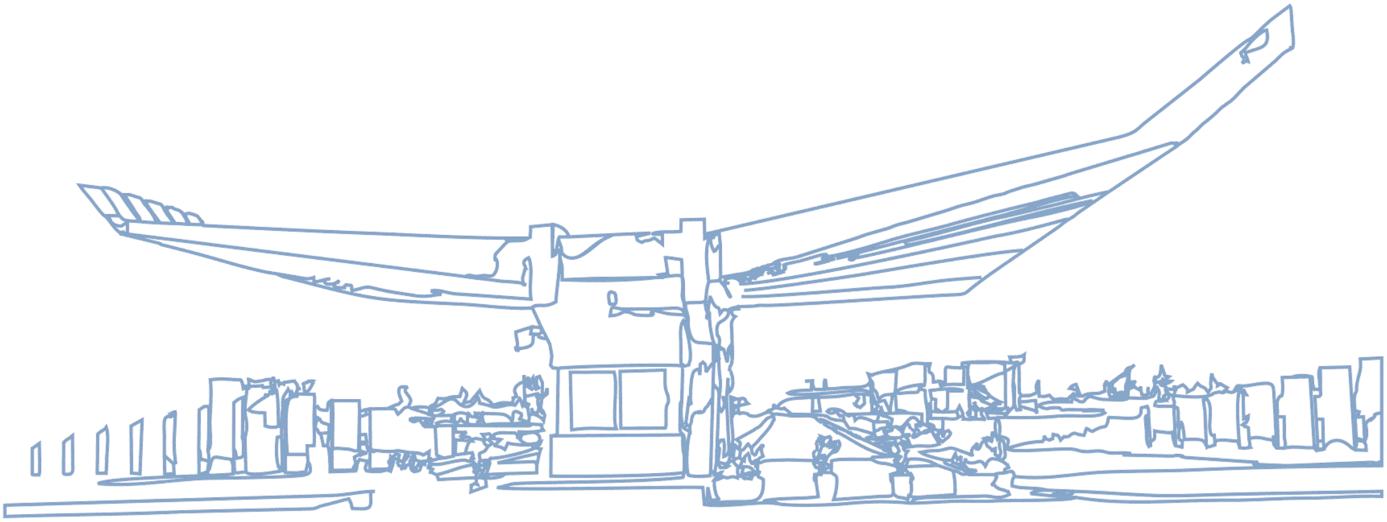
EPOKA UNIVERSITY | Computer Engineering Department

CEN 571 – Data Mining

Data Mining with Spark



PREPARED:
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21.6.2020
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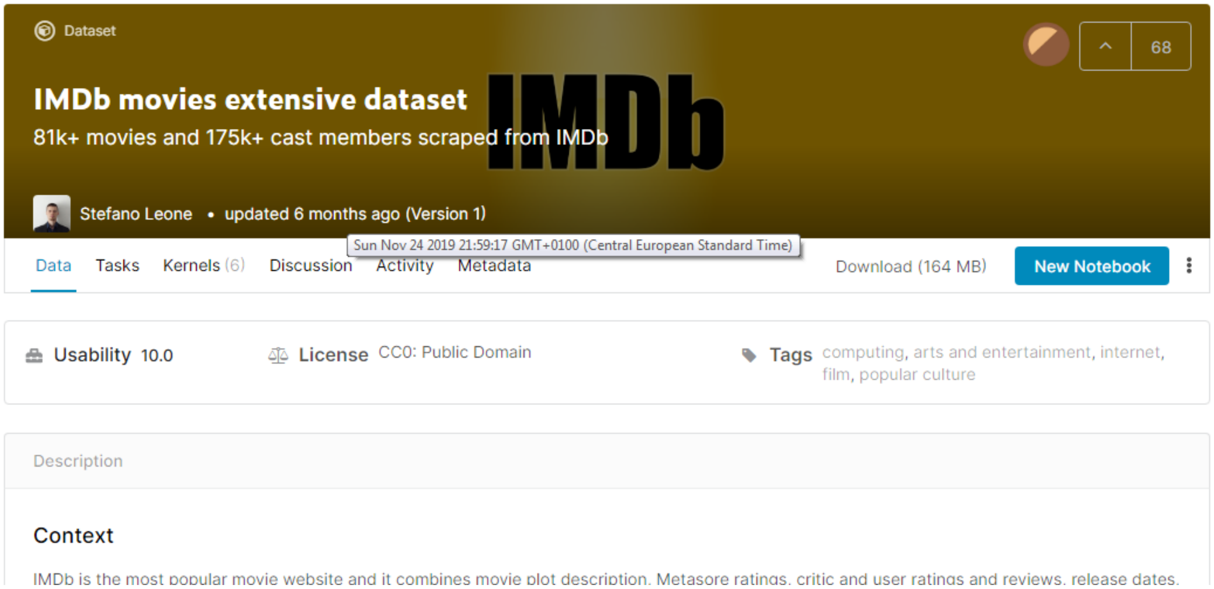
ACCEPTED:
Prof.Dr. Arben Asllani

1. Dataset

The dataset was taken by Kaggle.com



IMDb movies extensive dataset

81k+ movies and 175k+ cast members scraped from IMDb

Stefano Leone • updated 6 months ago (Version 1)

Sun Nov 24 2019 21:59:17 GMT+0100 (Central European Standard Time)

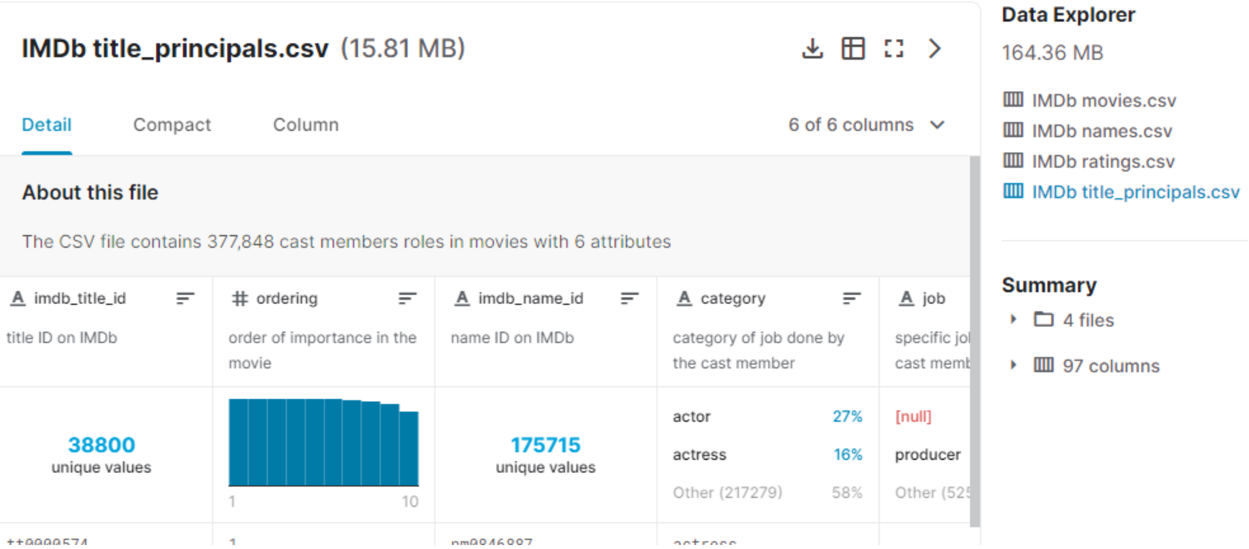
Usability 10.0 License CC0: Public Domain Tags computing, arts and entertainment, internet, film, popular culture

Description

Context

IMDb is the most popular movie website and it combines movie plot description, Metasore ratings, critic and user ratings and reviews, release dates,

With a size of 168 MB, the latest one, of 6 months, composed of 4 tables, by Stefano Leone. All in CSV format as shown below.



IMDb title_principals.csv (15.81 MB)

Data Explorer

164.36 MB

- IMDb movies.csv
- IMDb names.csv
- IMDb ratings.csv
- IMDb title_principals.csv

Summary

- 4 files
- 97 columns

About this file

The CSV file contains 377,848 cast members roles in movies with 6 attributes

imdb_title_id	ordering	imdb_name_id	category	job
title ID on IMDb	order of importance in the movie	name ID on IMDb	category of job done by the cast member	specific jol cast memb
38800 unique values	1 10	175715 unique values	actor 27% actress 16% Other (217279) 58%	[null] producer Other (525
tt0000574	1	nm0846887	actress	

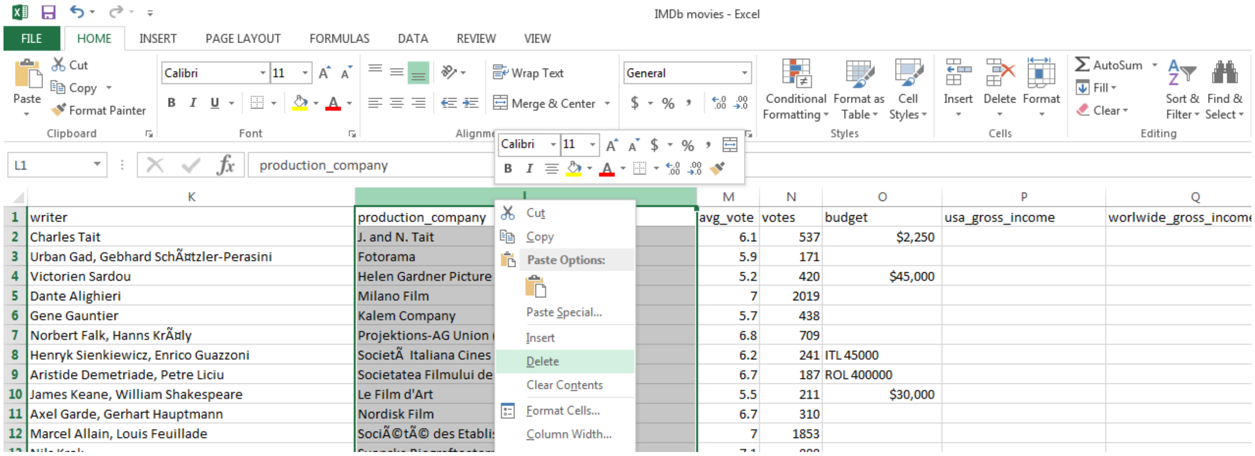
2. Cleaning the unwanted data, the data selection according to the project’s goals.

Some redundant features will be removed, and data will be processed using Map Reduce, with corresponding code and jar files.

Removing some columns was used the Microsoft Excel, where the data was displayed better and modified.

Ex: According to my goals, I don’t need a movie Description, cast list, reviews numbers from users and anything to do with the price, or the user’s that rate professions, spouses’ number and so on.

We also delete the cast data from dataset.



	K	L	M	N	O	P	Q
1	writer	production_company	avg_vote	votes	budget	usa_gross_income	worlwide_gross_income
2	Charles Tait	J. and N. Tait	6.1	537	$2,250		
3	Urban Gad, Gebhard SchÃ¤tzler-Perasini	Fotorama	5.9	171			
4	Victorien Sardou	Helen Gardner Picture	5.2	420	$45,000		
5	Dante Alighieri	Milano Film	7	2019			
6	Gene Gauntier	Kalem Company	5.7	438			
7	Norbert Falk, Hanns KrÃ¤ly	Projektions-AG Union (	6.8	709			
8	Henryk Sienkiewicz, Enrico Guazzoni	SocietÃ Italiana Cines	6.2	241	ITL 45000		
9	Aristide Demetriade, Petre Liciu	Societatea Filmului de	6.7	187	ROL 400000		
10	James Keane, William Shakespeare	Le Film d'Art	5.5	211	$30,000		
11	Axel Garde, Gerhart Hauptmann	Nordisk Film	6.7	310			
12	Marcel Allain, Louis Feuillade	SociÃ©tÃ© des Etabli:	7	1853			

From all data of 4 tables, I reduced it to 2 and removed the unnecessary features for all of them.

3. Writing the Spark Application code in python

All the code is included as a single python file, included on the project submission folders.

```
"""
Main commands to proceed with, before the python

hadoop fs -ls
hadoop fs -mkdir /Spark_APP
hadoop fs -mkdir /Spark_APP/input
hadoop fs -copyFromLocal movies.csv /Spark_APP/input
hadoop fs -copyFromLocal ratings.csv /Spark_APP/input
hadoop fs -ls /Spark_APP/input

//run py Spark_APP
spark-submit IBDM_movies.py /Spark_APP/input/movies.csv
/Spark_APP/input/ratings.csv /Spark_APP
"""

"""
Author: Baftjar Tabaku
Epoka University
Data Mining
"""

import sys
from sched import scheduler

from pyspark.sql import SparkSession
from pyspark.sql.types import IntegerType
from pyspark.sql.types import FloatType

if __name__ == "__main__":
    if len(sys.argv) < 4:
        sys.stderr.write("Error: Usage: IBDM_movies.py <input-file 1> <input-
file 2> </Root of files>")
        sys.exit()

    spark = SparkSession.builder.getOrCreate()
    spark.sparkContext.setLogLevel("WARN")


    # Functions part to get the genders differences in vote for each movie
    def opinion_difference(num1, num2):
        return num1 - num2


    # Creating data frames
    # Movies table part, dealing with movies

    # IMDb_RDD_movies = spark.read.format("csv").option("header",
"true").load(
    #     "C:\\Users\\Baftjar
Tabaku\\PycharmProjects\\DataMining\\movies.csv")
    IMDb_RDD_movies = spark.read.format("csv").option("header",
"true").load(sys.argv[1])
```

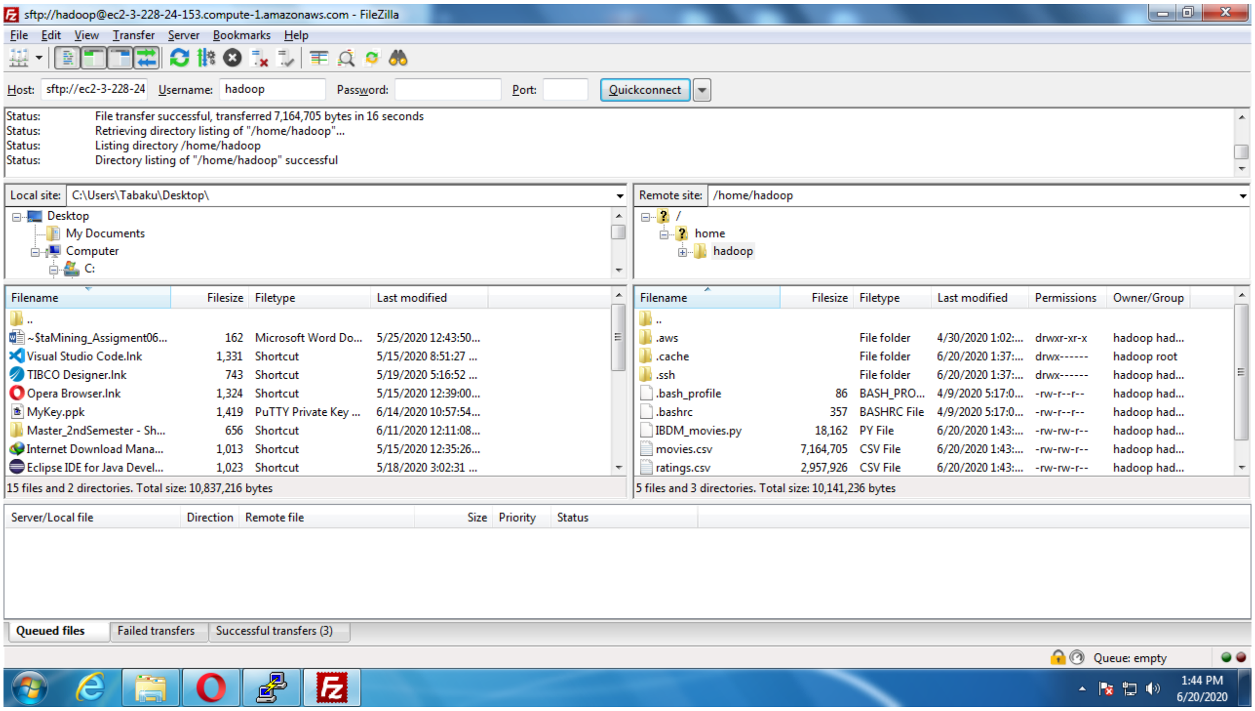
```
    # cast each variable to the current data type , except the strings
    IMDb_RDD_movies = IMDb_RDD_movies.withColumn("year",
IMDb_RDD_movies["year"].cast(IntegerType()))
    IMDb_RDD_movies = IMDb_RDD_movies.withColumn("duration",
IMDb_RDD_movies["duration"].cast(IntegerType()))
    IMDb_RDD_movies = IMDb_RDD_movies.withColumn("avg_vote",
IMDb_RDD_movies["avg_vote"].cast(FloatType()))
    IMDb_RDD_movies = IMDb_RDD_movies.withColumn("votes",
IMDb_RDD_movies["votes"].cast(IntegerType()))

    # Second RDD Ratings part
    IMDb_RDD_ratings = spark.read.format("csv").option("header",
"true").load(sys.argv[2])
    # Casting the variables
    IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("weighted_average_vote",

IMDb_RDD_ratings["weighted_average_vote"].cast(FloatType()))
    IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("total_votes",

IMDb_RDD_ratings["total_votes"].cast(IntegerType()))
    IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("mean_vote",
IMDb_RDD_ratings["mean_vote"].cast(FloatType()))
    IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("median_vote",

IMDb_RDD_ratings["median_vote"].cast(IntegerType()))
    IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("males_allages_avg_vote",

IMDb_RDD_ratings["males_allages_avg_vote"].cast(FloatType()))
    IMDb_RDD_ratings =
IMDb_RDD_ratings.withColumn("females_allages_avg_vote",

IMDb_RDD_ratings["females_allages_avg_vote"].cast(FloatType()))
    IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("top1000_voters_rating",

IMDb_RDD_ratings["top1000_voters_rating"].cast(FloatType()))

    # custom operations with functions
    IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("opinion_diff",

opinion_difference(IMDb_RDD_ratings["males_allages_avg_vote"],

IMDb_RDD_ratings[

"females_allages_avg_vote"]).cast(
                                                       FloatType()))

    # IMDb_RDD_ratings = IMDb_RDD_ratings.withColumn("opinion_diff",
abs(["opinion_diff"]))

    # On the movies data we add a column, as the first task, the difference
in opinion

    IMDb_RDD_movies.printSchema()
    IMDb_RDD_movies.show()

    IMDb_RDD_ratings.printSchema()
    IMDb_RDD_ratings.show()

    # ---------------------------------------------------------------
    # Operations part, making them as tables for further operations
    # Creating two main tables
    IMDb_RDD_movies.registerTempTable("IMDb_movies")
    IMDb_RDD_ratings.registerTempTable("IMDb_ratings")

    selected_all_movies = spark.sql("SELECT * FROM IMDb_movies")
    selected_all_ratings = spark.sql("SELECT * FROM IMDb_ratings")
    selected_all_movies.show(10)
    selected_all_ratings.show(10)

    # Sort all movies
    selected_all_movies = spark.sql(
        "SELECT imdb_title_id, title,genre, year ,duration FROM IMDb_movies
SORT BY duration ASC")
    # selected_all_movies.show(100)  # first 100 movies sorted to demonstrate
the query
    selected_all_movies.show(10)

    # counting movies of year 2010
    count_2010_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2010 FROM
IMDb_movies where year=2010 GROUP BY year")
    count_2010_movies.show()

    # counting movies of year 2011
    count_2011_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2011 FROM
IMDb_movies where year=2011 GROUP BY year")
    count_2011_movies.show()

    # counting movies of year 2012
    count_2012_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2012 FROM
IMDb_movies where year=2012 GROUP BY year")
    count_2012_movies.show()

    # counting movies of year 2013
    count_2013_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2013 FROM
IMDb_movies where year=2013 GROUP BY year")
    count_2013_movies.show()

    # counting movies of year 2014
    count_2014_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2014 FROM
IMDb_movies where year=2014 GROUP BY year")
    count_2014_movies.show()

    # counting movies of year 2015
    count_2015_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2015 FROM
IMDb_movies where year=2015 GROUP BY year")
    count_2015_movies.show()

    # counting movies of year 2016
    count_2016_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2016 FROM
IMDb_movies where year=2016 GROUP BY year")
    count_2016_movies.show()

    # counting movies of year 2017
    count_2017_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2017 FROM 
IMDb_movies where year=2017 GROUP BY year")
    count_2017_movies.show()

    # counting movies of year 2018
    count_2018_movies = spark.sql(
        "SELECT year , COUNT(imdb_title_id) as all_movies_2018 FROM 
IMDb_movies where year=2018 GROUP BY year")
    count_2018_movies.show()

    # Calculating the rating average of the movies for the years 
2010,2011,2012,2013,2014,2015,2016, 2017,2018
    # 2010
    average_rating2010 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2010 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2010")
    average_rating2010.show()

    # 2011
    average_rating2011 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2011 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2011")
    average_rating2011.show()

    # 2012
    average_rating2012 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2012 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2012")
    average_rating2012.show()

    # 2013
    average_rating2013 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2013 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2013")
    average_rating2013.show()

    # 2014
    average_rating2014 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2014 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2014")
    average_rating2014.show()

    # 2015
    average_rating2015 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2015 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2015")
    average_rating2015.show()

    # 2016
    average_rating2016 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2016 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2016")
```

```
    average_rating2016.show()

    # 2017
    average_rating2017 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2017 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2017")
    average_rating2017.show()

    # 2018
    average_rating2018 = spark.sql(
        "SELECT AVG (weighted_average_vote) as total_avg_2018 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2018")
    average_rating2018.show()

    # Total Males and females ratting average for years 2010, 2011, 2012,
2013, 2014, 2015,2016,2017,2018
    # 2010
    # Females
    total_female_avg_rate_2010 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2010 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2010")
    total_female_avg_rate_2010.show()

    # Males
    total_male_avg_rate_2010 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2010 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2010")
    total_male_avg_rate_2010.show()

    # 2011
    # Females
    total_female_avg_rate_2011 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2011 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2011")
    total_female_avg_rate_2011.show()

    # Males
    total_male_avg_rate_2011 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2011 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2011")
    total_male_avg_rate_2011.show()

    # 2012
    # Females
    total_female_avg_rate_2012 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2012 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2012")
    total_female_avg_rate_2012.show()

    # Males
    total_male_avg_rate_2012 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2012 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2012")
    total_male_avg_rate_2012.show()

    # 2013
    # Females
    total_female_avg_rate_2013 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2013 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2013")
    total_female_avg_rate_2013.show()

    # Males
    total_male_avg_rate_2013 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2013 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2013")
    total_male_avg_rate_2013.show()

    # 2014
    # Females
    total_female_avg_rate_2014 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2014 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2014")
    total_female_avg_rate_2014.show()

    # Males
    total_male_avg_rate_2014 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2014 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2014")
    total_male_avg_rate_2014.show()

    # 2015
    # Females
    total_female_avg_rate_2015 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2015 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2015")
    total_female_avg_rate_2015.show()

    # Males
    total_male_avg_rate_2015 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2015 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2015")
    total_male_avg_rate_2015.show()

    # 2016
    # Females
    total_female_avg_rate_2016 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2016 FROM
IMDb_movies JOIN IMDb_ratings ON
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2016")
    total_female_avg_rate_2016.show()

    # Males
    total_male_avg_rate_2016 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2016 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2016")
    total_male_avg_rate_2016.show()

    # 2017
    # Females
    total_female_avg_rate_2017 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2017 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2017")
    total_female_avg_rate_2017.show()

    # Males
    total_male_avg_rate_2017 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2017 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2017")
    total_male_avg_rate_2017.show()

    # 2018
    # Females
    total_female_avg_rate_2018 = spark.sql(
        "SELECT AVG(females_allages_avg_vote) as totalF_avg_2018 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2018")
    total_female_avg_rate_2018.show()

    # Males
    total_male_avg_rate_2018 = spark.sql(
        "SELECT AVG(males_allages_avg_vote) as totalM_avg_2018 FROM 
IMDb_movies JOIN IMDb_ratings ON 
IMDb_movies.imdb_title_id=IMDb_ratings.imdb_title_id WHERE year=2018")
    total_male_avg_rate_2018.show()

    # ============================Saving data===========================
    # TODO , finishing this part, saving the tables

    IMDb_RDD_movies.write.format('csv').option('header', 
'true').save(sys.argv[3] + "/output_movies/")
    IMDb_RDD_ratings.write.format('csv').option('header', 
'true').save(sys.argv[3] + "/output_ratings/")

    # udemy.write.format('csv').option('header', 
'true').save("PROJ/OutputMain/")

    # simple selected and sorted
    selected_all_movies.coalesce(1).write.csv(sys.argv[3] + "/AllMovies")
    # Movies 2010-2018 counted
    count_2010_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2010Num/")
    count_2011_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2011Num/")
    count_2012_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2012Num/")
    count_2013_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2013Num/")
    count_2014_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2014Num/")
    count_2015_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2015Num/")
    count_2016_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2016Num/")
    count_2017_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2017Num/")
    count_2018_movies.coalesce(1).write.csv(sys.argv[3] + "/Movies2018Num/")

    # Rating average
    average_rating2010.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2010/")
    average_rating2011.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2011/")
    average_rating2012.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2012/")
    average_rating2013.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2013/")
    average_rating2014.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2016/")
    average_rating2015.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2015/")
    average_rating2016.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2016/")
    average_rating2017.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2017/")
    average_rating2018.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2018/")

    # Males and females rating average for years 2010 - 2018
    # females
    total_female_avg_rate_2010.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2010/")
    total_female_avg_rate_2011.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2011/")
    total_female_avg_rate_2012.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2012/")
    total_female_avg_rate_2013.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2013/")
    total_female_avg_rate_2014.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2014/")
    total_female_avg_rate_2015.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2015/")
    total_female_avg_rate_2016.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2016/")
    total_female_avg_rate_2017.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2017/")
    total_female_avg_rate_2018.coalesce(1).write.csv(sys.argv[3] +
"/FemaleRatingAVG2018/")

    # Males
    total_male_avg_rate_2010.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2010/")
    total_male_avg_rate_2011.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2011/")
    total_male_avg_rate_2012.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2012/")
    total_male_avg_rate_2013.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2013/")
    total_male_avg_rate_2014.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2014/")
    total_male_avg_rate_2015.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2015/")
    total_male_avg_rate_2016.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2016/")
    total_male_avg_rate_2017.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2017/")
    total_male_avg_rate_2018.coalesce(1).write.csv(sys.argv[3] +
"/MaleRatingAVG2018/")

    # Movies 2010-2018 counted - END

    spark.stop()
```

4. Uploading the data into the cluster and processing calculations.

The data tables.csv were successfully added to the AWS cluster for further analyzing, using spark.

The output files and folders will be stored in the output folder, according to the ordering of the submission, below are the corresponding output screenshots.


sftp://hadoop@ec2-3-228-24-153.compute-1.amazonaws.com - FileZilla
File Edit View Transfer Server Bookmarks Help
Quickconnect
Queued files
Failed transfers
Successful transfers (3)
Queue: empty
1:44 PM
6/20/2020

Host: sftp://ec2-3-228-24 Username: hadoop Password: Port:

```
Status:    File transfer successful, transferred 7,164,705 bytes in 16 seconds
Status:    Retrieving directory listing of "/home/hadoop"...
Status:    Listing directory /home/hadoop
Status:    Directory listing of "/home/hadoop" successful
```

Local site: C:\Users\Tabaku\Desktop\

- Desktop
  - My Documents
  - Computer
    - C:

Filename	Filesize	Filetype	Last modified
..			
~$taMining_Assigment06...	162	Microsoft Word Do...	5/25/2020 12:43:50...
Visual Studio Code.lnk	1,331	Shortcut	5/15/2020 8:51:27 ...
TIBCO Designer.lnk	743	Shortcut	5/19/2020 5:16:52 ...
Opera Browser.lnk	1,324	Shortcut	5/15/2020 12:39:00...
MyKey.ppk	1,419	PuTTY Private Key ...	6/14/2020 10:57:54...
Master_2ndSemester - Sh...	656	Shortcut	6/11/2020 12:11:08...
Internet Download Mana...	1,013	Shortcut	5/15/2020 12:35:26...
Eclipse IDE for Java Devel...	1,023	Shortcut	5/18/2020 3:02:31 ...

15 files and 2 directories. Total size: 10,837,216 bytes

Remote site: /home/hadoop

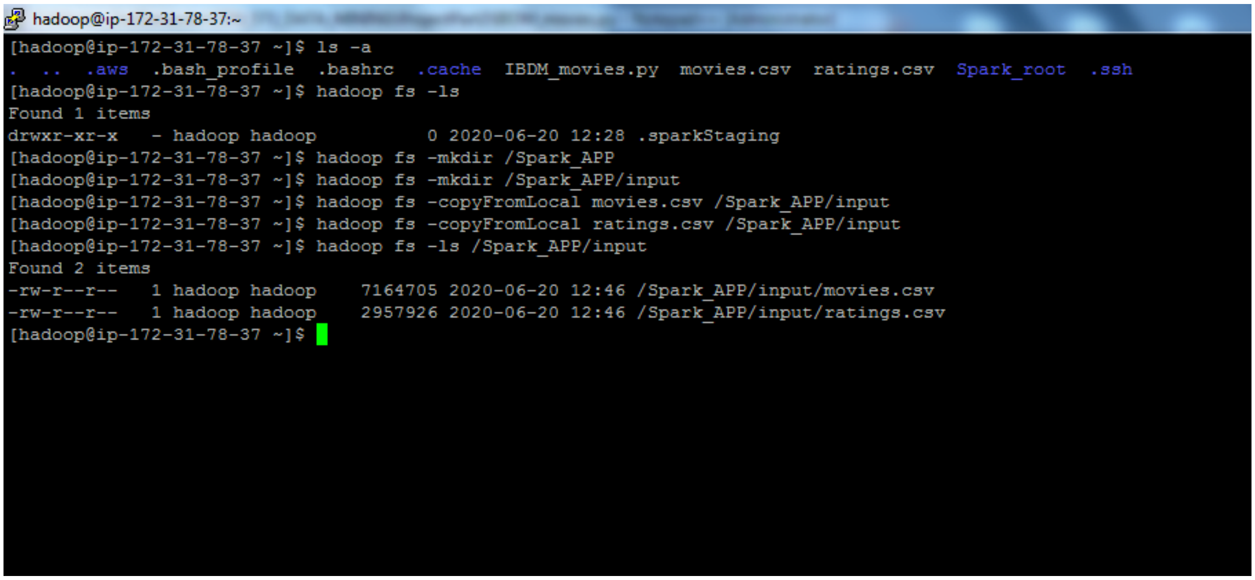
- /
  - home
    - hadoop

Filename	Filesize	Filetype	Last modified	Permissions	Owner/Group
..					
.aws		File folder	4/30/2020 1:02:...	drwxr-xr-x	hadoop had...
.cache		File folder	6/20/2020 1:37:...	drwx------	hadoop root
.ssh		File folder	6/20/2020 1:37:...	drwx------	hadoop had...
.bash_profile	86	BASH_PRO...	4/9/2020 5:17:0...	-rw-r--r--	hadoop had...
.bashrc	357	BASHRC File	4/9/2020 5:17:0...	-rw-r--r--	hadoop had...
IBDM_movies.py	18,162	PY File	6/20/2020 1:43:...	-rw-rw-r--	hadoop had...
movies.csv	7,164,705	CSV File	6/20/2020 1:43:...	-rw-rw-r--	hadoop had...
ratings.csv	2,957,926	CSV File	6/20/2020 1:43:...	-rw-rw-r--	hadoop had...

5 files and 3 directories. Total size: 10,141,236 bytes

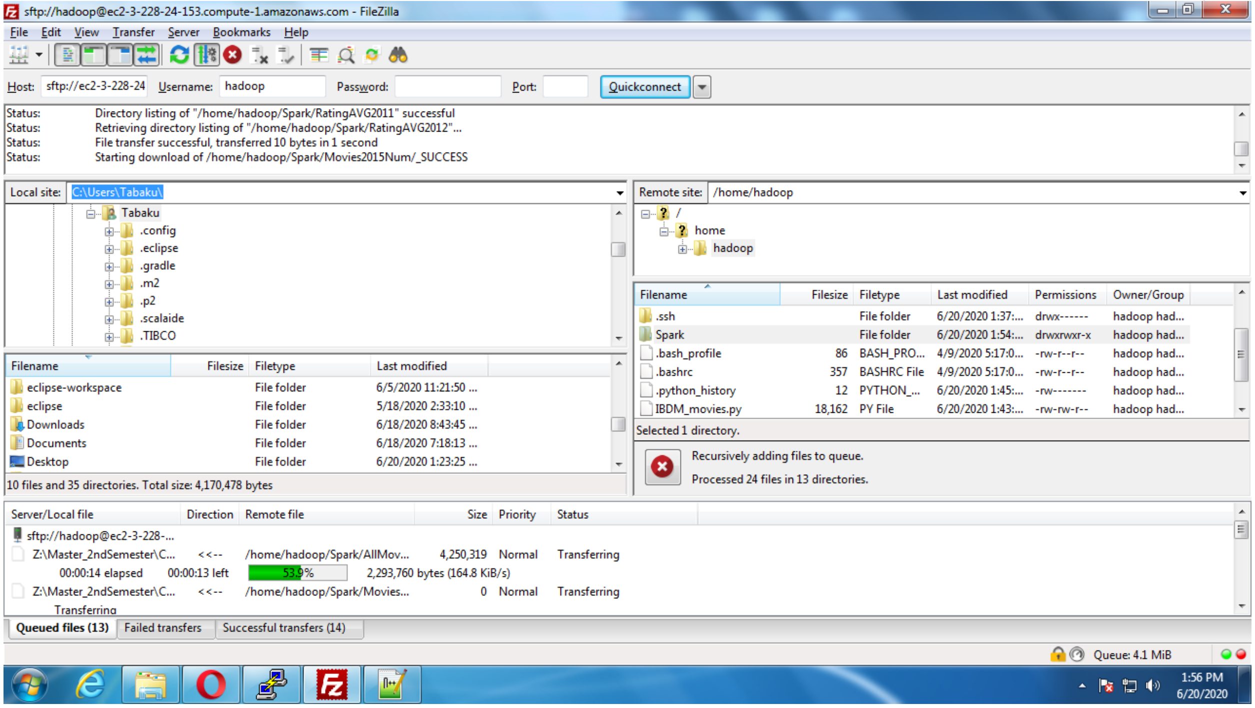
Server/Local file	Direction	Remote file	Size	Priority	Status

Files successfully passed into the cluster



```
[hadoop@ip-172-31-78-37 ~]$ ls -a
.  ..  .aws  .bash_profile  .bashrc  .cache  IBDM_movies.py  movies.csv  ratings.csv  Spark_root  .ssh
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -ls
Found 1 items
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 12:28 .sparkStaging
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -mkdir /Spark_APP
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -mkdir /Spark_APP/input
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -copyFromLocal movies.csv /Spark_APP/input
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -copyFromLocal ratings.csv /Spark_APP/input
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -ls /Spark_APP/input
Found 2 items
-rw-r--r--   1 hadoop hadoop    7164705 2020-06-20 12:46 /Spark_APP/input/movies.csv
-rw-r--r--   1 hadoop hadoop    2957926 2020-06-20 12:46 /Spark_APP/input/ratings.csv
[hadoop@ip-172-31-78-37 ~]$ 
```

After execution, data files will be transferred again to local directory for further analyze,



Host: sftp://ec2-3-228-24 Username: hadoop Password: Port:

```
Status:         Directory listing of "/home/hadoop/Spark/RatingAVG2011" successful
Status:         Retrieving directory listing of "/home/hadoop/Spark/RatingAVG2012"...
Status:         File transfer successful, transferred 10 bytes in 1 second
Status:         Starting download of /home/hadoop/Spark/Movies2015Num/_SUCCESS
```

Local site: C:\Users\Tabaku\

```
Tabaku
  .config
  .eclipse
  .gradle
  .m2
  .p2
  .scalaide
  .TIBCO
```

Filename	Filesize	Filetype	Last modified
eclipse-workspace		File folder	6/5/2020 11:21:50 ...
eclipse		File folder	5/18/2020 2:33:10 ...
Downloads		File folder	6/18/2020 8:43:45 ...
Documents		File folder	6/18/2020 7:18:13 ...
Desktop		File folder	6/20/2020 1:23:25 ...

10 files and 35 directories. Total size: 4,170,478 bytes

Remote site: /home/hadoop

```
/
  home
    hadoop
```

Filename	Filesize	Filetype	Last modified	Permissions	Owner/Group
.ssh		File folder	6/20/2020 1:37:...	drwx------	hadoop had...
Spark		File folder	6/20/2020 1:54:...	drwxrwxr-x	hadoop had...
.bash_profile	86	BASH_PRO...	4/9/2020 5:17:0...	-rw-r--r--	hadoop had...
.bashrc	357	BASHRC File	4/9/2020 5:17:0...	-rw-r--r--	hadoop had...
.python_history	12	PYTHON_...	6/20/2020 1:45:...	-rw-------	hadoop had...
IBDM_movies.py	18,162	PY File	6/20/2020 1:43:...	-rw-rw-r--	hadoop had...

Selected 1 directory.

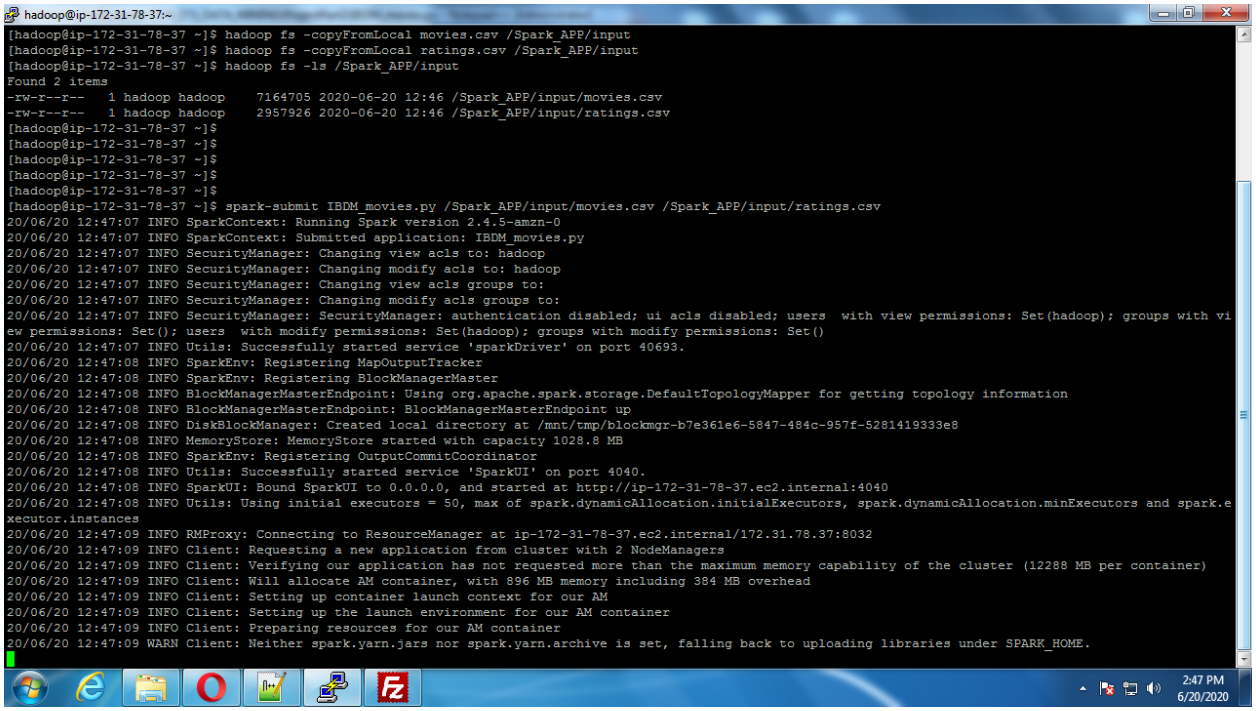
Recursively adding files to queue.

Processed 24 files in 13 directories.

```
Server/Local file            Direction  Remote file                     Size  Priority  Status
sftp://hadoop@ec2-3-228-...
Z:\Master_2ndSemester\C...   <<--       /home/hadoop/Spark/AllMov...  4,250,319  Normal  Transferring
      00:00:14 elapsed    00:00:13 left   53.9%   2,293,760 bytes (164.8 KiB/s)
Z:\Master_2ndSemester\C...   <<--       /home/hadoop/Spark/Movies...          0  Normal  Transferring
      Transferring
```

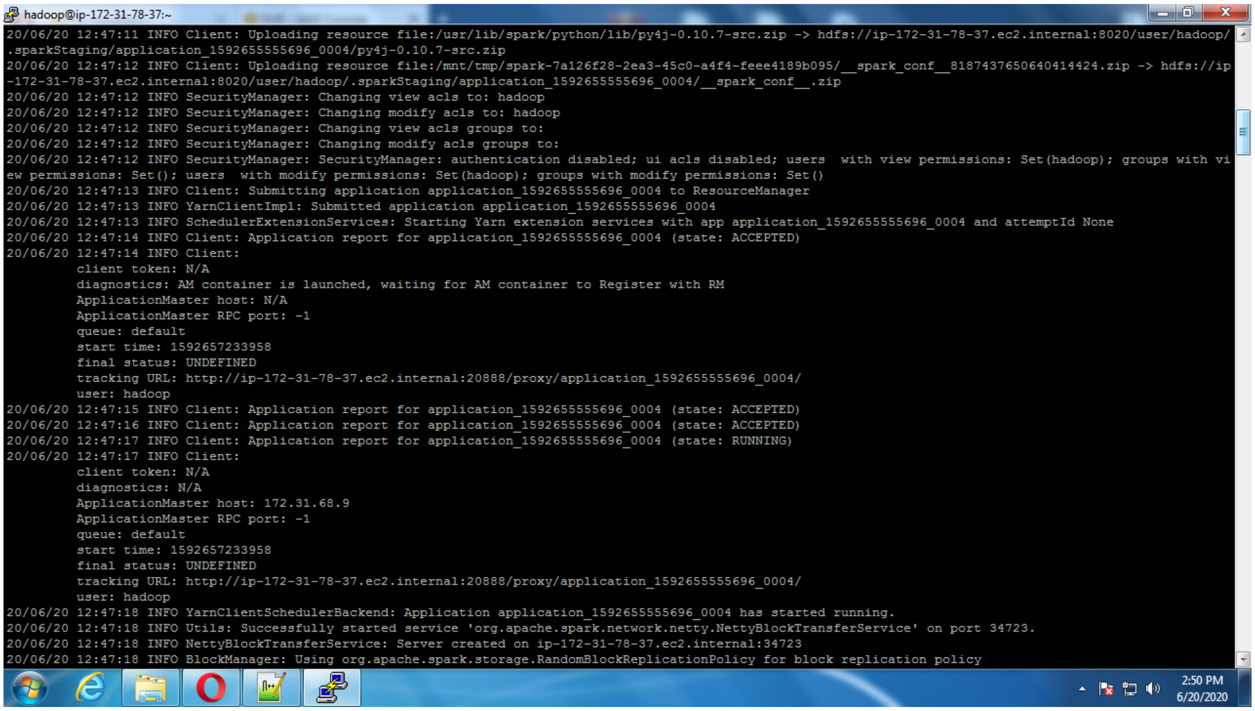
5. Spark used commands and their output

I choose the python do these, I have included the commands in the code part, they are inside the python file, better than running them one by one.



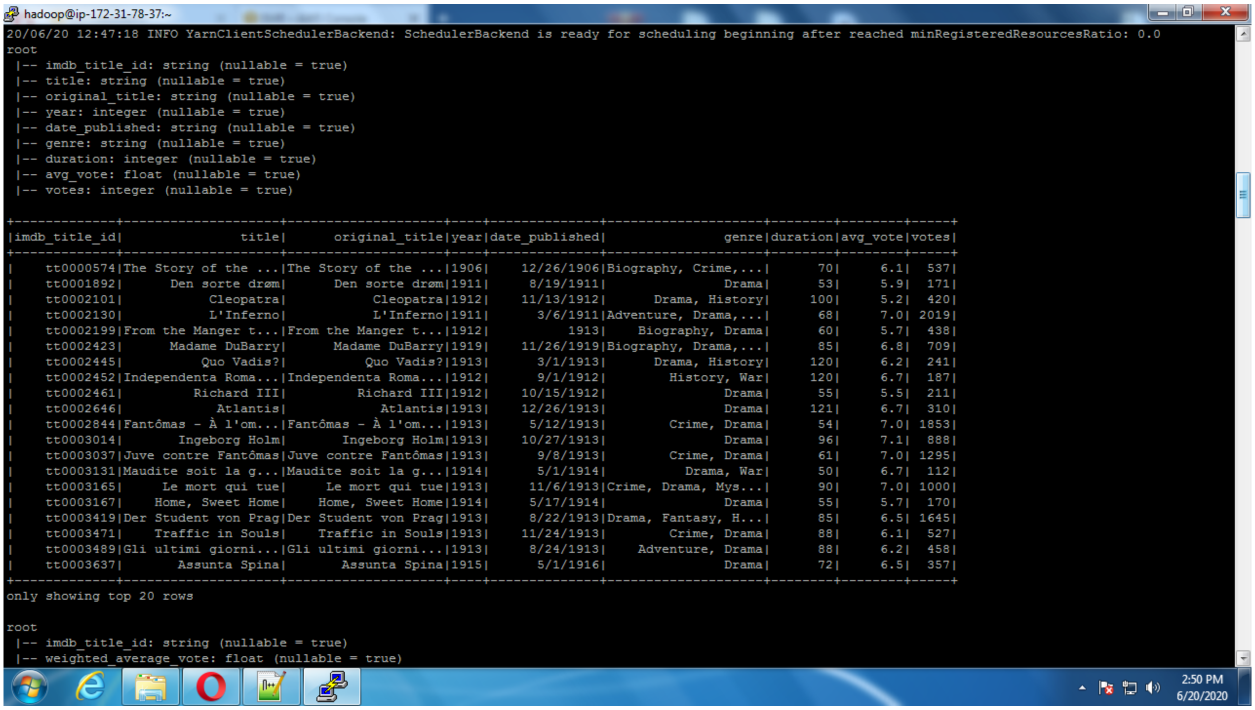
```
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -copyFromLocal movies.csv /Spark_APP/input
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -copyFromLocal ratings.csv /Spark_APP/input
[hadoop@ip-172-31-78-37 ~]$ hadoop fs -ls /Spark_APP/input
Found 2 items
-rw-r--r--   1 hadoop hadoop    7164705 2020-06-20 12:46 /Spark_APP/input/movies.csv
-rw-r--r--   1 hadoop hadoop    2957926 2020-06-20 12:46 /Spark_APP/input/ratings.csv
[hadoop@ip-172-31-78-37 ~]$
[hadoop@ip-172-31-78-37 ~]$
[hadoop@ip-172-31-78-37 ~]$
[hadoop@ip-172-31-78-37 ~]$
[hadoop@ip-172-31-78-37 ~]$
[hadoop@ip-172-31-78-37 ~]$ spark-submit IBDM_movies.py /Spark_APP/input/movies.csv /Spark_APP/input/ratings.csv
20/06/20 12:47:07 INFO SparkContext: Running Spark version 2.4.5-amzn-0
20/06/20 12:47:07 INFO SparkContext: Submitted application: IBDM_movies.py
20/06/20 12:47:07 INFO SecurityManager: Changing view acls to: hadoop
20/06/20 12:47:07 INFO SecurityManager: Changing modify acls to: hadoop
20/06/20 12:47:07 INFO SecurityManager: Changing view acls groups to:
20/06/20 12:47:07 INFO SecurityManager: Changing modify acls groups to:
20/06/20 12:47:07 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users  with view permissions: Set(hadoop); groups with vi
ew permissions: Set(); users  with modify permissions: Set(hadoop); groups with modify permissions: Set()
20/06/20 12:47:07 INFO Utils: Successfully started service 'sparkDriver' on port 40693.
20/06/20 12:47:08 INFO SparkEnv: Registering MapOutputTracker
20/06/20 12:47:08 INFO SparkEnv: Registering BlockManagerMaster
20/06/20 12:47:08 INFO BlockManagerMasterEndpoint: Using org.apache.spark.storage.DefaultTopologyMapper for getting topology information
20/06/20 12:47:08 INFO BlockManagerMasterEndpoint: BlockManagerMasterEndpoint up
20/06/20 12:47:08 INFO DiskBlockManager: Created local directory at /mnt/tmp/blockmgr-b7e361e6-5847-484c-957f-5281419333e8
20/06/20 12:47:08 INFO MemoryStore: MemoryStore started with capacity 1028.8 MB
20/06/20 12:47:08 INFO SparkEnv: Registering OutputCommitCoordinator
20/06/20 12:47:08 INFO Utils: Successfully started service 'SparkUI' on port 4040.
20/06/20 12:47:08 INFO SparkUI: Bound SparkUI to 0.0.0.0, and started at http://ip-172-31-78-37.ec2.internal:4040
20/06/20 12:47:08 INFO Utils: Using initial executors = 50, max of spark.dynamicAllocation.initialExecutors, spark.dynamicAllocation.minExecutors and spark.e
xecutor.instances
20/06/20 12:47:09 INFO RMProxy: Connecting to ResourceManager at ip-172-31-78-37.ec2.internal/172.31.78.37:8032
20/06/20 12:47:09 INFO Client: Requesting a new application from cluster with 2 NodeManagers
20/06/20 12:47:09 INFO Client: Verifying our application has not requested more than the maximum memory capability of the cluster (12288 MB per container)
20/06/20 12:47:09 INFO Client: Will allocate AM container, with 896 MB memory including 384 MB overhead
20/06/20 12:47:09 INFO Client: Setting up container launch context for our AM
20/06/20 12:47:09 INFO Client: Setting up the launch environment for our AM container
20/06/20 12:47:09 INFO Client: Preparing resources for our AM container
20/06/20 12:47:09 WARN Client: Neither spark.yarn.jars nor spark.yarn.archive is set, falling back to uploading libraries under SPARK_HOME.
```

Due to the fact that there are like 60.000 + records to millions, I decided to use the ".show(10)" records or each, then the results, with full selections are saved automatically in CSV files according to their records.



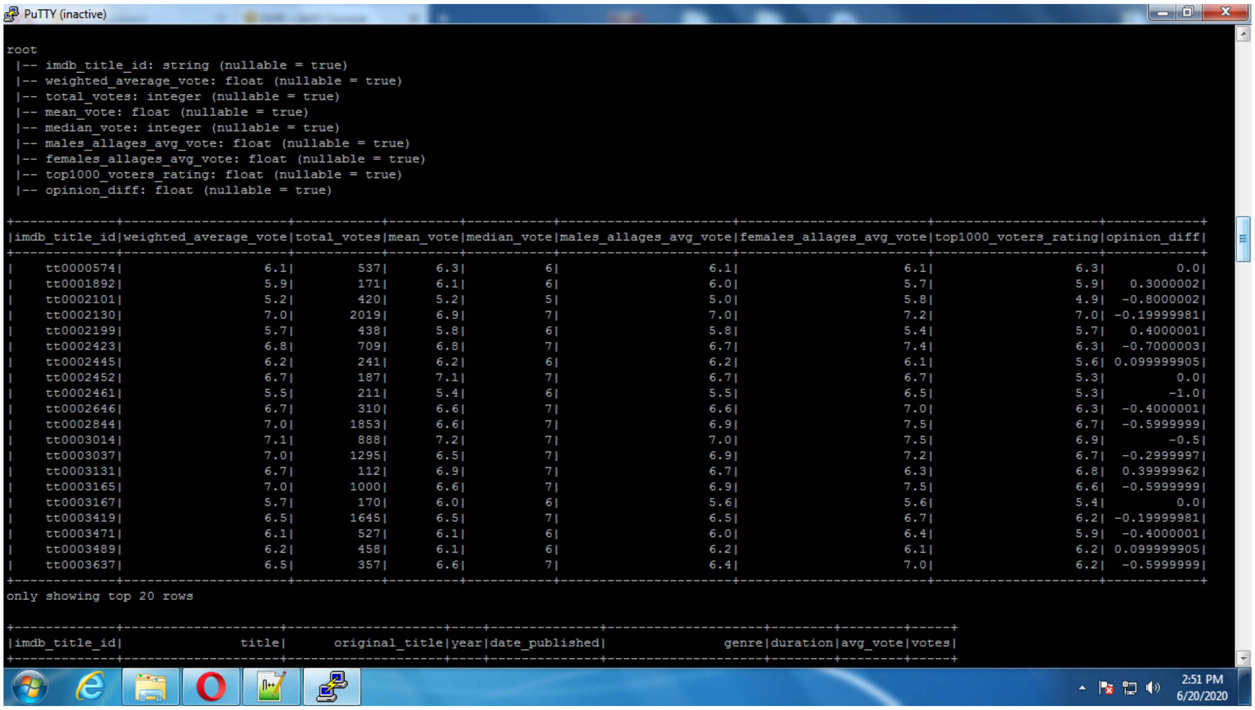
```
20/06/20 12:47:11 INFO Client: Uploading resource file:/usr/lib/spark/python/lib/py4j-0.10.7-src.zip -> hdfs://ip-172-31-78-37.ec2.internal:8020/user/hadoop/
.sparkStaging/application_1592655555696_0004/py4j-0.10.7-src.zip
20/06/20 12:47:12 INFO Client: Uploading resource file:/mnt/tmp/spark-7a126f28-2ea3-45c0-a4f4-feee4189b095/__spark_conf__8187437650640414424.zip -> hdfs://ip
-172-31-78-37.ec2.internal:8020/user/hadoop/.sparkStaging/application_1592655555696_0004/__spark_conf__.zip
20/06/20 12:47:12 INFO SecurityManager: Changing view acls to: hadoop
20/06/20 12:47:12 INFO SecurityManager: Changing modify acls to: hadoop
20/06/20 12:47:12 INFO SecurityManager: Changing view acls groups to:
20/06/20 12:47:12 INFO SecurityManager: Changing modify acls groups to:
20/06/20 12:47:12 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users  with view permissions: Set(hadoop); groups with vi
ew permissions: Set(); users  with modify permissions: Set(hadoop); groups with modify permissions: Set()
20/06/20 12:47:13 INFO Client: Submitting application application_1592655555696_0004 to ResourceManager
20/06/20 12:47:13 INFO YarnClientImpl: Submitted application application_1592655555696_0004
20/06/20 12:47:13 INFO SchedulerExtensionServices: Starting Yarn extension services with app application_1592655555696_0004 and attemptId None
20/06/20 12:47:14 INFO Client: Application report for application_1592655555696_0004 (state: ACCEPTED)
20/06/20 12:47:14 INFO Client:
         client token: N/A
         diagnostics: AM container is launched, waiting for AM container to Register with RM
         ApplicationMaster host: N/A
         ApplicationMaster RPC port: -1
         queue: default
         start time: 1592657233958
         final status: UNDEFINED
         tracking URL: http://ip-172-31-78-37.ec2.internal:20888/proxy/application_1592655555696_0004/
         user: hadoop
20/06/20 12:47:15 INFO Client: Application report for application_1592655555696_0004 (state: ACCEPTED)
20/06/20 12:47:16 INFO Client: Application report for application_1592655555696_0004 (state: ACCEPTED)
20/06/20 12:47:17 INFO Client: Application report for application_1592655555696_0004 (state: RUNNING)
20/06/20 12:47:17 INFO Client:
         client token: N/A
         diagnostics: N/A
         ApplicationMaster host: 172.31.68.9
         ApplicationMaster RPC port: -1
         queue: default
         start time: 1592657233958
         final status: UNDEFINED
         tracking URL: http://ip-172-31-78-37.ec2.internal:20888/proxy/application_1592655555696_0004/
         user: hadoop
20/06/20 12:47:18 INFO YarnClientSchedulerBackend: Application application_1592655555696_0004 has started running.
20/06/20 12:47:18 INFO Utils: Successfully started service 'org.apache.spark.network.netty.NettyBlockTransferService' on port 34723.
20/06/20 12:47:18 INFO NettyBlockTransferService: Server created on ip-172-31-78-37.ec2.internal:34723
20/06/20 12:47:18 INFO BlockManager: Using org.apache.spark.storage.RandomBlockReplicationPolicy for block replication policy
```

Tables and structures, the movies table,



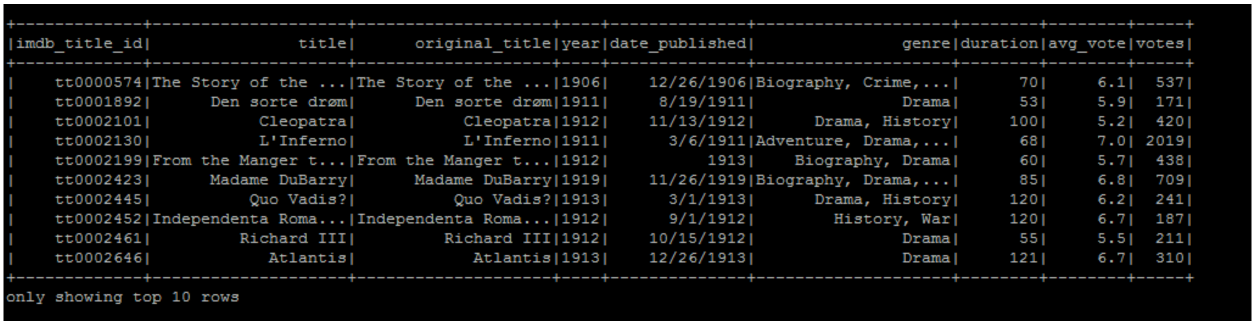
```
20/06/20 12:47:18 INFO YarnClientSchedulerBackend: SchedulerBackend is ready for scheduling beginning after reached minRegisteredResourcesRatio: 0.0
root
 |-- imdb_title_id: string (nullable = true)
 |-- title: string (nullable = true)
 |-- original_title: string (nullable = true)
 |-- year: integer (nullable = true)
 |-- date_published: string (nullable = true)
 |-- genre: string (nullable = true)
 |-- duration: integer (nullable = true)
 |-- avg_vote: float (nullable = true)
 |-- votes: integer (nullable = true)

+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
|imdb_title_id|               title|      original_title|year|date_published|               genre|duration|avg_vote|votes|
+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
|    tt0000574|The Story of the ...|The Story of the ...|1906|    12/26/1906|Biography, Crime,...|      70|     6.1|  537|
|    tt0001892|      Den sorte drøm|      Den sorte drøm|1911|     8/19/1911|               Drama|      53|     5.9|  171|
|    tt0002101|           Cleopatra|           Cleopatra|1912|    11/13/1912|      Drama, History|     100|     5.2|  420|
|    tt0002130|           L'Inferno|           L'Inferno|1911|      3/6/1911|Adventure, Drama,...|      68|     7.0| 2019|
|    tt0002199|From the Manger t...|From the Manger t...|1912|          1913|    Biography, Drama|      60|     5.7|  438|
|    tt0002423|      Madame DuBarry|      Madame DuBarry|1919|    11/26/1919|Biography, Drama,...|      85|     6.8|  709|
|    tt0002445|          Quo Vadis?|          Quo Vadis?|1913|      3/1/1913|      Drama, History|     120|     6.2|  241|
|    tt0002452|Independenta Roma...|Independenta Roma...|1912|      9/1/1912|        History, War|     120|     6.7|  187|
|    tt0002461|         Richard III|         Richard III|1912|    10/15/1912|               Drama|      55|     5.5|  211|
|    tt0002646|            Atlantis|            Atlantis|1913|    12/26/1913|               Drama|     121|     6.7|  310|
|    tt0002844|Fantômas - À l'om...|Fantômas - À l'om...|1913|     5/12/1913|        Crime, Drama|      54|     7.0| 1853|
|    tt0003014|       Ingeborg Holm|       Ingeborg Holm|1913|    10/27/1913|               Drama|      96|     7.1|  888|
|    tt0003037|Juve contre Fantômas|Juve contre Fantômas|1913|      9/8/1913|        Crime, Drama|      61|     7.0| 1295|
|    tt0003131|Maudite soit la g...|Maudite soit la g...|1914|      5/1/1914|          Drama, War|      50|     6.7|  112|
|    tt0003165|     Le mort qui tue|     Le mort qui tue|1913|     11/6/1913|Crime, Drama, Mys...|      90|     7.0| 1000|
|    tt0003167|    Home, Sweet Home|    Home, Sweet Home|1914|     5/17/1914|               Drama|      55|     5.7|  170|
|    tt0003419|Der Student von Prag|Der Student von Prag|1913|     8/22/1913|Drama, Fantasy, H...|      85|     6.5| 1645|
|    tt0003471|    Traffic in Souls|    Traffic in Souls|1913|    11/24/1913|        Crime, Drama|      88|     6.1|  527|
|    tt0003489|Gli ultimi giorni...|Gli ultimi giorni...|1913|     8/24/1913|    Adventure, Drama|      88|     6.2|  458|
|    tt0003637|       Assunta Spina|       Assunta Spina|1915|      5/1/1916|               Drama|      72|     6.5|  357|
+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
only showing top 20 rows

root
 |-- imdb_title_id: string (nullable = true)
 |-- weighted_average_vote: float (nullable = true)
```

The ratings table, there will be added also an ‘opinion_diff’ column which will be the total male and female opinion difference about a certain movie.

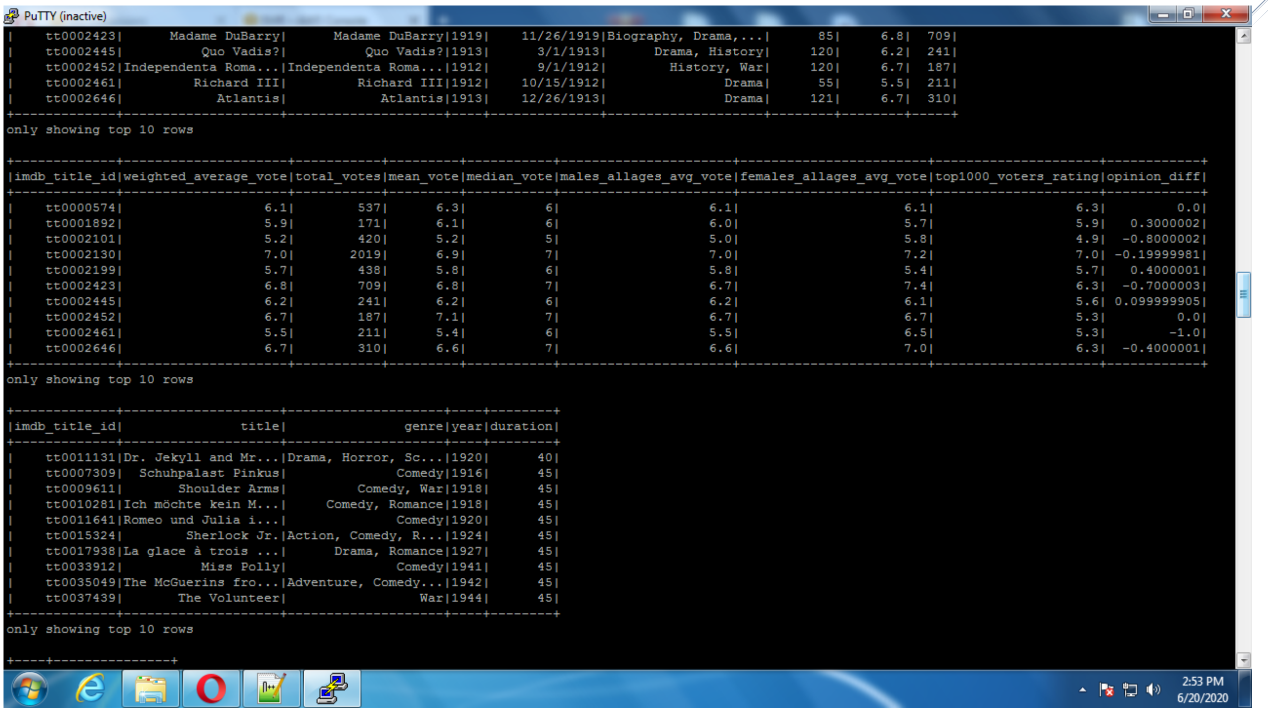


```
root
 |-- imdb_title_id: string (nullable = true)
 |-- weighted_average_vote: float (nullable = true)
 |-- total_votes: integer (nullable = true)
 |-- mean_vote: float (nullable = true)
 |-- median_vote: integer (nullable = true)
 |-- males_allages_avg_vote: float (nullable = true)
 |-- females_allages_avg_vote: float (nullable = true)
 |-- top1000_voters_rating: float (nullable = true)
 |-- opinion_diff: float (nullable = true)

+-------------+---------------------+-----------+---------+-----------+----------------------+------------------------+---------------------+------------+
|imdb_title_id|weighted_average_vote|total_votes|mean_vote|median_vote|males_allages_avg_vote|females_allages_avg_vote|top1000_voters_rating|opinion_diff|
+-------------+---------------------+-----------+---------+-----------+----------------------+------------------------+---------------------+------------+
|    tt0000574|                  6.1|        537|      6.3|          6|                   6.1|                     6.1|                  6.3|         0.0|
|    tt0001892|                  5.9|        171|      6.1|          6|                   6.0|                     5.7|                  5.9|   0.3000002|
|    tt0002101|                  5.2|        420|      5.2|          5|                   5.0|                     5.8|                  4.9|  -0.8000002|
|    tt0002130|                  7.0|       2019|      6.9|          7|                   7.0|                     7.2|                  7.0| -0.19999981|
|    tt0002199|                  5.7|        438|      5.8|          6|                   5.8|                     5.4|                  5.7|   0.4000001|
|    tt0002423|                  6.8|        709|      6.8|          7|                   6.7|                     7.4|                  6.3|  -0.7000003|
|    tt0002445|                  6.2|        241|      6.2|          6|                   6.2|                     6.1|                  5.6| 0.099999905|
|    tt0002452|                  6.7|        187|      7.1|          7|                   6.7|                     6.7|                  5.3|         0.0|
|    tt0002461|                  5.5|        211|      5.4|          6|                   5.5|                     6.5|                  5.3|        -1.0|
|    tt0002646|                  6.7|        310|      6.6|          7|                   6.6|                     7.0|                  6.3|  -0.4000001|
|    tt0002844|                  7.0|       1853|      6.6|          7|                   6.9|                     7.5|                  6.7|  -0.5999999|
|    tt0003014|                  7.1|        888|      7.2|          7|                   7.0|                     7.5|                  6.9|        -0.5|
|    tt0003037|                  7.0|       1295|      6.5|          7|                   6.9|                     7.2|                  6.7|  -0.2999997|
|    tt0003131|                  6.7|        112|      6.9|          7|                   6.7|                     6.3|                  6.8|  0.39999962|
|    tt0003165|                  7.0|       1000|      6.6|          7|                   6.9|                     7.5|                  6.6|  -0.5999999|
|    tt0003167|                  5.7|        170|      6.0|          6|                   5.6|                     5.6|                  5.4|         0.0|
|    tt0003419|                  6.5|       1645|      6.5|          7|                   6.5|                     6.7|                  6.2| -0.19999981|
|    tt0003471|                  6.1|        527|      6.1|          6|                   6.0|                     6.4|                  5.9|  -0.4000001|
|    tt0003489|                  6.2|        458|      6.1|          6|                   6.2|                     6.1|                  6.2| 0.099999905|
|    tt0003637|                  6.5|        357|      6.6|          7|                   6.4|                     7.0|                  6.2|  -0.5999999|
+-------------+---------------------+-----------+---------+-----------+----------------------+------------------------+---------------------+------------+
only showing top 20 rows

+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
|imdb_title_id|               title|      original_title|year|date_published|               genre|duration|avg_vote|votes|
+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
```

Simple select on movies,

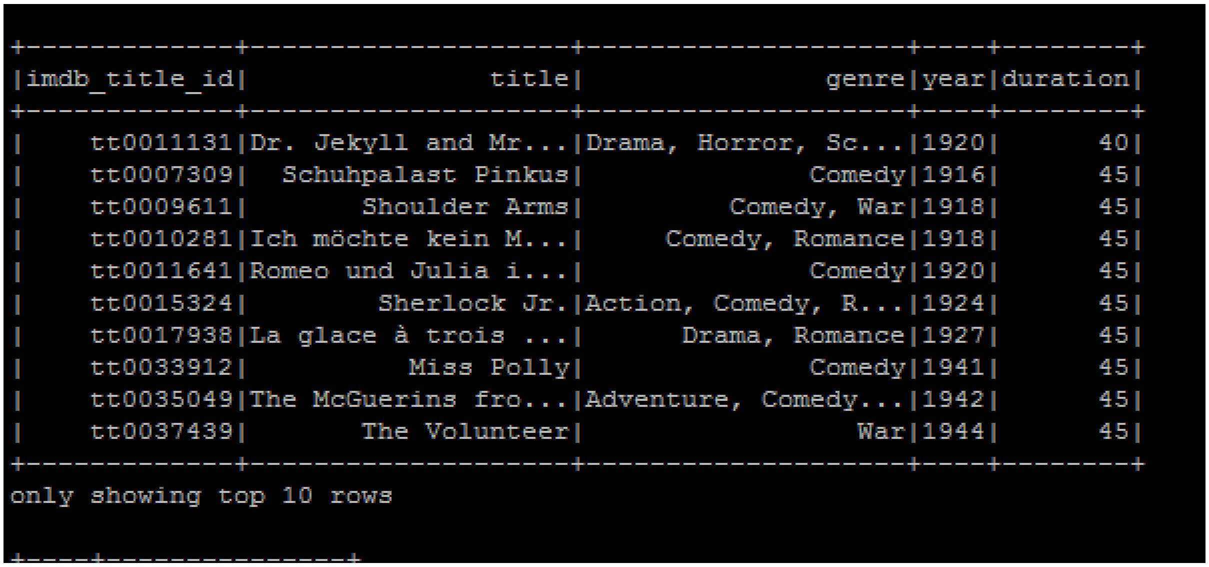


```
+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
|imdb_title_id|               title|      original_title|year|date_published|               genre|duration|avg_vote|votes|
+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
|    tt0000574|The Story of the ...|The Story of the ...|1906|    12/26/1906|Biography, Crime,...|      70|     6.1|  537|
|    tt0001892|      Den sorte drøm|      Den sorte drøm|1911|     8/19/1911|               Drama|      53|     5.9|  171|
|    tt0002101|           Cleopatra|           Cleopatra|1912|    11/13/1912|      Drama, History|     100|     5.2|  420|
|    tt0002130|           L'Inferno|           L'Inferno|1911|      3/6/1911|Adventure, Drama,...|      68|     7.0| 2019|
|    tt0002199|From the Manger t...|From the Manger t...|1912|          1913|    Biography, Drama|      60|     5.7|  438|
|    tt0002423|      Madame DuBarry|      Madame DuBarry|1919|    11/26/1919|Biography, Drama,...|      85|     6.8|  709|
|    tt0002445|          Quo Vadis?|          Quo Vadis?|1913|      3/1/1913|      Drama, History|     120|     6.2|  241|
|    tt0002452|Independenta Roma...|Independenta Roma...|1912|      9/1/1912|        History, War|     120|     6.7|  187|
|    tt0002461|         Richard III|         Richard III|1912|    10/15/1912|               Drama|      55|     5.5|  211|
|    tt0002646|            Atlantis|            Atlantis|1913|    12/26/1913|               Drama|     121|     6.7|  310|
+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
only showing top 10 rows
```



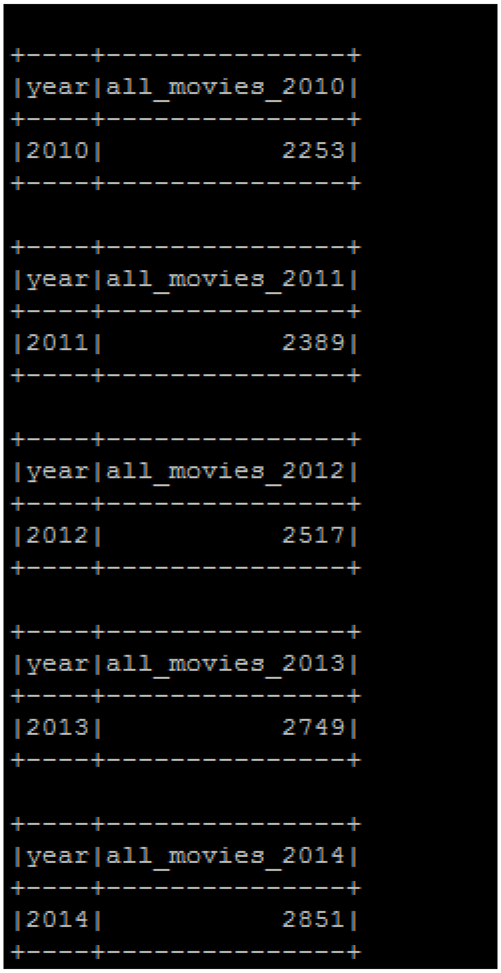
```
|    tt0002423|      Madame DuBarry|      Madame DuBarry|1919|    11/26/1919|Biography, Drama,...|      85|     6.8|  709|
|    tt0002445|          Quo Vadis?|          Quo Vadis?|1913|      3/1/1913|     Drama, History|     120|     6.2|  241|
|    tt0002452|Independenta Roma...|Independenta Roma...|1912|      9/1/1912|        History, War|     120|     6.7|  187|
|    tt0002461|         Richard III|         Richard III|1912|    10/15/1912|               Drama|      55|     5.5|  211|
|    tt0002646|            Atlantis|            Atlantis|1913|    12/26/1913|               Drama|     121|     6.7|  310|
+-------------+--------------------+--------------------+----+--------------+--------------------+--------+--------+-----+
only showing top 10 rows

+-------------+---------------------+-----------+---------+-----------+----------------------+------------------------+---------------------+------------+
|imdb_title_id|weighted_average_vote|total_votes|mean_vote|median_vote|males_allages_avg_vote|females_allages_avg_vote|top1000_voters_rating|opinion_diff|
+-------------+---------------------+-----------+---------+-----------+----------------------+------------------------+---------------------+------------+
|    tt0000574|                  6.1|        537|      6.3|          6|                   6.1|                     6.1|                  6.3|         0.0|
|    tt0001892|                  5.9|        171|      6.1|          6|                   6.0|                     5.7|                  5.9|   0.3000002|
|    tt0002101|                  5.2|        420|      5.2|          5|                   5.0|                     5.8|                  4.9|  -0.8000002|
|    tt0002130|                  7.0|       2019|      6.9|          7|                   7.0|                     7.2|                  7.0| -0.19999981|
|    tt0002199|                  5.7|        438|      5.8|          6|                   5.8|                     5.4|                  5.7|   0.4000001|
|    tt0002423|                  6.8|        709|      6.8|          7|                   6.7|                     7.4|                  6.3|  -0.7000003|
|    tt0002445|                  6.2|        241|      6.2|          6|                   6.2|                     6.1|                  5.6| 0.099999905|
|    tt0002452|                  6.7|        187|      7.1|          7|                   6.7|                     6.7|                  5.3|         0.0|
|    tt0002461|                  5.5|        211|      5.4|          6|                   5.5|                     6.5|                  5.3|        -1.0|
|    tt0002646|                  6.7|        310|      6.6|          7|                   6.6|                     7.0|                  6.3|  -0.4000001|
+-------------+---------------------+-----------+---------+-----------+----------------------+------------------------+---------------------+------------+
only showing top 10 rows

+-------------+--------------------+--------------------+----+--------+
|imdb_title_id|               title|               genre|year|duration|
+-------------+--------------------+--------------------+----+--------+
|    tt0011131|Dr. Jekyll and Mr...|Drama, Horror, Sc...|1920|      40|
|    tt0007309|  Schuhpalast Pinkus|              Comedy|1916|      45|
|    tt0009611|       Shoulder Arms|         Comedy, War|1918|      45|
|    tt0010281|Ich möchte kein M...|     Comedy, Romance|1918|      45|
|    tt0011641|Romeo und Julia i...|              Comedy|1920|      45|
|    tt0015324|        Sherlock Jr.|Action, Comedy, R...|1924|      45|
|    tt0017938|La glace à trois ...|      Drama, Romance|1927|      45|
|    tt0033912|          Miss Polly|              Comedy|1941|      45|
|    tt0035049|The McGuerins fro...|Adventure, Comedy...|1942|      45|
|    tt0037439|       The Volunteer|                 War|1944|      45|
+-------------+--------------------+--------------------+----+--------+
only showing top 10 rows

+----+---------------+
```

An sorted selection, according to the duration of first 10 rows

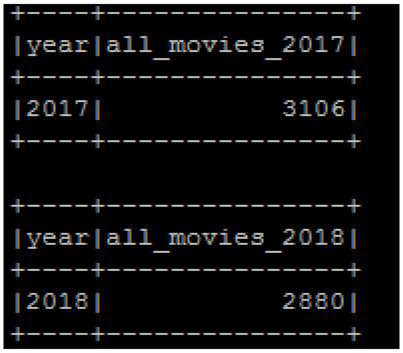


```
+-------------+--------------------+--------------------+----+--------+
|imdb_title_id|               title|               genre|year|duration|
+-------------+--------------------+--------------------+----+--------+
|    tt0011131|Dr. Jekyll and Mr...|Drama, Horror, Sc...|1920|      40|
|    tt0007309|  Schuhpalast Pinkus|              Comedy|1916|      45|
|    tt0009611|       Shoulder Arms|         Comedy, War|1918|      45|
|    tt0010281|Ich möchte kein M...|     Comedy, Romance|1918|      45|
|    tt0011641|Romeo und Julia i...|              Comedy|1920|      45|
|    tt0015324|        Sherlock Jr.|Action, Comedy, R...|1924|      45|
|    tt0017938|La glace à trois ...|      Drama, Romance|1927|      45|
|    tt0033912|          Miss Polly|              Comedy|1941|      45|
|    tt0035049|The McGuerins fro...|Adventure, Comedy...|1942|      45|
|    tt0037439|       The Volunteer|                 War|1944|      45|
+-------------+--------------------+--------------------+----+--------+
only showing top 10 rows

+----+---------------+
```

Movies over the years,

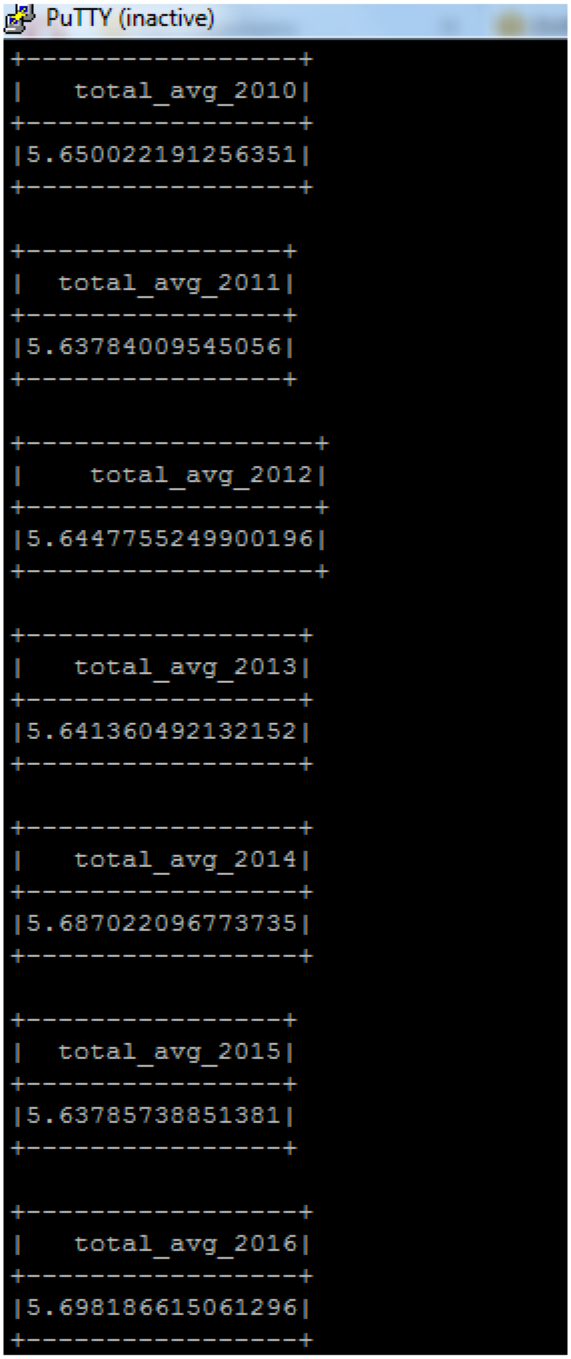


```
+----+---------------+
|year|all_movies_2010|
+----+---------------+
|2010|           2253|
+----+---------------+

+----+---------------+
|year|all_movies_2011|
+----+---------------+
|2011|           2389|
+----+---------------+

+----+---------------+
|year|all_movies_2012|
+----+---------------+
|2012|           2517|
+----+---------------+

+----+---------------+
|year|all_movies_2013|
+----+---------------+
|2013|           2749|
+----+---------------+

+----+---------------+
|year|all_movies_2014|
+----+---------------+
|2014|           2851|
+----+---------------+
```

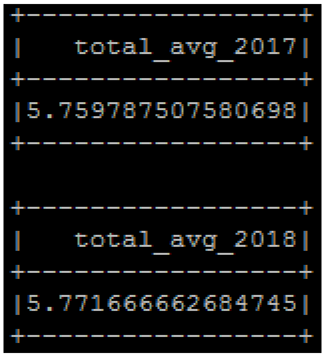


```
+----+---------------+
|year|all_movies_2017|
+----+---------------+
|2017|           3106|
+----+---------------+

+----+---------------+
|year|all_movies_2018|
+----+---------------+
|2018|           2880|
+----+---------------+
```

Average rating for movies over the years 2010-2018

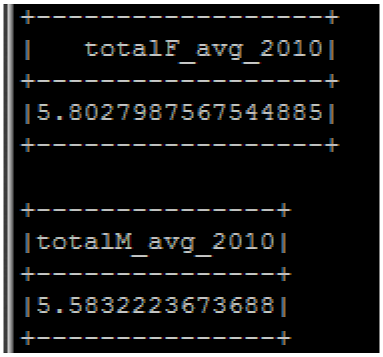


```
+-----------------+
|   total_avg_2010|
+-----------------+
|5.650022191256351|
+-----------------+

+----------------+
|  total_avg_2011|
+----------------+
|5.63784009545056|
+----------------+

+------------------+
|    total_avg_2012|
+------------------+
|5.6447755249900196|
+------------------+

+-----------------+
|   total_avg_2013|
+-----------------+
|5.641360492132152|
+-----------------+

+-----------------+
|   total_avg_2014|
+-----------------+
|5.687022096773735|
+-----------------+

+----------------+
|  total_avg_2015|
+----------------+
|5.63785738851381|
+----------------+

+-----------------+
|   total_avg_2016|
+-----------------+
|5.698186615061296|
+-----------------+
```

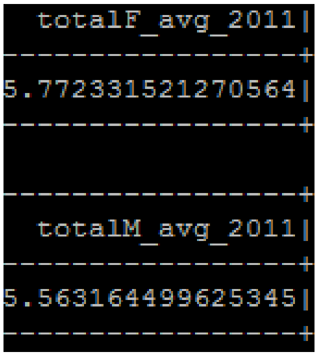


```
+-----------------+
|   total_avg_2017|
+-----------------+
|5.759787507580698|
+-----------------+

+-----------------+
|   total_avg_2018|
+-----------------+
|5.771666662684745|
+-----------------+
```

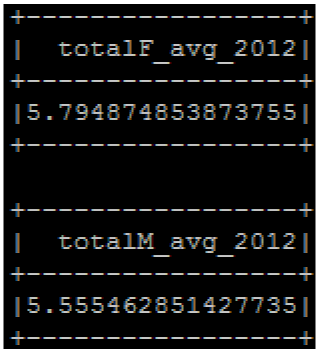
Average ratings for booth males and females, for years 2010 – 2018,



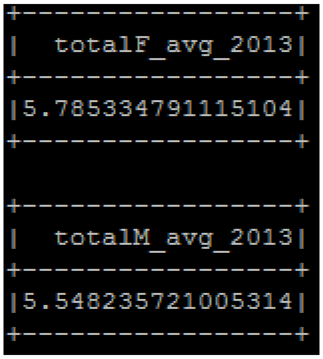
```
+-----------------+
|   totalF_avg_2010|
+-----------------+
|5.802798756754488 5|
+-----------------+

+---------------+
|totalM_avg_2010|
+---------------+
|5.5832223673688|
+---------------+
```



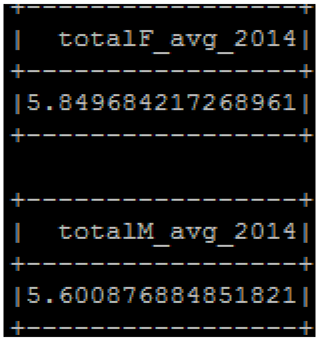
```
  totalF_avg_2011|
-----------------+
5.772331521270564|
-----------------+

-----------------+
  totalM_avg_2011|
-----------------+
5.563164499625345|
-----------------+
```



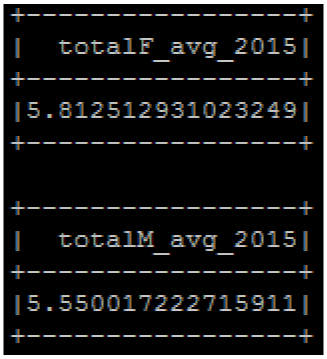
```
+-----------------+
|  totalF_avg_2012|
+-----------------+
|5.794874853873755|
+-----------------+

+-----------------+
|  totalM_avg_2012|
+-----------------+
|5.555462851427735|
+-----------------+
```



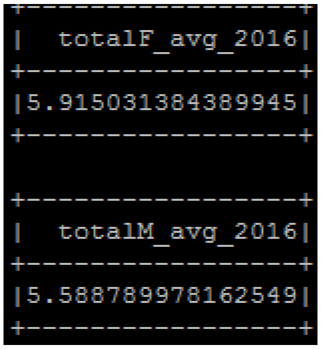
```
+-----------------+
|  totalF_avg_2013|
+-----------------+
|5.785334791115104|
+-----------------+

+-----------------+
|  totalM_avg_2013|
+-----------------+
|5.548235721005314|
+-----------------+
```



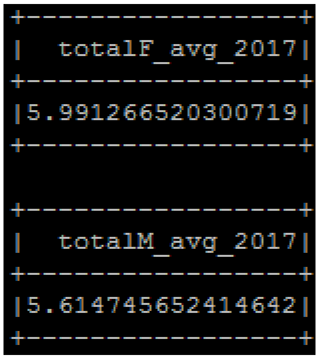
```
+-----------------+
|  totalF_avg_2014|
+-----------------+
|5.849684217268961|
+-----------------+

+-----------------+
|  totalM_avg_2014|
+-----------------+
|5.600876884851821|
+-----------------+
```



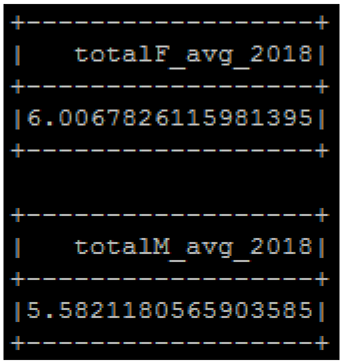
```
+-----------------+
|  totalF_avg_2015|
+-----------------+
|5.812512931023249|
+-----------------+

+-----------------+
|  totalM_avg_2015|
+-----------------+
|5.550017222715911|
+-----------------+
```



```
+-----------------+
|  totalF_avg_2016|
+-----------------+
|5.915031384389945|
+-----------------+

+-----------------+
|  totalM_avg_2016|
+-----------------+
|5.588789978162549|
+-----------------+
```

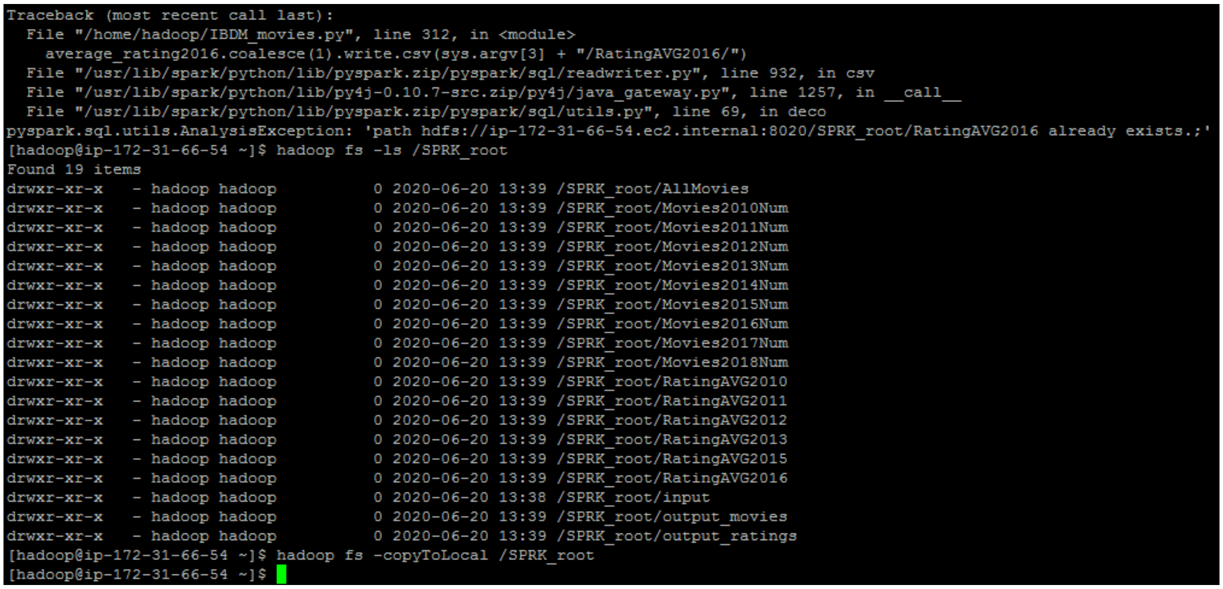


```
+-----------------+
|  totalF_avg_2017|
+-----------------+
|5.991266520300719|
+-----------------+

+-----------------+
|  totalM_avg_2017|
+-----------------+
|5.614745652414642|
+-----------------+
```



```
+------------------+
|   totalF_avg_2018|
+------------------+
|6.0067826115981395|
+------------------+

+------------------+
|   totalM_avg_2018|
+------------------+
|5.5821180565903585|
+------------------+
```

Some data folders,



```
Traceback (most recent call last):
  File "/home/hadoop/IBDM_movies.py", line 312, in <module>
    average_rating2016.coalesce(1).write.csv(sys.argv[3] + "/RatingAVG2016/")
  File "/usr/lib/spark/python/lib/pyspark.zip/pyspark/sql/readwriter.py", line 932, in csv
  File "/usr/lib/spark/python/lib/py4j-0.10.7-src.zip/py4j/java_gateway.py", line 1257, in __call__
  File "/usr/lib/spark/python/lib/pyspark.zip/pyspark/sql/utils.py", line 69, in deco
pyspark.sql.utils.AnalysisException: 'path hdfs://ip-172-31-66-54.ec2.internal:8020/SPRK_root/RatingAVG2016 already exists.;'
[hadoop@ip-172-31-66-54 ~]$ hadoop fs -ls /SPRK_root
Found 19 items
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/AllMovies
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2010Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2011Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2012Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2013Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2014Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2015Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2016Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2017Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/Movies2018Num
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/RatingAVG2010
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/RatingAVG2011
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/RatingAVG2012
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/RatingAVG2013
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/RatingAVG2015
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/RatingAVG2016
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:38 /SPRK_root/input
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/output_movies
drwxr-xr-x   - hadoop hadoop          0 2020-06-20 13:39 /SPRK_root/output_ratings
[hadoop@ip-172-31-66-54 ~]$ hadoop fs -copyToLocal /SPRK_root
[hadoop@ip-172-31-66-54 ~]$
```