VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

J Component report

Programme : Int. Mtech CSE with BA

Course Title : BigData Frameworks

Course Code : CSE3120

Slot : G1

Title: Book Recommendation System using PySpark

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Shreya Alajangi | 20MIA1172

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Sign:

Date:

CONTENTS

Table of contents:

Abstract:

The Abstract on Book Recommendation System Using Pyspark is an innovative approach to help readers find books that match their interests. The system uses Pyspark, a powerful tool for big data processing, to analyze user behavior and recommend books based on their preferences.

The system works by collecting data about the user's reading history, including the books they have read and rated. It then uses this information to create a personalized recommendation list of books that the user might enjoy.

Objective:

The objective of the book recommendation system using Pyspark is to provide users with personalized recommendations based on their reading history and preferences. The system uses collaborative filtering techniques to analyze user behavior and recommend books that are similar to those they have enjoyed in the past.

Introduction

Introduction of book recommendations system using pyspark

The development of a book recommendation system is an essential task for online booksellers and libraries. A well-implemented system can provide customers with better suggestions, increasing their satisfaction and loyalty. Additionally, it can reduce the workload of bookstore staff by automating the process of finding suitable books for readers. One way to improve the accuracy and efficiency of this process is by using PySpark technology .This recommendation system extracts various elements from book texts to predict future interests, including writing style. The proposed content-based recommender includes over a hundred lexical, syntactic, stylometric and fiction-based feature. This approach provides more accurate predictions when compared to other methods such as collaborative filtering. By analyzing different textual aspects of books in detail through PySpark processing capabilities, recommendations become personalized while providing users with new authors or genres they might not have otherwise considered on their own. Therefore PySpark technology has much potential in creating effective Book Recommendation Systems that could revolutionize how users interact with these services improving overall customer experience significantly while decreasing manual workloads for bookstore employees alike.

Literature survey

There have been several studies and research papers conducted on the use of PySpark for developing book recommendation systems. Below are some of the relevant papers and articles that can be used as a literature survey:

1. "A PySpark-based Collaborative Filtering Recommendation System for Books" by Bo Wang, Yingjie Chen, and Shaohua Teng (2021): In this paper, the authors proposed a collaborative filtering recommendation system for books using PySpark. They used matrix factorization techniques to predict user-item ratings, and evaluated their model on the BookCrossing dataset.

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Overall, the literature survey suggests that PySpark is a powerful tool for building book recommendation systems using collaborative filtering algorithms. These studies provide insights into the use of PySpark for various tasks such as data preparation, feature engineering, model building, and evaluation.

Implementation:

The methodology used in developing a book recommendation system using PySpark is an innovative and practical approach to enhancing the user experience. By utilizing big data analysis techniques, this system can accurately predict users' preferences and generate personalized recommendations that increase engagement and satisfactionwe have explored the different components of this methodology, including data collection, pre-processing, feature extraction, modeling, and evaluation. We have seen how each step contributes to the overall accuracy and effectiveness of the recommendation engine. Moreover, we have discussed several challenges faced in implementing such systems like cold-start problem or sparsity issue. However through collaborative filtering techniques such as ALS algorithm these issues could be addressed efficiently. Overall, this technology has significant potential for various industries ranging from e-commerce giants to small-scale businesses seeking customer retention strategies by providing tailored products/services resulting in increased sales revenue.

```
[ ]  import pyspark as ps
     from pyspark.sql import SQLContext
     from pyspark.ml.evaluation import RegressionEvaluator
     from pyspark.ml.tuning import CrossValidator, ParamGri
     from pyspark.ml import Pipeline
     from pyspark.sql import Row
     from pyspark.ml.recommendation import ALS
     from pyspark.sql.functions import udf, col, when
     import numpy as np

     # to show all predicted book image
```

```
[ ]  pip install pyspark
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting pyspark
  Downloading pyspark-3.3.2.tar.gz (281.4 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 281.4/281.4 MB 3.9 MB/s eta 0:00:00
  Preparing metadata (setup.py) ... done
Collecting py4j==0.10.9.5
  Downloading py4j-0.10.9.5-py2.py3-none-any.whl (199 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 199.7/199.7 kB 18.2 MB/s eta 0:00:00
Building wheels for collected packages: pyspark
  Building wheel for pyspark (setup.py) ... done
  Created wheel for pyspark: filename=pyspark-3.3.2-py2.py3-none-any.whl size=281824028 sha256=5f717c989d8fec91cd
  Stored in directory: /root/.cache/pip/wheels/6c/e3/9b/0525ce8a69478916513509d43693511463c6468db0de237c86
Successfully built pyspark
Installing collected packages: py4j, pyspark
  Attempting uninstall: py4j
    Found existing installation: py4j 0.10.9.7
    Uninstalling py4j-0.10.9.7:
```

```
for rank in range(4,10):
    als = ALS(maxIter=iterations, regParam=regularization_parameter, rank=rank, userCol="user_id", itemCol="book_i
    model = als.fit(training_df)
    predictions = model.transform(validation_df)
    new_predictions = predictions.filter(col('prediction') != np.nan)
    evaluator = RegressionEvaluator(metricName="rmse", labelCol="rating", predictionCol="prediction")
    rmse = evaluator.evaluate(new_predictions)
    print("Rank :", rank, " Root-mean-square error = " + str(rmse))
```

```
Rank : 4  Root-mean-square error = 0.8950541255193993
Rank : 5  Root-mean-square error = 0.8952936963692165
Rank : 6  Root-mean-square error = 0.8993009541692296
```

Rank is a hyperparameter in ALS that represents the number of latent factors used to represent users and items. We got the RMSE values from rank 4 to 9 for userid, bookid and rating.

```
als = ALS(maxIter=iterations, regParam=regularization_parameter, rank=4, userCol="user_id", itemCol="book_id", rat
model = als.fit(training_df)
predictions = model.transform(validation_df)
new_predictions = predictions.filter(col('prediction') != np.nan)
evaluator = RegressionEvaluator(metricName="rmse", labelCol="rating", predictionCol="prediction")
rmse = evaluator.evaluate(new_predictions)
print("Root-mean-square error = " + str(rmse))
```

```
Root-mean-square error = 0.8950541255193993
```

```
[ ]  als= ALS(maxIter=iterations, regParam=regularization_parameter, rank=5, userCol="user_id", itemCol="book_id", rat
model = als.fit(training_df)
predictions = model.transform(validation_df)
new_predictions = predictions.filter(col('prediction') != np.nan)
evaluator = RegressionEvaluator(metricName="rmse", labelCol="rating", predictionCol="prediction")
```

This is the root mean square value for only one rank, i.e for rank 4.

Following books are recommended

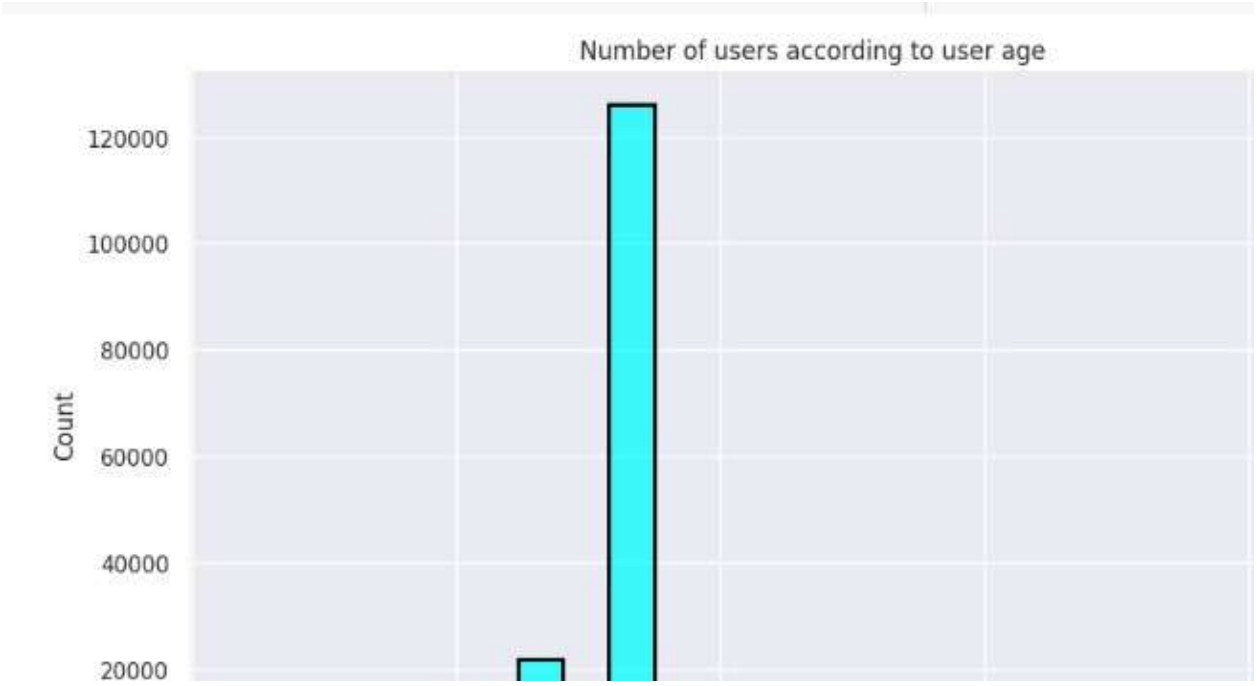
	index	bookRating	ISBN	bookTitle	bookAuthor	yearOfPublication
0	408	5787	0316666343	The Lovely Bones: A Novel	Alice Sebold	2002
1	748	4108	0385504209	The Da Vinci Code	Dan Brown	2003
2	522	3134	0312195516	The Red Tent (Bestselling Backlist)	Anita Diamant	1998
3	2143	2798	059035342X	Harry Potter and the Sorcerer's Stone (Harry P...	J. K. Rowling	1999
4	356	2595	0142001740	The Secret Life of Bees	Sue Monk Kidd	2003
5	26	2551	0971880107	Wild Animus	Rich Shapero	2004
6	1105	2524	0060928336	Divine Secrets of the Ya-Ya Sisterhood: A Novel	Rebecca Wells	1997
7	706	2402	0446672211	Where the Heart Is (Oprah's Book Club (Paperba...	Billie Letts	1998

These books are recommended for the users based on book rating, book title, book author

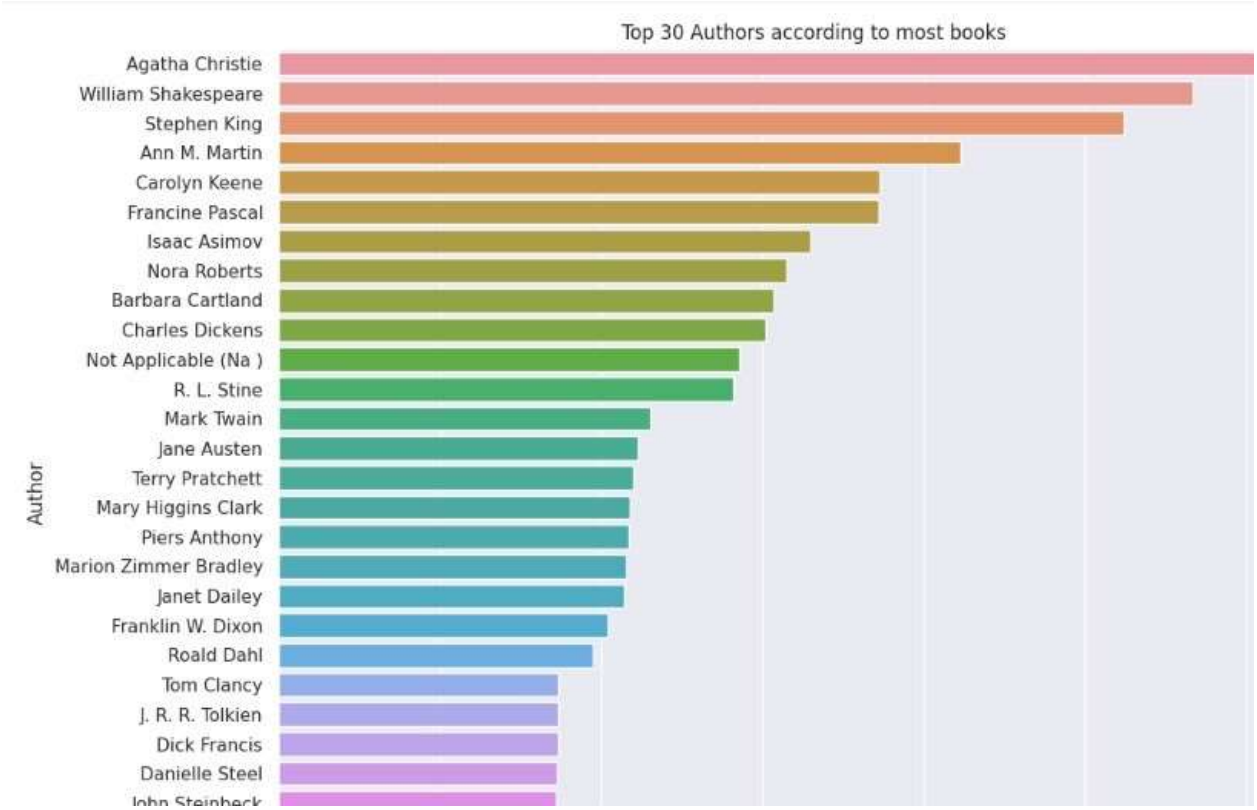
```
[ ]  books.loc[(books.bookAuthor == 'Elaine Corvidae') | (books.bookAuthor == 'Linnea Si
```

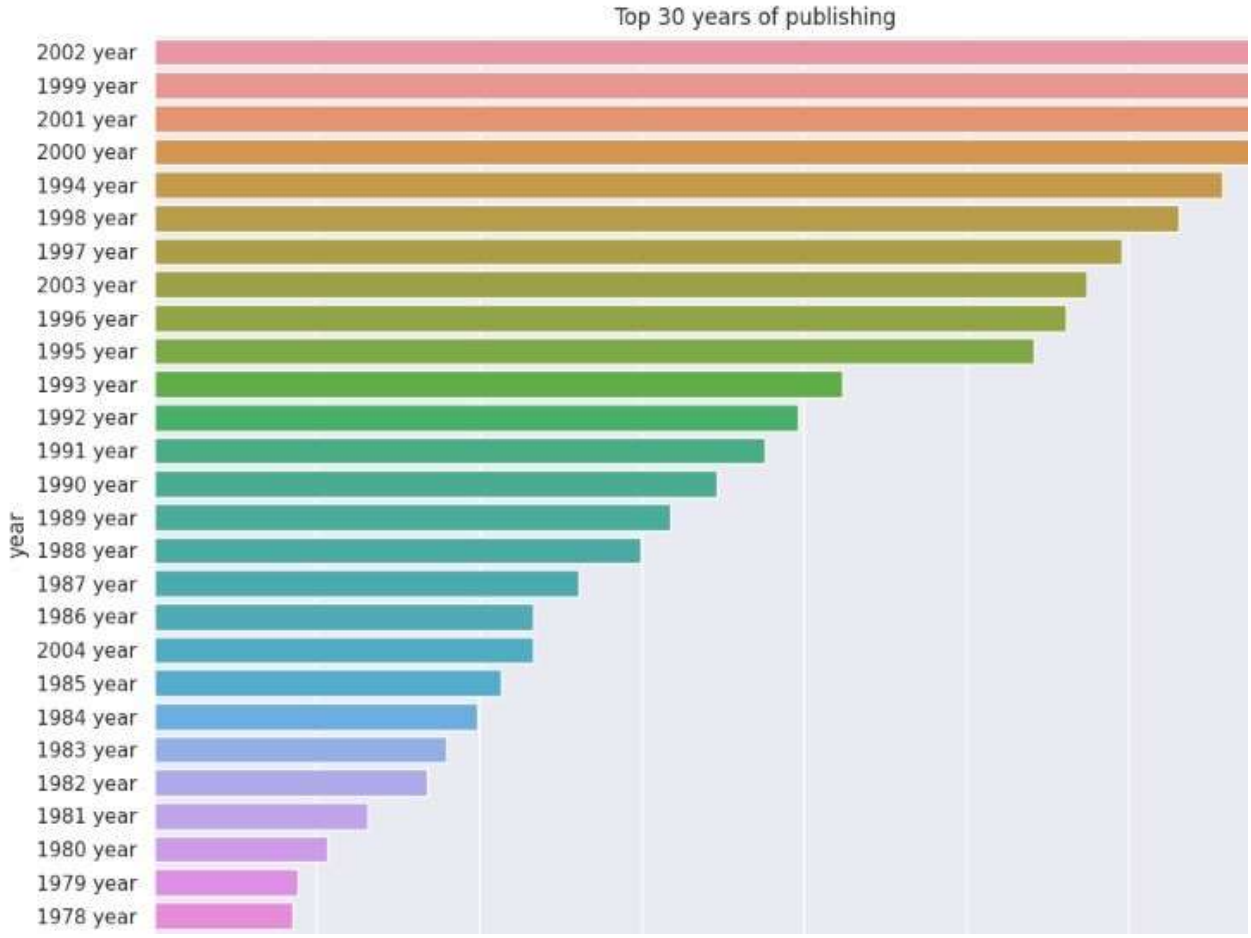
	ISBN	bookTitle	bookAuthor	yearOfPublication	pu
126762	1931696934	Winter's Orphans	Elaine Corvidae	2001	No
128890	193169656X	Tyrant Moon	Elaine Corvidae	2002	
129001	0759901880	Wolfkin	Elaine Corvidae	2001	Hard Shell Word

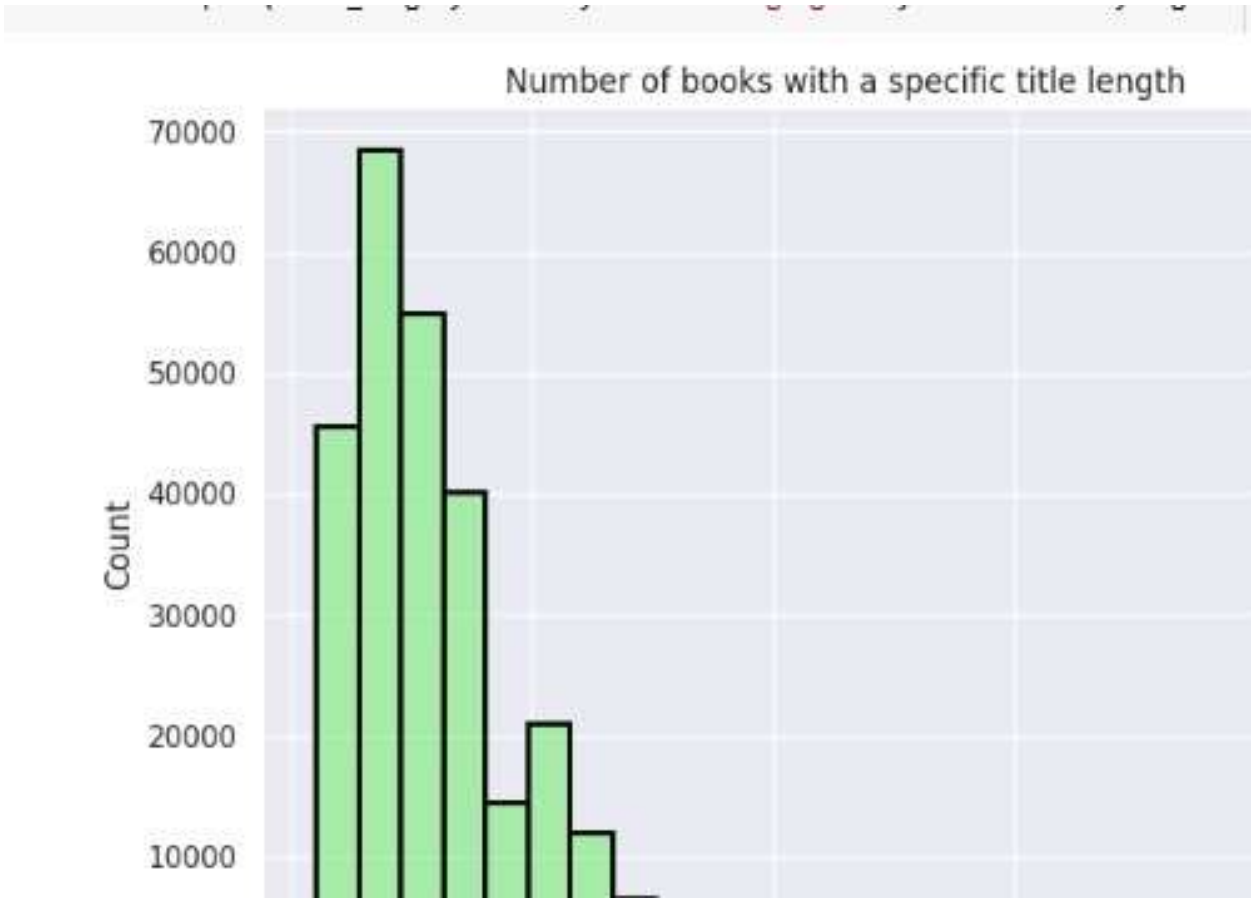
This shows the data for particular recommended book based on book authors

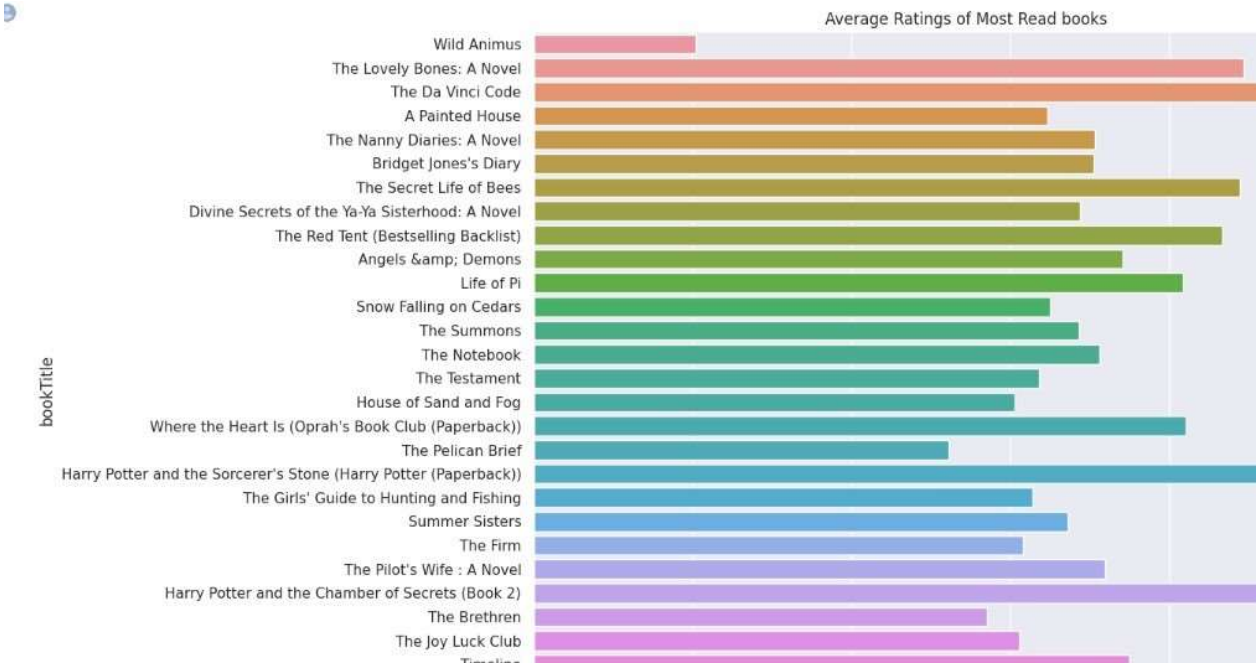


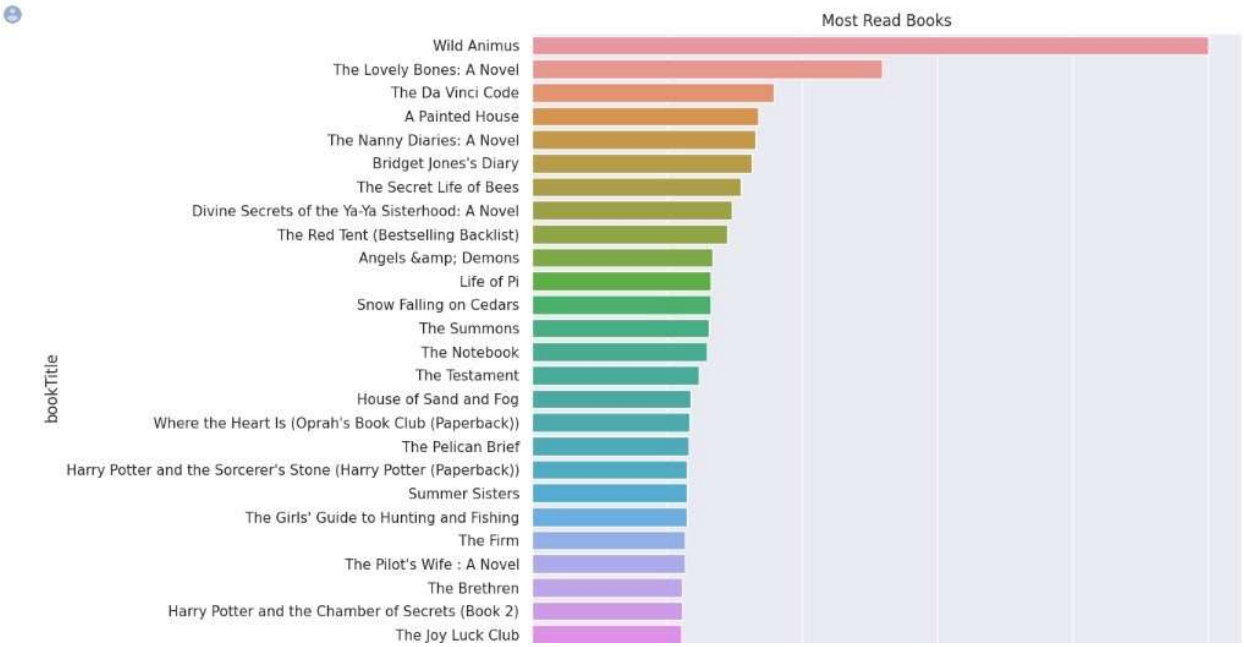
Visualizing the age distribution of the users



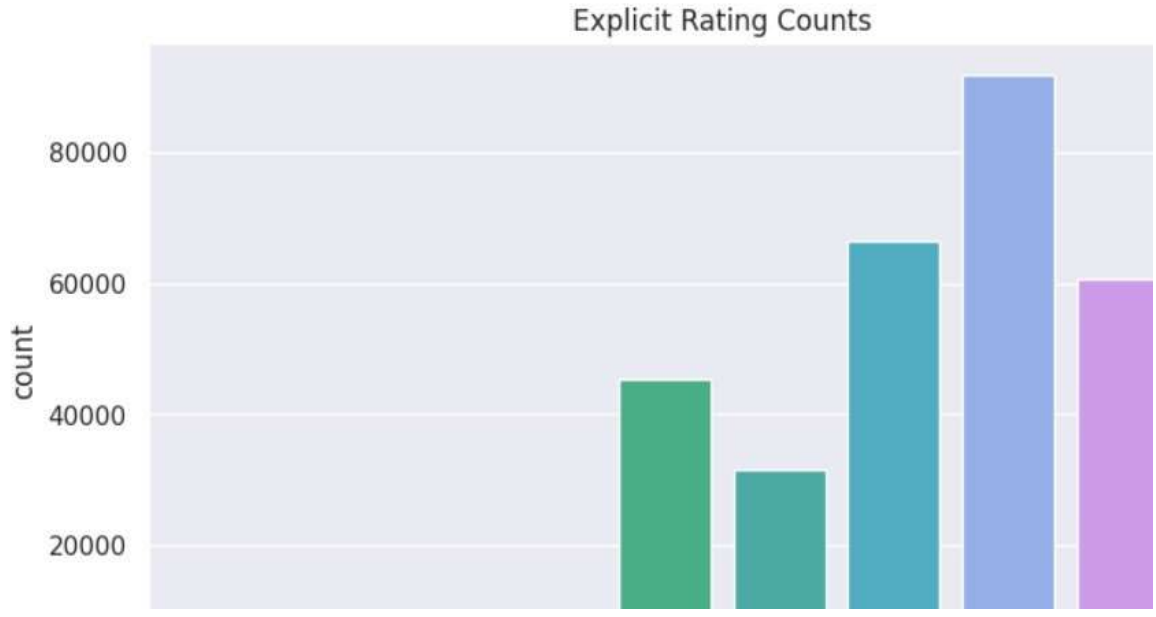

Top 30 years of publishing
year
2002 year
1999 year
2001 year
2000 year
1994 year
1998 year
1997 year
2003 year
1996 year
1995 year
1993 year
1992 year
1991 year
1990 year
1989 year
1988 year
1987 year
1986 year
2004 year
1985 year
1984 year
1983 year
1982 year
1981 year
1980 year
1979 year
1978 year


Number of books with a specific title length
Count
70000
60000
50000
40000
30000
20000
10000


Average Ratings of Most Read books
bookTitle
Wild Animus
The Lovely Bones: A Novel
The Da Vinci Code
A Painted House
The Nanny Diaries: A Novel
Bridget Jones's Diary
The Secret Life of Bees
Divine Secrets of the Ya-Ya Sisterhood: A Novel
The Red Tent (Bestselling Backlist)
Angels & Demons
Life of Pi
Snow Falling on Cedars
The Summons
The Notebook
The Testament
House of Sand and Fog
Where the Heart Is (Oprah's Book Club (Paperback))
The Pelican Brief
Harry Potter and the Sorcerer's Stone (Harry Potter (Paperback))
The Girls' Guide to Hunting and Fishing
Summer Sisters
The Firm
The Pilot's Wife : A Novel
Harry Potter and the Chamber of Secrets (Book 2)
The Brethren
The Joy Luck Club




```
[ ]  plt.figure(figsize=(9, 5))
     plt.title('Explicit Rating Counts')
     sns.countplot(x = 'bookRating', data = rating_explicit);
```

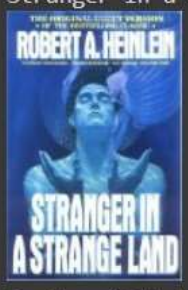


```
[ ]  cvModel_pred = cvModel.transform(validation_df)
     cvModel_pred = cvModel_pred.filter(col('prediction') != np.nan)
     rmse = evaluator.evaluate(cvModel_pred)
     print("the rmse for optimal grid parameters with cross validation is: {}".format(rmse))

     the rmse for optimal grid parameters with cross validation is: 0.8922312924039375

[ ]  # Build final model with Rank 4 and Lambda 0.18
     final_als = ALS(maxIter=10, regParam=0.1, rank=4, userCol="user_id", itemCol="book_id", ratingCol="rati
     final_model = final_als.fit(training_df)

[ ]  # show 10 predictions
     predictions = final_model.transform(validation_df)
     predictions.show(n = 10)
     # Predictin is very much match with actual ratings

     +-------+-------+------+----------+
     |book_id|user_id|rating|prediction|
     +-------+-------+------+----------+
     |      1|    314|     5| 3.8403635|
     |      1|   1169|     4|   3.79071|
     |      1|   5885|     5|  4.078003|
     |      1|  15494|     5| 3.6876159|
     |      1|  16913|     5| 4.3893557|
```

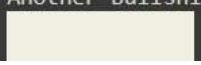
Predictions has been made using cvModel. Here, it is predicted for top 10 rows and it shows the predictions based on book_id, user_id, rating.

```
[ ]  for book in for_one_user.take(10):
         print(book.title)
         display(Image(url=book.image_url))

     Anthem
```

```
     Stranger in a Strange Land
```




```
     Another Bullshit Night in Suck City
```



These are the outputs of book titles using image url. We have given the image url's of 10 users and the output we got is the images of book titles.

Conclusion

In conclusion, the emergence of book recommendation systems using pyspark has brought about a new wave of excitement in the world of literature. The potential benefits for readers, publishers, and authors are immense, as this technology allows for more personalized reading experiences and greater visibility for lesser-known titles. However, implementing such systems also requires careful consideration of their limitations and challenges. As discussed throughout this essay, one key challenge is ensuring that the algorithm takes into account diverse reader preferences and avoids creating "filter bubbles." Additionally, access to quality data remains crucial for accurate recommendations. Despite these obstacles, the use of pyspark-based recommendation systems can revolutionize how we discover books. In summary, by leveraging advanced machine learning techniques like collaborative filtering and content-based filtering through pyspark libraries such as MLLib or PySpark MLlib APIBook Recommendation System with Pyspark can provide meaningful insights into what people want to read next based on historic interactions. Moreover it helps publishing houses identify which author's work sells best in each region or genre hence improving sales revenue while Authors gain more

recognition from satisfied readers who found them via Book Recommendation Systems. Overall, book recommendation systems using pyspark represent an exciting development for the literary industry that holds great promise for enhancing our reading experiences while also benefiting all stakeholders involved- be they writers or publishers alike.

References

1. Kulkarni, Swapna. (2015). "A Recommendation Engine Using Apache Spark." Master's Projects. San Jose State University. DOI: https://doi.org/10.31979/etd.9rb7-rarq https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=1455&context=etd_projects
2. (n.d). "iONLINE BOOK RECOMMENDER SYSTEM USING COLLABORATIVE FILTERING ALGORITHM," Bachelor of Technology in Computer Science Engineering Project Report, Anil Neerukonda Institute of Technology and Sciences, Department of Computer Science and Engineering. https://cse.anits.edu.in/projects/projects2021B10.pdf
3. (n.d) http://cs.iupui.edu/~fgsong/publication/icitst13.pdf
4. Nayek, Jayanta KR and Das, Rajesh. (2021). "Evaluation of Famous Recommender Systems: A Comparative Analysis". Library Philosophy and Practice (e-journal). Publisher: DigitalCommons@University of Nebraska-Lincoln. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=9899&context=libphilprac
5. Alharthi, Haifa. (2019), "Natural Language Processing for Book Recommender Systems", PhD thesis, University of Ottawa. https://ruor.uottawa.ca/bitstream/10393/39134/1/Alharthi_Haifa_2019_thesis.pdf

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[ ]  import pyspark as ps
     from pyspark.sql import SQLContext
     from pyspark.ml.evaluation import RegressionEvaluator
     from pyspark.ml.tuning import CrossValidator, ParamGri
     from pyspark.ml import Pipeline
     from pyspark.sql import Row
     from pyspark.ml.recommendation import ALS
     from pyspark.sql.functions import udf, col, when
     import numpy as np

     # to show all predicted book image
```

```
[ ]  pip install pyspark
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting pyspark
  Downloading pyspark-3.3.2.tar.gz (281.4 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 281.4/281.4 MB 3.9 MB/s eta 0:00:00
  Preparing metadata (setup.py) ... done
Collecting py4j==0.10.9.5
  Downloading py4j-0.10.9.5-py2.py3-none-any.whl (199 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 199.7/199.7 kB 18.2 MB/s eta 0:00:00
Building wheels for collected packages: pyspark
  Building wheel for pyspark (setup.py) ... done
  Created wheel for pyspark: filename=pyspark-3.3.2-py2.py3-none-any.whl size=281824028 sha256=5f717c989d8fec91cd
  Stored in directory: /root/.cache/pip/wheels/6c/e3/9b/0525ce8a69478916513509d43693511463c6468db0de237c86
Successfully built pyspark
Installing collected packages: py4j, pyspark
  Attempting uninstall: py4j
    Found existing installation: py4j 0.10.9.7
    Uninstalling py4j-0.10.9.7:
```

```
for rank in range(4,10):
    als = ALS(maxIter=iterations, regParam=regularization_parameter, rank=rank, userCol="user_id", itemCol="book_i
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```
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```

```
Root-mean-square error = 0.8950541255193993
```

```
[ ]  als= ALS(maxIter=iterations, regParam=regularization_parameter, rank=5, userCol="user_id", itemCol="book_id", rat
model = als.fit(training_df)
predictions = model.transform(validation_df)
new_predictions = predictions.filter(col('prediction') != np.nan)
evaluator = RegressionEvaluator(metricName="rmse", labelCol="rating", predictionCol="prediction")
```

This is the root mean square value for only one rank, i.e for rank 4.

Following books are recommended

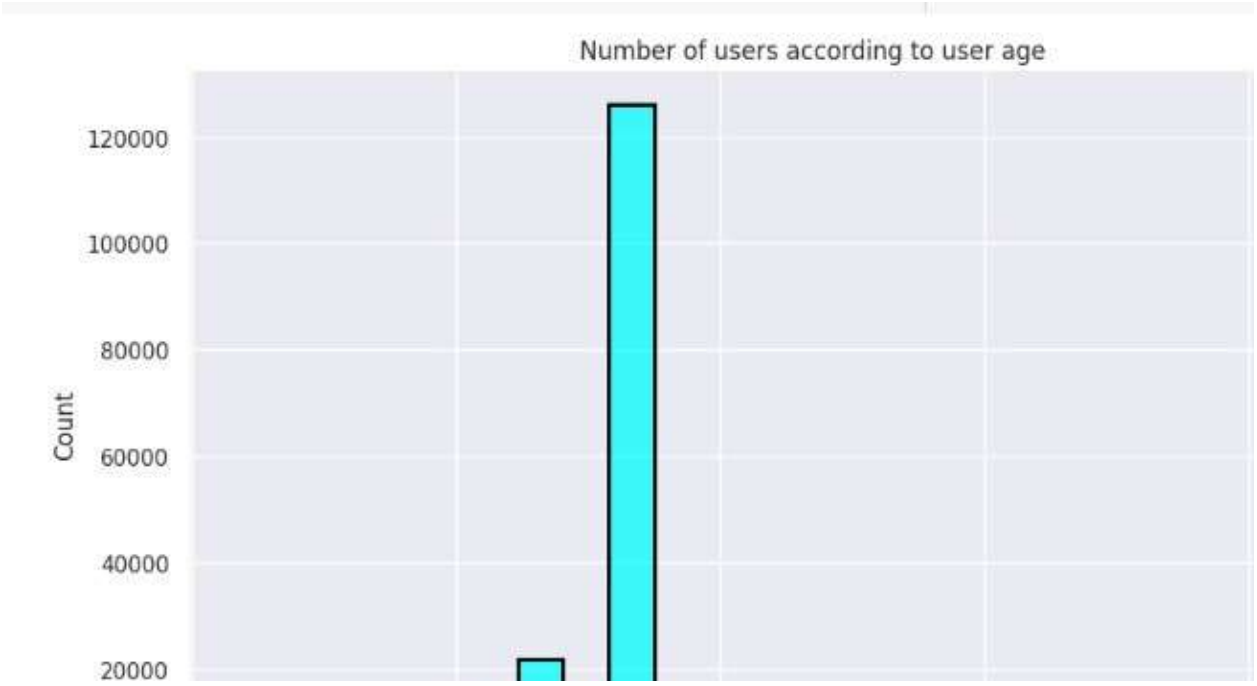
	index	bookRating	ISBN	bookTitle	bookAuthor	yearOfPublication
0	408	5787	0316666343	The Lovely Bones: A Novel	Alice Sebold	2002
1	748	4108	0385504209	The Da Vinci Code	Dan Brown	2003
2	522	3134	0312195516	The Red Tent (Bestselling Backlist)	Anita Diamant	1998
3	2143	2798	059035342X	Harry Potter and the Sorcerer's Stone (Harry P...	J. K. Rowling	1999
4	356	2595	0142001740	The Secret Life of Bees	Sue Monk Kidd	2003
5	26	2551	0971880107	Wild Animus	Rich Shapero	2004
6	1105	2524	0060928336	Divine Secrets of the Ya-Ya Sisterhood: A Novel	Rebecca Wells	1997
7	706	2402	0446672211	Where the Heart Is (Oprah's Book Club (Paperba...	Billie Letts	1998

These books are recommended for the users based on book rating, book title, book author

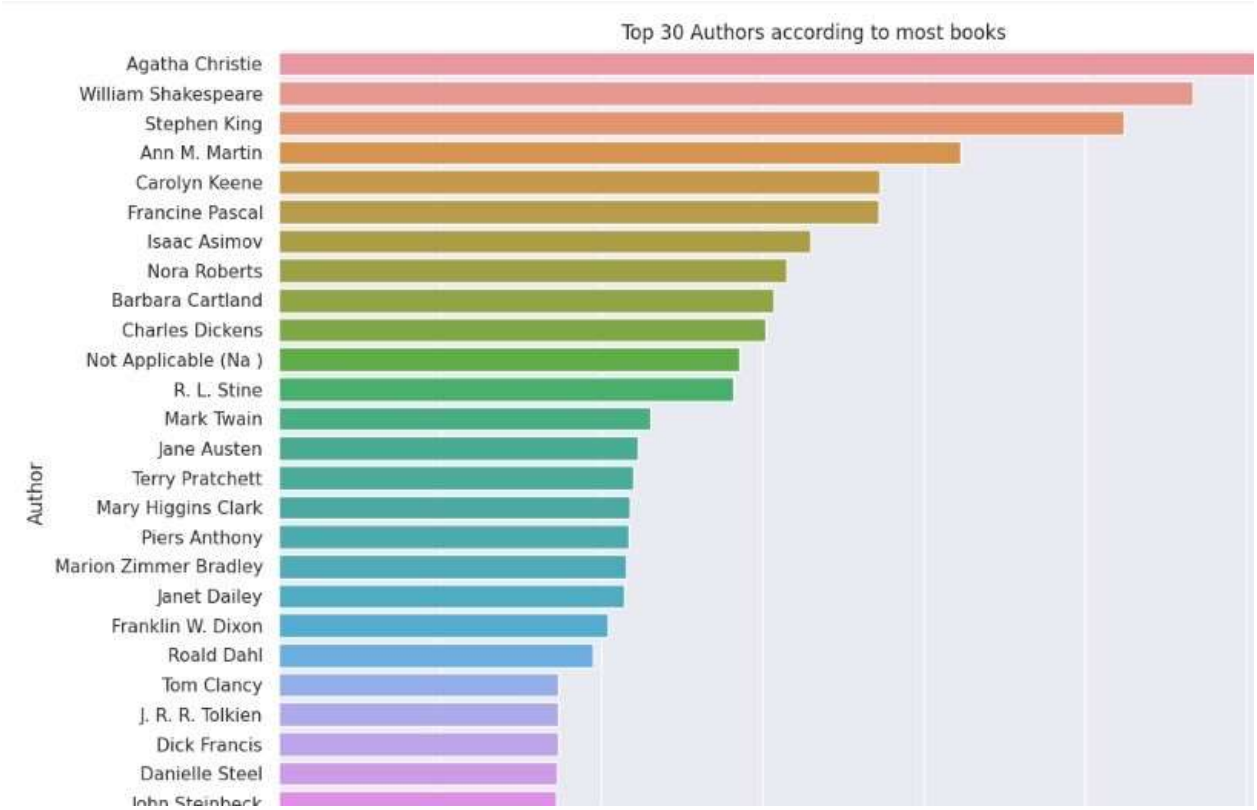
```
[ ]  books.loc[(books.bookAuthor == 'Elaine Corvidae') | (books.bookAuthor == 'Linnea Si
```

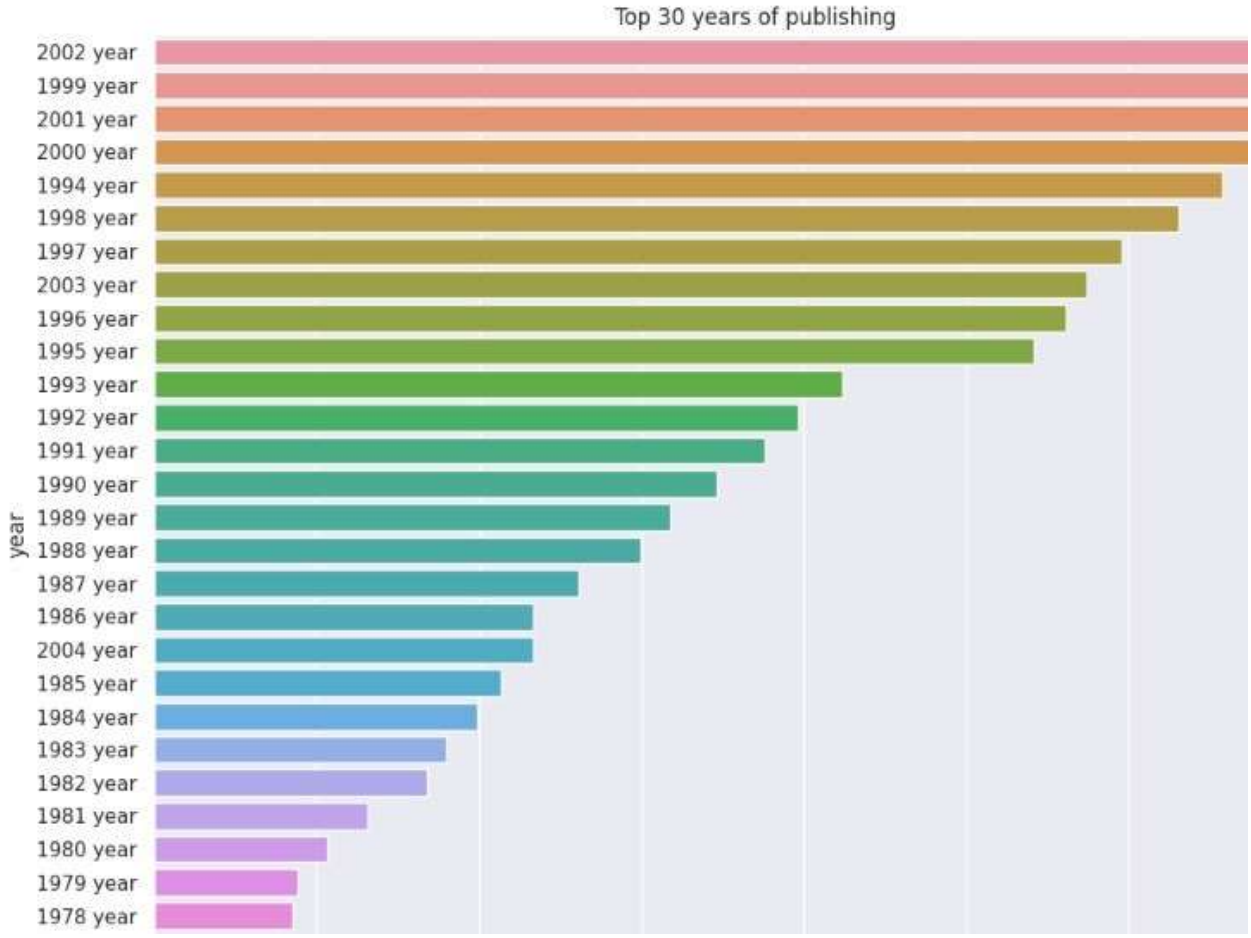
	ISBN	bookTitle	bookAuthor	yearOfPublication	pu
126762	1931696934	Winter's Orphans	Elaine Corvidae	2001	No
128890	193169656X	Tyrant Moon	Elaine Corvidae	2002	
129001	0759901880	Wolfkin	Elaine Corvidae	2001	Hard Shell Word

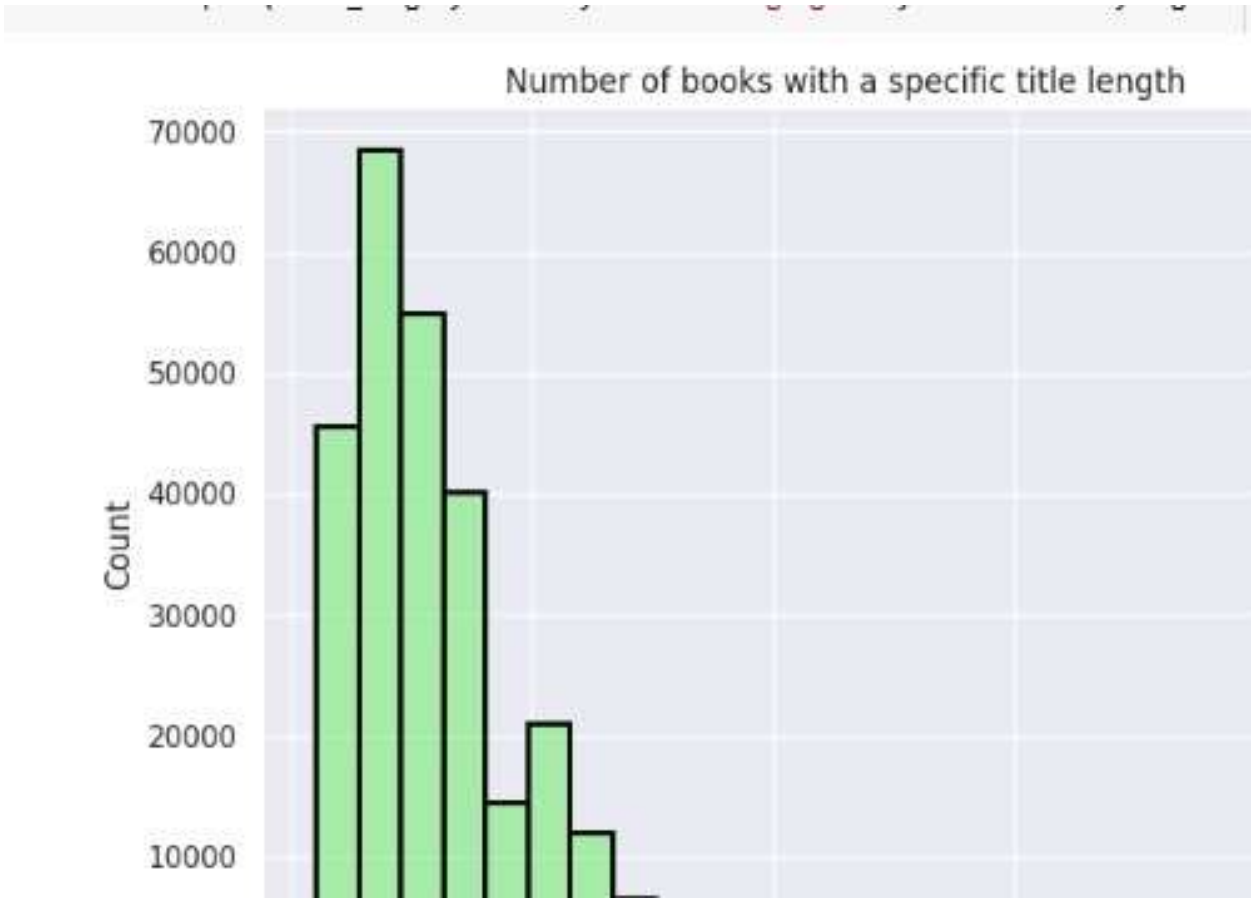
This shows the data for particular recommended book based on book authors

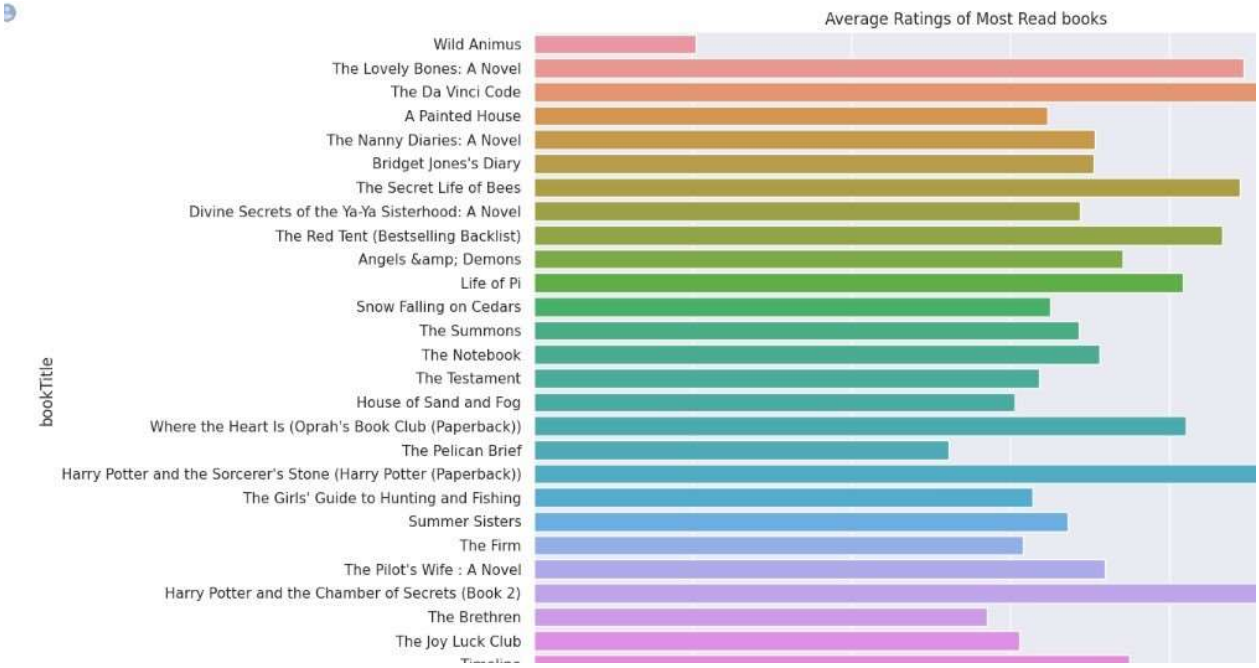


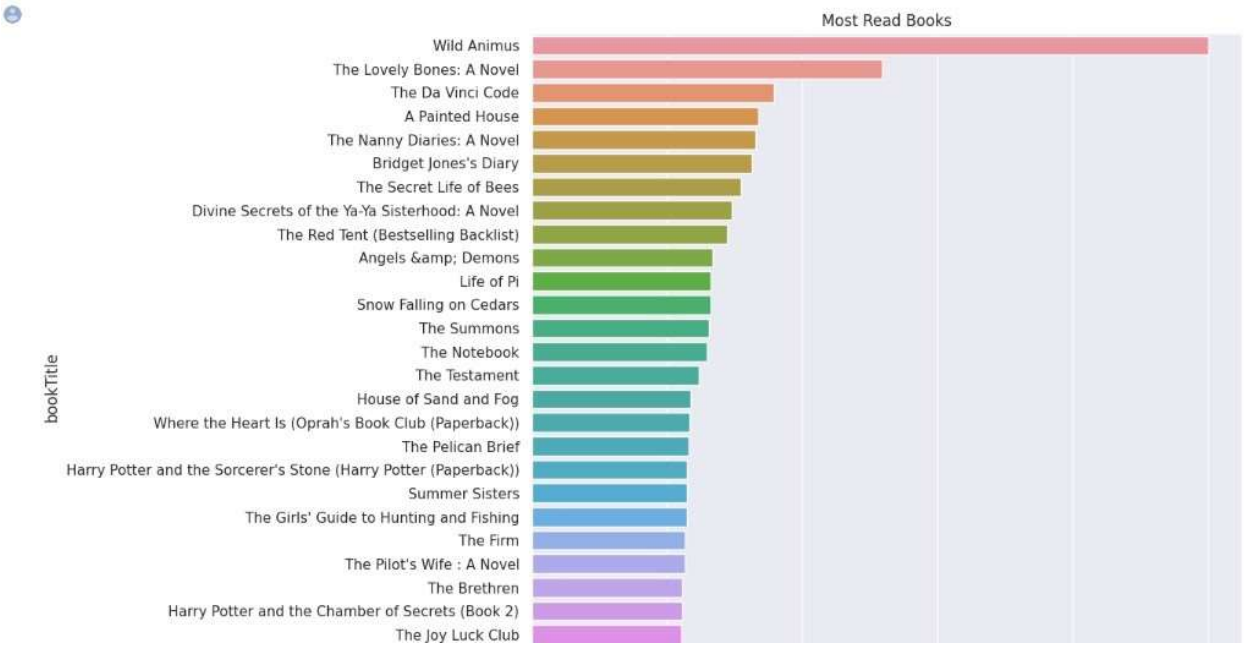
Visualizing the age distribution of the users



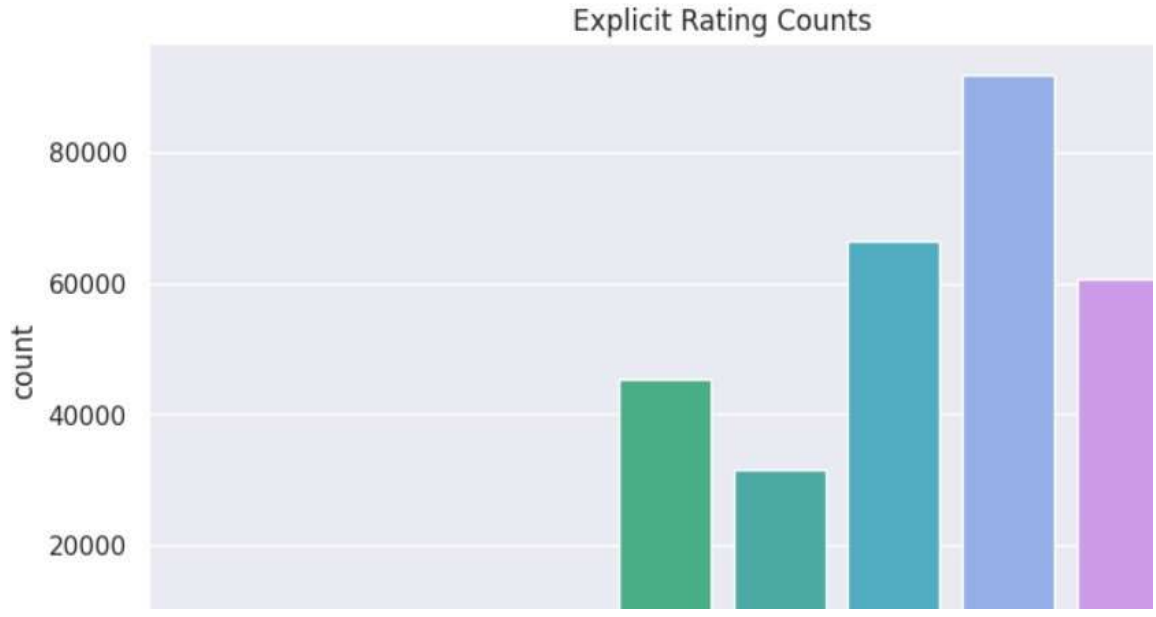

Top 30 years of publishing
year
2002 year
1999 year
2001 year
2000 year
1994 year
1998 year
1997 year
2003 year
1996 year
1995 year
1993 year
1992 year
1991 year
1990 year
1989 year
1988 year
1987 year
1986 year
2004 year
1985 year
1984 year
1983 year
1982 year
1981 year
1980 year
1979 year
1978 year


Number of books with a specific title length
Count
70000
60000
50000
40000
30000
20000
10000


Average Ratings of Most Read books
bookTitle
Wild Animus
The Lovely Bones: A Novel
The Da Vinci Code
A Painted House
The Nanny Diaries: A Novel
Bridget Jones's Diary
The Secret Life of Bees
Divine Secrets of the Ya-Ya Sisterhood: A Novel
The Red Tent (Bestselling Backlist)
Angels & Demons
Life of Pi
Snow Falling on Cedars
The Summons
The Notebook
The Testament
House of Sand and Fog
Where the Heart Is (Oprah's Book Club (Paperback))
The Pelican Brief
Harry Potter and the Sorcerer's Stone (Harry Potter (Paperback))
The Girls' Guide to Hunting and Fishing
Summer Sisters
The Firm
The Pilot's Wife : A Novel
Harry Potter and the Chamber of Secrets (Book 2)
The Brethren
The Joy Luck Club




```
[ ]  plt.figure(figsize=(9, 5))
     plt.title('Explicit Rating Counts')
     sns.countplot(x = 'bookRating', data = rating_explicit);
```

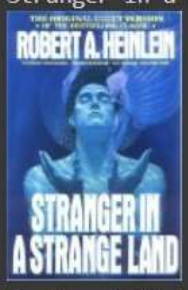


```
[ ]  cvModel_pred = cvModel.transform(validation_df)
     cvModel_pred = cvModel_pred.filter(col('prediction') != np.nan)
     rmse = evaluator.evaluate(cvModel_pred)
     print("the rmse for optimal grid parameters with cross validation is: {}".format(rmse))

     the rmse for optimal grid parameters with cross validation is: 0.8922312924039375

[ ]  # Build final model with Rank 4 and Lambda 0.18
     final_als = ALS(maxIter=10, regParam=0.1, rank=4, userCol="user_id", itemCol="book_id", ratingCol="rati
     final_model = final_als.fit(training_df)

[ ]  # show 10 predictions
     predictions = final_model.transform(validation_df)
     predictions.show(n = 10)
     # Predictin is very much match with actual ratings

     +-------+-------+------+----------+
     |book_id|user_id|rating|prediction|
     +-------+-------+------+----------+
     |      1|    314|     5| 3.8403635|
     |      1|   1169|     4|   3.79071|
     |      1|   5885|     5|  4.078003|
     |      1|  15494|     5| 3.6876159|
     |      1|  16913|     5| 4.3893557|
```

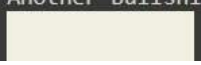
Predictions has been made using cvModel. Here, it is predicted for top 10 rows and it shows the predictions based on book_id, user_id, rating.

```
[ ]  for book in for_one_user.take(10):
         print(book.title)
         display(Image(url=book.image_url))

     Anthem
```

```
     Stranger in a Strange Land
```




```
     Another Bullshit Night in Suck City
```



These are the outputs of book titles using image url. We have given the image url's of 10 users and the output we got is the images of book titles.

Conclusion

In conclusion, the emergence of book recommendation systems using pyspark has brought about a new wave of excitement in the world of literature. The potential benefits for readers, publishers, and authors are immense, as this technology allows for more personalized reading experiences and greater visibility for lesser-known titles. However, implementing such systems also requires careful consideration of their limitations and challenges. As discussed throughout this essay, one key challenge is ensuring that the algorithm takes into account diverse reader preferences and avoids creating "filter bubbles." Additionally, access to quality data remains crucial for accurate recommendations. Despite these obstacles, the use of pyspark-based recommendation systems can revolutionize how we discover books. In summary, by leveraging advanced machine learning techniques like collaborative filtering and content-based filtering through pyspark libraries such as MLLib or PySpark MLlib APIBook Recommendation System with Pyspark can provide meaningful insights into what people want to read next based on historic interactions. Moreover it helps publishing houses identify which author's work sells best in each region or genre hence improving sales revenue while Authors gain more

recognition from satisfied readers who found them via Book Recommendation Systems. Overall, book recommendation systems using pyspark represent an exciting development for the literary industry that holds great promise for enhancing our reading experiences while also benefiting all stakeholders involved- be they writers or publishers alike.

References

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