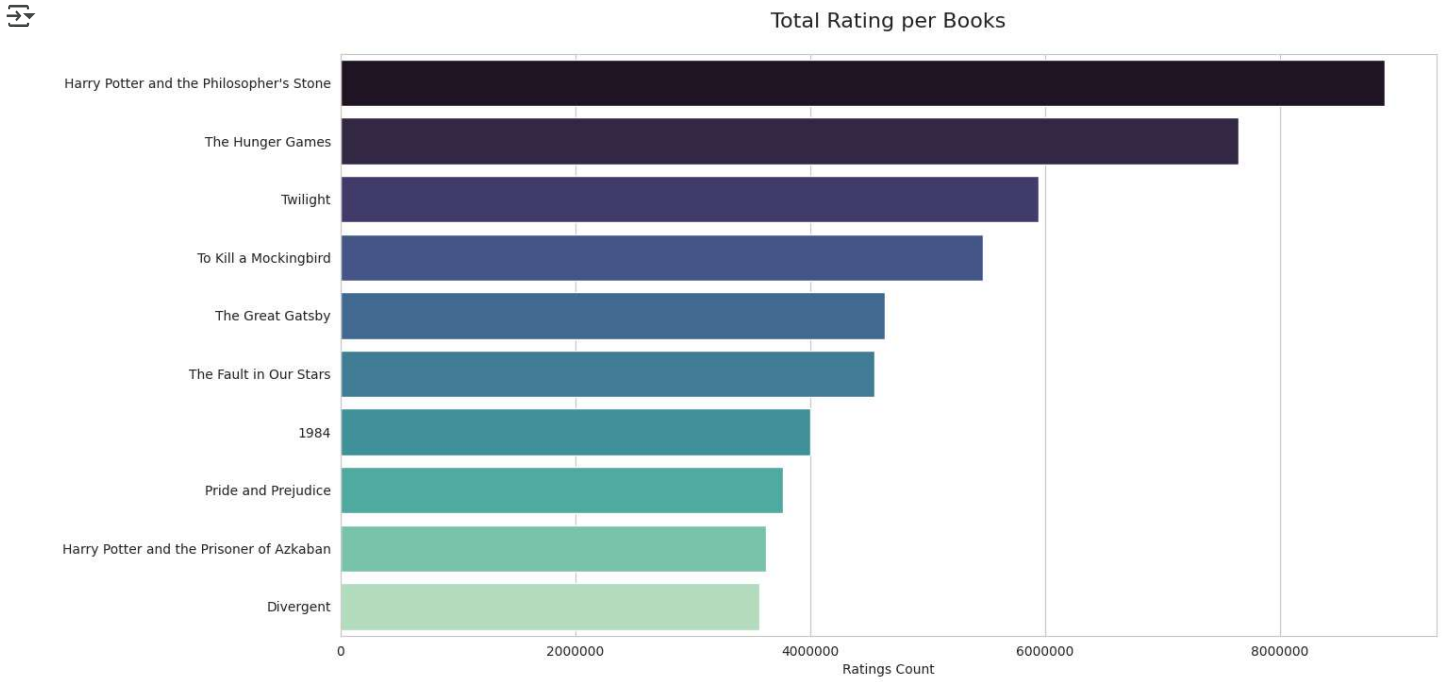
```
df.describe()
```

	rating	total_rating_clean
count	1120.000000	1.120000e+03
mean	4.140589	2.941330e+05
std	0.278698	7.273204e+05
min	2.000000	2.000000e+00
25%	3.960000	8.667500e+02
50%	4.150000	2.988100e+04
75%	4.340000	2.267212e+05
max	4.890000	8.889571e+06

```
def bar_chart(x, y, title=None, sc=False, xlabel=None, ylabel=None):
    """
    This function plot categorical distribution using seaborn barplot

    Parameters
    ----------
    x: x axis values
    y: y axis values
    title: title of the plot

    Returns
    ----------
    None
    """

    plt.figure(figsize=(15,8))
    if not sc:
        plt.ticklabel_format(style='plain', axis='x')
    ax = sns.barplot(x=x, y=y, palette='mako')
```

```
    ax.set_title(title, pad=20, fontsize=16)
    ax.set_xlabel(xlabel)
    ax.set_ylabel(ylabel)
    plt.show()
```

```
top_10_rated_book = df.sort_values('total_rating_clean', ascending=False).head(10).set_index('title')
bar_chart(
    x=top_10_rated_book['total_rating_clean'],
    y=top_10_rated_book.index,
    title='Total Rating per Books',
    xlabel='Ratings Count'
)
```

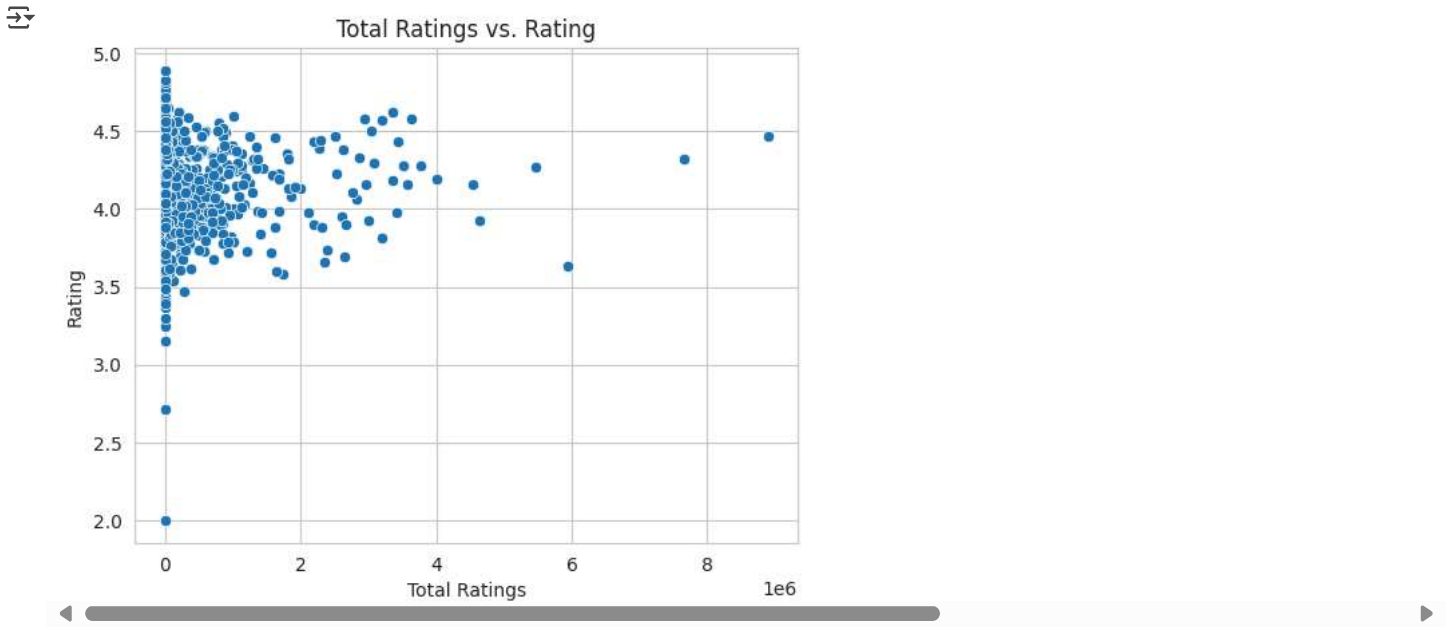


From the plot above we can conclude that:

1. Usually the beginning books of the series have the most rating, i.e Harry Potter and the Phiolosopher Stone, The Hunger Games, Twilight.
2. J.K Rowling dominates the most rated books chart with Harry Potter and the Philosopher's Stone and Harry Potter and the Prisoner of Azkaban with over than 12 million rating on GoodReads.

Now, comparing total ratings to rating.

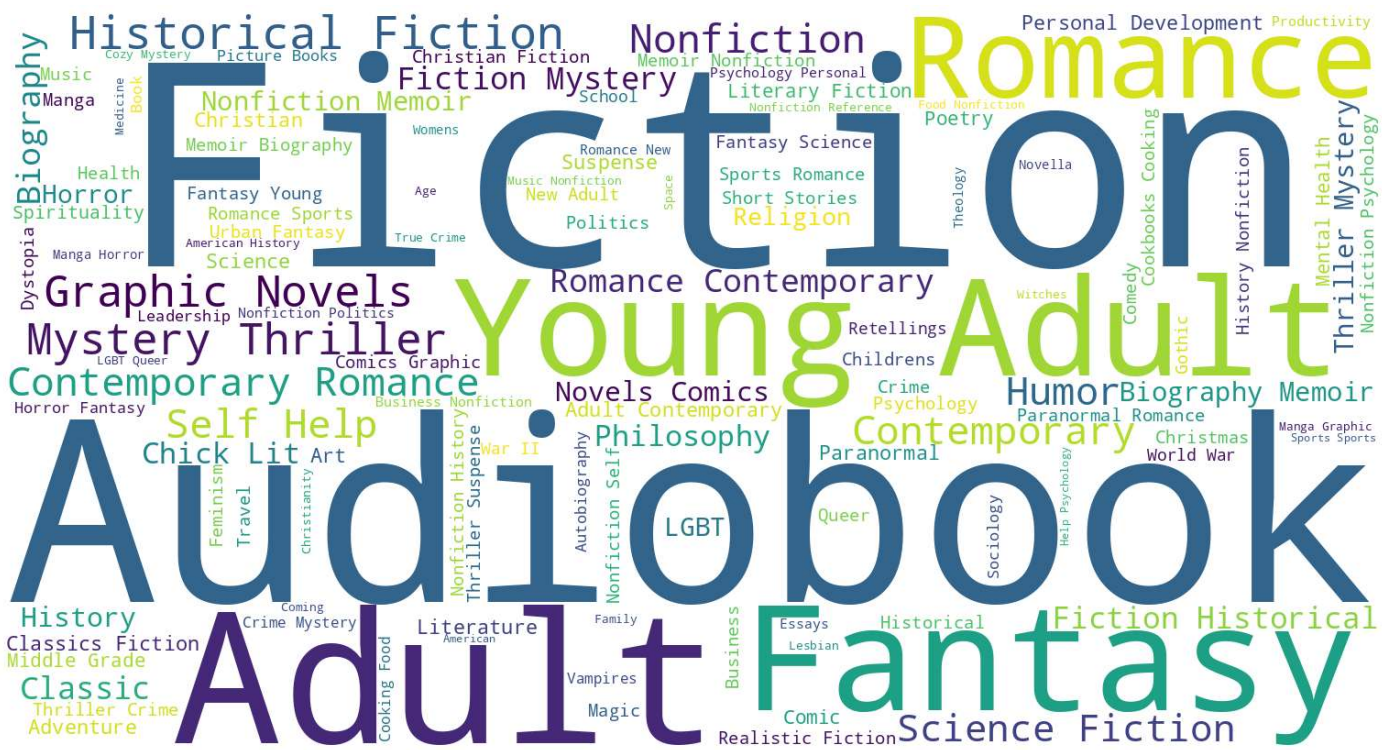
```
sns.scatterplot(data=df, x='total_rating_clean', y='rating')

plt.title('Total Ratings vs. Rating')
plt.xlabel('Total Ratings')
plt.ylabel('Rating')
plt.show()
```



From this plot we can compare to plot before, we can see that some book with most total rating is not in the highest rated books chart. We can conclude that having that much number of rating doesnt make the book the highest rated books.

Now, checking genre with most books

```
def create_wordcloud(data):
    """
    This function used to create wordcloud from given data

    Parameters
    ----------
    data: a set of string/text

    Returns
    ----------
    None
    """

    wordcloud = WordCloud(
        width=1500,
        height=800,
        min_font_size=12,
        background_color='white'
    ).generate(data)
    plt.figure(figsize=(15,8))
    plt.imshow(wordcloud)
    plt.axis('off')
    plt.tight_layout(pad=0)
    plt.show()


joined_genre = ' '.join(df['list_genre_clean'].apply(lambda x: ' '.join(x)).values)
create_wordcloud(joined_genre)
```



From the wordcloud above we can see that most books have Fiction genre, followed by Adult and Audiobook.

```
temp = df[~(df['total_rating_clean'] > min_rating)]
temp.head()
```

	title	author	description	rating	total_rating_clean	list_genre_clean
0	Insurgent	Veronica Roth	One choice can transform you—or it can destroy you. But every choice has consequences, and as unrest surges in the factions all around her, Tris Prior must continue trying to save those she loves—and herself—while grappling with haunting questions of grief and forgiveness, identity and loyalty, politics and love.\n\nTris's initiation day should have been marked by celebration and victory with her chosen faction; instead, the day ended with unspeakable horrors. War now looms as conflict between the factions and their ideologies grows. And in times of war, sides must be chosen, secrets will emerge, and choices will become even more irrevocable—and even more powerful. Transformed by her own decisions but also by haunting grief and guilt, radical new discoveries, and shifting relationships, Tris must fully embrace her Divergence, even if she does not know what she may lose by doing so.\n\nNew York Times bestselling author Veronica Roth's much-anticipated second book of the dystopian DIVERGENT series is another intoxicating thrill ride of a story, rich with hallmark twists, heartbreaks, romance, and powerful insights about human nature.	3.99	1375098	[Young-Adult, Dystopia, Fiction, Fantasy, Science-Fiction, Romance, Adventure]
1	New Moon	Stephenie Meyer	There is an alternate cover edition for ISBN13 9780316160193 here. \n\nI knew we were both in mortal danger. Still, in that instant, I felt well. Whole. I could feel my heart racing in my chest, the blood pulsing hot and fast through my veins again. My lungs filled deep with the sweet scent that came off his skin. It was like there had never been any hole in my chest. I was perfect - not healed, but as if there had never been a wound in the first place. \n\nI FELT LIKE I WAS TRAPPED IN ONE OF THOSE TERRIFYING NIGHTMARES, the one where you have to run, run till your lungs burst, but you can't make your body move fast enough.... But this was no dream, and, unlike the nightmare, I wasn't running for my life; I was racing to save something infinitely more precious. My own life meant little to me today. \n\nFOR BELLA SWAN THERE IS ONE THING more important than life itself: Edward Cullen. But being in love with a vampire is even more dangerous than Bella could ever have imagined. Edward has already rescued Bella from the clutches of one evil vampire, but now, as their daring relationship threatens all that is near and dear to them, they realize their troubles may be just beginning....\n\nLEGIONS OF READERS ENTRANCED BY THE New York Times bestseller Twilight are hungry for the continuing story of star-crossed lovers Bell and Edward. In New Moon, Stephanie Meyer delivers another irresistible combination of romance and suspense with a supernatural spin. passionate, riveting, and full of surprising twists and turns, this vampire love saga is well on its way to literary immortality. SOUTHEASTERN LIBRARY ASSOCIATION'S (SELA) 2018 Author of the Year in fiction\nPUBLISHERS LUNCH BUZZ BOOK, Winter 2017/2018\nSIBA Trio 2018 Selection\nSIBA OKRA PICK Winter 2018\nFirst Pick for SOUTHERN LADY Book Club\n\nSet in the Carolinas in the 1940s, The Road to Bittersweet is a beautifully written, evocative account of a young woman reckoning not just with the unforgiving landscape, but with the rocky emotional terrain that leads from innocence to wisdom.\n\nFor fourteen	3.58	1747095	[Young-Adult, Fantasy, Romance, Vampires, Fiction, Paranormal, Paranormal-Romance]

Next steps: Generate code with temp | View recommended plots | New interactive sheet

Feature Selection and extraction

Because we are using Content Based Approach, the feature we are subseting is title, author, genre, and keywords.

```
def strip_html(text):
    """
    This function strip html tags from text

    Parameters
    ----------
    text: some text

    Returns
    ----------
    text: cleaned text from html
    """

    clean = re.compile('<.*?>')
```

```
        return re.sub(clean, '', text)

    def remove_stopwords(text):
        """
        This function remove stopwords from text

        Parameters
        ----------
        text: some text

        Returns
        ----------
        text: cleaned text from stopwords
        """

        text = text.split()
        text = [word for word in text if word not in stopwords]
        return ' '.join(text)

    def remove_digits(text):
        """
        This function remove number/digits from text

        Parameters
        ----------
        text: some text

        Returns
        ----------
        text: cleaned text from number/digits
        """

        text = re.sub(r'[0-9]', '', text)
        return text

    def remove_punctuation(text):
        """
        This function remove punctuation from text

        Parameters
        ----------
        text: some text

        Returns
        ----------
        text: cleaned text from punctuation
        """

        text = ''.join([word for word in text if word not in punctuation])
        return text

    def get_keywords(text):
        """
        This function get keywords from text

        Parameters
        ----------
        text: some text

        Returns
        ----------
        text: list of keywords
        """

        doc = nlp(text)
        return ' '.join([item.text.strip() for item in doc.ents])

    def parse_text(text):
        """
        This function parse the text

        Parameters
        ----------
        text: some text

        Returns
        ----------
        text: parsed text
```

```
    text: parsed text
    """

    text = text.lower()
    text = strip_html(text)
    text = remove_stopwords(text)
    text = remove_digits(text)
    text = remove_punctuation(text)
    text = get_keywords(text)
    return text


df['keywords'] = df['description'].apply(parse_text)
df.head()
```

	title	author	description	rating	total_rating_clean	list_genre_clean	keywords
0	Insurgent	Veronica Roth	One choice can transform you—or it can destroy you. But every choice has consequences, and as unrest surges in the factions all around her, Tris Prior must continue trying to save those she loves—and herself—while grappling with haunting questions of grief and forgiveness, identity and loyalty, politics and love.\n\nTris's initiation day should have been marked by celebration and victory with her chosen faction; instead, the day ended with unspeakable horrors. War now looms as conflict between the factions and their ideologies grows. And in times of war, sides must be chosen, secrets will emerge, and choices will become even more irrevocable—and even more powerful. Transformed by her own decisions but also by haunting grief and guilt, radical new discoveries, and shifting relationships, Tris must fully embrace her Divergence, even if she does not know what she may lose by doing so.\n\nNew York Times bestselling author Veronica Roth's much-anticipated second book of the dystopian DIVERGENT series is another intoxicating thrill ride of a story, rich with hallmark twists, heartbreaks, romance, and powerful insights about human nature.	3.99	1375098	[Young-Adult, Dystopia, Fiction, Fantasy, Science-Fiction, Romance, Adventure]	one triss new york second
1	New Moon	Stephenie Meyer	There is an alternate cover edition for ISBN13 9780316160193 here. \n\nI knew we were both in mortal danger. Still, in that instant, I felt well. Whole. I could feel my heart racing in my chest, the blood pulsing hot and fast through my veins again. My lungs filled deep with the sweet scent that came off his skin. It was like there had never been any hole in my chest. I was perfect - not healed, but as if there had never been a wound in the first place. \n\nI FELT LIKE I WAS TRAPPED IN ONE OF THOSE TERRIFYING NIGHTMARES, the one where you have to run, run till your lungs burst, but you can't make your body move fast enough.... But this was no dream, and, unlike the nightmare, I wasn't running for my life; I was racing to save something infinitely more precious. My own life meant little to me today. \n\nFOR BELLA SWAN THERE IS ONE THING more important than life itself: Edward Cullen. But being in love with a vampire is even more dangerous than Bella could ever have imagined. Edward has already rescued Bella from the clutches of one evil vampire, but now, as their daring relationship threatens all that is near and dear to them, they realize their troubles may be just beginning....\n\nLEGIONS OF READERS ENTRANCED BY THE New York Times bestseller Twilight are hungry for the continuing story of star-crossed lovers Bell and Edward. In New Moon, Stephanie Meyer delivers another irresistible combination of romance and suspense with a supernatural spin. passionate, riveting, and full of surprising twists and turns, this vampire love saga is well	3.58	1747095	[Young-Adult, Fantasy, Romance, Vampires, Fiction, Paranormal, Paranormal-Romance]	first today one one new york new moon stephanie meyer

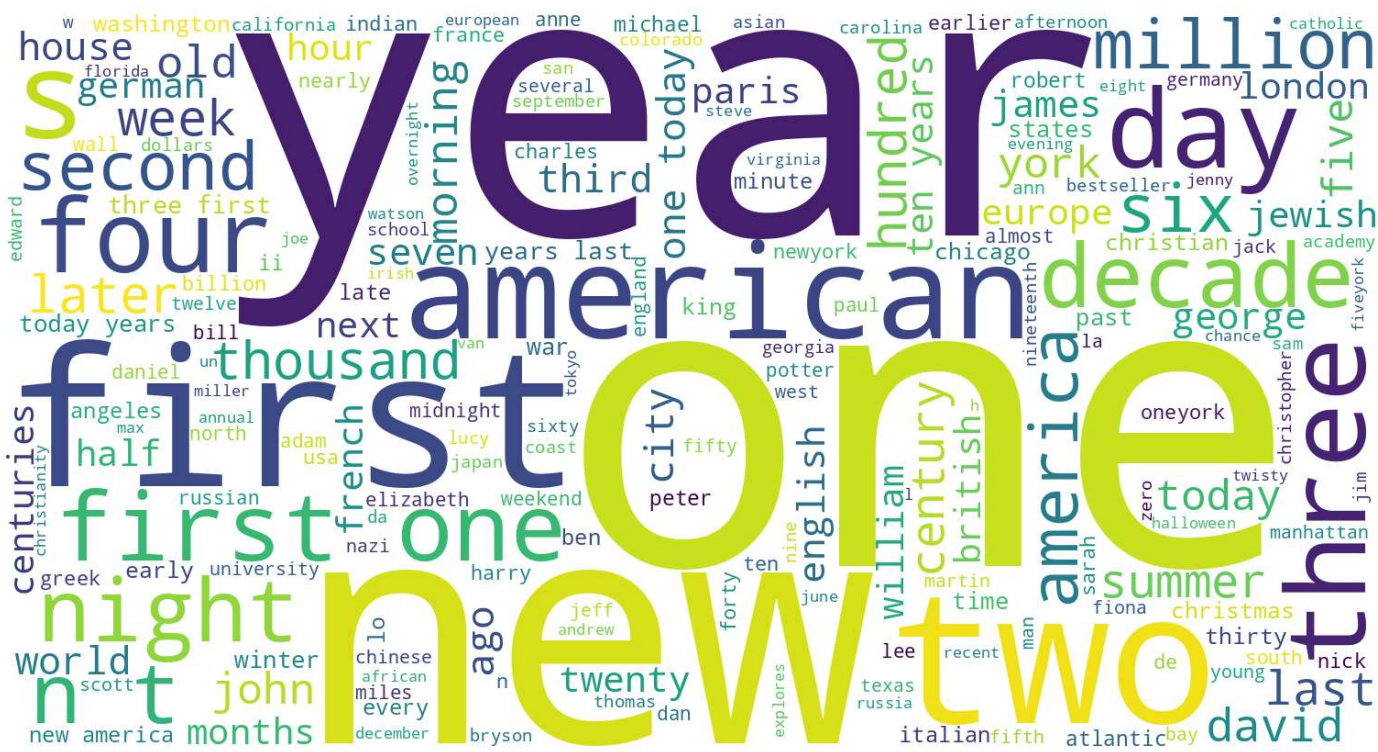
Next steps: Generate code with df | View recommended plots | New interactive sheet

```
features = ['title', 'author', 'list_genre_clean', 'keywords']
final_df = df.loc[:, features]
final_df['list_genre_clean'] = final_df['list_genre_clean'].apply(lambda x: ' '.join(x))
final_df['keywords'] = final_df['keywords'].apply(lambda x: ' '.join(list(set(x.split()))))
final_df.head()
```

	title	author	list_genre_clean	keywords
0	Insurgent	Veronica Roth	Young-Adult Dystopia Fiction Fantasy Science-Fiction Romance Adventure	york one triss new second
1	New Moon	Stephenie Meyer	Young-Adult Fantasy Romance Vampires Fiction Paranormal Paranormal-Romance	york stephanie meyer first one today moon new
2	Harry Potter and the Half-Blood Prince	J.K. Rowling	Fantasy Young-Adult Fiction Magic Childrens Adventure Audiobook	dumbledore harry returns year one sixth potter weeks harrys

Next steps: Generate code with final_df View recommended plots New interactive sheet

```
joined_keyword = ''.join(final_df['keywords'].values)
create_wordcloud(joined_keyword)
```



From the wordcloud above, we can see that "year" is the most occurred keywords of all books. It can happens because in most books description starting with telling the year of the books. Next we can create a corpus from book genre and keywords to find the frequency of corpus between books. We are using TfidfVectorizer to find the corpus frequency and convert it to vector array.

```
final_df['corpus'] =  final_df[['list_genre_clean', 'keywords']].agg(' '.join, axis=1).str.lower()
final_df.head()
```

	title	author	list_genre_clean	keywords	corpus
0	Insurgent	Veronica Roth	Young-Adult Dystopia Fiction Fantasy Science-Fiction Romance Adventure	york one triss new second	young-adult dystopia fiction fantasy science-fiction romance adventure york one triss new second
1	New Moon	Stephenie Meyer	Young-Adult Fantasy Romance Vampires Fiction Paranormal Paranormal-Romance	york stephanie meyer first one today moon new	young-adult fantasy romance vampires fiction paranormal paranormal-romance york stephanie meyer first one today moon new
2	Harry Potter and the Half-Blood Prince	J.K. Rowling	Fantasy Young-Adult Fiction Magic Childrens Adventure Audiobook	dumbledore harry returns year one sixth potter weeks harrys	fantasy young-adult fiction magic childrens adventure audiobook dumbledore harry returns year one sixth potter weeks harrys
3	Harry Potter and the Chamber of	J.K.	Fantasy Fiction Young-Adult Magic	harry returns year one potter harry's draco	fantasy fiction young-adult magic childrens middle-grade audiobook harry returns year one

Next steps: Generate code with final_df | View recommended plots | New interactive sheet

```
tfidf = vectorizer.fit_transform(final_df['corpus'])
tfidf
```

```
<Compressed Sparse Row sparse matrix of dtype 'float64'
        with 15960 stored elements and shape (1120, 3447)>
```

Modeling

After getting the frequency, then we need to find the similarity between vector for clustering. We will use cosine similarity to find similarity between vector.

```
cosine_sim = cosine_similarity(tfidf, tfidf)
cosine_sim_df = pd.DataFrame(cosine_sim)
cosine_sim_df.head()
```

	0	1	2	3	4	5	6	7	8	9	...	1110	1111	1112	1113	
0	1.000000	0.231847	0.179829	0.170170	0.172100	0.236551	0.147152	0.167470	0.141770	0.285607	...	0.077192	0.081710	0.0	0.0	0.(
1	0.231847	1.000000	0.074733	0.072854	0.065818	0.090467	0.056277	0.064047	0.094114	0.557052	...	0.051155	0.045032	0.0	0.0	0.(
2	0.179829	0.074733	1.000000	0.559068	0.441109	0.543760	0.365902	0.416425	0.477081	0.080312	...	0.025176	0.022890	0.0	0.0	0.(
3	0.170170	0.072854	0.559068	1.000000	0.509708	0.571324	0.467327	0.580207	0.718103	0.137831	...	0.024543	0.022314	0.0	0.0	0.(
4	0.172100	0.065818	0.441109	0.509708	1.000000	0.573125	0.600336	0.626189	0.502845	0.084649	...	0.016823	0.024126	0.0	0.0	0.(

5 rows × 1120 columns

After getting the distance between item in vector, we feed the data into KMeans and run for 40 iteration to get the sse for finding the best k (elbow) using KneeLocator.

```
for k in n_k:
    print(f'Cluster {k}/40')
    kmeans = KMeans(n_clusters=k, **kmeans_params)
    kmeans.fit(cosine_sim)
    sse.append(kmeans.inertia_)
    clear_output(wait=True)
locator = KneeLocator(n_k, sse, curve='convex', direction='decreasing')
print('Best cluster for KMeans:', locator.elbow)
```

```
Best cluster for KMeans: 9
```

```
kmeans = KMeans(n_clusters=locator.elbow, **kmeans_params)
kmeans.fit(cosine_sim)
final_df['cluster'] = kmeans.labels_
final_df.head(15)
```

	title	author	list_genre_clean	keywords	corpus	cluster
0	Insurgent	Veronica Roth	Young-Adult Dystopia Fiction Fantasy Science-Fiction Romance Adventure	york one triss new second	young-adult dystopia fiction fantasy science-fiction romance adventure york one triss new second	5
1	New Moon	Stephenie Meyer	Young-Adult Fantasy Romance Vampires Fiction Paranormal Paranormal-Romance	york stephanie meyer first one today moon new	young-adult fantasy romance vampires fiction paranormal paranormal-romance york stephanie meyer first one today moon new	5
2	Harry Potter and the Half-Blood Prince	J.K. Rowling	Fantasy Young-Adult Fiction Magic Childrens Adventure Audiobook	dumbledore harry returns year one sixth potter weeks harrys	fantasy young-adult fiction magic childrens adventure audiobook dumbledore harry returns year one sixth potter weeks harrys	7
3	Harry Potter and the Chamber of Secrets	J.K. Rowling	Fantasy Fiction Young-Adult Magic Childrens Middle-Grade Audiobook	harry returns year one potter harry's draco second summer	fantasy fiction young-adult magic childrens middle-grade audiobook harry returns year one potter harry's draco second summer	7
4	Harry Potter and the Order of the Phoenix	J.K. Rowling	Fantasy Young-Adult Fiction Magic Childrens Adventure Audiobook	holidays harry year ron hermione potter fifth summer	fantasy young-adult fiction magic childrens adventure audiobook holidays harry year ron hermione potter fifth summer	7
5	Harry Potter and the Deathly Hallows	J.K. Rowling	Young-Adult Fiction Magic Childrens Adventure Audiobook Fantasy	potter seventh harry	young-adult fiction magic childrens adventure audiobook fantasy potter seventh harry	7
6	Harry Potter and the Prisoner of Azkaban	J.K. Rowling	Fantasy Fiction Young-Adult Magic Childrens Middle-Grade Adventure	school harry year ron hermione potter third azkaban called guard	fantasy fiction young-adult magic childrens middle-grade adventure school harry year ron hermione potter third azkaban called guard	7
7	Harry Potter and the Goblet of Fire	J.K. Rowling	Fantasy Young-Adult Fiction Magic Childrens Middle-Grade Adventure	holidays days harry year potter counting summer fourth	fantasy young-adult fiction magic childrens middle-grade adventure holidays days harry year potter counting summer fourth	7
8	Harry Potter and the Philosopher's Stone	J.K. Rowling	Fantasy Fiction Young-Adult Magic Childrens Middle-Grade Classics	potter harry	fantasy fiction young-adult magic childrens middle-grade classics potter harry	7
9	Twilight	Stephenie Meyer	Fantasy Young-Adult Romance Fiction Vampires Paranormal Paranormal-Romance	third second three first	fantasy young-adult romance fiction vampires paranormal paranormal-romance third second three first	5
10	Divergent	Veronica Roth	Young-Adult Dystopia Fiction Fantasy Science-Fiction	chicago five one	young-adult dystopia fiction fantasy science-fiction romance adventure chicago	5

Next steps: Generate code with final_df | View recommended plots | New interactive sheet

Now lets get 1 book from final_df for test the recommendation system then we create book map for getting book recommendation based on title given. And return the book index if the book given exists in dataset.

```
test_book = final_df.sample(1, random_state=13)
test_book
```

	title	author	list_genre_clean	keywords	corpus	cluster
249	The Myth of Normal: Trauma, Illness, and Healing in a Toxic	Gabor Maté	Nonfiction Psychology Self-Help Health Mental-Health	canada two half four percent today fifth europe daniel americans myth	nonfiction psychology self-help health mental-health science sociology canada two half four percent today fifth europe	2

```
book_map = pd.Series(final_df.index, index=final_df['title'])
book_map.head()
```

title	0
Insurgent	0
New Moon	1
Harry Potter and the Half-Blood Prince	2
Harry Potter and the Chamber of Secrets	3
Harry Potter and the Order of the Phoenix	4

dtype: int64

```
def get_recommendation(title, top_n=11):
    """
    This function get recommendation from given book title

    Parameters
    ----------
    title: a text of book title
    top_n: (default 11) how much book want to get recommendation - given book title

    Returns
    ----------
    top_n_recommendation: a DataFrame contains recommended book
    """
    top_n = top_n + 1
    # get index from input title
    book_id = book_map[title]

    # calculate similarity score, sort value descending and get top_n book
    sim_score = list(enumerate(cosine_sim[book_id]))
    sim_score = sorted(sim_score, key=lambda x: x[1], reverse=True)
    sim_score = sim_score[:top_n]

    # get book index from top_n recommendation
    book_indices = [score[0] for score in sim_score]
    scores = [score[1] for score in sim_score]
    top_n_recommendation = final_df[['title', 'author', 'list_genre_clean']].iloc[book_indices]
    top_n_recommendation['list_genre_clean'] = top_n_recommendation['list_genre_clean'].apply(lambda x: x.split())
    top_n_recommendation['score'] = scores
    top_n_recommendation.reset_index(drop=True, inplace=True)
    return top_n_recommendation[1:]


test_title = test_book['title'].values[0]
pd.set_option('display.max_colwidth', None)
test_df = final_df[['title', 'author', 'list_genre_clean', 'cluster']].loc[final_df['title'] == test_title]
test_df['list_genre_clean'] = test_df['list_genre_clean'].apply(lambda x: x.split())
test_df
```

	title	author	list_genre_clean	cluster
249	The Myth of Normal: Trauma, Illness, and Healing in a	Gabor	[Nonfiction, Psychology, Self-Help, Health, Mental-Health, Science,	2

```
recommendation = get_recommendation(test_title)
recommendation
```