Project_4:Music_Popularity_Prediction_v3

November 7, 2024

1 Project 4: Music Popularity Prediction V3

By: Robert S Balch

2 Introduction

Welcome to my project on Music Popularity Prediction. In this analysis, I've developed predictive models to forecast song popularity on Spotify's Top 200 Weekly (Global) charts for 2020 & 2021. This project aims to provide insights into the factors that contribute to a song's success on these charts.

3 Project Overview

My goal was to create supervised regression models that could predict a song's popularity score based on various features. I've used a dataset provided by DDC Data Science, which includes information about songs, their audio features, artist popularity, and other relevant characteristics.

The data. A chosen data set is provided by DDC Data Science

4 Imports

[2]:
```
import sys
print(sys.executable)
```

```
/usr/local/bin/python
```

[3]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.colors as mcolors
import seaborn as sns

from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
import xgboost as xgb

from sklearn.metrics import mean_squared_error, root_mean_squared_error,r2_score
```

[4]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
#n_test_split
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor
from sklearn.ensemble import RandomForestRegressor
import xgboost as xgb

from sklearn.metrics import mean_squared_error, root_mean_squared_error,r2_score
```

[5]:
```
%%capture
url = "https://ddc-datascience.s3.amazonaws.com/Projects/Project.4-Spotify/Data/
↪Spotify.csv"
!curl -s -I {url}
```

5 Data Exploration

[6]:
```
df_1 = pd.read_csv(url).copy()
```

5.1 Head

[7]:
```
df_1.head()
```

[7]:
```
   Index  Highest Charting Position  Number of Times Charted  \
0      1                          1                        8
1      2                          2                        3
2      3                          1                       11
3      4                          3                        5
4      5                          5                        1

  Week of Highest Charting                          Song Name     Streams  \
0   2021-07-23--2021-07-30                            Beggin'  48,633,449
1   2021-07-23--2021-07-30          STAY (with Justin Bieber)  47,248,719
2   2021-06-25--2021-07-02                           good 4 u  40,162,559
3   2021-07-02--2021-07-09                         Bad Habits  37,799,456
4   2021-07-23--2021-07-30  INDUSTRY BABY (feat. Jack Harlow)  33,948,454

           Artist Artist Followers                  Song ID  \
0        Måneskin          3377762  3Wrjm47oTz2sjIgck11l5e
1    The Kid LAROI         2230022  5HCyWlXZPP0y6Gqq8TgA20
2   Olivia Rodrigo         6266514  4ZtFanR9U6ndgddUvNcjcG
3      Ed Sheeran         83293380  6PQ88X9TkUIAUIZJHW2upE
4       Lil Nas X          5473565  27NovPIUIRrOZoCHxABJwK

                                    Genre  … Danceability Energy Loudness  \
0  ['indie rock italiano', 'italian pop']  …        0.714    0.8   -4.808
1                 ['australian hip hop']  …        0.591  0.764   -5.484
2                                ['pop']  …        0.563  0.664   -5.044
3                     ['pop', 'uk pop']  …        0.808  0.897   -3.712
4           ['lgbtq+ hip hop', 'pop rap']  …        0.736  0.704   -7.409

  Speechiness Acousticness Liveness    Tempo Duration (ms) Valence  Chord
0      0.0504        0.127    0.359  134.002        211560   0.589      B
1      0.0483       0.0383    0.103  169.928        141806   0.478  C#/Db
2       0.154        0.335   0.0849  166.928        178147   0.688      A
3      0.0348       0.0469    0.364  126.026        231041   0.591      B
4      0.0615       0.0203   0.0501  149.995        212000   0.894  D#/Eb

[5 rows x 23 columns]
```

5.2 Tail

5.3 Shape

[8]:
```
df_1.shape
```

[8]:
```
(1556, 23)
```

5.4 columns

[ ]:
```
df_1.columnsColab_Notebooks/Module-4/Project/Project.4-Spotify/Project_4:
 ↪Music_Popularity_Prediction.ipynb
```

[ ]:
```
Index(['Index', 'Highest Charting Position', 'Number of Times Charted',
       'Week of Highest Charting', 'Song Name', 'Streams', 'Artist',
       'Artist Followers', 'Song ID', 'Genre', 'Release Date', 'Weeks Charted',
       'Popularity', 'Danceability', 'Energy', 'Loudness', 'Speechiness',
       'Acousticness', 'Liveness', 'Tempo', 'Duration (ms)', 'Valence',
       'Chord'],
      dtype='object')
```

5.5 Dtypes

[10]:
```
df_1.dtypes
```

```
[10]: Index                          int64
      Highest Charting Position      int64
      Number of Times Charted        int64
      Week of Highest Charting      object
      Song Name                     object
      Streams                       object
      Artist                        object
      Artist Followers              object
      Song ID                       object
      Genre                         object
      Release Date                  object
      Weeks Charted                 object
      Popularity                    object
      Danceability                  object
      Energy                        object
      Loudness                      object
      Speechiness                   object
      Acousticness                  object
      Liveness                      object
      Tempo                         object
      Duration (ms)                 object
      Valence                       object
      Chord                         object
      dtype: object
```

5.6 Describe

```
[11]: df_1.describe()
```

```
[11]:              Index  Highest Charting Position  Number of Times Charted
      count  1556.000000                1556.000000              1556.000000
      mean    778.500000                  87.744216                10.668380
      std     449.322824                  58.147225                16.360546
      min       1.000000                   1.000000                 1.000000
      25%     389.750000                  37.000000                 1.000000
      50%     778.500000                  80.000000                 4.000000
      75%    1167.250000                 137.000000                12.000000
      max    1556.000000                 200.000000               142.000000
```

5.7 Isnull Sum

```
[12]: df_1.isnull().sum()
```

```
[12]: Index                        0
      Highest Charting Position    0
      Number of Times Charted      0
      Week of Highest Charting     0
```

```
Song Name                    0
Streams                      0
Artist                       0
Artist Followers             0
Song ID                      0
Genre                        0
Release Date                 0
Weeks Charted                0
Popularity                   0
Danceability                 0
Energy                       0
Loudness                     0
Speechiness                  0
Acousticness                 0
Liveness                     0
Tempo                        0
Duration (ms)                0
Valence                      0
Chord                        0
dtype: int64
```

5.8 Isna Sum

```
[13]: df_1.isna().sum()
```

```
[13]: Index                        0
      Highest Charting Position    0
      Number of Times Charted      0
      Week of Highest Charting     0
      Song Name                    0
      Streams                      0
      Artist                       0
      Artist Followers             0
      Song ID                      0
      Genre                        0
      Release Date                 0
      Weeks Charted                0
      Popularity                   0
      Danceability                 0
      Energy                       0
      Loudness                     0
      Speechiness                  0
      Acousticness                 0
      Liveness                     0
      Tempo                        0
      Duration (ms)                0
      Valence                      0
```

```
Chord                          0
dtype: int64
```

5.9 unique values

[14]:
```
df_1.count('rows').unique().sum()
```

[14]:
```
np.int64(1556)
```

[15]:
```
df_1.count('columns')
```

[15]:
```
0       23
1       23
2       23
3       23
4       23
        ..
1551    23
1552    23
1553    23
1554    23
1555    23
Length: 1556, dtype: int64
```

5.10 Sort_values

[16]:
```
df_1.sort_values(by = ['Popularity'], ascending = False).head(10)
```

[16]:
```
    Index  Highest Charting Position  Number of Times Charted  \
1       2                          2                        3
2       3                          1                       11
3       4                          3                        5
5       6                          1                       18
4       5                          5                        1
8       9                          3                        8
14     15                          2                       10
7       8                          2                       10
9      10                          8                       10
11     12                          9                        9

   Week of Highest Charting                             Song Name     Streams  \
1    2021-07-23--2021-07-30          STAY (with Justin Bieber)  47,248,719
2    2021-06-25--2021-07-02                           good 4 u  40,162,559
3    2021-07-02--2021-07-09                         Bad Habits  37,799,456
5    2021-05-07--2021-05-14      MONTERO (Call Me By Your Name)  30,071,134
4    2021-07-23--2021-07-30  INDUSTRY BABY (feat. Jack Harlow)  33,948,454
8    2021-06-18--2021-06-25                           Yonaguni  25,030,128
```

```
14   2021-05-21--2021-05-28                             Butter  19,985,713
7    2021-06-18--2021-06-25                         Todo De Ti  26,951,613
9    2021-07-02--2021-07-09              I WANNA BE YOUR SLAVE  24,551,591
11   2021-07-02--2021-07-09                      Qué Más Pues?  22,405,111

                     Artist Artist Followers                 Song ID  \
1             The Kid LAROI          2230022  5HCyWlXZPP0y6Gqq8TgA20
2            Olivia Rodrigo          6266514  4ZtFanR9U6ndgddUvNcjcG
3                Ed Sheeran         83293380  6PQ88X9TkUIAUIZJHW2upE
5                 Lil Nas X          5473565  67BtfxlNbhBmCDR2L2l8qd
4                 Lil Nas X          5473565  27NovPIUIRrOZoCHxABJwK
8                 Bad Bunny         36142273  2JPLbjOn0wPCngEot2STUS
14                      BTS         37106176  2bgTY4UwhfBYhGT4HUYStN
7            Rauw Alejandro          6080597  4fSIb4hdOQ151TILNsSEaF
9                  Måneskin          3377762  4pt5fDVTg5GhEvEtlz9dKk
11  J Balvin, Maria Becerra         29051363  6hf0RpxTbOprT5nnwzkk8e

                                             Genre  … Danceability Energy   \
1                           ['australian hip hop']  …        0.591  0.764
2                                          ['pop']  …        0.563  0.664
3                                ['pop', 'uk pop']  …        0.808  0.897
5                    ['lgbtq+ hip hop', 'pop rap']  …         0.61  0.508
4                    ['lgbtq+ hip hop', 'pop rap']  …        0.736  0.704
8             ['latin', 'reggaeton', 'trap latino']  …        0.644  0.648
14                    ['k-pop', 'k-pop boy group']  …        0.759  0.459
7               ['puerto rican pop', 'trap latino']  …         0.78  0.718
9            ['indie rock italiano', 'italian pop']  …         0.75  0.608
11  ['latin', 'reggaeton', 'reggaeton colombiano']  …        0.891  0.819

   Loudness Speechiness Acousticness Liveness    Tempo Duration (ms) Valence  \
1    -5.484      0.0483       0.0383    0.103  169.928        141806   0.478
2    -5.044       0.154        0.335   0.0849  166.928        178147   0.688
3    -3.712      0.0348       0.0469    0.364  126.026        231041   0.591
5    -6.682       0.152        0.297    0.384  178.818        137876   0.758
4    -7.409      0.0615       0.0203   0.0501  149.995        212000   0.894
8    -4.601       0.118        0.276    0.135  179.951        206710    0.44
14   -5.187      0.0948      0.00323   0.0906  109.997        164442   0.695
7    -3.605      0.0506         0.31   0.0932  127.949        199604   0.342
9    -4.008      0.0387      0.00165    0.178  132.507        173347   0.958
11   -3.964       0.106       0.0261    0.173  101.968        217773   0.768

    Chord
1   C#/Db
2       A
3       B
5   G#/Ab
4   D#/Eb
```

```
8     C#/Db
14    G#/Ab
7     D#/Eb
9     C#/Db
11    G#/Ab

[10 rows x 23 columns]
```

6 Data Cleaning and Feature Engineering

6.1 New copy of dataframe

[17]:
```
df_cleaning = df_1.copy()
df_cleaning
```

[17]:
```
      Index  Highest Charting Position  Number of Times Charted  \
0         1                          1                        8
1         2                          2                        3
2         3                          1                       11
3         4                          3                        5
4         5                          5                        1
…     …                          …                        …
1551   1552                        195                        1
1552   1553                        196                        1
1553   1554                        197                        1
1554   1555                        198                        1
1555   1556                        199                        1

     Week of Highest Charting                          Song Name     Streams  \
0      2021-07-23--2021-07-30                            Beggin'  48,633,449
1      2021-07-23--2021-07-30          STAY (with Justin Bieber)  47,248,719
2      2021-06-25--2021-07-02                           good 4 u  40,162,559
3      2021-07-02--2021-07-09                         Bad Habits  37,799,456
4      2021-07-23--2021-07-30    INDUSTRY BABY (feat. Jack Harlow)  33,948,454
…                         …                                  …         …
1551   2019-12-27--2020-01-03                          New Rules   4,630,675
1552   2019-12-27--2020-01-03                 Cheirosa - Ao Vivo   4,623,030
1553   2019-12-27--2020-01-03           Havana (feat. Young Thug)   4,620,876
1554   2019-12-27--2020-01-03           Surtada - Remix Brega Funk   4,607,385
1555   2019-12-27--2020-01-03  Lover (Remix) [feat. Shawn Mendes]   4,595,450

                         Artist Artist Followers                 Song ID  \
0                      Måneskin          3377762  3Wrjm47oTz2sjIgck11l5e
1                  The Kid LAROI          2230022  5HCyWlXZPP0y6Gqq8TgA20
2                Olivia Rodrigo          6266514  4ZtFanR9U6ndgddUvNcjcG
3                    Ed Sheeran         83293380  6PQ88X9TkUIAUIZJHW2upE
4                     Lil Nas X          5473565  27NovPIUIRrOZoCHxABJwK
```

```
…                              …               …                      …
1551                    Dua Lipa        27167675  2ekn2ttSfGqwhhate0LSR0
1552              Jorge & Mateus        15019109  2PWjKmjyTZeDpmOUa3a5da
1553              Camila Cabello        22698747  1rfofaqEpACxVEHIZBJe6W
1554  Dadá Boladão, Tati Zaqui, OIK       208630  5F8ffc8KWKNawllr5WsW0r
1555                Taylor Swift        42227614  3i9UVldZOE0aD0JnyfAZZ0

                                                 Genre  … Danceability  \
0              ['indie rock italiano', 'italian pop']  …        0.714
1                              ['australian hip hop']  …        0.591
2                                             ['pop']  …        0.563
3                                   ['pop', 'uk pop']  …        0.808
4                       ['lgbtq+ hip hop', 'pop rap']  …        0.736
…                                                 …  …          …
1551                   ['dance pop', 'pop', 'uk pop']  …        0.762
1552           ['sertanejo', 'sertanejo universitario']  …        0.528
1553  ['dance pop', 'electropop', 'pop', 'post-teen …  …        0.765
1554                   ['brega funk', 'funk carioca']  …        0.832
1555                          ['pop', 'post-teen pop']  …        0.448

     Energy Loudness Speechiness Acousticness Liveness    Tempo Duration (ms)  \
0       0.8   -4.808      0.0504        0.127    0.359  134.002        211560
1     0.764   -5.484      0.0483       0.0383    0.103  169.928        141806
2     0.664   -5.044       0.154        0.335   0.0849  166.928        178147
3     0.897   -3.712      0.0348       0.0469    0.364  126.026        231041
4     0.704   -7.409      0.0615       0.0203   0.0501  149.995        212000
…       …        …           …            …        …        …             …
1551    0.7   -6.021      0.0694      0.00261    0.153  116.073        209320
1552   0.87   -3.123      0.0851         0.24    0.333   152.37        181930
1553  0.523   -4.333        0.03        0.184    0.132  104.988        217307
1554   0.55   -7.026      0.0587        0.249    0.182  154.064        152784
1555  0.603   -7.176       0.064        0.433   0.0862  205.272        221307

     Valence  Chord
0      0.589      B
1      0.478  C#/Db
2      0.688      A
3      0.591      B
4      0.894  D#/Eb
…        …      …
1551   0.608      A
1552   0.714      B
1553   0.394      D
1554   0.881      F
1555   0.422      G

[1556 rows x 23 columns]
```

6.2 drop Index

```
[18]: df_cleaning.drop('Index', axis = 1, inplace = True)
      #i
```

```
[19]: df_cleaning.transpose()
```

```
[19]:                                                                      0    \
      Highest Charting Position                                            1
      Number of Times Charted                                              8
      Week of Highest Charting                          2021-07-23--2021-07-30
      Song Name                                                       Beggin'
      Streams                                                      48,633,449
      Artist                                                         Måneskin
      Artist Followers                                                3377762
      Song ID                                          3Wrjm47oTz2sjIgck11l5e
      Genre                           ['indie rock italiano', 'italian pop']
      Release Date                                                 2017-12-08
      Weeks Charted              2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
      Popularity                                                          100
      Danceability                                                      0.714
      Energy                                                              0.8
      Loudness                                                         -4.808
      Speechiness                                                      0.0504
      Acousticness                                                      0.127
      Liveness                                                          0.359
      Tempo                                                           134.002
      Duration (ms)                                                    211560
      Valence                                                           0.589
      Chord                                                                 B

                                                                           1    \
      Highest Charting Position                                            2
      Number of Times Charted                                              3
      Week of Highest Charting                          2021-07-23--2021-07-30
      Song Name                                      STAY (with Justin Bieber)
      Streams                                                      47,248,719
      Artist                                                     The Kid LAROI
      Artist Followers                                                2230022
      Song ID                                          5HCyWlXZPP0y6Gqq8TgA20
      Genre                                            ['australian hip hop']
      Release Date                                                 2021-07-09
      Weeks Charted              2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
      Popularity                                                           99
      Danceability                                                      0.591
      Energy                                                            0.764
      Loudness                                                         -5.484
```

```
Speechiness                                                      0.0483
Acousticness                                                     0.0383
Liveness                                                          0.103
Tempo                                                           169.928
Duration (ms)                                                    141806
Valence                                                           0.478
Chord                                                             C#/Db

                                                                    2    \
Highest Charting Position                                             1
Number of Times Charted                                              11
Week of Highest Charting                         2021-06-25--2021-07-02
Song Name                                                      good 4 u
Streams                                                      40,162,559
Artist                                                   Olivia Rodrigo
Artist Followers                                                6266514
Song ID                                          4ZtFanR9U6ndgddUvNcjcG
Genre                                                           ['pop']
Release Date                                                 2021-05-21
Weeks Charted                 2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
Popularity                                                           99
Danceability                                                      0.563
Energy                                                            0.664
Loudness                                                         -5.044
Speechiness                                                       0.154
Acousticness                                                      0.335
Liveness                                                         0.0849
Tempo                                                           166.928
Duration (ms)                                                    178147
Valence                                                           0.688
Chord                                                                 A

                                                                    3    \
Highest Charting Position                                             3
Number of Times Charted                                               5
Week of Highest Charting                         2021-07-02--2021-07-09
Song Name                                                    Bad Habits
Streams                                                      37,799,456
Artist                                                       Ed Sheeran
Artist Followers                                               83293380
Song ID                                          6PQ88X9TkUIAUIZJHW2upE
Genre                                                  ['pop', 'uk pop']
Release Date                                                 2021-06-25
Weeks Charted                 2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
Popularity                                                           98
Danceability                                                      0.808
Energy                                                            0.897
```

```
Loudness                                                                -3.712
Speechiness                                                             0.0348
Acousticness                                                            0.0469
Liveness                                                                 0.364
Tempo                                                                  126.026
Duration (ms)                                                           231041
Valence                                                                  0.591
Chord                                                                        B

                                                      4     \
Highest Charting Position                             5
Number of Times Charted                               1
Week of Highest Charting           2021-07-23--2021-07-30
Song Name                     INDUSTRY BABY (feat. Jack Harlow)
Streams                                      33,948,454
Artist                                        Lil Nas X
Artist Followers                                5473565
Song ID                          27NovPIUIRrOZoCHxABJwK
Genre                        ['lgbtq+ hip hop', 'pop rap']
Release Date                                 2021-07-23
Weeks Charted                    2021-07-23--2021-07-30
Popularity                                           96
Danceability                                      0.736
Energy                                            0.704
Loudness                                         -7.409
Speechiness                                      0.0615
Acousticness                                     0.0203
Liveness                                         0.0501
Tempo                                           149.995
Duration (ms)                                    212000
Valence                                           0.894
Chord                                             D#/Eb

                                                                      5     \
Highest Charting Position                                             1
Number of Times Charted                                              18
Week of Highest Charting                         2021-05-07--2021-05-14
Song Name                                MONTERO (Call Me By Your Name)
Streams                                                      30,071,134
Artist                                                        Lil Nas X
Artist Followers                                                5473565
Song ID                                          67BtfxlNbhBmCDR2L2l8qd
Genre                                   ['lgbtq+ hip hop', 'pop rap']
Release Date                                                 2021-03-31
Weeks Charted                 2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
Popularity                                                           97
Danceability                                                       0.61
```

```
Energy                                                              0.508
Loudness                                                           -6.682
Speechiness                                                         0.152
Acousticness                                                        0.297
Liveness                                                            0.384
Tempo                                                             178.818
Duration (ms)                                                      137876
Valence                                                             0.758
Chord                                                               G#/Ab

                                                                       6  \
Highest Charting Position                                               3
Number of Times Charted                                                16
Week of Highest Charting                           2021-05-14--2021-05-21
Song Name                                          Kiss Me More (feat. SZA)
Streams                                                        29,356,736
Artist                                                           Doja Cat
Artist Followers                                                  8640063
Song ID                                            748mdHapucXQri7IAO8yFK
Genre                                               ['dance pop', 'pop']
Release Date                                                   2021-04-09
Weeks Charted                 2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
Popularity                                                             94
Danceability                                                        0.762
Energy                                                              0.701
Loudness                                                           -3.541
Speechiness                                                        0.0286
Acousticness                                                        0.235
Liveness                                                            0.123
Tempo                                                             110.968
Duration (ms)                                                      208867
Valence                                                             0.742
Chord                                                               G#/Ab

                                                                       7  \
Highest Charting Position                                               2
Number of Times Charted                                                10
Week of Highest Charting                           2021-06-18--2021-06-25
Song Name                                                      Todo De Ti
Streams                                                        26,951,613
Artist                                                     Rauw Alejandro
Artist Followers                                                  6080597
Song ID                                            4fSIb4hdOQ151TILNsSEaF
Genre                                   ['puerto rican pop', 'trap latino']
Release Date                                                   2021-05-20
Weeks Charted                 2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
Popularity                                                             95
```

```
Danceability                                                          0.78
Energy                                                               0.718
Loudness                                                            -3.605
Speechiness                                                         0.0506
Acousticness                                                          0.31
Liveness                                                            0.0932
Tempo                                                              127.949
Duration (ms)                                                       199604
Valence                                                              0.342
Chord                                                               D#/Eb

                                                                       8    \
Highest Charting Position                                              3
Number of Times Charted                                                8
Week of Highest Charting                            2021-06-18--2021-06-25
Song Name                                                         Yonaguni
Streams                                                         25,030,128
Artist                                                           Bad Bunny
Artist Followers                                                  36142273
Song ID                                             2JPLbjOn0wPCngEot2STUS
Genre                                ['latin', 'reggaeton', 'trap latino']
Release Date                                                    2021-06-04
Weeks Charted              2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
Popularity                                                              96
Danceability                                                         0.644
Energy                                                               0.648
Loudness                                                            -4.601
Speechiness                                                          0.118
Acousticness                                                         0.276
Liveness                                                             0.135
Tempo                                                              179.951
Duration (ms)                                                       206710
Valence                                                               0.44
Chord                                                               C#/Db

                                                                       9    \
Highest Charting Position                                              8
Number of Times Charted                                               10
Week of Highest Charting                            2021-07-02--2021-07-09
Song Name                                             I WANNA BE YOUR SLAVE
Streams                                                         24,551,591
Artist                                                            Måneskin
Artist Followers                                                   3377762
Song ID                                             4pt5fDVTg5GhEvEtlz9dKk
Genre                               ['indie rock italiano', 'italian pop']
Release Date                                                    2021-03-19
Weeks Charted              2021-07-23--2021-07-30\n2021-07-16--2021-07-23…
```

```
Popularity                                                                  95
Danceability                                                              0.75
Energy                                                                   0.608
Loudness                                                                -4.008
Speechiness                                                             0.0387
Acousticness                                                           0.00165
Liveness                                                                 0.178
Tempo                                                                  132.507
Duration (ms)                                                           173347
Valence                                                                  0.958
Chord                                                                    C#/Db

                           …                        1546  \
Highest Charting Position  …                         143
Number of Times Charted    …                           1
Week of Highest Charting   …  2019-12-27--2020-01-03
Song Name                  …                    JACKBOYS
Streams                    …                   5,363,493
Artist                     …                    JACKBOYS
Artist Followers           …                      437907
Song ID                    …      62zKJrpbLxz6InR3tGyr7o
Genre                      …             ['rap', 'trap']
Release Date               …                  2019-12-27
Weeks Charted              …  2019-12-27--2020-01-03
Popularity                 …                          56
Danceability               …                       0.413
Energy                     …                        0.13
Loudness                   …                     -25.166
Speechiness                …                      0.0336
Acousticness               …                         0.9
Liveness                   …                       0.111
Tempo                      …                     123.342
Duration (ms)              …                       46837
Valence                    …                      0.0676
Chord                      …                           C

                                                                      1547  \
Highest Charting Position                                              156
Number of Times Charted                                                  1
Week of Highest Charting                            2019-12-27--2020-01-03
Song Name                                      Combatchy (feat. MC Rebecca)
Streams                                                          5,149,797
Artist                                          Anitta, Lexa, Luísa Sonza
Artist Followers                                                  10741972
Song ID                                             2bPtwnrpFNEe8N7Q85kLHw
Genre                      ['funk carioca', 'funk pop', 'pagode baiano', …
Release Date                                                    2019-11-20
```

```
Weeks Charted                                         2019-12-27--2020-01-03
Popularity                                                                64
Danceability                                                           0.826
Energy                                                                  0.73
Loudness                                                              -3.032
Speechiness                                                           0.0809
Acousticness                                                           0.383
Liveness                                                              0.0197
Tempo                                                                150.134
Duration (ms)                                                         157600
Valence                                                                0.605
Chord                                                                  C#/Db

                                                    1548  \
Highest Charting Position                            178
Number of Times Charted                                1
Week of Highest Charting          2019-12-27--2020-01-03
Song Name                                  Old Town Road
Streams                                        4,852,004
Artist                                         Lil Nas X
Artist Followers                                 5488666
Song ID                           2YpeDb67231RjR0MgVLzsG
Genre                      ['lgbtq+ hip hop', 'pop rap']
Release Date                                  2019-06-21
Weeks Charted                     2019-12-27--2020-01-03
Popularity                                            81
Danceability                                       0.878
Energy                                             0.619
Loudness                                           -5.56
Speechiness                                        0.102
Acousticness                                      0.0533
Liveness                                           0.113
Tempo                                            136.041
Duration (ms)                                     157067
Valence                                            0.639
Chord                                              F#/Gb

                                                           1549  \
Highest Charting Position                                   187
Number of Times Charted                                       1
Week of Highest Charting                 2019-12-27--2020-01-03
Song Name                  Let Me Know (I Wonder Why Freestyle)
Streams                                               4,701,532
Artist                                               Juice WRLD
Artist Followers                                       19102888
Song ID                                  3wwo0bJvDSorOpNfzEkfXx
Genre                                [ 'chicago rap', 'melodic rap']
```

```
Release Date                                    2019-12-07
Weeks Charted                   2019-12-27--2020-01-03
Popularity                                              76
Danceability                                         0.635
Energy                                               0.537
Loudness                                            -7.895
Speechiness                                         0.0832
Acousticness                                         0.172
Liveness                                             0.418
Tempo                                              125.028
Duration (ms)                                       215381
Valence                                              0.383
Chord                                                    G

                                                             1550  \
Highest Charting Position                                     190
Number of Times Charted                                         1
Week of Highest Charting                   2019-12-27--2020-01-03
Song Name                                         Ne reviens pas
Streams                                                 4,676,857
Artist                                     Gradur, Heuss L'enfoiré
Artist Followers                                          1390813
Song ID                                    4TnFANpjVwVKWzkxNzIyFH
Genre                    ['francoton', 'french hip hop', 'pop urbaine',…
Release Date                                           2019-11-29
Weeks Charted                              2019-12-27--2020-01-03
Popularity                                                     62
Danceability                                                0.932
Energy                                                      0.778
Loudness                                                   -3.384
Speechiness                                                0.0638
Acousticness                                                0.212
Liveness                                                    0.168
Tempo                                                     124.996
Duration (ms)                                              188613
Valence                                                     0.933
Chord                                                       A#/Bb

                                             1551  \
Highest Charting Position                     195
Number of Times Charted                         1
Week of Highest Charting   2019-12-27--2020-01-03
Song Name                               New Rules
Streams                                 4,630,675
Artist                                   Dua Lipa
Artist Followers                         27167675
Song ID                    2ekn2ttSfGqwhhate0LSR0
```

```
Genre                           ['dance pop', 'pop', 'uk pop']
Release Date                                        2017-06-02
Weeks Charted                           2019-12-27--2020-01-03
Popularity                                                  79
Danceability                                             0.762
Energy                                                     0.7
Loudness                                                -6.021
Speechiness                                             0.0694
Acousticness                                           0.00261
Liveness                                                 0.153
Tempo                                                  116.073
Duration (ms)                                           209320
Valence                                                  0.608
Chord                                                        A

                                                              1552  \
Highest Charting Position                                      196
Number of Times Charted                                          1
Week of Highest Charting                    2019-12-27--2020-01-03
Song Name                                      Cheirosa - Ao Vivo
Streams                                                  4,623,030
Artist                                              Jorge & Mateus
Artist Followers                                          15019109
Song ID                                     2PWjKmjyTZeDpmOUa3a5da
Genre                       ['sertanejo', 'sertanejo universitario']
Release Date                                            2019-10-11
Weeks Charted                               2019-12-27--2020-01-03
Popularity                                                      66
Danceability                                                 0.528
Energy                                                        0.87
Loudness                                                    -3.123
Speechiness                                                 0.0851
Acousticness                                                  0.24
Liveness                                                     0.333
Tempo                                                       152.37
Duration (ms)                                               181930
Valence                                                      0.714
Chord                                                            B

                                                                       1553  \
Highest Charting Position                                               197
Number of Times Charted                                                   1
Week of Highest Charting                             2019-12-27--2020-01-03
Song Name                                         Havana (feat. Young Thug)
Streams                                                           4,620,876
Artist                                                       Camila Cabello
Artist Followers                                                   22698747
```

```
Song ID                                              1rfofaqEpACxVEHIZBJe6W
Genre                       ['dance pop', 'electropop', 'pop', 'post-teen …
Release Date                                                     2018-01-12
Weeks Charted                                        2019-12-27--2020-01-03
Popularity                                                               81
Danceability                                                          0.765
Energy                                                                0.523
Loudness                                                             -4.333
Speechiness                                                            0.03
Acousticness                                                          0.184
Liveness                                                              0.132
Tempo                                                               104.988
Duration (ms)                                                        217307
Valence                                                               0.394
Chord                                                                     D

                                                   1554  \
Highest Charting Position                           198
Number of Times Charted                               1
Week of Highest Charting         2019-12-27--2020-01-03
Song Name                    Surtada - Remix Brega Funk
Streams                                       4,607,385
Artist                      Dadá Boladão, Tati Zaqui, OIK
Artist Followers                                 208630
Song ID                          5F8ffc8KWKNawllr5WsW0r
Genre                       ['brega funk', 'funk carioca']
Release Date                                 2019-09-25
Weeks Charted                    2019-12-27--2020-01-03
Popularity                                           60
Danceability                                      0.832
Energy                                             0.55
Loudness                                         -7.026
Speechiness                                      0.0587
Acousticness                                      0.249
Liveness                                          0.182
Tempo                                           154.064
Duration (ms)                                    152784
Valence                                           0.881
Chord                                                 F

                                                       1555
Highest Charting Position                               199
Number of Times Charted                                   1
Week of Highest Charting             2019-12-27--2020-01-03
Song Name                   Lover (Remix) [feat. Shawn Mendes]
Streams                                           4,595,450
Artist                                         Taylor Swift
Artist Followers                                        42227614
Song ID                                   3i9UVldZOE0aD0JnyfAZZ0
Genre                                   ['pop', 'post-teen pop']
Release Date                                          2019-11-13
Weeks Charted                             2019-12-27--2020-01-03
Popularity                                                    70
Danceability                                               0.448
Energy                                                     0.603
Loudness                                                  -7.176
Speechiness                                                0.064
Acousticness                                               0.433
Liveness                                                  0.0862
Tempo                                                    205.272
Duration (ms)                                             221307
Valence                                                    0.422
Chord                                                          G

[22 rows x 1556 columns]
```

6.3 Convert object columns with numbers to float64

[20]:
```
# List of columns to convert
columns_to_convert = ['Artist Followers', 'Streams','Popularity',␣
 ↪'Danceability', 'Energy', 'Loudness',
                      'Speechiness', 'Acousticness', 'Liveness', 'Tempo',␣
 ↪'Duration (ms)', 'Valence']

df_1[columns_to_convert] = df_1[columns_to_convert].apply(pd.to_numeric,␣
 ↪errors='coerce')
```

[21]:
```
df_1.dtypes
```

[21]:
```
Index                          int64
Highest Charting Position      int64
Number of Times Charted        int64
Week of Highest Charting      object
Song Name                     object
Streams                      float64
Artist                        object
Artist Followers             float64
Song ID                       object
Genre                         object
Release Date                  object
Weeks Charted                 object
Popularity                   float64
Danceability                 float64
Energy                       float64
```

```
Loudness                     float64
Speechiness                  float64
Acousticness                 float64
Liveness                     float64
Tempo                        float64
Duration (ms)                float64
Valence                      float64
Chord                         object
dtype: object
```

7 Data Cleaning Continued: Prepare DataFrame for Modeling and Training

[22]:
```
df_1 = df_1.drop("Index", axis = 1)
```

[23]:
```
df_1
```

[23]:
```
      Highest Charting Position  Number of Times Charted  \
0                             1                        8
1                             2                        3
2                             1                       11
3                             3                        5
4                             5                        1
…                           …                      …
1551                        195                        1
1552                        196                        1
1553                        197                        1
1554                        198                        1
1555                        199                        1

     Week of Highest Charting                           Song Name  Streams  \
0      2021-07-23--2021-07-30                             Beggin'      NaN
1      2021-07-23--2021-07-30             STAY (with Justin Bieber)      NaN
2      2021-06-25--2021-07-02                              good 4 u      NaN
3      2021-07-02--2021-07-09                            Bad Habits      NaN
4      2021-07-23--2021-07-30   INDUSTRY BABY (feat. Jack Harlow)      NaN
…                         …                                   …      …
1551   2019-12-27--2020-01-03                             New Rules      NaN
1552   2019-12-27--2020-01-03                    Cheirosa - Ao Vivo      NaN
1553   2019-12-27--2020-01-03             Havana (feat. Young Thug)      NaN
1554   2019-12-27--2020-01-03           Surtada - Remix Brega Funk      NaN
1555   2019-12-27--2020-01-03  Lover (Remix) [feat. Shawn Mendes]      NaN

                        Artist  Artist Followers                 Song ID  \
0                     Måneskin         3377762.0  3Wrjm47oTz2sjIgck11l5e
1                 The Kid LAROI         2230022.0  5HCyWlXZPP0y6Gqq8TgA20
```

```
2                  Olivia Rodrigo        6266514.0  4ZtFanR9U6ndgddUvNcjcG
3                      Ed Sheeran       83293380.0  6PQ88X9TkUIAUIZJHW2upE
4                      Lil Nas X         5473565.0  27NovPIUIRrOZoCHxABJwK
…                              …               …                       …
1551                    Dua Lipa        27167675.0  2ekn2ttSfGqwhhate0LSR0
1552              Jorge & Mateus        15019109.0  2PWjKmjyTZeDpmOUa3a5da
1553              Camila Cabello        22698747.0  1rfofaqEpACxVEHIZBJe6W
1554  Dadá Boladão, Tati Zaqui, OIK       208630.0  5F8ffc8KWKNawllr5WsW0r
1555                Taylor Swift        42227614.0  3i9UVldZOE0aD0JnyfAZZ0

                                                    Genre Release Date  …  \
0                ['indie rock italiano', 'italian pop']   2017-12-08  …
1                                 ['australian hip hop']   2021-07-09  …
2                                                ['pop']   2021-05-21  …
3                                      ['pop', 'uk pop']   2021-06-25  …
4                          ['lgbtq+ hip hop', 'pop rap']   2021-07-23  …
…                                                     …          …  …
1551                         ['dance pop', 'pop', 'uk pop']   2017-06-02  …
1552             ['sertanejo', 'sertanejo universitario']   2019-10-11  …
1553  ['dance pop', 'electropop', 'pop', 'post-teen …   2018-01-12  …
1554                         ['brega funk', 'funk carioca']   2019-09-25  …
1555                            ['pop', 'post-teen pop']   2019-11-13  …

     Danceability  Energy  Loudness  Speechiness  Acousticness  Liveness  \
0           0.714   0.800    -4.808       0.0504       0.12700    0.3590
1           0.591   0.764    -5.484       0.0483       0.03830    0.1030
2           0.563   0.664    -5.044       0.1540       0.33500    0.0849
3           0.808   0.897    -3.712       0.0348       0.04690    0.3640
4           0.736   0.704    -7.409       0.0615       0.02030    0.0501
…               …       …         …            …             …         …
1551        0.762   0.700    -6.021       0.0694       0.00261    0.1530
1552        0.528   0.870    -3.123       0.0851       0.24000    0.3330
1553        0.765   0.523    -4.333       0.0300       0.18400    0.1320
1554        0.832   0.550    -7.026       0.0587       0.24900    0.1820
1555        0.448   0.603    -7.176       0.0640       0.43300    0.0862

        Tempo  Duration (ms)  Valence  Chord
0     134.002       211560.0    0.589      B
1     169.928       141806.0    0.478  C#/Db
2     166.928       178147.0    0.688      A
3     126.026       231041.0    0.591      B
4     149.995       212000.0    0.894  D#/Eb
…         …              …        …      …
1551  116.073       209320.0    0.608      A
1552  152.370       181930.0    0.714      B
1553  104.988       217307.0    0.394      D
1554  154.064       152784.0    0.881      F
```

```
1555  205.272       221307.0    0.422      G

[1556 rows x 22 columns]
```

[24]:
```
df_clean_2 = df_1.copy()
```

7.1 Identify Object Columns & Drop them

[25]:
```
object_columns = df_clean_2.select_dtypes(include=['object']).columns
df_clean_2 = df_clean_2.drop(columns=object_columns)
```

[26]:
```
df_clean_2.isnull().sum()
```

[26]:
```
Highest Charting Position       0
Number of Times Charted         0
Streams                      1556
Artist Followers               11
Popularity                     11
Danceability                   11
Energy                         11
Loudness                       11
Speechiness                    11
Acousticness                   11
Liveness                       11
Tempo                          11
Duration (ms)                  11
Valence                        11
dtype: int64
```

[27]:
```
df_clean_2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1556 entries, 0 to 1555
Data columns (total 14 columns):
 #   Column                     Non-Null Count  Dtype
---  ------                     --------------  -----
 0   Highest Charting Position  1556 non-null   int64
 1   Number of Times Charted    1556 non-null   int64
 2   Streams                    0 non-null      float64
 3   Artist Followers           1545 non-null   float64
 4   Popularity                 1545 non-null   float64
 5   Danceability               1545 non-null   float64
 6   Energy                     1545 non-null   float64
 7   Loudness                   1545 non-null   float64
 8   Speechiness                1545 non-null   float64
 9   Acousticness               1545 non-null   float64
 10  Liveness                   1545 non-null   float64
 11  Tempo                      1545 non-null   float64
 12  Duration (ms)               1545 non-null   float64
 13  Valence                     1545 non-null   float64
dtypes: float64(12), int64(2)
memory usage: 170.3 KB
```

7.2 Drop Streams Column (essentially empty)

[28]:
```
df_clean_2.drop('Streams', axis = 1, inplace = True)
```

[29]:
```
df_clean_2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1556 entries, 0 to 1555
Data columns (total 13 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   Highest Charting Position   1556 non-null   int64
 1   Number of Times Charted     1556 non-null   int64
 2   Artist Followers            1545 non-null   float64
 3   Popularity                  1545 non-null   float64
 4   Danceability                1545 non-null   float64
 5   Energy                      1545 non-null   float64
 6   Loudness                    1545 non-null   float64
 7   Speechiness                 1545 non-null   float64
 8   Acousticness                1545 non-null   float64
 9   Liveness                    1545 non-null   float64
 10  Tempo                       1545 non-null   float64
 11  Duration (ms)               1545 non-null   float64
 12  Valence                     1545 non-null   float64
dtypes: float64(11), int64(2)
memory usage: 158.2 KB
```

7.3 Get means and replace null values with mean per column

[30]:
```
df_clean_2.isna().sum()
```

[30]:
```
Highest Charting Position     0
Number of Times Charted       0
Artist Followers             11
Popularity                   11
Danceability                 11
Energy                       11
Loudness                     11
Speechiness                  11
Acousticness                 11
Liveness                     11
Tempo                        11
Duration (ms)                11
```

```
Valence                        11
dtype: int64
```

[31]:
```
null_columns = df_clean_2.columns[df_clean_2.isnull().any()].tolist()
print("Columns with null values:")
null_columns
```

```
Columns with null values:
```

[31]:
```
['Artist Followers',
 'Popularity',
 'Danceability',
 'Energy',
 'Loudness',
 'Speechiness',
 'Acousticness',
 'Liveness',
 'Tempo',
 'Duration (ms)',
 'Valence']
```

[32]:
```
for col in null_columns:
    #Calculate the mean, exluding NaN values
    mean= df_clean_2[col].mean(skipna=True)

    #replace NaNs with the mean per column
    df_clean_2[col] = df_clean_2[col].fillna(mean)
```

[33]:
```
print("\nNull value count after replacement:")
print(df_clean_2.isnull().sum())
```

```

Null value count after replacement:
Highest Charting Position    0
Number of Times Charted      0
Artist Followers             0
Popularity                   0
Danceability                 0
Energy                       0
Loudness                     0
Speechiness                  0
Acousticness                 0
Liveness                     0
Tempo                        0
Duration (ms)                0
Valence                      0
dtype: int64
```

[34]:
```
df_clean_2.dtypes
```

[34]:
```
Highest Charting Position      int64
Number of Times Charted        int64
Artist Followers             float64
Popularity                   float64
Danceability                 float64
Energy                       float64
Loudness                     float64
Speechiness                  float64
Acousticness                 float64
Liveness                     float64
Tempo                        float64
Duration (ms)                float64
Valence                      float64
dtype: object
```

7.4 Drop columns that have no relation to target = "Popularity"

[35]:
```
df_clean_2.drop('Highest Charting Position', axis = 1, inplace = True)
```

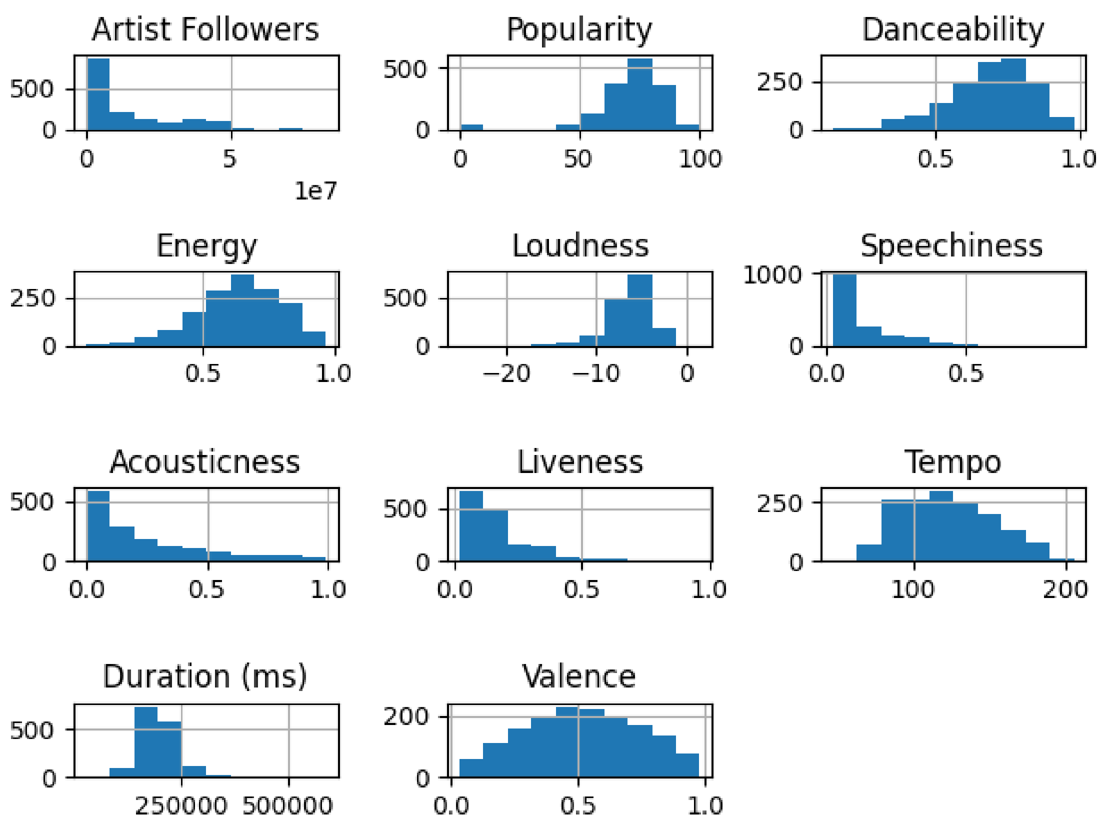
[36]:
```
df_clean_2.drop('Number of Times Charted', axis = 1, inplace = True)
```

[37]:
```
# df_clean_2.drop('Artist Followers', axis = 1, inplace = True)
```

[38]:
```
df_scaling = df_clean_2.copy()
```

[39]:
```
df_scaling.hist()
plt.tight_layout()
plt.show
```

[39]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```



8 Data Scaling

8.1 Data Scaling (standard scaler)

8.1.1 Setup standard scaled training and testing data

[40]:
```
df_3_std = df_scaling.copy()
```

[41]:
```
x1 = df_3_std.drop(['Popularity'], axis=1)
y1 = df_3_std['Popularity']

X_train_1, X_test_1, y_train_1, y_test_1 = train_test_split(x1, y1, test_size=0.
  ↪2)
```

[42]:
```
scaler = StandardScaler()
X_train_std = scaler.fit_transform(X_train_1)
X_test_std = scaler.transform(X_test_1)
```

[43]:
```
print("Before scaling:")
print(X_train_1.describe())
```

```python
print("\nAfter scaling:")
print(pd.DataFrame(X_train_std).describe())
```

```
Before scaling:
       Artist Followers  Danceability       Energy     Loudness  Speechiness  \
count      1.244000e+03   1244.000000  1244.000000  1244.000000  1244.000000
mean       1.502319e+07      0.688672     0.633649    -6.377879     0.123342
std        1.697594e+07      0.143047     0.161532     2.501783     0.109590
min        4.883000e+03      0.184000     0.054000   -25.166000     0.023200
25%        2.010879e+06      0.596750     0.529000    -7.493000     0.045775
50%        6.874642e+06      0.702000     0.641500    -6.063500     0.075450
75%        2.384846e+07      0.795250     0.753500    -4.770750     0.165000
max        8.333778e+07      0.980000     0.970000     1.509000     0.884000

       Acousticness     Liveness        Tempo  Duration (ms)      Valence
count   1244.000000  1244.000000  1244.000000    1244.000000  1244.000000
mean       0.246213     0.180991   123.219617  197943.723099     0.515175
std        0.250102     0.144075    29.634639   47771.864606     0.226094
min        0.000025     0.019700    46.718000   30133.000000     0.032000
25%        0.047725     0.096300    97.989750  169117.500000     0.344000
50%        0.157000     0.125500   122.129000  193764.000000     0.514704
75%        0.379000     0.214250   144.188500  218766.000000     0.687250
max        0.994000     0.962000   205.272000  588139.000000     0.977000

After scaling:
                  0             1             2             3             4  \
count  1.244000e+03  1.244000e+03  1.244000e+03  1.244000e+03  1.244000e+03
mean  -2.855879e-18 -3.626967e-16  2.227586e-16 -8.924622e-17 -3.926834e-17
std    1.000402e+00  1.000402e+00  1.000402e+00  1.000402e+00  1.000402e+00
min   -8.850379e-01 -3.529423e+00 -3.589887e+00 -7.512912e+00 -9.141580e-01
25%   -7.668234e-01 -6.428565e-01 -6.481114e-01 -4.459096e-01 -7.080796e-01
50%   -4.801989e-01  9.320933e-02  4.862487e-02  1.257126e-01 -4.371881e-01
75%    5.200783e-01  7.453532e-01  7.422646e-01  6.426518e-01  3.802789e-01
max    4.025820e+00  2.037402e+00  2.083095e+00  3.153771e+00  6.943750e+00

                  5             6             7             8             9
count  1.244000e+03  1.244000e+03  1.244000e+03  1.244000e+03  1.244000e+03
mean  -2.427497e-17  6.568522e-17 -1.485057e-16 -3.427055e-17  3.212864e-17
std    1.000402e+00  1.000402e+00  1.000402e+00  1.000402e+00  1.000402e+00
min   -9.847428e-01 -1.119948e+00 -2.582531e+00 -3.514165e+00 -2.137915e+00
25%   -7.939460e-01 -5.880646e-01 -8.517065e-01 -6.036569e-01 -7.574029e-01
50%   -3.568487e-01 -3.853103e-01 -3.681689e-02 -8.752859e-02 -2.086376e-03
75%    5.311457e-01  2.309379e-01  7.078647e-01  4.360443e-01  7.613821e-01
max    2.991130e+00  5.423046e+00  2.769913e+00  8.171174e+00  2.043445e+00
```

[44]:
```python
print("Mean:", X_train_std.mean(axis=0))
print("Std:", X_train_std.std(axis=0))
```

```
Mean: [-2.85587916e-18 -3.62696654e-16  2.22758575e-16 -8.92462238e-17
 -3.92683385e-17 -2.42749729e-17  6.56852207e-17 -1.48505716e-16
 -3.42705500e-17  3.21286406e-17]
Std: [1. 1. 1. 1. 1. 1. 1. 1. 1. 1.]
```

8.2 Data Scaling Continued (min-max scaler)

[45]:
```
df_3_mm = df_scaling.copy()
```

[46]:
```
x2 = df_3_mm.drop(['Popularity'], axis=1)
y2 = df_3_mm['Popularity']

X_train_2, X_test_2, y_train_2, y_test_2 = train_test_split(x2, y2, test_size=0.
 ↪2)
```

8.2.1 Setup mm scaled training and testing data

[47]:
```
scaler = MinMaxScaler()
X_train_mm = scaler.fit_transform(X_train_2)
X_test_mm = scaler.transform(X_test_2)
```

[48]:
```
print("Before scaling:")
print(X_train_2.describe())

print("\nAfter scaling:")
print(pd.DataFrame(X_train_mm).describe())
```

```
Before scaling:
       Artist Followers  Danceability       Energy     Loudness  Speechiness  \
count      1.244000e+03   1244.000000  1244.000000  1244.000000  1244.000000
mean       1.500581e+07      0.689197     0.632876    -6.327491     0.124355
std        1.683367e+07      0.142003     0.161036     2.458651     0.111424
min        4.883000e+03      0.150000     0.103000   -22.507000     0.023200
25%        2.203386e+06      0.600000     0.529000    -7.455000     0.045400
50%        7.383484e+06      0.702000     0.640000    -6.002500     0.077150
75%        2.384846e+07      0.794000     0.749000    -4.779500     0.164250
max        8.333778e+07      0.980000     0.966000     1.509000     0.884000

       Acousticness     Liveness        Tempo  Duration (ms)      Valence
count   1244.000000  1244.000000  1244.000000    1244.000000  1244.000000
mean       0.245874     0.183616   123.432479  197386.659299     0.509094
std        0.247645     0.147420    29.643415   44764.724834     0.226093
min        0.000038     0.027300    46.718000   30133.000000     0.032000
25%        0.047350     0.097100    98.020500  169354.750000     0.336750
50%        0.163000     0.125000   122.811023  194333.000000     0.509000
75%        0.371250     0.215250   143.909500  220000.250000     0.682000
max        0.994000     0.962000   205.272000  484147.000000     0.979000
```

```
After scaling:
                  0            1            2            3            4  \
count  1244.000000  1244.000000  1244.000000  1244.000000  1244.000000
mean      0.180012     0.649635     0.613993     0.673697     0.117513
std       0.202005     0.171088     0.186600     0.102376     0.129442
min       0.000000     0.000000     0.000000     0.000000     0.000000
25%       0.026382     0.542169     0.493627     0.626749     0.025790
50%       0.088544     0.665060     0.622248     0.687229     0.062674
75%       0.286124     0.775904     0.748552     0.738154     0.163859
max       1.000000     1.000000     1.000000     1.000000     1.000000

                  5            6            7            8            9
count  1244.000000  1244.000000  1244.000000  1244.000000  1244.000000
mean      0.247329     0.167237     0.483838     0.368389     0.503796
std       0.249149     0.157719     0.186961     0.098598     0.238747
min       0.000000     0.000000     0.000000     0.000000     0.000000
25%       0.047599     0.074676     0.323565     0.306646     0.321806
50%       0.163952     0.104526     0.479919     0.361663     0.503696
75%       0.373467     0.201081     0.612987     0.418197     0.686378
max       1.000000     1.000000     1.000000     1.000000     1.000000
```

[49]:
```python
print("Mean:", X_train_mm.mean(axis=0))
print("Std:", X_train_mm.std(axis=0))
```

```
Mean: [0.18001206 0.64963484 0.61399324 0.67369708 0.11751319 0.24732926
 0.16723656 0.48383818 0.36838877 0.50379557]
Std: [0.20192392 0.17101913 0.18652536 0.10233438 0.12939005 0.24904917
 0.15765541 0.18688584 0.09855804 0.23865076]
```

9 Model Selection and Training

9.1 Models: STD Scaler

9.1.1 Linear Regression std scaler

[50]:
```python
lr_model = LinearRegression()
lr_model.fit(X_train_std, y_train_1)
y_pred_lr = lr_model.predict(X_test_std)
print('Linear Regression:')
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_1,y_pred_lr)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_1,y_pred_lr):.2f}")
```

```
Linear Regression:
RMSE: 15.16%
R2 Score: 0.04
```

Cross Validation Score for Linear Regression

[51]:
```
lr_model = LinearRegression()
cv_scores = cross_val_score(lr_model, X_train_1, y_train_1, cv=5,␣
 ↪scoring='neg_mean_squared_error')
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 15.63
```

9.1.2 Decision Tree Model std scaler

[ ]:
```
dt_model = DecisionTreeRegressor()Certainly! I'll rewrite the analysis from␣
 ↪your perspective, addressing an audience who will be reading your project.␣
 ↪Here's how you might present your work:

### Introduction

Welcome to my project on Music Popularity Prediction. In this analysis, I've␣
 ↪developed a predictive model to forecast song popularity on Spotify's Top␣
 ↪200 Weekly (Global) charts for 2020 & 2021. This project aims to provide␣
 ↪insights into the factors that contribute to a song's success on these␣
 ↪charts.

### Project Overview

My goal was to create a supervised regression model that could predict a song's␣
 ↪popularity score based on various features. I've used a dataset provided by␣
 ↪DDC Data Science, which includes information about songs, their audio␣
 ↪features, artist popularity, and other relevant characteristics.

### Methodology

1. **Data Preparation**: I began by importing and cleaning the dataset. I used␣
 ↪Python libraries such as pandas, numpy, and scikit-learn for data␣
 ↪manipulation and analysis.

2. **Feature Engineering**: I selected and prepared the following features:
   - Audio Features: Loudness, Energy, Danceability, Valence, Tempo
   - Artist Popularity: Number of artist followers
   - Song Characteristics: Duration
   - Genre: Binary features for major genres
   - Release Timing: Days since release
   - Feature Interactions: Audio features × Artist popularity
   - Cultural and Temporal Factors: Year (2020 vs 2021)

3. **Model Selection**: I experimented with several regression models:
   - Linear Regression
   - Decision Tree Regressor
   - Random Forest Regressor
   - XGBoost Regressor

4. **Model Evaluation**: I used cross-validation to assess model performance,␣
  ↪focusing on Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and␣
  ↪R-squared (R²) as evaluation metrics.

### Results

After training and evaluating the models, I found that [insert your findings␣
  ↪here, e.g., "the Random Forest Regressor performed best with an R² score of␣
  ↪X.XX and an RMSE of Y.YY"].

### Key Insights

1. **Feature Importance**: The most important features in predicting song␣
  ↪popularity were [list the top 3-5 features based on your analysis].

2. **Model Interpretation**: I observed that [describe any interesting patterns␣
  ↪or correlations you found, e.g., "songs with higher energy and danceability␣
  ↪tend to have higher popularity scores"].

3. **Performance Comparison**: [Compare the performance of different models, e.
  ↪g., "The Random Forest model outperformed the Linear Regression model by X%␣
  ↪in terms of R²"].

### Limitations and Future Work

While this project provides valuable insights into song popularity, there are␣
  ↪some limitations to consider:

1. The dataset is limited to 2020 & 2021, which may not capture long-term␣
  ↪trends.
2. Some potentially important factors like lyrics content or music video views␣
  ↪are not included in the dataset.
3. The model's performance could be improved by incorporating more advanced␣
  ↪feature engineering techniques or exploring other machine learning␣
  ↪algorithms.

### Conclusion

This project demonstrates the potential of machine learning in predicting song␣
  ↪popularity on Spotify's Top 200 Weekly charts. The insights gained from this␣
  ↪analysis could be valuable for music industry professionals, artists, and␣
  ↪streaming platforms looking to understand and potentially influence song␣
  ↪popularity.
```

```
By understanding which factors contribute most to a song's success,␣
  ↪stakeholders can make more informed decisions about song production,␣
  ↪marketing strategies, and playlist curation. Future work could involve␣
  ↪expanding the dataset, incorporating additional features, and exploring more␣
  ↪advanced machine learning techniques to further improve prediction accuracy.
dt_model.fit(X_train_std, y_train_1)
y_pred_dt = dt_model.predict(X_test_std)

print("\nDecision Tree:")
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_1, y_pred_dt)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_1, y_pred_dt):.2f}")
```

```
Decision Tree:
RMSE: 14.17%
R2 Score: 0.16
```

Cross Validation Score for Decision Tree

[53]:
```
dt_model = DecisionTreeRegressor()
cv_scores = cross_val_score(dt_model, X_train_std, y_train_1, cv=5,␣
  ↪scoring='neg_mean_squared_error')
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 14.57
```

Feature Importance for Decision Tree

[54]:
```
dt_model.fit(X_train_std, y_train_1)

feature_importances = dt_model.feature_importances_
feature_names = X_train_1.columns
feature_importance_df = pd.DataFrame({'feature': feature_names, 'importance':␣
  ↪feature_importances})
feature_importance_df = feature_importance_df.sort_values('importance',␣
  ↪ascending=False)
print(feature_importance_df)
```

```
            feature  importance
0  Artist Followers    0.600323
1      Danceability    0.055325
7             Tempo    0.051575
4       Speechiness    0.049274
6          Liveness    0.045333
3          Loudness    0.044734
9           Valence    0.044718
5      Acousticness    0.042127
8     Duration (ms)    0.035648
```

```
2            Energy    0.030943
```

9.1.3 Random Forest Model std scaler

[55]:
```python
rf_model = RandomForestRegressor(n_estimators=100)
rf_model.fit(X_train_std, y_train_1)
y_pred_rf = rf_model.predict(X_test_std)

print("\nRandom Forest:")
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_1, y_pred_rf)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_1, y_pred_rf):.2f}")
```

```
Random Forest:
RMSE: 10.07%
R2 Score: 0.58
```

Cross Validation Score for Random Forest

[56]:
```python
rf_model = RandomForestRegressor(n_estimators=100)
cv_scores = cross_val_score(rf_model, X_train_1, y_train_1, cv=5,␣
  ↪scoring='neg_mean_squared_error')
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 10.88
```

Feature Importance for Random Forest

[57]:
```python
rf_model.fit(X_train_std, y_train_1)

feature_importances = rf_model.feature_importances_
feature_names = X_train_1.columns
feature_importance_df = pd.DataFrame({'feature': feature_names, 'importance':␣
  ↪feature_importances})
feature_importance_df = feature_importance_df.sort_values('importance',␣
  ↪ascending=False)
print(feature_importance_df)
```

```
            feature  importance
0  Artist Followers    0.586970
1      Danceability    0.056786
3          Loudness    0.055212
4       Speechiness    0.050095
9           Valence    0.048851
6          Liveness    0.047240
5      Acousticness    0.040879
2            Energy    0.039756
7             Tempo    0.038204
8     Duration (ms)    0.036006
```

9.1.4 XGBoost Model std scaler

[58]:
```
xgb_model = xgb.XGBRegressor(n_estimators=100)
xgb_model.fit(X_train_std, y_train_1)
y_pred_xgb = xgb_model.predict(X_test_std)

print("\nXGBoost:")
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_1, y_pred_xgb)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_1, y_pred_xgb):.2f}")
```

```
XGBoost:
RMSE: 10.32%
R2 Score: 0.55
```

Cross Validation Score for XGBoost

[59]:
```
xgb_model = RandomForestRegressor(n_estimators=100)
cv_scores = cross_val_score(rf_model, X_train_std, y_train_1, cv=5,␣
  ↪scoring='neg_mean_squared_error')
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 10.91
```

Feature Importance for XGBoost

[60]:
```
xgb_model.fit(X_train_std, y_train_1)

feature_importances = xgb_model.feature_importances_
feature_importance_df = pd.DataFrame({'feature': feature_names, 'importance':␣
  ↪feature_importances})
feature_importance_df = feature_importance_df.sort_values('importance',␣
  ↪ascending=False)
print(feature_importance_df)
```

```
            feature  importance
0  Artist Followers    0.580929
3          Loudness    0.055263
1      Danceability    0.053465
9           Valence    0.052384
4       Speechiness    0.051421
6          Liveness    0.047823
2            Energy    0.042646
7             Tempo    0.041453
5      Acousticness    0.038274
8     Duration (ms)    0.036341
```

9.1.5 STD Model Comparison Table

[61]:
```
results = {
    'Model': ['Linear Regression', 'Decision Tree', 'Random Forest', 'XGBoost'],
    'RMSE': [np.sqrt(mean_squared_error(y_test_1, y_pred_lr)),
             np.sqrt(mean_squared_error(y_test_1, y_pred_dt)),
             np.sqrt(mean_squared_error(y_test_1, y_pred_rf)),
             np.sqrt(mean_squared_error(y_test_1, y_pred_xgb))],
    'R2 Score': [r2_score(y_test_1, y_pred_lr),
                 r2_score(y_test_1, y_pred_dt),
                 r2_score(y_test_1, y_pred_rf),
                 r2_score(y_test_1, y_pred_xgb)]
}

results_df = pd.DataFrame(results)
print(results_df)
```

```
               Model       RMSE  R2 Score
0  Linear Regression  15.158785  0.036740
1      Decision Tree  14.167396  0.158615
2      Random Forest  10.066779  0.575189
3            XGBoost  10.315816  0.553911
```

9.2 Models: MM Scaler

9.2.1 Linear Regression mm scaler

[62]:
```
lr_model = LinearRegression()
lr_model.fit(X_train_mm, y_train_2)
y_pred_lr = lr_model.predict(X_test_mm)
print('Linear Regression:')
y_pred_lr = lr_model.predict(X_test_std)
print('Linear Regression:')
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_1,y_pred_lr)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_1,y_pred_lr):.2f}")
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_2,y_pred_lr)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_2,y_pred_lr):.2f}")
```

```
Linear Regression:
Linear Regression:
RMSE: 38.03%
R2 Score: -5.06
RMSE: 39.44%
R2 Score: -4.90
```

Cross Validation Score for Linear Regression mm

[63]:
```
lr_model = LinearRegression()
cv_scores = cross_val_score(lr_model, X_train_mm, y_train_2, cv=5,␣
 ↪scoring='neg_mean_squared_error')
```

```
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 15.41
```

9.2.2 Decision Tree mm scaler

[64]:
```
dt_model = DecisionTreeRegressor()
dt_model.fit(X_train_mm, y_train_2)
y_pred_dt = dt_model.predict(X_test_mm)

print("\nDecision Tree:")
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_2, y_pred_dt)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_2, y_pred_dt):.2f}")
```

```

Decision Tree:
RMSE: 14.84%
R2 Score: 0.16
```

Cross Validation Score for Decision Tree mm

[65]:
```
cv_scores = cross_val_score(dt_model, X_train_mm, y_train_2, cv=5,␣
 ↪scoring='neg_mean_squared_error')
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 14.39
```

Feature Importance for Decision Tree mm

[66]:
```
dt_model.fit(X_train_mm, y_train_2)

feature_importances = dt_model.feature_importances_
feature_names = X_train_2.columns
feature_importance_df = pd.DataFrame({'feature': feature_names, 'importance':␣
 ↪feature_importances})
feature_importance_df = feature_importance_df.sort_values('importance',␣
 ↪ascending=False)
print(feature_importance_df)
```

```
             feature  importance
0   Artist Followers    0.614245
4        Speechiness    0.071105
2             Energy    0.051089
3           Loudness    0.047083
7              Tempo    0.043985
6           Liveness    0.042395
5       Acousticness    0.039479
8      Duration (ms)    0.033401
```

```
9           Valence    0.032421
1      Danceability    0.024799
```

9.2.3 Random Forest mm scaler

[67]:
```
rf_model = RandomForestRegressor(n_estimators=100)
rf_model.fit(X_train_mm, y_train_2)
y_pred_rf = rf_model.predict(X_test_mm)

print("\nRandom Forest:")
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_2, y_pred_rf)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_2, y_pred_rf):.2f}")
```

```
Random Forest:
RMSE: 10.86%
R2 Score: 0.55
```

Cross Validation Score Random Forest mm

[68]:
```
rf_model = RandomForestRegressor(n_estimators=100)
cv_scores = cross_val_score(rf_model, X_train_2, y_train_2, cv=5,␣
 ↪scoring='neg_mean_squared_error')
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 10.71
```

Feature Importance for Random Forest mm

[69]:
```
rf_model.fit(X_train_mm, y_train_2)

feature_importances = rf_model.feature_importances_
feature_names = X_train_2.columns
feature_importance_df = pd.DataFrame({'feature': feature_names, 'importance':␣
 ↪feature_importances})
feature_importance_df = feature_importance_df.sort_values('importance',␣
 ↪ascending=False)
print(feature_importance_df)
```

```
            feature  importance
0  Artist Followers    0.581954
3          Loudness    0.069626
4       Speechiness    0.053389
6          Liveness    0.050916
1      Danceability    0.043224
2            Energy    0.043053
8     Duration (ms)    0.040544
5      Acousticness    0.039911
9           Valence    0.039841
7             Tempo    0.037542
```

9.2.4 XGBoost mm scaler

[70]:
```
xgb_model = xgb.XGBRegressor(n_estimators=100)
xgb_model.fit(X_train_mm, y_train_2)
y_pred_xgb = xgb_model.predict(X_test_mm)

print("\nXGBoost:")
print(f"RMSE: {np.sqrt(mean_squared_error(y_test_2, y_pred_xgb)) :.2f}%")
print(f"R2 Score: {r2_score(y_test_2, y_pred_xgb):.2f}")
```

```

XGBoost:
RMSE: 11.99%
R2 Score: 0.45
```

Cross Validation Score for XGBoost mm

[71]:
```
xgb_model = xgb.XGBRegressor(n_estimators=100)
cv_scores = cross_val_score(rf_model, X_train_2, y_train_2, cv=5,␣
  ↪scoring='neg_mean_squared_error')
rmse = np.sqrt(-cv_scores.mean())
print(f"Cross-validated RMSE: {rmse:.2f}")
```

```
Cross-validated RMSE: 10.69
```

Feature Importance for XGBoost mm

[72]:
```
xgb_model.fit(X_train_mm, y_train_2)

feature_importances = xgb_model.feature_importances_
feature_names = X_train_2.columns
feature_importance_df = pd.DataFrame({'feature': feature_names, 'importance':␣
  ↪feature_importances})
feature_importance_df = feature_importance_df.sort_values('importance',␣
  ↪ascending=False)
print(feature_importance_df)
```

```
            feature  importance
0  Artist Followers    0.401930
5      Acousticness    0.087532
4       Speechiness    0.078639
8     Duration (ms)    0.069953
3          Loudness    0.069588
9           Valence    0.068392
2            Energy    0.066063
6          Liveness    0.054426
1      Danceability    0.053320
7             Tempo    0.050158
```

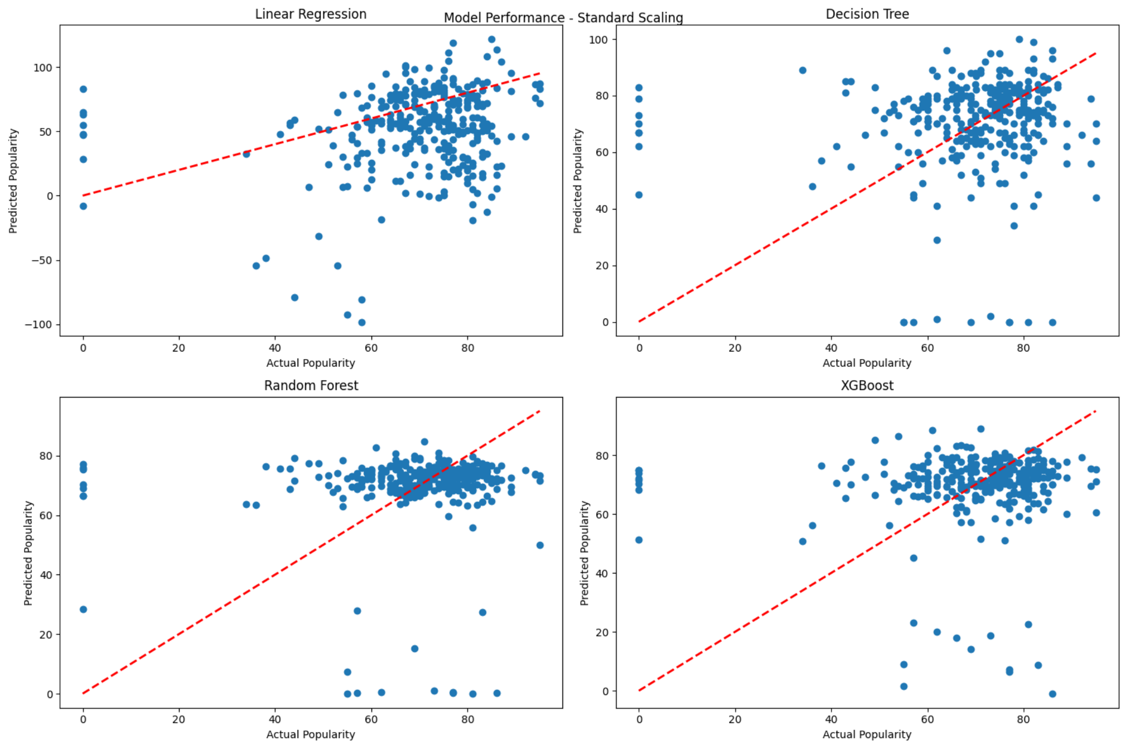
9.2.5 MM Model Comparison Table

[73]:
```
results = {
    'Model': ['Linear Regression', 'Decision Tree', 'Random Forest', 'XGBoost'],
    'RMSE': [np.sqrt(mean_squared_error(y_test_2, y_pred_lr)),
             np.sqrt(mean_squared_error(y_test_2, y_pred_dt)),
             np.sqrt(mean_squared_error(y_test_2, y_pred_rf)),
             np.sqrt(mean_squared_error(y_test_2, y_pred_xgb))],
    'R2 Score': [r2_score(y_test_2, y_pred_lr),
                 r2_score(y_test_2, y_pred_dt),
                 r2_score(y_test_2, y_pred_rf),
                 r2_score(y_test_2, y_pred_xgb)]
}

results_df = pd.DataFrame(results)
print(results_df)
```

```
               Model       RMSE  R2 Score
0  Linear Regression  39.437529 -4.898392
1      Decision Tree  14.839850  0.164833
2      Random Forest  10.855057  0.553133
3            XGBoost  11.988273  0.454961
```

9.3 Model Plotting STD Scaler

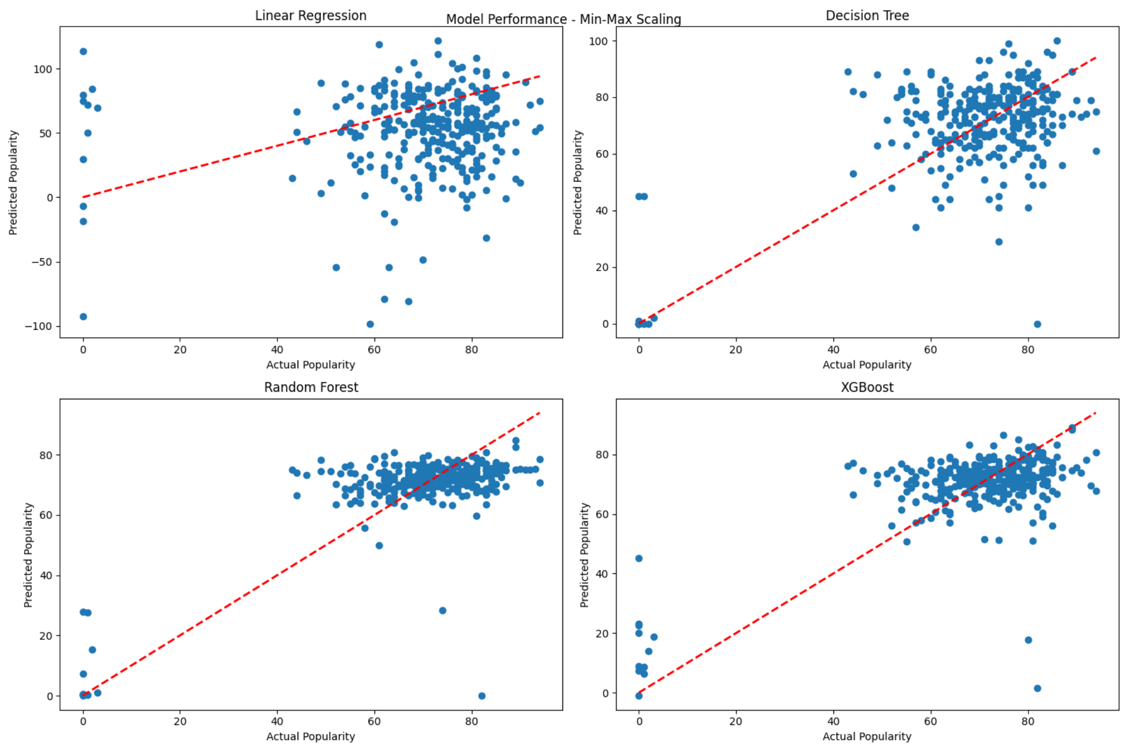
[74]:
```
plt.figure(figsize=(15, 10))

plt.subplot(2, 2, 1)
plt.scatter(y_test_1, y_pred_lr)
plt.plot([y_test_1.min(), y_test_1.max()], [y_test_1.min(), y_test_1.max()],␣
 ↪'r--', lw=2)
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('Linear Regression')

plt.subplot(2, 2, 2)
plt.scatter(y_test_1, y_pred_dt)
plt.plot([y_test_1.min(), y_test_1.max()], [y_test_1.min(), y_test_1.max()],␣
 ↪'r--', lw=2)
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('Decision Tree')

plt.subplot(2, 2, 3)
plt.scatter(y_test_1, y_pred_rf)
plt.plot([y_test_1.min(), y_test_1.max()], [y_test_1.min(), y_test_1.max()],␣
 ↪'r--', lw=2)
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('Random Forest')

plt.subplot(2, 2, 4)
plt.scatter(y_test_1, y_pred_xgb)
plt.plot([y_test_1.min(), y_test_1.max()], [y_test_1.min(), y_test_1.max()],␣
  ↪'r--', lw=2)
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('XGBoost')

plt.tight_layout()
plt.suptitle('Model Performance - Standard Scaling')
plt.show()
```



9.4 Model Plotting MinMax Scaler

[75]:
```
plt.figure(figsize=(15, 10))

plt.subplot(2, 2, 1)
plt.scatter(y_test_2, y_pred_lr)
plt.plot([y_test_2.min(), y_test_2.max()], [y_test_2.min(), y_test_2.max()],␣
  ↪'r--', lw=2)
```

```
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('Linear Regression')

plt.subplot(2, 2, 2)
plt.scatter(y_test_2, y_pred_dt)
plt.plot([y_test_2.min(), y_test_2.max()], [y_test_2.min(), y_test_2.max()],␣
  ↪'r--', lw=2)
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('Decision Tree')

plt.subplot(2, 2, 3)
plt.scatter(y_test_2, y_pred_rf)
plt.plot([y_test_2.min(), y_test_2.max()], [y_test_2.min(), y_test_2.max()],␣
  ↪'r--', lw=2)
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('Random Forest')

plt.subplot(2, 2, 4)
plt.scatter(y_test_2, y_pred_xgb)
plt.plot([y_test_2.min(), y_test_2.max()], [y_test_2.min(), y_test_2.max()],␣
  ↪'r--', lw=2)
plt.xlabel('Actual Popularity')
plt.ylabel('Predicted Popularity')
plt.title('XGBoost')

plt.tight_layout()
plt.suptitle('Model Performance - Min-Max Scaling')
plt.show()
```



9.5 Methodology

1. **Data Preparation**: I began by importing and cleaning the dataset. I used Python libraries such as pandas, numpy, and scikit-learn for data manipulation and analysis.

2. **Feature Engineering**: I selected and prepared the following features:

   - Audio Features: Loudness, Energy, Danceability, Valence, Tempo
   - Artist Popularity: Number of artist followers
   - Song Characteristics: Duration
   - Genre: Binary features for major genres
   - Release Timing: Days since release
   - Feature Interactions: Audio features $\times$ Artist popularity
   - Cultural and Temporal Factors: Year (2020 vs 2021)

3. **Model Selection**: I experimented with several regression models:

   - Linear Regression
   - Decision Tree Regressor
   - Random Forest Regressor
   - XGBoost Regressor

4. **Model Evaluation**: I used cross-validation to assess model performance using Root Mean Squared Error (RMSE), and R-squared (R^2) as evaluation metrics.

9.5.1 Key Insights

1. **Feature Importance**: The most important features in predicting song popularity were [list the top 3-5 features based on your analysis].
2. **Model Interpretation**: I observed that [describe any interesting patterns or correlations you found, e.g., "songs with higher energy and danceability tend to have higher popularity scores"].
3. **Performance Comparison**: [Compare the performance of different models, e.g., "The Random Forest model outperformed the Linear Regression model by X% in terms of R^2"].

9.5.2 Limitations and Future Work

While this project provides valuable insights into song popularity, there are some limitations to consider:

1. The dataset is limited to 2020 & 2021, which may not capture long-term trends.
2. Some potentially important factors like lyrics content or music video views are not included in the dataset.
3. The model's performance could be improved by incorporating more advanced feature engineering techniques or exploring other machine learning algorithms.

9.5.3 Conclusion

This project demonstrates the potential of machine learning in predicting song popularity on Spotify's Top 200 Weekly charts. The insights gained from this analysis could be valuable for music industry professionals, artists, and streaming platforms looking to understand and potentially influence song popularity.

By understanding which factors contribute most to a song's success, stakeholders can make more informed decisions about song production, marketing strategies, and playlist curation. Future work could involve expanding the dataset, incorporating additional features, and exploring more advanced machine learning techniques to further improve prediction accuracy.