Import libraries

```
#https://grouplens.org/datasets/movielens/
```

```
pip install pyspark
```

```
Requirement already satisfied: pyspark in /usr/local/lib/python3.10/dist-packages (3.4.1)
Requirement already satisfied: py4j==0.10.9.7 in /usr/local/lib/python3.10/dist-packages (from pyspark) (0.10.9.7)
```

```
from pyspark import SparkContext
import pandas as pd
from pyspark.sql.functions import col, explode
from pyspark import SparkContext
```

Initiate spark session

```
from pyspark.sql import SparkSession
sc = SparkContext
# sc.setCheckpointDir('checkpoint')
spark = SparkSession.builder.appName('Recommendations').getOrCreate()
```

```
from google.colab import drive
drive.mount('/content/drive')
```

1. Load data

```
movies = spark.read.csv('/content/drive/MyDrive/Colab Notebooks/movies.csv',header=True)
ratings = spark.read.csv("/content/drive/MyDrive/Colab Notebooks/ratings.csv",header=True)
```

```
movies.show()
ratings.show()
```

```
+-------+--------------------+--------------------+
|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|      1|   4.0|964982703|
|     1|      3|   4.0|964981247|
|     1|      6|   4.0|964982224|
|     1|     47|   5.0|964983815|
|     1|     50|   5.0|964982931|
|     1|     70|   3.0|964982400|
|     1|    101|   5.0|964980868|
|     1|    110|   4.0|964982176|
|     1|    151|   5.0|964984041|
|     1|    157|   5.0|964984100|
|     1|    163|   5.0|964983650|
|     1|    216|   5.0|964981208|
```

```
|     1|    223|   3.0|964980985|
|     1|    231|   5.0|964981179|
|     1|    235|   4.0|964980908|
|     1|    260|   5.0|964981680|
|     1|    296|   3.0|964982967|
|     1|    316|   3.0|964982310|
|     1|    333|   5.0|964981179|
|     1|    349|   4.0|964982563|
+------+-------+------+---------+
only showing top 20 rows
```

```
ratings.printSchema()
```

```
root
 |-- userId: string (nullable = true)
 |-- movieId: string (nullable = true)
 |-- rating: string (nullable = true)
 |-- timestamp: string (nullable = true)
```

```
ratings = ratings.\
    withColumn('userId', col('userId').cast('integer')).\
    withColumn('movieId', col('movieId').cast('integer')).\
    withColumn('rating', col('rating').cast('float')).\
    drop('timestamp')
ratings.show()
```

```
+------+-------+------+
|userId|movieId|rating|
+------+-------+------+
|     1|      1|   4.0|
|     1|      3|   4.0|
|     1|      6|   4.0|
|     1|     47|   5.0|
|     1|     50|   5.0|
|     1|     70|   3.0|
|     1|    101|   5.0|
|     1|    110|   4.0|
|     1|    151|   5.0|
|     1|    157|   5.0|
|     1|    163|   5.0|
|     1|    216|   5.0|
|     1|    223|   3.0|
|     1|    231|   5.0|
|     1|    235|   4.0|
|     1|    260|   5.0|
|     1|    296|   3.0|
|     1|    316|   3.0|
|     1|    333|   5.0|
|     1|    349|   4.0|
+------+-------+------+
only showing top 20 rows
```

Calculate sparsity

```
# Count the total number of ratings in the dataset
numerator = ratings.select("rating").count()

# Count the number of distinct userIds and distinct movieIds
num_users = ratings.select("userId").distinct().count()
num_movies = ratings.select("movieId").distinct().count()

# Set the denominator equal to the number of users multiplied by the number of movies
denominator = num_users * num_movies

# Divide the numerator by the denominator
sparsity = (1.0 - (numerator *1.0)/denominator)*100
print("The ratings dataframe is ", "%.2f" % sparsity + "% empty.")
```

```
The ratings dataframe is  98.30% empty.
```

Interpret ratings

```
# Group data by userId, count ratings
userId_ratings = ratings.groupBy("userId").count().orderBy('count', ascending=False)
userId_ratings.show()
```

```
+------+-----+
|userId|count|
+------+-----+
|   414| 2698|
|   599| 2478|
|   474| 2108|
|   448| 1864|
|   274| 1346|
|   610| 1302|
|    68| 1260|
|   380| 1218|
|   606| 1115|
|   288| 1055|
|   249| 1046|
|   387| 1027|
|   182|  977|
|   307|  975|
|   603|  943|
|   298|  939|
|   177|  904|
|   318|  879|
|   232|  862|
|   480|  836|
+------+-----+
only showing top 20 rows
```

```
# Group data by userId, count ratings
movieId_ratings = ratings.groupBy("movieId").count().orderBy('count', ascending=False)
movieId_ratings.show()
```

```
+-------+-----+
|movieId|count|
+-------+-----+
|    356|  329|
|    318|  317|
|    296|  307|
|    593|  279|
|   2571|  278|
|    260|  251|
|    480|  238|
|    110|  237|
|    589|  224|
|    527|  220|
|   2959|  218|
|      1|  215|
|   1196|  211|
|     50|  204|
|   2858|  204|
|     47|  203|
|    780|  202|
|    150|  201|
|   1198|  200|
|   4993|  198|
+-------+-----+
only showing top 20 rows
```

Build Out An ALS Model

```
# Import the required functions
from pyspark.ml.evaluation import RegressionEvaluator
from pyspark.ml.recommendation import ALS
from pyspark.ml.tuning import ParamGridBuilder, CrossValidator
```

```
# Create test and train set
(train, test) = ratings.randomSplit([0.8, 0.2], seed = 1234)

# Create ALS model
als = ALS(userCol="userId", itemCol="movieId", ratingCol="rating", nonnegative = True, implicitPrefs = False, coldStartStrategy="drop")

# Confirm that a model called "als" was created
type(als)
```

```
pyspark.ml.recommendation.ALS
```

Tell Spark how to tune your ALS model

```
# Import the requisite items
from pyspark.ml.evaluation import RegressionEvaluator
```

```
from pyspark.ml.tuning import ParamGridBuilder, CrossValidator

# Add hyperparameters and their respective values to param_grid
param_grid = ParamGridBuilder() \
            .addGrid(als.rank, [10, 50, 100, 150]) \
            .addGrid(als.regParam, [.01, .05, .1, .15]) \
            .build()
            #             .addGrid(als.maxIter, [5, 50, 100, 200]) \


# Define evaluator as RMSE and print length of evaluator
evaluator = RegressionEvaluator(metricName="rmse", labelCol="rating", predictionCol="prediction")
print ("Num models to be tested: ", len(param_grid))
```

```
Num models to be tested:  16
```

Build your cross validation pipeline

```
# Build cross validation using CrossValidator
cv = CrossValidator(estimator=als, estimatorParamMaps=param_grid, evaluator=evaluator, numFolds=5)

# Confirm cv was built
print(cv)
```

```
CrossValidator_49218e193661
```

Best Model and Best Model Parameters

```
#Fit cross validator to the 'train' dataset
model = cv.fit(train)

#Extract best model from the cv model above
best_model = model.bestModel
```

```


# Print best_model
print(type(best_model))

# Complete the code below to extract the ALS model parameters
print("**Best Model**")

# # Print "Rank"
print("  Rank:", best_model._java_obj.parent().getRank())

# Print "MaxIter"
print("  MaxIter:", best_model._java_obj.parent().getMaxIter())

# Print "RegParam"
print("  RegParam:", best_model._java_obj.parent().getRegParam())
```

```
<class 'pyspark.ml.recommendation.ALSModel'>
**Best Model**
  Rank: 50
  MaxIter: 10
  RegParam: 0.15
```

```
# View the predictions
test_predictions = best_model.transform(test)
RMSE = evaluator.evaluate(test_predictions)
print(RMSE)
```

```
0.8692921299296869
```

```
test_predictions.show()
```

```
+------+-------+------+----------+
|userId|movieId|rating|prediction|
+------+-------+------+----------+
|   580|   1580|   4.0|   3.45169|
|   580|  44022|   3.5| 3.1713147|
|   597|    471|   2.0|  4.163025|
|   108|   1959|   5.0|   3.87913|
|   368|   2122|   2.0| 1.8805976|
|   436|    471|   3.0|  3.657902|
|   587|   1580|   4.0| 3.8653302|
|    27|   1580|   3.0| 3.3503187|
|   606|   1580|   2.5| 3.1741173|
```

```
|   606|  44022|   4.0| 2.7711148|
|    91|   2122|   4.0| 2.2577322|
|   157|   3175|   2.0| 3.4996016|
|   232|   1580|   3.5| 3.3879662|
|   232|  44022|   3.0|  3.107938|
|   246|   1645|   4.0| 3.7548573|
|   599|   2366|   3.0| 2.8609328|
|   111|   1088|   3.0|  3.189333|
|   111|   3175|   3.5| 3.0787396|
|    47|   1580|   1.5|  2.775062|
|   140|   1580|   3.0| 3.3890245|
+------+-------+------+----------+
only showing top 20 rows
```

Make Recommendations

```
# Generate n Recommendations for all users
nrecommendations = best_model.recommendForAllUsers(10)
nrecommendations.limit(10).show()
```

```
+------+--------------------+
|userId|     recommendations|
+------+--------------------+
|     1|[{3379, 5.8084493...|
|     2|[{131724, 4.79579...|
|     3|[{6835, 4.852526}...|
|     4|[{3851, 4.8515286...|
|     5|[{3379, 4.5817575...|
|     6|[{33649, 4.750657...|
|     7|[{8477, 4.5287256...|
|     8|[{3379, 4.716567}...|
|     9|[{3379, 4.9013042...|
|    10|[{71579, 4.527629...|
+------+--------------------+
```

```
nrecommendations = nrecommendations\
    .withColumn("rec_exp", explode("recommendations"))\
    .select('userId', col("rec_exp.movieId"), col("rec_exp.rating"))

nrecommendations.limit(10).show()
```

```
+------+-------+---------+
|userId|movieId|   rating|
+------+-------+---------+
|     1|   3379|5.8084493|
|     1|  33649| 5.649271|
|     1|   5490| 5.531026|
|     1| 171495|5.4284987|
|     1|   8477|5.4112787|
|     1|   5915|5.3981776|
|     1|   5416|5.3959126|
|     1|   5328|5.3959126|
|     1|   3951|5.3959126|
|     1|  78836|5.3262763|
+------+-------+---------+
```

Do the recommendations make sense?

Lets merge movie name and genres to teh recommendation matrix for interpretability.

```
nrecommendations.join(movies, on='movieId').filter('userId = 100').show()
```

```
+-------+------+---------+--------------------+--------------------+
|movieId|userId|   rating|               title|              genres|
+-------+------+---------+--------------------+--------------------+
|  67618|   100| 5.148249|Strictly Sexual (...|Comedy|Drama|Romance|
|  33649|   100| 5.053467|  Saving Face (2004)|Comedy|Drama|Romance|
|   3379|   100|5.0466537| On the Beach (1959)|               Drama|
|  42730|   100|4.9903436|   Glory Road (2006)|               Drama|
|  93008|   100| 4.919112|Very Potter Seque...|      Comedy|Musical|
|  77846|   100| 4.919112| 12 Angry Men (1997)|         Crime|Drama|
|  25906|   100| 4.919112|Mr. Skeffington (...|       Drama|Romance|
| 184245|   100|4.8997493|De platte jungle ...|         Documentary|
| 179135|   100|4.8997493|Blue Planet II (2...|         Documentary|
| 138966|   100|4.8997493|Nasu: Summer in A...|           Animation|
+-------+------+---------+--------------------+--------------------+
```

```
ratings.join(movies, on='movieId').filter('userId = 100').sort('rating', ascending=False).limit(10).show()
```

```
ratings.join(movies, on='movieId').filter('userId = 100').sort('rating', ascending=False).limit(10).show()
```

```
+-------+------+------+--------------------+--------------------+
|movieId|userId|rating|               title|              genres|
+-------+------+------+--------------------+--------------------+
|   1101|   100|   5.0|      Top Gun (1986)|      Action|Romance|
|   1958|   100|   5.0|Terms of Endearme...|        Comedy|Drama|
|   2423|   100|   5.0|Christmas Vacatio...|              Comedy|
|   4041|   100|   5.0|Officer and a Gen...|       Drama|Romance|
|   5620|   100|   5.0|Sweet Home Alabam...|      Comedy|Romance|
|    368|   100|   4.5|     Maverick (1994)|Adventure|Comedy|...|
|    934|   100|   4.5|Father of the Bri...|              Comedy|
|    539|   100|   4.5|Sleepless in Seat...|Comedy|Drama|Romance|
|     16|   100|   4.5|       Casino (1995)|         Crime|Drama|
|    553|   100|   4.5|    Tombstone (1993)|Action|Drama|Western|
+-------+------+------+--------------------+--------------------+
```

5m 1s completed at 5:26 PM