Netflix_EDA_and_DataPreparation

June 29, 2019

1. Business Problem

1.1 Problem Description

Netflix is all about connecting people to the movies they love. To help customers find those movies, they developed world-class movie recommendation system: CinematchSM. Its job is to predict whether someone will enjoy a movie based on how much they liked or disliked other movies. Netflix use those predictions to make personal movie recommendations based on each customer's unique tastes. And while Cinematch is doing pretty well, it can always be made better.

Now there are a lot of interesting alternative approaches to how Cinematch works that netflix haven't tried. Some are described in the literature, some aren't. We're curious whether any of these can beat Cinematch by making better predictions. Because, frankly, if there is a much better approach it could make a big difference to our customers and our business.

Credits: https://www.netflixprize.com/rules.html

1.2 Problem Statement

Netflix provided a lot of anonymous rating data, and a prediction accuracy bar that is 10% better than what Cinematch can do on the same training data set. (Accuracy is a measurement of how closely predicted ratings of movies match subsequent actual ratings.)

1.3 Sources

https://www.netflixprize.com/rules.html

https://www.kaggle.com/netflix-inc/netflix-prize-data

Netflix blog: https://medium.com/netflix-techblog/netflix-recommendations-beyond-the-5-stars-part-1-55838468f429 (very nice blog)

surprise library: http://surpriselib.com/ (we use many models from this library)

surprise library doc: http://surprise.readthedocs.io/en/stable/getting_started.html (we use many models from this library)

installing surprise: https://github.com/NicolasHug/Surprise#installation

Research paper: http://courses.ischool.berkeley.edu/i290-dm/s11/SECURE/a1-koren.pdf (most of our work was inspired by this paper)

SVD Decomposition : https://www.youtube.com/watch?v=P5mlg91as1c

1.4 Real world/Business Objectives and constraints

Objectives: 1. Predict the rating that a user would give to a movie that he ahs not yet rated. 2. Minimize the difference between predicted and actual rating (RMSE and MAPE)

Constraints: 1. Some form of interpretability.

2. Machine Learning Problem

2.1 Data

2.1.1 Data Overview
Get the data from : https://www.kaggle.com/netflix-inc/netflix-prize-data/data
Data files :
combined_data_1.txt
combined_data_2.txt
combined_data_3.txt
combined_data_4.txt
movie_titles.csv
2.1.2 Example Data point
2.2 Mapping the real world problem to a Machine Learning Problem
2.2.1 Type of Machine Learning Problem
2.2.2 Performance metric
Mean Absolute Percentage Error: https://en.wikipedia.org/wiki/Mean_absolute_percentage_error
Root Mean Square Error: https://en.wikipedia.org/wiki/Root-mean-square_deviation
2.2.3 Machine Learning Objective and Constraints

1. Minimize RMSE.
2. Try to provide some interpretability.

```
In [112]: # this is just to know how much time will it take to run this entire ipython notebook
          from datetime import datetime
          import pandas as pd
          import numpy as np
          import random

          import matplotlib
          import matplotlib.pyplot as plt
          import seaborn as sns
          sns.set()
          sns.set_style('whitegrid')

          import os
          from scipy import sparse
          from scipy.sparse import csr_matrix
          import pickle

          from sklearn.metrics.pairwise import cosine_similarity

          from sklearn.model_selection import train_test_split
```

1 Configs

```
In [2]: base_dir = '/media/amd_3/20DAD539DAD50BC2/DSET_REPO/DataSets/CS05_NETFLIX_MOVIE_RECOMMEN
        # set path for the structured cleaned data csv file
        df_path = './data/movie_data.csv'

        df_size = -1 # set -1 if you wnt to consider the entire size
```

```
    # sample the dataset by selecting subset of users, movies randomly
    num_users = 25000
    num_movies = 3000
```

3. Exploratory Data Analysis

3.1 Preprocessing

3.1.1 Converting / Merging whole data to required format: u_i, m_j, r_ij

```
In [3]: def get_dataframe(base_dir):

            if os.path.isfile('./data/movie_data.csv'):
                print('File already exists in the path')
                return


            start = datetime.now()

            # list of file names
            file_name_list = ['combined_data_1.txt','combined_data_2.txt',
                              'combined_data_3.txt', 'combined_data_4.txt']

            # a csv file for structured data
            data = open('./data/movie_data.csv', mode='w')

            # process file by file
            for fname in file_name_list:
                print('Reading data from file: ', fname)

                # form absolute path of file
                abs_path = os.path.join(base_dir, fname)

                # open file and extract required fields
                with open(abs_path) as f:

                    # process a single file
                    for line in f:

                        # strip the whitespaces
                        line = line.strip()

                        if ',' in line:
                            row = [x for x in line.split(',')]
                            data.write(','.join([movie_id] + row))
                            data.write('\n')
                        elif ':' in line:
                            movie_id = line.replace(':', '')
                        else:
```

```
                            print('Invalid line found !!!')

            # close the file
            data.close()
            print('Time taken :', datetime.now() - start)
```

```
In [4]: get_dataframe(base_dir)
```

```
File already exists in the path
```

```
In [5]: def dedupe_dataframe(df_path):

            if os.path.exists('./data/deduped_movie_data.csv'):
                df = pd.read_csv('./data/deduped_movie_data.csv',
                                 names=['movie', 'user','rating','date'],
                                 delimiter=',')
                return df

            print("creating the dataframe from data.csv file..")
            df = pd.read_csv(df_path,  names=['movie', 'user','rating','date'],
                             delimiter=',')
            df['date'] = pd.to_datetime(df['date'], format='%Y-%m-%d')

            # we are arranging the ratings according to time.
            print(datetime.now(),  ' Sorting the dataframe by date..')
            df = df.sort_values(by='date')
            print(datetime.now(),  ' Sorting of data frame completed')

            # dedupe the data frames
            print(datetime.now(), ' Removing duplicates ...')
            df = df.drop_duplicates(subset=['movie','user','rating', 'date'],
                                    keep='last')
            print(datetime.now(), ' Duplicates removed  ...')

            print("Total data ")
            print("-"*50)
            print("\nTotal no of ratings :",df.shape[0])
            print("Total No of Users   :", len(np.unique(df.user)))
            print("Total No of movies  :", len(np.unique(df.movie)))

            df.to_csv('./data/deduped_movie_data.csv', index=False)

            return df
```

```
In [6]: df = dedupe_dataframe(df_path)
```

```
        # just for the test purpose
        if df_size > 0:
```

```
            print('Dataset size will be set to a limit of ', df_size)
            df = df.tail(n=df_size)
```

```
/home/amd_3/anaconda3/lib/python3.6/site-packages/IPython/core/interactiveshell.py:2903: DtypeWa
  if self.run_code(code, result):
```

3.1 Basic Statistics of the Data

```
In [7]: print('Total data')
        print("-"*50)
        print('\nTotal no of ratings :', df.shape[0])
        print('Total No of Users   :', len(set(df['user'])))
        print('Total No of movies  :', len(set(df['movie'])))
```

```
Total data
--------------------------------------------------

Total no of ratings : 100480508
Total No of Users   : 481961
Total No of movies  : 20273
```

```
In [8]: # method to make y-axis more readable
        def human(num, units = 'M'):

            units = units.lower()
            num = float(num)

            if units == 'k':
                return str(num/10**3) + " K"
            elif units == 'm':
                return str(num/10**6) + " M"
            elif units == 'b':
                return str(num/10**9) +  " B"
```

```
In [9]: def basic_analysis(df, prefix_name):

            # set start time
            start = datetime.now()

            print('-'*50)
            print(prefix_name + ' Total no of ratings :', df.shape[0])
            print(prefix_name + ' Total No of Users   :', len(set(df['user'])))
            print(prefix_name + ' Total No of movies  : ', len(set(df['movie'])))

            # add day of week
            df['date'] = pd.to_datetime(df['date'], format='%Y-%m-%d')
            df['day_of_week'] = df.date.dt.weekday_name
```

```
# 1. Distribution of ratings
plt.title(prefix_name + ' - Distribution of ratings', fontsize=15)
sns.countplot(df.rating)
plt.ylabel('Count')
plt.xlabel('Rating')
plt.show()
plt.close()

# 2. Number of ratings per Month
ax = df.resample('m', on='date')['rating'].count().plot()
ax.set_title(prefix_name + ' No of ratings per month')
plt.xlabel('Month')
plt.ylabel('No of ratings(per month)')
ax.set_yticklabels([human(item, 'M') for item in ax.get_yticks()])
plt.show()
plt.close()

# 3. Analysis on the Ratings given by user
no_of_rated_movies_per_user = df.groupby(by='user')['rating'].count().sort_values(as

fig = plt.figure(figsize=plt.figaspect(.5))
ax1 = plt.subplot(121)
sns.kdeplot(no_of_rated_movies_per_user, shade=True, ax=ax1)
plt.xlabel('No of ratings by user')
plt.title(prefix_name + '- PDF')
ax2 = plt.subplot(122)
sns.kdeplot(no_of_rated_movies_per_user, shade=True, cumulative=True,ax=ax2)
plt.xlabel('No of ratings by user')
plt.title(prefix_name + ' CDF')
plt.show()
plt.close()

print(prefix_name + ' Describe information :\n' \
      + str(no_of_rated_movies_per_user.describe()))

# Qunatile analysis
quantiles = no_of_rated_movies_per_user.quantile(np.arange(0,1.01,0.01),
                                                 interpolation='higher')
plt.title(prefix_name + ' Quantiles and their Values')
quantiles.plot()
# quantiles with 0.05 difference
plt.scatter(x=quantiles.index[::5], y=quantiles.values[::5], c='orange',
            label='quantiles with 0.05 intervals')
# quantiles with 0.25 difference
plt.scatter(x=quantiles.index[::25], y=quantiles.values[::25], c='m',
            label = 'quantiles with 0.25 intervals')
plt.ylabel('No of ratings by user')
```

```
plt.xlabel('Value at the quantile')
plt.legend(loc='best')

# annotate the 25th, 50th, 75th and 100th percentile values....
for x,y in zip(quantiles.index[::25], quantiles[::25]):
    plt.annotate(s="({} , {})".format(x,y), xy=(x,y), xytext=(x-0.05, y+500)
                 ,fontweight='bold')
plt.show()
plt.close()


no_of_ratings_per_movie = df.groupby(by='movie')['rating'].count().sort_values(ascen

fig = plt.figure(figsize=plt.figaspect(.5))
ax = plt.gca()
plt.plot(no_of_ratings_per_movie.values)
plt.title(prefix_name + ' - # RATINGS per Movie')
plt.xlabel('Movie')
plt.ylabel('No of Users who rated a movie')
ax.set_xticklabels([])
plt.show()
plt.close()


fig, ax = plt.subplots()
sns.countplot(x='day_of_week', data=df, ax=ax)
plt.title(prefix_name + ' No of ratings on each day...')
plt.ylabel('Total no of ratings')
plt.xlabel('Day')
ax.set_yticklabels([human(item, 'M') for item in ax.get_yticks()])
plt.show()
plt.close()

fig = plt.figure(figsize=plt.figaspect(.45))
sns.boxplot(y='rating', x='day_of_week', data=df)
plt.show()
plt.close()

print('Total time for plot : ', datetime.now() - start)

# add day of week column
print(prefix_name + ' - Average ratings per week day')
avg_week_df = df.groupby(by=['day_of_week'])['rating'].mean()
print(" AVerage ratings")
print("-"*30)
print(avg_week_df)
print('\n')
```

2 Sample the data

```
In [10]: def sample_the_data_frame(df, num_users, num_movies):

             if os.path.exists('./data/Sampled_Deduped_Data.csv'):
                 df = pd.read_csv('./data/Sampled_Deduped_Data.csv', index_col=False)
                 return df


             # get unique movies & users from the data frame
             users_set = set(df['user'].tolist())
             movies_set = set(df['movie'].tolist())

             # sample desired number of users & movies from the data frame
             selected_users = list(set(random.sample(users_set, num_users)))
             selected_movies = list(set(random.sample(movies_set, num_movies)))

             print('Number of sampled users:%d, number of sample movies:%d'%(len(selected_users)
                                                                              len(selected_movies

             # 1. select based on users
             #df_or = df[(df['user'].isin(selected_users)) | (df['movie'].isin(selected_movies))
             df_and = df[(df['user'].isin(selected_users)) & (df['movie'].isin(selected_movies))

             df_and = df_and.sort_values(['date'], ascending=True)

             # write sampled data to disk
             df_and.to_csv('./data/Sampled_Deduped_Data.csv', index=False)

             #
             return df_and

In [11]: df = sample_the_data_frame(df, num_users, num_movies)
```

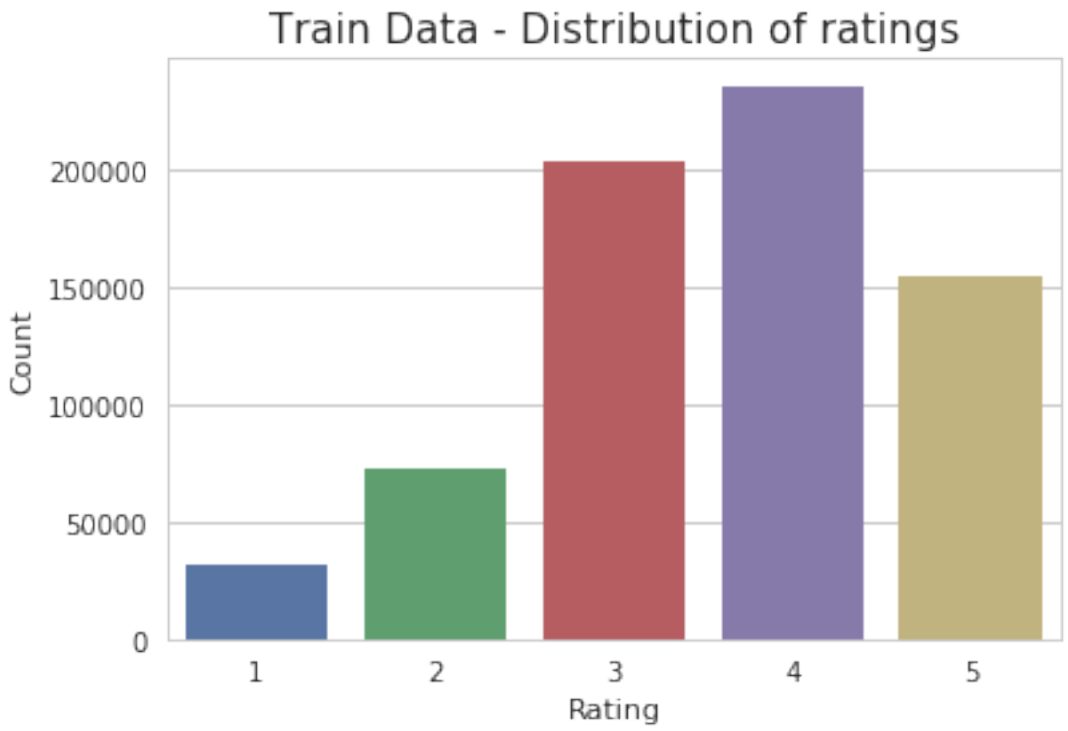
3.2 Spliting data into Train and Test(80:20)

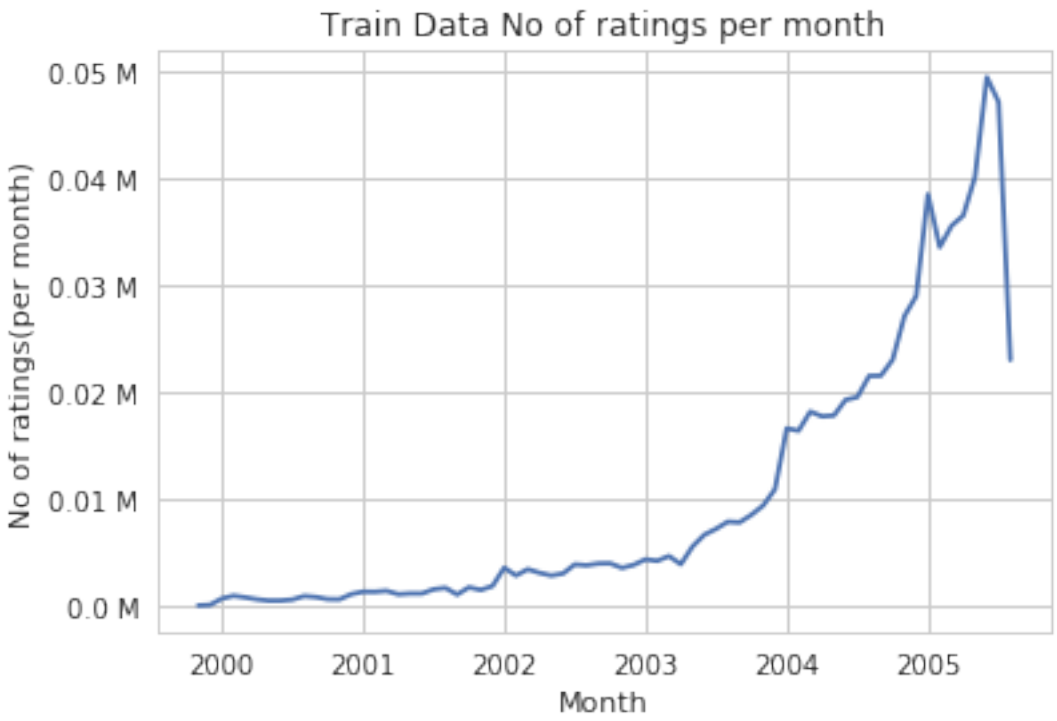
```
In [12]: if os.path.exists('./data/DF_train.csv') and os.path.exists('./data/DF_test.csv'):
             print('Train , Test files already exists !!!')
             df_train = pd.read_csv('./data/DF_train.csv', index_col=False)
             df_test = pd.read_csv('./data/DF_test.csv', index_col=False)
         else:
             df_train, df_test = train_test_split(df, test_size=0.20, shuffle=False)
             df_train.to_csv('./data/DF_train.csv', index=False)
             df_test.to_csv('./data/DF_test.csv', index=False)
```

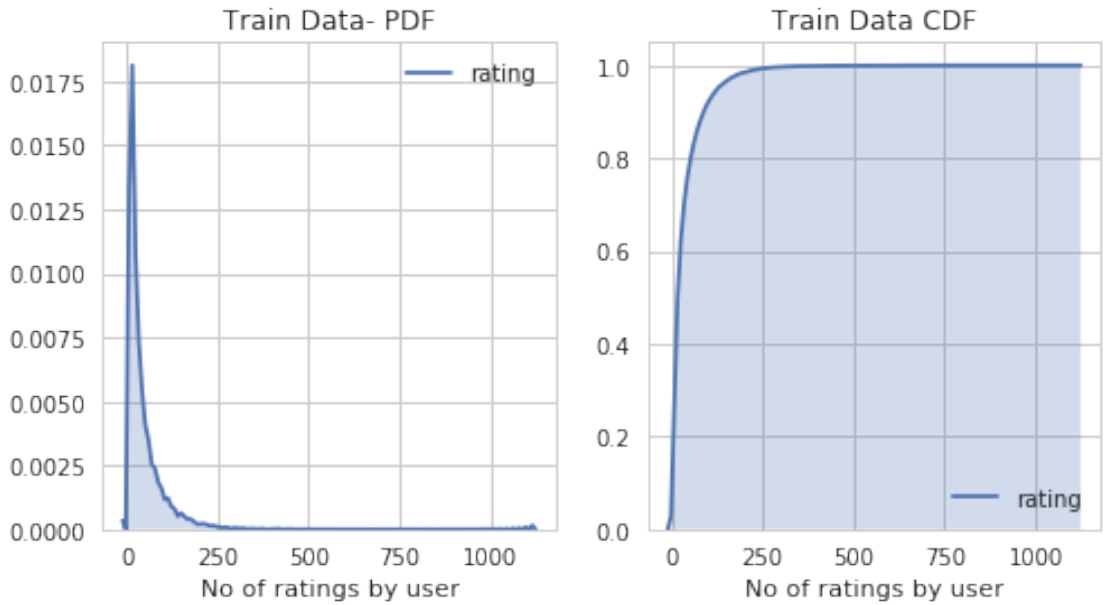
3.2.1 Basic Statistics in Train data (#Ratings, #Users, and #Movies)

```
In [13]: basic_analysis(df_train, 'Train Data')
```

```
---------------------------------------------------
Train Data Total no of ratings : 696736
Train Data Total No of Users   : 20515
Train Data Total No of movies  :  2726


/home/amd_3/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:12: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html#
  if sys.path[0] == '':
/home/amd_3/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:13: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html#
  del sys.path[0]
```



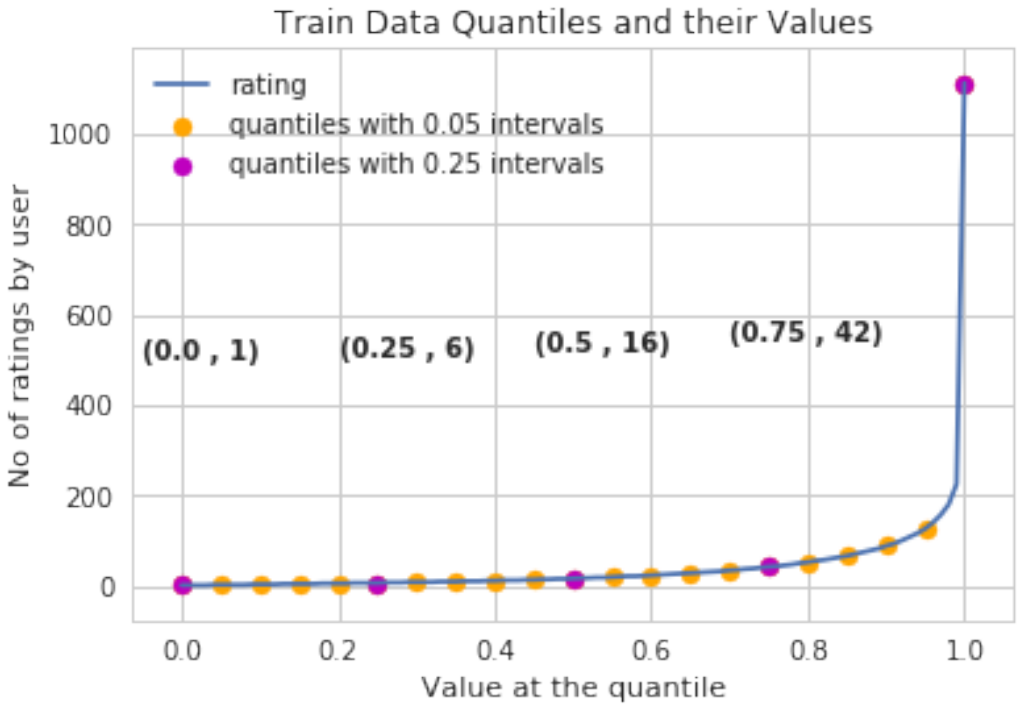


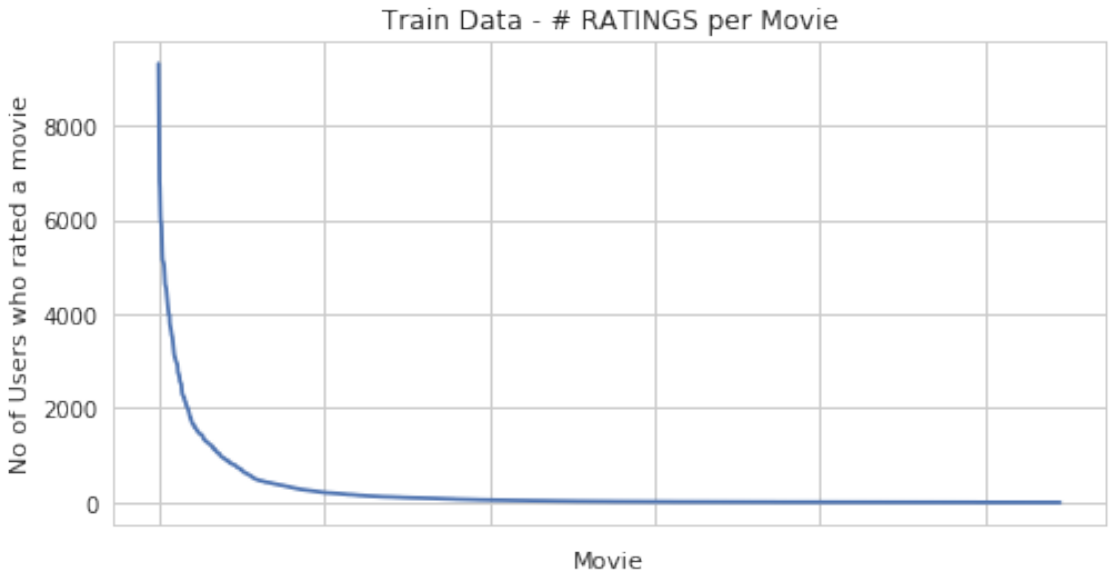


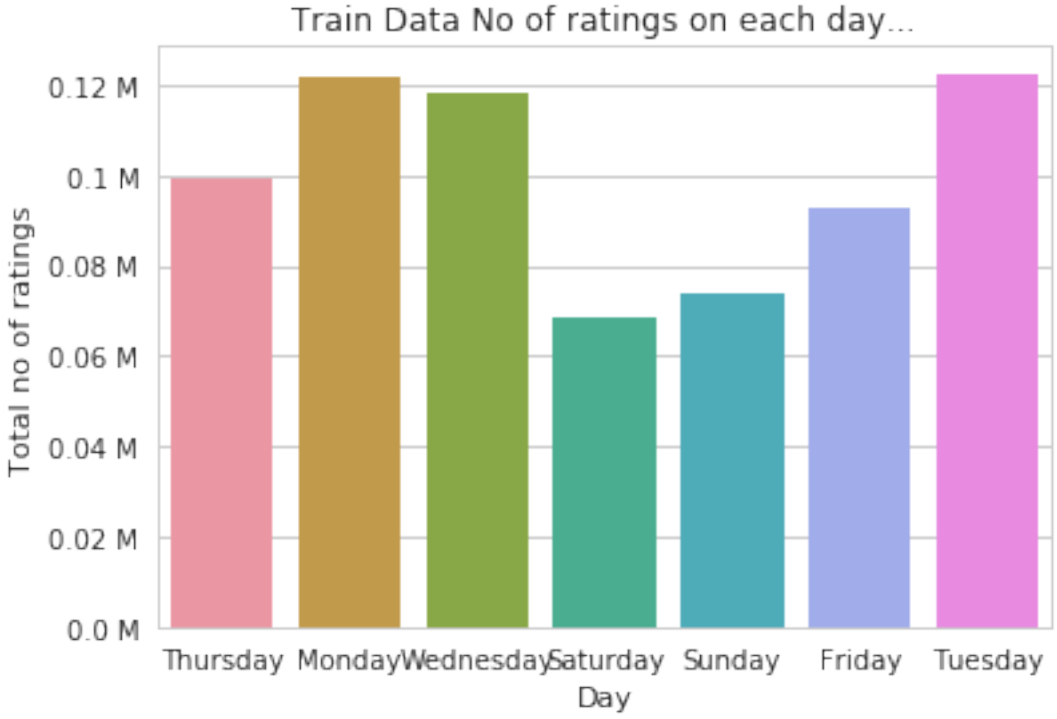

```
Train Data Describe information :
count    20515.000000
mean        33.962272
```

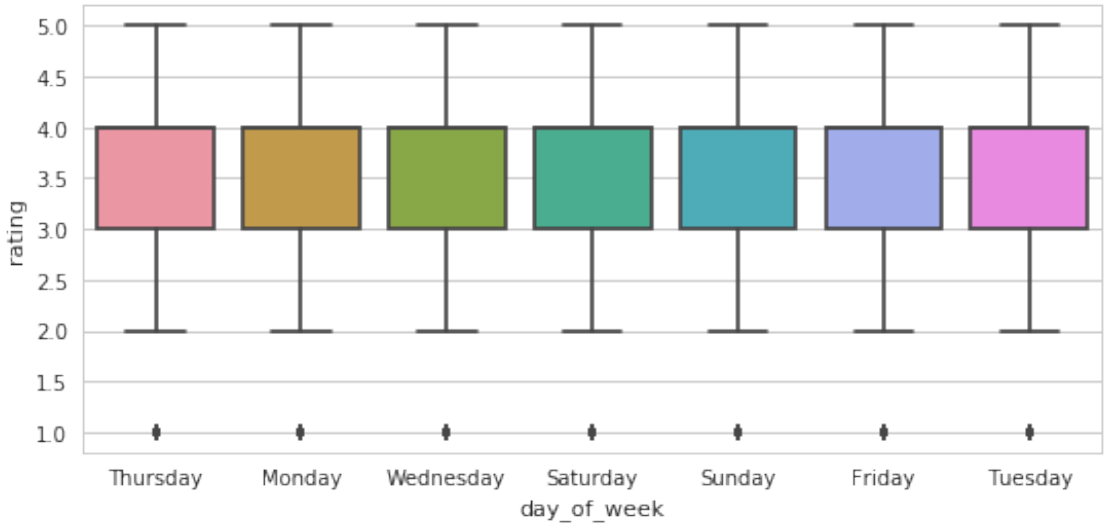
```
std          48.224927
min           1.000000
25%           6.000000
50%          16.000000
75%          42.000000
max        1112.000000
Name: rating, dtype: float64
```

(1.0 , 1112)




Train Data - # RATINGS per Movie
No of Users who rated a movie
8000
6000
4000
2000
0
Movie


Train Data No of ratings on each day...
Total no of ratings
0.12 M
0.1 M
0.08 M
0.06 M
0.04 M
0.02 M
0.0 M
Thursday
Monday
Wednesday
Saturday
Sunday
Friday
Tuesday
Day

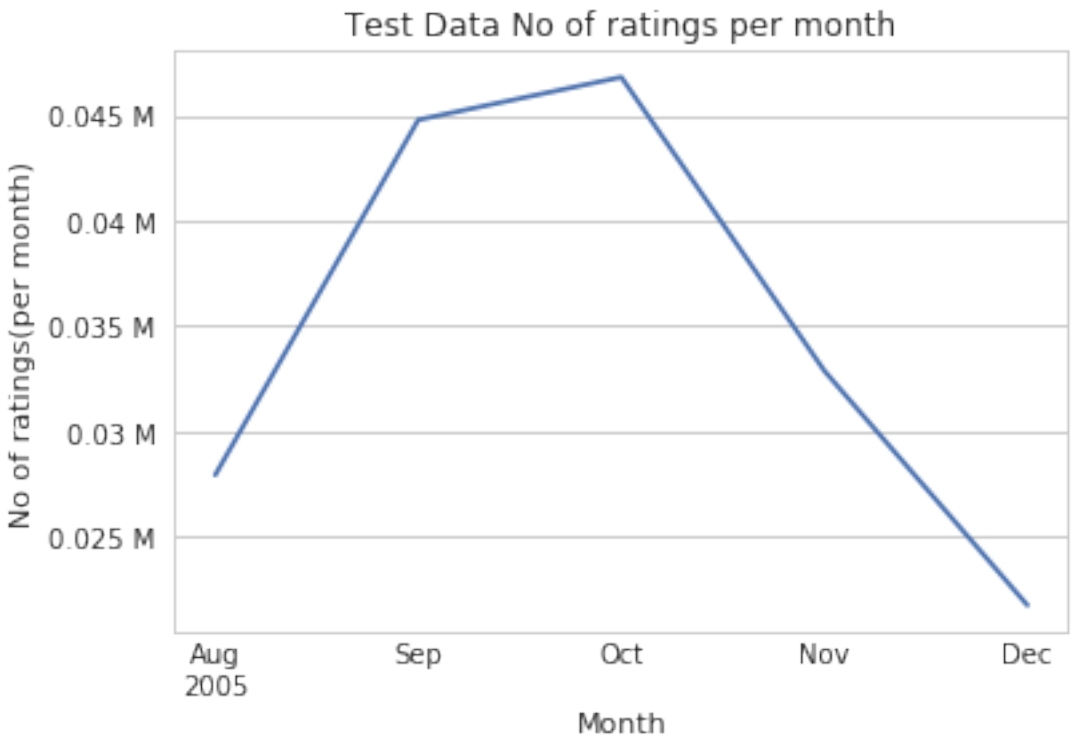


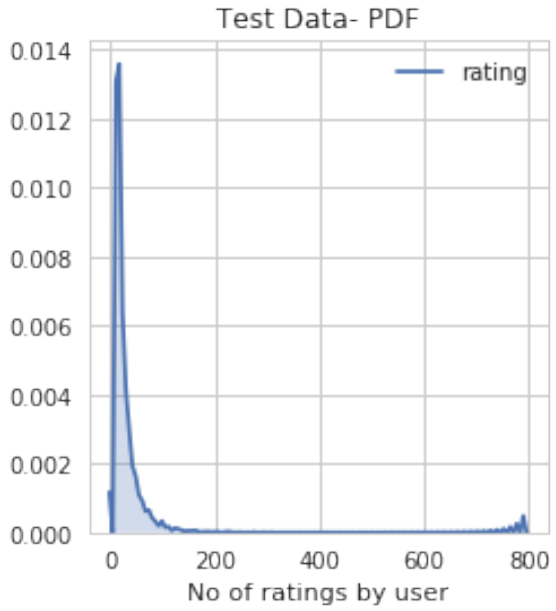

```
Total time for plot :  0:00:38.845502
Train Data - Average ratings per week day
 AVerage ratings
------------------------------
day_of_week
Friday       3.581220
Monday       3.580953
Saturday     3.609983
Sunday       3.592532
Thursday     3.589330
Tuesday      3.568810
Wednesday    3.592213
Name: rating, dtype: float64
```

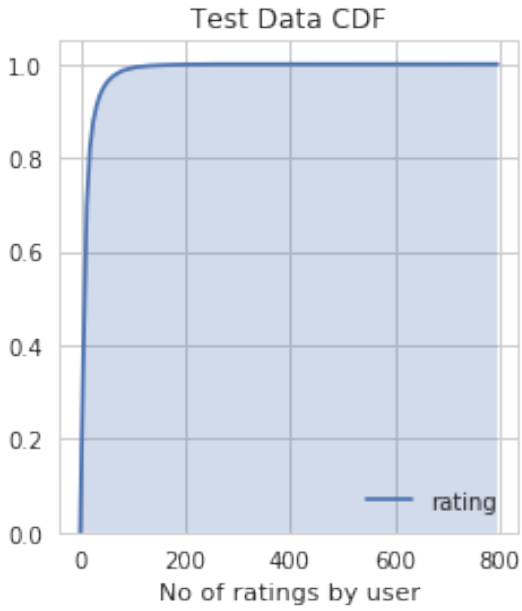
3.2.2 Basic Statistics in Test data (#Ratings, #Users, and #Movies)

```
In [14]: basic_analysis(df_test, 'Test Data')

--------------------------------------------------
Test Data Total no of ratings : 174185
Test Data Total No of Users   : 14910
Test Data Total No of movies  :  2348


/home/amd_3/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:12: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

```
See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html#
  if sys.path[0] == '':
/home/amd_3/anaconda3/lib/python3.6/site-packages/ipykernel_launcher.py:13: SettingWithCopyWarni
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html#
  del sys.path[0]
```



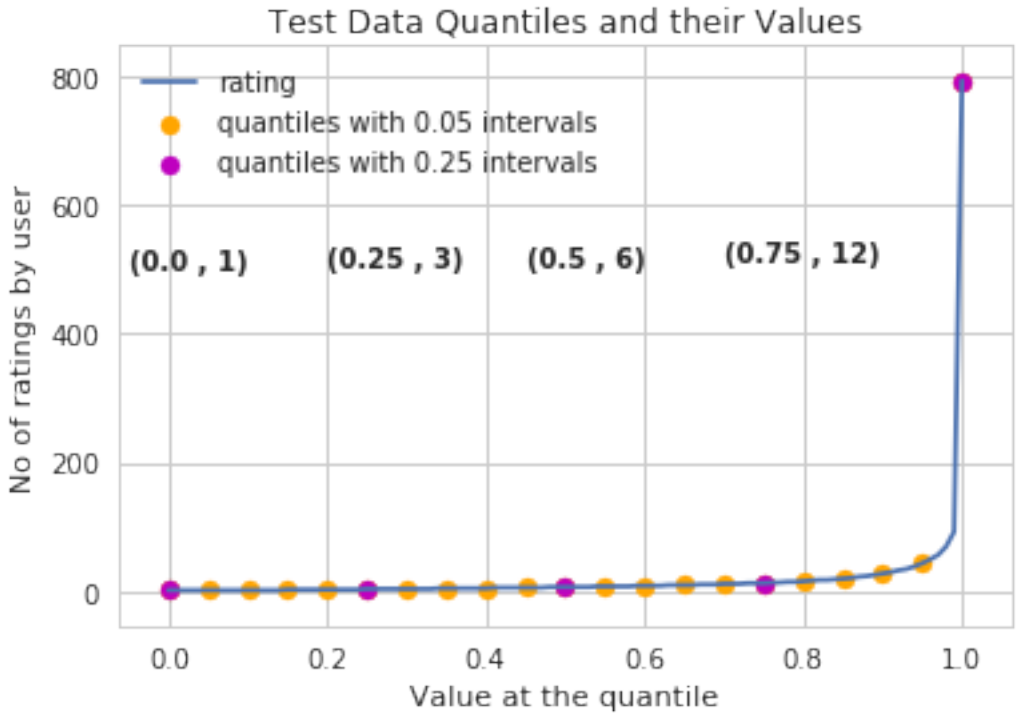


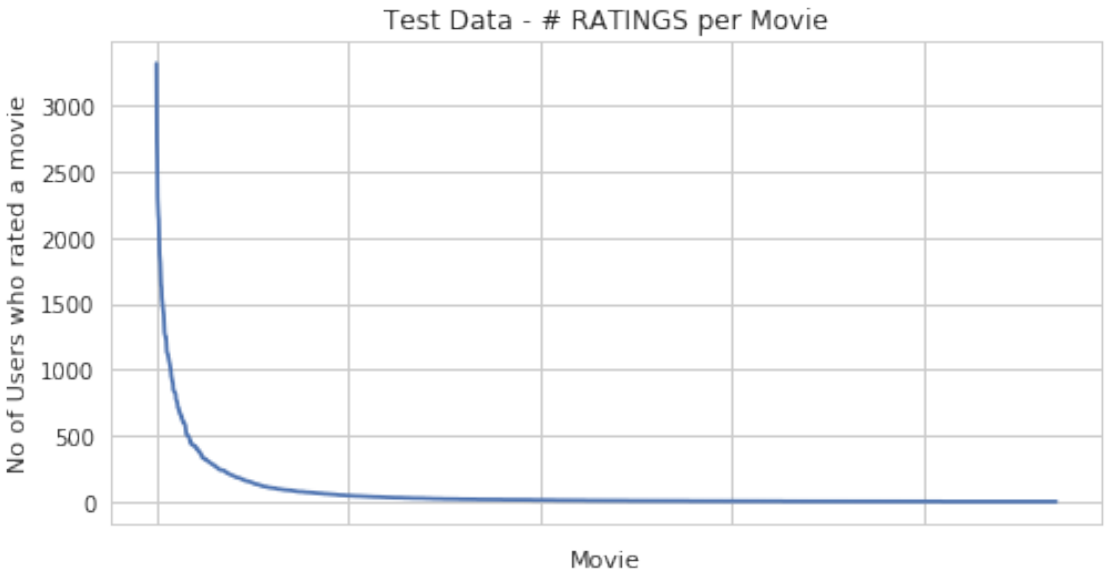


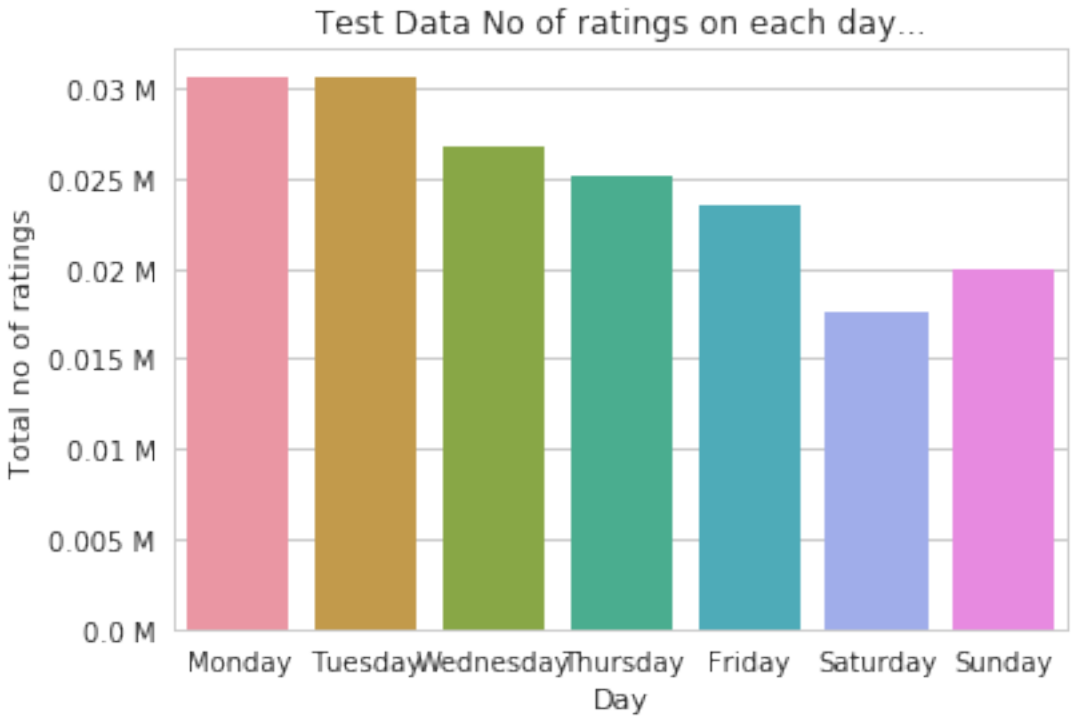

```
Test Data Describe information :
count    14910.000000
```

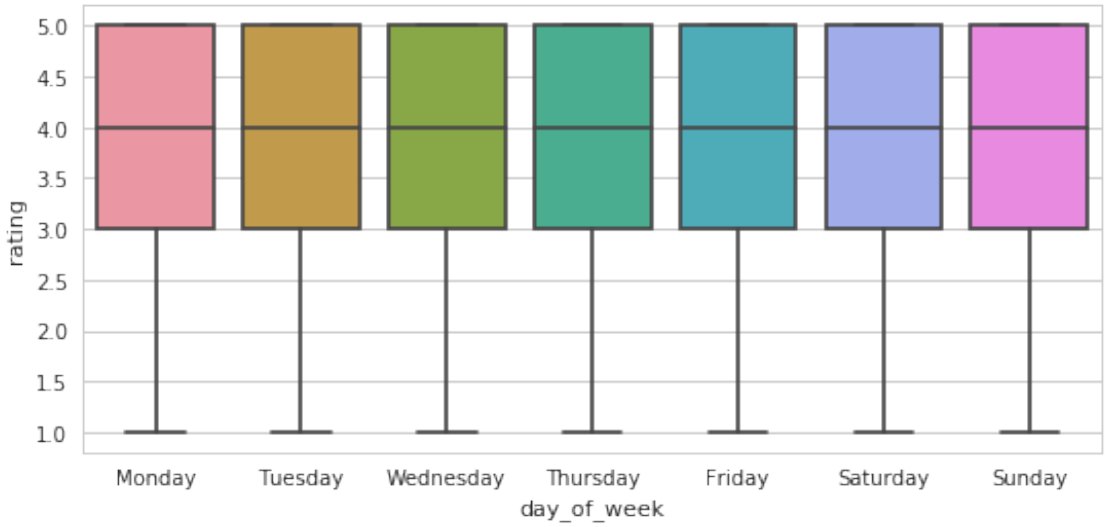
```
mean         11.682428
std          19.556655
min           1.000000
25%           3.000000
50%           6.000000
75%          12.000000
max         793.000000
Name: rating, dtype: float64
```

(1.0 , 793)




Test Data - # RATINGS per Movie
No of Users who rated a movie
3000
2500
2000
1500
1000
500
0
Movie


Test Data No of ratings on each day...
Total no of ratings
0.03 M
0.025 M
0.02 M
0.015 M
0.01 M
0.005 M
0.0 M
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday
Day




```
Total time for plot :  0:00:02.146961
Test Data - Average ratings per week day
 AVerage ratings
------------------------------
day_of_week
Friday       3.640968
Monday       3.665373
Saturday     3.689816
Sunday       3.682455
Thursday     3.674987
Tuesday      3.655318
Wednesday    3.678616
Name: rating, dtype: float64
```

3.3.8 Cold Start problem

3.3.8.1 Cold Start problem with Users

```
In [15]: users_set_test = set(df_test['user'])
         new_users = users_set_test - set(df_train['user'])
         print('Number of unique users in the test dataset :', len(users_set_test))
         print('Number of new users (users present only in test data) : ', len(new_users))
         print('Percentage of new users : ', (len(new_users) * 100.0)/len(users_set_test))

Number of unique users in the test dataset : 14910
Number of new users (users present only in test data) :  4002
Percentage of new users :  26.841046277665995
```

We might have to handle **new users** (***4002***) who didn't appear in train data.

3.3.8.2 Cold Start problem with Movies

```
In [16]: movies_set_test = set(df_test['movie'])
         new_movies = movies_set_test - set(df_train['movie'])
         print('Number of unique movies in the test dataset :', len(movies_set_test))
         print('Number of new movies (movies present only in test data) : ', len(new_movies))
         print('Percentage of new movies : ', (len(new_movies) * 100.0)/len(movies_set_test))
```

```
Number of unique movies in the test dataset : 2348
Number of new movies (movies present only in test data) :  81
Percentage of new movies :  3.4497444633730834
```

We might have to handle **81 movies** (small comparatively) in test data

4. Featurization

- **GAvg** : Average rating of all the ratings
- **Similar users rating of this movie**:
  - sur1, sur2, sur3, sur4, sur5 (top 5 similar users who rated that movie..)
- **Similar movies rated by this user**:
  - smr1, smr2, smr3, smr4, smr5 (top 5 similar movies rated by this movie..)
- **UAvg** : User's Average rating
- **MAvg** : Average rating of this movie
- **rating** : Rating of this movie by this user.

2.1 Compute average dictionaries from the train data

```
In [116]: # 1. Global average  single scalar value eg: 3.7
          global_average = df_train['rating'].mean()

          # 2. Movie Wise average rating {movie_1 : 3.5, movie_9: 3.9 ...}
          movie_dict = dict(df_train.groupby(['movie'])['rating'].mean())

          # 3. User Wise average rating {user_1 : 3.1, user_9: 4.2 ... }
          user_dict = dict(df_train.groupby(['user'])['rating'].mean())

          # Get sparse matrix of train data
          train_sparse_matrix = sparse.csr_matrix((df_train.rating.values,
                                                   (df_train.user.values,
                                                    df_train.movie.values)),)
```

```
In [117]: def get_top_five_similar(similar_arg_array, key_elem):

              # declare a list for holding similar argument values
              top_similar_args = list()

              for arg in similar_arg_array[::-1]:
                  # skip the element which is same as key element
                  if arg == key_elem:
                      continue

                  # stop when we have found 5 elements
                  if len(top_similar_args) == 5:
                      return np.array(top_similar_args)

                  # consider this arg as similar
                  else:
                      top_similar_args.append(arg)


              return np.array(top_similar_args)

In [121]: def get_top_similar_entity(train_sparse_matrix, user_dict, movie_dict):

              # set path for similar entity dictioanry
              sim_users_dict_path = './data/train_sim_users_dictionary.pkl'
              sim_movies_dict_path = './data/train_sim_movies_dictionary.pkl'

              # if similar users dictionary exists return it
              if os.path.exists(sim_users_dict_path):
                  print('Similar users dictioary pre exist !!!')

                  #load model from disk
                  pickle_in = open(sim_users_dict_path, "rb")
                  sim_users_dict = pickle.load(pickle_in)
                  pickle_in.close()

              else:

                  sim_users_dict = dict()
                  print(datetime.now(), 'Start time')

                  for index, user in enumerate(list(user_dict.keys())):
                      sim_user_array = cosine_similarity(train_sparse_matrix[user],
                                                         train_sparse_matrix).flatten()
                      sorted_arg_array = sim_user_array.argsort()
                      sim_users_dict[user] = get_top_five_similar(sorted_arg_array, user)

                      if (index + 1) % 500 == 0:
```

```
                    print(datetime.now(), 'Processed %d users'%((index+1)*500,))

            print(datetime.now(), 'End time')

            # save model to disk
            pickle_out = open(sim_users_dict_path,"wb")
            pickle.dump(sim_users_dict, pickle_out)
            pickle_out.close()


        # if similar users dictionary exists return it
        if os.path.exists(sim_movies_dict_path):

            print('Similar movies dictioary pre exist !!!')

            #load model from disk
            pickle_in = open(sim_movies_dict_path, "rb")
            sim_movies_dict = pickle.load(pickle_in)
            pickle_in.close()

        else:

            # Get movie similarity matrix
            movie_sim_matrix = cosine_similarity(train_sparse_matrix.T)

            # Get the indices of top 5 similar movies for each movie
            movie_sim_matrix = movie_sim_matrix.argsort(axis=1)

            sim_movies_dict = dict()

            for movie in list(movie_dict.keys()):
                sim_movies_dict[movie] = get_top_five_similar(movie_sim_matrix[movie],
                                                              movie)

            # save model to disk
            pickle_out = open(sim_movies_dict_path, "wb")
            pickle.dump(sim_movies_dict, pickle_out)
            pickle_out.close()


        return (sim_users_dict, sim_movies_dict,)
```

```
In [122]: sim_users_dict, sim_movies_dict = get_top_similar_entity(train_sparse_matrix, user_dic
```

```
Similar users dictioary pre exist !!!
Similar movies dictioary pre exist !!!
```

new user & new movie

new user & old movie
old user & new movie
old user & old movie # this is the best case
If user is present we can get his/her most similar users
If movie is present we can get its most similar movies
Inorder to create featue vector we need both the user & movie present in the train data. If either of is missing, we can substitute the avergae rating values of user, movie.

```
In [126]: def featurize_movie_data(df, partition, train_sparse_matrix):

              if os.path.exists('./data/Final_' + partition + '.csv'):
                  print('File: ' + './data/Final_' + partition + '.csv already created !!!')
                  return

              # open the file for final train data
              reg_file = open('./data/Final_' + partition + '.csv', mode='w')

              print('Shape of input data :', df.shape)

              users_df_count = 0

              # do by grouping on user # this is to speedup the computation
              for user, user_df in df.groupby(['user']):

                  # check user, movie is present or not
                  try:
                      avg_user_rating = user_dict[user]
                      user_present = True
                      # get the top 5 similar users of this user
                      top_similar_users = sim_users_dict[user]

                  except KeyError: # IndexError
                      user_present = False

                  except:
                      print('Error in processing user : ', user)
                      continue

                  # iterate over each row in the user data frame
                  for index, row in user_df.iterrows():

                      # test whether the movie is present or not
                      try:
                          avg_movie_rating = movie_dict[row.movie]
                          movie_present = True
                          top_similar_movies = sim_movies_dict[row.movie]
                      except KeyError: # IndexError
                          movie_present = False
```

```
        except:
            print('Error in processing movie : ', row.movie)
            continue

        # Proceed based on user present, movie present

        # Case 1: both user & movie not present
        if (not user_present) and (not movie_present):
            # substitute global average irrespective of user, movie
            top_sim_user_ratings = [global_average] * 5
            top_sim_movie_ratings = [global_average] * 5
            avg_movie_rating = global_average
            avg_user_rating = global_average

        # Case 2: user present but movie not present
        elif (user_present) and (not movie_present):
            # substitute sim user rating with avg rating of its similar users to a
            top_sim_user_ratings = [user_dict.get(sim_user, global_average) for
                                    sim_user in top_similar_users]
            top_sim_movie_ratings = [global_average] * 5
            avg_movie_rating = global_average

        # Case 3: user not present but movie present
        elif (not user_present) and (movie_present):
            # substitute sim movies rating with avg rating of its similar movies b
            top_sim_movie_ratings = [movie_dict.get(sim_movie, global_average) for
                                     sim_movie in top_similar_movies]
            top_sim_user_ratings = [global_average] * 5
            avg_user_rating = global_average

        # Case 4: user present & movie present (best case)
        else:
            # ========== Get top user based rating feature ======================
            # get the ratings of most similar users for this movie
            top_sim_user_ratings = train_sparse_matrix[top_similar_users,
                                                       row.movie].toarray().flatte

            # repalce zero ratings by the average rating for that movie by all use
            top_sim_user_ratings[top_sim_user_ratings==0] = movie_dict[row.movie]


            # ========== Get top movie based rating feature ======================
            top_sim_movie_ratings = train_sparse_matrix[user,
                                        top_similar_movies].toarray().flatten()

            # repalce zero ratings by the average rating for that movie by all use
            top_sim_movie_ratings[top_sim_movie_ratings==0] = user_dict[user]
```

```
                    # convert to list
                    top_sim_user_ratings = list(top_sim_user_ratings)
                    top_sim_movie_ratings = list(top_sim_movie_ratings)



                # Prepare the vector
                feat_vector = [row.date, row.user, row.movie] + \
                              top_sim_user_ratings + \
                              top_sim_movie_ratings + \
                              [global_average, avg_user_rating,
                              avg_movie_rating, row.rating]


                feat_vector = [str(item) for item in feat_vector]
                current_row = (','.join(feat_vector)) + '\n'

                # write the row to disk
                reg_file.write(current_row)

            # update the user count
            users_df_count = users_df_count + 1

            if (users_df_count % 4000) == 0:
                print(datetime.now(), ' Processed %d users '%(users_df_count,))


        # close the file to complete the writing
        reg_file.close()

        # set column names
        col_names = ['date', 'user', 'movie', 'sur1', 'sur2', 'sur3', 'sur4', 'sur5',
                     'smr1', 'smr2', 'smr3', 'smr4', 'smr5',
                     'Gavg','UAvg', 'MAvg', 'rating']

        # read dataframe from disk
        df = pd.read_csv('./data/Final_' + partition + '.csv',
                         index_col=False , names=col_names)

        # write to disk
        df.to_csv('./data/Final_' + partition + '.csv', index=False)

        print('Sample data frame ' + partition + ':\n', df.head())


        print(datetime.now(), ' Created final ' + partition + ' data !!!')
```

In [128]:
```
# prepare train data
```

```
          featurize_movie_data(df_train, 'Train', train_sparse_matrix)
```

```
Shape of input data : (696736, 5)
2019-06-23 23:41:31.567885  Processed 4000 users
2019-06-23 23:43:58.308912  Processed 8000 users
2019-06-23 23:46:11.615666  Processed 12000 users
2019-06-23 23:48:27.946312  Processed 16000 users
2019-06-23 23:50:35.842992  Processed 20000 users
Sample data frame Train:
                  date  user  movie  sur1  sur2  sur3  sur4  sur5  smr1  smr2  \
0  2005-06-13 00:00:00   296   4640     4     4     3     4     5     3     3
1  2005-06-13 00:00:00   296   6902     3     3     3     3     3     3     3
2  2005-06-13 00:00:00   296  10359     5     3     3     3     3     3     3
3  2005-02-07 00:00:00   308  13471     3     3     3     4     3     2     2
4  2005-02-07 00:00:00   308   7635     3     4     4     2     2     2     2

   smr3  smr4  smr5      Gavg      UAvg      MAvg  rating
0     3     3     3  3.586035  3.333333  4.110700       5
1     3     3     3  3.586035  3.333333  3.755409       2
2     3     3     3  3.586035  3.333333  3.256491       3
3     2     2     2  3.586035  2.666667  3.421661       2
4     2     2     2  3.586035  2.666667  2.865879       3
2019-06-23 23:51:05.985469  Created final Train data !!!
```

```
In [129]: # prepare test data
          featurize_movie_data(df_test, 'Test', train_sparse_matrix)
```

```
Shape of input data : (174185, 5)
2019-06-23 23:51:36.627871  Processed 4000 users
2019-06-23 23:52:07.239045  Processed 8000 users
2019-06-23 23:52:37.075862  Processed 12000 users
Sample data frame Test:
                  date  user  movie      sur1      sur2      sur3      sur4  \
0  2005-12-16 00:00:00   177  12470  3.586035  3.586035  3.586035  3.586035
1  2005-12-16 00:00:00   177  10359  3.586035  3.586035  3.586035  3.586035
2  2005-12-16 00:00:00   177  17169  3.586035  3.586035  3.586035  3.586035
3  2005-12-16 00:00:00   177  13651  3.586035  3.586035  3.586035  3.586035
4  2005-12-16 00:00:00   177  17324  3.586035  3.586035  3.586035  3.586035

       sur5      smr1      smr2      smr3      smr4      smr5      Gavg  \
0  3.586035  3.690944  3.451161  3.692144  3.358638  3.330142  3.586035
1  3.586035  3.823619  3.545988  3.255159  3.585621  3.539228  3.586035
2  3.586035  3.945255  4.328924  4.145440  3.374704  3.589595  3.586035
3  3.586035  3.409039  3.690944  3.741748  3.765557  3.330142  3.586035
4  3.586035  3.912706  3.589595  3.308271  4.112702  3.129618  3.586035

       UAvg      MAvg  rating
```

```
0  3.586035  3.409039       3
1  3.586035  3.256491       3
2  3.586035  3.912706       4
3  3.586035  3.692144       3
4  3.586035  3.945255       3
2019-06-23 23:53:04.333774  Created final Test data !!!
```

3 Procedure Summary

Dataframe is preapraed from the raw text files

Basic EDA such as distribution, count statistics is done on the prepared dataset

Sample of 25K users & 3K movies is taken

Dataset is partitioned into train, test set based on time stamp

Cold start problem is handled by substituting the global average value & based on other similarity information

Features are created using the similarity metrics

4 Conclusion

The train, test dataset is prepared using the similarity features

Cold start problem is handled by similarity metric & global average rating value