MOST STREAMED SPOTIFY SONG ANALYSIS USING MACHINE LEARNING ALGORITHMS

```
# Import the 'warnings' module to manage warnings in the code
import warnings
# Ignore all warnings to prevent them from being displayed during code
execution
warnings.filterwarnings('ignore')
# Import the required libraries for data analysis and visualization
import numpy as np
import pandas as pd
import matplotlib
import plotly.express as px
import matplotlib.pyplot as plt
import seaborn as sns
# Import the 'StandardScaler' class from the'sklearn.preprocessing'
module
from sklearn.preprocessing import StandardScaler
```

Data Loading & Extraction

```
# Open the "spotify-2023.csv" CSV file and read it into the Pandas
DataFrame ('df_sportify').
# To address character encoding issues, specify the encoding as
"cp775".
df_sportify = pd.read_csv("spotify-2023.csv", encoding = "cp775")

# To quickly examine the data, show the first 5 rows of the DataFrame
"df_sportify."
df_sportify.head(5)
```

```
                              track_name    artist(s)_name  artist_count
\
0  Seven (feat. Latto) (Explicit Ver.)  Latto, Jung Kook             2

1                                 LALA       Myke Towers             1

2                              vampire    Olivia Rodrigo             1

3                         Cruel Summer      Taylor Swift             1

4                        WHERE SHE GOES         Bad Bunny             1


   released_year  released_month  released_day
in_spotify_playlists  \
```

```
0           2023                7              14                    553

1           2023                3              23                   1474

2           2023                6              30                   1397

3           2019                8              23                   7858

4           2023                5              18                   3133


   in_spotify_charts    streams  in_apple_playlists  ...  bpm key
mode  \
0                147  141381703                  43  ...  125   B
Major
1                 48  133716286                  48  ...   92  C#
Major
2                113  140003974                  94  ...  138   F
Major
3                100  800840817                 116  ...  170   A
Major
4                 50  303236322                  84  ...  144   A
Minor

  danceability_%  valence_% energy_% acousticness_%  instrumentalness_
%  \
0             80         89       83              31
0
1             71         61       74               7
0
2             51         32       53              17
0
3             55         58       72              11
0
4             65         23       80              14
63

   liveness_%  speechiness_%
0           8              4
1          10              4
2          31              6
3          11             15
4          11              6

[5 rows x 24 columns]
```

```
# To quickly examine the data, show the last 5 rows of the DataFrame
"df_sportify."
df_sportify.tail(5)
```

```
                    track_name      artist(s)_name  artist_count  \
948               My Mind & Me        Selena Gomez             1
949  Bigger Than The Whole Sky        Taylor Swift             1
950       A Veces (feat. Feid)  Feid, Paulo Londra             2
951               En La De Ella  Feid, Sech, Jhayco             3
952                       Alone           Burna Boy             1

     released_year  released_month  released_day  in_spotify_playlists
\
948           2022              11             3                   953

949           2022              10            21                  1180

950           2022              11             3                   573

951           2022              10            20                  1320

952           2022              11             4                   782


     in_spotify_charts    streams  in_apple_playlists  ...  bpm key
mode  \
948                  0   91473363                  61  ...  144   A
Major
949                  0  121871870                   4  ...  166  F#
Major
950                  0   73513683                   2  ...   92  C#
Major
951                  0  133895612                  29  ...   97  C#
Major
952                  2   96007391                  27  ...   90   E
Minor

    danceability_%  valence_% energy_% acousticness_%
instrumentalness_%  \
948             60         24       39             57
0
949             42          7       24             83
1
950             80         81       67              4
0
951             82         67       77              8
0
952             61         32       67             15
0

     liveness_%  speechiness_%
948           8              3
949          12              6
950           8              6
951          12              5
```

```
952          11               5

[5 rows x 24 columns]
```

Data Pre-Processing

```
# Display the count of unique values in the 'artist_count' column
df_sportify['artist_count'].value_counts()
```

```
1    587
2    254
3     85
4     15
5      5
6      3
8      2
7      2
Name: artist_count, dtype: int64
```

```
# Display the count of unique values in the 'released_year' column
df_sportify['released_year'].value_counts()
```

```
2022    402
2023    175
2021    119
2020     37
2019     36
2017     23
2016     18
2014     13
2013     13
2015     11
2018     10
2012     10
2011     10
2010      7
2002      6
1999      5
1984      4
2000      4
2004      4
1963      3
1958      3
1995      2
1970      2
1959      2
1985      2
1957      2
```

```
1986      2
2003      2
1991      2
2008      2
1975      2
1982      2
1946      1
2005      1
1942      1
1996      1
1998      1
1950      1
1979      1
2007      1
1952      1
1971      1
1994      1
1930      1
1973      1
1997      1
1968      1
1992      1
1983      1
1987      1
Name: released_year, dtype: int64
```

```
# Display the count of unique values in the 'released_month' column
df_sportify['released_month'].value_counts()
```

```
1     134
5     128
3      86
6      86
11     80
12     75
10     73
4      66
7      62
2      61
9      56
8      46
Name: released_month, dtype: int64
```

```
# Display the count of unique values in the 'released_day' column
df_sportify['released_day'].value_counts()
```

```
1     95
21    44
13    43
24    40
```

```
2     39
20    39
4     39
7     39
6     39
10    37
9     36
22    33
3     32
25    28
17    28
14    26
8     25
19    25
5     25
23    23
29    23
30    22
11    22
28    21
27    21
15    21
16    20
31    19
18    19
12    17
26    13
Name: released_day, dtype: int64
```

```
# Display the count of unique values in the 'in_spotify_playlists' column
df_sportify['in_spotify_playlists'].value_counts()
```

```
1150     3
1112     3
356      3
86       3
3006     3
        ..
2598     1
542      1
2459     1
10624    1
1320     1
Name: in_spotify_playlists, Length: 879, dtype: int64
```

```
# Display the count of unique values in the 'in_spotify_charts' column
df_sportify['in_spotify_charts'].value_counts()
```

```
0      405
4       48
2       42
6       36
3       18
      ...
76       1
58       1
79       1
66       1
147      1
Name: in_spotify_charts, Length: 82, dtype: int64
```

```
# Display the count of unique values in the 'streams' column
df_sportify['streams'].value_counts()
```

```
723894473     2
156338624     2
1223481149    2
395591396     2
1695712020    1
             ..
1357608774    1
294352144     1
972164968     1
920045682     1
96007391      1
Name: streams, Length: 949, dtype: int64
```

```
# Display the count of unique values in the 'danceability_%' column
df_sportify['danceability_%'].value_counts()
```

```
70    43
77    32
80    31
56    30
74    29
      ..
23     1
27     1
29     1
96     1
38     1
Name: danceability_%, Length: 72, dtype: int64
```

```
# Display the count of unique values in the 'speechiness_%' column
df_sportify['speechiness_%'].value_counts()
```

```
4     175
3     152
5     130
```

```
6      76
8      52
7      49
9      37
10     24
11     22
12     16
14     15
13     12
16     11
23     11
20     10
24     10
25      9
36      8
28      8
21      8
31      8
29      7
33      7
32      7
22      7
19      7
15      6
34      6
17      6
26      6
18      6
27      5
39      5
38      5
40      4
30      4
35      4
46      3
2       3
37      2
44      2
45      2
42      1
64      1
49      1
41      1
43      1
59      1
Name: speechiness_%, dtype: int64
```

```
# Provide a succinct overview of the DataFrame 'df_sportify'. This
covers memory usage, non-null counts, and data types.
df_sportify.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 953 entries, 0 to 952
Data columns (total 24 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   track_name            953 non-null    object
 1   artist(s)_name        953 non-null    object
 2   artist_count          953 non-null    int64
 3   released_year         953 non-null    int64
 4   released_month        953 non-null    int64
 5   released_day          953 non-null    int64
 6   in_spotify_playlists  953 non-null    int64
 7   in_spotify_charts     953 non-null    int64
 8   streams               953 non-null    int64
 9   in_apple_playlists    953 non-null    int64
 10  in_apple_charts       953 non-null    int64
 11  in_deezer_playlists   953 non-null    object
 12  in_deezer_charts      953 non-null    int64
 13  in_shazam_charts      903 non-null    object
 14  bpm                   953 non-null    int64
 15  key                   858 non-null    object
 16  mode                  953 non-null    object
 17  danceability_%        953 non-null    int64
 18  valence_%             953 non-null    int64
 19  energy_%              953 non-null    int64
 20  acousticness_%        953 non-null    int64
 21  instrumentalness_%    953 non-null    int64
 22  liveness_%            953 non-null    int64
 23  speechiness_%         953 non-null    int64
dtypes: int64(18), object(6)
memory usage: 178.8+ KB
```

```
# This helps determine the existence and amount of missing data in the
dataset by checking and displaying the sum of the missing values in
each column of the DataFrame "df_sportify."
df_sportify.isnull().sum()
```

```
track_name              0
artist(s)_name          0
artist_count            0
released_year           0
released_month          0
released_day            0
in_spotify_playlists    0
in_spotify_charts       0
streams                 0
in_apple_playlists      0
in_apple_charts         0
in_deezer_playlists     0
in_deezer_charts        0
```

```
in_shazam_charts         50
bpm                       0
key                      95
mode                      0
danceability_%            0
valence_%                 0
energy_%                  0
acousticness_%            0
instrumentalness_%        0
liveness_%                0
speechiness_%             0
dtype: int64
```

Data Visualization

```
#Sort the DataFrame 'df_sportify' according to the 'key' column, then
count how many times each group's 'in_spotify_playlists' appears.
count_sportify_play = df_sportify.groupby('key')
['in_spotify_playlists'].count().reset_index()
# Use Plotly Express to create a bar plot that displays the total
number of playlists according to the song keys.
plot1 = px.bar(count_sportify_play, x='key', y='in_spotify_playlists',
title='Total playlist with respect to key of the songs', color='key')
# Use the previously defined Plotly Express object 'plot1' to display
the generated plot.
plot1.show()

#Group the'mode' column of the DataFrame 'df_sportify', then add up
the 'in_spotify_playlists' for every group.
sum_sportify_play = df_sportify.groupby('mode')
['in_spotify_playlists'].sum().reset_index()
# Use Plotly Express to create a pie chart that displays the total
number of playlists in relation to the song mode.
plot2 = px.pie(sum_sportify_play, values='in_spotify_playlists',
names='mode', title='Total paylist with respect to mode')
# Display the pie chart
plot2.show()

# Compute the total of 'danceability_%' for each year by grouping the
DataFrame 'df_sportify' by the'released_year' column.
#Using Plotly Express, create an area plot that shows the total amount
of danceability relative to the year that the songs were released.
sum_dancebility = df_sportify.groupby('released_year')['danceability_
%'].sum().reset_index()
plot3 = px.area(sum_dancebility, x='released_year', y='danceability_
%', title='Total sum of the danceability of song with respect to
year')
plot3.show()
```

```
#To find the total of'speechiness_%' for each key, group the DataFrame
'df_sportify' by the 'key' column.
# Using Plotly Express, create an area plot that shows the total sum
of the speechiness percentage in relation to the song key.
sum_speechiness = df_sportify.groupby('key')['speechiness_
%'].sum().reset_index()
plot4 = px.area(sum_speechiness, x='key', y='speechiness_%',
title='Total sum of the speechiness percentage song with respect to
key')
plot4.show()

# Count the instances of'streams' for each key by grouping the
DataFrame 'df_sportify' by the 'key' column.
# 'Most Stream analysis': use Plotly Express to create a pie chart
that shows the distribution of streams among various keys.
sum_sportify_stream = df_sportify.groupby('key')
['streams'].count().reset_index()
plot5 = px.pie(sum_sportify_stream, values='streams', names='key',
title='Most Stream analysis')
plot5.show()

# Group the DataFrame 'df_sportify' by the 'mode' column and count the
occurrences of 'streams' for each mode.
# Create a pie chart using Plotly Express, displaying the distribution
of streams among different modes in a 'Most stream by mode' analysis.
sum_sportify_stream1 = df_sportify.groupby('mode')
['streams'].count().reset_index()
plot6 = px.pie(sum_sportify_stream1, values='streams', names='mode',
hole=0.6, title='Most stream by mode')
plot6.show()

# Take specific columns out of the DataFrame 'df_sportify':
'artist(s)_name, track_name, in_deezer_playlists, in_shazam_charts,
key'.
# Columns are dropped when the 'axis=1' parameter is used, and changes
are applied directly to the original DataFrame when the 'inplace=True'
option is selected.
df_sportify.drop(['artist(s)_name','track_name',
'in_deezer_playlists', 'in_shazam_charts', 'key'], axis=1,
inplace=True)

# After removing certain columns, show the first few rows of the
updated DataFrame "df_sportify"
df_sportify.head()
```

```
   artist_count  released_year  released_month  released_day  \
0             2           2023               7            14
1             1           2023               3            23
2             1           2023               6            30
3             1           2019               8            23
```

```
4              1           2023                5             18

   in_spotify_playlists  in_spotify_charts    streams
in_apple_playlists  \
0                   553                147  141381703
43
1                  1474                 48  133716286
48
2                  1397                113  140003974
94
3                  7858                100  800840817
116
4                  3133                 50  303236322
84

   in_apple_charts  in_deezer_charts  bpm   mode  danceability_%
valence_%  \
0              263                10  125  Major              80
89
1              126                14   92  Major              71
61
2              207                14  138  Major              51
32
3              207                12  170  Major              55
58
4              133                15  144  Minor              65
23

   energy_%  acousticness_%  instrumentalness_%  liveness_%
speechiness_%
0        83              31                   0           8
4
1        74               7                   0          10
4
2        53              17                   0          31
6
3        72              11                   0          11
15
4        80              14                  63          11
6

# Show a brief summary of the updated DataFrame "df_sportify" # Data
types, non-null counts, and memory usage following column removal are
all included in this.
df_sportify.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 953 entries, 0 to 952
Data columns (total 19 columns):
 #   Column                Non-Null Count  Dtype
```

```
---  ------                  --------------  -----
 0   artist_count            953 non-null    int64
 1   released_year           953 non-null    int64
 2   released_month          953 non-null    int64
 3   released_day            953 non-null    int64
 4   in_spotify_playlists    953 non-null    int64
 5   in_spotify_charts       953 non-null    int64
 6   streams                 953 non-null    int64
 7   in_apple_playlists      953 non-null    int64
 8   in_apple_charts         953 non-null    int64
 9   in_deezer_charts        953 non-null    int64
 10  bpm                     953 non-null    int64
 11  mode                    953 non-null    object
 12  danceability_%          953 non-null    int64
 13  valence_%               953 non-null    int64
 14  energy_%                953 non-null    int64
 15  acousticness_%          953 non-null    int64
 16  instrumentalness_%      953 non-null    int64
 17  liveness_%              953 non-null    int64
 18  speechiness_%           953 non-null    int64
dtypes: int64(18), object(1)
memory usage: 141.6+ KB
```

```
# Convert the values in DataFrame 'df_sportify's'mode' column to
binary representation:
#'Major' corresponds to 1 and 'Minor' to 0.
df_sportify['mode'] = df_sportify['mode'].map({'Major': 1, 'Minor':
0})

#Present a brief description of the DataFrame 'df_sportify' following
the application of binary representation to the'mode' column.
df_sportify.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 953 entries, 0 to 952
Data columns (total 19 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   artist_count            953 non-null    int64
 1   released_year           953 non-null    int64
 2   released_month          953 non-null    int64
 3   released_day            953 non-null    int64
 4   in_spotify_playlists    953 non-null    int64
 5   in_spotify_charts       953 non-null    int64
 6   streams                 953 non-null    int64
 7   in_apple_playlists      953 non-null    int64
 8   in_apple_charts         953 non-null    int64
 9   in_deezer_charts        953 non-null    int64
 10  bpm                     953 non-null    int64
 11  mode                    953 non-null    int64
```

```
 12  danceability_%        953 non-null    int64
 13  valence_%             953 non-null    int64
 14  energy_%              953 non-null    int64
 15  acousticness_%        953 non-null    int64
 16  instrumentalness_%    953 non-null    int64
 17  liveness_%            953 non-null    int64
 18  speechiness_%         953 non-null    int64
dtypes: int64(19)
memory usage: 141.6 KB
```

```
# To evaluate the effects of earlier changes, check and show the total
of missing values in each column of the DataFrame "df_sportify" .
df_sportify.isnull().sum()
```

```
artist_count             0
released_year            0
released_month           0
released_day             0
in_spotify_playlists     0
in_spotify_charts        0
streams                  0
in_apple_playlists       0
in_apple_charts          0
in_deezer_charts         0
bpm                      0
mode                     0
danceability_%           0
valence_%                0
energy_%                 0
acousticness_%           0
instrumentalness_%       0
liveness_%               0
speechiness_%            0
dtype: int64
```

Random Forest Classifier

```
# Import the Scikit-Learn modules required for RandomForestClassifier.
# Import functions to divide the dataset and assess the performance of
the model
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix
from sklearn.metrics import mean_squared_error, mean_absolute_error,
r2_score
```

```
# For modeling, keep the target variable (y) and the features (X)
apart.
# Y contains the'mode' column, which represents the target variable,
while
# X contains all other columns.
X = df_sportify.drop('mode', axis=1)
y = df_sportify['mode']

# Use train_test_split to divide the dataset into training and testing
sets.
# X_train and y_train stand for the training features and target
variable, and X_test and y_test for the testing features and variable.
# For reproducibility, a random seed (random_state=42) is utilized,
and the test set size is set to 20%.
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)

rf_model = RandomForestClassifier()
rf_model.fit(X_train, y_train)
```

```
RandomForestClassifier()
```

```
rf_y_pred = rf_model.predict(X_test)

accuracy_rf = accuracy_score(y_test, rf_y_pred)
print('Accuracy of  RandomForestClassifier is ', round(accuracy_rf,2))
```

```
Accuracy of  RandomForestClassifier is  0.57
```

```
rf_report = classification_report(y_test, rf_y_pred)

print('Classification Report:\n', rf_report)
```

```
Classification Report:
               precision    recall  f1-score   support

           0       0.50      0.33      0.39        83
           1       0.59      0.75      0.66       108

    accuracy                           0.57       191
   macro avg       0.55      0.54      0.53       191
weighted avg       0.55      0.57      0.55       191
```

Linear Regression

```
# Import the Scikit-Learn modules required for LinearRegression.
from sklearn.linear_model import LinearRegression
```

```
# Creating X and y
X = df_sportify['released_month']
y = df_sportify['streams']

#Splitting the variables as training and testing
X_train, X_test, y_train, y_test = train_test_split(X, y,
train_size=0.7, test_size=0.3, random_state=100)

# Reshaping the train set without adding a new column
X_train_reshaped = X_train.values.reshape(-1, 1)
X_test_reshaped = X_test.values.reshape(-1, 1)

# Creating an instance of the Linear Regression model
linear_model = LinearRegression()

# Fitting the model using the .fit() method
linear_model.fit(X_train_reshaped, y_train)
```

```
LinearRegression()
```

```
# Displaying the intercept value
print("Intercept Value:", linear_model.intercept_)

# Displaying the slope value
print('Slope Value:', linear_model.coef_[0])
```

```
Intercept Value: 503289040.99568623
Slope Value: 985953.7146833077
```

```
# Generating predictions for y_values
predicted_y_train = linear_model.predict(X_train_reshaped)
predicted_y_test = linear_model.predict(X_test_reshaped)

#Calculating the R-squared value
r_squared = r2_score(y_test, predicted_y_test)
print("R-squared:", r_squared)

# Comparing the R-squared values for both the training and testing
datasets
print("R-squared on Train Data:", r2_score(y_train,
predicted_y_train))
print("R-squared on Test Data:", r2_score(y_test, predicted_y_test))
```

```
R-squared: -0.002235377063729338
R-squared on Train Data: 3.4999363452525856e-05
R-squared on Test Data: -0.002235377063729338
```

```
# Generate predictions on the test dataset
predicted_y = linear_model.predict(X_test_reshaped)

# Assess the model performance using regression metrics
mse = mean_squared_error(y_test, predicted_y)
```

```
mae = mean_absolute_error(y_test, predicted_y)

print("Mean Squared Error:", mse)
print("Mean Absolute Error:", mae)
```

```
Mean Squared Error: 2.6679141351877642e+17
Mean Absolute Error: 370968404.78580385
```

DecisionTreeClassifier

```
# Import the Scikit-Learn modules required for DecisionTreeClassifier.
from sklearn.tree import DecisionTreeClassifier

X = df_sportify.drop('mode', axis=1)  # Features
y = df_sportify['mode']  # Target variable
X_train, X_temp, y_train, y_temp = train_test_split(X, y,
test_size=0.3, random_state=42)
X_test, X_val, y_test, y_val = train_test_split(X_temp, y_temp,
test_size=0.5, random_state=42)

#Establish a decision tree classifier
classifier_model = DecisionTreeClassifier()

#Train the model using the training dataset
classifier_model.fit(X_train, y_train)
```

```
DecisionTreeClassifier()
```

```
# Generate predictions on the test dataset
predicted_y_test = classifier_model.predict(X_test)

# Calculate training accuracy
training_accuracy = accuracy_score(y_train,
classifier_model.predict(X_train))

# Compute test accuracy
testing_accuracy = accuracy_score(y_test, predicted_y_test)

# Assess validation accuracy
validation_accuracy = accuracy_score(y_val,
classifier_model.predict(X_val))

# Compute cross-validation score
cross_validation_score = cross_val_score(classifier_model, X, y,
cv=5).mean()

# Display the results
print("Train Accuracy:", training_accuracy)
print("Test Accuracy:", testing_accuracy)
```

```
print("Validation Accuracy:", validation_accuracy)
print("Cross-Validation Score:", cross_validation_score)
```

```
Train Accuracy: 1.0
Test Accuracy: 0.4965034965034965
Validation Accuracy: 0.6153846153846154
Cross-Validation Score: 0.5183521631303389
```

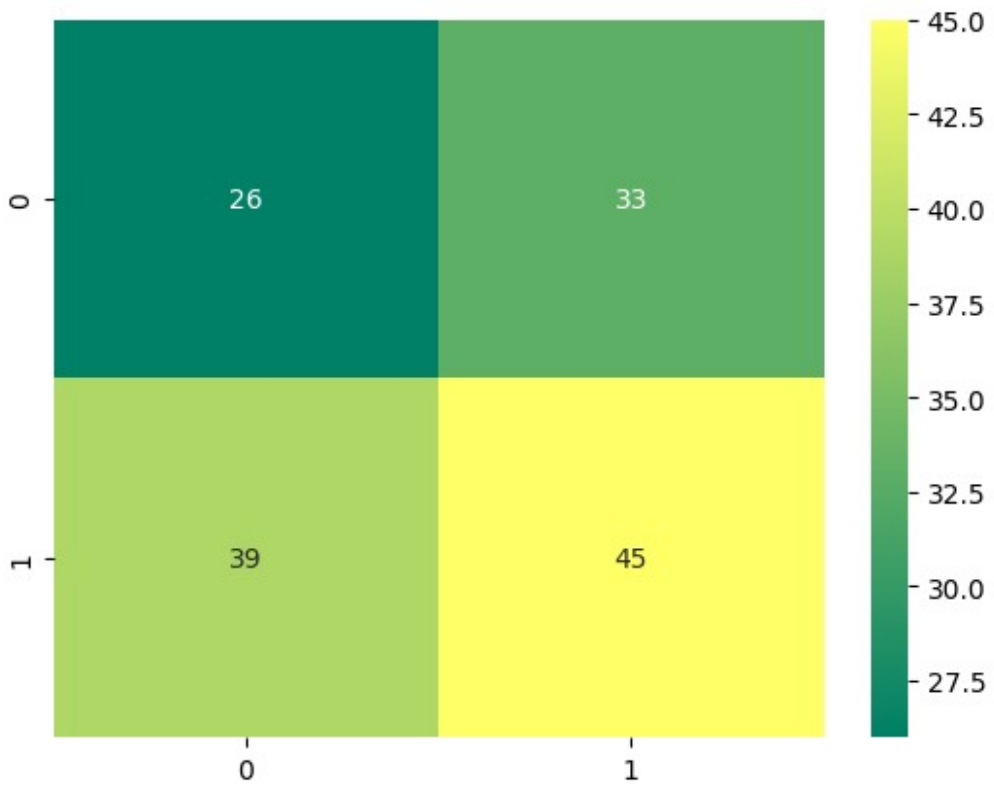
```
# Create a classification report
classification_report_result = classification_report(y_test,
predicted_y_test, output_dict=True)

# Convert the classification report dictionary into a DataFrame
classification_report_dataframe =
pd.DataFrame(classification_report_result).transpose()

# Display the Classification Report DataFrame
print("\nClassification Report:")
print(classification_report_dataframe)
```

```
Classification Report:
              precision    recall  f1-score     support
0              0.400000  0.440678  0.419355   59.000000
1              0.576923  0.535714  0.555556   84.000000
accuracy       0.496503  0.496503  0.496503    0.496503
macro avg      0.488462  0.488196  0.487455  143.000000
weighted avg   0.503927  0.496503  0.499361  143.000000
```

```
#Display the Confusion Matrix
print("\nConfusion Matrix:")
sns.heatmap(confusion_matrix(y_test, predicted_y_test), annot=True,
cmap='summer')
```

```
Confusion Matrix:
```

```
<Axes: >
```


26
33
39
45
0
1
0
1
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5