ICT707 Task 3 - Part 1

Instructions

- Follow instructions on 'Google Colab for Task3.doc' for running this notebook:
- 1. Visit and log in to Google Colab site: https://colab.research.google.com/
- 2. Download this notebook from Blackboard and then upload it to Colab
- 3. Run “PySpark Environment Setting” cell to get spark and pySpark installed.
- 4. Type in your NAME and ID in the first coding cell.
- 5. Place the data files on the correct GDrive folder - 'Colab Notebooks'.
- 6. Run the first cell of “Connect GDrive for data set files” to mount GDrive as the storage of data files. Follow the instruction to complete the authorization of using GDrive.
- 7. Run Imports
- 8. Create Spark Session
- 9. Load CSV file and test
- **After you finish, make sure all cells are executed. Go to menu "File->Download .ipynb" to download your work as 2 files: (1) a Jupyter notebook file and (2) a HTML file. And then submit both files to Blackboard.**
- If you see any error related to spark context, please **run the last cell** and then retry. Or reload the notebook and install the PySpark environment.

0 Task 3 Setup

1 PySpark Environment Setting

```
# Please run this cell to get Java and spark installed
!apt-get update
!apt-get install openjdk-8-jdk-headless -qq > /dev/null
!wget -q https://archive.apache.org/dist/spark/spark-2.4.7/spark-2.4.7-bin-hadoop2.7.tgz
!tar xf spark-2.4.7-bin-hadoop2.7.tgz
!pip install pyspark==2.4.7

import os
os.environ["JAVA_HOME"] = "/usr/lib/jvm/java-8-openjdk-amd64"
os.environ["SPARK_HOME"] = "/content/spark-2.4.7-bin-hadoop2.7"
```

```
Get:1 https://cloud.r-project.org/bin/linux/ubuntu bionic-cran40/ InRelease [3,626 B]
Ign:2 https://developer.download.nvidia.com/compute/cuda/repos/ubuntu1804/x86_64  InRele
Ign:3 https://developer.download.nvidia.com/compute/machine-learning/repos/ubuntu1804/x8
Get:4 https://developer.download.nvidia.com/compute/cuda/repos/ubuntu1804/x86_64  Releas
Hit:5 https://developer.download.nvidia.com/compute/machine-learning/repos/ubuntu1804/x8
Get:6 https://developer.download.nvidia.com/compute/cuda/repos/ubuntu1804/x86_64  Releas
Get:7 http://security.ubuntu.com/ubuntu bionic-security InRelease [88.7 kB]
Get:8 http://ppa.launchpad.net/c2d4u.team/c2d4u4.0+/ubuntu bionic InRelease [15.9 kB]
Hit:10 http://archive.ubuntu.com/ubuntu bionic InRelease
Get:11 https://developer.download.nvidia.com/compute/cuda/repos/ubuntu1804/x86_64  Packa
Get:12 http://archive.ubuntu.com/ubuntu bionic-updates InRelease [88.7 kB]
Hit:13 http://ppa.launchpad.net/cran/libgit2/ubuntu bionic InRelease
Hit:14 http://ppa.launchpad.net/deadsnakes/ppa/ubuntu bionic InRelease
Get:15 http://security.ubuntu.com/ubuntu bionic-security/universe amd64 Packages [1,466
Get:16 http://archive.ubuntu.com/ubuntu bionic-backports InRelease [74.6 kB]
Get:17 http://ppa.launchpad.net/graphics-drivers/ppa/ubuntu bionic InRelease [21.3 kB]
Get:18 http://archive.ubuntu.com/ubuntu bionic-updates/main amd64 Packages [2,995 kB]
Get:19 http://ppa.launchpad.net/c2d4u.team/c2d4u4.0+/ubuntu bionic/main Sources [1,825 k
Get:20 http://security.ubuntu.com/ubuntu bionic-security/main amd64 Packages [2,557 kB]
Get:21 http://security.ubuntu.com/ubuntu bionic-security/restricted amd64 Packages [781
Get:22 http://security.ubuntu.com/ubuntu bionic-security/multiverse amd64 Packages [21.1
Get:23 http://archive.ubuntu.com/ubuntu bionic-updates/universe amd64 Packages [2,244 kB
Get:24 http://archive.ubuntu.com/ubuntu bionic-updates/multiverse amd64 Packages [29.1 k
Get:25 http://archive.ubuntu.com/ubuntu bionic-updates/restricted amd64 Packages [815 kB
Get:26 http://ppa.launchpad.net/c2d4u.team/c2d4u4.0+/ubuntu bionic/main amd64 Packages
Get:27 http://ppa.launchpad.net/graphics-drivers/ppa/ubuntu bionic/main amd64 Packages
Fetched 14.9 MB in 8s (1,954 kB/s)
Reading package lists... Done
Collecting pyspark==2.4.7
  Downloading pyspark-2.4.7.tar.gz (217.9 MB)
     |████████████████████████████████| 217.9 MB 55 kB/s
Collecting py4j==0.10.7
  Downloading py4j-0.10.7-py2.py3-none-any.whl (197 kB)
     |████████████████████████████████| 197 kB 72.8 MB/s
Building wheels for collected packages: pyspark
  Building wheel for pyspark (setup.py) ... done
  Created wheel for pyspark: filename=pyspark-2.4.7-py2.py3-none-any.whl size=218279467
  Stored in directory: /root/.cache/pip/wheels/da/28/74/56054e5fe3413c8c58b67e4d7483d486
Successfully built pyspark
Installing collected packages: py4j, pyspark
Successfully installed py4j-0.10.7 pyspark-2.4.7
```

2 Enter your NAME and ID

```
# Please enter your NAME and student ID
NAME = "Aman Babbar"
ID = "1122515"
```

3 Add data file

```
# Make sure you have relevant data files uploaded, replace 'text_file_name.csv' with your csv
# And then use the correct data file names below
datafile_1 = "/content/gdrive/My Drive/Colab Notebooks/rating.csv"
datafile_2 = "/content/gdrive/My Drive/Colab Notebooks/movies.csv"
```

4 Connect GDrive for data set files

```
# Mount the cloud folder for data file storage
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Mounted at /content/gdrive
```

5 Run Imports

```
# Imports utilised
from pyspark.sql import SparkSession
from pyspark.ml.recommendation import ALS
from pyspark.ml.feature import VectorAssembler, StringIndexer
from pyspark.ml.classification import LogisticRegression
from pyspark.ml.evaluation import RegressionEvaluator

import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

6 Create Spark Session

```
# Create Spark Session

sc = SparkSession.builder\
        .master('local[*]') \
        .appName('ICT707_Task3') \
        .getOrCreate()
```

7 Load CSV File

```
# file should display the head() records without errors
# Loading csv file for PySpark and Python 3
data = sc.read.csv(datafile_1, inferSchema = True, header = True)
movie_title = pd.read_csv(datafile_2)
data.head()
```

```
Row(userId=1, movieId=1, rating=4.0, timestamp=964982703)
```

1 Exploratory Data Analysis

• telling its number of rows and columns,

• doing the data cleaning (missing values or duplicated records) if necessary

• selecting 3 columns, and drawing 1 plot (e.g. bar chart, histogram, boxplot, etc.) for each to summarise it

```
# To be able to visualise the data, the dataframe must be transferred to pandas
data_pandas = data.toPandas()
data_pandas.shape
```

```
(100836, 4)
```

1.1 EDA - Description

```
#checking the parameters in the data
data_pandas.head(10)
```

	userId	movieId	rating	timestamp
0	1	1	4.0	964982703
1	1	3	4.0	964981247
2	1	6	4.0	964982224
3	1	47	5.0	964983815
4	1	50	5.0	964982931
5	1	70	3.0	964982400
6	1	101	5.0	964980868
7	1	110	4.0	964982176
8	1	151	5.0	964984041
9	1	157	5.0	964984100

```
#checking unique number of ratings
data_pandas['rating'].unique()
```

```
array([4. , 4.5, 2.5, 3.5, 3. , 5. , 0.5, 2. , 1.5, 1. ])
```

```
movie_title.head()
```

	movieId	title	genres
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy
1	2	Jumanji (1995)	Adventure|Children|Fantasy
2	3	Grumpier Old Men (1995)	Comedy|Romance
3	4	Waiting to Exhale (1995)	Comedy|Drama|Romance
4	5	Father of the Bride Part II (1995)	Comedy

```
# telling its number of rows and columns,
s = data_pandas.shape
print("Rows = ", s[0])
print("Columns = ", s[1])
```

```
Rows =  100836
Columns =  4
```

```
data_pandas= pd.merge(data_pandas,movie_title,on='movieId')
data_pandas.head()
```

	userId	movieId	rating	timestamp	title	ge
0	1	1	4.0	964982703	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fa
1	5	1	4.0	847434962	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fa
2	7	1	4.5	1106635946	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fa
3	15	1	2.5	1510577970	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fa

1.2 EDA - Cleaning

```
# doing the data cleaning (missing values or duplicated records) if necessary
#removing any missing values
data_pandas = data_pandas.dropna()
```

```
#checking for duplicated values
duplicate = data_pandas[data_pandas.duplicated()]
duplicate
```

userId	movieId	rating	timestamp	title	genres

1.3 EDA - Graphs

```
# Lets sort them and see which movie has the highest mean of ratings.
New_data=pd.DataFrame(data_pandas.groupby(by='title')['rating'].mean())
New_data['No. of people Rated']=data_pandas.groupby(by='title')['rating'].count()
New_data = pd.merge(New_data,movie_title,on='title')
New_data = New_data.sort_values(by = 'No. of people Rated', ascending = False)
New_data.head(10)
```

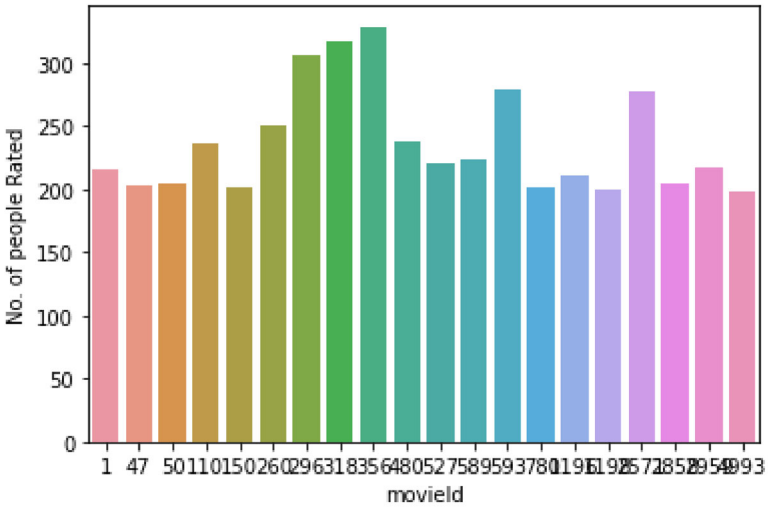
	title	rating	No. of people Rated	movieId	genres
3161	Forrest Gump (1994)	4.164134	329	356	Comedy|Drama|Romance|War
7597	Shawshank Redemption, The (1994)	4.429022	317	318	Crime|Drama
6868	Pulp Fiction (1994)	4.197068	307	296	Comedy|Crime|Drama|Thriller
7684	Silence of the Lambs, The (1991)	4.161290	279	593	Crime|Horror|Thriller
5515	Matrix, The (1999)	4.192446	278	2571	Action|Sci-Fi|Thriller
8005	Star Wars: Episode IV - A New Hope (1977)	4.231076	251	260	Action|Adventure|Sci-Fi
4665	Jurassic Park (1993)	3.750000	238	480	Action|Adventure|Sci-Fi|Thriller

```
#selecting 3 columns, and drawing 1 plot (e.g. bar chart, histogram, boxplot, etc.) for each
# graph 1 scatterplot
sns.scatterplot(x = 'rating', y = 'No. of people Rated', data = New_data)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcf97d104d0>
```

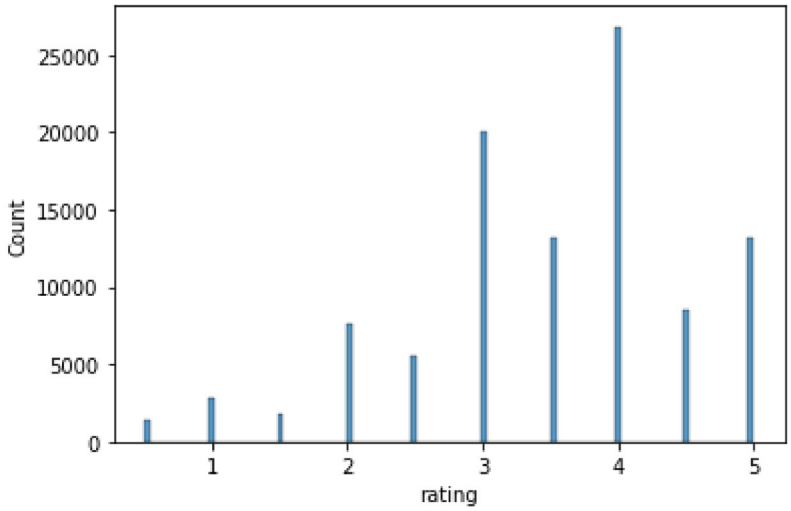

```
# graph 2 bar plot top 10 highest rated movies
nd = New_data.head(20)
sns.barplot(x = 'movieId', y = 'No. of people Rated', data = nd)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcf950c0f90>
```




```
# graph 3 histogram
sns.histplot(data_pandas['rating'])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fcf968dae90>
```



2 Recommendation Engine

This subtask requires you to implement a recommender system on Collaborative filtering with Alternative Least Squares Algorithm.

You need to include

• Model training and predictions

• Model evaluation using MSE

```
# Splitting the data into Training and Test data that is used for both Task I.2 and Task I.3
# hint: training_data, testing_data = data.randomSplit([???,???])
training_data, testing_data = data.randomSplit([0.8, 0.2], 1)
training_data.count()
```

```
80628
```

```
#Recommendation system using Alternative Least Squares Algorithm
# hint: als = ALS(maxIter=??,regParam=??,userCol = "???", itemCol = "???", ratingCol = "???",
# hint: model = als.fit(???)
als = ALS(maxIter=20,regParam=0.05,userCol = "userId", itemCol = "movieId", ratingCol = "rati
model = als.fit(training_data)
```

```
#Evaluate the model using Mean Square Error
# hint: predictions = model.transform(????)
# hint: evaluator = RegressionEvaluator(?????)
# hint: mse = evaluator.evaluate(????)
predictions = model.transform(testing_data)
evaluator = RegressionEvaluator(metricName="mse",labelCol="rating",predictionCol="prediction"
mse = evaluator.evaluate(predictions)
print(mse)
```

```
0.8910080132069791
```

3 Classification

This subtask requires you to implement a classification system with Logistic regression.

You need to include

• Logistic Regression model training

• Model evaluation

```
# Logistic Regression
# hint: assembler = VectorAssembler().setInputCols([???????,????]).setOutputCol(????)
# hint: train_vector = assembler.transform(?????)

assembler = VectorAssembler().setInputCols(["userId","movieId"]).setOutputCol("features")
train_vector = assembler.transform(data)
```

```
indexer = StringIndexer(inputCol="rating", outputCol="label")
indexed = indexer.fit(train_vector).transform(train_vector)
indexed
```

```
DataFrame[userId: int, movieId: int, rating: double, timestamp: int, features: vector, l
```

```
#train test split
training_data, testing_data = indexed.randomSplit([0.8, 0.2], 1)
training_data.count()
```

```
80628
```

```
# Create the Logistic Regression Model and train it
# hint: lr = LogisticRegression()
# hint: lr_model = lr.fit(?????)
lr = LogisticRegression(maxIter=20, regParam=0.05, elasticNetParam=0.8, featuresCol = 'featur
lr_model = lr.fit(training_data)
```

```
# Test the model
# hint: test_vector = assembler.transform(testing)
# hint: test_vector = test_vector.select("features", "label")
# hint: test_vector = lr_model.transform(test_vector)
# hint:
test_vector = lr_model.transform(testing_data)
train_vector = lr_model.transform(training_data)
train_vector.show()
```

```
+------+-------+------+---------+-----------+-----+--------------------+---------------
|userId|movieId|rating|timestamp|   features|label|       rawPrediction|         probabi
+------+-------+------+---------+-----------+-----+--------------------+---------------
|     1|      1|   4.0|964982703|  [1.0,1.0]|  0.0|[1.35919048143069...|[0.265106194767
|     1|      3|   4.0|964981247|  [1.0,3.0]|  0.0|[1.35919048143069...|[0.265106194767
|     1|      6|   4.0|964982224|  [1.0,6.0]|  0.0|[1.35919048143069...|[0.265106194767
|     1|     47|   5.0|964983815| [1.0,47.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|     70|   3.0|964982400| [1.0,70.0]|  1.0|[1.35919048143069...|[0.265106194767
|     1|    101|   5.0|964980868|[1.0,101.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|    110|   4.0|964982176|[1.0,110.0]|  0.0|[1.35919048143069...|[0.265106194767
|     1|    151|   5.0|964984041|[1.0,151.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|    157|   5.0|964984100|[1.0,157.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|    216|   5.0|964981208|[1.0,216.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|    223|   3.0|964980985|[1.0,223.0]|  1.0|[1.35919048143069...|[0.265106194767
|     1|    231|   5.0|964981179|[1.0,231.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|    235|   4.0|964980908|[1.0,235.0]|  0.0|[1.35919048143069...|[0.265106194767
|     1|    260|   5.0|964981680|[1.0,260.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|    296|   3.0|964982967|[1.0,296.0]|  1.0|[1.35919048143069...|[0.265106194767
|     1|    316|   3.0|964982310|[1.0,316.0]|  1.0|[1.35919048143069...|[0.265106194767
|     1|    349|   4.0|964982563|[1.0,349.0]|  0.0|[1.35919048143069...|[0.265106194767
|     1|    362|   5.0|964982588|[1.0,362.0]|  2.0|[1.35919048143069...|[0.265106194767
|     1|    367|   4.0|964981710|[1.0,367.0]|  0.0|[1.35919048143069...|[0.265106194767
|     1|    423|   3.0|964982363|[1.0,423.0]|  1.0|[1.35919048143069...|[0.265106194767
```

```
+------+-------+------+---------+-----------+-----+-------------------+---------------
only showing top 20 rows
```

```
# Model Evaluation using Root Mean Square Error (RMSE)
# hint: rmse_test = evaluator.evaluate(?????, {evaluator.metricName: "rmse"})
# hint: rmse_train = evaluator.evaluate(?????, {evaluator.metricName: "rmse"})
#print("RMSE for Test:",rmse_test)
#print("RMSE for Train:",rmse_train)
rmse_test = evaluator.evaluate(test_vector, {evaluator.metricName: "rmse"})
rmse_train = evaluator.evaluate(train_vector, {evaluator.metricName: "rmse"})
print("RMSE for Test:",rmse_test)
print("RMSE for Train:",rmse_train)
```

```
RMSE for Test: 3.6585933532744397
RMSE for Train: 3.652170190484411
```

Shut down SparkContext when exiting

If you have error messages related to sparkContext, try to run the following cell, and then rerun all cells.

```
sc.stop()
```