

finalnotebook_section4_ajit_sans

June 6, 2021

```
[1]: pip install spotipy --upgrade
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: spotipy in
/home/aselvaku/.local/lib/python3.8/site-packages (2.18.0)
Requirement already satisfied: six>=1.15.0 in /opt/conda/lib/python3.8/site-
packages (from spotipy) (1.15.0)
Requirement already satisfied: urllib3>=1.26.0 in
/home/aselvaku/.local/lib/python3.8/site-packages (from spotipy) (1.26.5)
Requirement already satisfied: requests>=2.25.0 in
/home/aselvaku/.local/lib/python3.8/site-packages (from spotipy) (2.25.1)
Requirement already satisfied: idna<3,>=2.5 in /opt/conda/lib/python3.8/site-
packages (from requests>=2.25.0->spotipy) (2.8)
Requirement already satisfied: chardet<5,>=3.0.2 in
/opt/conda/lib/python3.8/site-packages (from requests>=2.25.0->spotipy) (3.0.4)
Requirement already satisfied: certifi>=2017.4.17 in
/opt/conda/lib/python3.8/site-packages (from requests>=2.25.0->spotipy)
(2019.11.28)
Note: you may need to restart the kernel to use updated packages.
```

```
[2]: import spotipy
import spotipy.util as util
from spotipy.oauth2 import SpotifyOAuth
from spotipy.oauth2 import SpotifyClientCredentials
import spotipy.oauth2 as oauth2

import pandas as pd
import numpy as np
import ast # for dictionary

from numpy import unique
from numpy import where
from sklearn.datasets import make_classification
from sklearn.cluster import AgglomerativeClustering
from matplotlib import pyplot
```

1 Load Sample Data

```
[5]: df = pd.read_csv('data_by_artist_o.csv')
sample_df = df.drop(columns=['genres', 'popularity', 'count', 'artists'])

sample = sample_df.to_numpy()
sample_df.head()
```

```
[5]:
```

	acousticness	danceability	duration_ms	energy	instrumentalness	\
0	0.590111	0.467222	250318.555556	0.394003	0.011400	
1	0.862538	0.441731	287280.000000	0.406808	0.081158	
2	0.856571	0.348286	328920.000000	0.286571	0.024593	
3	0.884926	0.425074	262890.962963	0.245770	0.073587	
4	0.510714	0.467143	270436.142857	0.488286	0.009400	

	liveness	loudness	speechiness	tempo	valence	key	mode
0	0.290833	-14.448000	0.210389	117.518111	0.389500	5	1
1	0.315215	-10.690000	0.176212	103.044154	0.268865	5	1
2	0.325786	-15.230714	0.118514	77.375857	0.354857	0	1
3	0.275481	-15.639370	0.123200	88.667630	0.372030	0	1
4	0.195000	-10.236714	0.098543	122.835857	0.482286	5	1

2 Implement PCA

```
[6]: import scipy.io as sio
import matplotlib
import matplotlib.pyplot as plt
from numpy.matlib import repmat
from sklearn.preprocessing import normalize

%matplotlib inline
```

```
[7]: def eigsort(V, eigvals):

    # Sort the eigenvalues from largest to smallest. Store the sorted
    # eigenvalues in the column vector lamdb.
    lohival = np.sort(eigvals)
    lohiindex = np.argsort(eigvals)
    lamdb = np.flip(lohival)
    index = np.flip(lohiindex)
    Dsort = np.diag(lamdb)

    # Sort eigenvectors to correspond to the ordered eigenvalues. Store sorted
    # eigenvectors as columns of the matrix vsort.
    M = np.size(lamdb)
    Vsort = np.zeros((M, M))
```

```

    for i in range(M):
        Vsort[:,i] = V[:,index[i]]
    return Vsort, Dsort

# normc(M) normalizes the columns of M to a length of 1.
def normc(Mat):
    return normalize(Mat, norm='l2', axis=0)

def PCA_(data):

    m,n = data.shape

    mean = np.mean(data, 0)
    Z = data - mean
    C = np.dot(Z.T, Z)

    D, V = np.linalg.eig(C)
    Vsort, Dsort = eigsort(V, D)
    U = np.dot(Z, Vsort)
    U = normc(U)

    return U, Vsort, Dsort, Z
#use first * columns of Z as input for algo

```

3 Run PCA

```
[8]: U, Vsort, Dsort, Z = PCA_(sample)
```

```
[9]: eigenvalues = []
    for i in range(12):
        eigenvalues.append(Dsort[i,i])

    eigenvalues
```

```
[9]: [420804751995824.75,
      17966169.90668353,
      880522.7041980289,
      346870.45638083183,
      5232.672596639826,
      2581.0627245786814,
      2115.9808646581946,
      1581.3448672598574,
      656.848869111608,
      468.610678908101,
```

```
293.7826557205403,  
209.29361740664388]
```

```
[10]: c = np.dot(U.T, Z)  
  
# project data into new coordinate space, consisting of top 4 eigenvectors  
proj_data = np.dot( U[:,0:4], c[0:4] ) + np.mean(sample, 0)  
  
proj_data.shape
```

```
[10]: (28680, 12)
```

```
[11]: import plotly.express as px
```

```
[12]: # visualizes all the original dimensions  
features = sample_df.columns  
fig = px.scatter_matrix(sample_df, dimensions=features)  
fig.update_traces(diagonal_visible=False)  
fig.show()
```

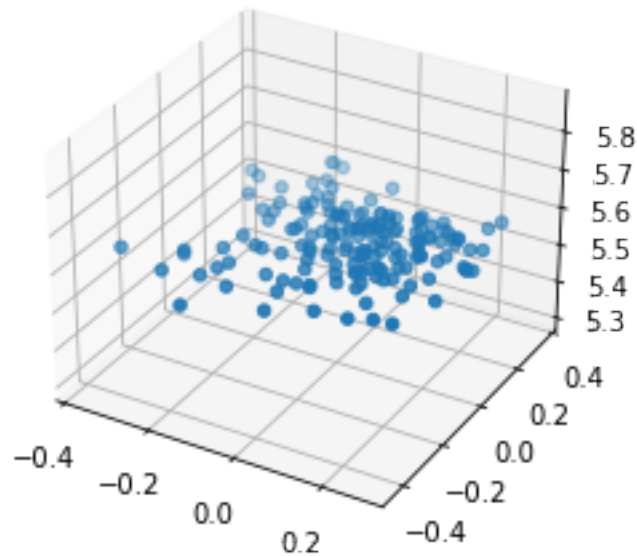
```
[13]: # visualizes all the principal components  
fig = px.scatter_matrix(  
    U,  
    labels=tuple(features),  
    dimensions=range(12),  
)  
fig.update_traces(diagonal_visible=False)  
fig.show()
```

```
[14]: # visualizes first four principal components  
fig = px.scatter_matrix(  
    U,  
    labels=tuple(features),  
    dimensions=range(4),  
)  
fig.update_traces(diagonal_visible=False)  
fig.show()
```

```
[15]: ### THOUGHT: you can view this graph from a certain angle, which will represent  
    ↪ the principle components above  
a = proj_data[:,0]  
b = proj_data[:,1]  
c = proj_data[:,2]  
cc = proj_data[:,3]  
  
fig = px.scatter_3d(x=a, y=b, z=c, color=cc)  
fig.show()
```

4 Agglomerative (hierarchal) Clustering

```
[153]: # agglomerative clustering
# define the model
model = AgglomerativeClustering(n_clusters=10)
# fit model and predict clusters
yhat = model.fit_predict(Z[:,0:3])
# retrieve unique clusters
clusters = unique(yhat)
# create scatter plot for samples from each cluster
for cluster in clusters:
    #get row indexes for samples with this cluster
    row_ix = where(yhat == cluster)
    #create scatter of these samples
    #pyplot.scatter(Z[:,0:2][row_ix, 0], Z[:,0:2][row_ix, 1])
    ax = plt.axes(projection='3d')
    ax.scatter3D(Z[:,0:3][row_ix, 0], Z[:,0:3][row_ix, 1], Z[:,0:3][row_ix, 2])
# show the plot
pyplot.show()
```



```
[249]: yhat
```

```
[249]: array([8, 8, 7, ..., 3, 1, 0])
```

```
[155]: songs_clusters = where(yhat == 4)
songs_clusters
```

```
[155]: (array([ 19,  36,  45,  74,  77,  82, 106, 112, 113, 122, 130,
          158, 160, 162, 186, 191, 207, 258, 261, 265, 270, 283,
          297, 301, 302, 324, 359, 365, 367, 382, 402, 418, 496,
          510, 517, 518, 537, 544, 556, 594, 603, 605, 607, 612,
          615, 632, 643, 648, 665, 667, 674, 676, 681, 683, 693,
          704, 716, 740, 757, 770, 790, 792, 807, 819, 832, 837,
          851, 854, 859, 884, 886, 888, 897, 926, 977, 980, 995,
          999, 1000, 1040, 1054, 1067, 1092, 1112, 1126, 1141, 1168, 1191,
          1199, 1200, 1224, 1233, 1241, 1242, 1264, 1296, 1342, 1346, 1355,
          1359, 1362, 1369, 1381, 1383, 1388, 1394, 1400, 1404, 1405, 1441,
          1455, 1470, 1474, 1493, 1503, 1505, 1519, 1536, 1538, 1576, 1610,
          1615, 1621, 1631, 1632, 1638, 1641, 1654, 1668, 1680, 1691, 1694,
          1719, 1751, 1758, 1769, 1771]),)
```

5 Genre Analysis

```
[164]: df['genres']
```

```
[164]: 0          ['show tunes']
      1                  []
      2                  []
      3                  []
      4                  []
      ...
      28675                  []
      28676  ['c-pop', 'classic cantopop', 'classic mandopo...
      28677                  []
      28678          ['chinese indie', 'chinese indie rock']
      28679          ['classic korean pop']
      Name: genres, Length: 28680, dtype: object
```

```
[168]: df['genres'][29]
```

```
[168]: "['alternative metal', 'christian rock', 'nu metal', 'post-grunge', 'rap rock']"
```

```
[224]: my_dict = dict()
      my_dict['x'] = 1
      'y' in my_dict

      strlist = '[1,2]'
      ast.literal_eval(strlist)
```

```
[224]: [1, 2]
```

6 Genre Analysis Function for Agglomerative

```
[283]: genre_dict = dict()
q = where(yhat == 4)
for i in q:
    for j in df['genres'][i]:
        res_list = ast.literal_eval(j)
        print(res_list)
        for genre in res_list:
            if genre in genre_dict:
                genre_dict[genre] += 1
            else:
                genre_dict[genre] = 1

dict(sorted(genre_dict.items(), key=lambda item: item[1]))
#         for elem in j:
#             print(j)
```

```
[]
['boy band', 'dance pop', 'europop', 'pop']
['alternative rock', 'dance-punk', 'double drumming', 'indie rock', 'modern
rock', 'post-hardcore']
[]
['bachata', 'latin', 'tropical']
[]
['new wave pop', 'pop rock']
['detroit trap', 'rap', 'southern hip hop', 'trap']
['hardcore', 'hardcore punk', 'melodic hardcore', 'punk', 'skate punk',
'straight edge', 'thrash core']
['grunge', 'riot grrrl']
['asian american hip hop', 'pop']
['lo-fi beats']
['boy band', 'dance pop']
[]
['baltimore hip hop', 'drill', 'underground hip hop', 'vapor trap']
['hip hop', 'rap', 'southern hip hop', 'trap', 'vapor trap']
[]
[]
[]
['trap soul']
[]
['modern rock']
['la indie', 'modern alternative rock', 'modern rock', 'pop rock', 'rock',
'stomp pop']
['gruperas inmortales', 'nu-cumbia', 'regional mexican']
['focus']
['motown', 'soul']
```

['contemporary country', 'country', 'country road', 'modern country rock',
 'texas country']
 []
 []
 ['dance rock', 'double drumming', 'new romantic', 'new wave', 'new wave pop',
 'post-punk', 'punk', 'ska']
 ['alternative country', 'roots americana', 'roots rock', 'texas country']
 ['american contemporary classical']
 ['latin jazz']
 ['classical mezzo-soprano', 'classical performance', 'opera']
 ['celtic', 'new age', 'string folk']
 ['barockinterpreten', 'baroque ensemble', 'choral', 'classical performance',
 'historically informed performance']
 ['jazz trio']
 []
 ['album rock', 'art rock', 'classic rock', 'classic uk pop', 'country rock',
 'folk', 'folk rock', 'mellow gold', 'progressive rock', 'soft rock', 'symphonic
 rock']
 []
 ['chanson', 'french indie pop', 'french pop', 'french rock', 'nouvelle chanson
 francaise']
 ['electro house']
 ['blues', 'blues rock', 'classic rock', 'electric blues', 'memphis soul', 'soul
 blues', 'traditional blues']
 ['classic italian pop', 'swing italiano', 'vintage italian pop']
 ['grupera', 'regional mexican']
 []
 ['pop']
 ['alternative country', 'country rock', 'folk', 'heartland rock', 'new
 americana', 'pub rock', 'roots rock']
 ['bachata', 'bachata dominicana', 'latin', 'merengue', 'tropical']
 ['smooth jazz']
 ['berlin minimal techno']
 ['funky tech house', 'tech house']
 ['cosmic american', 'experimental', 'folk rock', 'outsider', 'psychedelic rock']
 []
 ['disco', 'funk', 'minneapolis sound', 'new jack swing', 'post-disco', 'quiet
 storm', 'soul', 'urban contemporary']
 []
 ['dance pop', 'electropop', 'pop dance', 'romanian pop']
 ['axe', 'pagode']
 ['chill r&b']
 []
 ['canadian hip hop', 'pop']
 []
 ['alternative metal', 'alternative rock', 'grunge', 'hard rock', 'nu metal',
 'rock']
 ['lo-fi beats']

['indie rock', 'modern alternative rock', 'modern blues rock', 'neo-
 psychedelic', 'space rock', 'stoner rock']
 ['dance rock', 'europop', 'new romantic', 'new wave', 'new wave pop',
 'synthpop']
 []
 ['latin', 'latin arena pop', 'latin pop', 'spanish pop', 'spanish pop rock']
 ['hollywood', 'pop']
 ['french opera', 'french romanticism', 'late romantic era']
 ['hip hop', 'underground hip hop']
 ['big beat', 'drill and bass', 'electronica', 'intelligent dance music',
 'jazztronica', 'ninja', 'nu jazz', 'trip hop']
 ['acoustic pop', 'indie folk', 'lilith', 'neo mellow', 'new americana', 'pop
 rock', 'stomp and holler']
 ['baroque ensemble', 'classical performance']
 ['chamber orchestra', 'string orchestra']
 ['fado']
 ['grupera', 'latin', 'mexican pop', 'regional mexican']
 ['background music', 'background piano', 'calming instrumental', 'focus', 'neo-
 classical']
 ['sitar', 'world fusion']
 []
 []
 ['blues rock', 'country rock', 'deep new americana', 'funk', 'jam band',
 'louisiana blues', 'modern blues', 'modern blues rock', 'new americana', 'new
 orleans blues', 'roots rock']
 ['easy listening']
 ['easy listening']
 ['spytrack']
 ['classical performance', 'orchestral performance']
 []
 ['native american']
 []
 []
 ['british classical piano']
 ['dark jazz', 'soundtrack']
 []
 ['anti-folk', 'buffalo ny indie', 'ectofolk', 'folk', 'lilith', 'pop rock',
 'singer-songwriter', "women's music"]
 ['cumbia', 'cumbia salvadorena']
 []
 ['classical performance', 'violin']
 ['latin christian', 'mariachi cristiano']
 []
 ['boy band', 'new jack swing']
 ['classic uk pop', 'merseybeat']
 ['late romantic era', 'russian romanticism']
 ['bachata dominicana', 'dominican pop', 'latin', 'tropical']
 ['bhajan', 'classic bollywood', 'desi pop', 'filmi', 'ghazal', 'modern

```

bollywood', 'sufi']
['meditation']
['alternative country', 'deep new americana', 'modern southern rock', 'new
americana', 'roots americana', 'roots rock', 'southern americana', 'texas
country']
['caucasian classical', 'classical', 'early modern classical', 'russian modern
classical']
[]
['uk alternative pop']
[]
[]
['atl hip hop', 'conscious hip hop', 'hip hop', 'rap']
['classic soul', 'motown', 'rhythm and blues', 'soul', 'southern soul']
[]
['late romantic era', 'operetta', 'victorian britain']
['historic orchestral performance']
[]
['classical performance', 'classical piano', 'italian classical piano']
[]
['christian alternative rock', 'christian rock']
['classic opm', 'manila sound', 'opm']
[]
[]
['alternative metal', 'melodic metalcore', 'metalcore', 'nu metal', 'pop punk',
'rap rock', 'screamo']

```

```

[283]: {'dance-punk': 1,
        'post-hardcore': 1,
        'detroit trap': 1,
        'hardcore': 1,
        'hardcore punk': 1,
        'melodic hardcore': 1,
        'skate punk': 1,
        'straight edge': 1,
        'thrash core': 1,
        'riot grrrl': 1,
        'asian american hip hop': 1,
        'baltimore hip hop': 1,
        'drill': 1,
        'trap soul': 1,
        'la indie': 1,
        'stomp pop': 1,
        'gruperas inmortales': 1,
        'nu-cumbia': 1,
        'contemporary country': 1,
        'country': 1,
        'country road': 1,

```

'modern country rock': 1,
'post-punk': 1,
'ska': 1,
'american contemporary classical': 1,
'latin jazz': 1,
'classical mezzo-soprano': 1,
'opera': 1,
'celtic': 1,
'new age': 1,
'string folk': 1,
'barockinterpreten': 1,
'choral': 1,
'historically informed performance': 1,
'jazz trio': 1,
'album rock': 1,
'art rock': 1,
'mellow gold': 1,
'progressive rock': 1,
'soft rock': 1,
'symphonic rock': 1,
'chanson': 1,
'french indie pop': 1,
'french pop': 1,
'french rock': 1,
'nouvelle chanson francaise': 1,
'electro house': 1,
'blues': 1,
'electric blues': 1,
'memphis soul': 1,
'soul blues': 1,
'traditional blues': 1,
'classic italian pop': 1,
'swing italiano': 1,
'vintage italian pop': 1,
'heartland rock': 1,
'pub rock': 1,
'merengue': 1,
'smooth jazz': 1,
'berlin minimal techno': 1,
'funky tech house': 1,
'tech house': 1,
'cosmic american': 1,
'experimental': 1,
'outsider': 1,
'psychedelic rock': 1,
'disco': 1,
'minneapolis sound': 1,

'post-disco': 1,
'quiet storm': 1,
'urban contemporary': 1,
'electropop': 1,
'pop dance': 1,
'romanian pop': 1,
'axe': 1,
'pagode': 1,
'chill r&b': 1,
'canadian hip hop': 1,
'hard rock': 1,
'neo-psychedelic': 1,
'space rock': 1,
'stoner rock': 1,
'synthpop': 1,
'latin arena pop': 1,
'latin pop': 1,
'spanish pop': 1,
'spanish pop rock': 1,
'hollywood': 1,
'french opera': 1,
'french romanticism': 1,
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'drill and bass': 1,
'electronica': 1,
'intelligent dance music': 1,
'jazztronica': 1,
'ninja': 1,
'nu jazz': 1,
'trip hop': 1,
'acoustic pop': 1,
'indie folk': 1,
'neo mellow': 1,
'stomp and holler': 1,
'chamber orchestra': 1,
'string orchestra': 1,
'fado': 1,
'mexican pop': 1,
'background music': 1,
'background piano': 1,
'calming instrumental': 1,
'neo-classical': 1,
'sitar': 1,
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'jam band': 1,
'louisiana blues': 1,
'modern blues': 1,

'new orleans blues': 1,
'spytrack': 1,
'orchestral performance': 1,
'native american': 1,
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'dark jazz': 1,
'soundtrack': 1,
'anti-folk': 1,
'buffalo ny indie': 1,
'ectofolk': 1,
'singer-songwriter': 1,
"women's music": 1,
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'cumbia salvadorena': 1,
'violin': 1,
'latin christian': 1,
'mariachi cristiano': 1,
'merseybeat': 1,
'russian romanticism': 1,
'dominican pop': 1,
'bhajan': 1,
'classic bollywood': 1,
'desi pop': 1,
'filmi': 1,
'ghazal': 1,
'modern bollywood': 1,
'sufi': 1,
'meditation': 1,
'modern southern rock': 1,
'southern americana': 1,
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'classical': 1,
'early modern classical': 1,
'russian modern classical': 1,
'uk alternative pop': 1,
'atl hip hop': 1,
'conscious hip hop': 1,
'classic soul': 1,
'rhythm and blues': 1,
'southern soul': 1,
'operetta': 1,
'victorian britain': 1,
'historic orchestral performance': 1,
'classical piano': 1,
'italian classical piano': 1,
'christian alternative rock': 1,
'christian rock': 1,

'classic opm': 1,
'manila sound': 1,
'opm': 1,
'melodic metalcore': 1,
'metalcore': 1,
'pop punk': 1,
'rap rock': 1,
'screamo': 1,
'europop': 2,
'alternative rock': 2,
'double drumming': 2,
'indie rock': 2,
'bachata': 2,
'southern hip hop': 2,
'trap': 2,
'punk': 2,
'grunge': 2,
'lo-fi beats': 2,
'underground hip hop': 2,
'vapor trap': 2,
'modern alternative rock': 2,
'rock': 2,
'focus': 2,
'motown': 2,
'dance rock': 2,
'new romantic': 2,
'new wave': 2,
'roots americana': 2,
'baroque ensemble': 2,
'classic rock': 2,
'classic uk pop': 2,
'folk rock': 2,
'blues rock': 2,
'grupera': 2,
'bachata dominicana': 2,
'funk': 2,
'new jack swing': 2,
'alternative metal': 2,
'nu metal': 2,
'modern blues rock': 2,
'lilith': 2,
'deep new americana': 2,
'easy listening': 2,
'boy band': 3,
'dance pop': 3,
'modern rock': 3,
'tropical': 3,

```

'new wave pop': 3,
'rap': 3,
'hip hop': 3,
'regional mexican': 3,
'soul': 3,
'texas country': 3,
'alternative country': 3,
'country rock': 3,
'folk': 3,
'late romantic era': 3,
'pop rock': 4,
'roots rock': 4,
'new americana': 4,
'pop': 5,
'latin': 5,
'classical performance': 6}

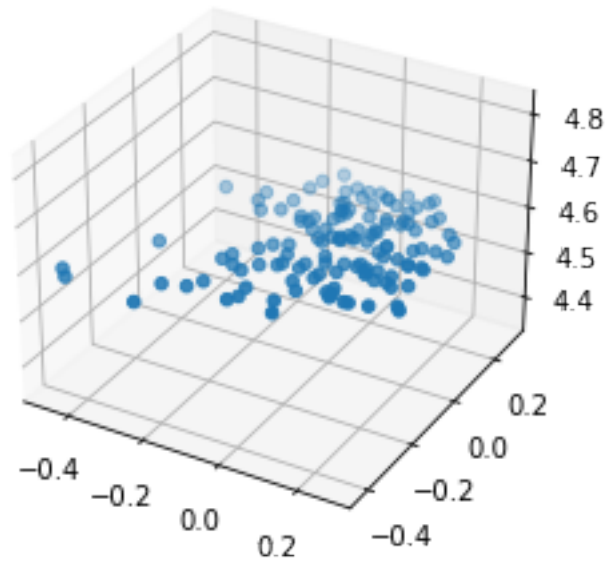
```

7 BIRCH Clustering

```

[285]: # birch clustering
from sklearn.cluster import Birch
# define the model
model = Birch(threshold=0.01, n_clusters=10)
# fit the model
model.fit(Z[:,0:3])
# assign a cluster to each example
yhat1 = model.predict(Z[:,0:3])
# retrieve unique clusters
clusters = unique(yhat1)
# create scatter plot for samples from each cluster
for cluster in clusters:
    # get row indexes for samples with this cluster
    row_ix = where(yhat1 == cluster)
    # create scatter of these samples
    ax = plt.axes(projection='3d')
    ax.scatter3D(Z[:,0:3][row_ix, 0], Z[:,0:3][row_ix, 1], Z[:,0:3][row_ix, 2])
# show the plot
pyplot.show()

```



8 Genre Analysis Function for BIRCH

```
[286]: my_dict = dict()
my_dict['x'] = 1
'y' in my_dict

strlist = '[1,2]'
ast.literal_eval(strlist)

genre_dict = dict()
q = where(yhat1 == 4)
for i in q:
    for j in df['genres'][i]:
        res_list = ast.literal_eval(j)
        print(res_list)
        for genre in res_list:
            if genre in genre_dict:
                genre_dict[genre] += 1
            else:
                genre_dict[genre] = 1

dict(sorted(genre_dict.items(), key=lambda item: item[1]))
```

```
['dark trap', 'meme rap']
['k-pop', 'k-pop girl group']
['dub', 'east coast reggae', 'reggae', 'reggae rock', 'roots reggae']
```


['japanese city pop']
 ['atl hip hop', 'dirty south rap', 'southern hip hop', 'trap']
 ['bow pop', 'cello', 'classify']
 ['dance pop', 'k-pop', 'k-pop girl group', 'pop dance']
 ['g funk', 'gangster rap', 'hip hop', 'rap', 'west coast rap']
 ['sad rap']
 ['dance pop', 'electropowerpop', 'pop', 'pop punk', 'pop rap', 'post-teen pop']
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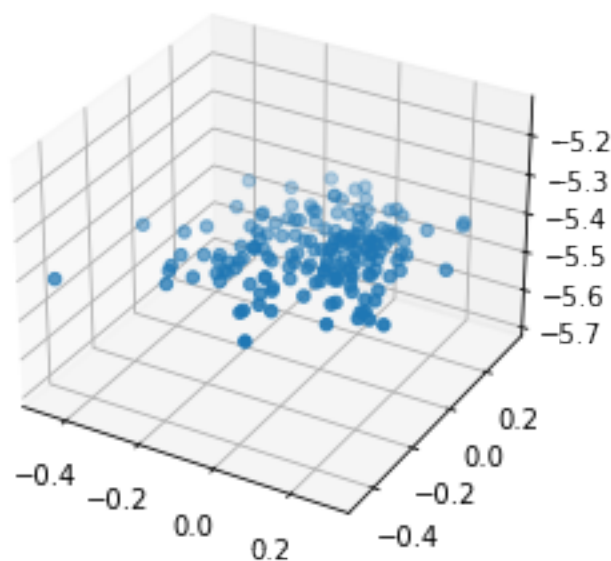
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9 DBScan Clustering

```
[287]: from sklearn.cluster import DBSCAN
# define the model
model = DBSCAN(eps=0.30, min_samples=10)
# fit model and predict clusters
yhat2 = model.fit_predict(Z[:,0:3])
# retrieve unique clusters
clusters = unique(yhat2)
# create scatter plot for samples from each cluster
for cluster in clusters:
    # get row indexes for samples with this cluster
    row_ix = where(yhat2 == cluster)
    # create scatter of these samples
    ax = plt.axes(projection='3d')
    ax.scatter3D(Z[:,0:3][row_ix, 0], Z[:,0:3][row_ix, 1], Z[:,0:3][row_ix, 2])
# show the plot
pyplot.show()
```



10 Genre Analysis Function for DBScan

```
[288]: my_dict = dict()
my_dict['x'] = 1
'y' in my_dict
```

```

strlist = '[1,2]'
ast.literal_eval(strlist)

genre_dict = dict()
q = where(yhat2 == 4)
for i in q:
    for j in df['genres'][i]:
        res_list = ast.literal_eval(j)
        print(res_list)
        for genre in res_list:
            if genre in genre_dict:
                genre_dict[genre] += 1
            else:
                genre_dict[genre] = 1

dict(sorted(genre_dict.items(), key=lambda item: item[1]))

```

```

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