spotify_learn

December 9, 2018

```
In [1]: import matplotlib.pyplot as plt
        import numpy as np
        import csv
        import pandas as pd
        import codecs
        from sklearn import ensemble, preprocessing, metrics, linear_model, svm
        from sklearn.model_selection import cross_validate, cross_val_score, train_test_split,
        import networkx as nx
```

```
In [2]: def GetData(): # get the data from excel
            with open("billboard_2000_2018_spotify_lyrics.csv", newline='', encoding="utf8", e
                X_colnames = next(csv.reader(csvfile))

            X_date = []
            X_title = []
            X_peak_pos = []
            X_last_pos = []
            X_weeks = []
            X_rank = []
            X_change = []
            X_genre = []
            X_energy = []
            X_liveness = []
            X_tempo = []
            X_speechiness = []
            X_acousticness = []
            X_instrumentalness = []
            X_danceability = []
            X_key = []
            X_duration_ms = []
            X_loudness = []
            X_valence = []
            X_mode = []
            with open("billboard_2000_2018_spotify_lyrics.csv", newline='', encoding="utf8", e
                #X_colnames = next(csv.reader(csvfile))
                reader = csv.DictReader(csvfile)
                for row in reader:
                    if row[X_colnames[X_colnames.index('valence')]] != 'unknown':
                        X_date.append(row[X_colnames[X_colnames.index('date')]])
                        X_title.append(row[X_colnames[X_colnames.index('title')]])
                        X_peak_pos.append(row[X_colnames[X_colnames.index('peak_pos')]])
                        X_last_pos.append(row[X_colnames[X_colnames.index('last_pos')]])
                        X_weeks.append(row[X_colnames[X_colnames.index('weeks')]])
                        X_rank.append(row[X_colnames[X_colnames.index('rank')]])
                        X_change.append(row[X_colnames[X_colnames.index('change')]])
                        X_genre.append(row[X_colnames[X_colnames.index('genre')]])
                        X_energy.append(row[X_colnames[X_colnames.index('energy')]])
                        X_liveness.append(row[X_colnames[X_colnames.index('liveness')]])
                        X_tempo.append(row[X_colnames[X_colnames.index('tempo')]])
                        X_speechiness.append(row[X_colnames[X_colnames.index('speechiness')]])
                        X_acousticness.append(row[X_colnames[X_colnames.index('acousticness')]]
                        X_instrumentalness.append(row[X_colnames[X_colnames.index('instrumental
                        X_danceability.append(row[X_colnames[X_colnames.index('danceability')]]
                        X_key.append(row[X_colnames[X_colnames.index('key')]])
                        X_duration_ms.append(row[X_colnames[X_colnames.index('duration_ms')]])
                        X_loudness.append(row[X_colnames[X_colnames.index('loudness')]])
                        X_valence.append(row[X_colnames[X_colnames.index('valence')]])
                        X_mode.append(row[X_colnames[X_colnames.index('mode')]])

            return np.array(X_date), np.array(X_title), np.array(X_peak_pos), np.array(X_last_p

In [3]: def DistMap(): # construct a distance map for [3, 10, 25, 50, 100] mapping
            distMap = dict()
            for i in range(0,101):
                if i==0:
                    distMap[i] = -1
                elif i>=1 and i<=3:
                    distMap[i] = 0
                elif i<=10 and i>=4:
                    distMap[i] = 1
                elif i<=25 and i>=11:
                    distMap[i] = 2
                elif i<=50 and i>=26:
                    distMap[i] = 3
                else:
                    distMap[i] = 4
            return distMap

In [4]: def dataPreprocessing(dist, X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X
                              X_speechiness, X_acousticness, X_instrumentalness, X_danceability
            # make all features into proper data type
            X_energy = X_energy.astype('float64')
            X_liveness = X_liveness.astype('float64')
            X_tempo = X_tempo.astype('float64')
            X_speechiness = X_speechiness.astype('float64')
```

```
X_acousticness = X_acousticness.astype('float64')
X_instrumentalness = X_instrumentalness.astype('float64')
X_danceability = X_danceability.astype('float64')
X_duration_ms = X_duration_ms.astype('float64')
X_loudness = X_loudness.astype('float64')
X_valence = X_valence.astype('float64')
X_peak_pos = X_peak_pos.astype('int')
X_last_pos = X_last_pos.astype('int')
X_weeks = X_weeks.astype('int')
X_rank = X_rank.astype('int')
X_key = X_key.astype('int')
X_mode = X_mode.astype('int')

# try to combine X_key and X_mode into one feature
X_key_mode = np.zeros(len(X_key))
for i in range(len(X_key)):
    if X_mode[i]==1:
        X_key_mode[i] = X_key[i]
    else:
        X_key_mode[i] = (-1) * X_key[i]

# normalize data to zero mean with variance one
#X_energy = preprocessing.scale(X_energy)
#X_liveness = preprocessing.scale(X_liveness)
X_tempo = preprocessing.scale(X_tempo)
#X_speechiness = preprocessing.scale(X_speechiness)
#X_acousticness = preprocessing.scale(X_acousticness)
#X_instrumentalness = preprocessing.scale(X_instrumentalness)
#X_danceability = preprocessing.scale(X_danceability)
X_duration_ms = preprocessing.scale(X_duration_ms)
X_loudness = preprocessing.scale(X_loudness)
X_key_mode = preprocessing.scale(X_key_mode)
#X_valence = preprocessing.scale(X_valence)

# 1. turn ranking into corresponding distance
# 2. process non-numeric symbols
    # if dist = 50, binary classification
    # if dist = 0, division will be [3, 10, 25, 50, 100]
distMap = DistMap()
for i in range(len(X_rank)):
    if X_change[i] == 'Re-Entry':
        X_change[i] = X_peak_pos[i] - X_weeks[i]
    elif X_change[i] == 'New' or X_change[i] == 'Hot Shot Debut':
        X_change[i] = 0
        X_peak_pos[i] = 0
        X_last_pos[i] = 0
    else:
        X_change[i] = X_last_pos[i] - X_rank[i]
```

```
                if dist != 0:
                    X_rank[i] = int((X_rank[i]-1)/dist)
                    X_peak_pos[i] = int((X_peak_pos[i]-1)/dist)
                    X_last_pos[i] = int((X_last_pos[i]-1)/dist)
                else: # dist = 0
                    X_rank[i] = distMap[X_rank[i]]
                    X_peak_pos[i] = distMap[X_peak_pos[i]]
                    X_last_pos[i] = distMap[X_last_pos[i]]

            return X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre
```

```
In [5]: def genrePreprocessing(X_genre):
            # create corresponding genre dictionary
            genre = []
            genre_dict = dict()
            for i in range(len(X_genre)):
                X_genre[i] = X_genre[i].replace('[', '')
                X_genre[i] = X_genre[i].replace(']', '')
                X_genre[i] = X_genre[i].split(',')
                for j in range(len(X_genre[i])):
                    if j == 0:
                        if X_genre[i][j] != '' and X_genre[i][j] != 'unknown':
                            if X_genre[i][j] not in genre:
                                genre.append(X_genre[i][j])
                                #print('[i, j, X]: ', i, j, X_genre[i][j])
                                genre_dict[X_genre[i][j]] = 1
                            else:
                                genre_dict[X_genre[i][j]] += 1
                    else:
                        if X_genre[i][j] != '' and X_genre[i][j] != 'unknown':
                            if X_genre[i][j][1:] not in genre:
                                genre.append(X_genre[i][j][1:])
                                #print('[i, j, X]: ', i, j, X_genre[i][j][1:])
                                genre_dict[X_genre[i][j][1:]] = 1
                            else:
                                genre_dict[X_genre[i][j][1:]] += 1

            return genre_dict, genre
```

```
In [6]: def dfSongGenre(X_genre, genre):
            # create indicator matrix for song and genre
            genre_indicator = np.zeros((len(X_genre), len(genre)))
            for i in range(len(X_genre)):
                for j in range(len(X_genre[i])):
                    if j == 0:
                        if X_genre[i][j] != '' and X_genre[i][j] != 'unknown':
                            genre_indicator[i][genre.index(X_genre[i][j])] = 1
                    else:
                        if X_genre[i][j] != '' and X_genre[i][j] != 'unknown':
                            genre_indicator[i][genre.index(X_genre[i][j][1:])] = 1

            # create indicator data frame between song and genre
            df_song_genre = pd.DataFrame(genre_indicator,columns=genre)

            return genre_indicator, df_song_genre
```

```
In [7]: def adjGenre(X_genre, genre):
            # create adjacency matrix for genre
            genre_Adj = np.zeros((len(genre), len(genre)))
            for i in range(len(X_genre)):
                if len(X_genre[i]) == 1:
                    if X_genre[i][0] != '' and X_genre[i][0] != 'unknown':
                        genre_Adj[genre.index(X_genre[i][0])][genre.index(X_genre[i][0])] += 1
                else:
                    for j in range(len(X_genre[i])):
                        if j == 0:
                            genre_Adj[genre.index(X_genre[i][j])][genre.index(X_genre[i][j])]
                        else:
                            genre_Adj[genre.index(X_genre[i][j][1:])][genre.index(X_genre[i][j
                        for k in range(j+1, len(X_genre[i])):
                            if j == 0:
                                genre_Adj[genre.index(X_genre[i][j])][genre.index(X_genre[i][k
                                genre_Adj[genre.index(X_genre[i][k][1:])][genre.index(X_genre[
                            else:
                                genre_Adj[genre.index(X_genre[i][j][1:])][genre.index(X_genre[
                                genre_Adj[genre.index(X_genre[i][k][1:])][genre.index(X_genre[

            # create data frame for genre
            df_genre = pd.DataFrame(genre_Adj,columns=genre)

            return genre_Adj, df_genre
```

```
In [8]: def GenreCentrality(genre_Adj):
            # calculate genre centrality
            G_genre = nx.Graph()
            G_genre = nx.from_numpy_matrix(genre_Adj)

            cc_centrality = nx.closeness_centrality(G_genre)
            cc = list(cc_centrality.values())

            bc_centrality = nx.betweenness_centrality(G_genre, weight='weight')
            bc = list(bc_centrality.values())

            dc_centrality = nx.degree_centrality(G_genre)
            dc = list(dc_centrality.values())
            ec_centrality = nx.eigenvector_centrality(G_genre, weight='weight')
            ec = list(ec_centrality.values())

            return cc, bc, dc, ec
```

```
In [9]: def GenrelinearSum(genre_indicator, cc, bc, dc, ec):
            # compute summation of the centralities for each genre
            X_genre_cc = genre_indicator @ cc
            X_genre_bc = genre_indicator @ bc
            X_genre_dc = genre_indicator @ dc
            X_genre_ec = genre_indicator @ ec

            X_genre_cc = preprocessing.scale(X_genre_cc)
            X_genre_bc = preprocessing.scale(X_genre_bc)
            X_genre_dc = preprocessing.scale(X_genre_dc)
            X_genre_ec = preprocessing.scale(X_genre_ec)

            return X_genre_cc, X_genre_bc, X_genre_dc, X_genre_ec
```

```
In [10]: def GenreNum_Prob(X_genre, genre_dict, genre):
             # calculate number of genres on songs
             X_genre_num = np.zeros(len(X_genre))
             for i in range(len(X_genre)):
                 if '' in  X_genre[i] or 'unknown' in X_genre[i]:
                     X_genre_num[i] = 0
                 else:
                     X_genre_num[i] = len(X_genre[i])

             # find genre distribution and genre probability of songs
             X_genre_distribution = np.zeros(len(genre))
             for i in range(len(genre)):
                 X_genre_distribution[i] = genre_dict[genre[i]]/int(sum(X_genre_num))

             X_genre_prob = np.zeros(len(X_genre))
             for i in range(len(X_genre)):
                 if X_genre[i][0] == '' or X_genre[i][0] == 'unknown':
                     X_genre_prob[i] = 0
                 else:
                     for j in range(len(X_genre[i])):
                         if j == 0:
                             X_genre_prob[i] += X_genre_distribution[genre.index(X_genre[i][j]
                         else:
                             X_genre_prob[i] += X_genre_distribution[genre.index(X_genre[i][j]

             X_genre_num = preprocessing.scale(X_genre_num)
             X_genre_prob = preprocessing.scale(X_genre_prob)

             return X_genre_num, X_genre_distribution, X_genre_prob
```

```
In [11]: def buildTrainTestData(data_X, data_y):
             # build taining and testing data
             train_X = data_X[71:]
             train_y = data_y[71:]
             test_X = data_X[:70]
             test_y = data_y[:70]

             return train_X, train_y, test_X, test_y
```

```
In [181]: # get the data as np.array
          [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_energ

          # data preprocessing
          dist = 1 # distance for ranking
          # dist = 0 # if dist = 0, division will be [3, 10, 25, 50, 100]
          [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_energ
```

```
In [182]: # create genre dictionary
          [genre_dict, genre] = genrePreprocessing(X_genre)

          # create genre dataframe
          [genre_indicator, df_song_genre] = dfSongGenre(X_genre, genre)

          # create adjacency matrix for genre
          [genre_Adj, df_genre] = adjGenre(X_genre, genre)

          # genre centrality calculation
          [cc, bc, dc, ec] = GenreCentrality(genre_Adj)
          # np.argmax(dc), np.argmax(cc), np.argmax(bc), np.argmax(ec) = (3, 2, 2, 3)

          # create feature as linear summation of genres
          [X_genre_cc, X_genre_bc, X_genre_dc, X_genre_ec] = GenrelinearSum(genre_indicator, c

          # create feature as number of genres and probability distribution of genres
          [X_genre_num, X_genre_distribution, X_genre_prob] = GenreNum_Prob(X_genre, genre_dic
```

```
In [14]: # build data from features
         data_X = np.array([X_genre_num, (X_genre_prob*X_genre_num), X_genre_bc, X_genre_cc, X_
                            X_weeks, X_peak_pos, X_last_pos, #X_change[71:],
                            X_energy, X_liveness, X_tempo, X_speechiness, X_acousticness, X_i
                            X_duration_ms, X_loudness, X_valence, X_key_mode]).T
         data_y = X_rank

         [train_X, train_y, test_X, test_y] = buildTrainTestData(data_X, data_y)
```

```
In [ ]:
```

```
In [15]: # build random forest model
         forest = ensemble.RandomForestClassifier(n_estimators = 100)
         forest_fit = forest.fit(train_X, train_y)

         # cross-validation
         cv = ShuffleSplit(n_splits=10, test_size=0.3, random_state=0)
         cv_test_score = cross_val_score(forest, data_X, data_y, cv=cv)
         print('cv_test_score:', cv_test_score)

         # predict
         test_y_predicted = forest.predict(test_X)

         feature_importance = forest.feature_importances_
         print('feature_importance:', feature_importance)

         # performance
         accuracy = metrics.accuracy_score(test_y, test_y_predicted)
         print("accuracy: ", accuracy)
```

```
cv_test_score: [0.07688829 0.08322026 0.0877431  0.07869742 0.08412483 0.076436
 0.08819539 0.08231569 0.08367255 0.08457711]
feature_importance: [0.02390326 0.04132116 0.04195811 0.03947066 0.03940373 0.04151473
 0.05052447 0.0513871  0.06672349 0.05573109 0.0596599  0.05881902
 0.0585024  0.05855219 0.03146299 0.05841702 0.05886203 0.05835076
 0.05780031 0.04763557]
accuracy:  0.02857142857142857
```

```
In [1009]: # build SVM model
           linearSVM = svm.LinearSVC(max_iter=1000)
           linearSVM_fit = linearSVM.fit(train_X, train_y)

           # cross-validation
           cv = ShuffleSplit(n_splits=10, test_size=0.3, random_state=0)
           cv_test_score = cross_val_score(forest, data_X, data_y, cv=cv)
           print('cv_test_score:', cv_test_score)

           # predict
           test_y_predicted_SVM = linearSVM.predict(test_X)

           SVMcoef = linearSVM.coef_
           print('SVM coef:', SVMcoef)

           # performance
           accuracy_SVM = metrics.accuracy_score(test_y, test_y_predicted_SVM)
           print("accuracy_SVM: ", accuracy_SVM)
```

```
cv_test_score: [0.94934419 0.9434645  0.94753505 0.93848937 0.94120308 0.9375848
 0.94210764 0.94527363 0.94708277 0.94527363]
SVM coef: [[-1.40521688e-01  7.15059483e-02 -1.00046008e-01  4.50284897e-01
```

```
   1.56416643e-03 -1.14852596e-01 -6.58520667e-02  1.25124218e+00
   1.36304148e+00  1.30595962e-01  1.20530648e-01 -6.97371267e-03
  -8.34751699e-02  1.62559284e-02  7.55039785e-02 -3.06411797e-02
  -1.61076956e-02  1.02947629e-02 -1.13466704e-01  4.99064308e-04]]
accuracy_SVM:  0.7
```

```
In [16]: distance_list = np.array([1, 25, 50, 0])
         len_dist = len(distance_list)
         trials = 20

         accuracy_temp_fst = np.zeros((len_dist, trials))
         dist_Frobenius_norm_fst = np.zeros((len_dist, trials))
         dist_medium_fst = np.zeros((len_dist, trials))
         histogram_count_fst = np.zeros((len_dist, 100))

         accuracy_temp_svm = np.zeros((len_dist, trials))
         dist_Frobenius_norm_svm = np.zeros((len_dist, trials))
         dist_medium_svm = np.zeros((len_dist, trials))
         histogram_count_svm = np.zeros((len_dist, 100))

         for dis in range(len(distance_list)):
         ###############---change data here---################################################
             # get the data as np.array
             [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_e

             dist = distance_list[dis]
             [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_e

             # build data from features
             data_X = np.array([X_genre_num, (X_genre_prob*X_genre_num), X_genre_bc, X_genre_c
                                   X_weeks, X_peak_pos, X_last_pos, #X_change[71:],
                                   X_energy, X_liveness, X_tempo, X_speechiness, X_acousticness,
                                   X_duration_ms, X_loudness, X_valence, X_key_mode]).T
             data_y = X_rank
             # build taining and testing data
             [train_X, train_y, test_X, test_y] = buildTrainTestData(data_X, data_y)

         ###############---change data here---################################################

             for i in range(trials):
                 if i%9==0:
                     print('trials: ', i)

                 # build random forest model
                 forest = ensemble.RandomForestClassifier(n_estimators = 100)
                 forest_fit = forest.fit(train_X, train_y)
                 # predict
```

```
            test_y_predicted_fst = forest.predict(test_X)
            # performance
            accuracy_temp_fst[dis][i] = metrics.accuracy_score(test_y, test_y_predicted_f

            difference = abs(test_y_predicted_fst - test_y.T)
            dist_Frobenius_norm_fst[dis][i] = np.linalg.norm(difference)
            dist_medium_fst[dis][i] = np.median(difference)
            for j in range(len(difference)):
                histogram_count_fst[dis][difference[j]] += 1

            # build SVM model
            linearSVM = svm.LinearSVC(max_iter=1000)
            linearSVM_fit = linearSVM.fit(train_X, train_y)
            # predict
            test_y_predicted_svm = linearSVM.predict(test_X)

            # performance
            accuracy_temp_svm[dis][i] = metrics.accuracy_score(test_y, test_y_predicted_s

            difference = abs(test_y_predicted_svm - test_y.T)
            dist_Frobenius_norm_svm[dis][i] = np.linalg.norm(difference)
            dist_medium_svm[dis][i] = np.median(difference)
            for j in range(len(difference)):
                histogram_count_svm[dis][difference[j]] += 1
```

```
trials:  0


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  "the number of iterations.", ConvergenceWarning)
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trials:  9
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  18
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  0
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  9


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  18


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  0


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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```
trials:  9
```

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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  18
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  0
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  9


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  18


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
In [42]: max(train_y)

Out[42]: 0

In [19]: accuracy_temp_fst[0,:]

Out[19]: array([0.02857143, 0.04285714, 0.        , 0.        , 0.        ,
                0.04285714, 0.02857143, 0.01428571, 0.04285714, 0.        ,
                0.        , 0.01428571, 0.01428571, 0.04285714, 0.05714286,
                0.02857143, 0.01428571, 0.02857143, 0.04285714, 0.        ])

In [41]: mean_accuracy_fst = np.zeros(4)
         std_accuracy_fst = np.zeros(4)
         mean_accuracy_svm = np.zeros(4)
         std_accuracy_svm = np.zeros(4)
         for i in range(4):
             mean_accuracy_fst[i] = np.mean(accuracy_temp_fst[i,:])
             std_accuracy_fst[i] = np.std(accuracy_temp_fst[i,:])
             mean_accuracy_svm[i] = np.mean(accuracy_temp_svm[i,:])
             std_accuracy_svm[i] = np.std(accuracy_temp_svm[i,:])

         fig = plt.figure()
         plt.errorbar(range(4), mean_accuracy_fst, std_accuracy_fst, marker=".", lw=2, capthick
         plt.errorbar(range(4), mean_accuracy_svm, std_accuracy_svm, marker=".", lw=2, capthick

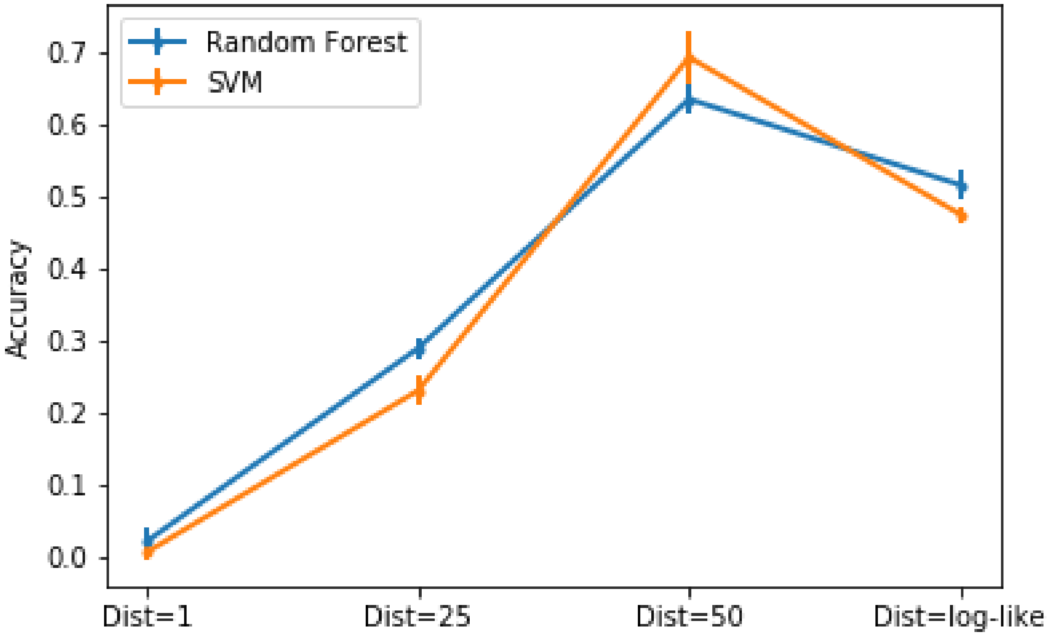
         plt.legend(('Random Forest', 'SVM'))
         plt.ylabel('Accuracy')
         plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])

         plt.show()


         fig.savefig('RF_SVM_20trials_dist_accuracy.png')

         with open('RF_SVM_20trials_dist_accuracy_fst.txt', 'w') as f:
             for item in accuracy_temp_fst:
                 f.write("%s\n" % item)
         with open('RF_SVM_20trials_dist_accuracy_svm.txt', 'w') as f:
             for item in accuracy_temp_fst:
                 f.write("%s\n" % item)
         '''
         accuracy_temp_fst = accuracy_temp_fst[:trials]
         accuracy_temp_svm = accuracy_temp_svm[:trials]
         fig = plt.figure()
         plt.plot(range(trials), accuracy_temp_fst, '-o')
         plt.plot(range(trials), accuracy_temp_svm, '-*')
         plt.legend(('Random Forest', 'SVM'))
         plt.ylabel('Accuracy (%)')
         plt.xlabel('# of Trials')
         plt.show()
         mean_accuracy_fst = np.mean(accuracy_temp_fst)
         std_accuracy_fst = np.std(accuracy_temp_fst)
         print('[mean_accuracy, std_accuracy]= ', [mean_accuracy_fst, std_accuracy_fst])

         '''
```



```
Out[41]: "\naccuracy_temp_fst = accuracy_temp_fst[:trials]\naccuracy_temp_svm = accuracy_temp_s
```

```
In [47]: mean_dist_norm_fst = np.zeros(4)
         std_dist_norm_fst = np.zeros(4)
         mean_dist_norm_svm = np.zeros(4)
         std_dist_norm_svm = np.zeros(4)
         for i in range(4):
             mean_dist_norm_fst[i] = np.mean(dist_Frobenius_norm_fst[i,:])
             std_dist_norm_fst[i] = np.std(dist_Frobenius_norm_fst[i,:])
             mean_dist_norm_svm[i] = np.mean(dist_Frobenius_norm_svm[i,:])
             std_dist_norm_svm[i] = np.std(dist_Frobenius_norm_svm[i,:])

         fig = plt.figure()
         plt.errorbar(range(4), mean_dist_norm_fst, std_dist_norm_fst, marker=".", lw=2, capthi
         plt.errorbar(range(4), mean_dist_norm_svm, std_dist_norm_svm, marker=".", lw=2, capthi

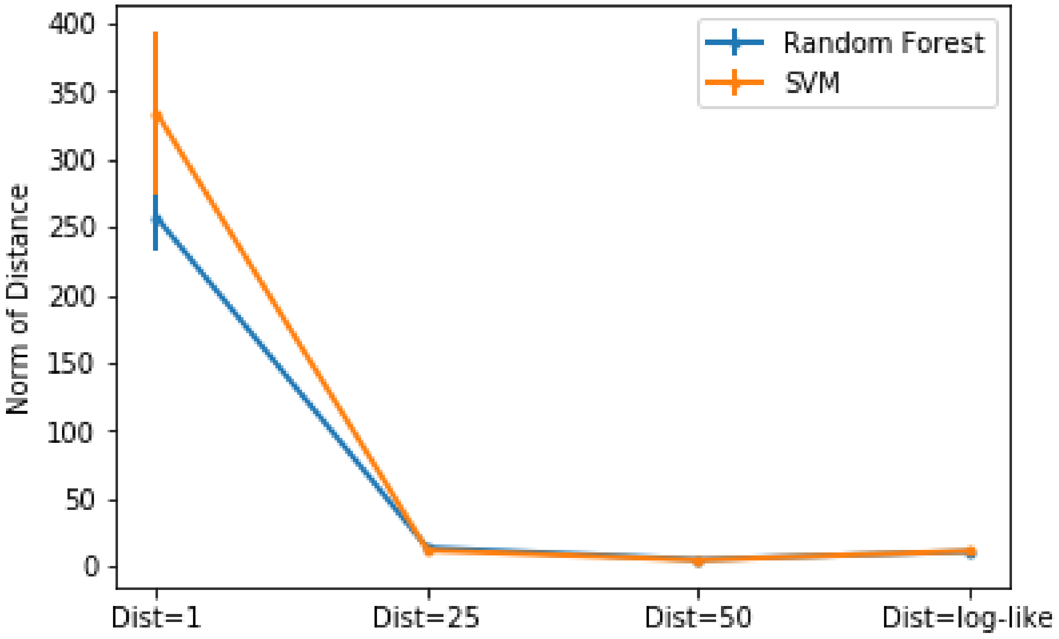
         plt.legend(('Random Forest', 'SVM'))
         plt.ylabel('Norm of Distance')
         plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])

         plt.show()


         fig.savefig('RF_SVM_20trials_dist_norm.png')

         with open('RF_SVM_20trials_dist_norm_fst.txt', 'w') as f:
             for item in dist_Frobenius_norm_fst:
                 f.write("%s\n" % item)
         with open('RF_SVM_20trials_dist_norm_svm.txt', 'w') as f:
             for item in dist_Frobenius_norm_svm:
                 f.write("%s\n" % item)

         '''fig = plt.figure()
         plt.plot(range(trials), dist_Frobenius_norm_fst, '-o')
         plt.plot(range(trials), dist_Frobenius_norm_svm, '-*')
         plt.legend(('Random Forest', 'SVM'))
         plt.ylabel('Norm of Distance')
         plt.xlabel('# of Trials')'''
```



```
Out[47]: "fig = plt.figure()\nplt.plot(range(trials), dist_Frobenius_norm_fst, '-o')\nplt.plot

In [48]: mean_dist_medium_fst = np.zeros(4)
         std_dist_medium_fst = np.zeros(4)
         mean_dist_medium_svm = np.zeros(4)
```

```
std_dist_medium_svm = np.zeros(4)
for i in range(4):
    mean_dist_medium_fst[i] = np.mean(dist_medium_fst[i,:])
    std_dist_medium_fst[i] = np.std(dist_medium_fst[i,:])
    mean_dist_medium_svm[i] = np.mean(dist_medium_svm[i,:])
    std_dist_medium_svm[i] = np.std(dist_medium_svm[i,:])

fig = plt.figure()
plt.errorbar(range(4), mean_dist_medium_fst, std_dist_medium_fst, marker=".", lw=2, ca
plt.errorbar(range(4), mean_dist_medium_svm, std_dist_medium_svm, marker=".", lw=2, ca

plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Medium of Distance')
plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])

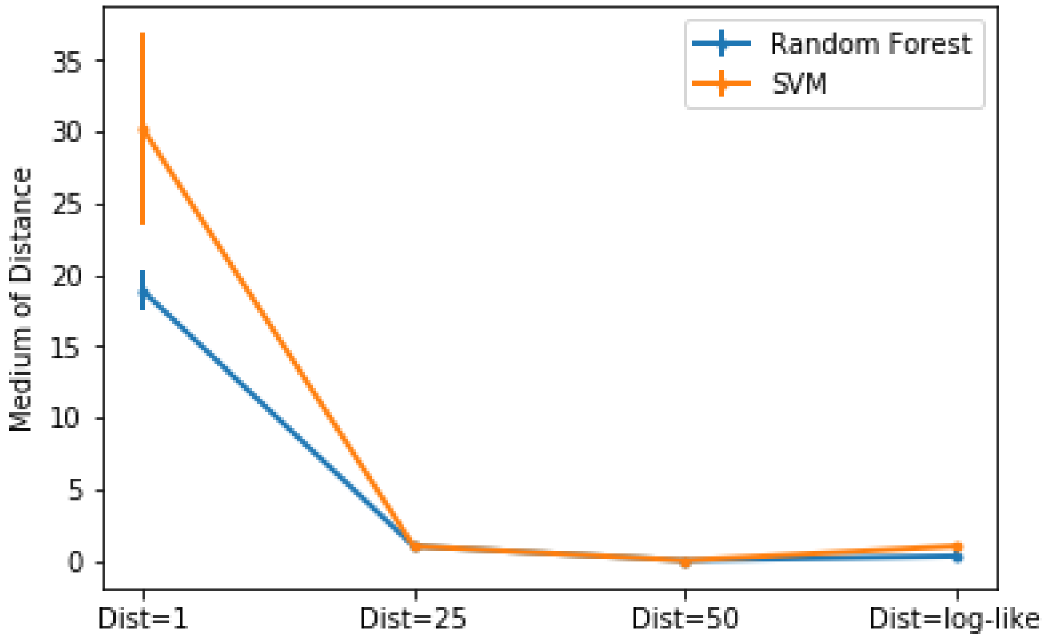
plt.show()


fig.savefig('RF_SVM_20trials_dist_medium.png')

with open('RF_SVM_20trials_dist_medium_fst.txt', 'w') as f:
    for item in dist_medium_fst:
        f.write("%s\n" % item)
with open('RF_SVM_20trials_dist_medium_svm.txt', 'w') as f:
    for item in dist_medium_svm:
        f.write("%s\n" % item)


'''fig = plt.figure()
plt.plot(range(trials), dist_medium_fst, '-o')
plt.plot(range(trials), dist_medium_svm, '-*')
plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Medium of Distance')
plt.xlabel('# of Trials')

plt.show()'''
```



```
Out[48]: "fig = plt.figure()\nplt.plot(range(trials), dist_medium_fst, '-o')\nplt.plot(range(t
```

```
In [57]: # Dist = 1
         fig = plt.figure()
         plt.plot(range(0,100), histogram_count_fst[0][:], '-o')
         plt.plot(range(0,100), histogram_count_svm[0][:], '-*')
         plt.legend(('Random Forest', 'SVM'))
         plt.ylabel('Frequency')
         plt.xlabel('Ranking Dist. (Dist=1)')

         plt.show()
         fig.savefig('RF_SVM_20trials_dist1_hist.png')

         # Dist = 25
         fig = plt.figure()
         plt.plot(range(0,4), histogram_count_fst[1][:4], '-o')
         plt.plot(range(0,4), histogram_count_svm[1][:4], '-*')
         plt.legend(('Random Forest', 'SVM'))
         plt.ylabel('Frequency')
         plt.xlabel('Ranking Dist. (Dist=25)')
         plt.xticks(range(4))

         plt.show()
         fig.savefig('RF_SVM_20trials_dist25_hist.png')

         # Dist = 50
```

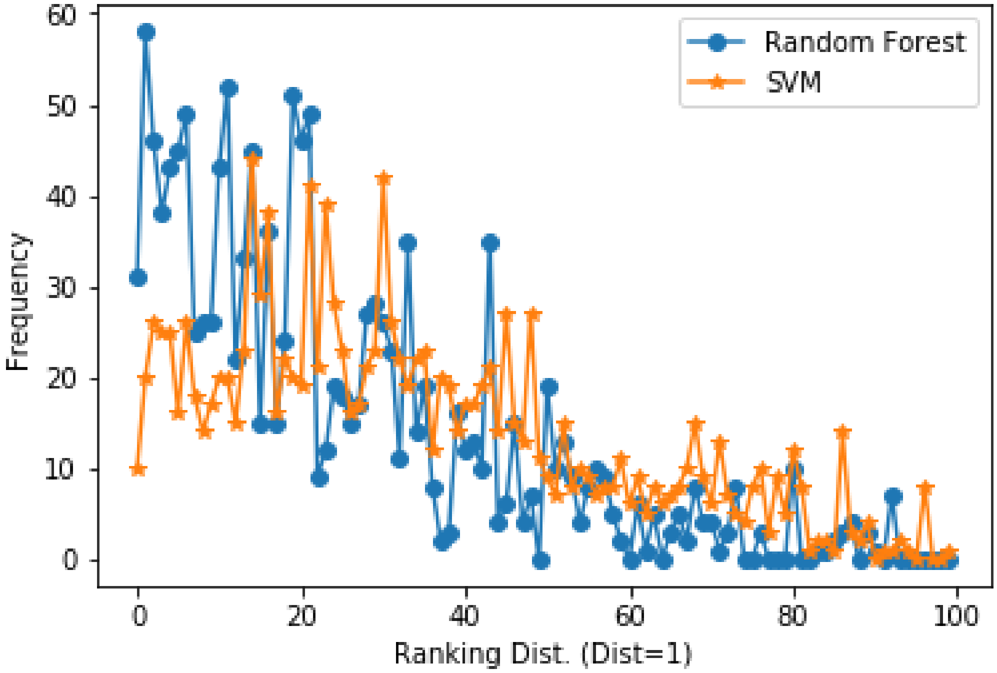
```
fig = plt.figure()
plt.plot(range(0,2), histogram_count_fst[2][:2], '-o')
plt.plot(range(0,2), histogram_count_svm[2][:2], '-*')
plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Frequency')
plt.xlabel('Ranking Dist. (Dist=50)')
plt.xticks(range(2))

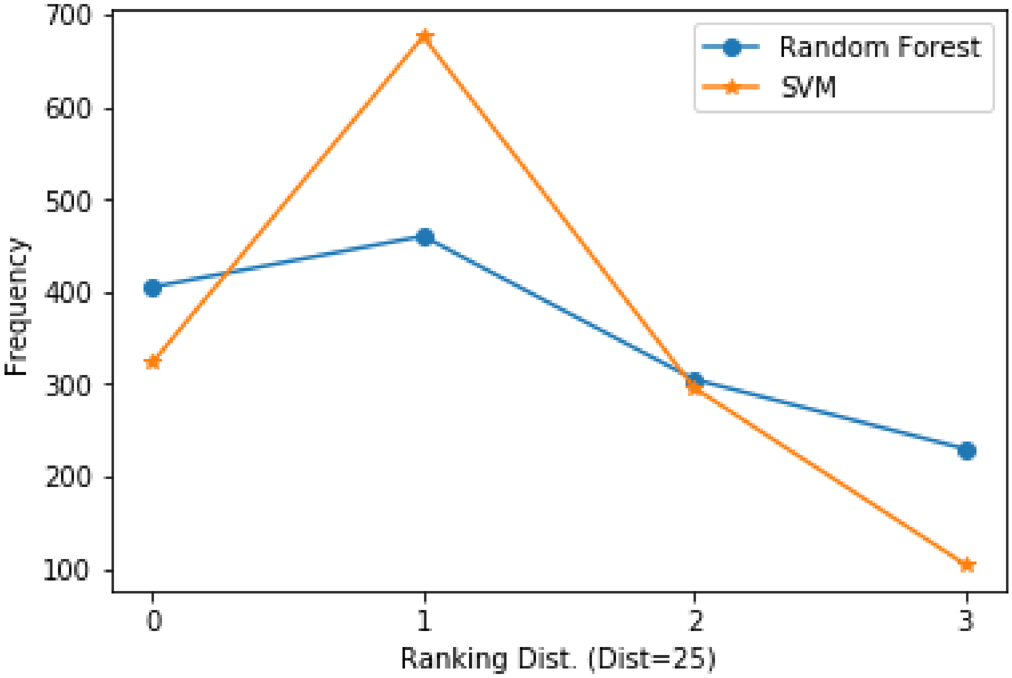
plt.show()
fig.savefig('RF_SVM_20trials_dist50_hist.png')

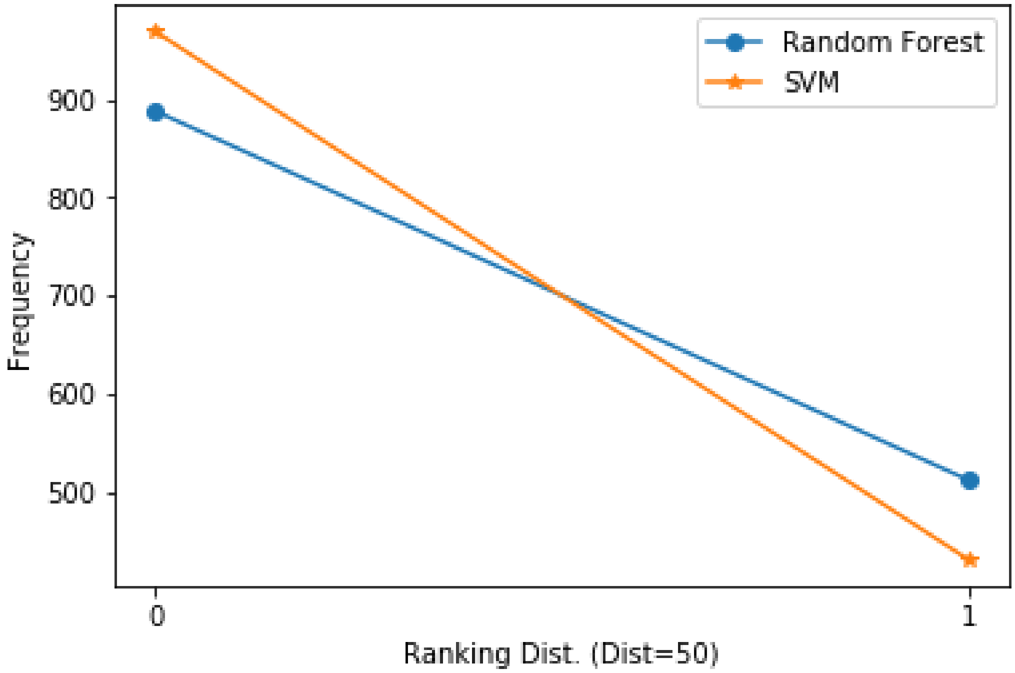
# Dist = log-like
fig = plt.figure()
plt.plot(range(0,5), histogram_count_fst[3][:5], '-o')
plt.plot(range(0,5), histogram_count_svm[3][:5], '-*')
plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Frequency')
plt.xlabel('Ranking Dist. (Dist=log-like)')
plt.xticks(range(5))

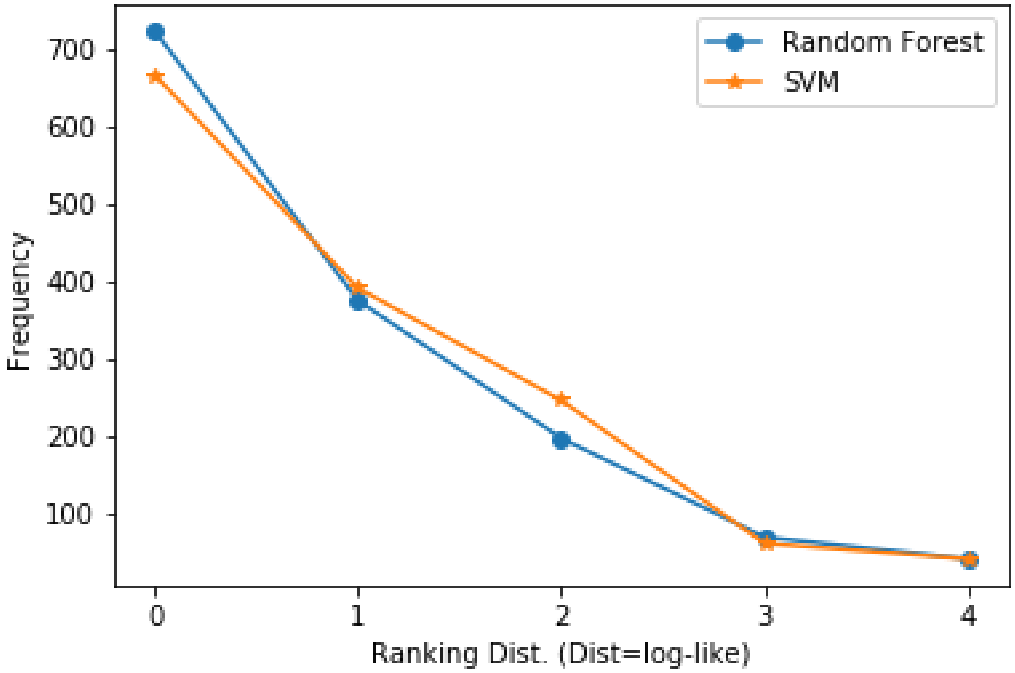
plt.show()
fig.savefig('RF_SVM_20trials_distloglike_hist.png')


with open('RF_SVM_20trials_dist_hist_fst.txt', 'w') as f:
    for item in histogram_count_fst:
        f.write("%s\n" % item)
with open('RF_SVM_20trials_dist_hist_svm.txt', 'w') as f:
    for item in histogram_count_svm:
        f.write("%s\n" % item)
```


Frequency
60
50
40
30
20
10
0
0
20
40
60
80
100
Ranking Dist. (Dist=1)
Random Forest
SVM


Frequency
700
600
500
400
300
200
100
0
1
2
3
Ranking Dist. (Dist=25)
Random Forest
SVM


Random Forest
SVM
900
800
700
600
500
Frequency
0
1
Ranking Dist. (Dist=50)


Random Forest
SVM
700
600
500
400
300
200
100
Frequency
0
1
2
3
4
Ranking Dist. (Dist=log-like)

```
In [ ]:
```

```
In [ ]: # smaller network!!!!
```

```
In [164]: # implement smaller network
          distance_list = np.array([1, 25, 50, 0])
          len_dist = len(distance_list)
          trials = 51

          batch_size = 400#2500
          test_size = 100
          data_size = batch_size + test_size
          jump_range = int((len(X_title) - data_size)/(trials-1))


          accuracy_temp_fst = np.zeros((len_dist, trials))
          dist_Frobenius_norm_fst = np.zeros((len_dist, trials))
          dist_medium_fst = np.zeros((len_dist, trials))
          histogram_count_fst = np.zeros((len_dist, 100))

          accuracy_temp_svm = np.zeros((len_dist, trials))
          dist_Frobenius_norm_svm = np.zeros((len_dist, trials))
          dist_medium_svm = np.zeros((len_dist, trials))
          histogram_count_svm = np.zeros((len_dist, 100))

          for dis in range(len(distance_list)):
          ###############---change data here---##############################################
              # get the data as np.array
              [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_

              dist = distance_list[dis]
              [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_

              # build data from features
              data_X = np.array([X_genre_num, (X_genre_prob*X_genre_num), X_genre_bc, X_genre_
                                  X_weeks, X_peak_pos, X_last_pos, #X_change[71:],
                                  X_energy, X_liveness, X_tempo, X_speechiness, X_acousticness
                                  X_duration_ms, X_loudness, X_valence, X_key_mode]).T
              data_y = X_rank

          ###############---change data here---##############################################

              for i in range(trials):
                  if i%9==0:
                      print('trials: ', i)

                  if i!=51:
                      # build taining and testing data (test[j:j+batch_size], train[j+batch_si
                      train_X = data_X[i*jump_range:i*jump_range+batch_size]
                      train_y = data_y[i*jump_range:i*jump_range+batch_size]
```

```
                test_X = data_X[i*jump_range+batch_size:i*jump_range+data_size]
                test_y = data_y[i*jump_range+batch_size:i*jump_range+data_size]
            else:
                # build taining and testing data (test[7368-101-2500:7368-101], train[73
                train_X = data_X[7368-data_size-1:7368-test_size-1]
                train_y = data_y[7368-data_size-1:7368-test_size-1]
                test_X = data_X[7368-test_size-1:7368]
                test_y = data_y[7368-test_size-1:7368]

            # build random forest model
            forest = ensemble.RandomForestClassifier(n_estimators = 100)
            forest_fit = forest.fit(train_X, train_y)
            # predict
            test_y_predicted_fst = forest.predict(test_X)
            # performance
            accuracy_temp_fst[dis][i] = metrics.accuracy_score(test_y, test_y_predicted_f

            difference = abs(test_y_predicted_fst - test_y.T)
            dist_Frobenius_norm_fst[dis][i] = np.linalg.norm(difference)
            dist_medium_fst[dis][i] = np.median(difference)
            for j in range(len(difference)):
                histogram_count_fst[dis][difference[j]] += 1

            # build SVM model
            linearSVM = svm.LinearSVC(max_iter=1000)
            linearSVM_fit = linearSVM.fit(train_X, train_y)
            # predict
            test_y_predicted_svm = linearSVM.predict(test_X)

            # performance
            accuracy_temp_svm[dis][i] = metrics.accuracy_score(test_y, test_y_predicted_s

            difference = abs(test_y_predicted_svm - test_y.T)
            dist_Frobenius_norm_svm[dis][i] = np.linalg.norm(difference)
            dist_medium_svm[dis][i] = np.median(difference)
            for j in range(len(difference)):
                histogram_count_svm[dis][difference[j]] += 1
```

```
trials:  0
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
```

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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  9


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  18


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  27
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  36
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
```

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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  45
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  0
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  9
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  18
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  27
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
```

```
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  36
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  45
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  0
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  9
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
```

```
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  18


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  27


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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trials:  36


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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trials:  45


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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trials:  0


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trials:  9


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trials:  18


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  27
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  36
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  45
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
In [166]: mean_accuracy_fst = np.zeros(4)
          std_accuracy_fst = np.zeros(4)
          mean_accuracy_svm = np.zeros(4)
          std_accuracy_svm = np.zeros(4)
          for i in range(4):
              mean_accuracy_fst[i] = np.mean(accuracy_temp_fst[i,:])
              std_accuracy_fst[i] = np.std(accuracy_temp_fst[i,:])
              mean_accuracy_svm[i] = np.mean(accuracy_temp_svm[i,:])
              std_accuracy_svm[i] = np.std(accuracy_temp_svm[i,:])

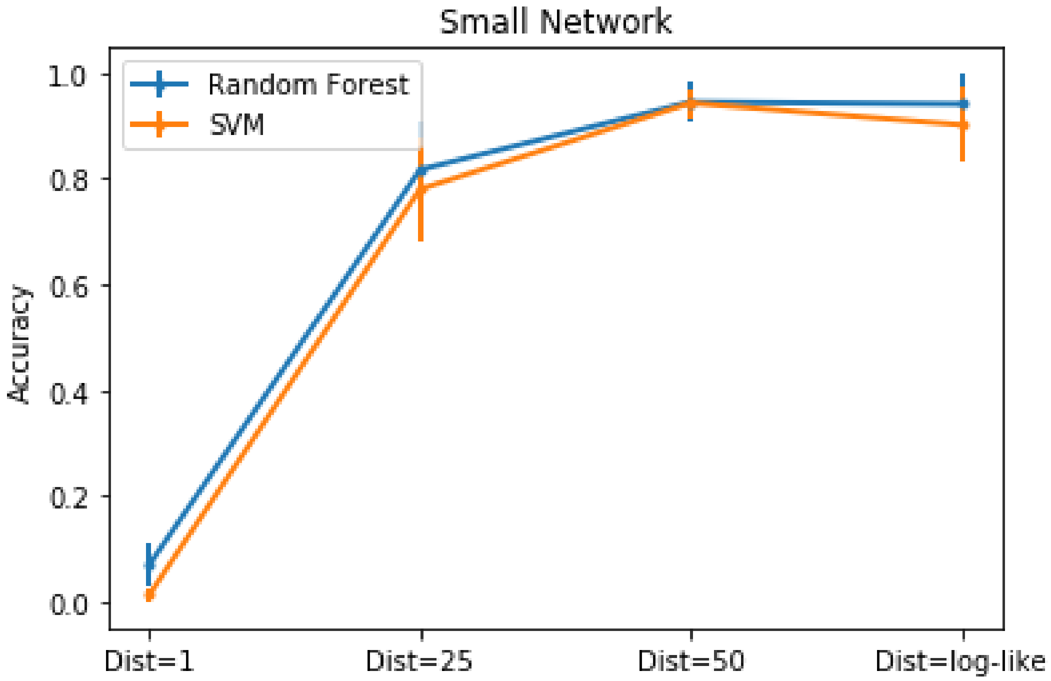
          fig = plt.figure()
          plt.errorbar(range(4), mean_accuracy_fst, std_accuracy_fst, marker=".", lw=2, capthic
          plt.errorbar(range(4), mean_accuracy_svm, std_accuracy_svm, marker=".", lw=2, capthi

          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Accuracy')
          plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])
          plt.title('Small Network')

          plt.show()
```

```
fig.savefig('RF_SVM_smallNet_500_51trials_dist_accuracy.png')

with open('RF_SVM_smallNet_500_51trials_dist_accuracy_fst.txt', 'w') as f:
    for item in accuracy_temp_fst:
        f.write("%s\n" % item)
with open('RF_SVM_smallNet_500_51trials_dist_accuracy_svm.txt', 'w') as f:
    for item in accuracy_temp_fst:
        f.write("%s\n" % item)
```



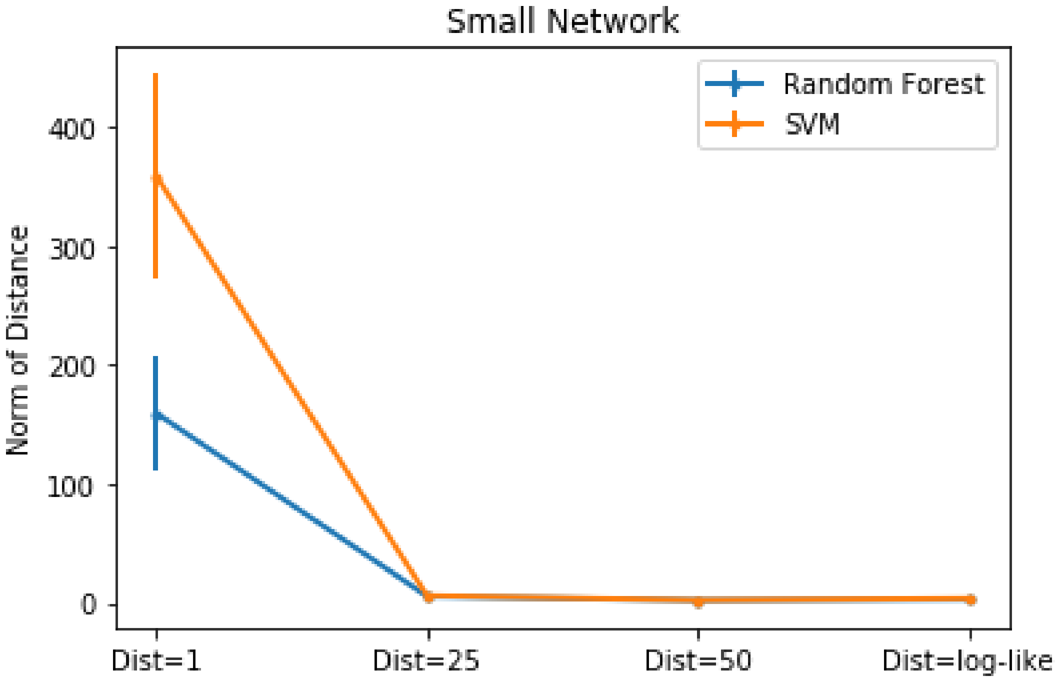
```
In [169]: mean_dist_norm_fst = np.zeros(4)
          std_dist_norm_fst = np.zeros(4)
          mean_dist_norm_svm = np.zeros(4)
          std_dist_norm_svm = np.zeros(4)
          for i in range(4):
              mean_dist_norm_fst[i] = np.mean(dist_Frobenius_norm_fst[i,:])
              std_dist_norm_fst[i] = np.std(dist_Frobenius_norm_fst[i,:])
              mean_dist_norm_svm[i] = np.mean(dist_Frobenius_norm_svm[i,:])
              std_dist_norm_svm[i] = np.std(dist_Frobenius_norm_svm[i,:])

          fig = plt.figure()
          plt.errorbar(range(4), mean_dist_norm_fst, std_dist_norm_fst, marker=".", lw=2, capt
          plt.errorbar(range(4), mean_dist_norm_svm, std_dist_norm_svm, marker=".", lw=2, captl
          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Norm of Distance')
          plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])
          plt.title('Small Network')

          plt.show()


          fig.savefig('RF_SVM_smallNet_500_51trials_dist_norm.png')

          with open('RF_SVM_smallNet_500_51trials_dist_norm_fst.txt', 'w') as f:
              for item in dist_Frobenius_norm_fst:
                  f.write("%s\n" % item)
          with open('RF_SVM_smallNet_500_51trials_dist_norm_svm.txt', 'w') as f:
              for item in dist_Frobenius_norm_svm:
                  f.write("%s\n" % item)
```



```
In [167]: mean_dist_medium_fst = np.zeros(4)
          std_dist_medium_fst = np.zeros(4)
          mean_dist_medium_svm = np.zeros(4)
          std_dist_medium_svm = np.zeros(4)
          for i in range(4):
              mean_dist_medium_fst[i] = np.mean(dist_medium_fst[i,:])
```

```
    std_dist_medium_fst[i] = np.std(dist_medium_fst[i,:])
    mean_dist_medium_svm[i] = np.mean(dist_medium_svm[i,:])
    std_dist_medium_svm[i] = np.std(dist_medium_svm[i,:])

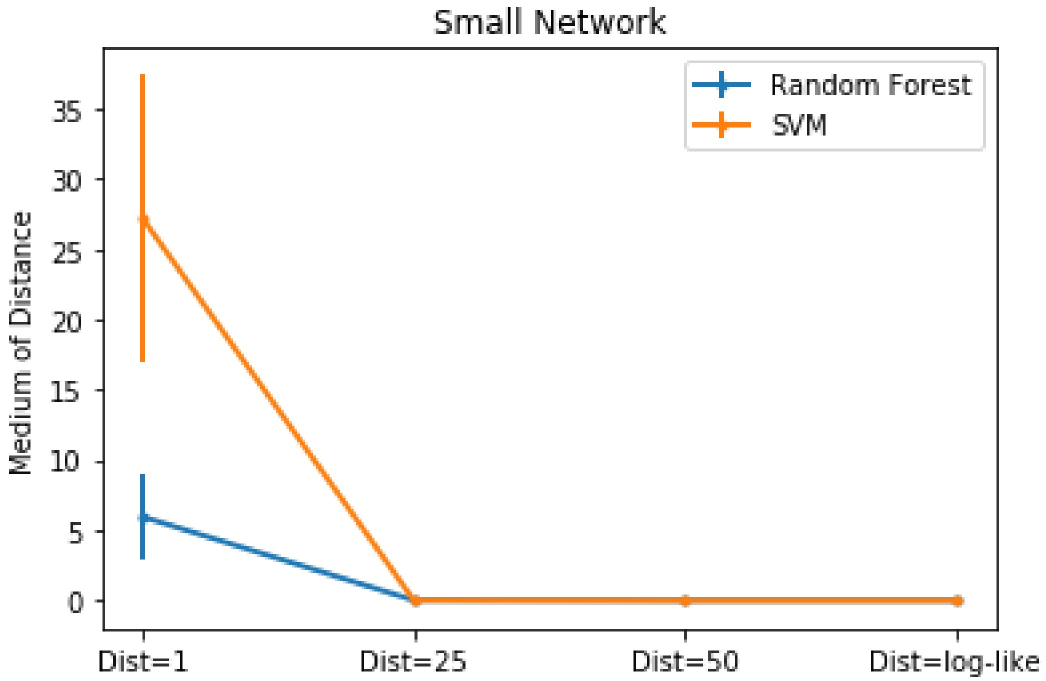
fig = plt.figure()
plt.errorbar(range(4), mean_dist_medium_fst, std_dist_medium_fst, marker=".", lw=2, c
plt.errorbar(range(4), mean_dist_medium_svm, std_dist_medium_svm, marker=".", lw=2, c

plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Medium of Distance')
plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])
plt.title('Small Network')

plt.show()


fig.savefig('RF_SVM_smallNet_500_51trials_dist_medium.png')

with open('RF_SVM_smallNet_500_51trials_dist_medium_fst.txt', 'w') as f:
    for item in dist_medium_fst:
        f.write("%s\n" % item)
with open('RF_SVM_smallNet_500_51trials_dist_medium_svm.txt', 'w') as f:
    for item in dist_medium_svm:
        f.write("%s\n" % item)
```



```
In [168]: # Dist = 1
          fig = plt.figure()
          plt.plot(range(0,100), histogram_count_fst[0][:], '-o')
          plt.plot(range(0,100), histogram_count_svm[0][:], '-*')
          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Frequency')
          plt.xlabel('Ranking Dist. (Dist=1)')
          plt.title('Small Network')

          plt.show()
          fig.savefig('RF_SVM_smallNet_500_51trials_dist1_hist.png')

          # Dist = 25
          fig = plt.figure()
          plt.plot(range(0,4), histogram_count_fst[1][:4], '-o')
          plt.plot(range(0,4), histogram_count_svm[1][:4], '-*')
          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Frequency')
          plt.xlabel('Ranking Dist. (Dist=25)')
          plt.xticks(range(4))
          plt.title('Small Network')

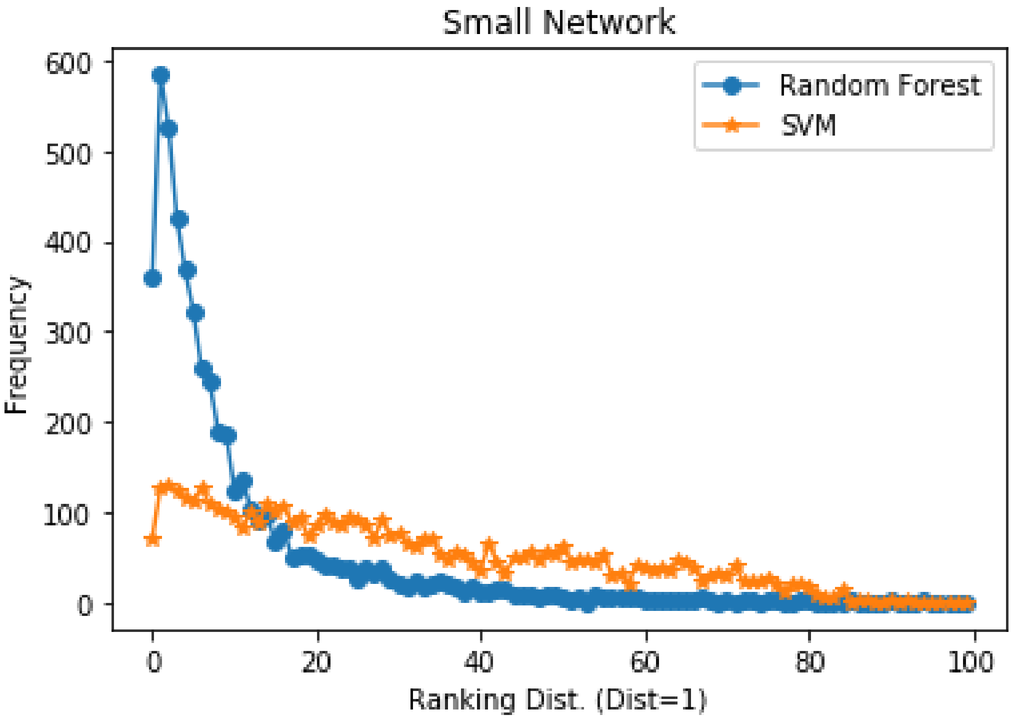
          plt.show()
          fig.savefig('RF_SVM_smallNet_500_51trials_dist25_hist.png')

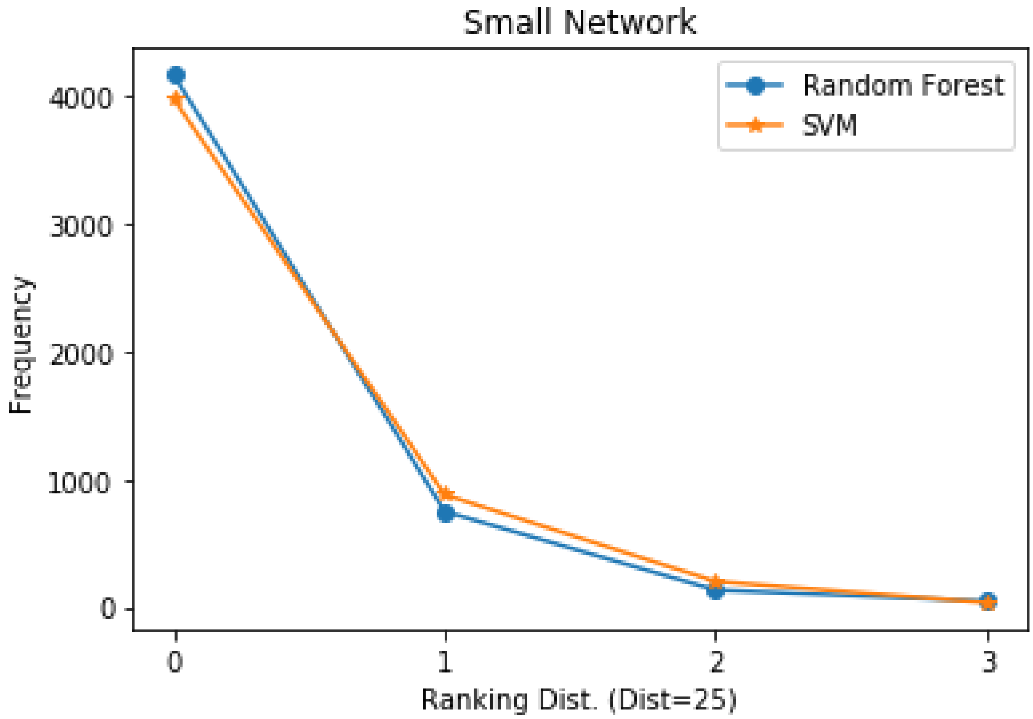
          # Dist = 50
          fig = plt.figure()
          plt.plot(range(0,2), histogram_count_fst[2][:2], '-o')
          plt.plot(range(0,2), histogram_count_svm[2][:2], '-*')
          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Frequency')
          plt.xlabel('Ranking Dist. (Dist=50)')
          plt.xticks(range(2))
          plt.title('Small Network')

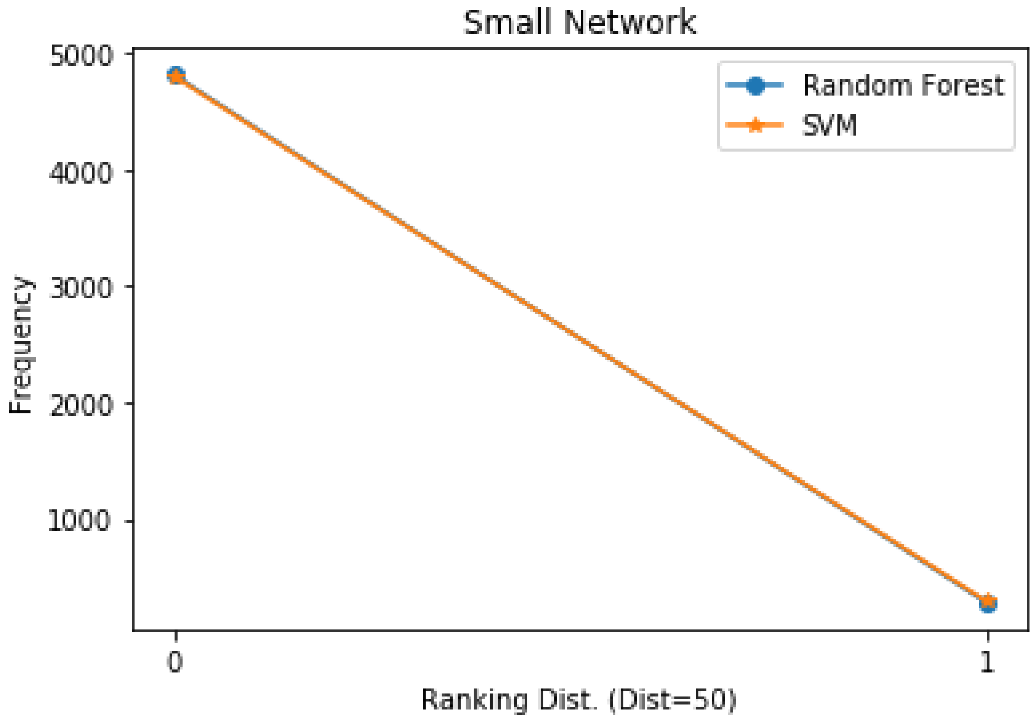
          plt.show()
          fig.savefig('RF_SVM_smallNet_500_51trials_dist50_hist.png')

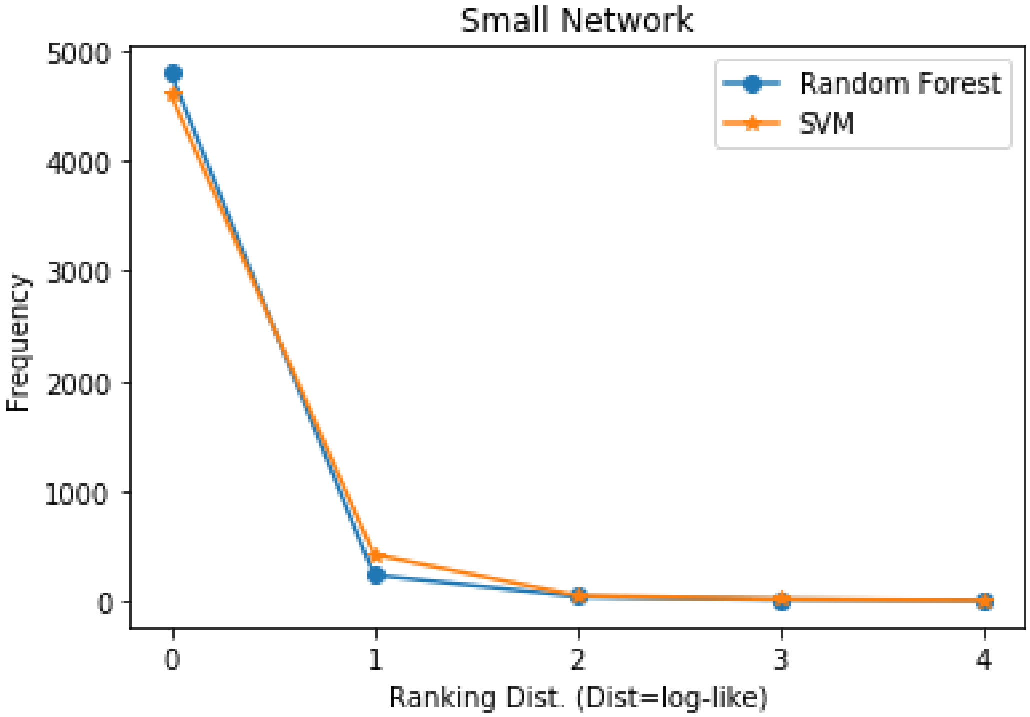
          # Dist = log-like
          fig = plt.figure()
          plt.plot(range(0,5), histogram_count_fst[3][:5], '-o')
          plt.plot(range(0,5), histogram_count_svm[3][:5], '-*')
          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Frequency')
          plt.xlabel('Ranking Dist. (Dist=log-like)')
          plt.xticks(range(5))
          plt.title('Small Network')
plt.show()
fig.savefig('RF_SVM_smallNet_500_51trials_distloglike_hist.png')


with open('RF_SVM_smallNet_500_51trials_dist_hist_fst.txt', 'w') as f:
    for item in histogram_count_fst:
        f.write("%s\n" % item)
with open('RF_SVM_smallNet_500_51trials_dist_hist_svm.txt', 'w') as f:
    for item in histogram_count_svm:
        f.write("%s\n" % item)
```




Small Network
Random Forest
SVM
Frequency
4000
3000
2000
1000
0
0
1
2
3
Ranking Dist. (Dist=25)


Small Network
Random Forest
SVM
Frequency
5000
4000
3000
2000
1000
0
1
Ranking Dist. (Dist=50)



```
In [ ]:

In [238]: np.shape(genre_indicator)

Out[238]: (7367, 390)

In [ ]:

In [245]: def adjGenre(data_size, genre_indicator, start):

              # create adjacency matrix for song
              song_Adj = np.zeros((data_size, data_size))

              for i in range(data_size):
                  song_Adj[i][i] = sum(genre_indicator[i + start])
                  if song_Adj[i][i] == 0:
                      song_Adj[i][i] = 1
                  for j in range(i+1, data_size):
                      count = sum(genre_indicator[i + start] * genre_indicator[j + start])
                      song_Adj[i][j] = count
                      song_Adj[j][i] = count

              # create data frame for song
              df_song = pd.DataFrame(song_Adj,columns=range(data_size))

              return song_Adj, df_song
```

```
In [277]: def SongCentrality(song_Adj):
              # calculate song centralities
              G_song = nx.Graph()
              G_song = nx.from_numpy_matrix(song_Adj)

              cc_centrality_song = nx.closeness_centrality(G_song)
              cc_song = list(cc_centrality.values())

              bc_centrality_song = nx.betweenness_centrality(G_song, weight='weight')
              bc_song = list(bc_centrality.values())

              dc_centrality_song = nx.degree_centrality(G_song)
              dc_song = list(dc_centrality.values())

              ec_centrality_song = nx.eigenvector_centrality(G_song, weight='weight')
              ec_song = list(ec_centrality.values())

              #X_song_cc = preprocessing.scale(cc_song)
              #X_song_bc = preprocessing.scale(bc_song)
              #X_song_dc = preprocessing.scale(dc_song)
              #X_song_ec = preprocessing.scale(ec_song)

              return cc_centrality, bc_centrality, dc_centrality, ec_centrality
```

```
In [ ]:
```

```
In [247]: # small network with song centrality!!
```

```
In [295]: i*jump_range, i*jump_range+len(cc_centrality)
```

```
Out[295]: (411, 883)
```

```
In [307]: len(X_date[7368-data_size-1:7368])
```

```
Out[307]: 500
```

```
In [ ]:
```

```
In [ ]:
```

```
In [308]: # implement smaller network
          distance_list = np.array([1, 25, 50, 0])
          len_dist = len(distance_list)
          trials = 51

          batch_size = 400#2500
          test_size = 100
          data_size = batch_size + test_size
          jump_range = int((len(X_title) - data_size)/(trials-1))
```

```
accuracy_temp_fst = np.zeros((len_dist, trials))
dist_Frobenius_norm_fst = np.zeros((len_dist, trials))
dist_medium_fst = np.zeros((len_dist, trials))
histogram_count_fst = np.zeros((len_dist, 100))

accuracy_temp_svm = np.zeros((len_dist, trials))
dist_Frobenius_norm_svm = np.zeros((len_dist, trials))
dist_medium_svm = np.zeros((len_dist, trials))
histogram_count_svm = np.zeros((len_dist, 100))

for dis in range(len(distance_list)):
###############---change data here---################################################
    # get the data as np.array
    [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_

    dist = distance_list[dis]
    [X_date, X_title, X_peak_pos, X_last_pos, X_weeks, X_rank, X_change, X_genre, X_

###############---change data here---################################################

    for i in range(trials):
        if i%9==0:
            print('trials: ', i)

        # create adjacency matrix for song
        if i!=51:
            [song_Adj, df_song] = adjGenre(data_size, genre_indicator, i*jump_range)

            # calculate song centralities
            [cc_centrality, bc_centrality, dc_centrality, ec_centrality] = SongCentra
            X_song_cc = np.zeros(len(X_genre_num))
            X_song_bc = np.zeros(len(X_genre_num))
            X_song_dc = np.zeros(len(X_genre_num))
            X_song_ec = np.zeros(len(X_genre_num))

            for l in range(data_size):
                if l in cc_centrality.keys():
                    X_song_cc[i*jump_range+l] = cc_centrality[l]
                if l in bc_centrality.keys():
                    X_song_bc[i*jump_range+l] = bc_centrality[l]
                if l in dc_centrality.keys():
                    X_song_dc[i*jump_range+l] = dc_centrality[l]
                if l in ec_centrality.keys():
                    X_song_ec[i*jump_range+l] = ec_centrality[l]

            X_song_cc[i*jump_range:i*jump_range+data_size] = preprocessing.scale(X_so
            X_song_bc[i*jump_range:i*jump_range+data_size] = preprocessing.scale(X_so
            X_song_dc[i*jump_range:i*jump_range+data_size] = preprocessing.scale(X_so
            X_song_ec[i*jump_range:i*jump_range+data_size] = preprocessing.scale(X_so
        else:
            [song_Adj, df_song] = adjGenre(data_size, genre_indicator, 7368-data_size

            # calculate song centralities
            [cc_centrality, bc_centrality, dc_centrality, ec_centrality] = SongCentra
            X_song_cc = np.zeros(len(X_genre_num))
            X_song_bc = np.zeros(len(X_genre_num))
            X_song_dc = np.zeros(len(X_genre_num))
            X_song_ec = np.zeros(len(X_genre_num))

            for l in range(data_size):
                if l in cc_centrality.keys():
                    X_song_cc[7368-data_size-1+l] = cc_centrality[l]
                if l in bc_centrality.keys():
                    X_song_bc[7368-data_size-1+l] = bc_centrality[l]
                if l in dc_centrality.keys():
                    X_song_dc[7368-data_size-1+l] = dc_centrality[l]
                if l in ec_centrality.keys():
                    X_song_ec[7368-data_size-1+l] = ec_centrality[l]

            X_song_cc[7368-data_size-1:7368] = preprocessing.scale(X_song_cc[7368-dat
            X_song_bc[7368-data_size-1:7368] = preprocessing.scale(X_song_bc[7368-dat
            X_song_dc[7368-data_size-1:7368] = preprocessing.scale(X_song_dc[7368-dat
            X_song_ec[7368-data_size-1:7368] = preprocessing.scale(X_song_ec[7368-dat




        # build data from features
        data_X = np.array([X_genre_num, (X_genre_prob*X_genre_num), X_genre_bc, X_gen
                            X_song_cc, X_song_bc, X_song_dc, X_song_ec,
                            X_weeks, X_peak_pos, X_last_pos, #X_change[71:],
                            X_energy, X_liveness, X_tempo, X_speechiness, X_acousticn
                            X_duration_ms, X_loudness, X_valence, X_key_mode]).T
        data_y = X_rank

        if i!=51:
            # build taining and testing data (test[j:j+batch_size], train[j+batch_si
            train_X = data_X[i*jump_range:i*jump_range+batch_size]
            train_y = data_y[i*jump_range:i*jump_range+batch_size]
            test_X = data_X[i*jump_range+batch_size:i*jump_range+data_size]
            test_y = data_y[i*jump_range+batch_size:i*jump_range+data_size]
        else:
            # build taining and testing data (test[7368-101-2500:7368-101], train[736
            train_X = data_X[7368-data_size-1:7368-test_size-1]
```

```
                train_y = data_y[7368-data_size-1:7368-test_size-1]
                test_X = data_X[7368-test_size-1:7368]
                test_y = data_y[7368-test_size-1:7368]

            # build random forest model
            forest = ensemble.RandomForestClassifier(n_estimators = 100)
            forest_fit = forest.fit(train_X, train_y)
            # predict
            test_y_predicted_fst = forest.predict(test_X)
            # performance
            accuracy_temp_fst[dis][i] = metrics.accuracy_score(test_y, test_y_predicted_

            difference = abs(test_y_predicted_fst - test_y.T)
            dist_Frobenius_norm_fst[dis][i] = np.linalg.norm(difference)
            dist_medium_fst[dis][i] = np.median(difference)
            for j in range(len(difference)):
                histogram_count_fst[dis][difference[j]] += 1

            # build SVM model
            linearSVM = svm.LinearSVC(max_iter=1000)
            linearSVM_fit = linearSVM.fit(train_X, train_y)
            # predict
            test_y_predicted_svm = linearSVM.predict(test_X)

            # performance
            accuracy_temp_svm[dis][i] = metrics.accuracy_score(test_y, test_y_predicted_

            difference = abs(test_y_predicted_svm - test_y.T)
            dist_Frobenius_norm_svm[dis][i] = np.linalg.norm(difference)
            dist_medium_svm[dis][i] = np.median(difference)
            for j in range(len(difference)):
                histogram_count_svm[dis][difference[j]] += 1
```

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trials:  0


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Liblin
  "the number of iterations.", ConvergenceWarning)
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trials:  9


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trials:  18


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trials:  27


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  "the number of iterations.", ConvergenceWarning)


trials:  36


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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trials:  45


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trials:  0


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trials:  18
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trials:  27
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
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trials:  36
```

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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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trials:  45
```

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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  0
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
```

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trials:  9
```

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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
```

```
  "the number of iterations.", ConvergenceWarning)


trials:  18


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  27


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  36


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  45


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  0


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  9
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  18
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  27


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
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C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)


trials:  36


C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
trials:  45
```

```
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
C:\Users\weich\Anaconda5\lib\site-packages\sklearn\svm\base.py:922: ConvergenceWarning: Libline
  "the number of iterations.", ConvergenceWarning)
```

```
In [513]: abs(test_y_predicted_svm - test_y.T)
```

```
Out[513]: array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0,
                 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
                 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1,
                 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0,
                 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])
```

```
In [309]: mean_accuracy_fst = np.zeros(4)
          std_accuracy_fst = np.zeros(4)
          mean_accuracy_svm = np.zeros(4)
          std_accuracy_svm = np.zeros(4)
          for i in range(4):
              mean_accuracy_fst[i] = np.mean(accuracy_temp_fst[i,:])
              std_accuracy_fst[i] = np.std(accuracy_temp_fst[i,:])
              mean_accuracy_svm[i] = np.mean(accuracy_temp_svm[i,:])
              std_accuracy_svm[i] = np.std(accuracy_temp_svm[i,:])

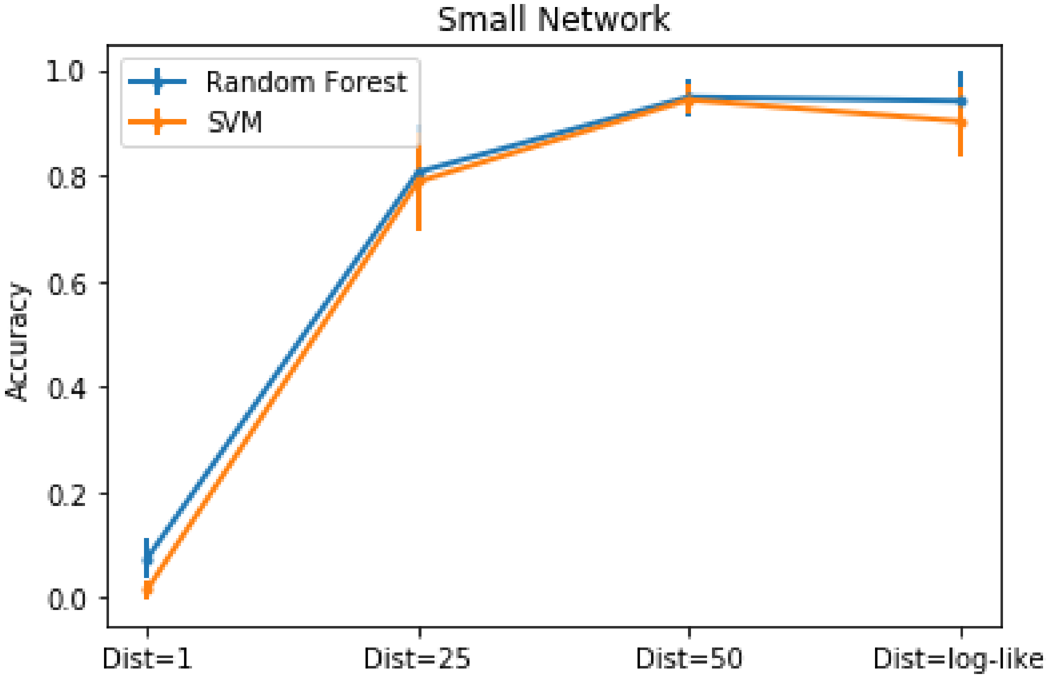
          fig = plt.figure()
          plt.errorbar(range(4), mean_accuracy_fst, std_accuracy_fst, marker=".", lw=2, capthi
          plt.errorbar(range(4), mean_accuracy_svm, std_accuracy_svm, marker=".", lw=2, capthi

          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Accuracy')
          plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])
          plt.title('Small Network')

          plt.show()


          fig.savefig('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_accuracy.png')

          with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_accuracy_fst.txt', 'w') as
              for item in accuracy_temp_fst:
                  f.write("%s\n" % item)
          with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_accuracy_svm.txt', 'w') as
              for item in accuracy_temp_fst:
                  f.write("%s\n" % item)
```



```
In [310]: mean_dist_norm_fst = np.zeros(4)
          std_dist_norm_fst = np.zeros(4)
          mean_dist_norm_svm = np.zeros(4)
          std_dist_norm_svm = np.zeros(4)
          for i in range(4):
              mean_dist_norm_fst[i] = np.mean(dist_Frobenius_norm_fst[i,:])
              std_dist_norm_fst[i] = np.std(dist_Frobenius_norm_fst[i,:])
              mean_dist_norm_svm[i] = np.mean(dist_Frobenius_norm_svm[i,:])
              std_dist_norm_svm[i] = np.std(dist_Frobenius_norm_svm[i,:])
```

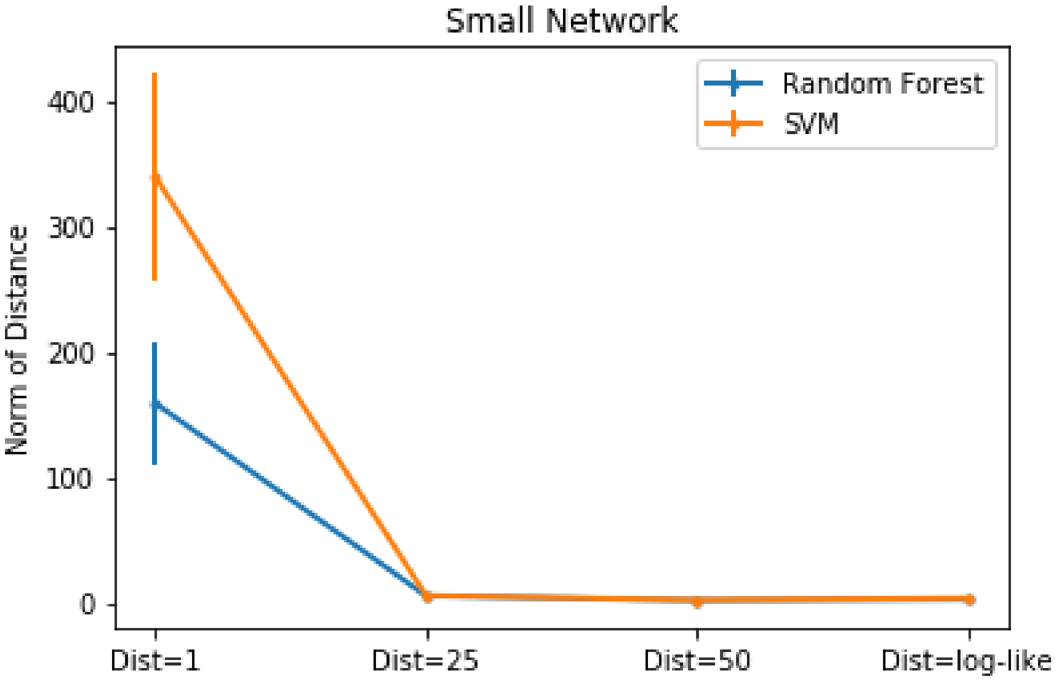
```
fig = plt.figure()
plt.errorbar(range(4), mean_dist_norm_fst, std_dist_norm_fst, marker=".", lw=2, captl
plt.errorbar(range(4), mean_dist_norm_svm, std_dist_norm_svm, marker=".", lw=2, captl

plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Norm of Distance')
plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])
plt.title('Small Network')

plt.show()


fig.savefig('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_norm.png')

with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_norm_fst.txt', 'w') as f:
    for item in dist_Frobenius_norm_fst:
        f.write("%s\n" % item)
with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_norm_svm.txt', 'w') as f:
    for item in dist_Frobenius_norm_svm:
        f.write("%s\n" % item)
```



```
In [311]: mean_dist_medium_fst = np.zeros(4)
          std_dist_medium_fst = np.zeros(4)
```

```
mean_dist_medium_svm = np.zeros(4)
std_dist_medium_svm = np.zeros(4)
for i in range(4):
    mean_dist_medium_fst[i] = np.mean(dist_medium_fst[i,:])
    std_dist_medium_fst[i] = np.std(dist_medium_fst[i,:])
    mean_dist_medium_svm[i] = np.mean(dist_medium_svm[i,:])
    std_dist_medium_svm[i] = np.std(dist_medium_svm[i,:])

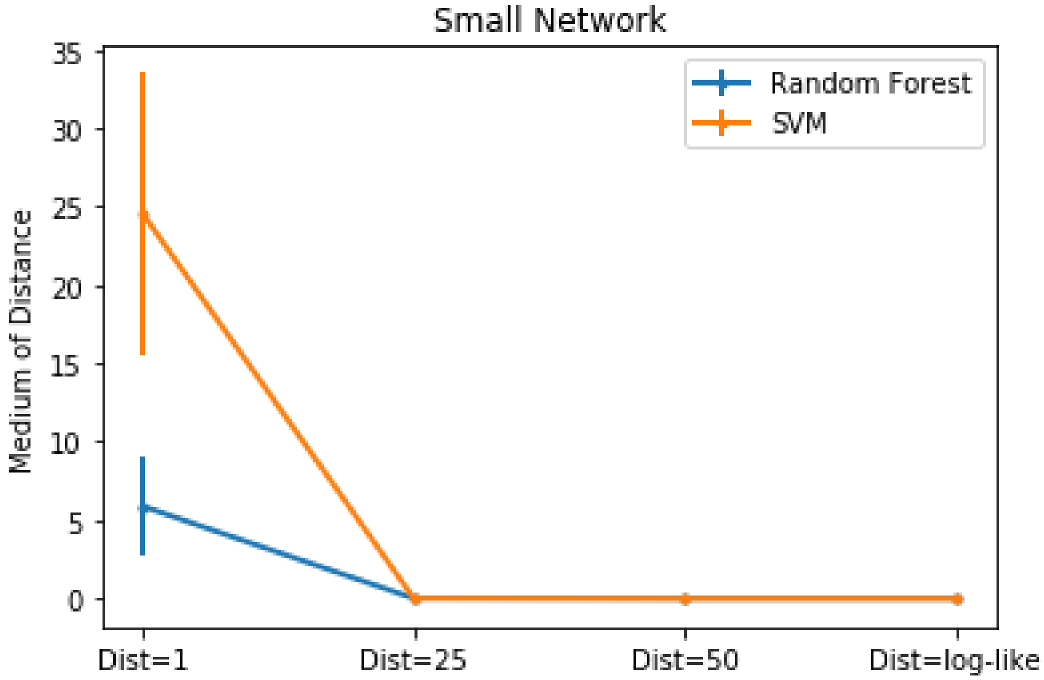
fig = plt.figure()
plt.errorbar(range(4), mean_dist_medium_fst, std_dist_medium_fst, marker=".", lw=2,
plt.errorbar(range(4), mean_dist_medium_svm, std_dist_medium_svm, marker=".", lw=2,

plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Medium of Distance')
plt.xticks([0., 1., 2., 3.], ["Dist=1", "Dist=25", "Dist=50", "Dist=log-like"])
plt.title('Small Network')

plt.show()


fig.savefig('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_medium.png')

with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_medium_fst.txt', 'w') as f
    for item in dist_medium_fst:
        f.write("%s\n" % item)
with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_medium_svm.txt', 'w') as f
    for item in dist_medium_svm:
        f.write("%s\n" % item)
```



```
In [312]: # Dist = 1
          fig = plt.figure()
          plt.plot(range(0,100), histogram_count_fst[0][:], '-o')
          plt.plot(range(0,100), histogram_count_svm[0][:], '-*')
          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Frequency')
          plt.xlabel('Ranking Dist. (Dist=1)')
          plt.title('Small Network')

          plt.show()
          fig.savefig('RF_SVM_smallNet_500_51trials_w_songCentrl_dist1_hist.png')

          # Dist = 25
          fig = plt.figure()
          plt.plot(range(0,4), histogram_count_fst[1][:4], '-o')
          plt.plot(range(0,4), histogram_count_svm[1][:4], '-*')
          plt.legend(('Random Forest', 'SVM'))
          plt.ylabel('Frequency')
          plt.xlabel('Ranking Dist. (Dist=25)')
          plt.xticks(range(4))
          plt.title('Small Network')

          plt.show()
          fig.savefig('RF_SVM_smallNet_500_51trials_w_songCentrl_dist25_hist.png')
```

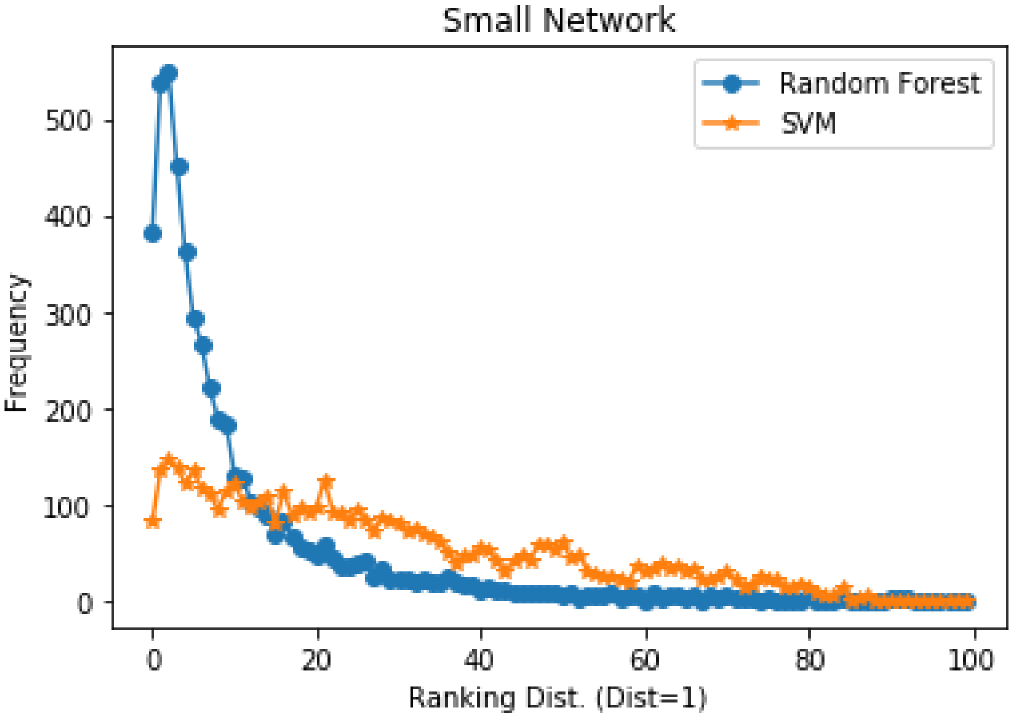
```
# Dist = 50
fig = plt.figure()
plt.plot(range(0,2), histogram_count_fst[2][:2], '-o')
plt.plot(range(0,2), histogram_count_svm[2][:2], '-*')
plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Frequency')
plt.xlabel('Ranking Dist. (Dist=50)')
plt.xticks(range(2))
plt.title('Small Network')

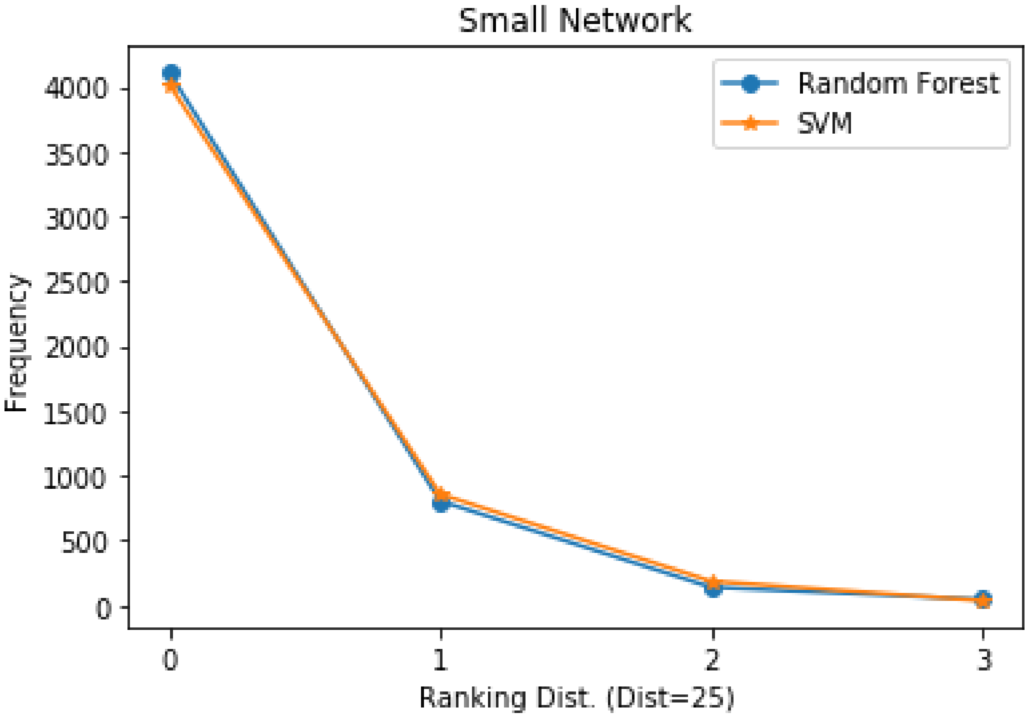
plt.show()
fig.savefig('RF_SVM_smallNet_500_51trials_w_songCentrl_dist50_hist.png')

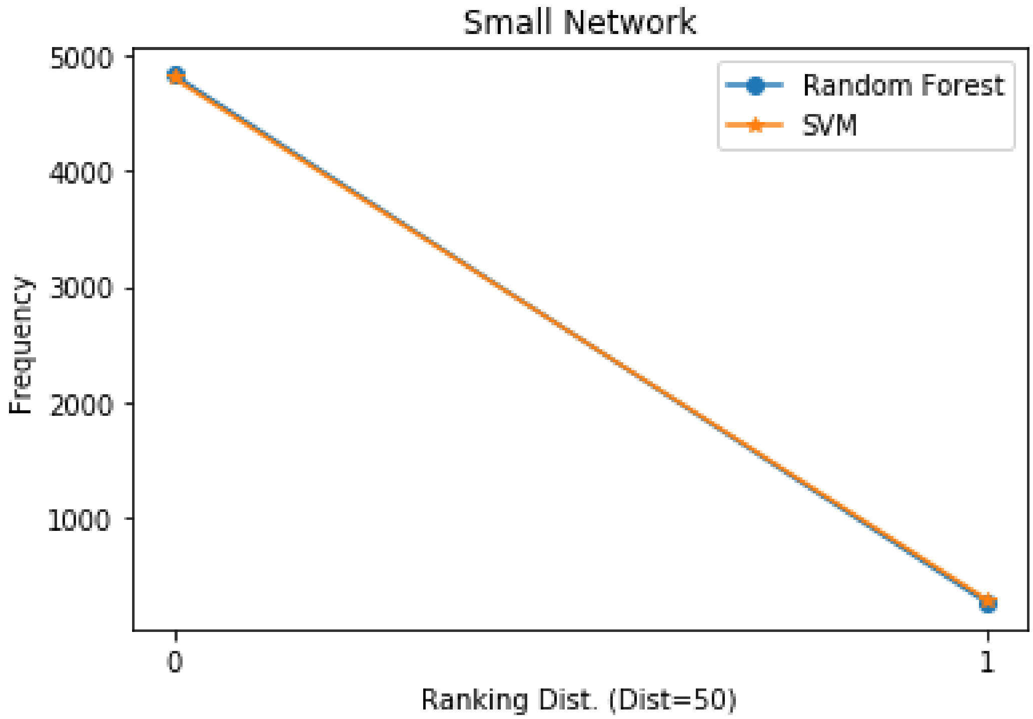
# Dist = log-like
fig = plt.figure()
plt.plot(range(0,5), histogram_count_fst[3][:5], '-o')
plt.plot(range(0,5), histogram_count_svm[3][:5], '-*')
plt.legend(('Random Forest', 'SVM'))
plt.ylabel('Frequency')
plt.xlabel('Ranking Dist. (Dist=log-like)')
plt.xticks(range(5))
plt.title('Small Network')

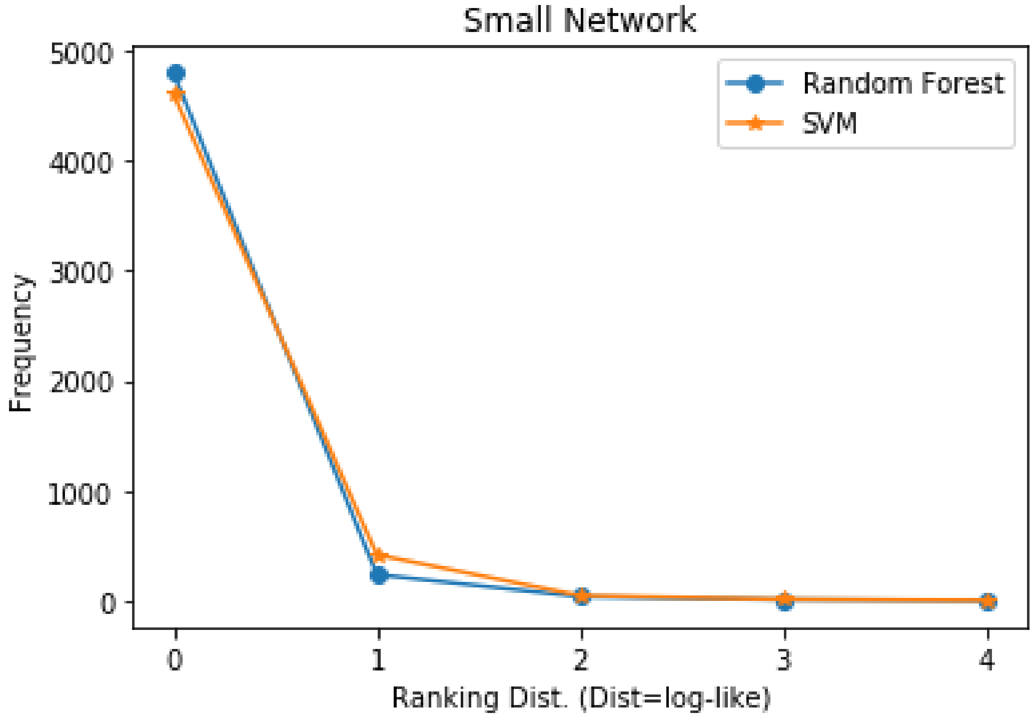
plt.show()
fig.savefig('RF_SVM_smallNet_500_51trials_w_songCentrl_distloglike_hist.png')


with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_hist_fst.txt', 'w') as f:
    for item in histogram_count_fst:
        f.write("%s\n" % item)
with open('RF_SVM_smallNet_500_51trials_w_songCentrl_dist_hist_svm.txt', 'w') as f:
    for item in histogram_count_svm:
        f.write("%s\n" % item)
```


Small Network
Random Forest
SVM
Frequency
0
100
200
300
400
500
0
20
40
60
80
100
Ranking Dist. (Dist=1)


Small Network
Random Forest
SVM
Frequency
0
500
1000
1500
2000
2500
3000
3500
4000
0
1
2
3
Ranking Dist. (Dist=25)


Small Network
Frequency
5000
4000
3000
2000
1000
0
1
Ranking Dist. (Dist=50)
Random Forest
SVM


Small Network
Frequency
5000
4000
3000
2000
1000
0
0
1
2
3
4
Ranking Dist. (Dist=log-like)
Random Forest
SVM

```
In [314]: forest.feature_importances_

Out[314]: array([0.00510356, 0.01070712, 0.01696856, 0.0062856 , 0.01344696,
                 0.01465837, 0.00601506, 0.00920641, 0.00680579, 0.00974346,
                 0.34756903, 0.12528649, 0.29837686, 0.0120086 , 0.01808972,
                 0.01124988, 0.01314123, 0.01141162, 0.0068522 , 0.0139614 ,
                 0.0134749 , 0.01275217, 0.00908574, 0.00779927])
```

```
In [315]: linearSVM.coef_

Out[315]: array([[-0.31902047,  0.03441939,  0.24473077,  0.45042741, -0.5239891 ,
                   0.17536458, -0.2433299 , -0.02653041,  0.41005982, -0.18026296,
                  -0.14868206,  0.4618543 ,  0.23471348,  0.19253904,  0.33991079,
                  -0.08488624,  0.00084286, -0.24156419,  0.1119263 ,  0.76080722,
                  -0.04184351,  0.13911275, -0.38284232,  0.02502093]])
```

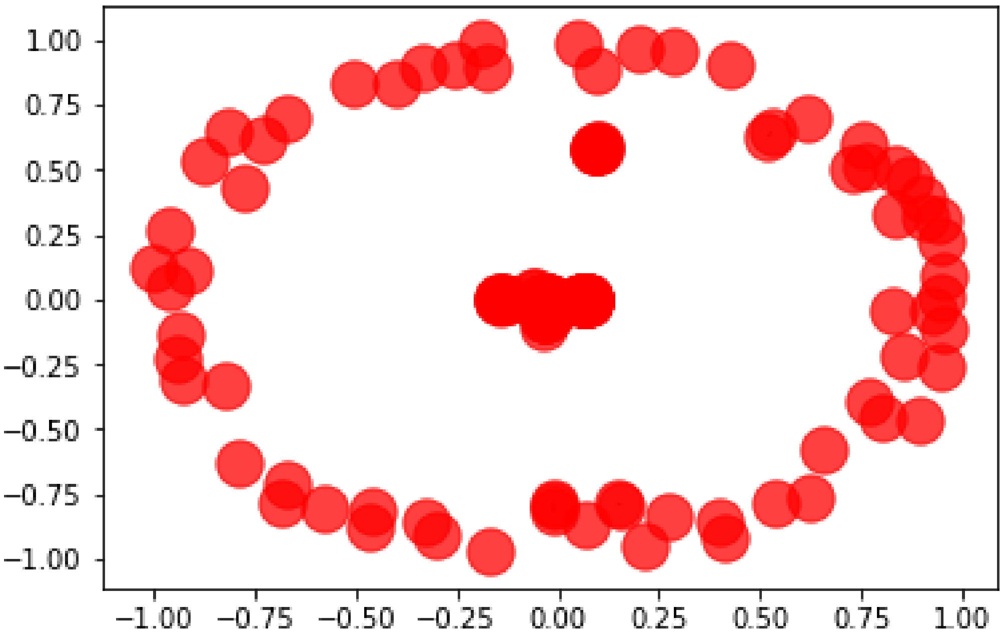
```
In [321]: fi_fst = forest.feature_importances_
          fi_svm = linearSVM.coef_
          with open('RF_SVM_smallNet_500_51trials_w_songCentrl_featureImport_fst.txt', 'w') as
              for item in fi_fst:
                  f.write("%s\n" % item)
          with open('RF_SVM_smallNet_500_51trials_w_songCentrl_featureImport_svm.txt', 'w') as
              for item in fi_svm:
                  f.write("%s\n" % item)
```

```
In [ ]:
```

```
In [231]: # construct graph with weight
          G_song = nx.Graph()
          G_song = nx.from_numpy_matrix(song_Adj)

          pos = nx.spring_layout(G_song)
          #ns = np.array(ec)*3000
          nx.draw_networkx_nodes(G_song, pos, alpha=0.75)
          #nx.draw_networkx_nodes(G_giant_component, pos, nodelist=centrality.keys(), node_siz
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a me
          nx.draw_networkx_edges(G_song, pos, alpha=0.7)
          plt.show()

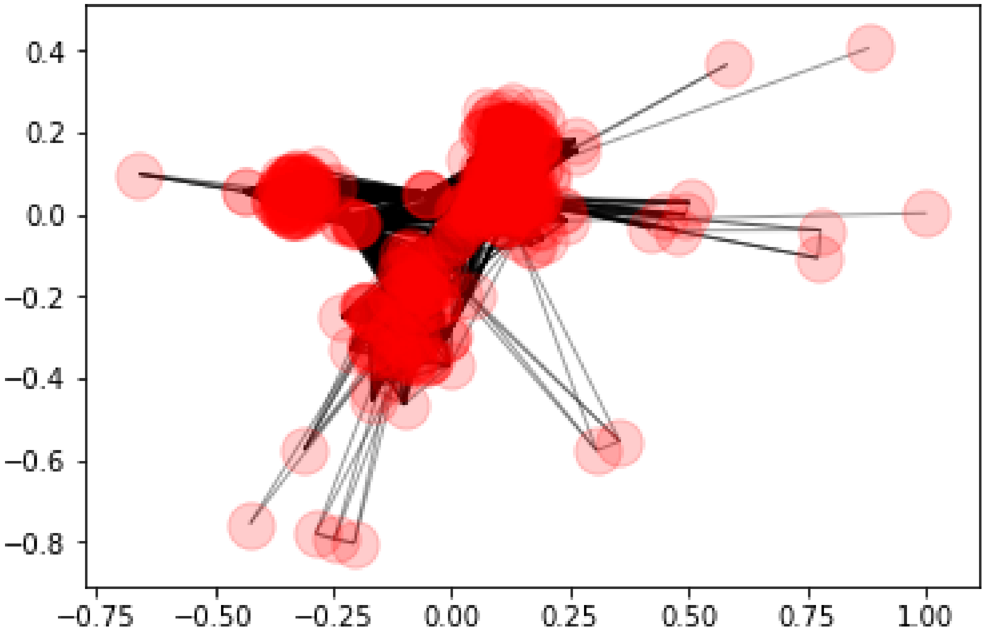
C:\Users\weich\Anaconda5\lib\site-packages\networkx\drawing\nx_pylab.py:611: MatplotlibDeprecat
  if cb.is_numlike(alpha):
```



```
In [174]: # construct graph with weight
          rows, cols = np.where(song_Adj > 0)
          edges = zip(rows.tolist(), cols.tolist())

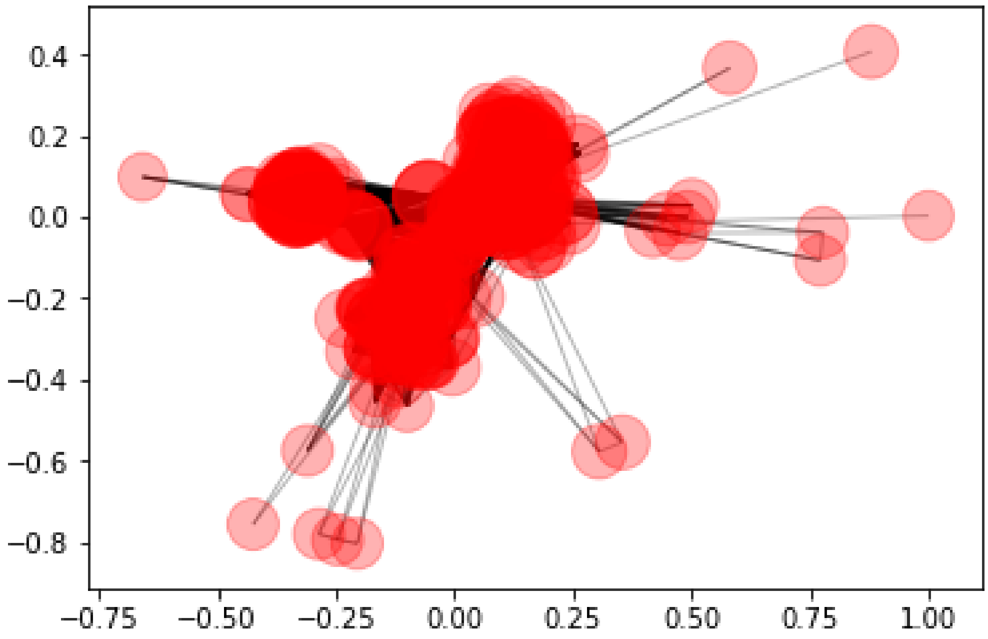
          # find largest component in graph
          G_giant_component_song = max(nx.connected_component_subgraphs(G_song), key=len)
          #G_genre.add_edges_from(edges)

          pos = nx.spring_layout(G_giant_component_song)
          nx.draw_networkx_nodes(G_giant_component_song, pos, alpha=0.2)
          #ns = np.array(ec)*3000
          #nx.draw_networkx_nodes(G_giant_component, pos, nodelist=centrality.keys(), node_siz
          #nx.draw_networkx_labels(G_genre, pos) # adding labels will result in a mess
          nx.draw_networkx_edges(G_giant_component_song, pos, width=1, alpha=0.4)
          plt.show()
```



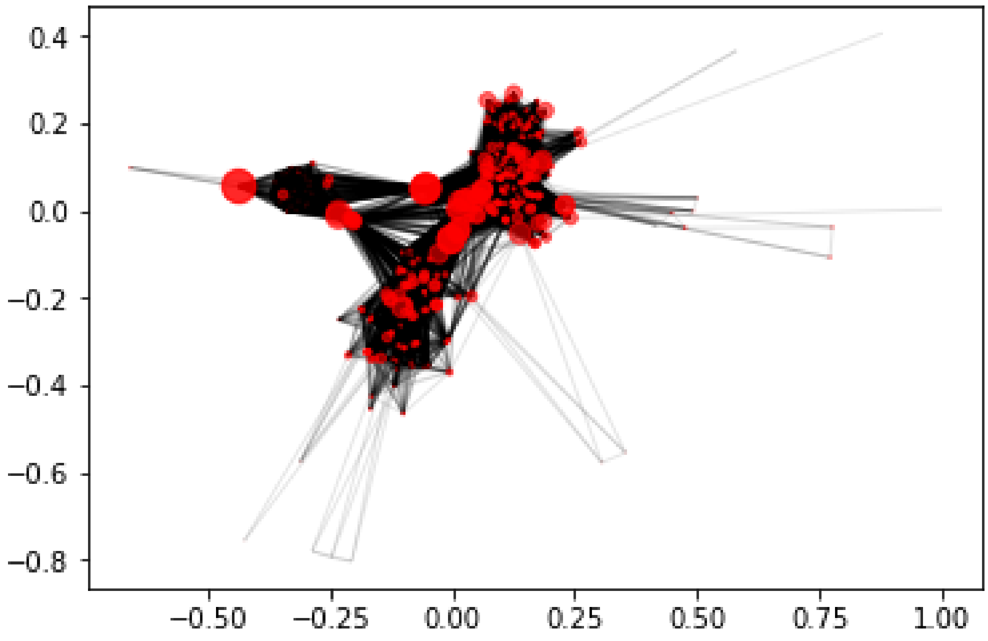
```
In [175]: # compute closeness centrality with weight
          cc_centrality = nx.closeness_centrality(G_giant_component_song)
          cc = list(cc_centrality.values())

          # scale size of nodes
          ns = np.array(cc)*1000
          nx.draw_networkx_nodes(G_giant_component_song, pos, nodelist=cc_centrality.keys(), no
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a mes
          nx.draw_networkx_edges(G_giant_component_song, pos, alpha=0.3)
          plt.show()
```



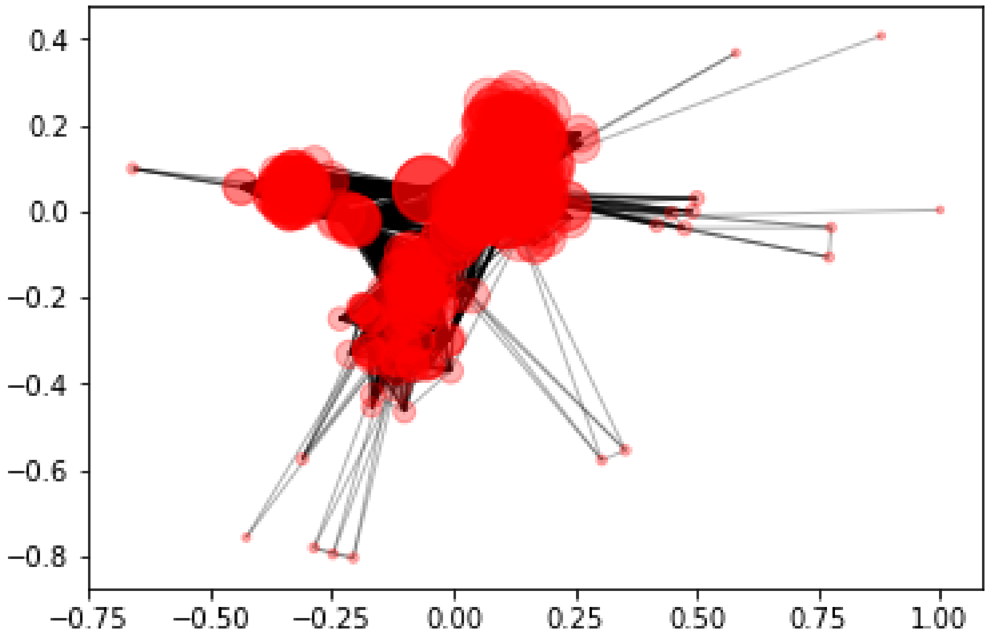
```
In [176]: # compute betweenness centrality with weight
          bc_centrality = nx.betweenness_centrality(G_giant_component_song, weight='weight')
          bc = list(bc_centrality.values())

          # scale size of nodes
          ns = np.array(bc)*3000
          nx.draw_networkx_nodes(G_giant_component_song, pos, nodelist=bc_centrality.keys(), no
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a me
          nx.draw_networkx_edges(G_giant_component_song, pos, alpha=0.1)
          plt.show()
```



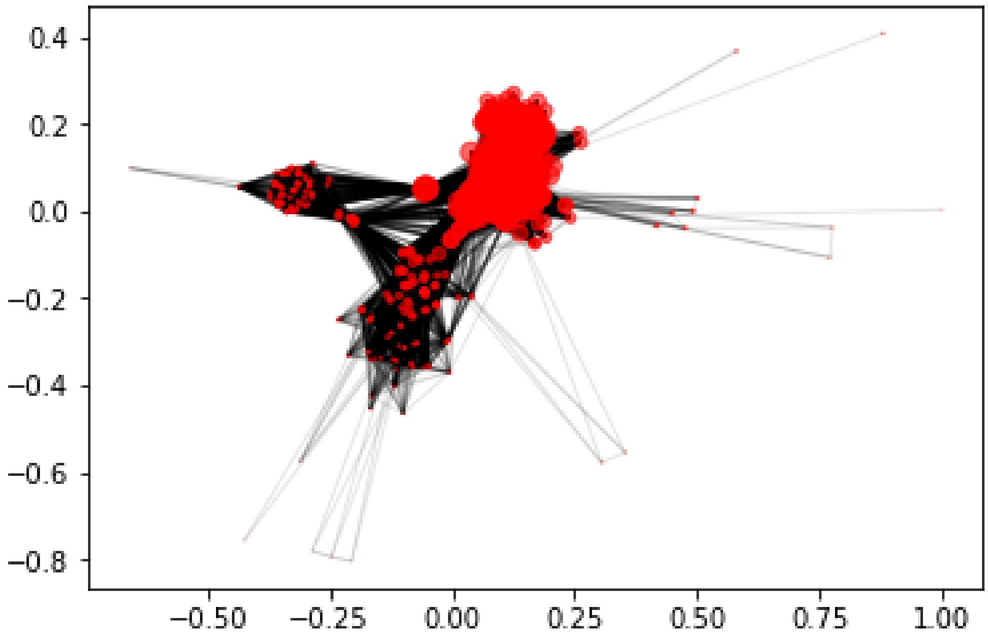
```
In [177]: # compute degree centrality with weight
          dc_centrality = nx.degree_centrality(G_giant_component_song)
          dc = list(dc_centrality.values())

          # scale size of nodes
          ns = np.array(dc)*1000
          nx.draw_networkx_nodes(G_giant_component_song, pos, nodelist=dc_centrality.keys(), no
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a me
          nx.draw_networkx_edges(G_giant_component_song, pos, alpha=0.3)
          plt.show()
```



```
In [178]: # compute eigenvector centrality with weight
          ec_centrality = nx.eigenvector_centrality(G_giant_component_song, weight='weight')
          ec = list(ec_centrality.values())

          # scale size of nodes
          ns = np.array(ec)*2000
          nx.draw_networkx_nodes(G_giant_component_song, pos, nodelist=ec_centrality.keys(), no
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a me
          nx.draw_networkx_edges(G_giant_component_song, pos, alpha=0.1)
          plt.show()
```



```
In [ ]:

In [947]:

In [ ]: #normalisation of data
        #incorporate centrality measures to song data
        #reduction of genre dimension
        #above or below top 50 rather than individual ranks

In [643]: # find division between weeks
          index_weeks = []
          prev_date = []
          for i in range(len(X_date)):
              if prev_date != X_date[i]:
                  prev_date = X_date[i]
                  index_weeks.append(i)

In [ ]:

In [786]: [X_date[70], X_date[71]]

In [5]: df_song_genre

Out[5]:       u'rap'  u'pop rap'  u'dance pop'  u'pop'  u'post-teen pop'  \
        0        1.0         0.0           0.0     0.0               0.0
        1        1.0         1.0           0.0     0.0               0.0
```

```
2        0.0         0.0           1.0     1.0               1.0
3        1.0         0.0           0.0     1.0               0.0
4        0.0         0.0           0.0     0.0               0.0
5        1.0         0.0           0.0     1.0               0.0
6        0.0         0.0           1.0     1.0               0.0
7        1.0         0.0           0.0     1.0               0.0
8        1.0         1.0           1.0     1.0               0.0
9        1.0         1.0           0.0     1.0               0.0
10       0.0         0.0           1.0     1.0               1.0
11       0.0         0.0           0.0     1.0               0.0
12       0.0         0.0           0.0     0.0               0.0
13       0.0         0.0           0.0     0.0               0.0
14       0.0         0.0           0.0     0.0               0.0
15       1.0         1.0           0.0     1.0               0.0
16       1.0         1.0           0.0     1.0               0.0
17       1.0         1.0           0.0     1.0               0.0
18       0.0         0.0           0.0     0.0               0.0
19       0.0         0.0           0.0     0.0               0.0
20       1.0         1.0           0.0     0.0               0.0
21       0.0         0.0           0.0     0.0               0.0
22       0.0         0.0           0.0     0.0               0.0
23       0.0         0.0           0.0     1.0               0.0
24       0.0         0.0           0.0     0.0               0.0
25       0.0         0.0           0.0     0.0               0.0
26       1.0         1.0           0.0     0.0               0.0
27       0.0         0.0           0.0     1.0               0.0
28       0.0         0.0           0.0     1.0               0.0
29       1.0         1.0           0.0     1.0               0.0
...      ...         ...           ...     ...               ...
7337     0.0         0.0           0.0     0.0               0.0
7338     0.0         0.0           0.0     0.0               0.0
7339     1.0         1.0           0.0     0.0               0.0
7340     0.0         0.0           0.0     0.0               0.0
7341     0.0         0.0           1.0     1.0               1.0
7342     0.0         0.0           0.0     0.0               0.0
7343     1.0         1.0           0.0     0.0               0.0
7344     0.0         0.0           0.0     0.0               0.0
7345     0.0         0.0           1.0     1.0               0.0
7346     0.0         0.0           0.0     0.0               0.0
7347     1.0         1.0           0.0     0.0               0.0
7348     0.0         0.0           1.0     1.0               0.0
7349     0.0         0.0           0.0     0.0               0.0
7350     0.0         0.0           1.0     1.0               0.0
7351     1.0         1.0           0.0     0.0               0.0
7352     0.0         0.0           0.0     0.0               0.0
7353     0.0         0.0           0.0     0.0               0.0
7354     0.0         0.0           0.0     0.0               0.0
7355     1.0         1.0           1.0     1.0               0.0
```

```
7356     0.0         0.0           0.0    0.0              0.0
7357     0.0         0.0           0.0    0.0              0.0
7358     0.0         0.0           0.0    0.0              0.0
7359     0.0         1.0           1.0    1.0              1.0
7360     0.0         0.0           0.0    1.0              0.0
7361     0.0         0.0           1.0    0.0              0.0
7362     0.0         1.0           1.0    1.0              1.0
7363     0.0         0.0           0.0    0.0              0.0
7364     0.0         0.0           0.0    0.0              0.0
7365     0.0         0.0           0.0    0.0              0.0
7366     0.0         0.0           1.0    1.0              1.0

      u'contemporary country'  u'country road'  u'indie r&b'  u'r&b'  \
0                         0.0              0.0           0.0     0.0
1                         0.0              0.0           0.0     0.0
2                         0.0              0.0           0.0     0.0
3                         0.0              0.0           0.0     0.0
4                         1.0              1.0           0.0     0.0
5                         0.0              0.0           0.0     0.0
6                         0.0              0.0           1.0     1.0
7                         0.0              0.0           0.0     0.0
8                         0.0              0.0           0.0     0.0
9                         0.0              0.0           0.0     0.0
10                        0.0              0.0           0.0     0.0
11                        0.0              0.0           0.0     0.0
12                        0.0              0.0           0.0     0.0
13                        0.0              0.0           0.0     0.0
14                        0.0              0.0           0.0     0.0
15                        0.0              0.0           0.0     0.0
16                        0.0              0.0           0.0     0.0
17                        0.0              0.0           0.0     0.0
18                        0.0              0.0           0.0     0.0
19                        1.0              1.0           0.0     0.0
20                        0.0              0.0           0.0     0.0
21                        1.0              1.0           0.0     0.0
22                        0.0              0.0           0.0     0.0
23                        0.0              0.0           0.0     0.0
24                        1.0              1.0           0.0     0.0
25                        1.0              1.0           0.0     0.0
26                        0.0              0.0           0.0     0.0
27                        0.0              0.0           0.0     0.0
28                        0.0              0.0           0.0     0.0
29                        0.0              0.0           0.0     0.0
...                       ...              ...           ...     ...
7337                      1.0              1.0           0.0     0.0
7338                      0.0              0.0           0.0     0.0
7339                      0.0              0.0           0.0     0.0
7340                      1.0              1.0           0.0     0.0
```

```
7341                      0.0              0.0           0.0     0.0
7342                      0.0              0.0           0.0     0.0
7343                      0.0              0.0           0.0     0.0
7344                      0.0              0.0           0.0     0.0
7345                      0.0              0.0           0.0     1.0
7346                      0.0              0.0           0.0     0.0
7347                      0.0              0.0           0.0     0.0
7348                      0.0              0.0           0.0     0.0
7349                      0.0              0.0           0.0     0.0
7350                      0.0              0.0           0.0     0.0
7351                      0.0              0.0           0.0     0.0
7352                      0.0              0.0           0.0     0.0
7353                      0.0              0.0           0.0     0.0
7354                      0.0              0.0           0.0     1.0
7355                      0.0              0.0           0.0     0.0
7356                      0.0              1.0           0.0     0.0
7357                      0.0              0.0           0.0     0.0
7358                      0.0              0.0           0.0     0.0
7359                      0.0              0.0           0.0     1.0
7360                      0.0              0.0           0.0     0.0
7361                      0.0              0.0           0.0     0.0
7362                      0.0              0.0           0.0     1.0
7363                      1.0              0.0           0.0     0.0
7364                      1.0              1.0           0.0     0.0
7365                      0.0              0.0           1.0     1.0
7366                      0.0              0.0           0.0     1.0

      u'urban contemporary'          ...           u'deep norteno'  \
0                       0.0          ...                       0.0
1                       0.0          ...                       0.0
2                       0.0          ...                       0.0
3                       0.0          ...                       0.0
4                       0.0          ...                       0.0
5                       0.0          ...                       0.0
6                       1.0          ...                       0.0
7                       0.0          ...                       0.0
8                       0.0          ...                       0.0
9                       0.0          ...                       0.0
10                      0.0          ...                       0.0
11                      0.0          ...                       0.0
12                      0.0          ...                       0.0
13                      0.0          ...                       0.0
14                      0.0          ...                       0.0
15                      0.0          ...                       0.0
16                      0.0          ...                       0.0
17                      0.0          ...                       0.0
18                      0.0          ...                       0.0
19                      0.0          ...                       0.0
```

```
20                      0.0          ...                       0.0
21                      0.0          ...                       0.0
22                      0.0          ...                       0.0
23                      0.0          ...                       0.0
24                      0.0          ...                       0.0
25                      0.0          ...                       0.0
26                      0.0          ...                       0.0
27                      0.0          ...                       0.0
28                      0.0          ...                       0.0
29                      0.0          ...                       0.0
...                     ...          ...                       ...
7337                    0.0          ...                       0.0
7338                    0.0          ...                       0.0
7339                    0.0          ...                       0.0
7340                    0.0          ...                       0.0
7341                    1.0          ...                       0.0
7342                    0.0          ...                       0.0
7343                    0.0          ...                       0.0
7344                    0.0          ...                       0.0
7345                    1.0          ...                       0.0
7346                    0.0          ...                       0.0
7347                    0.0          ...                       0.0
7348                    0.0          ...                       0.0
7349                    0.0          ...                       0.0
7350                    0.0          ...                       0.0
7351                    0.0          ...                       0.0
7352                    0.0          ...                       0.0
7353                    0.0          ...                       0.0
7354                    1.0          ...                       0.0
7355                    0.0          ...                       0.0
7356                    0.0          ...                       0.0
7357                    0.0          ...                       0.0
7358                    1.0          ...                       0.0
7359                    1.0          ...                       0.0
7360                    0.0          ...                       0.0
7361                    0.0          ...                       0.0
7362                    1.0          ...                       0.0
7363                    0.0          ...                       0.0
7364                    0.0          ...                       0.0
7365                    1.0          ...                       0.0
7366                    1.0          ...                       0.0

      u'duranguense'  u'norteno'  u'indie jazz'  u'french pop'  \
0                0.0         0.0            0.0            0.0
1                0.0         0.0            0.0            0.0
2                0.0         0.0            0.0            0.0
3                0.0         0.0            0.0            0.0
4                0.0         0.0            0.0            0.0
```

```
5                0.0         0.0            0.0            0.0
6                0.0         0.0            0.0            0.0
7                0.0         0.0            0.0            0.0
8                0.0         0.0            0.0            0.0
9                0.0         0.0            0.0            0.0
10               0.0         0.0            0.0            0.0
11               0.0         0.0            0.0            0.0
12               0.0         0.0            0.0            0.0
13               0.0         0.0            0.0            0.0
14               0.0         0.0            0.0            0.0
15               0.0         0.0            0.0            0.0
16               0.0         0.0            0.0            0.0
17               0.0         0.0            0.0            0.0
18               0.0         0.0            0.0            0.0
19               0.0         0.0            0.0            0.0
20               0.0         0.0            0.0            0.0
21               0.0         0.0            0.0            0.0
22               0.0         0.0            0.0            0.0
23               0.0         0.0            0.0            0.0
24               0.0         0.0            0.0            0.0
25               0.0         0.0            0.0            0.0
26               0.0         0.0            0.0            0.0
27               0.0         0.0            0.0            0.0
28               0.0         0.0            0.0            0.0
29               0.0         0.0            0.0            0.0
...              ...         ...            ...            ...
7337             0.0         0.0            0.0            0.0
7338             0.0         0.0            0.0            0.0
7339             0.0         0.0            0.0            0.0
7340             0.0         0.0            0.0            0.0
7341             0.0         0.0            0.0            0.0
7342             0.0         0.0            0.0            0.0
7343             0.0         0.0            0.0            0.0
7344             0.0         0.0            0.0            0.0
7345             0.0         0.0            0.0            0.0
7346             0.0         0.0            0.0            0.0
7347             0.0         0.0            0.0            0.0
7348             0.0         0.0            0.0            0.0
7349             0.0         0.0            0.0            0.0
7350             0.0         0.0            0.0            0.0
7351             0.0         0.0            0.0            0.0
7352             0.0         0.0            0.0            0.0
7353             0.0         0.0            0.0            0.0
7354             0.0         0.0            0.0            0.0
7355             0.0         0.0            0.0            0.0
7356             0.0         0.0            0.0            0.0
7357             0.0         0.0            0.0            0.0
7358             0.0         0.0            0.0            0.0
```

```
7359             0.0         0.0            0.0            0.0
7360             0.0         0.0            0.0            0.0
7361             0.0         0.0            0.0            0.0
7362             0.0         0.0            0.0            0.0
7363             0.0         0.0            0.0            0.0
7364             0.0         0.0            0.0            0.0
7365             0.0         0.0            0.0            0.0
7366             0.0         0.0            0.0            0.0

      u'deep latin christian'  u'grunge pop'  u'hip house'  u'italian pop'  \
0                         0.0            0.0           0.0             0.0
1                         0.0            0.0           0.0             0.0
2                         0.0            0.0           0.0             0.0
3                         0.0            0.0           0.0             0.0
4                         0.0            0.0           0.0             0.0
5                         0.0            0.0           0.0             0.0
6                         0.0            0.0           0.0             0.0
7                         0.0            0.0           0.0             0.0
8                         0.0            0.0           0.0             0.0
9                         0.0            0.0           0.0             0.0
10                        0.0            0.0           0.0             0.0
11                        0.0            0.0           0.0             0.0
12                        0.0            0.0           0.0             0.0
13                        0.0            0.0           0.0             0.0
14                        0.0            0.0           0.0             0.0
15                        0.0            0.0           0.0             0.0
16                        0.0            0.0           0.0             0.0
17                        0.0            0.0           0.0             0.0
18                        0.0            0.0           0.0             0.0
19                        0.0            0.0           0.0             0.0
20                        0.0            0.0           0.0             0.0
21                        0.0            0.0           0.0             0.0
22                        0.0            0.0           0.0             0.0
23                        0.0            0.0           0.0             0.0
24                        0.0            0.0           0.0             0.0
25                        0.0            0.0           0.0             0.0
26                        0.0            0.0           0.0             0.0
27                        0.0            0.0           0.0             0.0
28                        0.0            0.0           0.0             0.0
29                        0.0            0.0           0.0             0.0
...                       ...            ...           ...             ...
7337                      0.0            0.0           0.0             0.0
7338                      0.0            0.0           0.0             0.0
7339                      0.0            0.0           0.0             0.0
7340                      0.0            0.0           0.0             0.0
7341                      0.0            0.0           0.0             0.0
7342                      0.0            0.0           0.0             0.0
7343                      0.0            0.0           0.0             0.0
```

```
7344                       0.0            0.0           0.0              0.0
7345                       0.0            0.0           0.0              0.0
7346                       0.0            0.0           0.0              0.0
7347                       0.0            0.0           0.0              0.0
7348                       0.0            0.0           0.0              0.0
7349                       0.0            0.0           0.0              0.0
7350                       0.0            0.0           0.0              0.0
7351                       0.0            0.0           0.0              0.0
7352                       0.0            0.0           0.0              0.0
7353                       0.0            0.0           0.0              0.0
7354                       0.0            0.0           0.0              0.0
7355                       0.0            0.0           0.0              0.0
7356                       0.0            0.0           0.0              0.0
7357                       0.0            0.0           0.0              0.0
7358                       0.0            0.0           0.0              0.0
7359                       0.0            0.0           0.0              0.0
7360                       0.0            0.0           0.0              0.0
7361                       0.0            0.0           0.0              0.0
7362                       0.0            0.0           0.0              0.0
7363                       0.0            0.0           0.0              0.0
7364                       0.0            0.0           0.0              0.0
7365                       0.0            0.0           0.0              0.0
7366                       0.0            0.0           0.0              0.0

      u'indie anthem-folk'
0                     0.0
1                     0.0
2                     0.0
3                     0.0
4                     0.0
5                     0.0
6                     0.0
7                     0.0
8                     0.0
9                     0.0
10                    0.0
11                    0.0
12                    0.0
13                    0.0
14                    0.0
15                    0.0
16                    0.0
17                    0.0
18                    0.0
19                    0.0
20                    0.0
21                    0.0
22                    0.0
```

```
        23                     0.0
        24                     0.0
        25                     0.0
        26                     0.0
        27                     0.0
        28                     0.0
        29                     0.0
        ...                    ...
        7337                   0.0
        7338                   0.0
        7339                   0.0
        7340                   0.0
        7341                   0.0
        7342                   0.0
        7343                   0.0
        7344                   0.0
        7345                   0.0
        7346                   0.0
        7347                   0.0
        7348                   0.0
        7349                   0.0
        7350                   0.0
        7351                   0.0
        7352                   0.0
        7353                   0.0
        7354                   0.0
        7355                   0.0
        7356                   0.0
        7357                   0.0
        7358                   0.0
        7359                   0.0
        7360                   0.0
        7361                   0.0
        7362                   0.0
        7363                   0.0
        7364                   0.0
        7365                   0.0
        7366                   0.0

        [7367 rows x 390 columns]

In [7]: df_genre

Out[7]:      u'rap'  u'pop rap'  u'dance pop'  u'pop'  u'post-teen pop'  \
        0    1828.0      1582.0         572.0   908.0              49.0
        1    1582.0      2201.0        1099.0  1195.0             325.0
        2     572.0      1099.0        2685.0  2203.0            1392.0
        3     908.0      1195.0        2203.0  3114.0            1449.0
```

```
4      49.0       325.0        1392.0  1449.0            1563.0
5       0.0         0.0          37.0    31.0              36.0
6       0.0         0.0           0.0     0.0               6.0
7     127.0       195.0         259.0   258.0              45.0
8     479.0       797.0        1195.0   974.0             438.0
9     327.0       630.0         932.0   734.0             318.0
10    116.0       112.0          99.0   134.0              90.0
11    430.0       708.0         764.0   519.0             223.0
12   1290.0      1248.0         462.0   570.0              16.0
13      0.0        29.0          82.0   129.0               0.0
14      5.0         5.0           4.0    19.0               0.0
15      0.0         0.0           9.0    42.0               0.0
16      0.0         0.0          30.0    70.0               0.0
17    953.0       857.0         278.0   519.0               7.0
18      0.0         0.0           6.0     0.0               0.0
19      0.0         0.0          37.0    30.0              36.0
20    116.0       115.0           0.0     4.0               0.0
21      0.0         0.0           3.0     6.0               2.0
22      0.0         0.0           0.0     0.0               6.0
23      0.0        10.0         119.0   147.0             146.0
24      5.0         3.0           0.0     4.0               0.0
25   1034.0      1124.0         512.0   567.0              35.0
26     35.0        25.0           0.0    21.0               0.0
27     17.0        17.0           0.0    10.0               0.0
28      0.0         0.0           0.0     1.0               3.0
29      0.0         0.0           0.0     1.0               0.0
..      ...         ...           ...     ...               ...
360     0.0         0.0           0.0     0.0               0.0
361     0.0         0.0           0.0     0.0               0.0
362     0.0         0.0           0.0     0.0               0.0
363     0.0         0.0           0.0     0.0               0.0
364     0.0         0.0           0.0     0.0               0.0
365     0.0         0.0           0.0     0.0               0.0
366     0.0         0.0           0.0     0.0               0.0
367     0.0         0.0           0.0     0.0               0.0
368     0.0         0.0           0.0     0.0               0.0
369     0.0         0.0           0.0     0.0               0.0
370     0.0         0.0           0.0     0.0               0.0
371     0.0         0.0           0.0     0.0               0.0
372     0.0         0.0           0.0     0.0               0.0
373     0.0         0.0           0.0     0.0               0.0
374     0.0         0.0           0.0     0.0               0.0
375     0.0         0.0           0.0     0.0               0.0
376     0.0         0.0           0.0     0.0               0.0
377     0.0         0.0           0.0     0.0               0.0
378     0.0         0.0           0.0     0.0               0.0
379     0.0         0.0           0.0     0.0               0.0
380     0.0         0.0           0.0     0.0               0.0
```

```
381     0.0         0.0           0.0     0.0               0.0
382     0.0         0.0           0.0     0.0               0.0
383     0.0         0.0           0.0     0.0               0.0
384     0.0         0.0           0.0     0.0               0.0
385     0.0         0.0           0.0     0.0               0.0
386     0.0         0.0           0.0     0.0               0.0
387     0.0         0.0           0.0     0.0               0.0
388     0.0         0.0           0.0     0.0               0.0
389     0.0         0.0           0.0     0.0               0.0

     u'contemporary country'  u'country road'  u'indie r&b'  u'r&b'  \
0                        0.0              0.0         127.0   479.0
1                        0.0              0.0         195.0   797.0
2                       37.0              0.0         259.0  1195.0
3                       31.0              0.0         258.0   974.0
4                       36.0              6.0          45.0   438.0
5                     1252.0           1109.0           0.0     0.0
6                     1109.0           1126.0           0.0     0.0
7                        0.0              0.0         325.0   305.0
8                        0.0              0.0         305.0  1326.0
9                        0.0              0.0         265.0   981.0
10                       7.0              0.0           5.0     7.0
11                       0.0              0.0         225.0   774.0
12                       0.0              0.0          90.0   369.0
13                       0.0              0.0           0.0     0.0
14                       0.0              0.0           0.0     4.0
15                       0.0              0.0           0.0     0.0
16                       0.0              0.0           0.0     0.0
17                       0.0              0.0          62.0   177.0
18                       0.0              0.0           0.0     0.0
19                    1142.0           1060.0           0.0     0.0
20                       0.0              0.0           2.0     2.0
21                       0.0              0.0           1.0     1.0
22                     617.0            620.0           0.0     0.0
23                       5.0              0.0           3.0    29.0
24                       0.0              0.0           1.0     1.0
25                       0.0              0.0         118.0   394.0
26                       0.0              0.0           4.0     0.0
27                       0.0              0.0           0.0     0.0
28                       0.0              0.0           0.0     0.0
29                       0.0              0.0           0.0     0.0
..                       ...              ...           ...     ...
360                      0.0              0.0           0.0     0.0
361                      0.0              0.0           0.0     0.0
362                      0.0              0.0           0.0     2.0
363                      0.0              0.0           0.0     0.0
364                      0.0              0.0           0.0     0.0
365                      0.0              0.0           0.0     0.0
```

```
366                      0.0              0.0           0.0     0.0
367                      0.0              0.0           0.0     0.0
368                      0.0              0.0           0.0     0.0
369                      0.0              0.0           0.0     0.0
370                      0.0              0.0           0.0     0.0
371                      0.0              0.0           0.0     0.0
372                      0.0              0.0           0.0     0.0
373                      0.0              0.0           0.0     0.0
374                      0.0              0.0           0.0     0.0
375                      0.0              0.0           0.0     0.0
376                      0.0              0.0           0.0     0.0
377                      0.0              0.0           0.0     0.0
378                      0.0              0.0           0.0     0.0
379                      0.0              0.0           0.0     0.0
380                      0.0              0.0           0.0     0.0
381                      0.0              0.0           0.0     0.0
382                      0.0              0.0           0.0     0.0
383                      0.0              0.0           1.0     0.0
384                      0.0              0.0           0.0     0.0
385                      0.0              0.0           0.0     0.0
386                      0.0              0.0           0.0     0.0
387                      0.0              0.0           0.0     0.0
388                      0.0              0.0           0.0     0.0
389                      0.0              0.0           0.0     0.0

     u'urban contemporary'          ...           u'deep norteno'  \
0                    327.0          ...                       0.0
1                    630.0          ...                       0.0
2                    932.0          ...                       0.0
3                    734.0          ...                       0.0
4                    318.0          ...                       0.0
5                      0.0          ...                       0.0
6                      0.0          ...                       0.0
7                    265.0          ...                       0.0
8                    981.0          ...                       0.0
9                   1044.0          ...                       0.0
10                     8.0          ...                       0.0
11                   720.0          ...                       0.0
12                   304.0          ...                       0.0
13                     0.0          ...                       0.0
14                     4.0          ...                       0.0
15                     0.0          ...                       0.0
16                     0.0          ...                       0.0
17                    95.0          ...                       0.0
18                     0.0          ...                       0.0
19                     0.0          ...                       0.0
20                     0.0          ...                       0.0
21                     0.0          ...                       0.0
```

```
22                     0.0          ...                       0.0
23                    23.0          ...                       0.0
24                     0.0          ...                       0.0
25                   346.0          ...                       0.0
26                     0.0          ...                       0.0
27                     0.0          ...                       0.0
28                     0.0          ...                       0.0
29                     0.0          ...                       0.0
..                     ...          ...                       ...
360                    0.0          ...                       0.0
361                    0.0          ...                       0.0
362                    2.0          ...                       0.0
363                    0.0          ...                       0.0
364                    0.0          ...                       0.0
365                    0.0          ...                       0.0
366                    0.0          ...                       0.0
367                    0.0          ...                       0.0
368                    0.0          ...                       0.0
369                    0.0          ...                       0.0
370                    0.0          ...                       0.0
371                    0.0          ...                       0.0
372                    0.0          ...                       0.0
373                    0.0          ...                       0.0
374                    0.0          ...                       0.0
375                    0.0          ...                       0.0
376                    0.0          ...                       0.0
377                    0.0          ...                       0.0
378                    0.0          ...                       0.0
379                    0.0          ...                       0.0
380                    0.0          ...                       1.0
381                    0.0          ...                       1.0
382                    0.0          ...                       1.0
383                    1.0          ...                       0.0
384                    0.0          ...                       0.0
385                    0.0          ...                       0.0
386                    0.0          ...                       0.0
387                    0.0          ...                       0.0
388                    0.0          ...                       0.0
389                    0.0          ...                       0.0

     u'duranguense'  u'norteno'  u'indie jazz'  u'french pop'  \
0               0.0         0.0            0.0            0.0
1               0.0         0.0            0.0            0.0
2               0.0         0.0            0.0            0.0
3               0.0         0.0            0.0            0.0
4               0.0         0.0            0.0            0.0
5               0.0         0.0            0.0            0.0
6               0.0         0.0            0.0            0.0
```

```
7               0.0        0.0            1.0            0.0
8               0.0        0.0            0.0            0.0
9               0.0        0.0            1.0            0.0
10              0.0        0.0            0.0            0.0
11              0.0        0.0            0.0            0.0
12              0.0        0.0            0.0            0.0
13              0.0        0.0            0.0            0.0
14              0.0        0.0            0.0            0.0
15              0.0        0.0            0.0            0.0
16              0.0        0.0            0.0            0.0
17              0.0        0.0            0.0            0.0
18              0.0        0.0            0.0            0.0
19              0.0        0.0            0.0            0.0
20              0.0        0.0            0.0            0.0
21              0.0        0.0            0.0            0.0
22              0.0        0.0            0.0            0.0
23              0.0        0.0            0.0            0.0
24              0.0        0.0            0.0            0.0
25              0.0        0.0            0.0            0.0
26              0.0        0.0            0.0            0.0
27              0.0        0.0            0.0            0.0
28              0.0        0.0            0.0            0.0
29              0.0        0.0            0.0            0.0
..              ...        ...            ...            ...
360             0.0        0.0            0.0            0.0
361             0.0        0.0            0.0            0.0
362             0.0        0.0            0.0            0.0
363             0.0        0.0            0.0            0.0
364             0.0        0.0            0.0            0.0
365             0.0        0.0            0.0            0.0
366             0.0        0.0            0.0            0.0
367             0.0        0.0            0.0            0.0
368             0.0        0.0            0.0            0.0
369             0.0        0.0            0.0            0.0
370             0.0        0.0            0.0            0.0
371             0.0        0.0            0.0            0.0
372             0.0        0.0            0.0            0.0
373             0.0        0.0            0.0            0.0
374             0.0        0.0            0.0            0.0
375             0.0        0.0            0.0            0.0
376             0.0        0.0            0.0            0.0
377             0.0        0.0            0.0            0.0
378             0.0        0.0            0.0            0.0
379             0.0        0.0            0.0            0.0
380             1.0        1.0            0.0            0.0
381             1.0        1.0            0.0            0.0
382             1.0        1.0            0.0            0.0
383             0.0        0.0            1.0            0.0
```

```
384             0.0         0.0            0.0            1.0
385             0.0         0.0            0.0            0.0
386             0.0         0.0            0.0            0.0
387             0.0         0.0            0.0            0.0
388             0.0         0.0            0.0            0.0
389             0.0         0.0            0.0            0.0

     u'deep latin christian'  u'grunge pop'  u'hip house'  u'italian pop'  \
0                        0.0            0.0           0.0             0.0
1                        0.0            0.0           0.0             0.0
2                        0.0            0.0           0.0             0.0
3                        0.0            0.0           0.0             0.0
4                        0.0            0.0           0.0             0.0
5                        0.0            0.0           0.0             0.0
6                        0.0            0.0           0.0             0.0
7                        0.0            0.0           0.0             0.0
8                        0.0            0.0           0.0             0.0
9                        0.0            0.0           0.0             0.0
10                       0.0            0.0           0.0             0.0
11                       0.0            0.0           0.0             0.0
12                       0.0            0.0           0.0             0.0
13                       1.0            0.0           0.0             0.0
14                       0.0            0.0           0.0             0.0
15                       0.0            0.0           0.0             0.0
16                       1.0            0.0           0.0             0.0
17                       0.0            0.0           0.0             0.0
18                       0.0            0.0           0.0             0.0
19                       0.0            0.0           0.0             0.0
20                       0.0            0.0           0.0             0.0
21                       0.0            0.0           0.0             0.0
22                       0.0            0.0           0.0             0.0
23                       0.0            0.0           0.0             0.0
24                       0.0            0.0           0.0             0.0
25                       0.0            0.0           0.0             0.0
26                       0.0            0.0           0.0             0.0
27                       0.0            0.0           0.0             0.0
28                       0.0            0.0           0.0             0.0
29                       0.0            0.0           0.0             0.0
..                       ...            ...           ...             ...
360                      0.0            0.0           0.0             0.0
361                      0.0            0.0           0.0             0.0
362                      0.0            0.0           0.0             0.0
363                      0.0            0.0           0.0             0.0
364                      0.0            0.0           0.0             0.0
365                      0.0            0.0           0.0             0.0
366                      0.0            0.0           0.0             0.0
367                      0.0            0.0           0.0             0.0
368                      0.0            0.0           0.0             0.0
```

```
369                      0.0            0.0           0.0             0.0
370                      0.0            0.0           0.0             0.0
371                      0.0            0.0           0.0             0.0
372                      0.0            0.0           0.0             0.0
373                      0.0            0.0           0.0             0.0
374                      0.0            0.0           0.0             0.0
375                      0.0            0.0           1.0             0.0
376                      0.0            0.0           0.0             1.0
377                      0.0            0.0           0.0             0.0
378                      0.0            0.0           0.0             0.0
379                      0.0            0.0           0.0             0.0
380                      0.0            0.0           0.0             0.0
381                      0.0            0.0           0.0             0.0
382                      0.0            0.0           0.0             0.0
383                      0.0            0.0           0.0             0.0
384                      0.0            0.0           0.0             0.0
385                      1.0            0.0           0.0             0.0
386                      0.0            1.0           0.0             0.0
387                      0.0            0.0           1.0             0.0
388                      0.0            0.0           0.0             1.0
389                      0.0            0.0           0.0             0.0

     u'indie anthem-folk'
0                     0.0
1                     0.0
2                     0.0
3                     0.0
4                     0.0
5                     0.0
6                     0.0
7                     0.0
8                     0.0
9                     0.0
10                    0.0
11                    0.0
12                    0.0
13                    0.0
14                    0.0
15                    0.0
16                    0.0
17                    0.0
18                    0.0
19                    0.0
20                    0.0
21                    0.0
22                    0.0
23                    0.0
24                    0.0
```

```
25                      0.0
26                      0.0
27                      0.0
28                      0.0
29                      0.0
..                      ...
360                     0.0
361                     0.0
362                     0.0
363                     0.0
364                     0.0
365                     0.0
366                     0.0
367                     0.0
368                     0.0
369                     0.0
370                     0.0
371                     0.0
372                     0.0
373                     0.0
374                     0.0
375                     0.0
376                     0.0
377                     0.0
378                     0.0
379                     0.0
380                     0.0
381                     0.0
382                     0.0
383                     0.0
384                     0.0
385                     0.0
386                     0.0
387                     0.0
388                     0.0
389                     1.0

[390 rows x 390 columns]
```

```
In [14]: df_song
```

```
Out[14]:       0     1     2     3     4     5     6     7     8     9    ...   7357  \
         0     1.0   1.0   0.0   1.0   0.0   1.0   0.0   1.0   1.0   1.0  ...    0.0
         1     1.0   2.0   0.0   1.0   0.0   1.0   0.0   1.0   2.0   2.0  ...    0.0
         2     0.0   0.0   3.0   1.0   0.0   1.0   2.0   1.0   2.0   1.0  ...    0.0
         3     1.0   1.0   1.0   2.0   0.0   2.0   1.0   2.0   2.0   2.0  ...    0.0
         4     0.0   0.0   0.0   0.0   2.0   0.0   0.0   0.0   0.0   0.0  ...    0.0
         5     1.0   1.0   1.0   2.0   0.0   2.0   1.0   2.0   2.0   2.0  ...    0.0
```

```
6     0.0  0.0  2.0  1.0  0.0  1.0  5.0  1.0  2.0  1.0  ...  0.0
7     1.0  1.0  1.0  2.0  0.0  2.0  1.0  3.0  2.0  2.0  ...  0.0
8     1.0  2.0  2.0  2.0  0.0  2.0  2.0  2.0  5.0  3.0  ...  0.0
9     1.0  2.0  1.0  2.0  0.0  2.0  1.0  2.0  3.0  4.0  ...  0.0
10    0.0  0.0  3.0  1.0  0.0  1.0  2.0  1.0  2.0  1.0  ...  0.0
11    0.0  0.0  1.0  1.0  0.0  1.0  1.0  1.0  1.0  1.0  ...  0.0
12    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
13    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
14    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
15    1.0  2.0  1.0  2.0  0.0  2.0  1.0  2.0  3.0  4.0  ...  0.0
16    1.0  2.0  1.0  2.0  0.0  2.0  1.0  2.0  3.0  4.0  ...  0.0
17    1.0  2.0  1.0  2.0  0.0  2.0  1.0  2.0  3.0  4.0  ...  0.0
18    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
19    0.0  0.0  0.0  0.0  2.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
20    1.0  2.0  0.0  1.0  0.0  1.0  0.0  2.0  2.0  3.0  ...  0.0
21    0.0  0.0  0.0  0.0  2.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
22    0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
23    0.0  0.0  1.0  1.0  0.0  1.0  1.0  1.0  1.0  1.0  ...  0.0
24    0.0  0.0  0.0  0.0  2.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
25    0.0  0.0  0.0  0.0  2.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
26    1.0  2.0  0.0  1.0  0.0  1.0  0.0  2.0  2.0  3.0  ...  0.0
27    0.0  0.0  1.0  1.0  0.0  1.0  1.0  1.0  1.0  1.0  ...  0.0
28    0.0  0.0  1.0  1.0  0.0  1.0  1.0  2.0  1.0  1.0  ...  0.0
29    1.0  2.0  1.0  2.0  0.0  2.0  1.0  2.0  3.0  3.0  ...  0.0
...   ...  ...  ...  ...  ...  ...  ...  ...  ...  ...  ...  ...
7337  0.0  0.0  0.0  0.0  2.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7338  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7339  1.0  2.0  0.0  1.0  0.0  1.0  0.0  1.0  2.0  3.0  ...  0.0
7340  0.0  0.0  0.0  0.0  2.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7341  0.0  0.0  3.0  1.0  0.0  1.0  3.0  1.0  2.0  1.0  ...  0.0
7342  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7343  1.0  2.0  0.0  1.0  0.0  1.0  0.0  1.0  3.0  3.0  ...  0.0
7344  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7345  0.0  0.0  2.0  1.0  0.0  1.0  4.0  1.0  3.0  1.0  ...  0.0
7346  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7347  1.0  2.0  0.0  1.0  0.0  1.0  0.0  1.0  2.0  2.0  ...  0.0
7348  0.0  0.0  2.0  1.0  0.0  1.0  2.0  1.0  2.0  1.0  ...  0.0
7349  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7350  0.0  0.0  2.0  1.0  0.0  1.0  2.0  1.0  2.0  1.0  ...  0.0
7351  1.0  2.0  0.0  1.0  0.0  1.0  0.0  1.0  2.0  3.0  ...  0.0
7352  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7353  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7354  0.0  0.0  0.0  0.0  0.0  0.0  2.0  1.0  1.0  0.0  ...  0.0
7355  1.0  2.0  2.0  2.0  0.0  2.0  2.0  2.0  4.0  4.0  ...  0.0
7356  0.0  0.0  0.0  0.0  1.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7357  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  ...  0.0
7358  0.0  0.0  0.0  0.0  0.0  0.0  1.0  0.0  0.0  0.0  ...  0.0
7359  0.0  1.0  3.0  1.0  0.0  1.0  4.0  1.0  4.0  2.0  ...  0.0
```

```
7360   0.0   0.0   1.0   1.0   0.0   1.0   1.0   1.0   1.0   1.0  ...    0.0
7361   0.0   0.0   1.0   0.0   0.0   0.0   1.0   0.0   1.0   0.0  ...    0.0
7362   0.0   1.0   3.0   1.0   0.0   1.0   4.0   1.0   4.0   2.0  ...    0.0
7363   0.0   0.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0   0.0  ...    0.0
7364   0.0   0.0   0.0   0.0   2.0   0.0   0.0   0.0   0.0   0.0  ...    0.0
7365   0.0   0.0   0.0   0.0   0.0   0.0   3.0   0.0   0.0   1.0  ...    0.0
7366   0.0   0.0   3.0   1.0   0.0   1.0   4.0   1.0   2.0   1.0  ...    0.0

      7358  7359  7360  7361  7362  7363  7364  7365  7366
0      0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
1      0.0   1.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0
2      0.0   3.0   1.0   1.0   3.0   0.0   0.0   0.0   3.0
3      0.0   1.0   1.0   0.0   1.0   0.0   0.0   0.0   1.0
4      0.0   0.0   0.0   0.0   0.0   1.0   2.0   0.0   0.0
5      0.0   1.0   1.0   0.0   1.0   0.0   0.0   0.0   1.0
6      1.0   4.0   1.0   1.0   4.0   0.0   0.0   3.0   4.0
7      0.0   1.0   1.0   0.0   1.0   0.0   0.0   0.0   1.0
8      0.0   4.0   1.0   1.0   4.0   0.0   0.0   0.0   2.0
9      0.0   2.0   1.0   0.0   2.0   0.0   0.0   1.0   1.0
10     0.0   3.0   1.0   1.0   3.0   0.0   0.0   0.0   3.0
11     0.0   1.0   4.0   0.0   1.0   0.0   0.0   0.0   1.0
12     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
13     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
14     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
15     0.0   2.0   1.0   0.0   2.0   0.0   0.0   1.0   1.0
16     0.0   2.0   1.0   0.0   2.0   0.0   0.0   1.0   1.0
17     0.0   2.0   1.0   0.0   2.0   0.0   0.0   1.0   1.0
18     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
19     0.0   0.0   0.0   0.0   0.0   2.0   3.0   0.0   0.0
20     0.0   1.0   0.0   0.0   1.0   0.0   0.0   1.0   0.0
21     0.0   0.0   0.0   0.0   0.0   1.0   2.0   0.0   0.0
22     0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
23     0.0   1.0   1.0   0.0   1.0   0.0   0.0   0.0   1.0
24     0.0   0.0   0.0   0.0   0.0   2.0   3.0   0.0   0.0
25     0.0   0.0   0.0   0.0   0.0   2.0   3.0   0.0   0.0
26     0.0   1.0   0.0   0.0   1.0   0.0   0.0   1.0   0.0
27     0.0   1.0   1.0   0.0   1.0   0.0   0.0   0.0   1.0
28     0.0   1.0   1.0   0.0   1.0   0.0   0.0   0.0   1.0
29     0.0   2.0   1.0   0.0   2.0   0.0   0.0   0.0   1.0
...    ...   ...   ...   ...   ...   ...   ...   ...   ...
7337   0.0   0.0   0.0   0.0   0.0   2.0   3.0   0.0   0.0
7338   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7339   0.0   1.0   0.0   0.0   1.0   0.0   0.0   1.0   0.0
7340   0.0   0.0   0.0   0.0   0.0   2.0   3.0   0.0   0.0
7341   1.0   4.0   1.0   1.0   4.0   0.0   0.0   1.0   4.0
7342   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7343   0.0   2.0   0.0   0.0   2.0   0.0   0.0   1.0   0.0
7344   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

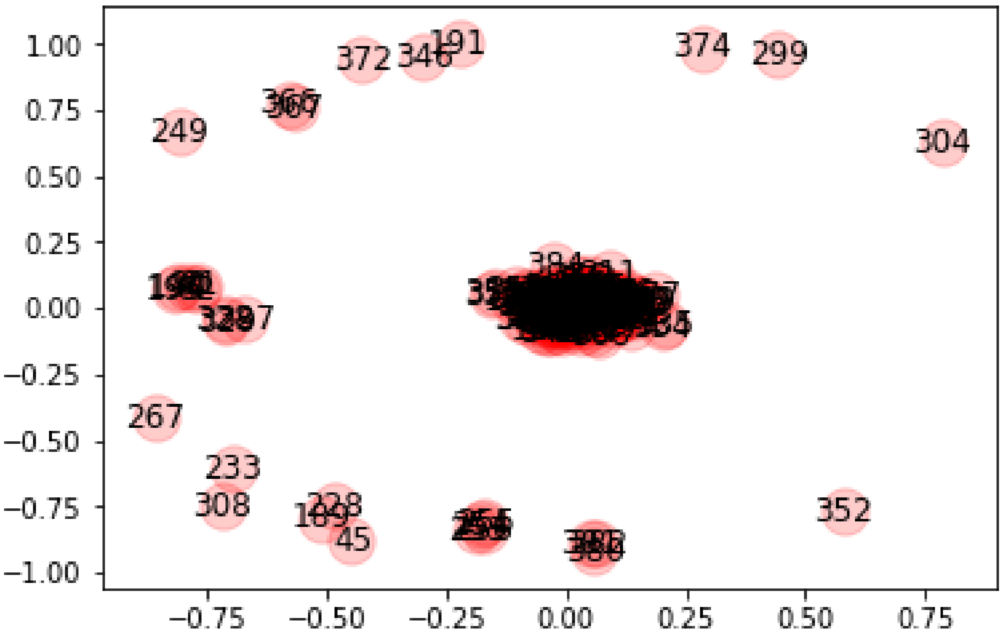
```
7345   2.0   5.0   1.0   1.0   5.0   0.0   0.0   2.0   4.0
7346   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7347   0.0   1.0   0.0   0.0   1.0   0.0   0.0   0.0   0.0
7348   0.0   2.0   1.0   1.0   2.0   0.0   0.0   0.0   3.0
7349   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7350   0.0   2.0   1.0   1.0   2.0   0.0   0.0   0.0   3.0
7351   0.0   1.0   0.0   0.0   1.0   0.0   0.0   1.0   0.0
7352   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7353   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7354   4.0   3.0   0.0   0.0   3.0   0.0   0.0   3.0   2.0
7355   0.0   3.0   1.0   1.0   3.0   0.0   0.0   1.0   2.0
7356   0.0   0.0   0.0   0.0   0.0   1.0   2.0   0.0   0.0
7357   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
7358   4.0   1.0   0.0   0.0   1.0   0.0   0.0   2.0   1.0
7359   1.0   7.0   1.0   1.0   7.0   0.0   0.0   2.0   5.0
7360   0.0   1.0   7.0   0.0   1.0   0.0   0.0   0.0   1.0
7361   0.0   1.0   0.0   1.0   1.0   0.0   0.0   0.0   1.0
7362   1.0   7.0   1.0   1.0   7.0   0.0   0.0   2.0   5.0
7363   0.0   0.0   0.0   0.0   0.0   3.0   3.0   0.0   0.0
7364   0.0   0.0   0.0   0.0   0.0   3.0   4.0   0.0   0.0
7365   2.0   2.0   0.0   0.0   2.0   0.0   0.0   7.0   2.0
7366   1.0   5.0   1.0   1.0   5.0   0.0   0.0   2.0   6.0

[7367 rows x 7367 columns]
```

```
In [901]: # generate whole graph of genres
          G_genre = nx.Graph()
          G_genre = nx.from_numpy_matrix(genre_Adj)

          G_temp = G_genre
          G_temp.remove_edges_from(nx.selfloop_edges(G_temp))
          nx.k_core(G_temp)

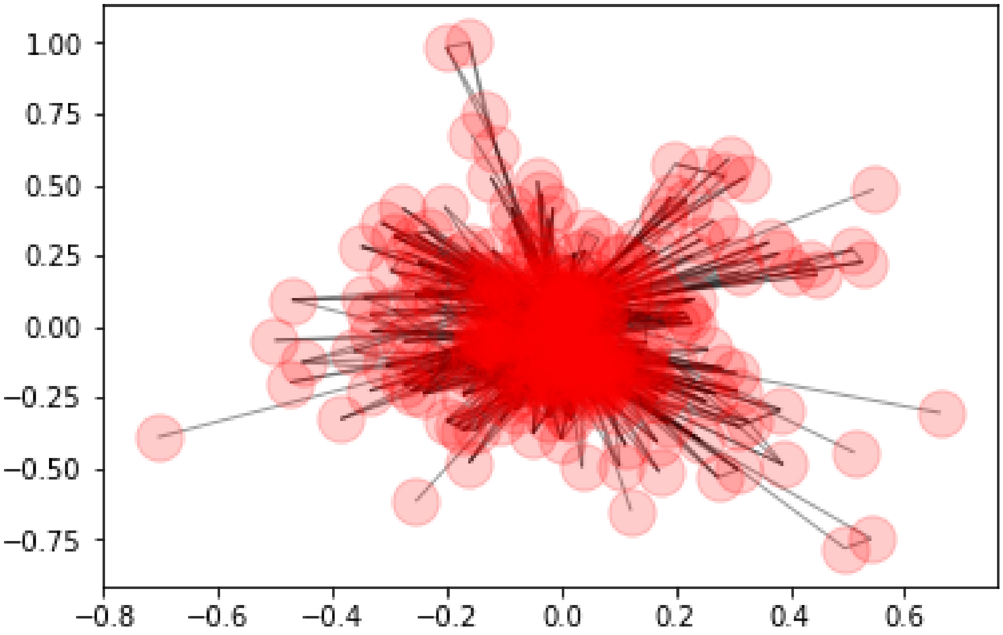
          pos = nx.spring_layout(G_temp)
          nx.draw_networkx_nodes(G_temp, pos, alpha=0.2)
          #ns = np.array(ec)*3000
          #nx.draw_networkx_nodes(G_giant_component, pos, nodelist=centrality.keys(), node_siz
          nx.draw_networkx_labels(G_temp, pos) # adding labels will result in a mess
          nx.draw_networkx_edges(G_temp, pos, width=1, alpha=0.4)
          plt.show()
```



```
In [902]: # construct graph with weight
          rows, cols = np.where(genre_Adj > 0)
          edges = zip(rows.tolist(), cols.tolist())

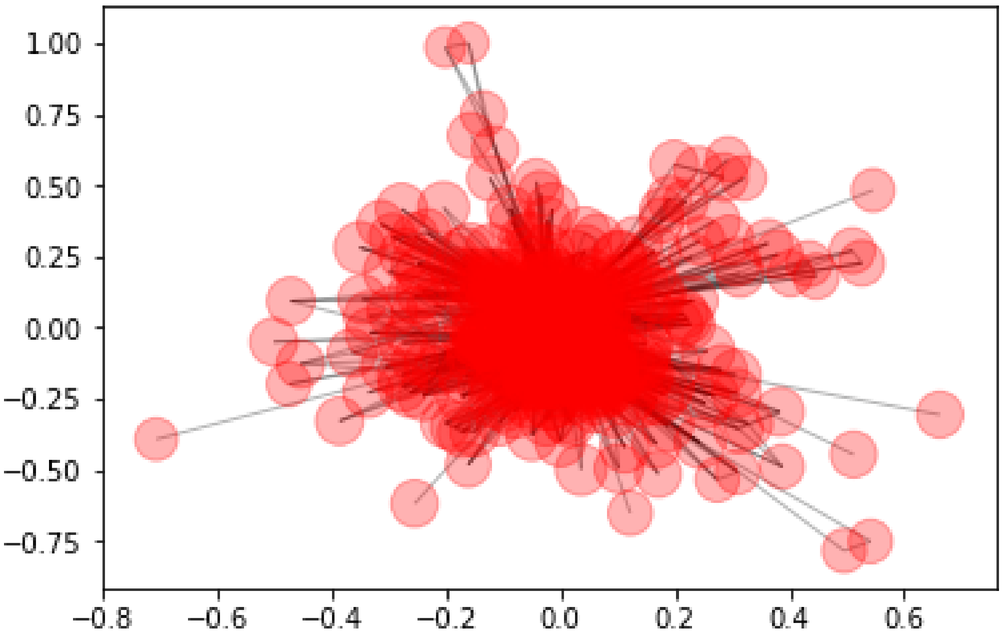
          # find largest component in graph
          G_giant_component_genre = max(nx.connected_component_subgraphs(G_genre), key=len)
          #G_genre.add_edges_from(edges)

          pos = nx.spring_layout(G_giant_component_genre)
          nx.draw_networkx_nodes(G_giant_component_genre, pos, alpha=0.2)
          #ns = np.array(ec)*3000
          #nx.draw_networkx_nodes(G_giant_component, pos, nodelist=centrality.keys(), node_siz
          #nx.draw_networkx_labels(G_genre, pos) # adding labels will result in a mess
          nx.draw_networkx_edges(G_giant_component_genre, pos, width=1, alpha=0.4)
          plt.show()
```



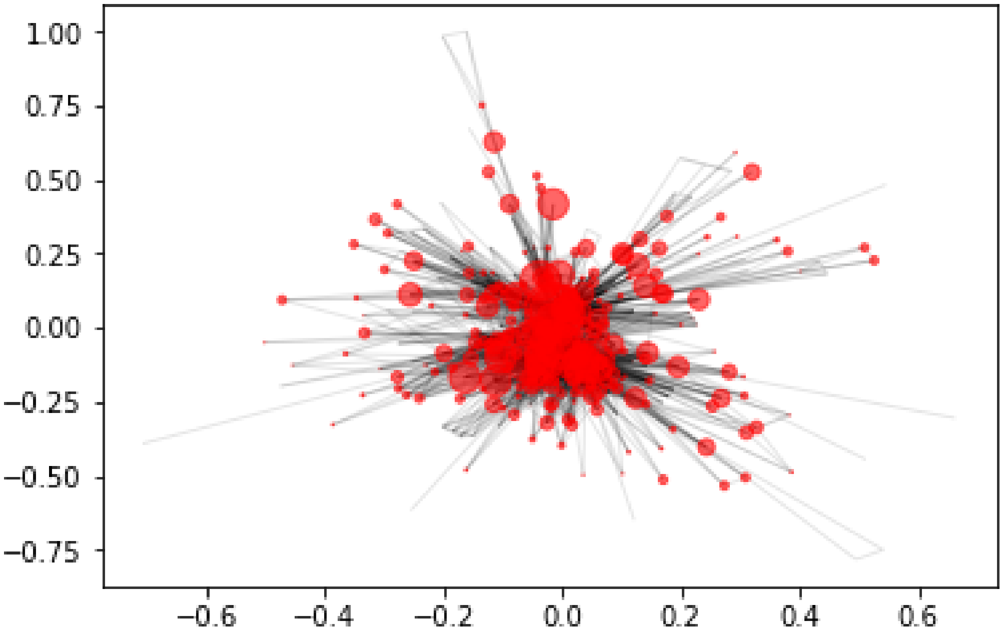
```
In [903]: # compute closeness centrality with weight
          cc_centrality = nx.closeness_centrality(G_giant_component_genre)
          cc = list(cc_centrality.values())

          # scale size of nodes
          ns = np.array(cc)*1000
          nx.draw_networkx_nodes(G_giant_component_genre, pos, nodelist=cc_centrality.keys(), n
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a mes
          nx.draw_networkx_edges(G_giant_component_genre, pos, alpha=0.3)
          plt.show()
```



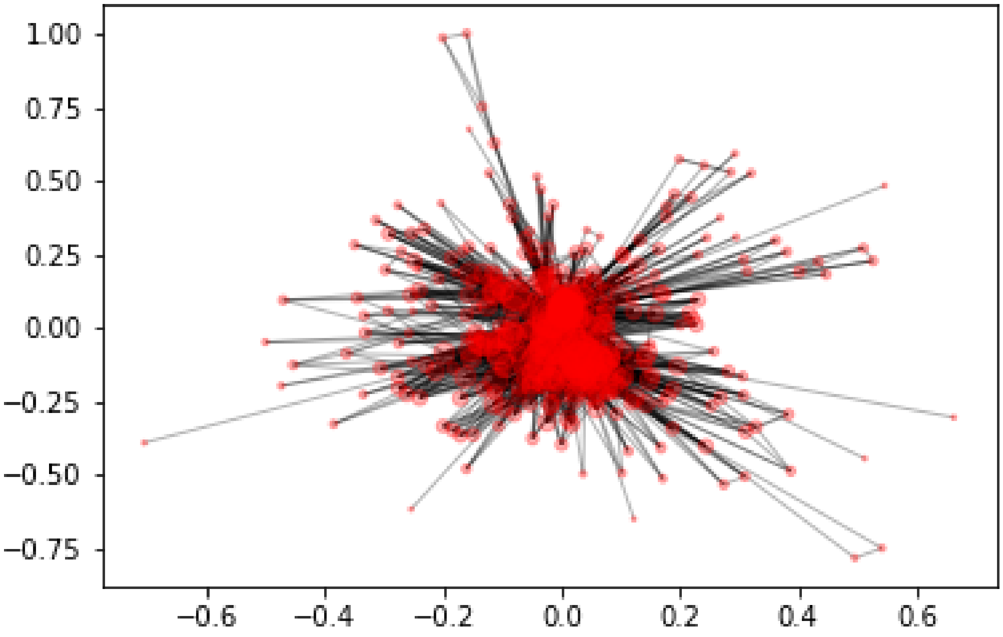
```
In [904]: # compute betweenness centrality with weight
          bc_centrality = nx.betweenness_centrality(G_giant_component_genre, weight='weight')
          bc = list(bc_centrality.values())

          # scale size of nodes
          ns = np.array(bc)*3000
          nx.draw_networkx_nodes(G_giant_component_genre, pos, nodelist=bc_centrality.keys(), n
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a mes
          nx.draw_networkx_edges(G_giant_component_genre, pos, alpha=0.1)
          plt.show()
```



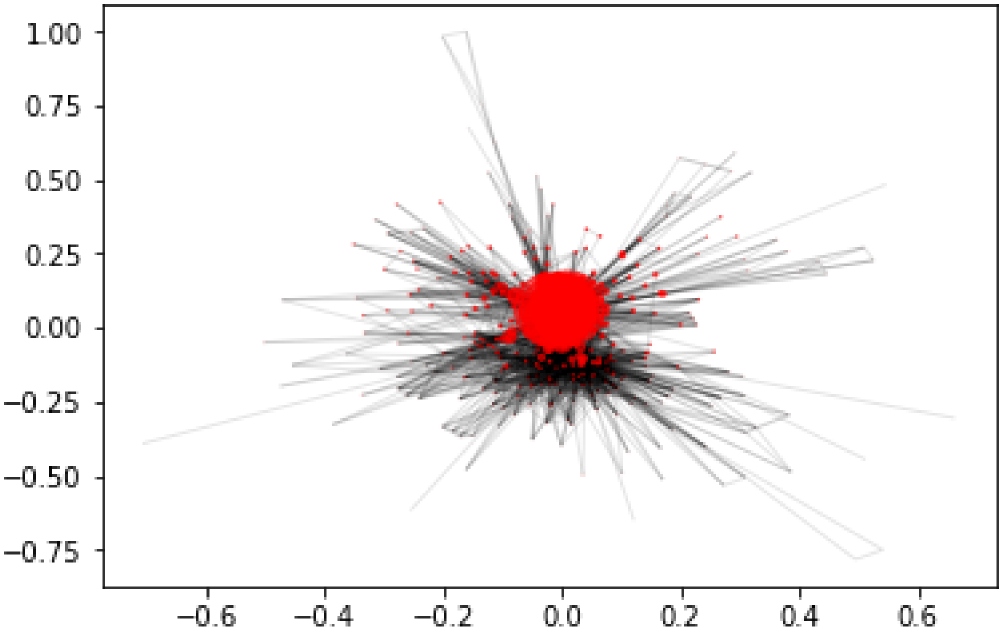
```
In [905]: # compute degree centrality with weight
          dc_centrality = nx.degree_centrality(G_giant_component_genre)
          dc = list(dc_centrality.values())

          # scale size of nodes
          ns = np.array(dc)*1000
          nx.draw_networkx_nodes(G_giant_component_genre, pos, nodelist=dc_centrality.keys(), n
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a mes
          nx.draw_networkx_edges(G_giant_component_genre, pos, alpha=0.3)
          plt.show()
```



```
In [906]: # compute eigenvector centrality with weight
          ec_centrality = nx.eigenvector_centrality(G_giant_component_genre, weight='weight')
          ec = list(ec_centrality.values())

          # scale size of nodes
          ns = np.array(ec)*2000
          nx.draw_networkx_nodes(G_giant_component_genre, pos, nodelist=ec_centrality.keys(), n
          #nx.draw_networkx_labels(G_giant_component, pos) # adding labels will result in a me
          nx.draw_networkx_edges(G_giant_component_genre, pos, alpha=0.1)
          plt.show()
```



```
In [ ]:
```

```
In [ ]:
```