COP_6526 Assignment 2

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(1) How to run the applications

To run the code for this assignment use the following command:

```
spark-submit MovieLensRecommender.py <directory>
```

For the *<directory>* parameter, please provide the full path of the directory containing the files *movies.dat* & *ratings.dat*.

If you are running this script from the same directory containing these files, then use a *./* instead.

The following example shows the command used when the files are located in a directory called */home/medium/*:

```
spark-submit MovieLensRecommender.py /home/medium/
```

PS: The code takes about 2 hours to finish.

A few points about the submitted files:

1. I have included the code for both algorithms in the same file for the following reasons:
   i. Ease of use
   ii. To ensure that both algorithms are being tested on the same test split data.
2. After running the script, a report showing the results of both algorithms will be generated and printed on screen, starting with the KMeans results and followed by the ALS results. A copy of that log in included with my submission, look for a file called *out_with_memroy_2g_param.log* (this is a very large text file, so it might be best to open it in a terminal window, or just use the command `tail -100 out_with_memroy_2g_param.log` to print the last 100 lines).

(2) How you tune the accuracy of each approach

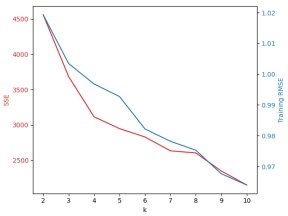
I use the same 70-30 data split on the ratings data set for both models. The data set contains 1 million ratings made by 6040 users on 3706 movies. After the split, the ratings are split into aproximately 700k for training and 300k for testing.

- **KMeans Parameter Tuning**

  First, I would like to make a note about the movies data set. I used the entire movies data set while training the k-means model, because, in a hypothetical scenario where this model is to be applied by a movie streaming company, I assume that the company will have the entire movie data set beforehand, and there will no be major changes to this data set later on; therefore, based on this assumption, I concluded that there will be no need to do a split on the movies data set.

  Second, to calculate the users' average cluster rating, I use the ratings training data only, because I assume that these are the ratings that we have beforehand, and that the user has still not seen the movies in the test data set.

  Finally, to find the best k, I trained the k-means model using 9 different k values, ranging from 2 to 10. For each k, I calculated the model's SSE. Also, I calculated the model's training RMSE using the ratings training data set. To choose the best model, I picked the k corresponding to the largest drop in SSE. Note that, as k increases, the training RMSE decreases. This does not imply that the model with the lowest training RMSE is the best model, quiet the opposite, it is highly probable that such model might be overfitting the data.



k	SSE	SSE Differential	Training RMSE
2	4561.205904	0.000000	1.019341
3	**3684.903938**	**-876.301967**	**1.003455**
4	3114.751107	-570.152830	0.996809
5	2947.874865	-166.876242	0.992731
6	2829.261595	-118.613270	0.982208
7	2632.921201	-196.340394	0.978191
8	2602.976426	-29.944776	0.975281
9	2347.202791	-255.773635	0.967629
10	2148.972410	-198.230381	0.963978

- **ALS Parameter Tuning**

  For ALS, I built a parameter grid with the following parameter value ranges:

  - ranks: 1, 10, and 100
  - maxIters: 5, 10, and 15
  - lambdas: 0.001, 0.01, and 0.05

  To test these values and find the best combination, I used cross-validation with 3 folds on the ratings training data set, and used the RMSE metric to evaluate the trained models. The below table shows the results:

Rank	MaxIter	RegParam	Training RMSE
1	5	0.001	0.918395
1	5	0.010	0.917812
1	5	0.050	0.920100
1	10	0.001	0.917004
1	10	0.010	0.917469
1	10	0.050	0.919369
1	15	0.001	0.917005
1	15	0.010	0.917366
1	15	0.050	0.918941
10	5	0.001	1.106366
10	5	0.010	0.966699
10	5	0.050	0.900097
10	10	0.001	1.123839
10	10	0.010	0.971304
10	10	0.050	0.894663
10	15	0.001	1.135694
10	15	0.010	0.974232
10	**15**	**0.050**	**0.892506**
100	5	0.001	1.427239
100	5	0.010	1.073515
100	5	0.050	0.907864
100	10	0.001	1.410619
100	10	0.010	1.054702
100	10	0.050	0.902293
100	15	0.001	1.408833
100	15	0.010	1.047212
100	15	0.050	0.899737

(3) Comparing accuracy of the two approaches

- **Best K-Means Model**

  Using the best k (k = 3) as measured by SSE on the ratings training data set, I built a K-Means model, and tested it on the ratings test data set. Here are the results according to the best k:

	Value
k	3
SSE	3684.903937589616
Training RMSE	1.0034548414997329

Using the best KMeans model, the Test RMSE = 1.033066366574847

- **Best ALS Model**

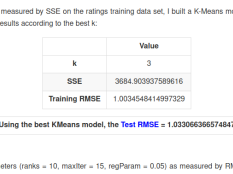
  Using the best hyperparameters (ranks = 10, maxIter = 15, regParam = 0.05) as measured by RMSE on the ratings training data set, I built an ALS model, and tested it on the ratings test data set. Here are the results according to the best hyperparameters:

	Value
Rank	10
MaxIter	15
RegParam	0.05
Training RMSE	0.8925057526849622

Using the best ALS model, the Test RMSE = 0.8641969899499401

- **Conclusion**

  The following bar chart compares the RMSE results of both models (using their best parameters), as calculated on the ratings test data set:



  As seen from the above results, ALS performed much better, especially when used with its best parameters.