kaggle_lyrics_genre_clustering

May 18, 2021

[42]:
```
!pip3 install langdetect
from langdetect import DetectorFactory, detect
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.cluster import KMeans
from sklearn.decomposition import PCA
from scipy.cluster.hierarchy import linkage, dendrogram
from matplotlib import pyplot as plt
import json
import re
import numpy as np
import pandas as pd
```

```
Requirement already satisfied: langdetect in /usr/local/lib/python3.7/dist-
packages (1.0.9)
Requirement already satisfied: six in /usr/local/lib/python3.7/dist-packages
(from langdetect) (1.15.0)
```

[43]:
```
with open("artist_lyrics_kaggle.json", "r", encoding='utf-8') as json_file:
  artist_lyrics = json.load(json_file)

with open("artist_genre_kaggle.json", "r", encoding='utf-8') as json_file:
  artist_genre = json.load(json_file)
```

[44]:
```
def extract_artists_lyrics_of_file (json_file):
  json_file_content = {}
  for k,v in json_file.items():
    json_file_content[k] = ' '.join(re.findall('[A-Za-z]+', v))
  return json_file_content

def extract_genre_by_artist (json_file, artist):
  return json_file[artist]

def load_stopwords_file(txt_file):
  stopwords_file = open(txt_file)
  stopwords_file_content = stopwords_file.read()
  return stopwords_file_content.splitlines()
```

```
def detect_language (content):
  # check lg iso-codes here: https://en.wikipedia.org/wiki/
 ↪List_of_ISO_639-1_codes
  return detect(content)

def evaluate_tfidf_matrix (stop_words, max_features, lyrics):
  vectorizer = TfidfVectorizer(stop_words=stop_words, max_features=max_features)
  lyrics_tfidf_matrix = vectorizer.fit_transform(lyrics)
  feature_names = vectorizer.get_feature_names()
  return lyrics_tfidf_matrix, feature_names

def extract_features_by_artist␣
 ↪(json_content_artist_lyrics,stop_words,max_features):
  artists, lyrics =␣
 ↪zip(*extract_artists_lyrics_of_file(json_content_artist_lyrics).items())
  lyrics_tfidf_matrix, feature_names =␣
 ↪evaluate_tfidf_matrix(stop_words,max_features,lyrics)
  return zip(artists,lyrics_tfidf_matrix.toarray())

def extract_features_by_genre␣
 ↪(json_content_artist_lyrics,json_content_artist_genre,stop_words,max_features):
  words_per_genre = {}
  for artist,lyrics in␣
 ↪extract_artists_lyrics_of_file(json_content_artist_lyrics).items():
    genre = extract_genre_by_artist(json_content_artist_genre, artist)
    words_per_genre[genre] = lyrics if not genre in words_per_genre else␣
 ↪words_per_genre[genre]+" "+lyrics
  genres, lyrics = zip(*words_per_genre.items())
  lyrics_tfidf_matrix, feature_names =␣
 ↪evaluate_tfidf_matrix(stop_words,max_features,lyrics)
  return zip(genres,lyrics_tfidf_matrix.toarray())

def apply_kmeans (json_content_artist_lyrics,stop_words,max_features):
  artists, lyrics =␣
 ↪zip(*extract_artists_lyrics_of_file(json_content_artist_lyrics).items())
  lyrics_tfidf_matrix, feature_names =␣
 ↪evaluate_tfidf_matrix(stop_words,max_features,lyrics)
  kmeans = KMeans(n_clusters=10)
  kmeans.fit(lyrics_tfidf_matrix.toarray())
  y_kmeans = kmeans.predict(lyrics_tfidf_matrix.toarray())
  scatter_kmeans(kmeans,y_kmeans,lyrics_tfidf_matrix.toarray())

def scatter_kmeans(kmeans,y_kmeans,lyrics_tfidf_matrix):
  plt.scatter(lyrics_tfidf_matrix[:, 0], lyrics_tfidf_matrix[:, 1], c=y_kmeans,␣
 ↪s=50, cmap='viridis')
  centers = kmeans.cluster_centers_
```

```
  plt.scatter(centers[:, 0], centers[:, 1], c='black', s=200, alpha=0.5);

def apply_hierarchical_clustering␣
 ↪(json_content_artist_lyrics,stop_words,max_features):
  artists, lyrics =␣
 ↪zip(*extract_artists_lyrics_of_file(json_content_artist_lyrics).items())
  lyrics_tfidf_matrix, feature_names =␣
 ↪evaluate_tfidf_matrix(stop_words,max_features,lyrics)
  clustered = linkage(lyrics_tfidf_matrix.toarray(), method='ward')
  plot_dendrogram(clustered, artists)

def plot_dendrogram(clustered, artists):
  plt.figure(figsize=(10, 25))
  plt.title('Hierarchical Clustering Dendrogram')
  plt.xlabel('Distance')
  plt.ylabel('Artists')
  plt.tight_layout()
  dendrogram(clustered,leaf_font_size=8.,labels = artists,orientation = 'left')
  plt.show()

def apply_pca (json_content_artist_lyrics,stop_words,max_features):
  artists, lyrics =␣
 ↪zip(*extract_artists_lyrics_of_file(json_content_artist_lyrics).items())
  genre_targets_df = pd.DataFrame ([extract_genre_by_artist(artist_genre,artist)␣
 ↪for artist in artists],columns=['target'])
  lyrics_tfidf_matrix, feature_names =␣
 ↪evaluate_tfidf_matrix(stop_words,max_features,lyrics)
  pca = PCA(n_components=2)
  principal_components = pca.fit_transform(lyrics_tfidf_matrix.toarray())
  principal_components_df = pd.DataFrame(data = principal_components,columns =␣
 ↪['PC1', 'PC2'])
  principal_components_targets_df = pd.concat([principal_components_df,␣
 ↪genre_targets_df], axis = 1)
  scatter_pca(principal_components_targets_df)

def scatter_pca(dataframe):
  fig = plt.figure(figsize = (8,8))
  ax = fig.add_subplot(1,1,1)
  ax.set_xlabel('PC1', fontsize = 15)
  ax.set_ylabel('PC2', fontsize = 15)
  ax.set_title('Principle Component Analysis', fontsize = 20)
  targets =␣
 ↪['Metal','Hip-Hop','Electronic','R&B','Country','Folk','Pop','Indie','Rock','Jazz']
  colors =␣
 ↪["#c3618c","#b45ac2","#c8ac42","#7178ca","#cb7140","#4bafd0","#d0454e","#52a674","#877f3a","#
  for target, color in zip(targets,colors):
```

```
    indicesToKeep = dataframe['target'] == target
    ax.scatter(dataframe.loc[indicesToKeep, 'PC1']
                , dataframe.loc[indicesToKeep, 'PC2']
                , c = color
                , s = 50)
  ax.legend(targets)
  ax.grid()
```

[45]:
```
artist_features_collection =␣
 ↪extract_features_by_artist(artist_lyrics,load_stopwords_file("stopwords.
 ↪txt"),20)
for artist_features in artist_features_collection:
  print(artist_features)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/feature_extraction/text.py:385:
UserWarning: Your stop_words may be inconsistent with your preprocessing.
Tokenizing the stop words generated tokens ['aren', 'couldn', 'didn', 'doesn',
'hadn', 'hasn', 'haven', 'isn', 'quelqu', 'shouldn', 'wasn', 'weren', 'won',
'wouldn'] not in stop_words.
  'stop_words.' % sorted(inconsistent))

('annihilator', array([0.0273178 , 0.31716876, 0.17854181, 0.18718156, 0.0216386
,
       0.19954673, 0.1697119 , 0.07279283, 0.37436313, 0.03119693,
       0.16989261, 0.24957542, 0.17854181, 0.        , 0.15598464,
       0.07984799, 0.61353957, 0.27037337, 0.00622117, 0.11370048]))
('busta-rhymes', array([0.14378449, 0.12256078, 0.0293295 , 0.04774456,
0.05044255,
       0.09668792, 0.03765435, 0.00984424, 0.03470094, 0.01747352,
       0.14718349, 0.19934585, 0.05045668, 0.70845626, 0.01353583,
       0.55221583, 0.07014021, 0.02928661, 0.17932904, 0.19320499]))
('crduan-xshadows', array([0.01813367, 0.40554446, 0.09585919, 0.19414362,
0.05835292,
       0.29193479, 0.        , 0.40985876, 0.37103004, 0.10354327,
       0.43572329, 0.17257211, 0.04357236, 0.        , 0.12942908,
       0.        , 0.29768689, 0.23728665, 0.00516204, 0.00943436]))
('fats-domino', array([0.53722901, 0.36924551, 0.11793196, 0.03471539,
0.11163924,
       0.07649641, 0.128763  , 0.1420175 , 0.03155945, 0.15464128,
       0.6343448 , 0.15464128, 0.10836991, 0.        , 0.13254967,
       0.        , 0.1420175 , 0.05049511, 0.03776074, 0.01380261]))
('game', array([0.04699422, 0.12001572, 0.05584047, 0.03245708, 0.03043136,
       0.04002218, 0.03580105, 0.01830429, 0.04962914, 0.01849299,
       0.10332518, 0.08510549, 0.06346375, 0.91842568, 0.03604246,
       0.29623051, 0.05340322, 0.03094745, 0.08647508, 0.08046692]))
('american-idol', array([0.39633939, 0.13026864, 0.09114959, 0.18178009,
0.10142909,
       0.11952635, 0.11680796, 0.17496866, 0.16560294, 0.0911029 ,
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       0.68581341, 0.18518581, 0.09931866, 0.        , 0.12771435,
       0.01089609, 0.22350011, 0.12132863, 0.05959577, 0.28440116]))
('dar-williams', array([0.04157767, 0.24620146, 0.29749375, 0.14068655,
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       0.12876595, 0.1031412 , 0.17585819, 0.20663337, 0.10551491,
       0.60508639, 0.21982273, 0.0888041 , 0.        , 0.18904755,
       0.        , 0.40887028, 0.22861564, 0.        , 0.19708709]))
('50-cent', array([0.09659613, 0.11464702, 0.02047469, 0.03565243, 0.07473247,
       0.06089455, 0.0440309 , 0.01765145, 0.03372999, 0.01922435,
       0.09621299, 0.11761805, 0.12796682, 0.85813725, 0.01363181,
       0.36172677, 0.06903288, 0.01625331, 0.17941443, 0.13662705]))
('amos-lee', array([0.36329588, 0.34573663, 0.06285189, 0.26275984, 0.12949604,
       0.11872023, 0.09874273, 0.19361251, 0.06223259, 0.08989152,
       0.48610906, 0.13137992, 0.15363795, 0.        , 0.16595358,
       0.        , 0.33882189, 0.15212412, 0.07446103, 0.37046159]))
('david-bowie', array([0.31168932, 0.21405056, 0.23480295, 0.14270038,
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       0.12711746, 0.13328904, 0.10822781, 0.20042188, 0.19721513,
       0.5500958 , 0.166751  , 0.26233157, 0.        , 0.16354425,
       0.00820762, 0.307848  , 0.15472569, 0.06043059, 0.26208854]))
('bobby-bare', array([0.18811546, 0.21482789, 0.20935288, 0.07914712,
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       0.        , 0.33920193, 0.13944968, 0.01352846, 0.10508185]))
('chamillionaire', array([0.09501377, 0.19877773, 0.05584937, 0.08593774,
0.08591262,
       0.11207609, 0.0689821 , 0.01382477, 0.10125708, 0.02540768,
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       0.06056764, 0.16066621, 0.05567271, 0.62767432, 0.28147968]))
('e-40', array([0.07537628, 0.17209048, 0.0532903 , 0.03517681, 0.05740965,
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('beirut', array([0.        , 0.08321148, 0.29413842, 0.1456201 , 0.06493116,
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       0.        , 0.56167752, 0.10401436, 0.        , 0.        ]))
('clannad', array([0.03892769, 0.1926402 , 0.26190395, 0.04445543, 0.0847959 ,
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       0.57956298, 0.05927391, 0.30680177, 0.        , 0.21486791,
       0.        , 0.32600648, 0.22968639, 0.        , 0.14582023]))
('chumbawamba', array([0.18702674, 0.32538275, 0.20784559, 0.06118308,
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       0.23252287, 0.27532386, 0.37822268, 0.03327513, 0.1277114 ]))
('doris-day', array([0.14361149, 0.05994311, 0.18404046, 0.06473856, 0.062366  ,
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       0.08717706, 0.06358788, 0.28293148, 0.0983067 , 0.06713628,
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       0.        , 0.2157952 , 0.09111353, 0.0172132 , 0.01835139]))
('andre-rieu', array([0.        , 0.07456574, 0.15061554, 0.16777292,
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       0.        , 0.24233866, 0.20505579, 0.        , 0.        ]))
('avicii', array([0.18751602, 0.13627302, 0.15073665, 0.24334468, 0.05401187,
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       0.62646267, 0.34392715, 0.0196613 , 0.        , 0.06164732,
       0.00553632, 0.19467575, 0.19143115, 0.08928934, 0.37959117]))
('etta-james', array([0.51212012, 0.05757366, 0.10547521, 0.1138084 ,
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       0.        , 0.11246947, 0.05489581, 0.05607052, 0.51238351]))
('ella-fitzgerald', array([0.19060229, 0.0902568 , 0.22036493, 0.08850424,
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       0.        , 0.18752383, 0.0858754 , 0.03984166, 0.04694729]))
('city-and-colour', array([0.00760615, 0.30401795, 0.20469555, 0.20991715,
0.04518661,
       0.03655278, 0.06644988, 0.24610977, 0.40535726, 0.13029341,
       0.54470769, 0.04343114, 0.27049055, 0.        , 0.26058681,
       0.01235125, 0.33297204, 0.14477045, 0.        , 0.01582893]))
('armin-van-buuren', array([0.01622262, 0.37052462, 0.13513205, 0.28818581,
0.00535418,
       0.08835557, 0.11548059, 0.14923908, 0.14409291, 0.09263115,
       0.69807988, 0.30362434, 0.05197386, 0.        , 0.19555466,
       0.        , 0.14923908, 0.20070083, 0.        , 0.07314753]))
('ernest-tubb', array([0.16069097, 0.21693908, 0.17599668, 0.06045843,
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       0.        , 0.25428105, 0.10491316, 0.03404153, 0.00388848]))
('curtis-mayfield', array([0.40792377, 0.13616233, 0.11996193, 0.06083849,
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('ataraxia', array([0.        , 0.13854303, 0.        , 0.20781454, 0.07207146,
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       0.41153418, 0.13854303, 0.        , 0.        , 0.69271514,
       0.        , 0.13854303, 0.13854303, 0.        , 0.        ]))
('britney-spears', array([0.67127893, 0.11005483, 0.04993067, 0.19044644,
0.1435763 ,
```

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       0.10116388, 0.07805323, 0.09758768, 0.0769524 , 0.04943869,
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       0.0029342 , 0.17496998, 0.06706466, 0.10801886, 0.41082067]))
('cradle-of-filth', array([0.00803427, 0.2064407 , 0.12355263, 0.03440678,
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       0.49209041, 0.08028249, 0.11583059, 0.        , 0.44728819,
       0.02609291, 0.2867232 , 0.36700569, 0.00457417, 0.00835994]))
('everything-but-the-girl', array([0.29269627, 0.20588428, 0.12537143,
0.19377344, 0.1795551 ,
       0.05504111, 0.10808964, 0.13927466, 0.15744092, 0.07266504,
       0.70150395, 0.11808069, 0.08256167, 0.        , 0.13624695,
       0.01549874, 0.38451917, 0.18771802, 0.0253585 , 0.08276105]))
('eric-clapton', array([0.48938042, 0.14797032, 0.16093842, 0.15840412,
0.12533211,
       0.10920821, 0.12771023, 0.18022026, 0.11477185, 0.15650707,
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       0.        , 0.32249942, 0.0958013 , 0.01021418, 0.13793465]))
('frank-zappa', array([0.30227641, 0.21898931, 0.09815172, 0.05571917,
0.25075971,
       0.12170813, 0.27491679, 0.12569209, 0.11532573, 0.11143835,
       0.53373972, 0.26304633, 0.25257709, 0.        , 0.19048182,
       0.09507484, 0.246201  , 0.06478974, 0.15039005, 0.32019634]))
('acid-drinkers', array([0.19044942, 0.28481261, 0.20048115, 0.39701152,
0.02693861,
       0.24406401, 0.14085329, 0.17261371, 0.19850576, 0.18124439,
       0.08545653, 0.31070467, 0.2789303 , 0.        , 0.18987508,
       0.30926125, 0.3538581 , 0.08630685, 0.03097973, 0.23591579]))
('bjrthrk', array([0.0638124 , 0.13765046, 0.18808624, 0.26315529, 0.11372897,
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       0.82578302, 0.21052423, 0.08586546, 0.        , 0.08097086,
       0.        , 0.19028152, 0.0850194 , 0.00968813, 0.07525223]))
('anthrax', array([0.03615637, 0.23027442, 0.10692688, 0.15086945, 0.        ,
       0.1897952 , 0.10529137, 0.08734547, 0.44202101, 0.13763529,
       0.19917738, 0.19851243, 0.38760992, 0.        , 0.06881764,
       0.08129426, 0.50819183, 0.25409591, 0.14567849, 0.2402018 ]))
('bathory', array([0.09241414, 0.0830615 , 0.35035606, 0.17100897, 0.04066768,
       0.1282994 , 0.03986966, 0.17100897, 0.39576361, 0.22475465,
       0.05321616, 0.0830615 , 0.40957117, 0.        , 0.39576361,
       0.08337038, 0.42019347, 0.23941256, 0.01169209, 0.03739561]))
('aquabats', array([0.13558545, 0.30721946, 0.27924902, 0.12903217, 0.12146214,
       0.07446641, 0.14414789, 0.01228878, 0.14132095, 0.08602145,
       0.21293485, 0.18433167, 0.53367591, 0.        , 0.15360973,
       0.        , 0.2826419 , 0.16589851, 0.03675868, 0.47698946]))
('bee-gees', array([0.19302695, 0.08869597, 0.11165486, 0.08281093, 0.08790753,
       0.11292849, 0.06645916, 0.17024582, 0.20891894, 0.06431509,
       0.83243706, 0.1652015 , 0.12991021, 0.        , 0.18033446,
       0.        , 0.16057754, 0.16225898, 0.00804734, 0.10984772]))
```

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('dmx', array([0.06921774, 0.13120004, 0.04206092, 0.0362025 , 0.0189745 ,
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       0.08193331, 0.13582743, 0.11271228, 0.81881966, 0.03184731,
       0.44820344, 0.09418094, 0.01769295, 0.12441177, 0.1080352 ]))
('gordon-lightfoot', array([0.11266207, 0.29278421, 0.37066344, 0.09484559,
0.06006562,
       0.1082837 , 0.22292917, 0.11134047, 0.19793862, 0.26804188,
       0.48997118, 0.16082513, 0.29986256, 0.        , 0.14845397,
       0.        , 0.40824841, 0.13195908, 0.06907621, 0.        ]))
('chemical-brothers', array([0.04969247, 0.41210448, 0.04093824, 0.44588353,
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       0.0560013 , 0.20926717, 0.17050722, 0.15248613, 0.16218979,
       0.76040928, 0.13169257, 0.20580477, 0.        , 0.15525861,
       0.        , 0.23566038, 0.0998091 , 0.00663451, 0.20613336]))
('connie-smith', array([0.12303392, 0.17335003, 0.18428957, 0.08667501,
0.03322362,
       0.07985881, 0.09926606, 0.26154565, 0.13989651, 0.13077283,
       0.81304167, 0.10188116, 0.07525157, 0.        , 0.10036054,
       0.        , 0.22657153, 0.22809214, 0.00363882, 0.01995134]))
('faithless', array([0.06515942, 0.29351426, 0.14612998, 0.24804022, 0.06881759,
```

```
       0.1377797 , 0.06746718, 0.14055612, 0.14055612, 0.21910219,
       0.63855077, 0.26871023, 0.18788141, 0.        , 0.10335009,
       0.01410788, 0.21496819, 0.17776215, 0.31161802, 0.09944095]))
('cseh-tamxi-xi', array([0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 0., 0.,
0., 0., 0.,
       0., 0., 0.]))
('christina-aguilera', array([0.3609974 , 0.14546021, 0.11737854, 0.13449588,
0.14905818,
       0.15207534, 0.05890063, 0.09356235, 0.08186705, 0.03508588,
       0.37418095, 0.21709389, 0.09744634, 0.        , 0.09356235,
       0.03367564, 0.18785565, 0.10745051, 0.07346519, 0.70170954]))
```

[46]:
```
genre_features_collection =␣
 ↪extract_features_by_genre(artist_lyrics,artist_genre,load_stopwords_file("stopwords.
 ↪txt"),20)
for genre_features in genre_features_collection:
  print(genre_features)
```

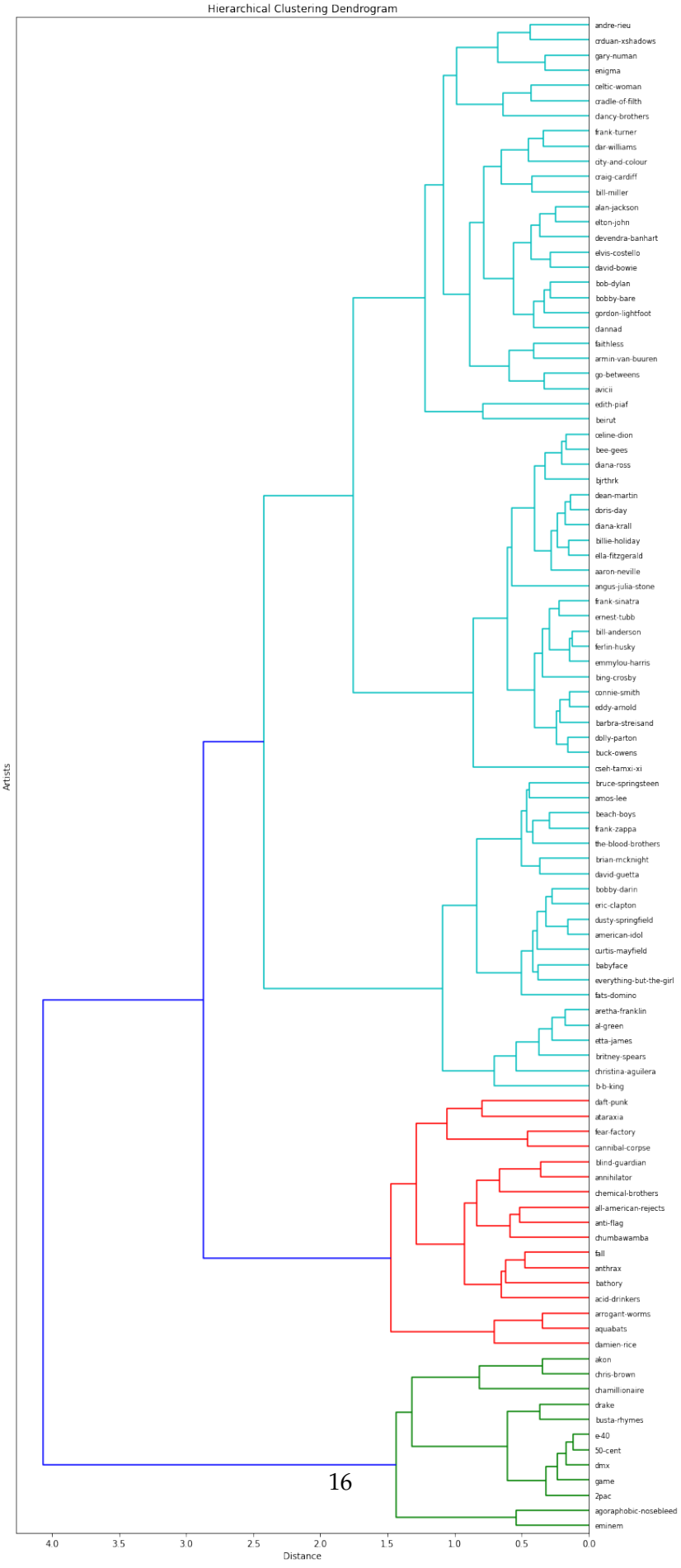
```
/usr/local/lib/python3.7/dist-packages/sklearn/feature_extraction/text.py:385:
UserWarning: Your stop_words may be inconsistent with your preprocessing.
Tokenizing the stop words generated tokens ['aren', 'couldn', 'didn', 'doesn',
'hadn', 'hasn', 'haven', 'isn', 'quelqu', 'shouldn', 'wasn', 'weren', 'won',
'wouldn'] not in stop_words.
  'stop_words.' % sorted(inconsistent))

('Metal', array([0.07090992, 0.2916229 , 0.19065845, 0.19065845, 0.04273379,
       0.13806302, 0.09485962, 0.15309028, 0.4696021 , 0.15402949,
       0.2009897 , 0.16436073, 0.36300242, 0.        , 0.2225914 ,
       0.06501061, 0.44847001, 0.26485558, 0.04789941, 0.11458291]))
('Hip-Hop', array([0.17999033, 0.23455642, 0.07350872, 0.08941204, 0.19260697,
       0.12570697, 0.0773962 , 0.04353978, 0.11849746, 0.0455542 ,
       0.23162314, 0.20960586, 0.17447718, 0.60462893, 0.0611748 ,
       0.4187969 , 0.17150856, 0.0651683 , 0.232542  , 0.24862203]))
('Electronic', array([0.15500641, 0.22797486, 0.1129568 , 0.26013045,
0.15583092,
       0.12449983, 0.11172005, 0.16654945, 0.20076629, 0.09646676,
       0.62579717, 0.25683244, 0.06967044, 0.00198639, 0.24652616,
       0.00760948, 0.26878772, 0.29269828, 0.04699663, 0.17479447]))
('R&B', array([0.46915234, 0.1442577 , 0.12508864, 0.13138504, 0.18259583,
       0.1123559 , 0.11067686, 0.15685052, 0.13054552, 0.08577107,
       0.64853001, 0.18595391, 0.11137646, 0.00471935, 0.12229023,
       0.01752544, 0.22932917, 0.10466029, 0.04071677, 0.26626809]))
('Pop', array([0.33953673, 0.12848781, 0.13330109, 0.15435919, 0.11979717,
       0.13430386, 0.0976026 , 0.16806366, 0.16712775, 0.08236055,
       0.7212565 , 0.21479258, 0.10388661, 0.02523241, 0.12949058,
       0.01163449, 0.21633015, 0.13249888, 0.05354773, 0.24460817]))
('Indie', array([0.10743405, 0.25643018, 0.20467363, 0.13723328, 0.09175025,
       0.09959215, 0.14507518, 0.1913424 , 0.19761592, 0.16781669,
```

```
       0.62892051, 0.18820564, 0.28152427, 0.        , 0.16389574,
       0.0113731 , 0.350533  , 0.13252814, 0.04548303, 0.19761592]))
('Folk', array([0.10323377, 0.23348199, 0.28751088, 0.09937457, 0.08007853,
       0.12445941, 0.18427711, 0.27110925, 0.14857945, 0.18331231,
       0.54414811, 0.12349461, 0.29137009, 0.        , 0.26628525,
       0.        , 0.34732858, 0.16015707, 0.02797925, 0.20743235]))
('Rock', array([0.46626424, 0.22118472, 0.16897683, 0.11848215, 0.16455855,
       0.11244083, 0.17880526, 0.1539186 , 0.15319724, 0.14445084,
       0.54543268, 0.16600125, 0.23732498, 0.00072412, 0.19837195,
       0.01497935, 0.27267126, 0.13624546, 0.03606763, 0.19025673]))
('Country', array([0.15266148, 0.194138  , 0.17810506, 0.09062097, 0.06436412,
       0.09143423, 0.14162431, 0.23003784, 0.15335856, 0.17322547,
       0.77446074, 0.14336702, 0.1434832 , 0.        , 0.15301002,
       0.        , 0.2718629 , 0.13918451, 0.01034008, 0.04833118]))
('Jazz', array([0.19617224, 0.09725629, 0.21426257, 0.07866806, 0.06522478,
       0.09792015, 0.12148738, 0.27832559, 0.10638444, 0.13111343,
       0.80809022, 0.14107141, 0.09841805, 0.        , 0.17409871,
       0.        , 0.19650417, 0.10771217, 0.02721848, 0.0390021 ]))
```

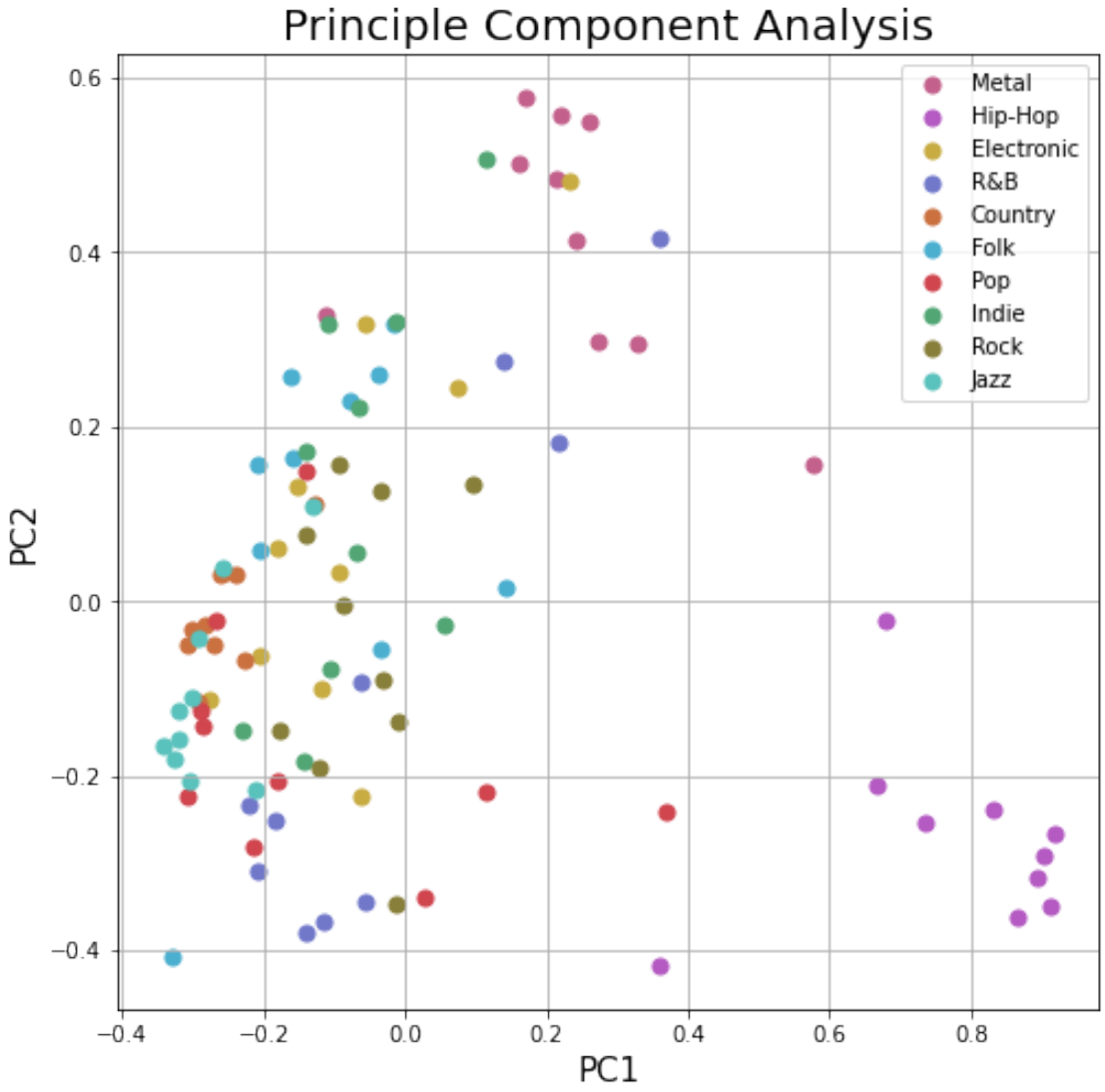
[47]:
```
apply_hierarchical_clustering(artist_lyrics,load_stopwords_file("stopwords.
↪txt"),20)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/feature_extraction/text.py:385:
UserWarning: Your stop_words may be inconsistent with your preprocessing.
Tokenizing the stop words generated tokens ['aren', 'couldn', 'didn', 'doesn',
'hadn', 'hasn', 'haven', 'isn', 'quelqu', 'shouldn', 'wasn', 'weren', 'won',
'wouldn'] not in stop_words.
  'stop_words.' % sorted(inconsistent))
```


Hierarchical Clustering Dendrogram
Artists
Distance
andre-rieu
crduan-xshadows
gary-numan
enigma
celtic-woman
cradle-of-filth
clancy-brothers
frank-turner
dar-williams
city-and-colour
craig-cardiff
bill-miller
alan-jackson
elton-john
devendra-banhart
elvis-costello
david-bowie
bob-dylan
bobby-bare
gordon-lightfoot
clannad
faithless
armin-van-buuren
go-betweens
avicii
edith-piaf
beirut
celine-dion
bee-gees
diana-ross
bjrthrk
dean-martin
doris-day
diana-krall
billie-holiday
ella-fitzgerald
aaron-neville
angus-julia-stone
frank-sinatra
ernest-tubb
bill-anderson
ferlin-husky
emmylou-harris
bing-crosby
connie-smith
eddy-arnold
barbra-streisand
dolly-parton
buck-owens
cseh-tamxi-xi
bruce-springsteen
amos-lee
beach-boys
frank-zappa
the-blood-brothers
brian-mcknight
david-guetta
bobby-darin
eric-clapton
dusty-springfield
american-idol
curtis-mayfield
babyface
everything-but-the-girl
fats-domino
aretha-franklin
al-green
etta-james
britney-spears
christina-aguilera
b-b-king
daft-punk
ataraxia
fear-factory
cannibal-corpse
blind-guardian
annihilator
chemical-brothers
all-american-rejects
anti-flag
chumbawamba
fall
anthrax
bathory
acid-drinkers
arrogant-worms
aquabats
damien-rice
akon
chris-brown
chamillionaire
drake
busta-rhymes
e-40
50-cent
dmx
game
2pac
agoraphobic-nosebleed
eminem
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

[48]:
```
apply_pca(artist_lyrics,load_stopwords_file("stopwords.txt"),20)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/feature_extraction/text.py:385:
UserWarning: Your stop_words may be inconsistent with your preprocessing.
Tokenizing the stop words generated tokens ['aren', 'couldn', 'didn', 'doesn',
'hadn', 'hasn', 'haven', 'isn', 'quelqu', 'shouldn', 'wasn', 'weren', 'won',
'wouldn'] not in stop_words.
  'stop_words.' % sorted(inconsistent))
```



[49]:
```
apply_kmeans(artist_lyrics,load_stopwords_file("stopwords.txt"),20)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/feature_extraction/text.py:385:
UserWarning: Your stop_words may be inconsistent with your preprocessing.
Tokenizing the stop words generated tokens ['aren', 'couldn', 'didn', 'doesn',
'hadn', 'hasn', 'haven', 'isn', 'quelqu', 'shouldn', 'wasn', 'weren', 'won',
'wouldn'] not in stop_words.
  'stop_words.' % sorted(inconsistent))
```