Are 3-Minute Songs Outdated?
Examining the Popularity of Shorter-Duration Songs on Online Streaming Platforms

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Abstract

In response to the growth of online streaming platforms for daily music consumption, this study aims to investigate if songs with shorter duration generate higher streams. In the past two decades alone, Spotify, launched in 2008, has gained 551 million users. This rapid growth has prompted interest in studying these platforms and their ranking algorithm, which determines popularity based on the number of streams. Further investigation on song duration has observed a general declining trend since the 1990s and earlier literature has explored why this decline might have happened. Drawing from these perspectives, we hope to compare these findings with songs that generate more than 500,000 hits on streaming platforms. Our dataset encompasses stream counts for around 17,841 tracks by artists, both local and international, available on Spotify. This dataset is supplemented with key performance indicators such as "danceability" (a song's dance-inducing quality), "energy" (a song's intensity and pace), and other metrics. The alternative hypothesis suggests a significant correlation between songs with shorter duration and higher streaming numbers, while the null hypothesis posits no such correlation. Sub-objectives of this hypothesis include assessing whether attributes like danceability and energy can also predict popularity. The study's insights are expected to offer valuable guidance to music producers, artists, and platform curators, enabling them to predict the ideal average song duration for the next decade and determine key metrics to produce chart-topping songs.

Keywords: mainstream music, duration, trending songs, chart-topping songs, popularity

I. Introduction

In October 2008, two Swedish entrepreneurs Daniel Ek and Martin Lorentzon launched Spotify, a streaming service that has been called by critics as "[a disruption to] the world of music" (Eriksson et al., 2019). With its innovative features and affordable rate, Spotify has amassed more than 550 million users, hinting at the massive growth of music streaming services within the entertainment industry. In 2021, Forbes reported that music streaming services alone generated more than $20 billion dollars in revenue, controlling for 84% of the music industry's revenue (Forbes, 2023). Approximately 32% of these streamers use Spotify (Forbes, 2023).

Considering the significance of Spotify and streaming services as revenue-generating operations within the music industry, our study aims to discover the variables that affect the number of streams that a song generates, which in turn would allow us to analyze its impact on revenue. By studying trends within music production for the past 20-30 years, analysts have revealed that there is a general decline in the duration of songs, essentially meaning that songs have gotten shorter for the past decades.

Bearing in mind the large potential for music streaming platforms to the music production industry, this study aims to study the variable that causes a song to generate higher streams, and thus higher revenue. By incorporating this into our study, we believe this insight would offer guidance to music producers, artists, and platform curators on projected music trends, which would enable them to predict the ideal average song duration for the next decade or determine other key metrics that might influence a song's climb to the top-charts.

The structure of this paper is as follows. In Section II, we will examine the growth of online music streaming services in the early 2000s and its relevance to the entertainment sector and media studies enthusiasts. We will also further expand on the emerging trend of songs with shorter durations in this section. In Section III, we define our hypothesis, based on the aforementioned literature. Next, Section IV discusses our data and the design of our empirical testing, followed by Section V which provides our analysis and findings. Section VI summarizes key findings and offers recommendations.

II. Literature Review

2.1 Spotify and Online Streaming Platforms

Spotify's rapid growth mainly comes from its innovative features. First, it gives users the unprecedented freedom to legally stream an unlimited number of songs, countering prevalent illegal music pirating activities in the early 2000s. Second, Spotify offers unparalleled convenience and accessibility through its app, essentially making Spotify accessible through numerous mediums. It's affordability also makes it a top choice for users. Spotify Premium, which gives users unlimited add-free services, costs only $10.99 per month in 2023.

In addition to Spotify, other music streaming services also offer their services within the same range, making their premium services universally accessible to anyone with a mobile device. It costs $10 to subscribe to YouTube Music, Apple Music, and Tidal, with the exception of Amazon, who offers their music streaming services for $9 with Prime membership (Durrani, 2023). According to Forbes, approximately 82 million Americans pay for on-demand streaming services (2023).

Online music streaming services usually generate revenue through the number of streams that they garnered, which indicates the amount of times the song has been played by users. In a 2015 analysis by Audiam, a company that aids music publishers to collect digital royalties, a single play on Spotify Premium was worth an average of about $0.68 of a cent in royalties per stream (Zillman, 2015). In 2023, Goldman Sachs predicts that the global revenue for recorded music is forecasted to grow 7.5% in 2023, with expected streaming rates remaining healthy and unchanged. However, the company also mentions that the music streaming services are seeing less revenue for every song streamed in 2023, as the industry has "yet to fully monetize its content" (Goldman Sachs, 2023). Based on these projections on the music streaming industry, our team recognizes the potential for streaming services as a subject of study to equip industry professionals seeking to create new opportunities.

2.2 Recent Trends in Music Production

By 1980, trends within music production began to take a different direction, creating a feel that sounds universally more digitized. From the late 1950s to the 80s, researchers working in scientific laboratories laid the foundation for creating music with computers, generating a number of digital products, including some of the first sound-generating computer programs (Prior, 2018). While researchers speculate that songs within the early 1900s or up to 1930s tend to have a shorter average duration due to technological limitations, UCLA has tracked the differences in average song length over the decades. There was a steady increase in the average song length from 1930 to 1990 (195 seconds to 259 seconds), followed by a steady decrease to 197 seconds in 2020 (Gangiredla, D., et al., 2020). While the early 1990s oversaw the longest songs on average, 2020 saw a rapid decline in the average song length, showing similar patterns to songs in the 1930s (Gangiredla, D., et al., 2020). Research shows that 25% percent of listeners will push the skip button in the first five seconds, and as streaming platforms aim to incentivize users to listen to an entire song to generate revenue, it is paramount that music production teams are able to find a song length that would maximize streaming (Wright, 2023). By analyzing these trends, our team hopes to prove if song length is indeed statistically significant and should be considered as a decision-making variable in song production in terms of its impact on revenue-making or if other variables should also be considered.

III. Hypothesis Development

In order to understand the causal relationship between revenue and a song's popularity on online streaming platforms, our study defines a song's 'popularity' as the number of views and streams that a song is able to generate, which in turn would generate revenue.

> **Popularity:** the number of views and streams that a song is able to generate, which in turn would generate revenue.

Based on the number of users alone, our study isolates Spotify, a streaming platform with the highest number of users, as a prime example to conduct our study. By acquiring data from Spotify, we hope we can study a large enough data source to generate a statistically significant test.

To study our dependent variable, which are the streams generated by each song in our data set, we aim to identify a number of other independent variables alongside duration that might affect a song's popularity. For the purpose of this study we have picked "danceability" (a song's dance-inducing quality) and "energy" (a song's intensity and pace) as confounding variables.

Considering the significance of Spotify and streaming services as revenue generating operations within the music industry, our study aims to discover the variables that affect the number of streams that a song generates, which in turn would allow us to analyze its impact on revenue. For the purpose of this study, we have defined the alternative hypothesis as:

> **Ha.** There is a statistically significant correlation between song duration and the song's popularity

Meanwhile, the null hypothesis is represented as:

> **Ho.** The duration of the song does not have a statistically significant impact on the song's popularity

IV. Methodology

4.1 Data

4.1.1 Dataset

Our dataset, sourced from Kaggle, encompasses songs released between 1986 and 2023 and accessible on Spotify. Data collection involves utilizing a function to send requests to Spotify's API, retrieving various attributes, and storing them in an Excel file. The dataset comprises over 34 variables, which include 22 numerical variables related to characteristics and 12 categorical variables for artists, genre, and album type, among others. These variables fall into four types: float, integral, strings, and booleans.

4.1.2 Data Cleaning

In our data cleaning process, we follow a systematic approach to ensure the accuracy and reliability of the dataset. First, we identify and eliminate outliers based on the variable 'duration_min,' employing a threshold that keeps data within ±3 standard deviations. This step helps to mitigate the impact of extreme values on our analysis. After capping out these outliers, any null or missing values are systematically dropped. This further ensures our subsequent analyses are conducted on a comprehensive and complete dataset.

Additionally, we enhance the dataset's clarity and focus by removing unnecessary categorical variables that do not contribute to our analytics, such as "hyperlinks," and "artist_ids.," and one of the replicated variables, "duration_ms." By doing so, we streamline the data to include only pertinent information.

This meticulous data-cleaning process prepared us with a robust and reliable dataset, laying the foundation for meaningful insights and accurate conclusions in our subsequent analyses.

4.2 Methods & Statistical Analysis

Our investigation aims to uncover the relationship between two numerical variables; the popularity of a song (considered the dependent variable) and its duration (regarded as the independent variable). We employed inferential and regression analyses. Our initial hypothesis posited a significant correlation between these two variables. To scrutinize this hypothesis, we utilized a correlation heatmap, a graphical representation that color-codes cells based on the strength and direction of correlation. Positive correlations were denoted by red, while negative correlations were represented by blue.

Furthermore, we conducted a simple linear regression analysis with the specific goal of elucidating a linear relationship that accurately characterizes the correlation between a song's duration and its corresponding popularity. This model served to provide a quantitative understanding of how changes in the duration variable relate to changes in the popularity variable. Overall, the use of these statistical methodologies, including correlation analysis and linear regression, has contributed to a refined understanding of the nuanced dynamics inherent in the relationship between the duration and a song’s popularity.

Upon realizing that the duration of a song alone doesn't sufficiently clarify its popularity, we opted for a principal component analysis (PCA) to pinpoint the key variables that contribute the most to our dependent variable. This process helps us focus on the most influential factors. Following the identification of these crucial independent variables, we conducted a multiple regression analysis to delve into the relationships between these variables and the popularity of the songs. This approach aims to provide a more nuanced understanding of how various factors collectively contribute to the overall popularity, aiding us in interpreting the significance of the graph or visual representation.

V. Results

5.1 Graphs and Results

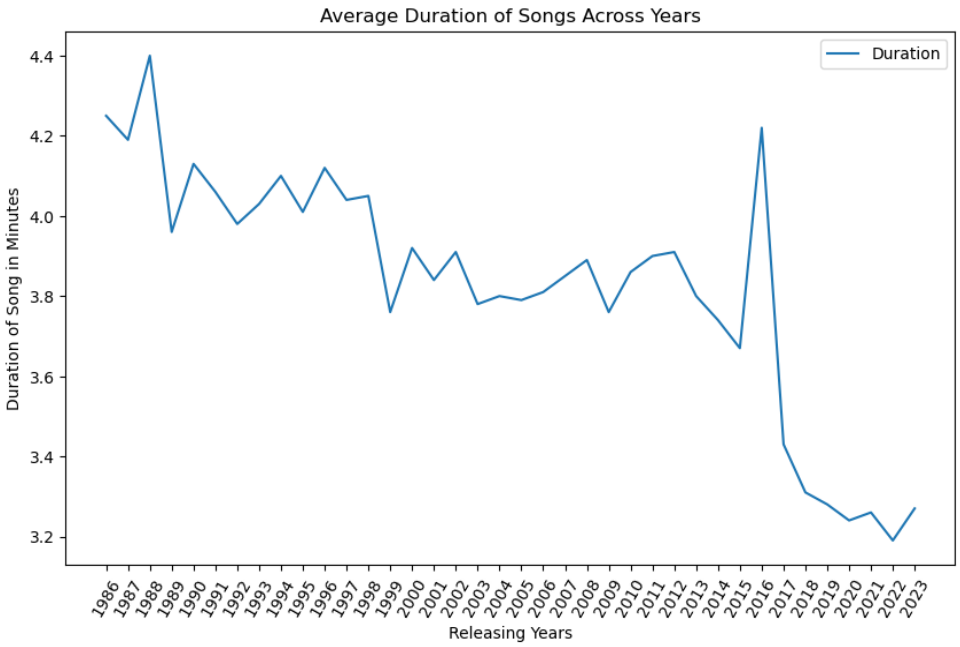
5.1.1 Data Description

	popularity	year	duration_min	energy	danceability
count	11324.00	11324.00	11324.00	11324.00	11324.00
mean	68.05	2004.31	3.77	0.65	0.61
std	9.32	11.02	0.92	0.21	0.16
min	45.00	1986.00	0.60	0.00	0.00
25%	61.00	1995.00	3.19	0.52	0.51
50%	68.00	2004.00	3.71	0.67	0.62
75%	75.00	2014.00	4.30	0.82	0.73
max	100.00	2023.00	7.02	1.00	0.99

In our analytical approach, we concentrate on pivotal variables, including “popularity (measured in score),” “duration_min,” “year,” and additional confounding variables such as “energy” and “danceability.” The “popularity” index, sourced from Spotify, encompasses factors such as total plays, recent frequency, and overall popularity, providing a thorough assessment of a song's popularity across the entire streaming platform.

To mitigate the impact of potential missing stream data in our dataset, we navigate this limitation by placing reliance on the Popularity Index. The “duration_min” index represents the song's duration in minutes, while the “year” index signifies the song's release year.

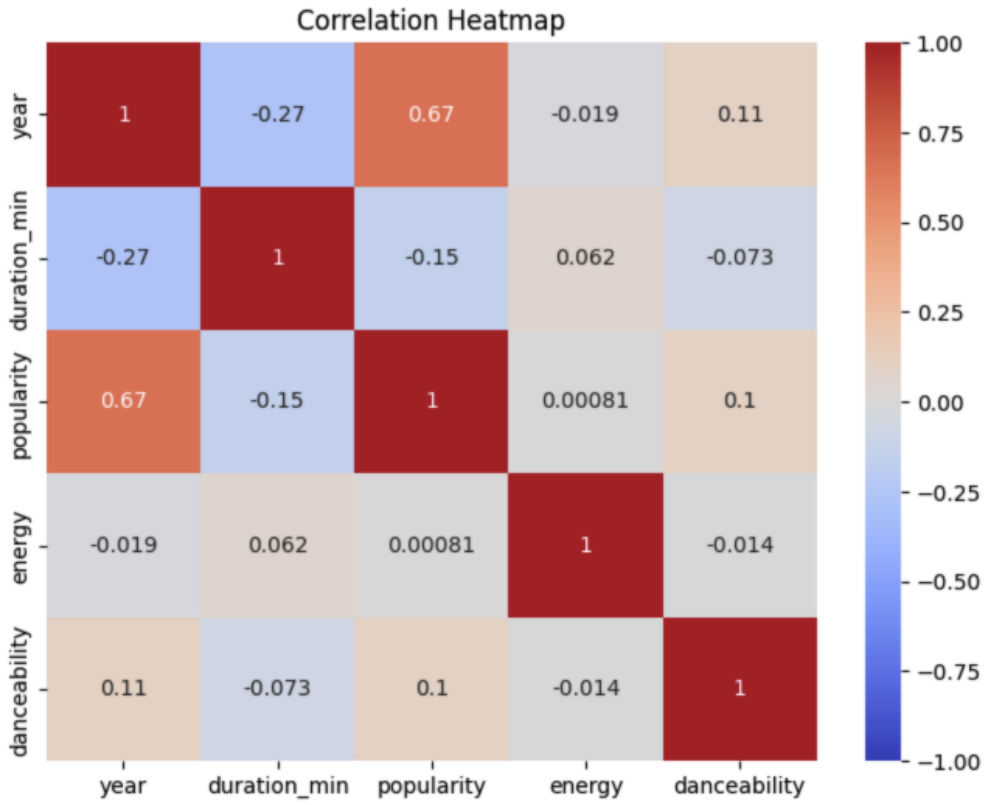
5.1.2 Average Duration Across Years



The line plot depicted provides a clear illustration of the trend of average song duration from 1986 to 2023. The x-axis marks the release years, while the y-axis measures the average lengths of songs in minutes for each respective year.

This graphical trend substantiates the findings of our statistical research, suggesting a growing prevalence of shorter songs in recent times. This visual highlights a shift towards briefer song formats in the modern era. Simultaneously, this prompts an analytical inquiry into whether songs with shorter durations indeed have higher popularity scores, suggesting a potential area for further research to explore the correlation between song length and its appeal to audiences.

5.1.3 Correlation Heatmap



A notable observation from the heatmap is the negative correlation of -0.15 between the duration of a song and its popularity, suggesting that shorter songs tend to be more popular. This could be interpreted as a trend where listeners prefer concise and to-the-point music, possibly due to shifting listening habits or the influence of music streaming platforms that favor shorter tracks.

Additionally, the heatmap hints at a negative relationship between the year of release and song duration, with a correlation coefficient of -0.27. This indicates that songs released more

recently are likely to be shorter in duration than older songs. This trend could reflect changes in the music industry and consumer preferences over time, with a possible shift towards shorter, more streamable content that caters to modern consumption patterns.

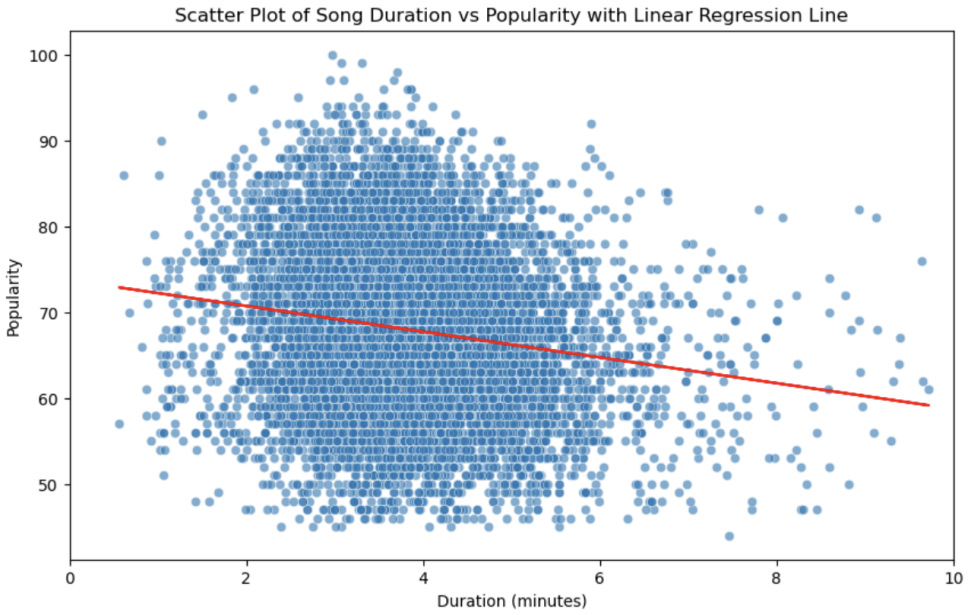
5.1.4 Simple Linear Regression

OLS Regression Results

Dep. Variable:	popularity	R-squared:	0.026
Model:	OLS	Adj. R-squared:	0.025
Method:	Least Squares	F-statistic:	300.1
Date:	Mon, 20 Nov 2023	Prob (F-statistic):	2.24e-66
Time:	18:03:40	Log-Likelihood:	-41608.
No. Observations:	11433	AIC:	8.322e+04
Df Residuals:	11431	BIC:	8.323e+04
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	73.7108	0.341	216.471	0.000	73.043	74.378
duration_min	-1.4981	0.086	-17.322	0.000	-1.668	-1.329

Omnibus:	148.310	Durbin-Watson:	0.539
Prob(Omnibus):	0.000	Jarque-Bera (JB):	99.863
Skew:	0.102	Prob(JB):	2.07e-22
Kurtosis:	2.590	Cond. No.	16.5



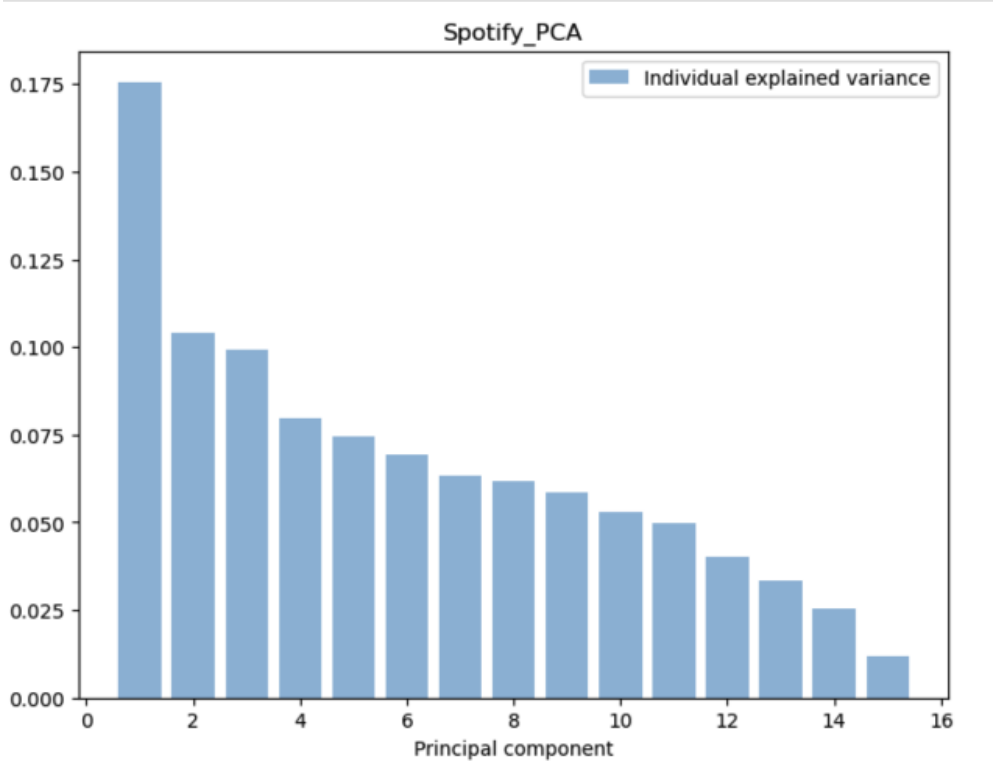
The results of our simple regression analysis offer intriguing insights into the relationship between song duration and popularity. With a negative coefficient of -1.549 for song duration and a highly significant p-value of less than 0.001, the data reveals a distinct inverse relationship. This implies that for every minute decrease in the length of a song, there is an associated increase of approximately 1.55 points in its popularity score.

This finding is further underscored by a robust t-statistic of -16.445, which underscores the strength and reliability of this relationship between song duration and popularity. However, it is crucial to note the R-squared value of 0.023 in our analysis. This relatively low figure suggests that while song duration is indeed a significant factor, it is not the sole determinant of a song's popularity. There are evidently other elements at play in the complex dynamics that dictate what makes a song popular.

In essence, while shorter songs tend to be more popular, this trend is part of a larger, multifaceted musical landscape. Various other factors, potentially including genre, an artist's popularity, marketing strategies, and cultural trends, also significantly contribute to a song's success. The analysis serves as a reminder that the music industry is influenced by a tapestry of elements, with song duration being an important, yet singular, thread in this broader picture.

5.2 PCA Analysis

```
array([0.176, 0.104, 0.099, 0.08 , 0.074, 0.069, 0.063, 0.062, 0.058,
       0.053, 0.05 , 0.04 , 0.034, 0.025, 0.012])
```



The simple regression analysis indicates that the popularity score of a song is limited to a maximum of 73.7 points, as indicated by the intercept of the regression model. However, this interpretation appears unrealistic and unreasonable, especially considering songs with higher popularity scores in our dataset. To gain a more comprehensive understanding, we proceeded with a multiple regression analysis to explore the potential impact of other variables on the "popularity" index.

Recognizing that our dataset comprises more than 20 numerical variables, we employed PCA analysis to reduce the number of variables used in the multiple regression. This approach aims to retain key information and enhance the efficiency of our analysis. From the histogram above we decided to select 8 variables, accounting for a cumulative variance of 72.7%.

Additionally, we delved into the PCA loading to identify the variables with the highest weights in the dataset. This step allows us to discern the significant contributors to our analysis and streamline the interpretation of results. The chosen variables for our analysis are "duration_min," "principal_artist_followers," "loudness," "tempo," "key," "mode," and "time_signature," with "popularity" designated as the dependent variable.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
popularity	0.0	-0.0036	0.9950	0.0922	0.0292	0.0220	-0.0042	-0.0028
duration_min	0.0	0.0012	-0.0211	-0.0104	-0.0048	0.9975	-0.0323	0.0117
danceability	0.0	0.0009	0.0018	-0.0049	-0.0008	-0.0167	0.0379	-0.0928
energy	-0.0	-0.0011	0.0006	-0.0388	-0.0112	0.0075	0.0261	-0.0753
instrumentalness	-0.0	0.0002	-0.0012	0.0130	0.0047	0.0022	0.0063	0.0168
key	-0.0	-0.0005	-0.0003	-0.2998	0.9539	0.0010	-0.0172	-0.0004
liveness	-0.0	-0.0000	-0.0003	-0.0043	-0.0017	-0.0032	0.0083	-0.0027
loudness	0.0	-0.0154	0.0971	-0.9476	-0.2980	-0.0103	-0.0072	0.0218
mode	-0.0	-0.0001	-0.0042	0.0083	-0.0153	-0.0315	-0.9954	-0.0611
speechiness	0.0	-0.0001	0.0004	-0.0020	0.0000	-0.0024	0.0272	-0.0182
tempo	-0.0	-0.9999	-0.0051	0.0145	0.0041	0.0013	0.0001	-0.0002
time_signature	0.0	0.0001	-0.0006	-0.0120	-0.0038	0.0157	0.0472	-0.9747
valence	-0.0	-0.0004	-0.0022	-0.0141	-0.0018	-0.0427	0.0190	-0.1177
acousticness	-0.0	0.0009	0.0000	0.0343	0.0091	-0.0320	-0.0476	0.1296
principal_artist_followers	1.0	-0.0000	-0.0000	0.0000	0.0000	-0.0000	-0.0000	0.0000

5.3 Multiple Regression

```
                            OLS Regression Results
==============================================================================
Dep. Variable:             popularity   R-squared:                       0.181
Model:                            OLS   Adj. R-squared:                  0.180
Method:                 Least Squares   F-statistic:                     356.7
Date:                Tue, 28 Nov 2023   Prob (F-statistic):               0.00
Time:                        22:59:43   Log-Likelihood:                -40164.
No. Observations:               11311   AIC:                         8.034e+04
Df Residuals:                   11303   BIC:                         8.040e+04
Df Model:                           7
Covariance Type:            nonrobust
================================================================================================
                                   coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------------------
const                           81.7882      1.060     77.129      0.000      79.710      83.867
duration_min                    -1.6504      0.080    -20.641      0.000      -1.807      -1.494
principal_artist_followers  1.603e-07   4.38e-09     36.625      0.000    1.52e-07    1.69e-07
loudness                        0.4581      0.022     21.183      0.000       0.416       0.501
tempo                          -0.0057      0.003     -2.137      0.033      -0.011      -0.000
key                            -0.0371      0.023     -1.643      0.100      -0.081       0.007
mode                           -1.5015      0.172     -8.739      0.000      -1.838      -1.165
time_signature                 -0.9402      0.229     -4.099      0.000      -1.390      -0.491
==============================================================================
Omnibus:                       83.732   Durbin-Watson:                   0.803
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               67.399
Skew:                           0.115   Prob(JB):                     2.31e-15
Kurtosis:                       2.700   Cond. No.                     2.83e+08
==============================================================================
```

The multiple regression analysis explores diverse song characteristics to discern factors impacting popularity. The adjusted R-squared value indicates a model fit of only 18%, meaning there is a lack of fit for the regression model. Despite this, examining the regression model coefficients reveals notable findings. Particularly, the negative coefficient for song duration suggests a significant inverse relationship with popularity, supported by statistical evidence rejecting the null hypothesis.

Our observations reveal a positive correlation between louder music and higher popularity, supported by statistically significant evidence that rejects the null hypothesis that there is no relationship between duration and popularity. Additionally, we find a positive correlation between the number of principal artist followers and popularity. This implies that a larger following may contribute to a higher popularity score, substantiated by a statistically significant p-value. These insights further illuminate the dynamics of factors influencing the popularity of songs in our analysis, highlighting the importance of both volume levels and artist followership.

However, it's noteworthy that other variables in this model exhibit negative relationships with popularity. Particularly, we fail to reject the null hypothesis for 'key' as the p-value exceeds the 0.05 alpha level, meaning there is no statistical evidence proving that a song’s key has an impact on its popularity. These nuanced findings provide valuable information about the intricate interplay of song characteristics and their impact on popularity scores in our analysis.

5.4 Prediction for Future Song Duration

P-value of the F-statistic: 0.0000000000000000000

OLS Regression Results

Dep. Variable:	duration_min	R-squared:	0.071
Model:	OLS	Adj. R-squared:	0.071
Method:	Least Squares	F-statistic:	864.3
Date:	Mon, 20 Nov 2023	Prob (F-statistic):	3.93e-183
Time:	21:01:58	Log-Likelihood:	-14556.
No. Observations:	11308	AIC:	2.912e+04
Df Residuals:	11306	BIC:	2.913e+04
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	47.8508	1.499	31.912	0.000	44.912	50.790
year	-0.0220	0.001	-29.399	0.000	-0.023	-0.021

Omnibus:	168.657	Durbin-Watson:	1.955
Prob(Omnibus):	0.000	Jarque-Bera (JB):	256.582
Skew:	0.159	Prob(JB):	1.92e-56
Kurtosis:	3.665	Cond. No.	3.65e+05

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 3.65e+05. This might indicate that there are strong multicollinearity or other numerical problems.

Table # depicts a subtle negative relationship between the year and duration, suggesting a trend toward shorter songs. However, the R-squared value indicates that we cannot definitively establish a statistically significant relationship between these two variables. With this simple regression equation ($y = 47.85 - 0.022x$), we can then predict and calculate the expected value for the duration in the upcoming decades, where in 2040 the average song duration might drop below three minutes (2.97 minutes).

VI. Discussion

Though the R-squared is quite low, the coefficient of duration corroborates research suggesting that shorter songs tend to be more popular. Streaming Algorithms might favor shorter tracks due to their potential for increased play counts, which can influence royalty calculations and playlist inclusions. Consumer behavior, such as a reduced attention span, may also influence the desire for quick, consumable content in today's fast-paced digital environment**.**

6.2 Limitations

The R-squared value from the regression analysis is low, suggesting that song duration alone does not provide a strong predictor of popularity. External factors influencing popularity, such as marketing efforts, social media influence, and the popularity of the artist were not included as variables in the model, which influenced the limitations of our model.

6.3 Interesting Findings

Our predictive analysis reveals regression models with a weak fit, indicating that those models do not have a statistically significant relationship between the popularity and duration of songs and other variables. This suggests that the duration may not have a substantial impact on a song's overall popularity. However, our descriptive analysis uncovers an intriguing trend: the average song duration has been steadily decreasing from 1986 to 2023, with a particularly rapid decline in the past two decades. In 2023, it reached a record low compared to the preceding two decades. In summary, while the length of a song may not play a crucial role in determining its popularity, it is noteworthy to observe a consistent and notable decline in the average song duration over the past few decades.

The decline in song duration may be influenced by the popularity of short-form content on platforms like TikTok, where viral videos have an average duration of only 19.5 seconds. This trend suggests a shift in people's attention spans, potentially contributing to the preference for shorter song durations (OWSINSKI, 2022).

6.4 Conclusion

Our analysis suggests that while quantitative models may not capture a strong relationship between duration and popularity, the decreasing trend in song durations may be influenced by qualitative factors. We encourage industry professionals to further explore and consider alternative variables to provide a more comprehensive understanding of the evolving dynamic within the music industry and audience preferences to boost music streams and revenue.

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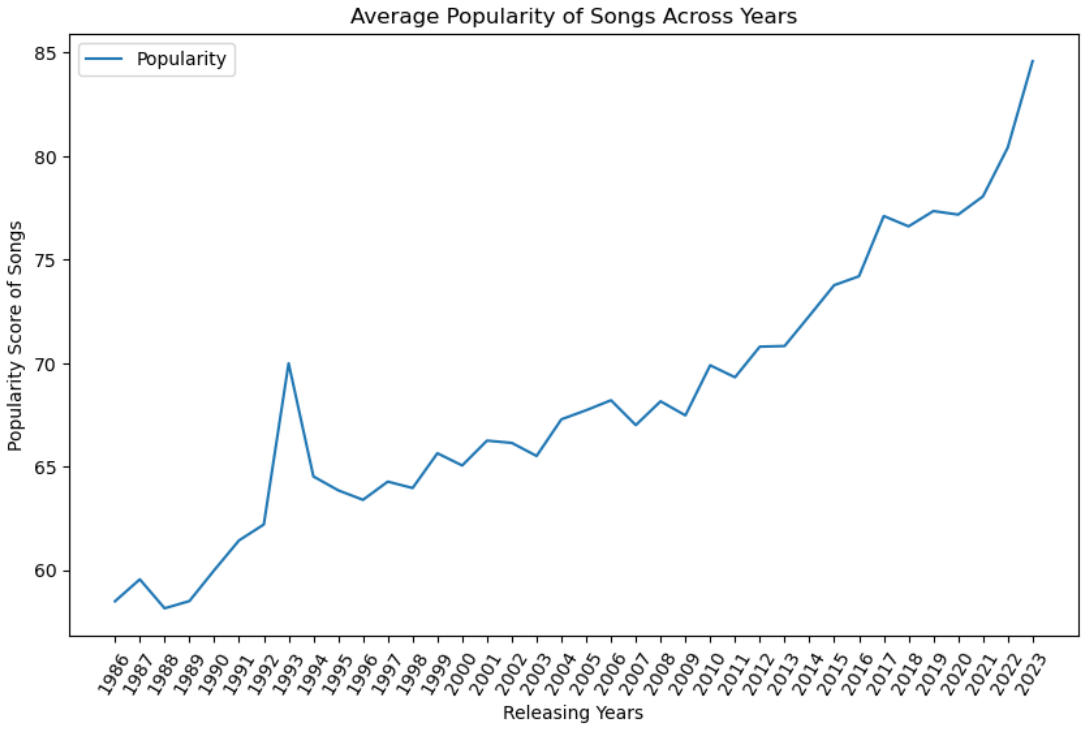
Appendix

Year	Ave of duration_min	Ave of popularity
1986	4.25	58.49
1987	4.19	59.55
1988	4.40	58.15
1989	3.96	58.50
1990	4.13	59.99
1991	4.06	61.43
1992	3.98	62.20
1993	4.03	69.99
1994	4.10	64.52
1995	4.01	63.85
1996	4.12	63.39
1997	4.04	64.27
1998	4.05	63.96
1999	3.76	65.64
2000	3.92	65.05
2001	3.84	66.25
2002	3.91	66.14
2003	3.78	65.51
2004	3.80	67.28
2005	3.79	67.72
2006	3.81	68.20
2007	3.85	67.00
2008	3.89	68.15
2009	3.76	67.47
2010	3.86	69.89
2011	3.90	69.31
2012	3.91	70.79
2013	3.80	70.82
2014	3.74	72.28
2015	3.67	73.76
2016	4.22	74.19
2017	3.43	77.10
2018	3.30	76.60
2019	3.28	77.34
2020	3.24	77.17
2021	3.26	78.05
2022	3.19	80.41
2023	3.27	84.58
Grand Total	**3.84**	**68.00**



Average Song Popularity Across the Years

By examining the annual averages of song popularity, this chart reveals an increasing trend in song duration from 1986 to 2023, with some turbulence and a peak in 1993. This suggests that sportify's own criteria for popularity is credible, not that a song released more recently has a higher popularity.