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CODING PROJECT:

The Determinants of Popular Songs

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1. Project description

1.1. Goal

The focus of this group project is on determinants of popular songs. In particular, the project analyzes which sound characteristics explain the popularity of different songs. The project further investigates the dynamics of the factors across time (2010 - 2019). That is, the main focus is a study of multivariate correlations. In addition, the project provides an interactive part which enables the user of this project to interact with the data. Therefore, our group project addresses the following questions:

- Which determinants explain the popularity of songs?
- Have any dynamics changed over time?

1.2. Resources

The inputs used by the project is a dataset of 609 songs from the top rankings of the years 2010 to 2019. The data set contains the songs' titles, artist, year published, genre, popularity and multiple sound characteristics. The sound measures analyzed are the beats per minute, energy, danceability, loudness, liveness, duration, acousticness and speechiness. The coding project was written in Python with the help of the Jupyter Notebook and a GitHub repository file.

You can find the files here:

- Dataset Top10s.csv
- GitHub Repository
- group.project.ipynb (File contains code to load in Jupyter Notebook)

How to use the document:

1. To use the document, you should download the **skills_group_project repository** from GitHub via the link (GitHub Repository) above.
2. After downloading/ cloning the repository, you should launch Jupyter Notebook via Anaconda.
3. Then open the file group.project.ipynb in Juypter Notebook to get access to the report and code. The group.project.ipynb contains the coded embedded in a report and a detailed documentation.
4. Run the code as described in the next chapter.

2. Code description

The group project is structured in the following parts:

1. Introduction
2. Set-Up and Data Understanding
3. Exploratory Analysis
4. Interactive part
5. Regression Analysis
6. Conclusion

In the following, the code for the exploratory analysis, the interactive part as well as the regression analysis is described and underpinned with code extracts.

2.1. Exploratory Analysis

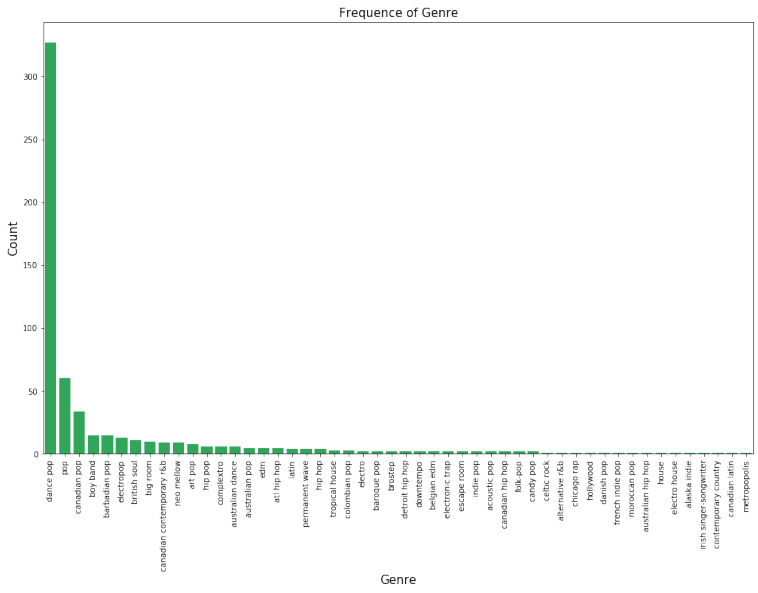
The exploratory analysis consists of a univariate and bivariate analysis. Since the variables are either categorical or numeric, barcharts respectively histograms are plotted regarding the univariate analysis. Both visualization techniques help the user to identify the distributions of the dataset.

The following code describes how to plot a barchart for the genre. In particular, the plot shows how many songs belong to a certain genre.

CODE 1:

```
plt.figure(figsize = (16, 10)) # create a figure using matplotlib and set the figure size
sn.countplot(x = "top genre", data = df, color = "#1DB954", order = df['top genre'].value_counts().index) # us
plt.ylabel("Count", fontsize = 15) # set title on the y-axis
plt.xlabel("Genre", fontsize = 15) # set title on the x-axis
plt.xticks(rotation="vertical") # rotate the title for better visualization
plt.title("Frequence of Genre", fontsize = 15) # set title
plt.show() # show plot
```

OUTPUT 2:

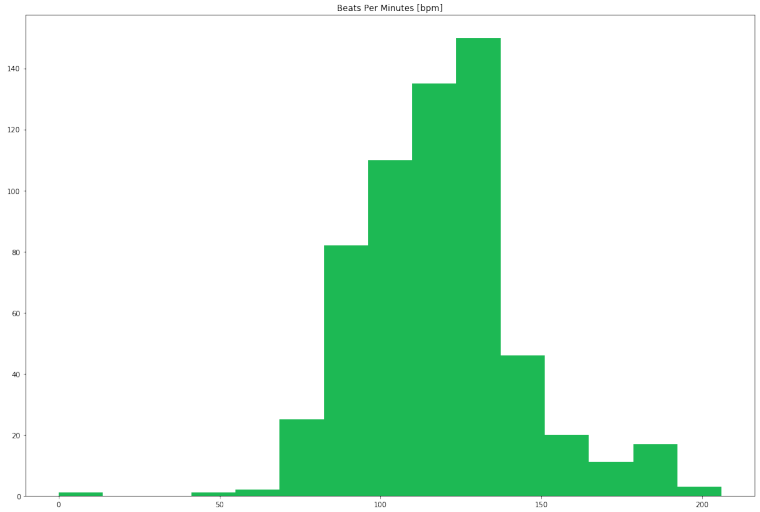


To understand the distribution of each numeric variable better, numerous histograms were plotted. The following histograms give an idea of how the values for the beats per minute variable are distributed.

CODE 2:

```
fig, axes = plt.subplots(figsize = (15,10)) # create a figure and one subplot, set the figuresize
plt.tight_layout() # using tight_layout to automatically adjust plot parameters.
axes.hist(df["bpm"], bins=15, color = "#1DB954") # Plot beats per minutes, set bin size to 15, set color to sp
axes.set_title("Beats Per Minutes [bpm]") #set a title
```

OUTPUT 2:

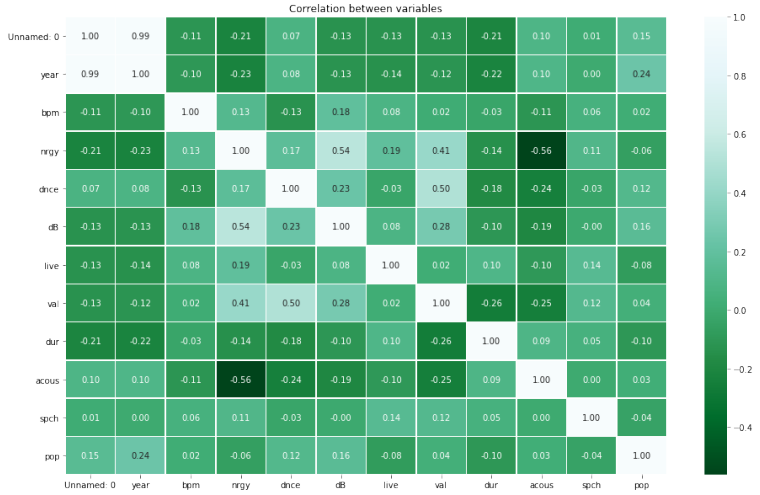


Regarding the univariate analysis, a correlation matrix and scatterplots were plotted. Color coding was used to identify relationships more easily. The following plot shows the correlations matrix.

CODE 3:

```
plt.figure(figsize=(16,10)) # plotting a figure and setting the size of the figure
sn.heatmap(df.corr(), # define the figer format, heatmap based on correlations between variables
           annot = True, # annot to write the values in the cell
           fmt = ".2f", # changing format so we get two decimal points
           cmap = "BuGn_r", # mapping from data value to color space  (colourcoding)
           linewidths=.5) # adding a line between each sells for better visual interpretation
plt.title("Correlation between variables") # setting a title
```

OUTPUT 3:



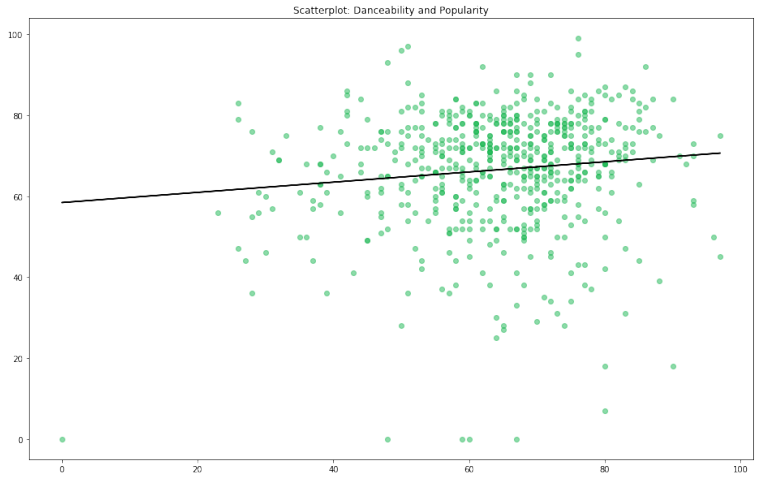
To see if there could be a potential relationship between an independent and the dependent variables "popularity" scatterplots were plotted. The following example shows the relationship between the independent variable "danceability" and the dependent variable "popularity".

CODE 4:

```
x = df["dnce"]
y = df["pop"]
m, b = np.polyfit(x, y, 1) # m = slope, b = intercept, using numpy to create a fitting line

fig, axes = plt.subplots(figsize = (16,10)) # create a figure and one subplot and set the size
plt.plot(x, y,
         "o", # scatterplot
         alpha = 0.5, # define size of points
         color = "#1DB954") # define color
plt.plot(x, m*x + b, color = "black") # plot the fitting line
plt.title("Scatterplot: Danceability and Popularity") # set the title
```

OUTPUT 4:



2.2. Interactive Part

The second part of the code provides the user with three search functions to interact with the dataset and extract information:

- Search for information about an artist
- Search for the top ranking of a year
- Search for information about a song

The user is first prompted by the following text and can enter the numbers 1, 2 and 3 to access the different functions:

```
Here you can perform multiple types of searches within the database.
ATTENTION: CAPITALIZE THE FIRST LETTER OF EVERY WORD AND NAME

What do you want to search for?
    1: Search for information about an artist
    2: Search for the Top Song ranking of a year
    3: Search for information about a song
    Please enter the corresponding number:
```

Search function #1:

Input: 1

Output:

```
ARTIST SEARCH FUNCTION
Enter an artist's name (or part of a name) to see their songs:
```

INPUT: Lady Gaga

OUTPUT:

	artist	title	year	top genre
3	Lady Gaga	Bad Romance	2010	dance pop
13	Lady Gaga	Telephone	2010	dance pop
18	Lady Gaga	Alejandro	2010	dance pop
62	Lady Gaga	Born This Way	2011	dance pop
76	Lady Gaga	The Edge Of Glory	2011	dance pop
81	Lady Gaga	You And I	2011	dance pop
82	Lady Gaga	Judas	2011	dance pop
86	Lady Gaga	Marry The Night	2011	dance pop
195	Lady Gaga	Applause	2013	dance pop
243	Lady Gaga	G.U.Y.	2014	dance pop
370	Lady Gaga	Million Reasons	2016	dance pop
405	Lady Gaga	Perfect Illusion	2016	dance pop
475	Lady Gaga	The Cure	2017	dance pop
524	Lady Gaga	Shallow - Radio Edit	2018	dance pop

Search function #2:

INPUT: 2

OUTPUT:

```
TOP SONG RANKING DISPLAY SEARCH FUNCTION (2010-2019)
Which year's ranking do you want to display?
```

INPUT: Love

OUTPUT:

	artist	title	year
0	Train	Hey, Soul Sister	2010
1	Eminem	Love The Way You Lie	2010
2	Kesha	TiK ToK	2010
3	Lady Gaga	Bad Romance	2010
4	Bruno Mars	Just the Way You Are	2010
5	Justin Bieber	Baby	2010
6	Taio Cruz	Dynamite	2010
7	OneRepublic	Secrets	2010
8	Alicia Keys	Empire State of Mind (Part II) Broken Down	2010
9	Rihanna	Only Girl (In The World)	2010
10	Flo Rida	Club Can't Handle Me (feat. David Guetta)	2010
11	Bruno Mars	Marry You	2010
12	Mike Posner	Cooler Than Me - Single Mix	2010
13	Lady Gaga	Telephone	2010
14	Far East Movement	Like A G6	2010
15	Usher	OMG (feat. will.i.am)	2010
16	Sean Kingston	Eenie Meenie	2010
17	The Black Eyed Peas	The Time (Dirty Bit)	2010
18	Lady Gaga	Alejandro	2010

Search function #3:

INPUT: 3

OUTPUT:

SONG SEARCH FUNCTION

Enter a song's name (or part of a name) to see information about it:

INPUT: Love

OUTPUT:

Here are the song(s) matching your query. The 'pop' column represents the song's popularity over a 100.

	title	artist	year	top genre	pop
1	Love The Way You Lie	Eminem	2010	detroit hip hop	82
19	Your Love Is My Drug	Kesha	2010	dance pop	69
47	DJ Got Us Fallin' In Love (feat. Pitbull)	Usher	2010	atl hip hop	52
58	Love On Top	Beyonc	2011	dance pop	76
85	We Found Love	Rihanna	2011	barbadian pop	61
111	Love You Like A Love Song	Selena Gomez & The Scene	2012	dance pop	76
121	International Love	Pitbull	2012	dance pop	72
168	Let Me Love You (Until You Learn To Love Yours...	Ne-Yo	2013	dance pop	70
174	I Love It (feat. Charli XCX)	Icona Pop	2013	candy pop	67
177	Love Somebody	Maroon 5	2013	pop	65
193	What About Love	Austin Mahone	2013	dance pop	54
224	Love Me Again	John Newman	2014	pop	73

2.3. Regression Analysis

In this section, the code creates a linear regression based on the dataset to predict the dependent variable popularity ("pop") by using the song attributes as independent variables. Additionally, the program will provide a Graphical User Interface that allows the user to enter values to calculate a predicted popularity.

The First lines of code create a regression model based on the dataset. Further it shows the intercept, the coefficients and the R Squared in the outpour after running the code.

CODE 1: Creation of the linear regression and printing values

```
# define independent and dependent variables
X = df[['bpm','nrgy','dnce','dB','live','val','dur','acous','spch']].astype(float)
Y = df['pop'].astype(float)

# create a linear regression
regr = linear_model.LinearRegression()
regr.fit(X, Y)

# show Intercept, Coefficients and R Squared
print('Intercept: \n', regr.intercept_)
print('Coefficients: \n', regr.coef_)
print('R Squared: \n', regr.score(X, Y))
```

OUTPUT 1: Intercept, Coefficients and R Squared

```
Intercept:
 91.94282688762436
Coefficients:
 [ 0.00555795 -0.19782577  0.08273298  1.28581571 -0.051513   -0.00558831
 -0.03885691 -0.02099692 -0.00574637]
R Squared:
 0.0727606471511052
```

The code that follows is used to create a Graphical User Interface to enable the user to enter values for all independent variables to calculate the popularity. Additionally, it will contain an overview of all the scatter plots from the descriptive statistics section to assist the user in finding values for the specific factor. To achieve this the tkinter is first imported. The window manager is initialized with the tk.Tk() method. There it is assigned to the variable root. This creates a blank window with minimize, maximize, and close buttons. Afterwards the window size is defined. Now that the framework of the GUI has been set the contents are determined. We create a position where the user will see the regression function below the input boxes, we created for the calculation (Code 3). Then we define

Code 2 creating the window, variables, and input boxes

```
def values():
    global New_bpm # 1st input variable
    New_bpm = float(entry1.get())

    global New_nrgy # 2nd input variable
    New_nrgy = float(entry2.get())

    global New_dnce # 3rd input variable
    New_dnce = float(entry3.get())

    global New_dB #our 4th input variable
    New_dB = float(entry4.get())
```

Code 3 new variables ("values")

the new variables (“values”) as the new entries, which then will be used for the calculation of the predicted popularity (Code 3). Here we customize the position and the color of our newly created window to highlight the result. The following line of code creates a button that triggers the calculation. Here we also choose a pink coloring to highlight the button. Additionally, we placed the button directly under the input boxes. To finish the code, we then set the characteristics of the scatterplot figures below (Code 4). The mainloop() method creates an infinite loop and thus displays the window until its closed by the user.

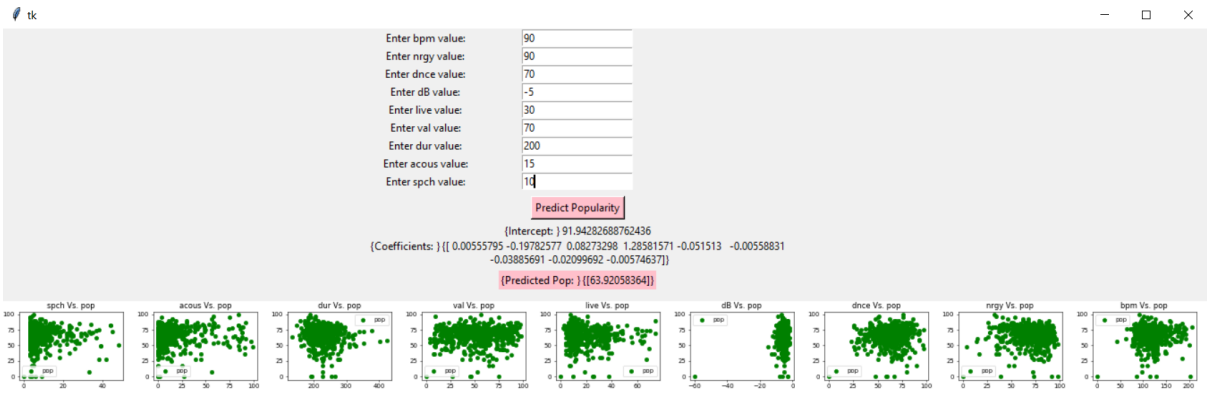
Code 4: Prediction result, button, and scatter plot

```
    # use new variable inputs to predict popularity
    Prediction_result  = ('Predicted Pop: ', regr.predict([[New_bpm ,New_nrgy
    label_Prediction = tk.Label(root, text= Prediction_result, bg='pink')
    canvas1.create_window(220, 280, window=label_Prediction)

    # button to call the 'values' command above
button1 = tk.Button (root, text='Predict Popularity',command=values, bg='pink'
canvas1.create_window(220, 200, window=button1)

#plot 1st scatter
figure1 = plt.Figure(figsize=(3,2), dpi=50)
ax1 = figure1.add_subplot(111)
ax1.scatter(df['bpm'].astype(float),df['pop'].astype(float), color = 'g')
scatter1 = FigureCanvasTkAgg(figure1, root)
scatter1.get_tk_widget().pack(side=tk.RIGHT, fill=tk.BOTH)
ax1.legend(['pop'])
ax1.set_xlabel('bpm')
ax1.set_title('bpm Vs. pop')
```

OUTPUT 2: Graphical User Interface



Now it could be considered that a time effect influences the accuracy of the model as it is only able to explain roughly 7% of the variance. Therefore, further regression models will be created to observe data from specific years separately to investigate if the coefficients are comparable in different years.

OUTPUT 3: Outputs of the 3 separate regressions

```
Intercept: 13.16657694442717
       Coefficient
bpm       0.038525
nrgy     -0.149665
dnce      0.181858
dB       -2.072549
live      0.012248
val       0.245779
dur       0.090588
acous     0.147582
spch     -0.073383
R Squared:
 0.1854610880537585
```

```
Intercept: 93.7709914679631
       Coefficient
bpm       0.094186
nrgy     -0.134569
dnce     -0.184927
dB        0.617794
live     -0.472033
val       0.139166
dur      -0.059729
acous    -0.121440
spch     -0.226186
R Squared:
 0.17339621408793626
```

```
Intercept: 89.18673696774455
       Coefficient
bpm       0.055150
nrgy     -0.154976
dnce     -0.001975
dB        2.252723
live      0.153551
val       0.077546
dur      -0.018819
acous     0.036186
spch     -0.282292
R Squared:
 0.16228633274333215
```

Output 3 shows that the coefficients differ significantly in different years. Thus, it can be assumed that a time effect distorts our previous regression, which could explain the low R-Squared value. However, it can be observed that the individual R-Squared values are not high enough for an accurate model. Therefore, we have to question if it makes sense to predict a songs popularity by using its characteristics.