What makes a song popular?

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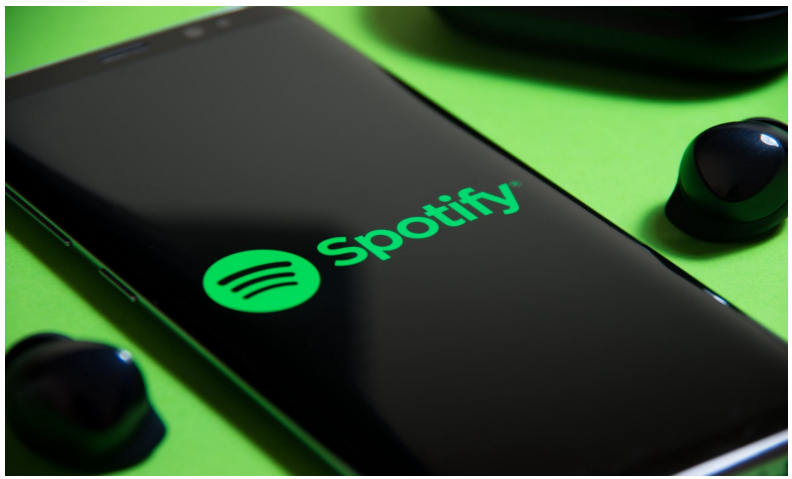
April 30, 2021

Context

- Spotify is popular and widely used, so it reflects people's opinions or taste in music.
- We'd like to analyse how the acoustic features alone influence the popularity of a song.



Data Source

The dataset used is from Kaggle.

- Consists of more than 170,000 tracks
- Years 1920 to 2021

Description

Dependent Variable: Popularity (POP)

- Concerned demographic: US Spotify users
- Ranges from 0 to 100
- Calculated by algorithm and based on
  - Total number of plays the track has had
  - How recent those plays are

Description

Independent Variables - Numerical variables

Name	Variable	Range	Explanation
Acousticness	ACOU	0-1	Usage of acoustic/electric means.
Danceability	DNC	0-1	How suitable a track is for dancing.
Energy	NRG	0-1	Perceptual measure of intensity and activity.
Duration	DUR	3.88-88.97	Length of the track (min).
Instrumentalness	INSTR	0-1	Whether a track contains any or no vocals.
Valence	VAL	0-1	Positiveness of the track.
Tempo	TMP	0-100	Speed in Beat Per Minute (BPM).
Liveness	LIV	0-1	Relative duration sounding as a live show.
Loudness	LOUD	(-60)-0	Relative loudness in decibel (dB).
Speechiness	SPCH	0-1	Relative length containing human voice.
Year	YR	1920-2021	Year of release of track.

Description

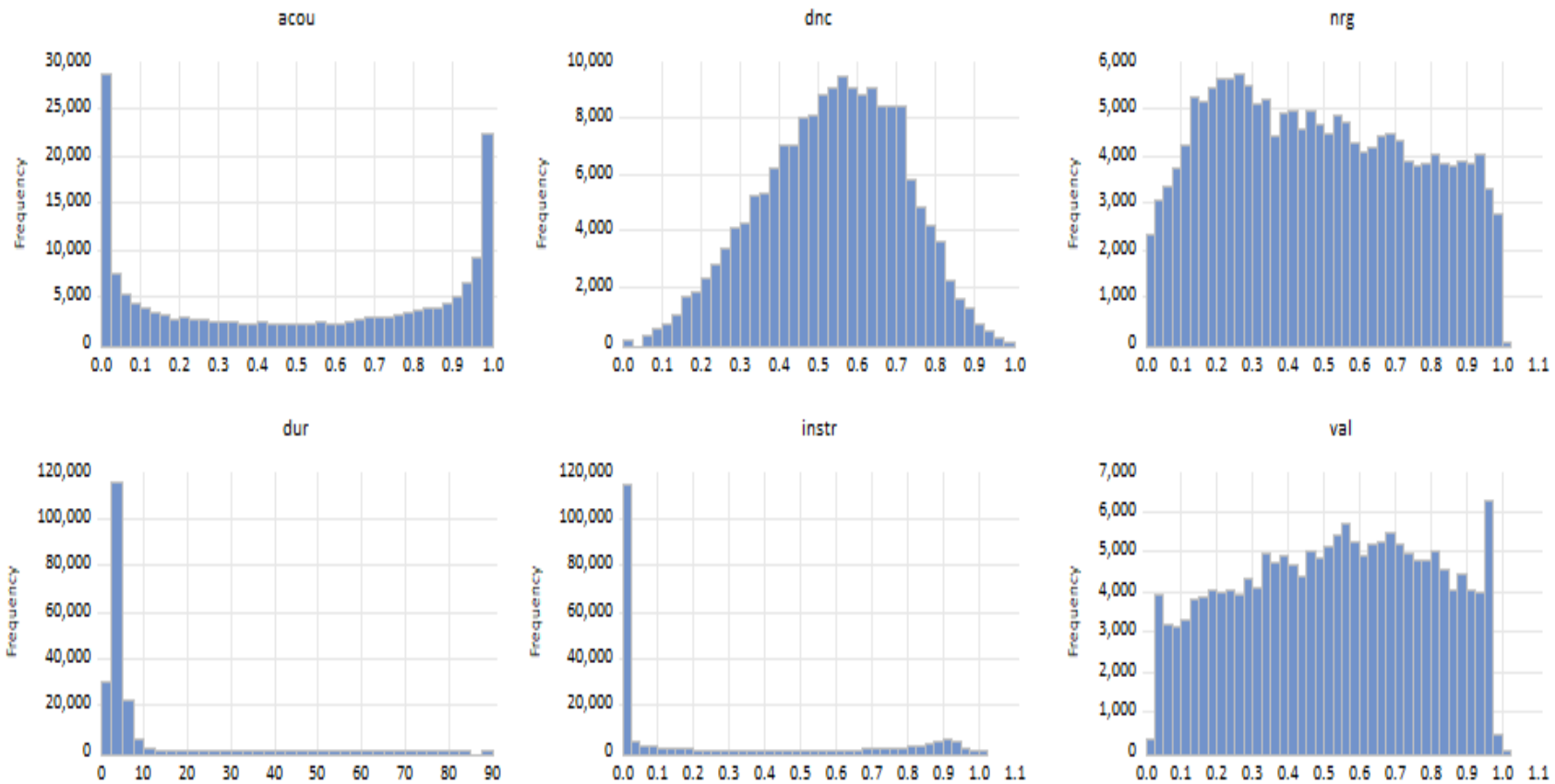
Independent Variables - Dummy variables

Name	Variable	Explanation
Mode	MODE	Type of scale, 0=Minor, 1=Major
Explicit	XPLC	0=No explicit content, 1=Explicit content

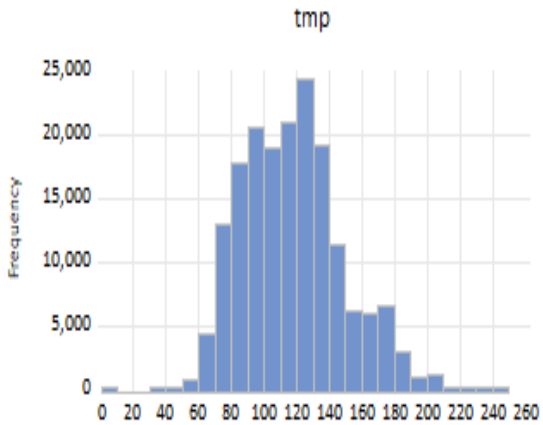
Independent Variables - Categorical variables

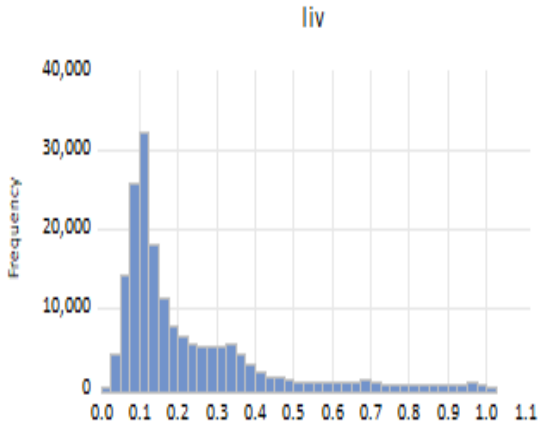
Name	Variable	Explanation
Key	KEY	The primary key of the track encoded as integers in between 0 and 11. E.g. 0 = C, 1 = C♯/D♭, 2 = D, and so on.

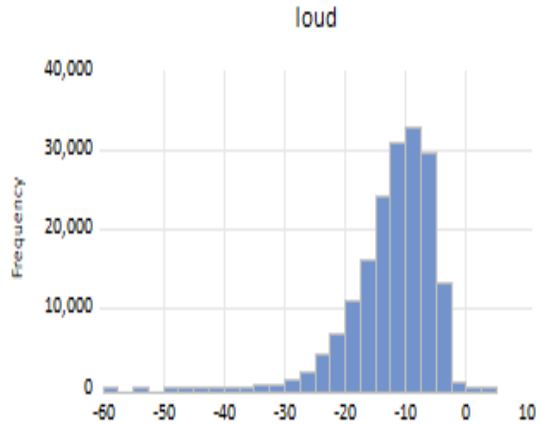
Distribution

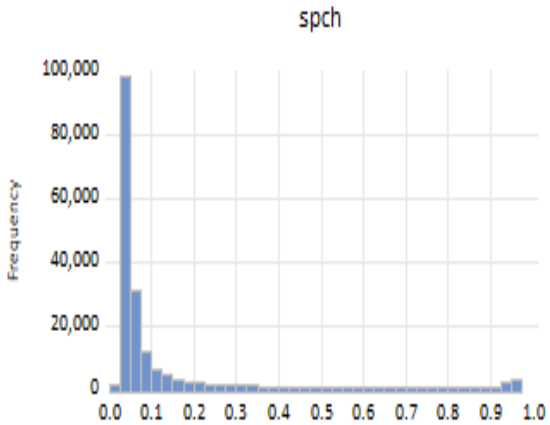


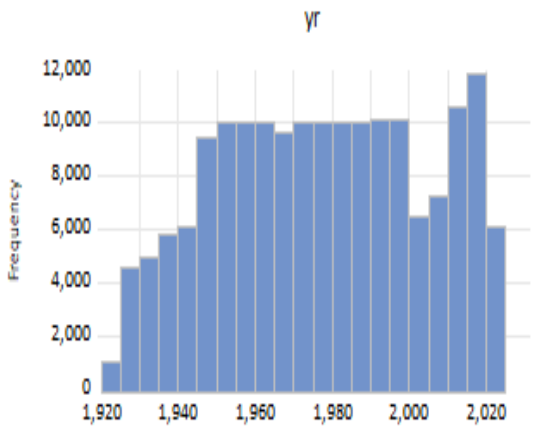
Distribution











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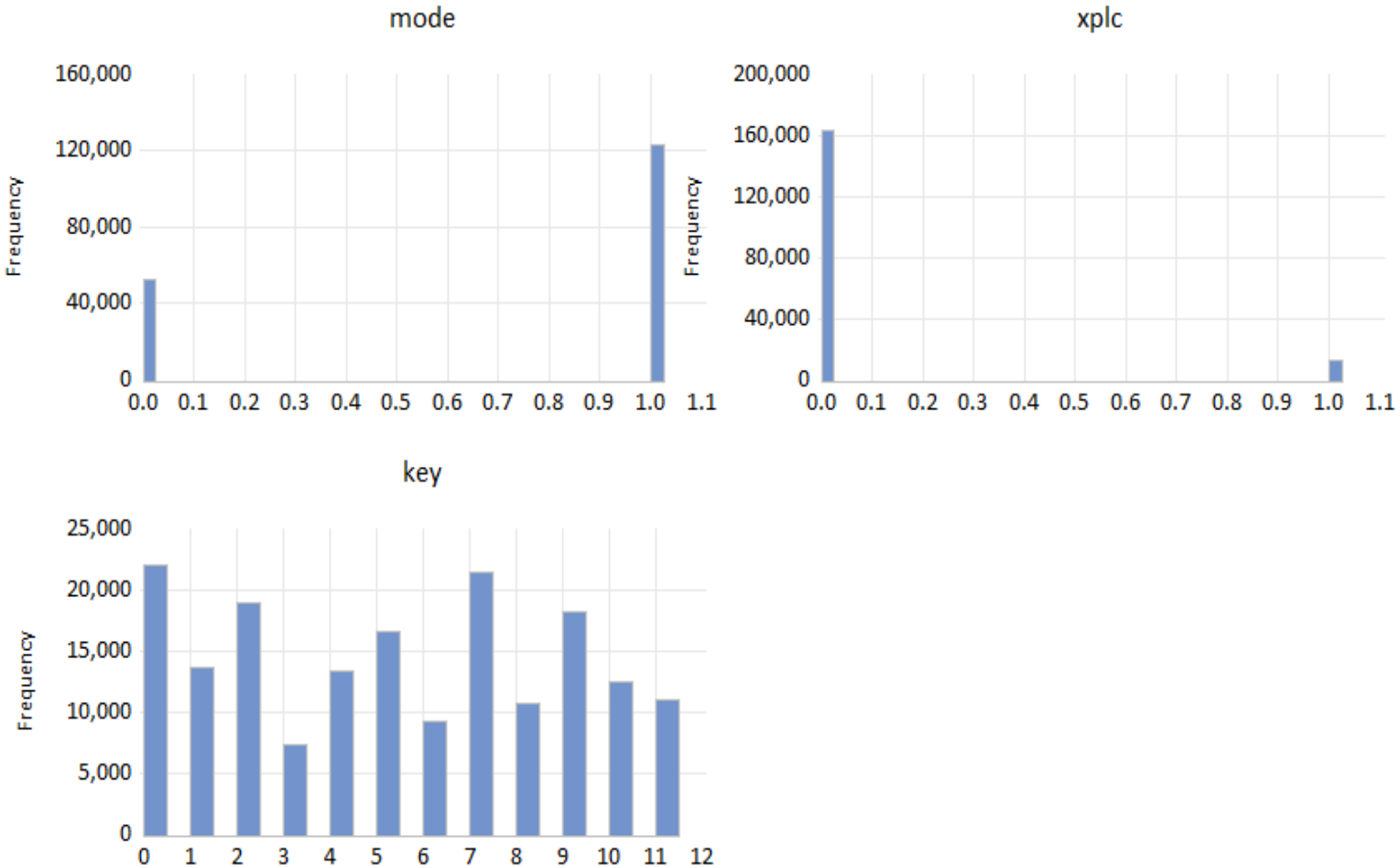

Estimated Equation

A first equation is estimated using least squares, for which the output is given by

	C	ACOU	DNC	DUR	INSTR	KEY	LIV	LOUD	MODE	NRG	SPCH	TMP	VAL	XPLC	YR
pop	-582.25	-7.55	-3.23	-0.04	-16.07	-0.04	-8.22	-0.04	0.71	-3.37	-22.06	-0.01	4.06	9.92	0.31
prob	0.000	0.000	0.000	0.018	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
R^2								0.36357							
F-stat[prob]								7117.013[0.000]							

Figure: Estimation output for Equation 1

Estimated equation

Name	Variable	Expectation	Model
Acousticness	ACOU	?	-7.55
Danceability	DNC	?	-3.23
Energy	NRG	+	-3.37
Duration	DUR	-	-0.04
Instrumentalness	INSTR	-	-16.07
Valence	VAL	+	+4.06
Tempo	TMP	+	-0.01
Liveness	LIV	-	-8.22
Loudness	LOUD	+	-0.04
Speechiness	SPCH	?	-22.06
Year	YR	?	+0.31
Mode	MODE	?	+0.71
Explicit	XPLC	?	+9.92

JB Test

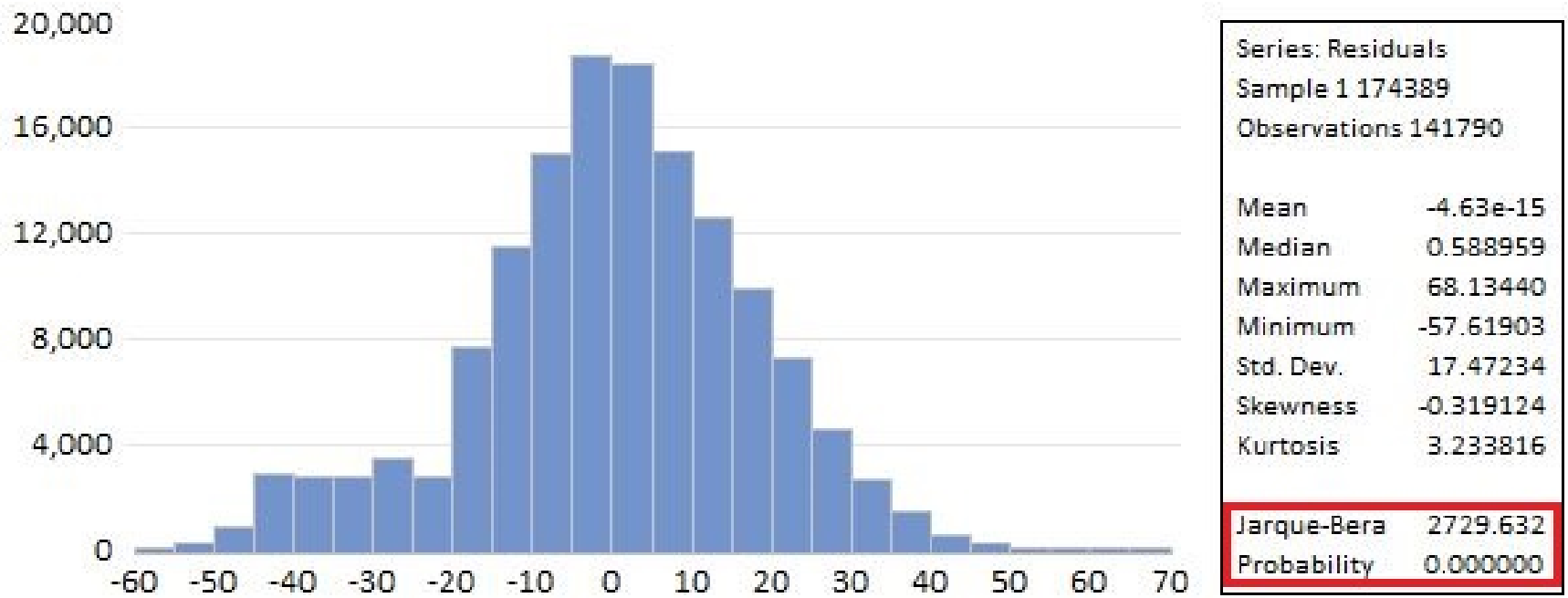

Figure: Jarque-Bera test

Breusch-Pagan-Godfrey Test

HTSK Test: BPG	
H_0 : HMSK	
F-stat[prob]	3230.089[0.000]
OBS $\times$ R^2	34289.03[0.000]

Figure: BPG test : Homoscedasticity

Variance inflation factors

Variable	ACOU	DNC	DUR	INSTR	KEY	LIV	LOUD	MODE	NRG	SPCH	TMP	VAL	XPLC	YR
Centered VIF	3.03	1.84	1.07	1.25	1.01	1.09	3.20	1.03	5.06	1.55	1.10	1.93	1.26	1.99
$1/(1\text{-}R^2) = 1.57$														

Figure: Variance Inflation factors

Stability Diagnostics

Ramsey's RESET test		
	Value	Probability
F-statistic	0.4162	0.5188

Figure: Ramsey's RESET test

Estimated equation

	C	ACOU	DNC	DUR	INSTR	KEY	LIV	LOUD	MODE	NRG	SPCH	TMP	VAL	
pop	-38625.32	9.50	5.23	0.06	-22.52	-0.01	-9.98	1.76	0.15	7.87	-13.49	-0.15	0.82	
prob	0.000	0.000	0.000	0.011	0.000	0.141	0.000	0.000	0.077	0.000	0.000	0.000	0.240	$R^2 = 0.4612$
	XPLC	YR	$ACOU^2$	DNC^2	DUR^2	$INSTR^2$	LIV^2	$LOUD^2$	NRG^2	$SPCH^2$	TMP^2	VAL^2	YR^2	F-stat = 5973.447
pop	11.63	38.05	-14.65	-0.45	-0.006	15.61	0.53	0.04	-15.07	1.34	0	-2.13	-0.009	
prob	0.000	0.000	0.000	0.689	0.000	0.000	0.514	0.000	0.000	0.174	0.000	0.000	0.000	

Figure: Estimation output for Equation 2

- slight improvement when removing DNC^2 and LIV^2.

Further analysis

- Sub-sample based analysis
- Popularity based on the time of the year

Autumn-Winter									Spring-Summer								
NRG	NRG^2	DNC	VAL	VAL^2	ACOU	$ACOU^2$	LOUD	$LOUD^2$	NRG	NRG^2	DNC	VAL	VAL^2	ACOU	$ACOU^2$	LOUD	$LOUD^2$
4.07	-15.81	-2.01	1.19	1.19	10.61	-16.66	2.02	-9.98	21.59	-30.32	10.19	0.31	-4.84	3.34	-4.69	3.13	0.09

Figure: Model based on seasons

- Out-of-sample prediction and best possible combinations
- Socio-cultural factors, language of track, artist familiarity