Case Study: Comprehensive Data Analytics on MovieLens Dataset

Problem Statement

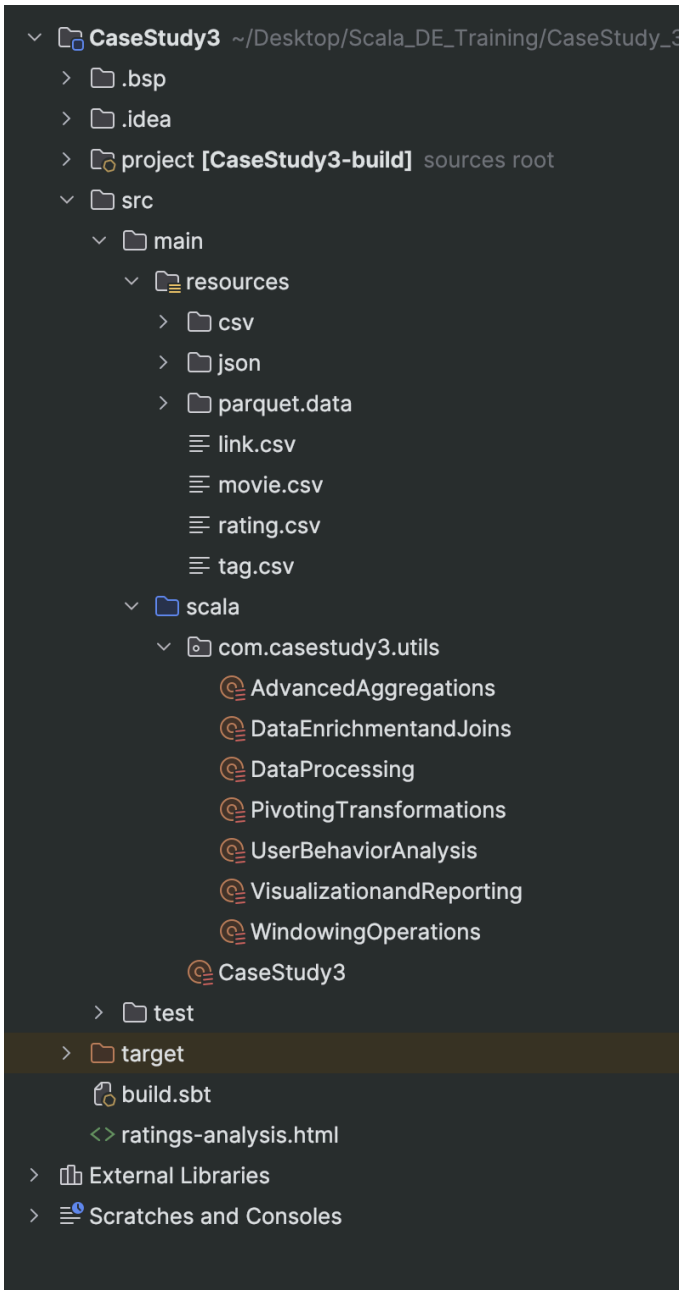
You are tasked with building a robust data pipeline to process, analyze, and generate actionable insights from the MovieLens dataset. The focus is on performing advanced data operations such as joins, aggregations, windowing, and other critical transformations, while optimizing the pipeline for performance and scalability. The case study will explore in-depth user behavior, movie trends, and genre analysis through sophisticated data operations.

Dataset Description

You will use the MovieLens 20M Dataset, which contains:

- ratings.csv: Contains user ratings for movies.
- movies.csv: Contains movie titles and genres.
- tags.csv: Contains user-assigned tags for movies.
- links.csv: (Optional) Maps movies to external metadata sources.

File Structure



1. Data Loading and Preprocessing

Load the MovieLens dataset into Spark DataFrames and perform essential preprocessing.

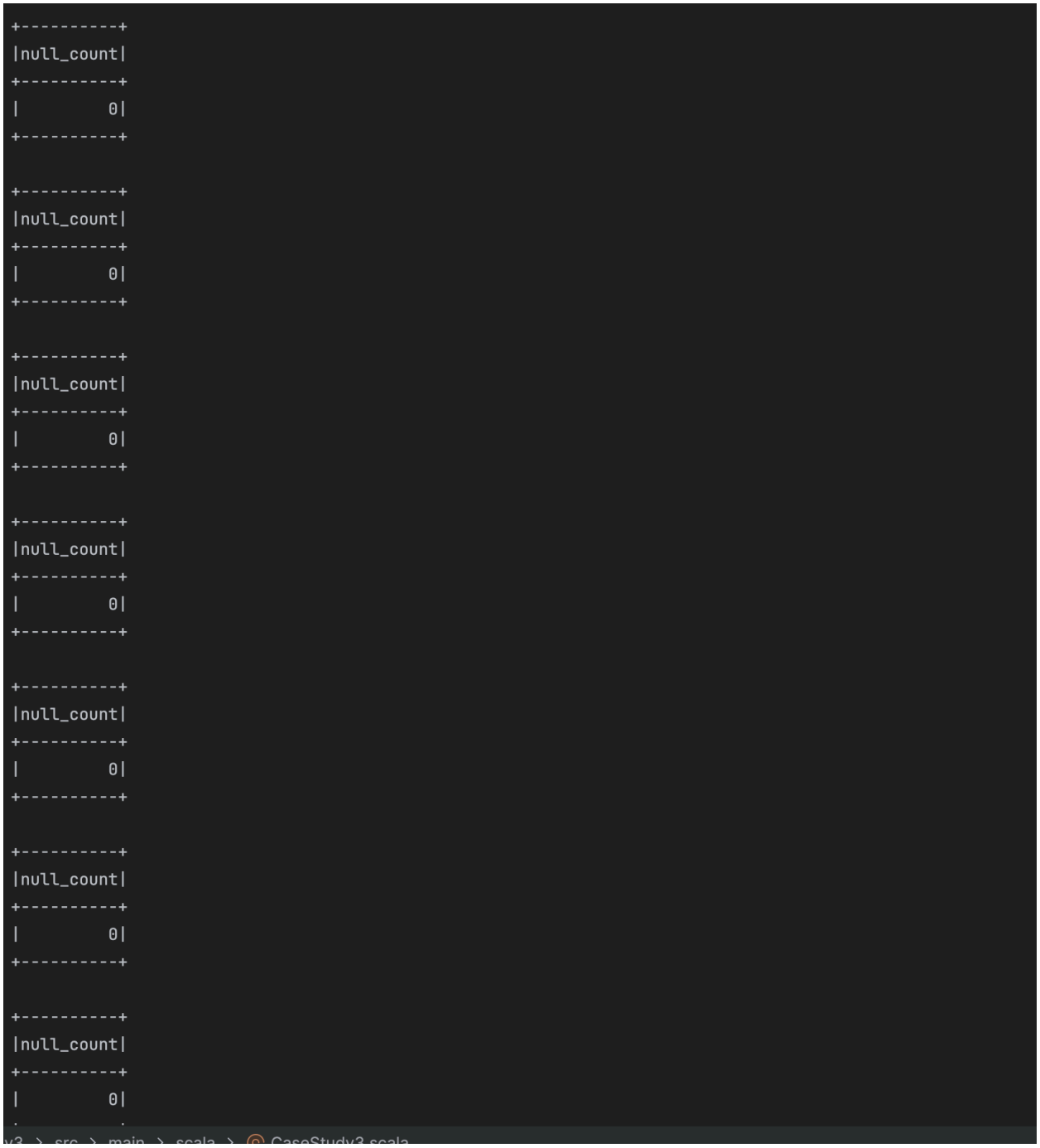
```
+-------+--------------------+--------------------+
|movieId|               title|              genres|
+-------+--------------------+--------------------+
|      1|    Toy Story (1995)|Adventure|Animati...|
|      2|      Jumanji (1995)|Adventure|Childre...|
|      3|Grumpier Old Men ...|      Comedy|Romance|
|      4|Waiting to Exhale...|Comedy|Drama|Romance|
|      5|Father of the Bri...|              Comedy|
|      6|         Heat (1995)|Action|Crime|Thri...|
|      7|      Sabrina (1995)|      Comedy|Romance|
|      8| Tom and Huck (1995)|  Adventure|Children|
|      9| Sudden Death (1995)|              Action|
|     10|    GoldenEye (1995)|Action|Adventure|...|
|     11|American Presiden...|Comedy|Drama|Romance|
|     12|Dracula: Dead and...|       Comedy|Horror|
|     13|        Balto (1995)|Adventure|Animati...|
|     14|        Nixon (1995)|               Drama|
|     15|Cutthroat Island ...|Action|Adventure|...|
|     16|       Casino (1995)|         Crime|Drama|
|     17|Sense and Sensibi...|       Drama|Romance|
|     18|   Four Rooms (1995)|              Comedy|
|     19|Ace Ventura: When...|              Comedy|
|     20|  Money Train (1995)|Action|Comedy|Cri...|
+-------+--------------------+--------------------+
only showing top 20 rows
```

```
+------+-------+------+-------------------+
|userId|movieId|rating|          timestamp|
+------+-------+------+-------------------+
|     1|      2|   3.5|2005-04-02 23:53:47|
|     1|     29|   3.5|2005-04-02 23:31:16|
|     1|     32|   3.5|2005-04-02 23:33:39|
|     1|     47|   3.5|2005-04-02 23:32:07|
|     1|     50|   3.5|2005-04-02 23:29:40|
|     1|    112|   3.5|2004-09-10 03:09:00|
|     1|    151|     4|2004-09-10 03:08:54|
|     1|    223|     4|2005-04-02 23:46:13|
|     1|    253|     4|2005-04-02 23:35:40|
|     1|    260|     4|2005-04-02 23:33:46|
|     1|    293|     4|2005-04-02 23:31:43|
|     1|    296|     4|2005-04-02 23:32:47|
|     1|    318|     4|2005-04-02 23:33:18|
|     1|    337|   3.5|2004-09-10 03:08:29|
|     1|    367|   3.5|2005-04-02 23:53:00|
|     1|    541|     4|2005-04-02 23:30:03|
|     1|    589|   3.5|2005-04-02 23:45:57|
|     1|    593|   3.5|2005-04-02 23:31:01|
|     1|    653|     3|2004-09-10 03:08:11|
|     1|    919|   3.5|2004-09-10 03:07:01|
+------+-------+------+-------------------+
only showing top 20 rows
```

```
+------+-------+----------------+-------------------+
|userId|movieId|             tag|          timestamp|
+------+-------+----------------+-------------------+
|    18|   4141|      Mark Waters|2009-04-24 18:19:40|
|    65|    208|        dark hero|2013-05-10 01:41:18|
|    65|    353|        dark hero|2013-05-10 01:41:19|
|    65|    521|    noir thriller|2013-05-10 01:39:43|
|    65|    592|        dark hero|2013-05-10 01:41:18|
|    65|    668|        bollywood|2013-05-10 01:37:56|
|    65|    898| screwball comedy|2013-05-10 01:42:40|
|    65|   1248|    noir thriller|2013-05-10 01:39:43|
|    65|   1391|            mars|2013-05-10 01:40:55|
|    65|   1617|         neo-noir|2013-05-10 01:43:37|
|    65|   1694|           jesus|2013-05-10 01:38:45|
|    65|   1783|    noir thriller|2013-05-10 01:39:43|
|    65|   2022|           jesus|2013-05-10 01:38:45|
|    65|   2193|          dragon|2013-05-10 02:01:54|
|    65|   2353|conspiracy theory|2013-05-10 02:01:06|
|    65|   2662|            mars|2013-05-10 01:40:55|
|    65|   2726|    noir thriller|2013-05-10 01:39:43|
|    65|   2840|           jesus|2013-05-10 01:38:45|
|    65|   3052|           jesus|2013-05-10 01:38:46|
|    65|   5135|        bollywood|2013-05-10 01:37:56|
+------+-------+----------------+-------------------+
only showing top 20 rows
```

```
+-------+------+------+
|movieId|imdbId|tmdbId|
+-------+------+------+
|      1|114709|   862|
|      2|113497|  8844|
|      3|113228| 15602|
|      4|114885| 31357|
|      5|113041| 11862|
|      6|113277|   949|
|      7|114319| 11860|
|      8|112302| 45325|
|      9|114576|  9091|
|     10|113189|   710|
|     11|112346|  9087|
|     12|112896| 12110|
|     13|112453| 21032|
|     14|113987| 10858|
|     15|112760|  1408|
|     16|112641|   524|
|     17|114388|  4584|
|     18|113101|     5|
|     19|112281|  9273|
|     20|113845| 11517|
+-------+------+------+
only showing top 20 rows
```

Handle missing or invalid values in all datasets.



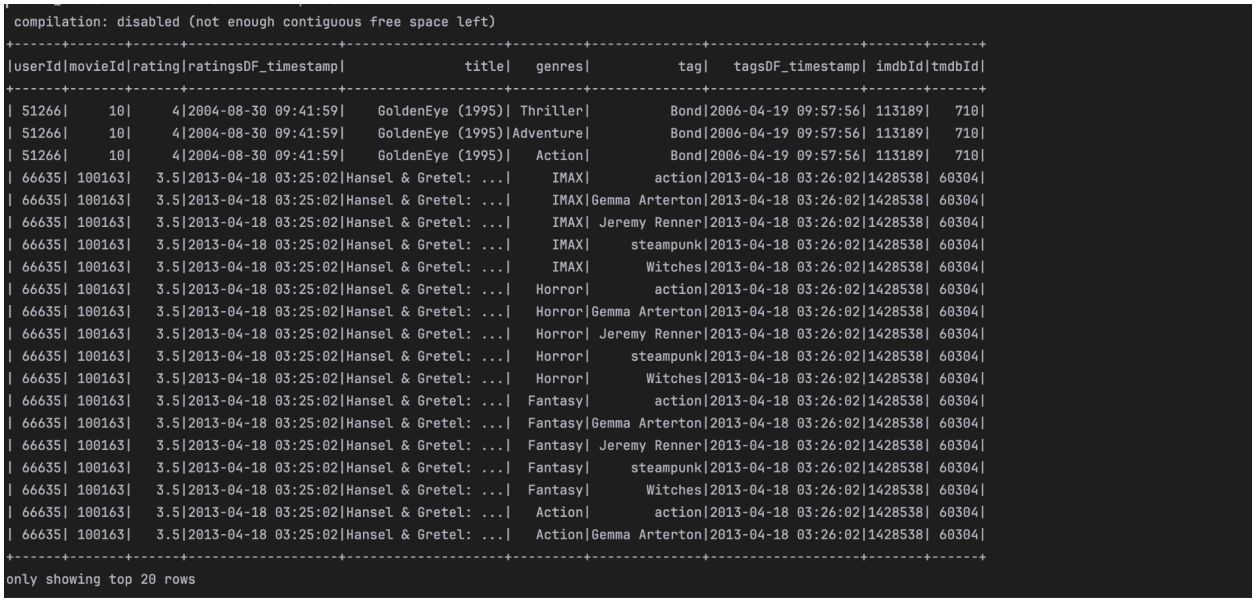
Normalize genres in movies.csv to create a one-movie-per-genre structure.

```
+-------+--------------------+---------+
|movieId|               title|   genres|
+-------+--------------------+---------+
|      1|    Toy Story (1995)|Adventure|
|      1|    Toy Story (1995)|Animation|
|      1|    Toy Story (1995)| Children|
|      1|    Toy Story (1995)|   Comedy|
|      1|    Toy Story (1995)|  Fantasy|
|      2|      Jumanji (1995)|Adventure|
|      2|      Jumanji (1995)| Children|
|      2|      Jumanji (1995)|  Fantasy|
|      3|Grumpier Old Men ...|   Comedy|
|      3|Grumpier Old Men ...|  Romance|
|      4|Waiting to Exhale...|   Comedy|
|      4|Waiting to Exhale...|    Drama|
|      4|Waiting to Exhale...|  Romance|
|      5|Father of the Bri...|   Comedy|
|      6|         Heat (1995)|   Action|
|      6|         Heat (1995)|    Crime|
|      6|         Heat (1995)| Thriller|
|      7|      Sabrina (1995)|   Comedy|
|      7|      Sabrina (1995)|  Romance|
|      8| Tom and Huck (1995)|Adventure|
+-------+--------------------+---------+
only showing top 20 rows
```

2. Data Enrichment and Joins

Enrich the ratings data with movie metadata and user-generated tags.

- Perform an inner join between ratings.csv and movies.csv on movieId.
- Left join the result with tags.csv on movieId and userId.
- Use links.csv to associate movies with external metadata, if applicable.



```
 compilation: disabled (not enough contiguous free space left)
+------+-------+------+-------------------+--------------------+---------+--------------+-------------------+-------+------+
|userId|movieId|rating|ratingsDF_timestamp|               title|   genres|           tag|   tagsDF_timestamp| imdbId|tmdbId|
+------+-------+------+-------------------+--------------------+---------+--------------+-------------------+-------+------+
| 51266|     10|     4|2004-08-30 09:41:59|    GoldenEye (1995)| Thriller|          Bond|2006-04-19 09:57:56| 113189|   710|
| 51266|     10|     4|2004-08-30 09:41:59|    GoldenEye (1995)|Adventure|          Bond|2006-04-19 09:57:56| 113189|   710|
| 51266|     10|     4|2004-08-30 09:41:59|    GoldenEye (1995)|   Action|          Bond|2006-04-19 09:57:56| 113189|   710|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|     IMAX|        action|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|     IMAX|Gemma Arterton|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|     IMAX| Jeremy Renner|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|     IMAX|     steampunk|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|     IMAX|       Witches|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|   Horror|        action|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|   Horror|Gemma Arterton|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|   Horror| Jeremy Renner|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|   Horror|     steampunk|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|   Horror|       Witches|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|  Fantasy|        action|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|  Fantasy|Gemma Arterton|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|  Fantasy| Jeremy Renner|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|  Fantasy|     steampunk|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|  Fantasy|       Witches|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|   Action|        action|2013-04-18 03:26:02|1428538| 60304|
| 66635| 100163|   3.5|2013-04-18 03:25:02|Hansel & Gretel: ...|   Action|Gemma Arterton|2013-04-18 03:26:02|1428538| 60304|
+------+-------+------+-------------------+--------------------+---------+--------------+-------------------+-------+------+
only showing top 20 rows
```

Used Caching for Memory Management.

3. Advanced Aggregations

Compute in-depth metrics to understand user behavior, movie popularity, and genre trends.

- Calculate average rating, total number of ratings, and rating variance for each movie.

```
- Calculate average rating, total number of ratings, and rating variance for each movie.
+-------+-----------------+-------------+------------------+--------------------+--------------------+
|movieId|   average_rating|total_ratings|   rating_variance|               title|              genres|
+-------+-----------------+-------------+------------------+--------------------+--------------------+
|   1090|  3.94311377245509|          334| 0.7460034885184588|      Platoon (1986)|           Drama|War|
|   2162|             3.75|           18|0.06617647058823528|NeverEnding Story...|Adventure|Childre...|
|    296| 4.457757296466974|         7812| 0.6702163497419152| Pulp Fiction (1994)|Comedy|Crime|Dram...|
|   4032|              3.5|            1|              null|Everlasting Piece...|              Comedy|
|   6731| 2.967741935483871|          186| 0.9638186573670443|Day of the Dead (...|Horror|Sci-Fi|Thr...|
|  89864|  4.12807881773399|          406| 0.4057775345131665|        50/50 (2011)|        Comedy|Drama|
|   1372|3.9779411764705883|          204| 0.8381809620399883|Star Trek VI: The...|Action|Mystery|Sc...|
|   3826|2.2127659574468086|          141| 0.9829787234042552|   Hollow Man (2000)|Horror|Sci-Fi|Thr...|
|  58559| 4.446294307196563|         3724| 0.7293201346868955|Dark Knight, The ...|Action|Crime|Dram...|
|   8092|              3.0|           15|               0.0|Frankenstein Unbo...| Drama|Horror|Sci-Fi|
|  90439|3.9541666666666666|          240| 0.5271792189679221|  Margin Call (2011)|      Drama|Thriller|
|   2696|             4.75|           22|0.16071428571428564|Dinner Game, The ...|              Comedy|
|   2700| 4.242647058823529|          612| 0.8776054202368341|South Park: Bigge...|Animation|Comedy|...|
|   3949| 4.246062992125984|          762| 0.8963379618612065|Requiem for a Dre...|               Drama|
|    919|4.2835820895522385|         1072| 0.4591886505846118|Wizard of Oz, The...|Adventure|Childre...|
| 101577|           3.6875|           24| 0.3220108695652172|    Host, The (2013)|Action|Adventure|...|
|   1953|3.8055555555555554|          162|0.26475155279503104|French Connection...|Action|Crime|Thri...|
|   2550| 4.438461538461539|          130| 0.5233154442456768|Haunting, The (1963)|     Horror|Thriller|
|  32657| 4.818181818181818|           22|0.15584415584415587|Man Who Planted T...|     Animation|Drama|
|   3993| 4.262711864406779|          118|  0.430392582934956|       Quills (2000)|       Drama|Romance|
+-------+-----------------+-------------+------------------+--------------------+--------------------+
only showing top 20 rows
```

- Identify the top 10 movies with the highest average rating (minimum 50 ratings).

```
- Identify the top 10 movies with the highest average rating (minimum 50 ratings).
+-------+--------------------+-----------------+-------------+
|movieId|               title|   average_rating|total_ratings|
+-------+--------------------+-----------------+-------------+
|  40033|Adventures of Pri...|              5.0|           64|
|   8580|Into the Woods (1...|              5.0|           56|
|  33801|Godzilla: Final W...|              5.0|           88|
|   4160|Widow of St. Pier...|             4.98|           50|
|   2585|Lovers of the Arc...|4.894736842105263|           76|
|   7505|Kingdom, The (Rig...| 4.887096774193548|           93|
| 101243|  Klip (Clip) (2012)|            4.875|           72|
|  97957|     Excision (2012)|4.866666666666666|           60|
|  45183|Protector, The (a...|4.863636363636363|           88|
|  26159|Tokyo Drifter (Tô...|            4.825|           60|
+-------+--------------------+-----------------+-------------+
```

-Aggregate data by genre to compute total ratings, average ratings, and most popular genre.

```
ggregate data by genre to compute total ratings, average ratings, and most popular genre.
------+-------------+-----------------+-----------+
genres|total_ratings|   average_rating|total_users|
------+-------------+-----------------+-----------+
 Drama|       200632|3.890947107141433|     200632|
------+-------------+-----------------+-----------+
```

Aggregate all the data and showing only the popular genre data by using limit operator.

- Calculate average rating per year using the parsed timestamp column.

```
alculate average rating per year using the parsed timestamp column.
----+-----------------+
year|    average_rating|
----+-----------------+
2012|3.7347949560081957|
2014| 3.673793873892598|
2013| 3.668952064743723|
2005| 4.057298168955472|
2000| 4.201560468140442|
2002|3.9157303370786516|
2009|3.8131947842359626|
2006|3.8188488118905615|
2004|4.0836175626658004|
2011|3.8275800167546508|
2008|3.782204994140488|
1999|  4.05088161209068|
2007|3.7131246438985155|
2015|3.8719307827900393|
2001| 4.015463917525773|
2010| 3.855782930576896|
2003| 4.013817480719794|
1998| 3.390885750962773|
1997| 4.006756756756757|
----+-----------------+
```

- Determine the top 5 most active users based on the number of ratings.

```
• - Determine the top 5 most active users based on the number of ratings.
+------+-----------+
|userId|num_ratings|
+------+-----------+
| 58612|      24178|
|130827|      21471|
|124998|      20942|
| 88738|      20156|
| 10616|      14812|
+------+-----------+
```

4. Windowing Operations

Use window functions to gain time-based insights.

- Rank movies by rating count and average rating within each genre.

```
Rank movies by rating count and average rating within each genre.
+-------+--------------------+-----------------+------------+-----------------+----+
|movieId|               title|           genres|rating_count|   average_rating|rank|
+-------+--------------------+-----------------+------------+-----------------+----+
| 131031|La liga no es cos...|(no genres listed)|           8|              3.0|   1|
| 130532|I giorni contati ...|(no genres listed)|           7|              2.5|   2|
| 129530|Slingshot Hip Hop...|(no genres listed)|           3|              5.0|   3|
| 114725|Study in Choreogr...|(no genres listed)|           3|              5.0|   3|
| 123939|Women Aren't Funn...|(no genres listed)|           3|              4.0|   5|
| 126593|       Kocken (2005)|(no genres listed)|           3|              3.0|   6|
| 125535|Fist of Jesus (2012)|(no genres listed)|           3|              3.0|   6|
| 123439|Wuthering Heights...|(no genres listed)|           3|              2.0|   8|
| 114723|      At Land (1944)|(no genres listed)|           2|              5.0|   9|
| 131082|   Playground (2009)|(no genres listed)|           2|              4.5|  10|
| 117192|Doctor Who: The T...|(no genres listed)|           2|              4.0|  11|
| 125910|  Stars Above (2012)|(no genres listed)|           1|              4.0|  12|
| 127005|A Year Along the ...|(no genres listed)|           1|              4.0|  12|
| 130298|    Pot v raj (2014)|(no genres listed)|           1|              3.5|  14|
| 130878|Doppelgänger Paul...|(no genres listed)|           1|              3.0|  15|
| 130296|  A Fight For (2014)|(no genres listed)|           1|              3.0|  15|
| 126552|   Fort McCoy (2014)|(no genres listed)|           1|              2.5|  17|
|  83829|Scorpio Rising (1...|(no genres listed)|           1|              0.5|  18|
|   2959|   Fight Club (1999)|           Action|        1702|4.662162162162162|   1|
|  79132|    Inception (2010)|           Action|        1525|4.371147540983607|   2|
+-------+--------------------+-----------------+------------+-----------------+----+
only showing top 20 rows
```

- Calculate rolling average ratings for each movie over a 30-day window.

```
Calculate the average rating for each movie over the last 30 days.
+-------+---------------+--------------------+------+------+---------+------------------+
|movieId|          title|              genres|userId|rating|timestamp|rolling_avg_rating|
+-------+---------------+--------------------+------+------+---------+------------------+
|      1|Toy Story (1995)|Adventure|Animati...| 99851|     4|822853800|               4.0|
|      1|Toy Story (1995)|Adventure|Animati...|124035|     5|823165403|               4.5|
|      1|Toy Story (1995)|Adventure|Animati...| 46380|     4|823235514| 4.333333333333333|
|      1|Toy Story (1995)|Adventure|Animati...|113947|     5|823244802|               4.5|
|      1|Toy Story (1995)|Adventure|Animati...|121731|     5|823494197|               4.6|
|      1|Toy Story (1995)|Adventure|Animati...|  8050|     5|824114137| 4.666666666666667|
|      1|Toy Story (1995)|Adventure|Animati...| 99961|     5|824981864| 4.714285714285714|
|      1|Toy Story (1995)|Adventure|Animati...| 22528|     4|824986853|             4.625|
|      1|Toy Story (1995)|Adventure|Animati...|107537|     4|824990660| 4.555555555555555|
|      1|Toy Story (1995)|Adventure|Animati...| 63203|     2|825060356|               4.3|
|      1|Toy Story (1995)|Adventure|Animati...| 81468|     5|825353770| 4.363636363636363|
|      1|Toy Story (1995)|Adventure|Animati...| 63308|     5|825471878| 4.454545454545454|
|      1|Toy Story (1995)|Adventure|Animati...| 20990|     5|825932188| 4.444444444444445|
|      1|Toy Story (1995)|Adventure|Animati...|137727|     5|825992544|               4.5|
|      1|Toy Story (1995)|Adventure|Animati...|  7546|     4|826273652|               4.4|
|      1|Toy Story (1995)|Adventure|Animati...| 94179|     5|826417952| 4.454545454545454|
|      1|Toy Story (1995)|Adventure|Animati...|  7334|     5|826446113|               4.5|
|      1|Toy Story (1995)|Adventure|Animati...| 13261|     5|826623271| 4.538461538461538|
|      1|Toy Story (1995)|Adventure|Animati...|135464|     5|826741034| 4.538461538461538|
|      1|Toy Story (1995)|Adventure|Animati...|  3338|     5|826942928| 4.571428571428571|
+-------+---------------+--------------------+------+------+---------+------------------+
only showing top 20 rows
```

- Analyze user activity trends based on the number of ratings over time.

```
- Analyze user activity trends based on the number of ratings over time.
Daily Activity Trend
+------+-------------------+-------------+
|userId|ratingsDF_timestamp|total_ratings|
+------+-------------------+-------------+
| 79366|1997-09-15 21:13:53|            6|
| 79366|1997-09-15 21:46:17|            2|
| 79366|1997-09-15 22:00:10|            2|
| 79366|1997-09-15 22:09:27|            4|
| 79366|1997-09-15 22:17:29|            2|
| 79366|1997-09-15 22:32:38|            3|
| 79366|1997-09-15 23:01:27|            2|
| 79366|1997-09-16 00:43:28|            1|
| 79366|1997-09-16 00:57:04|            2|
| 79366|1997-09-17 23:04:46|            5|
| 79366|1997-10-02 00:50:41|            6|
| 79366|1997-10-02 00:50:42|            2|
|  1835|1997-10-15 06:01:46|            3|
|  1835|1997-10-15 06:33:24|            3|
|  1835|1997-10-16 08:06:41|            2|
|  1835|1997-10-16 08:08:18|            3|
|  1835|1997-10-16 08:10:52|            3|
| 79366|1997-10-28 00:15:42|            1|
| 83726|1997-11-10 14:44:23|            3|
| 83726|1997-11-10 15:10:31|            7|
+------+-------------------+-------------+
only showing top 20 rows
```

```
Monthly Activity Trend
+------+-------+-------------+
|userId|  month|total_ratings|
+------+-------+-------------+
| 79366|1997-09|           29|
|  1835|1997-10|           14|
| 79366|1997-10|            9|
| 83726|1997-11|           82|
| 79366|1997-11|            2|
| 95895|1997-11|            6|
| 83726|1997-12|            2|
| 23333|1997-12|            4|
| 83726|1998-01|            2|
| 42259|1998-01|           20|
| 58612|1998-01|          695|
| 33323|1998-02|           28|
| 83726|1998-03|            3|
| 58612|1998-04|          140|
|  1835|1998-04|           23|
| 79366|1998-04|            2|
| 16687|1998-05|            4|
| 79366|1998-05|            8|
| 58612|1998-05|           15|
|106308|1998-05|           71|
+------+-------+-------------+
only showing top 20 rows
```

5. Pivoting and Complex Transformations

Perform complex transformations to analyze trends and anomalies.

- Create a pivot table showing average ratings per genre by year.

```
 Pivoting and Complex Transformations
+------------------+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
|             genre|1997|1998|1999|2000|2001|2002|2003|2004|2005|2006|2007|2008|2009|2010|2011|2012|2013|2014|2015|
+------------------+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
|             Crime| 4.0|3.83|4.38|4.22|4.14| 4.1|4.08|4.15|4.11|3.94|3.84|3.87|3.92| 4.0|3.96|3.88|3.77|3.79|4.07|
|           Romance| 3.5|3.02|3.98|4.32| 4.1|3.84|3.82|4.07|3.98|3.76|3.69|3.86|3.78|3.81| 3.8|3.77| 3.8|3.73|3.86|
|          Thriller| 4.0|3.12|3.89|3.93|4.03|3.78|3.89|4.01| 4.0|3.81| 3.7|3.82|3.77|3.83|3.79| 3.7|3.67|3.68|3.94|
|         Adventure|4.17|3.55|4.15|4.17|3.95|3.85| 4.1|4.09|4.01|3.83|3.71|3.69|3.79|3.78|3.75|3.64|3.54|3.62|3.73|
|             Drama|4.21|3.52|4.05|4.21|4.07|4.15|4.04|4.15|4.13|3.89|3.75|3.85|3.88|3.93|3.93|3.86|3.84|3.83|3.98|
|               War|4.67|2.14|4.22|4.25|4.33|4.43| 4.2|3.96|4.21|3.92|3.81|3.81|3.92| 3.9|3.94|3.78|3.81|3.74|4.15|
|       Documentary|null| 2.0|3.35|3.85| 4.0|4.12|4.09|4.24| 3.9|3.97|3.87|3.64|3.66|3.91|3.83|3.87|3.67|3.79| 4.0|
|           Fantasy|2.67|3.48|3.87|4.25| 4.1|3.88|4.19|4.18|4.18|3.84|3.71|3.73|3.83|3.77|3.84|3.61|3.58|3.55|3.91|
|           Mystery|4.25|3.43|3.83|4.33|4.21|4.11|4.06|4.19|4.21|3.91|3.78|3.93|3.91|3.98|3.98|3.83|3.82|3.85|4.01|
|           Musical|3.71|3.39|3.91|4.02|3.98|3.77|4.17|4.15|4.01|3.81|3.62|3.79|3.95|3.98|3.88|3.82|3.83| 3.7| 4.0|
|         Animation| 3.8| 3.7|4.14|4.79|3.45|3.92|4.15|4.27|4.25|3.94|3.98|3.89|3.91|3.94|3.99|3.91|3.75|3.59|3.74|
|         Film-Noir| 4.5|4.11|3.87|4.27|4.58|4.25| 4.2|4.18|4.27|4.16| 3.8|4.04|4.05|3.97|3.89|3.75|4.07|3.91|4.46|
|(no genres listed)|null|null|null|null|null|null|null|null|null|null|null|null|null|null|null| 0.5|null|4.71| 3.2|
|              IMAX| 4.0| 5.0| 5.0| 3.0|4.75|2.91|3.91|4.24|3.89|4.01|3.54|3.82|3.82|3.96|3.71|3.73|3.51|3.53|3.74|
|            Horror| 4.2|2.89|4.36|4.37|3.96|3.83|3.78|4.04|4.06|3.52|3.39|3.55|3.64|3.67|3.65|3.44|3.42|3.38| 3.7|
|           Western|null| 4.5| 3.9|4.32|4.18|3.98|3.98|4.22|4.13|3.83|3.78| 3.7|3.71|3.78| 3.9| 3.7|3.75|3.69|3.99|
|            Comedy| 3.8|3.35| 4.1|4.32|3.87|3.84|3.94|4.06| 4.0|3.73|3.67|3.72|3.75|3.78|3.78|3.72|3.59|3.68|3.79|
|          Children| 3.8|3.58|4.22|4.32|4.04|3.85|4.03|4.17|4.12|3.74|3.63|3.65| 3.8|3.82|3.89|3.64| 3.6|3.55|3.62|
|            Action|4.21|3.43|4.01|4.08|3.95|3.86|3.96|3.91|3.93|3.74|3.63|3.69|3.72|3.78|3.73|3.64| 3.5|3.51|3.77|
|            Sci-Fi|4.23|3.56|4.19|4.09|3.97| 3.7| 4.1|4.04|4.02|3.79|3.77|3.73|3.83|3.89|3.75| 3.7|3.62| 3.6|3.75|
+------------------+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
```

- Detect anomalies in ratings for movies within each genre.

Detect anomalies in ratings for movies within each genre.

movieId	title	genres	rating	z_score
1227	Once Upon a Time ...	Crime	0.5	-3.5610187452155215
1573	Face/Off (1997)	Crime	1	-3.039306390424684
1573	Face/Off (1997)	Crime	1	-3.039306390424684
1573	Face/Off (1997)	Crime	1	-3.039306390424684
1573	Face/Off (1997)	Crime	1	-3.039306390424684
20	Money Train (1995)	Crime	1	-3.039306390424684
2383	Police Academy 6:...	Crime	0.5	-3.5610187452155215
420	Beverly Hills Cop...	Crime	0.5	-3.5610187452155215
420	Beverly Hills Cop...	Crime	0.5	-3.5610187452155215
4246	Bridget Jones's D...	Romance	0.5	-3.23874235187354
4246	Bridget Jones's D...	Romance	0.5	-3.23874235187354
4246	Bridget Jones's D...	Romance	0.5	-3.23874235187354
4246	Bridget Jones's D...	Romance	0.5	-3.23874235187354
736	Twister (1996)	Romance	0.5	-3.23874235187354
736	Twister (1996)	Romance	0.5	-3.23874235187354
420	Beverly Hills Cop...	Thriller	0.5	-3.1750545040075036
420	Beverly Hills Cop...	Thriller	0.5	-3.1750545040075036
736	Twister (1996)	Thriller	0.5	-3.1750545040075036
736	Twister (1996)	Thriller	0.5	-3.1750545040075036
3704	Mad Max Beyond Th...	Adventure	0.5	-3.0760620981433253

only showing top 20 rows

userId	movieId	rating	ratingsDF_timestamp	title	genres	tag	tagsDF_timestamp	imdbId	tmdbId	rolling_avg	rolling_stddev	z_score
79713	592	3	1999-12-11 16:13:53	Batman (1989)	Crime	dark hero	2013-05-11 12:38:32	96895	268	4.866666666666666	0.5163977794943222	-3.6147844564602555
23333	1245	4	1999-12-30 05:04:59	Miller's Crossing...	Crime	neo-noir	2013-05-16 00:36:57	100150	379	4.933333333333334	0.2581988897471611	-3.6147844564602557
130517	4084	1	2001-08-26 02:33:59	Beverly Hills Cop...	Crime	crappy sequel	2006-06-01 06:00:32	92644	96	4.4	1.1212238211627763	-3.0324007890538725
7723	1206	4	2002-02-16 20:04:12	Clockwork Orange,...	Crime	Futuristmovies.com	2006-01-15 02:36:04	66921	185	4.933333333333334	0.2581988897471611	-3.6147844564602557
30739	1396	2	2002-05-14 15:58:11	Sneakers (1992)	Crime	ensemble cast	2013-05-11 16:52:31	105435	2322	4.6	0.8280786712108249	-3.1397982950077124
96370	4677	1.5	2003-05-15 18:04:34	Turner & Hooch (1...	Crime	dogs	2006-01-16 01:13:11	98536	6951	4.033333333333333	0.8338093878327917	-3.0382643447057904
1741	4719	0.5	2003-05-15 19:51:24	Osmosis Jones (2001)	Crime	ostensibly for ki...	2007-05-02 22:06:55	181739	12610	4.1	1.0555973258234952	-3.4103913603528304
3149	1729	2	2003-07-06 02:15:30	Jackie Brown (1997)	Crime	Tarantino	2006-02-20 03:46:06	119396	184	3.8	0.5916079783099616	-3.0425553170226594
1741	6662	3	2003-08-13 01:00:15	Pink Panther, The...	Crime	Inspector Clousea...	2007-04-29 12:05:01	57413	936	4.5	0.49999999999999994	-3.0000000000000004
107572	1783	1.5	2003-09-01 14:26:18	Palmetto (1998)	Crime	boring	2006-09-08 17:35:41	120782	30949	3.933333333333333	0.7761320457119086	-3.1352053388046275
58612	185	1.5	2004-02-27 17:07:36	Net, The (1995)	Crime	computers	2010-07-04 18:08:30	113957	1642	4.033333333333333	0.789816132912923	-3.2074975779364494
123297	4406	4.5	2004-03-30 23:21:34	Man Who Shot Libe...	Crime	BD-R	2011-09-22 19:52:24	56217	11697	4.033333333333333	0.12909944487358055	3.6147844564602557
123297	2731	5	2004-04-03 19:03:18	400 Blows, The (L...	Crime	DVD-Video	2007-02-26 21:43:18	53198	147	4.033333333333333	0.2968084198523318	3.256870769190453
58612	7523	0.5	2004-05-07 13:09:48	Desperate Hours (...	Crime	home invasion	2006-08-12 07:55:16	99409	31676	4.033333333333333	1.1412190641506792	-3.0961043714800884
10189	296	0.5	2004-08-07 07:44:14	Pulp Fiction (1994)	Crime	organized crime	2009-05-21 18:53:35	110912	680	3.8	0.9783367810436532	-3.3730715883743873
51266	50	3	2004-08-30 09:41:39	Usual Suspects, T...	Crime	unreliable narrators	2008-01-01 19:27:00	114814	629	4.6	0.50709255283711	-3.1552425509864612
103872	8370	4	2004-10-16 16:14:26	Blind Swordsman: ...	Crime	Takeshi Kitano	2006-05-16 11:01:27	363226	246	4.466666666666667	0.12909944487358055	-3.6147844564602557
131086	367	3	2005-03-23 23:39:00	Mask, The (1994)	Crime	carrey decline be...	2006-02-07 21:56:54	110475	854	4.5	0.49999999999999994	-3.0000000000000004
131910	6874	2	2005-04-14 21:31:58	Kill Bill: Vol. 1...	Crime	Bibliothek	2006-01-30 22:26:21	266697	24	4.8	0.7745966692414834	-3.6147844564602556
93004	2379	1	2005-07-25 17:47:11	Police Academy 2:...	Crime	idiot plot	2014-01-05 22:37:55	89822	10157	3.7333333333333334	0.8208590157935307	-3.3298450534663364

only showing top 20 rows

- Calculate rating distributions for each genre (e.g., percentage of 5-star ratings).

Calculate rating distributions for each genre (e.g., percentage of 5-star ratings).

genres	rating	rating_count	total_ratings	percentage
(no genres listed)	0.5	1	46	2.1739130434782608
(no genres listed)	2	3	46	6.521739130434782
(no genres listed)	2.5	8	46	17.391304347826086
(no genres listed)	3	16	46	34.78260869565217
(no genres listed)	3.5	1	46	2.1739130434782608
(no genres listed)	4	7	46	15.217391304347828
(no genres listed)	4.5	2	46	4.3478260869565215
(no genres listed)	5	8	46	17.391304347826086
Action	0.5	1707	107325	1.5904961565338924
Action	1	2524	107325	2.351735383181924
Action	1.5	2644	107325	2.463545306312602
Action	2	5285	107325	4.924295364546937
Action	2.5	6550	107325	6.102958304216166
Action	3	12173	107325	11.342184952247845
Action	3.5	16446	107325	15.3235499650594
Action	4	25217	107325	23.49592359655253
Action	4.5	16179	107325	15.07477288609364
Action	5	18600	107325	17.330538085255064
Adventure	0.5	1047	77199	1.3562351843935803
Adventure	1	1577	77199	2.042772574774285

only showing top 20 rows

6. User Behavior Analysis

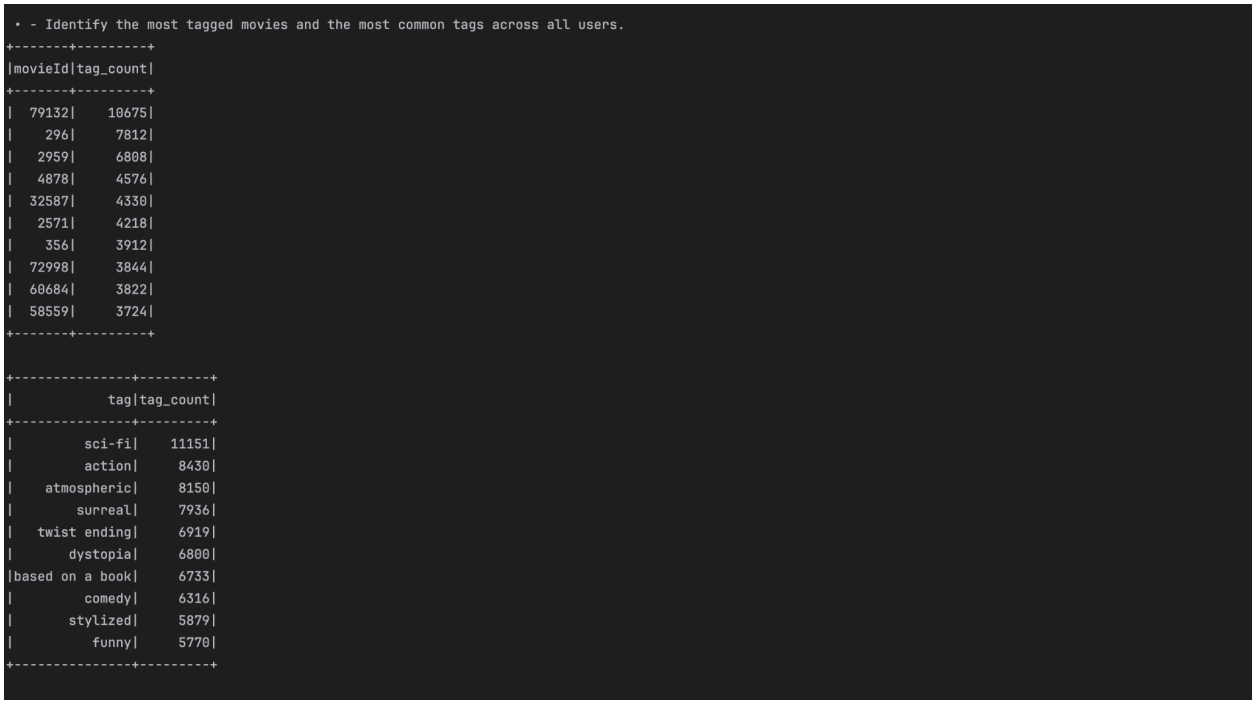
Deep dive into user preferences and rating patterns.

- Cluster users based on their rating behavior (e.g., predominantly high ratings, diverse ratings).

User Behavior Analysis

cluster	avg_rating_in_cluster	variance_in_cluster	rating_count_in_cluster	user_count
1	3.5949688937185 14	0.8587160816933747	9854.6	30
3	2.5925698192587037	0.0890947860440152	7.612435233160622	965
2	3.6715647043749544	0.9719422810322198	287.54859218891914	2202
0	4.548772735817733	0.16285936072597526	36.69232710752146	3962

- Identify the most tagged movies and the most common tags across all users.



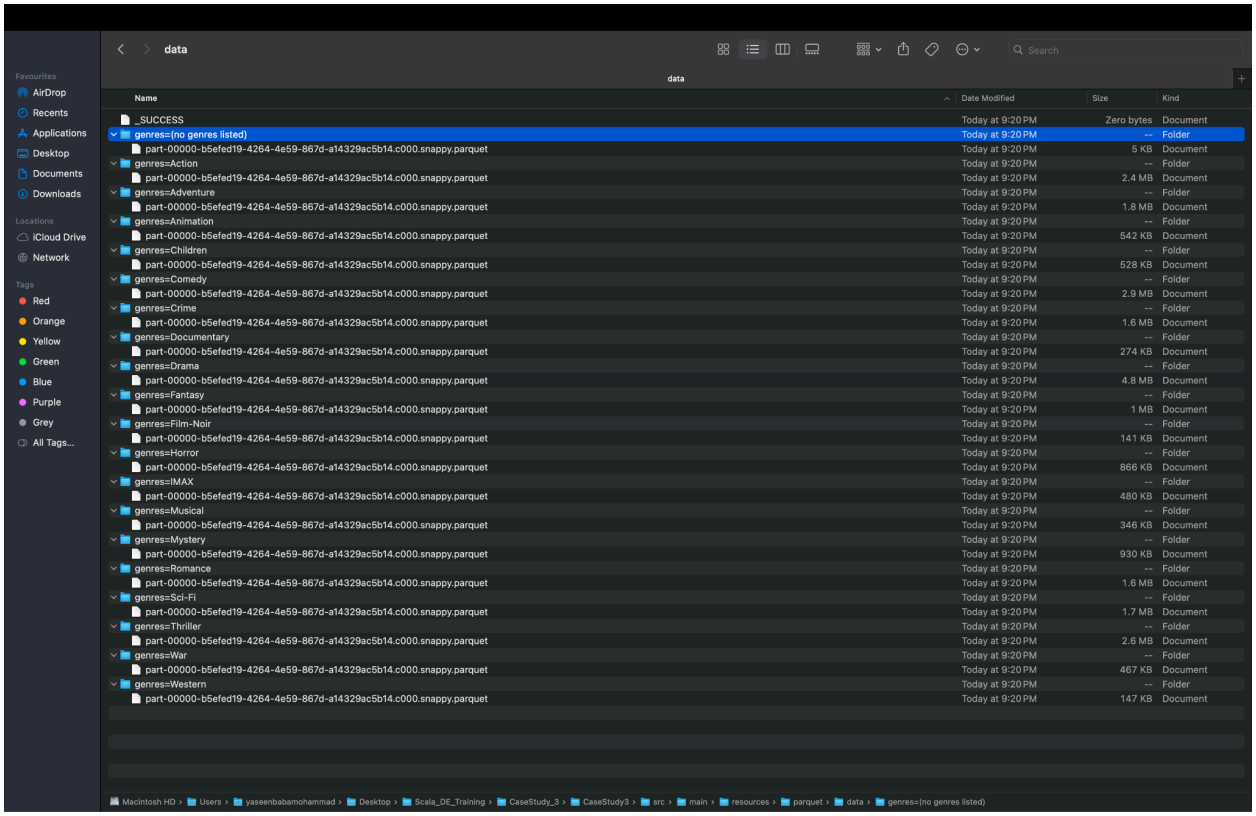
```
• - Identify the most tagged movies and the most common tags across all users.
+-------+---------+
|movieId|tag_count|
+-------+---------+
|  79132|    10675|
|    296|     7812|
|   2959|     6808|
|   4878|     4576|
|  32587|     4330|
|   2571|     4218|
|    356|     3912|
|  72998|     3844|
|  60684|     3822|
|  58559|     3724|
+-------+---------+

+---------------+---------+
|            tag|tag_count|
+---------------+---------+
|         sci-fi|    11151|
|         action|     8430|
|    atmospheric|     8150|
|        surreal|     7936|
|   twist ending|     6919|
|       dystopia|     6800|
|based on a book|     6733|
|         comedy|     6316|
|       stylized|     5879|
|          funny|     5770|
+---------------+---------+
```

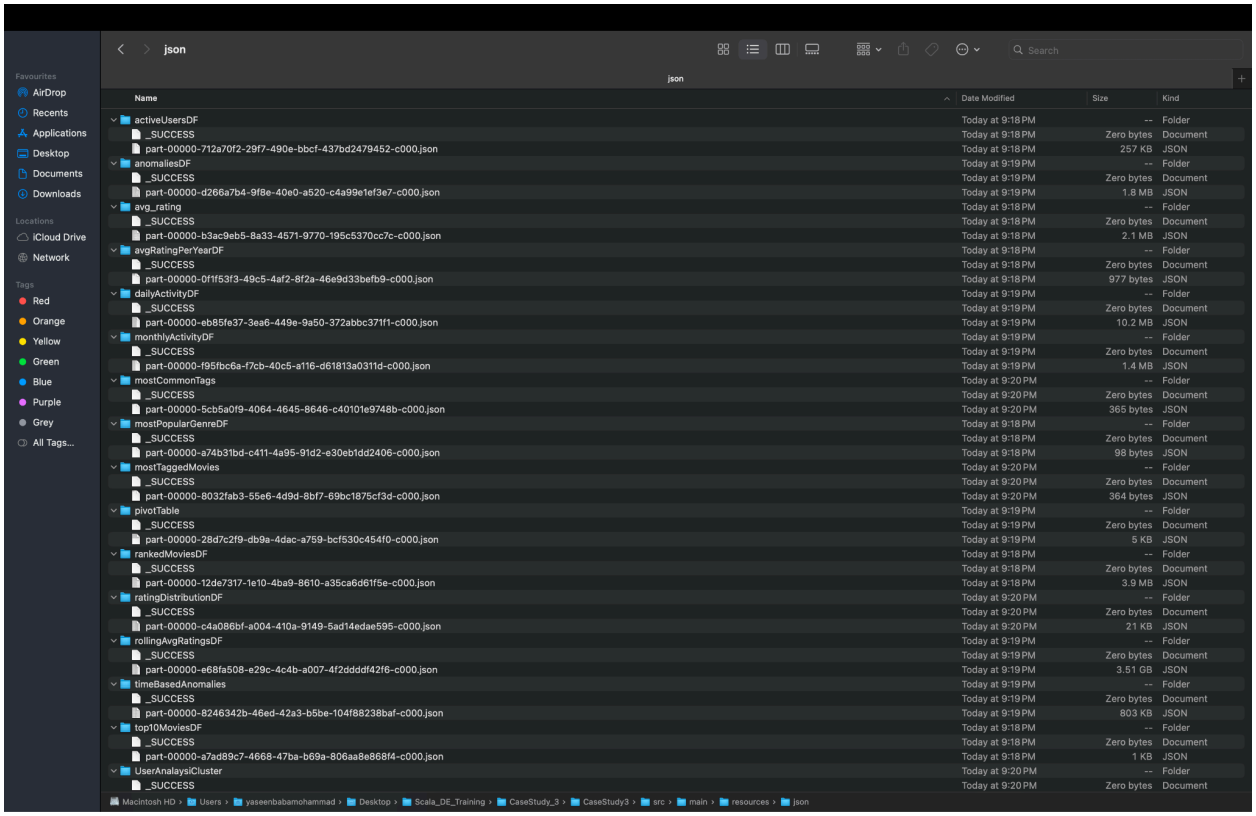
7. Storage Optimization

Optimize the storage of processed data for future use.

- Store enriched datasets in Parquet format, partitioned by genre.



- Save aggregated metrics in JSON format for visualization.


json
Search
Favourites
AirDrop
Recents
Applications
Desktop
Documents
Downloads
Locations
iCloud Drive
Network
Tags
Red
Orange
Yellow
Green
Blue
Purple
Grey
All Tags...
Name
Date Modified
Size
Kind
activeUsersDF — Today at 9:18 PM — -- — Folder
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part-00000-712a70f2-29f7-490e-bbcf-437bd2479452-c000.json — Today at 9:18 PM — 257 KB — JSON
anomaliesDF — Today at 9:19 PM — -- — Folder
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avg_rating — Today at 9:18 PM — -- — Folder
_SUCCESS — Today at 9:18 PM — Zero bytes — Document
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avgRatingPerYearDF — Today at 9:18 PM — -- — Folder
_SUCCESS — Today at 9:18 PM — Zero bytes — Document
part-00000-0f1f53f3-49c5-4af2-8f2a-46e9d33befb9-c000.json — Today at 9:18 PM — 977 bytes — JSON
dailyActivityDF — Today at 9:19 PM — -- — Folder
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monthlyActivityDF — Today at 9:19 PM — -- — Folder
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mostPopularGenreDF — Today at 9:18 PM — -- — Folder
_SUCCESS — Today at 9:18 PM — Zero bytes — Document
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ratingDistributionDF — Today at 9:20 PM — -- — Folder
_SUCCESS — Today at 9:20 PM — Zero bytes — Document
part-00000-c4a086bf-a004-410a-9149-5ad14edae595-c000.json — Today at 9:20 PM — 21 KB — JSON
rollingAvgRatingsDF — Today at 9:19 PM — -- — Folder
_SUCCESS — Today at 9:19 PM — Zero bytes — Document
part-00000-e68fa508-e29c-4c4b-a007-4f2ddddf42f6-c000.json — Today at 9:19 PM — 3.51 GB — JSON
timeBasedAnomalies — Today at 9:19 PM — -- — Folder
_SUCCESS — Today at 9:19 PM — Zero bytes — Document
part-00000-8246342b-46ed-42a3-b5be-104f88238baf-c000.json — Today at 9:19 PM — 803 KB — JSON
top10MoviesDF — Today at 9:18 PM — -- — Folder
_SUCCESS — Today at 9:18 PM — Zero bytes — Document
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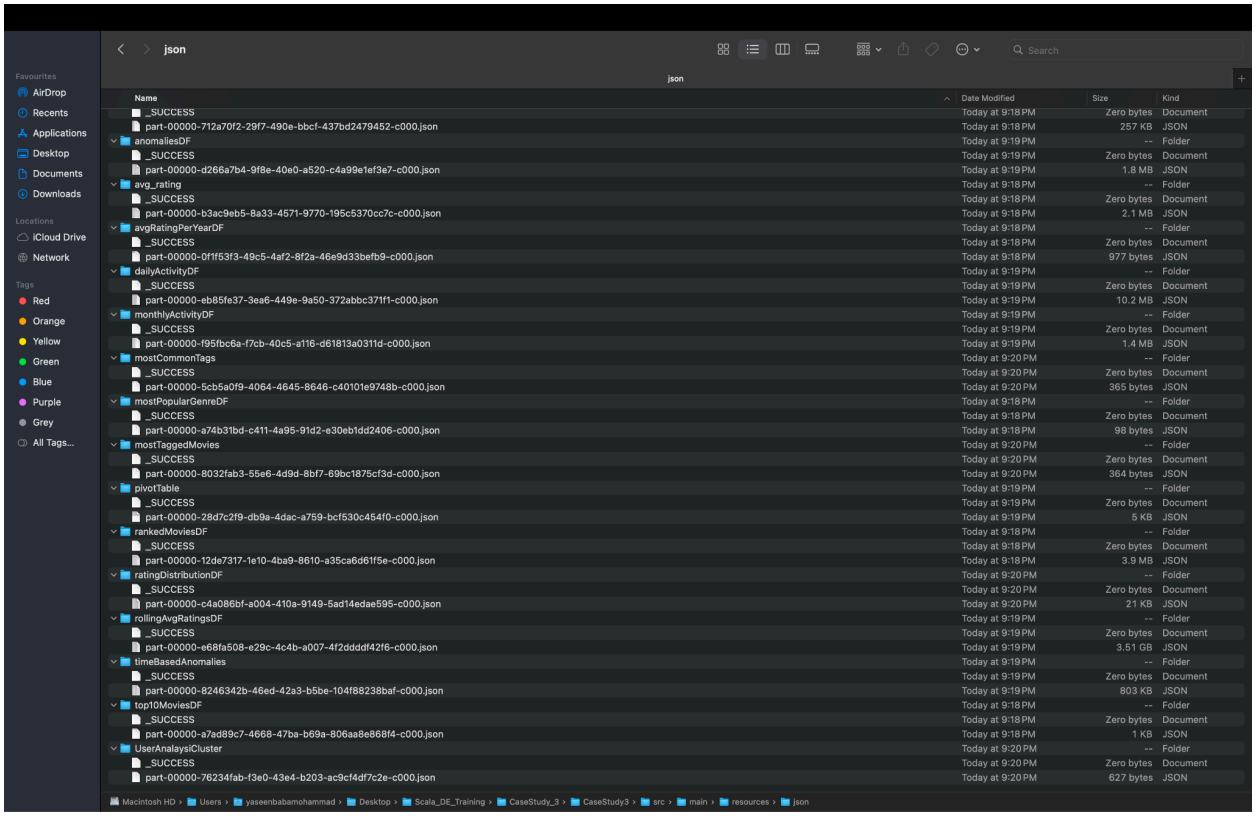
UserAnalaysiCluster — Today at 9:20 PM — -- — Folder
_SUCCESS — Today at 9:20 PM — Zero bytes — Document
Macintosh HD › Users › yaseenbabamohammad › Desktop › Scala_DE_Training › CaseStudy_3 › CaseStudy3 › src › main › resources › json



8. Visualization and Reporting

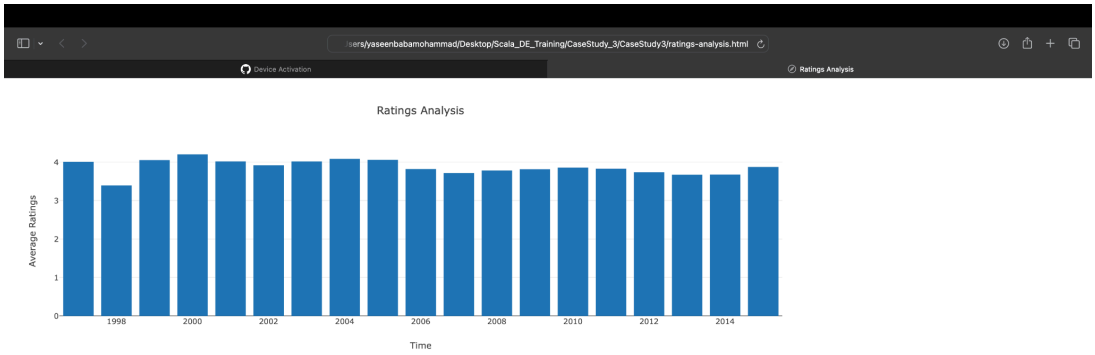
Generate reports and visualizations based on the aggregated data.
- Create summary reports for genre trends, user activity, and top-rated movies.

```
 Summary Reports for the User Activity
+------+------------+------------------+------------------+
|userId|movies_rated|        avg_rating|     rating_stddev|
+------+------------+------------------+------------------+
| 58612|       24178| 3.505811067912979|0.8475891165291282|
|130827|       21471| 3.156536723953239|0.9662294988137566|
|124998|       20942|  2.67407601948238| 1.145374902386008|
| 88738|       20156|3.6148045247072833|1.3099118789934774|
| 10616|       14812| 3.632088846880907|0.9725077185543893|
| 52814|       13613| 3.376478366267538|0.7077583352172978|
| 27898|       11732| 3.568232185475622|0.9115531655378883|
| 70201|       10702|3.0117735002803214|0.5675158579624405|
| 68558|       10320| 3.309980620155039|0.7489290086247757|
| 77463|        9601|3.7662222685136966|0.5465836968616014|
|  1741|        9516|3.2311370323665405|1.0578070543816132|
| 25737|        8548|3.8304281703322416|1.2761804095367304|
| 11081|        8309| 2.729510169695511|0.7679268298996731|
|  4450|        8099| 3.000432152117545|0.8756501650724755|
|  9815|        7986| 4.331329827197596|0.6031955477151367|
|123297|        7784| 4.044321685508736|0.5508580225705941|
| 28906|        7766| 3.366340458408447|0.7214192740294245|
|120937|        7533|3.9754413912120006|0.5569596189820307|
| 57434|        7289| 3.620112498285087|0.8565938075415146|
|119367|        7059|  4.19974500637484|1.0340518276894535|
+------+------------+------------------+------------------+
only showing top 20 rows
```

```
 Summary Reports for the Top Rated Movies
+-------+------------------+-----------+
|movieId|        avg_rating|num_ratings|
+-------+------------------+-----------+
|  77658| 4.739669421487603|        121|
|  42422|           4.71875|        128|
|  32460| 4.712765957446808|        188|
|   2959| 4.662162162162162|       6808|
|   4973| 4.661599099099099|       1776|
|   7669| 4.654929577464789|        142|
|   1233| 4.593896713615023|        639|
|    293|  4.56312625250501|       1996|
|    318|4.5556835637480795|       2604|
|  27156| 4.526315789473684|        285|
|   5618|4.5188953488372094|       2064|
|  55721|               4.5|        468|
|  27728|               4.5|        240|
|   4226| 4.496536796536796|       2310|
|   7502|4.4950495049504955|        303|
|   1916| 4.492063492063492|        126|
|   1188| 4.491803278688525|        122|
|   2139| 4.489130434782608|        184|
|   1221| 4.487623762376238|        404|
|  86781|4.4868421052631575|        114|
+-------+------------------+-----------+
only showing top 20 rows
```

```
Summary Reports for the Genres Trends
+------------------+------------------+------------+-------------+
|            genres|        avg_rating|unique_users|total_ratings|
+------------------+------------------+------------+-------------+
|             Drama| 3.890947107141433|        5495|       200632|
|            Comedy|  3.74152734795479|        4384|       118912|
|          Thriller|  3.76777100842162|        4282|       115061|
|            Action| 3.680801304449103|        3961|       107325|
|            Sci-Fi|3.7531929824561403|        3137|        78375|
|         Adventure|3.7280923328022384|        3343|        77199|
|           Romance| 3.797961542964177|        3435|        68336|
|             Crime| 3.912818109936451|        3570|        68294|
|           Fantasy|3.7539541727070125|        2644|        46217|
|           Mystery|3.9145623985126963|        2657|        42493|
|            Horror| 3.559419730273863|        2111|        36259|
|              IMAX| 3.702177044981591|        1770|        24988|
|         Animation| 3.880011842327863|        1666|        23644|
|          Children|3.7440638380692874|        1602|        20552|
|               War| 3.888863357843137|        1824|        19584|
|           Musical|3.8690921585095825|        1299|        13097|
|       Documentary|3.8139393268379096|         926|         9032|
|         Film-Noir|3.9944802989130435|         816|         5888|
|           Western|3.8154984840378097|         761|         5607|
|(no genres listed)| 3.369565217391304|          15|           46|
+------------------+------------------+------------+-------------+
```

- Generate plots for average ratings per year and rolling averages over time.


sers/yaseenbabamohammad/Desktop/Scala_DE_Training/CaseStudy_3/CaseStudy3/ratings-analysis.html
Device Activation
Ratings Analysis
Ratings Analysis
Average Ratings
0
1
2
3
4
1998
2000
2002
2004
2006
2008
2010
2012
2014
Time


ers/yaseenbabamohammad/Desktop/Scala_DE_Training/CaseStudy_3/CaseStudy3/ratings-analysis-7.html
Device Activation
Ratings Analysis
Ratings Analysis
Ratings Analysis
Ratings Analysis
Yearly Average Ratings
Ratings Analysis
Ratings Analysis
Yearly Average Ratings
Yearly Average Ratings
Rolling Average Ratings
0
1
2
3
4
3.713031
1998
2000
2002
2004
2006
2007
2008
2010
2012
2014
Year