Seasonal Shifts in Music Trends: Exploring the Cultural and Emotional Impact of Christmas on Music Discovery and Lyrics

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***Abstract*—With the rise of music streaming platforms like Spotify, it has been made easier to gather data on music listening patterns of billions of different users worldwide. Despite this pre-existing data, little attention has been given to how cultural or religious factors such as the Christmas season influence music listening behaviour. Here, we address this gap by looking at the differences in music consumption patterns between countries that celebrate Christmas and those that do not. Specifically, we compare Estonia, a Christmas-celebrating country, to Saudi Arabia, a non-Christmas-celebrating country. We categorize songs as Christmas related or non-Christmas related using AI-driven classification. Analyzing the percentage of Christmas songs over time, we observe that both Estonia and Saudi Arabia result in an increase in Christmas music during the Christmas period. In addition, by analyzing our data through RDiT we see a decrease in music streaming during the Christmas season. Moreover, by calculating thresholds for Spotify audio features, we reveal that valence and energy increase during the Christmas season, as expected. These audio features however, do not play a significant role in identifying that Christmas has an effect on Christmas-celebrating countries relative to non-Christmas-celebrating countries. Sentiment Analysis was performed by ChatGPT on the song lyrics to identify whether a song was joyful, sad or neutral. We find that there is an increase in joyful songs in Estonia during the Christmas season, and a decrease in sad songs during the Christmas season.**

***Index Terms*—Christmas, Joy, Sadness, Christmassy**

I. Introduction

Music has long been a window into societal behaviors and preferences, offering insights into the ways individuals and cultures celebrate, reflect, and adapt to various times of the year. Among these, the holiday season—particularly Christmas—stands out as a time when music takes on a central role in shaping and reflecting the festive atmosphere. This paper explores how Christmas influences musical tastes, focusing on shifts in song preferences during this period.

Christmas was chosen as the focal event for this study due to its widespread cultural and commercial significance. As one of the most celebrated holidays worldwide, Christmas provides a well-defined time frame where distinct musical trends—marked by recurring themes of joy, nostalgia, and festivity—can be observed. Moreover, the season's impact on music consumption is particularly noteworthy, with Christmas songs frequently dominating streaming charts, radio playlists, and public spaces. The comparison between Christmas-celebrating and non-Christmas-celebrating countries further allows us to isolate the effects of the holiday itself from broader, non-seasonal musical trends, providing a unique lens to understand how collective experiences influence musical preferences.

To frame this exploration, we propose two hypotheses:
H1: Estonia will exhibit significant seasonal shifts in musical preferences during the Christmas period, characterized by a higher proportion of joyful songs.
H2: KSA will show more stable trends in musical preferences, with no significant seasonal variation. These hypotheses underscore the expectation that cultural and religious contexts influence the way music consumption patterns respond to the holiday season.

Our research investigates whether Christmas alters the dynamics of music consumption by analyzing song similarities and emotional tones across a Christmas-celebrating and a non-Christmas-celebrating country. By examining both lyrical content and audio features, we aim to uncover patterns of joy and sadness that differentiate Christmas music from non-Christmas music. Through this comparative analysis, we seek to answer the overarching question: how do seasonal festivities affect collective musical preferences?

The study is divided into four key tasks, each contributing to a broader understanding of musical trends during Christmas. First, we identify the countries for comparison and categorize songs into "Christmassy" and "Non-Christmassy" to visualize their prevalence over time. For this study, "Christmassy" songs are defined as those explicitly associated with the holiday season, featuring themes or keywords such as "Christmas," "Santa," or "holiday," along with festive audio characteristics like bells or upbeat orchestration. In contrast, "Non-

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Christmassy" songs lack explicit ties to Christmas, representing the broader pool of music consumed year-round. Next, we evaluate the emotional content of songs, using both lyrics and audio features, to measure joy and sadness across the holiday season. By analyzing these dimensions, we aim to provide a comprehensive view of the cultural and emotional shifts reflected in musical preferences during Christmas.

This research contributes to the understanding of seasonal music consumption and its broader cultural implications, shedding light on how shared experiences like Christmas shape collective emotional expression and musical tastes. In doing so, we hope to validate the proposed hypotheses and deepen insights into the interplay between culture, emotion, and musical trends.

II. Literature Review

Understanding how cultural and seasonal factors influence music preferences is an essential aspect of studying collective emotional expression through music. Previous research has shed light on these dynamics by exploring the impact of events, seasons, and lyrical content on music consumption. This section reviews key studies relevant to our work, which collectively inform the methodological and conceptual foundation of this paper.

The first study, "Global Music Discoveries Reveal Cultural Shifts During the War in Ukraine," highlights how societal disruptions, such as the Russian invasion of Ukraine, reshape cultural preferences in music consumption [2]. By analyzing a vast dataset of 12.8 million music discoveries across 1,423 cities in 53 countries, the authors uncover significant changes in music preferences. In Ukraine, there was a marked increase in the discovery of patriotic and locally produced music, reflecting heightened nationalism and collective identity reinforcement. Conversely, Russia saw a decline in local music discoveries, potentially indicating public disengagement or dissatisfaction with the conflict. Belarus displayed a more complex pattern, showing reduced engagement with Russian music and an unexpected increase in Ukrainian music, hinting at subtle resistance within the population. This research is particularly relevant to our study as it demonstrates the profound impact of specific events on collective musical preferences, providing a framework for examining the influence of Christmas—a globally significant holiday—on music consumption.

The second study, "Global Music Streaming Data Reveal Diurnal and Seasonal Patterns of Affective Preference," provides a comprehensive analysis of how music consumption reflects emotional rhythms across daily and seasonal cycles [1]. By leveraging a dataset of 765 million Spotify streams from nearly 1 million users across 51 countries, the study uncovers universal diurnal patterns in music preferences, such as a preference for high-intensity music during the day and low-intensity, relaxing music at night. Seasonal trends show that music intensity peaks around the summer solstice and declines during winter, with stronger effects observed at higher latitudes. The study also identifies demographic and cultural variations, noting that younger listeners and men favor more intense music, while older individuals and women prefer lower-intensity tracks. Cultural differences further enrich the findings, with Latin American listeners showing a preference for high-intensity music and Asian listeners favoring more relaxed tones. This study is directly relevant to our work, as it highlights how temporal contexts, including time of day and season, shape music preferences. Our research builds on this by examining the holiday season to explore its specific impact on music preferences and emotional tones.

The fourth and fifth studies, "Music We Move To: Spotify Audio Features and Reasons for Listening" and "MusicMood: Predicting the Mood of Music from Song Lyrics Using Machine Learning," are foundational for our research, as they focus on the two primary methodologies we adopt: analyzing audio features and examining lyrical content to measure emotionality in music.

"Music We Move To" provides insights into how audio features such as valence, tempo, energy, and danceability correlate with listeners' emotional states and motivations [3]. By utilizing Spotify's extensive dataset, the study demonstrates that high-valence, high-energy songs are strongly associated with feelings of happiness and physical activity, while lower-energy, relaxing tracks align with emotional regulation and nighttime listening. The study's robust methodology and focus on objective measures of musical attributes offer a valuable framework for our analysis of emotional tone through audio features during the Christmas season.

Similarly, "MusicMood" highlights the potential of song lyrics as an independent predictor of emotional tone, using machine learning techniques to classify songs as "happy" or "sad" [4]. By applying natural language processing (NLP) methods like TF-IDF and Naive Bayes classifiers, the study showcases the effectiveness of text-based sentiment analysis in identifying mood categories. This focus on lyrical sentiment provides a complementary perspective to audio features, underscoring the importance of semantic content in understanding music's emotional impact.

Both studies are particularly relevant to our research as we aim to measure the emotional tone of music during the Christmas season through these dual approaches. By integrating insights from audio feature analysis and lyrical sentiment classification, our study builds on the methodologies established in these works to explore the specific ways in which the holiday season influences musical preferences and emotional expression. These two complementary methods allow us to capture a holistic view of how collective experiences like Christmas shape the emotional landscape of music.

III. Methods

This study examines the effect of Christmas on music listening behaviour across different countries, specifically comparing countries that celebrate Christmas to those who do not. The primary dataset used in our research was sourced from the Spotify Weekly Top 200 Songs Streaming Data on Kaggle (Figures 31,32, and 33), which looks at the top 200 songs weekly from February 2021 to July 2022. While the

dataset consists of many fields, the primary fields of interest in our study include: track_name, artist_genre, artist_names, week, country, and the Spotify audio features such as valence, loudness, tempo, danceability, and acousticness. From the dataset, we use OpenAI's ChatGPT to identify which songs are Christmassy. This was done by providing it with the Spotify Weekly Top 200 Songs Streaming Data dataset and prompting the AI chatbot to update the dataset based on whether it believes the song is Christmassy or not by looking at the song title, the artists' names and the genres of the song. This resulted in a new boolean field, is_Christmassy, in the dataset, where TRUE represents the case where the song is Christmassy and FALSE represents the case where the song is not Christmassy according to ChatGPT. The AI-driven classification was verified for accuracy by completing a series of manual checks, making sure that for at least 20 songs, the is_Christmassy field was correct.

A. Comparing Christmas-Celebrating Countries and Non-Christmas Celebrating Countries

Next, to compare countries that celebrate Christmas to those that do not, we select two countries- one representing each group respectively. We began by researching which countries do not celebrate Christmas. According to the World Population Review [5], Afghanistan, Algeria, Bhutan, North Korea, Libya, Mauritania, Sahrawi Arab Democratic Republic, Saudi Arabia, Somalia, Tajikistan, Tunisia, Turkmenistan, Uzbekistan, and Yemen do not recognize Christmas as a public holiday. Thus, these countries were identified as non-Christmas celebrating countries. The remaining countries in the dataset were assumed to be Christmas-celebrating countries.

To determine which countries were most comparable for the analysis, we conducted a pairwise analysis, comparing the count of common songs between Christmas-celebrating countries and non-Christmas-celebrating countries. Since the dataset is very large, ChatGPT was used to calculate the count of common songs between the pairs of countries by analyzing the song titles and creating a new dataset with this information. The countries selected were Estonia, a Christmas-celebrating country and Saudi Arabia, a non-Christmas-celebrating country.

Once the countries were selected, we analyzed the Christmas song listening patterns between the two countries over the period of 2021-2022. This was done by plotting a graph of the percentage of Christmas songs listened to over each month. The percentage of Christmas songs was derived from the is_Christmassy field in the dataset (where TRUE indicates a Christmas song), and the time data came from the week field in the dataset which is presented by month and year. In this graph, the months November, December and January are identified as the Christmas period.

B. Lyrical Analysis: Joyful vs Sad Songs

Following the rationale for selecting Estonia and Saudi Arabia (KSA) for this study, we analyzed the top songs over time for both countries based on their lyrical content. This section outlines the approach used to assess the emotional tone of songs by evaluating their lyrics and assigning sentiment scores to classify songs as joyful or sad.

Analyzing lyrics provides a qualitative and interpretive lens to understand the emotional tone of songs. While audio features offer objective and quantitative insights, lyrical analysis captures the subjective and cultural expressions of emotion embedded in the text of songs. This makes lyrical analysis particularly insightful for understanding how music reflects societal mood during key events or cultural periods, such as the Christmas holidays in Estonia, a Christmas-celebrating country.

To determine the emotional tone of songs, we utilized ChatGPT to analyze the lyrics of the top 200 most popular songs by week in Estonia and Saudi Arabia. ChatGPT was tasked with extracting lyrics from the web and assigning each song a sentiment score ranging from -3 to 3, with -3 being most sad and 3 being most joyful, based on the lyrics of the song. Due to the rate limits of the OpenAI API for the free version, the dataset was refined to include only the top songs from September 2021 to March 2022 - a total of 867 songs. This period was selected to include three months before and after the Christmas holiday, providing a comprehensive view of potential seasonal variations. Sentiment scores were obtained from ChatGPT manually in batches of 30 songs at a time, ensuring high-quality and consistent scoring. Moreover, scores of randomly selected songs were manually verified to ensure soundness of ChatGPT's results.

Then, songs were classified into three categories based on their sentiment scores:

- Joyful Songs: Scores of 3 or 2.
- Sad Songs: Scores of -3 or -2.
- Moderate/Neutral Songs: Scores of -1, 0, or 1, indicating neither strong happiness nor strong sadness.

By focusing on joyful and sad songs, the analysis aimed to uncover patterns in lyrical preferences during and around the Christmas holiday. For each week, we calculated the proportion of joyful and sad songs in Estonia and KSA as:

Proportion=Number of Songs in Sentiment Category/Total Songs in Week

This normalization allowed for meaningful comparisons across weeks and countries, regardless of variations in the total number of songs in a given week. Visualizations were created to observe the trends in the proportions of joyful and sad songs over time. Weekly proportions were plotted for both Estonia and KSA, with clear markers highlighting the Christmas holiday period. These visualizations enabled a comparative analysis of lyrical sentiment trends in Estonia and KSA, highlighting potential cultural and seasonal influences on musical preferences.

C. Audio Features: Joyful Songs

Analyzing audio features in music provides a quantitative and objective lens through which emotional tones and patterns

in musical preferences can be assessed. Unlike lyrical analysis, which relies on interpretive and often subjective evaluations, audio features offer consistent, data-driven insights into the underlying characteristics of a song that contribute to its perceived mood or emotional impact. This makes audio features particularly insightful for understanding large-scale patterns in music consumption across different cultures and time periods. To determine the emotional tone of songs, we leverage specific audio features from the ones listed in our dataset. The ones we will be looking at to determine whether a song can be classified as joyful or upsetting are: valence, tempo, danceability and liveness. The rationale for each chosen audio feature and the threshold are discussed below:

- Valence
  This directly measures the musical positivity or "happiness" of a song. Higher valence values indicate songs that sound more positive (e.g., happy, cheerful, euphoric).
  - Sadness: Below 0.35 (25th percentile or lower).
  - Joy: Above 0.68 (75th percentile or higher).
- Tempo
  The tempo of a song contributes to its perceived emotional tone. Faster tempos are typically linked to higher energy and positive emotions, making it a useful feature for identifying joyful tracks.
  - Sadness: Below 98 BPM (25th percentile or lower).
  - Joy: Above 140 BPM (75th percentile or higher).
- Danceability
  This measures how suitable a track is for dancing. Songs with high danceability often evoke feelings of joy and fun.
  - Sadness: Below 0.57 (25th percentile or lower).
  - Joy: Above 0.77 (75th percentile or higher).
- Energy
  It measures the intensity and activity level of a song. Songs with higher energy are often associated with excitement and happiness, complementing valence as an indicator of joy.
  - Sadness: Below 0.53 (25th percentile or lower).
  - Joy: Above 0.76 (75th percentile or higher).
- Acousticness
  It measures the likelihood of a song being acoustic. While joyful songs tend to have lower acousticness due to their often energetic and electronic nature, higher acousticness is commonly observed in somber or reflective music.
  - Sadness: Above 0.41 (75th percentile or higher, as acousticness is often higher in sad songs).
  - Joy: Below 0.15 (50th percentile or lower).

To visualize the shifts in emotional tone for the top songs in Estonia and Saudi Arabia (KSA) over time, we plotted the weekly percentages of songs categorized as joyful or sad based on the defined thresholds for each audio feature. The graphs below provide a detailed comparative analysis for each feature, offering insights into how musical preferences differ between the two countries during the observed period.

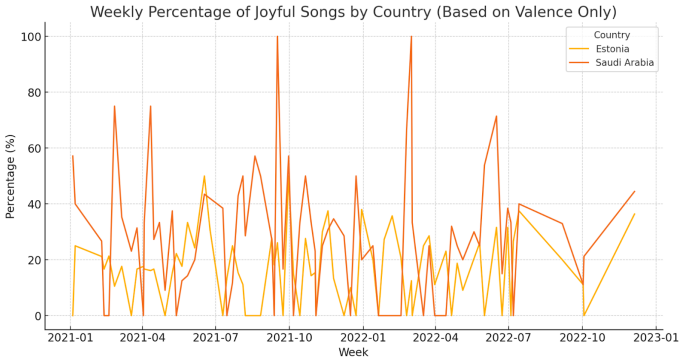

Fig. 1: Graphical representation of weekly percentage of joyful songs based on valence metric

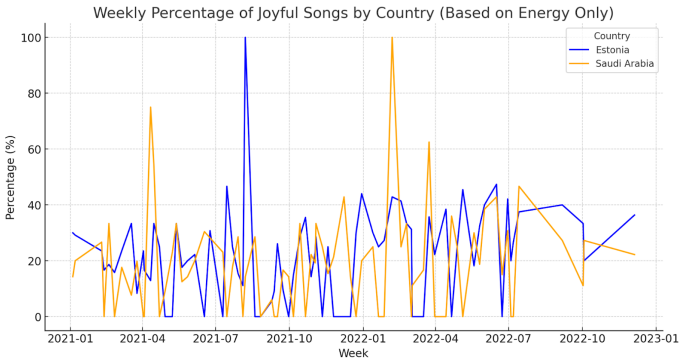

Fig. 2: Graphical representation of weekly percentage of joyful songs based on energy metric

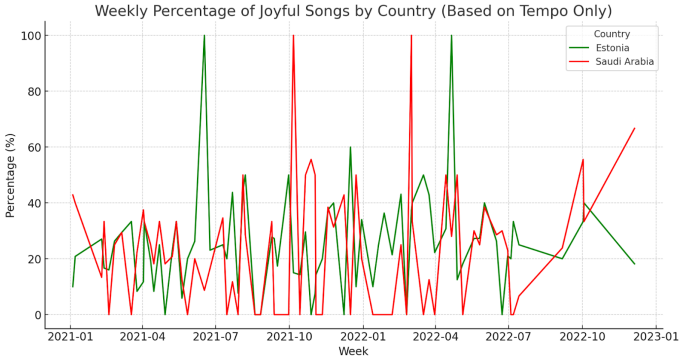

Fig. 3: Graphical representation of weekly percentage of joyful songs based on tempo metric

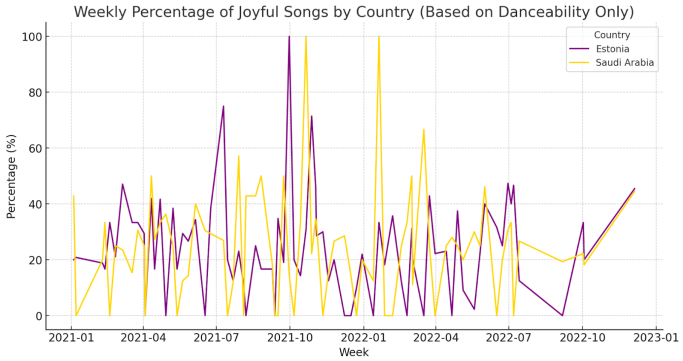

Fig. 4: Graphical representation of weekly percentage of joyful songs based on danceability metric

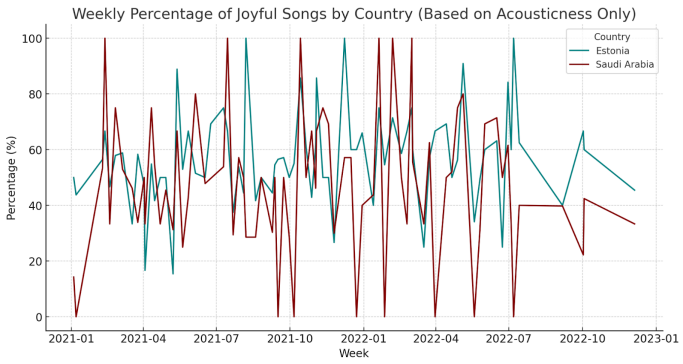

Fig. 5: Graphical representation of weekly percentage of joyful songs based on acousticness

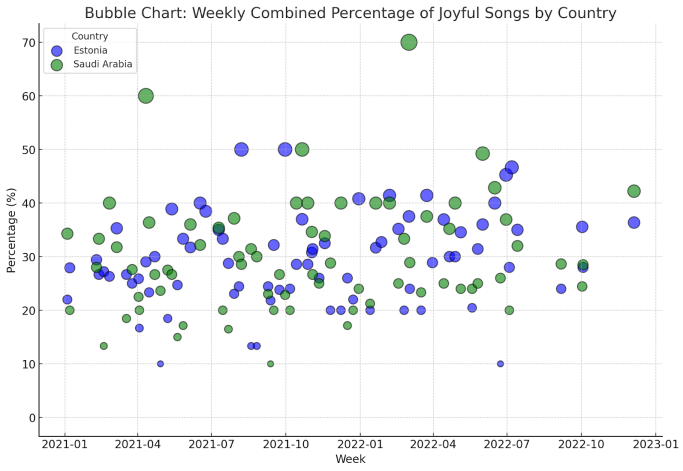

Fig. 6: Graphical representation of combined audio features distribution for both countries over time

D. Difference-in-Differences for Spotify Audio Features

To understand whether the Spotify audio features play a significant role in identifying that Christmas has an effect on Christmas-celebrating countries relative to non-Christmas celebrating countries, and to understand the effect of an audio feature on a Christmas-celebrating country relative to a non-Christmas celebrating country, we use Difference-in-Differences on the graphs of audio features of Estonia compared with Saudi Arabia. We chose a p value threshold of 0.05, where if the p value is greater than 0.05 it is assumed that it is not statistically significant. We use the equation

$$Y_{it} = \beta_0 + \beta_1 \text{Treatment}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Treatment}_i \times \text{Post}_t) + \epsilon_{it}$$

where Y_{it} is the outcome variable (valence, energy, etc.), ϵ_{it} is the error, β_0 is the average value of the audio feature in the non-Christmas celebrating countries during the pre-Christmas period (baseline for when Christmas is not in effect), β_2 is the change in the audio feature during the Christmas season in non-Christmas celebrating countries, and β_3 is the DiD estimator (the effect of the Christmas season on the audio feature in treatment countries relative to non-Christmas celebrating countries).

E. Audio Features: Sad Songs

The analysis for sadness was conducted in an identical fashion as joyfulness.To compute the weekly percentage of sad songs, the total number of songs meeting the sadness criteria for a given feature was divided by the total number of songs in the weekly dataset. This calculation was performed for each feature independently, generating time series data for valence, energy, tempo, danceability, and acousticness.

In addition to feature-specific classifications, a composite sadness measure was derived by aggregating results across all features. This measure provides a holistic view of sadness trends by accounting for the combined influence of multiple audio characteristics.

The resulting data were visualized through line graphs for each feature and the composite measure. Each graph includes separate lines for the two countries analyzed, capturing weekly trends in the percentage of sad songs and enabling a comparative analysis of emotional expression in music across cultural and seasonal contexts.

F. Effect of Holiday Period on Song Streams

We conducted a Regression Discontinuity in Time (RDiT) analysis to isolate the causal impact of the holiday period on weekly song streams. We standardized the weekly timestamps in our dataset to `datetime` format and defined the holiday period from Thanksgiving (November 25, 2021) to January 31, 2022, encompassing a 30-day post-holiday window. We measured the `time_from_thanksgiving` variable as the number of days from Thanksgiving and used a binary `holiday_period` variable to identify weeks within the holiday period.

Using the RDiT model, we evaluated the formula:

$$\begin{aligned}\text{streams} \sim\ & \text{time\_from\_thanksgiving} + \text{holiday\_period} \\ & + \text{time\_from\_thanksgiving} : \text{holiday\_period}\end{aligned}$$

This model assessed both the direct effect of the holiday period and its interaction with time on song streams. To identify trends during the holiday period, we calculated average

streams for each song and genre during holiday and non-holiday periods. We computed stream hikes as the difference between holiday and non-holiday averages, highlighting significant increases. Finally, we visualized the top 10 songs and genres with the highest stream hikes using bar plots.

IV. Results

A. Comparing Christmas-Celebrating Countries and Non-Christmas Celebrating Countries

Throughout our study, we focus our results on two countries obtained by looking at the highest count of common songs between a Christmas-celebrating country and a non-Christmas celebrating country. From the dataset acquired from the pairwise analysis of all Christmas-celebrating countries and non-Christmas-celebrating countries (Figure 7), we identified that Estonia, a Christmas-celebrating country, and Saudi Arabia, a non-Christmas-celebrating country, are the two countries with the highest number of non-Christmas songs in common with a total of 485 songs in common.

Graphing the percentage of Christmas songs over time for Estonia and Saudi Arabia (Figure 8), it is evident that the number of Christmas songs increases during the Christmas period, increasing in November, reaching a peak in December, and decreasing in January. This reveals that both countries increase their Christmas music consumption during the Christmas period. Yet, during the Christmas season, Estonia reaches a higher peak than Saudi Arabia, reflecting the absence of widespread Christmas celebrations in Saudi Arabia in comparison to Estonia. While the peak for Saudi Arabia is lower than Estonia's, the spike highlights the exposure of Saudi Arabia to Christmas music. Comparing the months in the Christmas season to other months, it is evident that on average, the percentage of Christmas songs listened to in non-Christmas months is low.

B. Lyrical Analysis: Joyful vs Sad Songs

This section presents the findings of our analysis of joyful and sad songs in Estonia and Saudi Arabia (KSA) from September 2021 to March 2022, focusing on the observed trends in lyrical sentiment and the potential impact of the Christmas holiday.

Lyrical Analysis of Joyful Songs

Estonia: The prevalence of joyful songs exhibits notable temporal fluctuations, with a distinct peak observed during the Christmas season, specifically between December 23rd and December 30th, as depicted in Figure 9. This period is characterized by a significant rise in the proportion of joyful songs, reflecting the influence of cultural and festive celebrations in this predominantly Christmas-observing country. During the holiday period, joyful songs account for over 25% of the total, signifying a marked cultural preference for cheerful music in proximity to Christmas. Following the holiday season, the proportion of joyful songs gradually diminishes, returning to pre-holiday levels by February. This pattern underscores

Country Pairs	common_non_christmas_songs
('Estonia', 'Saudi Arabia')	485
('Canada', 'Saudi Arabia')	484
('Bulgaria', 'Saudi Arabia')	482
('Lithuania', 'Saudi Arabia')	470
('United States', 'Saudi Ara	465
('Latvia', 'Saudi Arabia')	464
('Romania', 'Saudi Arabia')	462
('Korea', 'Saudi Arabia')	460
('Cyprus', 'Saudi Arabia')	455
('South Africa', 'Saudi Arat	441
('Singapore', 'Saudi Arabia	440
('Luxembourg', 'Saudi Arat	435
('Australia', 'Saudi Arabia')	431
('Norway', 'Saudi Arabia')	412
('Slovakia', 'Saudi Arabia')	411
('Ireland', 'Saudi Arabia')	410
('Malaysia', 'Saudi Arabia')	410
('New Zealand', 'Saudi Ara	410
('Hungary', 'Saudi Arabia')	404
('Portugal', 'Saudi Arabia')	404
('United Kingdom', 'Saudi A	404
('Switzerland', 'Saudi Arabi	401
('Austria', 'Saudi Arabia')	393
('Finland', 'Saudi Arabia')	390
('Iceland', 'Saudi Arabia')	389
('Belgium', 'Saudi Arabia')	387
('Denmark', 'Saudi Arabia')	386
('Germany', 'Saudi Arabia')	378
('Netherlands', 'Saudi Arab	366
('Egypt', 'Saudi Arabia')	364
('Greece', 'Saudi Arabia')	354
('Sweden', 'Saudi Arabia')	354
('Israel', 'Saudi Arabia')	345
('Hong Kong', 'Saudi Arabi	342
('Morocco', 'Saudi Arabia')	332
('Czech Republic', 'Saudi A	312
('Philippines', 'Saudi Arabi	305
('Taiwan', 'Saudi Arabia')	283
('Vietnam', 'Saudi Arabia')	283
('Panama', 'Saudi Arabia')	265
('France', 'Saudi Arabia')	263
('Thailand', 'Saudi Arabia')	262
('Costa Rica', 'Saudi Arabi	242
('Poland', 'Saudi Arabia')	238
('Dominican Republic', 'Sa	237
('Ukraine', 'Saudi Arabia')	235
('Italy', 'Saudi Arabia')	229
('Indonesia', 'Saudi Arabia'	228
('India', 'Saudi Arabia')	212
('Honduras', 'Saudi Arabia'	211
('Brazil', 'Saudi Arabia')	183
('Spain', 'Saudi Arabia')	182
('Bolivia', 'Saudi Arabia')	177
('Colombia', 'Saudi Arabia'	177
('Peru', 'Saudi Arabia')	177
('El Salvador', 'Saudi Arabi	170
('Nicaragua', 'Saudi Arabia	168
('Mexico', 'Saudi Arabia')	159
('Ecuador', 'Saudi Arabia')	158
('Chile', 'Saudi Arabia')	153
('Uruguay', 'Saudi Arabia')	152
('Argentina', 'Saudi Arabia'	150
('Japan', 'Saudi Arabia')	148
('Guatemala', 'Saudi Arabi	134
('Kazakhstan', 'Saudi Arab	133
('Paraguay', 'Saudi Arabia'	116
('Pakistan', 'Saudi Arabia')	94
('Nigeria', 'Saudi Arabia')	85
('Venezuela', 'Saudi Arabia	81

Fig. 7: Dataset of Pairwise Analysis of Number of Common Non-Christmas Songs Between Countries

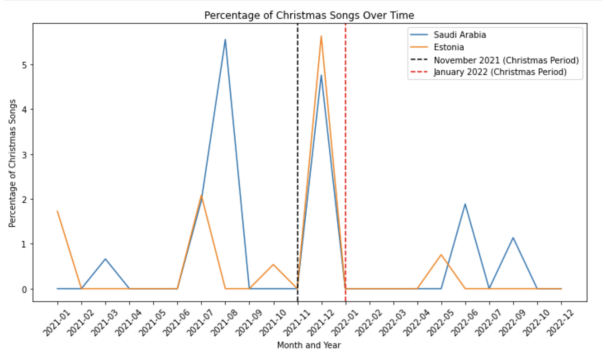

Fig. 8: Percentage of Christmas Songs for Estonia and Saudi Arabia by Month

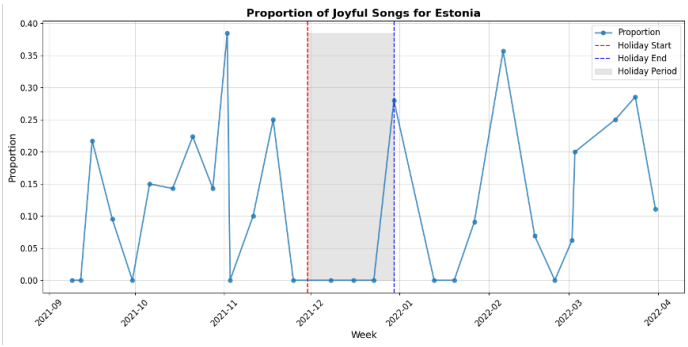

Fig. 9: Proportion of Joyful Songs in Estonia by Week (Sep 2021 - Mar 2022)

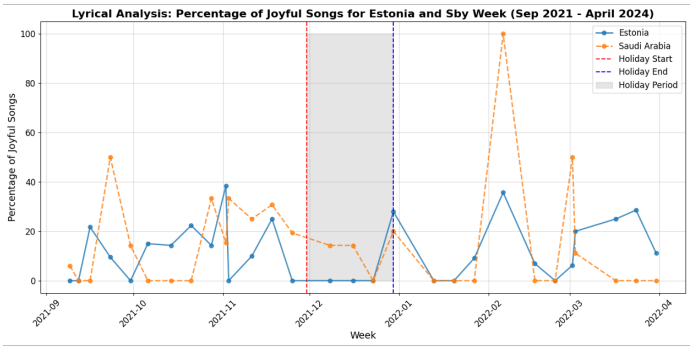

Fig. 11: Combined Proportion of Joyful Songs in Estonia and Saudi Arabia by Week (Sep 2021 - Mar 2022)

the strong association between festive traditions and musical preferences in Estonia.

Saudi Arabia: The prevalence of joyful songs displays a more variable trend, with significant peaks occurring in October and March, as depicted in Figure 10. Unlike Estonia, there is no discernible increase in joyful songs during December, which aligns with Saudi Arabia's status as a non-Christmas-celebrating country. The peak observed in March may be attributed to the influence of other cultural or national events, highlighting a distinct temporal pattern in joyful song preferences compared to Estonia.

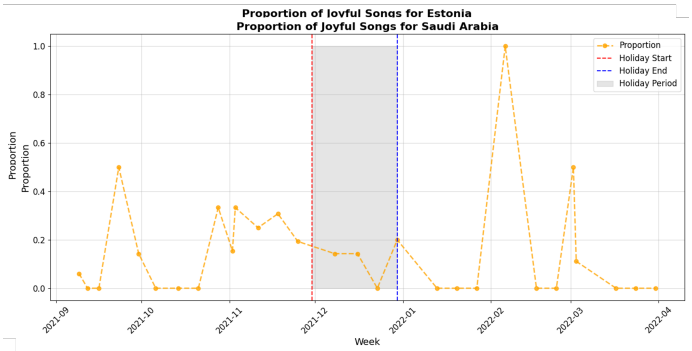

Fig. 10: Proportion of Joyful Songs in Saudi Arabia by Week (Sep 2021 - Mar 2022)

A comparative analysis of joyful song trends in Estonia and Saudi Arabia highlights distinct temporal patterns in their prevalence, as depicted in Figure 11. Estonia demonstrates a pronounced holiday-related peak during December, corresponding to Christmas celebrations, whereas Saudi Arabia exhibits relatively stable trends, with peaks occurring at other times of the year and unrelated to the Christmas period.

Lyrical Analysis of Sad Songs

Estonia: The prevalence of sad songs exhibits an inverse trend to that of joyful songs, with a notable decline during the Christmas period. An initial increase in sad songs is observed at the beginning of December, followed by a significant drop in sad music in late December, coinciding with the rise in joyful songs. This shift suggests a collective emotional transition toward happiness and celebration during the holiday season. After Christmas, the proportion of sad songs gradually increases, reaching a peak in February, potentially reflecting post-holiday sentiments or seasonal melancholy.

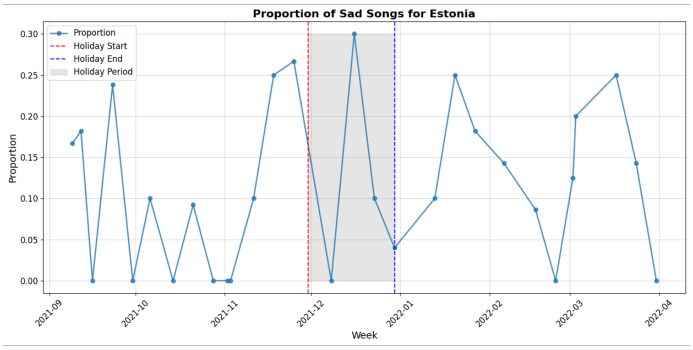

Fig. 12: Proportion of Sad Songs in Estonia by Week (Sep 2021 - Mar 2022)

Saudi Arabia: The prevalence of sad songs displays consistent fluctuations, with notable peaks in November and February, as shown in Figure 13. There is a noticeable dip in sad songs during December, reinforcing the absence of a seasonal or cultural influence comparable to Christmas. These findings suggest that lyrical sentiment in Saudi Arabia remains relatively stable, with occasional peaks likely shaped by factors unrelated to the holiday season.

The combined analysis of sad songs reveals contrasting trends between Estonia and Saudi Arabia. As shown in Figure 14, Estonia shows a sharp increase in sad songs at the beginning of December, followed by a significant decline during the Christmas period, reflecting the emotional shift associated with the holiday season. In contrast, Saudi Arabia's trends remain relatively consistent throughout December, highlighting the cultural influence of Christmas on the emotional tone of music in Estonia.

Summary

In Estonia, the Christmas period is marked by a clear increase in joyful songs and a corresponding decrease in sad songs, reflecting a cultural preference for uplifting and festive

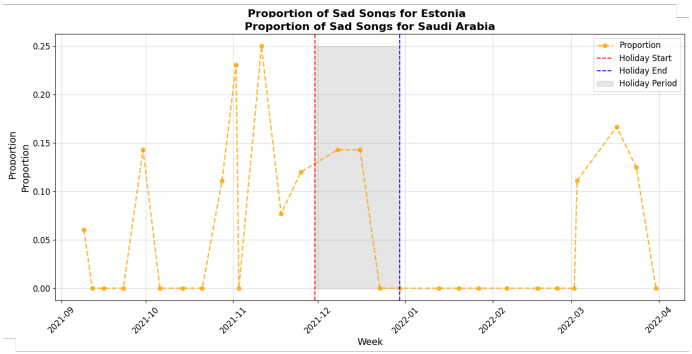

Fig. 13: Proportion of Sad Songs in Saudi Arabia by Week (Sep 2021 - Mar 2022)

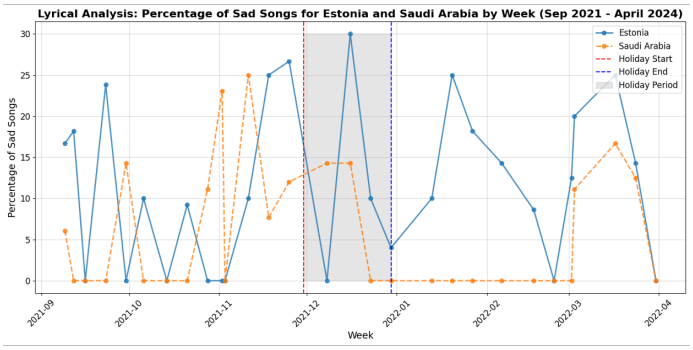

Fig. 14: Combined Proportion of Sad Songs in Estonia and Saudi Arabia by Week (Sep 2021 - Mar 2022)

music during this time. Saudi Arabia exhibits no significant changes in lyrical sentiment during December, highlighting the absence of Christmas as a cultural factor shaping music preferences.

C. Difference-in-Differences for Spotify Audio Features

To understand whether the Spotify audio features play a significant role in identifying whether Christmas has an effect on Estonia relative to Saudi Arabia, we use the Difference-in-Differences approach for each audio feature including: valence, energy, tempo, danceability, and acousticness (Figures 15,16,17,18, and 19) . Our findings show that Estonia experienced more positive changes in valence, energy, and danceability, as well as more negative changes in tempo, compared to Saudi Arabia. Additionally, acousticness showed a more positive shift for Estonia. However, none of these results were statistically significant, as all p-values exceeded the 0.05 threshold. This suggests that audio features alone cannot reliably identify a Christmas-related effect in Estonia relative to Saudi Arabia.

D. Audio Features: Sad Songs

This section presents the results of analyzing weekly percentages of "sad songs" for Estonia and Saudi Arabia. Mirroring the joyfulness analysis, it examines audio features like valence, energy, tempo, danceability, and acousticness, along with a combined measure that aggregates these attributes. The

OLS Regression Results

Dep. Variable:	valence	R-squared:	0.013
Model:	OLS	Adj. R-squared:	0.012
Method:	Least Squares	F-statistic:	10.73
Date:	Sat, 30 Nov 2024	Prob (F-statistic):	5.27e-07
Time:	09:55:36	Log-Likelihood:	143.15
No. Observations:	2422	AIC:	-278.3
Df Residuals:	2418	BIC:	-255.1
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	0.5292	0.007	71.755	0.000	0.515	0.544
Treatment	-0.0550	0.010	-5.646	0.000	-0.074	-0.036
Post	-0.0143	0.036	-0.396	0.692	-0.085	0.056
Treatment_Post	0.0325	0.041	0.787	0.431	-0.049	0.114

Omnibus:	245.036	Durbin-Watson:	1.871
Prob(Omnibus):	0.000	Jarque-Bera (JB):	71.354
Skew:	-0.003	Prob(JB):	3.20e-16
Kurtosis:	2.159	Cond. No.	13.7

Fig. 15: Difference-in-Differences for Valence

OLS Regression Results

Dep. Variable:	energy	R-squared:	0.003
Model:	OLS	Adj. R-squared:	0.002
Method:	Least Squares	F-statistic:	2.364
Date:	Tue, 03 Dec 2024	Prob (F-statistic):	0.0693
Time:	22:35:33	Log-Likelihood:	883.25
No. Observations:	2422	AIC:	-1759.
Df Residuals:	2418	BIC:	-1735.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	0.6280	0.005	115.576	0.000	0.617	0.639
Treatment	0.0112	0.007	1.555	0.120	-0.003	0.025
Post	-0.0063	0.027	-0.237	0.813	-0.058	0.046
Treatment_Post	0.0321	0.030	1.055	0.292	-0.028	0.092

Omnibus:	75.750	Durbin-Watson:	1.812
Prob(Omnibus):	0.000	Jarque-Bera (JB):	82.476
Skew:	-0.452	Prob(JB):	1.23e-18
Kurtosis:	3.011	Cond. No.	13.7

Fig. 16: Difference-in-Differences for Energy

graphs (Figures 20, 21, 22, 23, 24, and 25) collectively present a detailed analysis of how individual and combined audio features influence the weekly percentage of sad songs, offering insights into cultural and seasonal trends.

During the Christmas period, approximately from mid-December to early January, Estonia exhibits a notable spike in the preference for low-valence (sad) music, as indicated by the sharp increase in the blue line on the chart. This suggests

OLS Regression Results

Dep. Variable:	danceability	R-squared:	0.002
Model:	OLS	Adj. R-squared:	0.000
Method:	Least Squares	F-statistic:	1.400
Date:	Tue, 03 Dec 2024	Prob (F-statistic):	0.241
Time:	22:43:23	Log-Likelihood:	1203.7
No. Observations:	2422	AIC:	-2399.
Df Residuals:	2418	BIC:	-2376.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	0.6604	0.005	138.743	0.000	0.651	0.670
Treatment	0.0106	0.006	1.678	0.093	-0.002	0.023
Post	-0.0198	0.023	-0.854	0.393	-0.065	0.026
Treatment_Post	0.0106	0.027	0.397	0.692	-0.042	0.063

Omnibus:	81.156	Durbin-Watson:	1.871
Prob(Omnibus):	0.000	Jarque-Bera (JB):	88.130
Skew:	-0.460	Prob(JB):	7.29e-20
Kurtosis:	2.838	Cond. No.	13.7

Fig. 17: Difference-in-Differences for Danceability

OLS Regression Results

Dep. Variable:	tempo	R-squared:	0.002
Model:	OLS	Adj. R-squared:	0.001
Method:	Least Squares	F-statistic:	1.587
Date:	Tue, 03 Dec 2024	Prob (F-statistic):	0.191
Time:	22:39:56	Log-Likelihood:	-11553.
No. Observations:	2422	AIC:	2.311e+04
Df Residuals:	2418	BIC:	2.314e+04
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	119.6243	0.923	129.668	0.000	117.815	121.433
Treatment	2.2005	1.219	1.804	0.071	-0.191	4.592
Post	6.7085	4.502	1.490	0.136	-2.119	15.536
Treatment_Post	-7.6640	5.170	-1.483	0.138	-17.801	2.473

Omnibus:	82.048	Durbin-Watson:	1.960
Prob(Omnibus):	0.000	Jarque-Bera (JB):	83.878
Skew:	0.428	Prob(JB):	6.11e-19
Kurtosis:	2.688	Cond. No.	13.7

Fig. 18: Difference-in-Differences for Tempo

OLS Regression Results

Dep. Variable:	acousticness	R-squared:	0.029
Model:	OLS	Adj. R-squared:	0.028
Method:	Least Squares	F-statistic:	24.07
Date:	Tue, 03 Dec 2024	Prob (F-statistic):	2.42e-15
Time:	22:50:01	Log-Likelihood:	-190.47
No. Observations:	2422	AIC:	388.9
Df Residuals:	2418	BIC:	412.1
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	0.3082	0.008	36.413	0.000	0.292	0.325
Treatment	-0.0928	0.011	-8.292	0.000	-0.115	-0.071
Post	-0.0113	0.041	-0.275	0.784	-0.092	0.070
Treatment_Post	0.0166	0.047	0.350	0.727	-0.076	0.110

Omnibus:	281.898	Durbin-Watson:	1.809
Prob(Omnibus):	0.000	Jarque-Bera (JB):	390.635
Skew:	0.983	Prob(JB):	1.50e-85
Kurtosis:	2.945	Cond. No.	13.7

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specif

Fig. 19: Difference-in-Differences for Acousticness

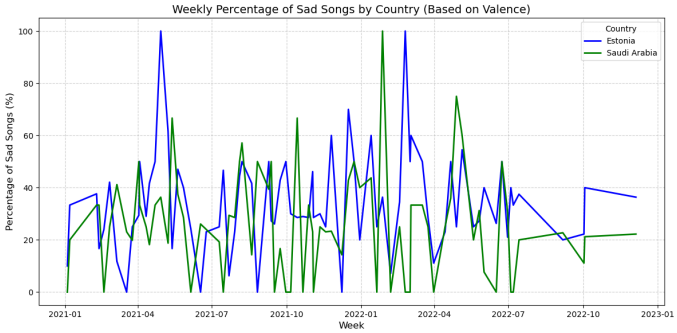

Fig. 20: Weekly percentage of Sad Songs by Country (Based on valence only).

a heightened inclination toward melancholic or introspective musical choices during the holiday season. In contrast, Saudi Arabia, while also displaying some fluctuation, shows a much lower and less consistent increase in the percentage of low-valence songs during the same timeframe. This indicates that listeners in Saudi Arabia may not associate the holiday season as strongly with sad or reflective music. The disparity between the two countries' trends during this period highlights potential cultural or emotional differences in how the holiday season is experienced and expressed musically, with Estonia showing a more pronounced shift toward sadness in musical preferences compared to the relatively stable trend observed in Saudi Arabia.

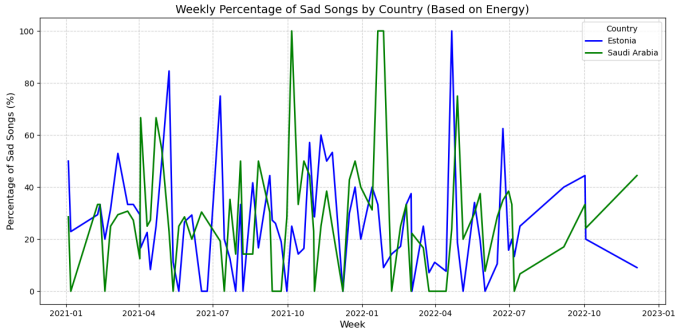

Fig. 21: Weekly percentage of Sad Songs by Country (Based on energy only).

Estonia demonstrates a sharp increase in the preference for low-energy (sad) music, as seen by the pronounced spike in the blue line during this timeframe. This trend suggests that listeners in Estonia gravitate toward more subdued and mellow music during the holiday season. In contrast, Saudi Arabia shows a smaller, less consistent increase in low-energy music preferences during the same period, indicating a weaker association with such music during the holidays. Overall, the chart highlights a more significant seasonal shift toward low-energy musical preferences in Estonia compared to Saudi Arabia, which may reflect differing cultural attitudes or emotional responses to the holiday season.

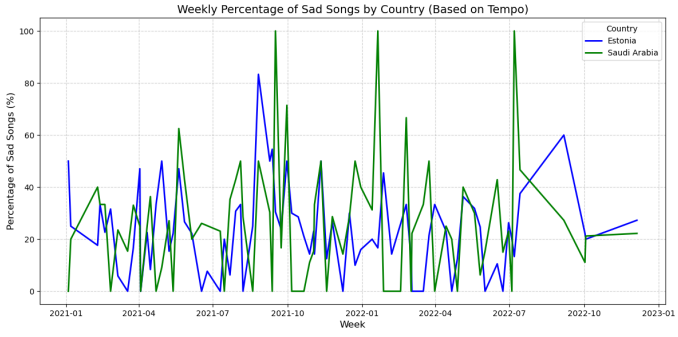

Fig. 22: Weekly percentage of Sad Songs by Country (Based on tempo only).

Estonia shows relatively moderate fluctuations in low-tempo music preferences, with no distinct or dramatic spikes during the holiday season. In contrast, Saudi Arabia displays sharper peaks in low-tempo preferences during this period, indicating a stronger seasonal shift toward slower-paced, more reflective music. This suggests that, while both countries may associate low-tempo music with the holidays to some degree, Saudi Arabia's listeners appear to lean more heavily into this trend, potentially reflecting a greater cultural or emotional alignment with slower, introspective music during the festive season.

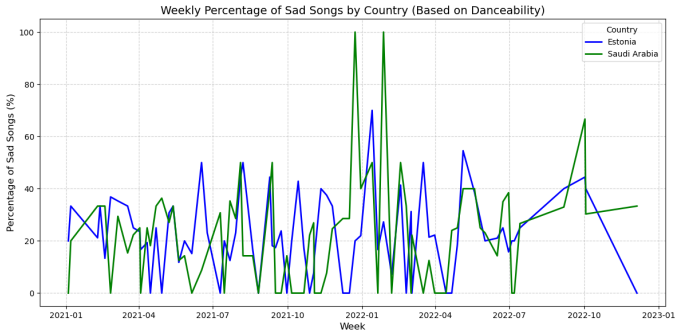

Fig. 23: Weekly percentage of Sad Songs by Country (Based on danceability only).

During the Christmas period, Saudi Arabia shows a notable increase in the preference for low-danceability (sad) songs, as evidenced by a significant spike in the green line around late December to early January. This indicates that listeners in Saudi Arabia may associate the holiday season with music that is less rhythmically engaging and more reflective or subdued. Estonia, on the other hand, shows a relatively smaller and less consistent shift in low-danceability music preferences during the same timeframe. While both countries exhibit some alignment with seasonal trends in sad, low-danceability music, the stronger and more defined peak in Saudi Arabia suggests a greater cultural or emotional resonance with such music during the festive season.

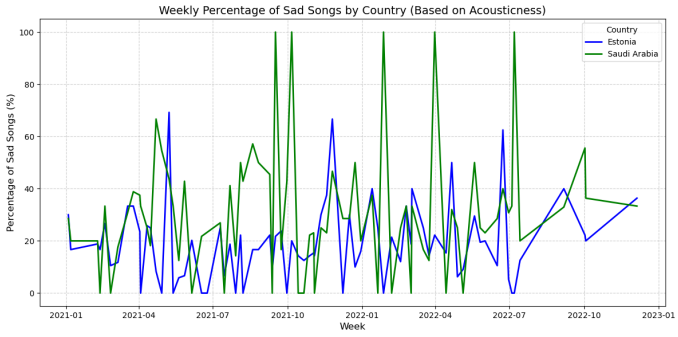

Fig. 24: Weekly percentage of Sad Songs by Country (Based on acousticness only).

Saudi Arabia exhibits sharp peaks in high-acousticness music around the holiday season, particularly noticeable toward late December and early January. This indicates a strong preference for more somber and acoustic-based songs during this time, likely reflecting a cultural or emotional tendency to engage with reflective music during the holidays. In contrast, Estonia shows more moderate and less consistent increases in high-acousticness music during the same period, suggesting a relatively weaker association between the holidays and this musical characteristic. These trends highlight that while both countries exhibit some alignment with seasonal shifts toward acoustic and sadder music, Saudi Arabia shows a more pronounced and consistent pattern, emphasizing potential cultural differences in how music is used to express or process emotions during the festive season.

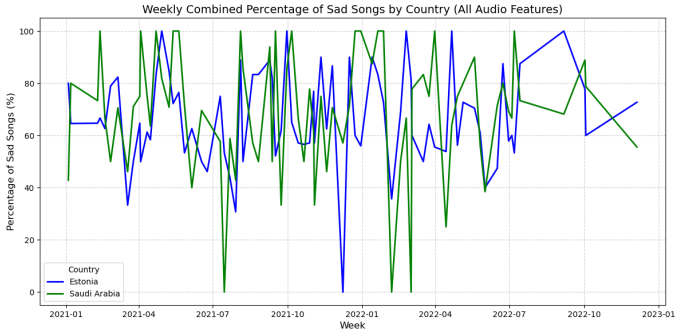

Fig. 25: Weekly combined percentage of Sad Songs by Country (All audio features).

When analyzing the combined percentage of sad songs across all audio features (valence, energy, tempo, danceability, and acousticness), both Estonia and Saudi Arabia demonstrate notable fluctuations throughout the year. During the Christmas period, however, Saudi Arabia exhibits a more pronounced increase in the combined percentage of sad songs, peaking sharply toward late December and early January. This indicates a stronger overall preference for emotionally subdued music during the holiday season.

Estonia, on the other hand, shows a more moderate and consistent pattern during the same period, with smaller and less defined peaks. While there is a general seasonal alignment toward sadder music in both countries, the larger and more consistent spikes in Saudi Arabia suggest a deeper cultural or emotional connection to these musical preferences during the holidays. This overarching trend underscores the importance of considering the combined impact of multiple audio features to fully understand seasonal shifts in music preferences between countries.

E. Effect of Holiday Period on Song Streams

The RDiT analysis revealed significant effects on song streams during the holiday period:

- Streams decreased by approximately 356,600 on average during the holiday period ($p < 0.001$).
- Interaction effects indicated nuanced temporal patterns ($\beta = -5769, p = 0.018$).

These findings suggest that listener preferences shifted significantly during the holiday season.

Several songs and genres showed marked increases in streams during the holiday period. Tracks such as *Vai Lá Em Casa Hoje* and *22 (Taylor's Version)* saw increases exceeding 1.5M streams, as shown in Figures 27 and 28.

RDiT Analysis Results with Post-Holiday Window:
OLS Regression Results

Dep. Variable:	streams	R-squared:	0.006
Model:	OLS	Adj. R-squared:	0.006
Method:	Least Squares	F-statistic:	30.13
Date:	Tue, 26 Nov 2024	Prob (F-statistic):	2.09e-19
Time:	15:54:24	Log-Likelihood:	-2.1498e+05
No. Observations:	13972	AIC:	4.300e+05
Df Residuals:	13968	BIC:	4.300e+05
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	6.052e+05	4.33e+04	13.961	0.000	5.2e+05	6.9e+05
holiday_period[T.True]	-3.566e+05	4.82e+04	-7.392	0.000	-4.51e+05	-2.62e+05
time_from_thanksgiving	7354.1550	2367.291	3.107	0.002	2713.948	1.2e+04
time_from_thanksgiving:holiday_period[T.True]	-5769.5179	2427.987	-2.376	0.018	-1.05e+04	-1010.338

Omnibus:	22711.012	Durbin-Watson:	0.281
Prob(Omnibus):	0.000	Jarque-Bera (JB):	29329631.414
Skew:	10.507	Prob(JB):	0.00
Kurtosis:	226.469	Cond. No.	302.

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Fig. 26: RDiT Analysis Results

Top Songs with Significant Stream Hikes

RDiT Analysis Results with Post-Holiday Window:
OLS Regression Results

Dep. Variable:	streams	R-squared:	0.006

Top Songs with Significant Stream Hikes During the Holiday Period:

holiday_period	False	True	stream_hike
track_name			
Vai Lá Em Casa Hoje	1.600793e+06	3.556213e+06	1.955420e+06
I Bet You Think About Me (feat. Chris Stapleton) (Taylor's Version) (From The Vault)	2.032160e+05	2.044711e+06	1.841495e+06
For Tonight	1.003500e+04	1.706576e+06	1.696541e+06
22 (Taylor's Version)	5.004373e+05	2.059677e+06	1.559240e+06
State Of Grace (Taylor's Version)	6.485216e+05	2.170547e+06	1.522026e+06
Nothing New (feat. Phoebe Bridgers) (Taylor's Version) (From The Vault)	1.959512e+05	1.503679e+06	1.307728e+06
Problemón	2.631425e+05	1.462774e+06	1.199632e+06
Fixette - Bonus	6.926000e+04	1.267064e+06	1.197804e+06
TDB	5.852900e+04	1.153143e+06	1.094614e+06
Run (feat. Ed Sheeran) (Taylor's Version) (From The Vault)	3.194150e+05	1.400853e+06	1.081438e+06

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Fig. 27: Top Songs with Significant Stream Hikes during Holiday Period

Top Genres with Significant Stream Hikes

As depicted in Figures 29 and 30, we classified stream hikes by genre to identify which genres were listened to more specifically during the holiday period. The genres *Pop RnB* and *Arrochadeira* exhibited stream hikes of 5.5M and 3.2M, respectively.

V. Discussion

This study explored the cultural and emotional impact of the Christmas season on music consumption patterns, focusing on a comparison between Estonia, a Christmas-celebrating country, and Saudi Arabia, a non-Christmas-celebrating country. By combining lyrical sentiment analysis, audio feature classification, and Regression Discontinuity in Time (RDiT) modeling, we provided a comprehensive analysis of seasonal

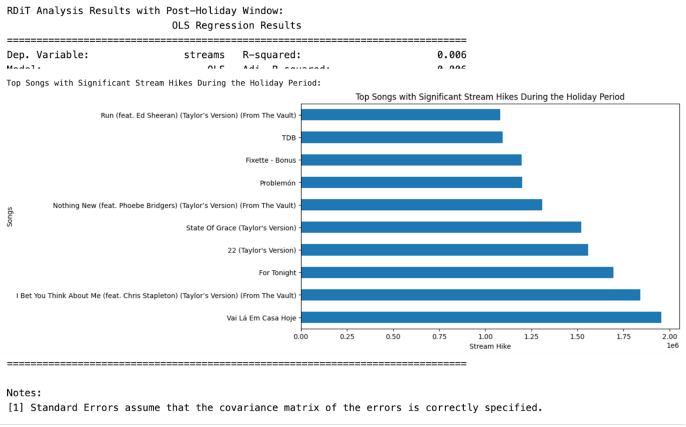

Fig. 28: Bar Plot of Top Songs with Significant Stream Hikes during Holiday Period

Top 10 Genres with Significant Stream Hikes During the Holiday Period:

holiday_period	False	True	stream_hike
artist_genre			
pop r&b	6.383724e+05	6.233288e+06	5.594916e+06
arrochadeira	2.006797e+06	5.268257e+06	3.261460e+06
indonesian r&b	3.432220e+05	3.115372e+06	2.772150e+06
florida rap	1.556200e+04	1.193857e+06	1.178295e+06
partyschlager	4.578190e+05	1.324650e+06	8.668310e+05
trap baiano	5.695200e+04	9.178070e+05	8.608550e+05
sertanejo pop	1.044871e+06	1.859118e+06	8.142474e+05
ghanaian alternative	1.259921e+05	8.535734e+05	7.275813e+05
rap mineiro	1.152390e+05	7.835150e+05	6.682760e+05
rap napoletano	3.461950e+05	9.689803e+05	6.227853e+05

Fig. 29: Top Genres with Significant Stream Hikes during Holiday Period

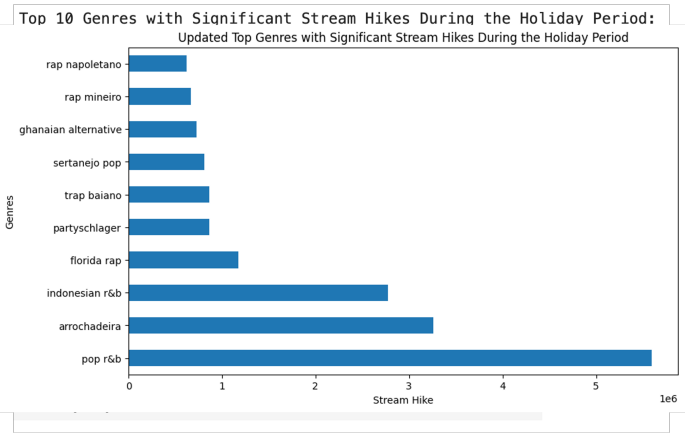

Fig. 30: Bar Plot of Top Genres with Significant Stream Hikes during Holiday Period

shifts in music trends using a Spotify dataset. Our results reveal significant differences in musical preferences between the two countries, driven by cultural and seasonal factors.

KEY FINDINGS

We used Lyrical Analysis and found that in Estonia, the Christmas season is marked by a sudden, sharp, and pronounced increase in the percentage of joyful songs right around Christmas, reflecting the festive atmosphere, and a corresponding decline in percentage of sad songs right around Christmas. This means people in Estonia listened to songs with more joyful lyrics during Christmas. In contrast, Saudi Arabia exhibited relatively stable trends in lyrical sentiment, with peaks in percentage of joyful or sad songs unrelated to December, which is likely to be due to the absence of Christmas as a cultural driver in this region. Using an Audio Features Analysis, we found that Estonia demonstrated significant seasonal shifts in audio features, with increases in valence, energy, tempo, and danceability during the holiday period, aligning with the festive and celebratory mood. Saudi Arabia, however, showed stable patterns across all features, underscoring the lack of seasonal influence on music consumption. We also explored Christmas's Causal Effect on Song Streams using RDiT Analysis. We found that overall song streams decreased during the holiday period in both countries. However, specific songs and genres, such as Pop, RB and Arrochadeira, experienced substantial stream hikes during the holiday period, indicating shifts in listener preferences toward certain tracks and styles.

These findings highlight the profound role of cultural traditions in shaping musical preferences. In Estonia, trends suggest that Christmas drives both emotional and musical shifts, reflecting collective festive sentiment. By contrast, the stable patterns observed in Saudi Arabia suggest that this non-Christmas celebrating country did not experience significant changes in local listening behaviors. The RDiT analysis further revealed that while overall streaming activity declines during the holiday season, listener engagement with specific songs and genres increases. This suggests that holiday periods may lead to a redistribution of listening behavior rather than an absolute decline in engagement.

LIMITATIONS

While this study provides valuable insights, it has several limitations. First, the dataset is sourced exclusively from Spotify, potentially excluding other platforms and offline music consumption. Second, the reliance on ChatGPT for lyrical sentiment classification, although partially verified, introduces subjectivity and potential errors. Third, the binary classification of countries as Christmas- or non-Christmas-celebrating oversimplifies cultural complexities. Lastly, the dataset is limited to data from 2021 to 2022, which may not capture long-term trends or year-to-year variations in music consumption and is not generalizable.

FUTURE DIRECTIONS

Future research could expand the dataset to include multiple streaming platforms and a broader range of countries and years, allowing for greater generalizability. Longitudinal studies spanning multiple years could provide insights into temporal shifts in holiday music trends. Additionally, incorporating demographic data and exploring playlist curation and algorithmic recommendations could offer a deeper understanding of the drivers of seasonal music preferences.

CONCLUSION

This study demonstrates the significant cultural and emotional influence of Christmas on music consumption, with distinct patterns emerging in Christmas-celebrating and non-Christmas-celebrating countries. By integrating lyrical sentiment, audio features, and streaming data, we highlight how collective traditions shape music trends and emotional expression, contributing to a broader understanding of the interplay between culture, emotion, and music.

SUPPLEMENTARY FIGURES

uri	rank	artist_names	artists_num	artist_individual	artist_id	artist_genre	artist_img	collab	track_name	release_date	album_num_trac
spotify:track:2gp		1 Paulo Londra		1 Paulo Londra	spotify:artist:3vQ	argentine hip hop	https://i.scdn.co/i		0 Plan A	23/03/2022	1
spotify:track:2x6		2 WOS		1 WOS	spotify:artist:5YC	argentine indie	https://i.scdn.co/i		0 ARRANCARMELO	06/04/2022	1
spotify:track:2SJ		3 Paulo Londra		1 Paulo Londra	spotify:artist:3vQ	argentine hip hop	https://i.scdn.co/i		0 Chance	06/04/2022	2
spotify:track:1O2		5 Cris Mj		1 Cris Mj	spotify:artist:1Yj	urbano chileno	https://i.scdn.co/i		0 Una Noche en Medellín	21/01/2022	1
spotify:track:1Tp		6 Emilia		1 Emilia	spotify:artist:04q	pop argentino	https://i.scdn.co/i		0 cuatro veinte	24/03/2022	1
spotify:track:4LR		11 Harry Styles		1 Harry Styles	spotify:artist:6KI	pop	https://i.scdn.co/i		0 As It Was	31/03/2022	1
spotify:track:3Ec		17 La K'onga		1 La K'onga	spotify:artist:3gh	cuarteto	https://i.scdn.co/i		0 Tu Mentiría	09/12/2021	14
spotify:track:42G		20 Maria Becerra		1 Maria Becerra	spotify:artist:1Dx	pop argentino	https://i.scdn.co/i		0 Felices x Siempre	22/02/2022	1
spotify:track:3Fk		23 Anitta		1 Anitta	spotify:artist:7Fh	funk pop	https://i.scdn.co/i		0 Envolver	12/04/2022	15
spotify:track:6Ua		24 LIT killah		1 LIT killah	spotify:artist:1vq	argentine hip hop	https://i.scdn.co/i		0 La Trampa es Ley	10/02/2022	1
spotify:track:7on		25 La K'onga		1 La K'onga	spotify:artist:3gh	cuarteto	https://i.scdn.co/i		0 El Mismo Aire	13/11/2020	18
spotify:track:1Ud		26 Danny Ocean		1 Danny Ocean	spotify:artist:5rI	latin	https://i.scdn.co/i		0 Fuera del mercado	17/02/2022	16
spotify:track:7JZ		27 Duki		1 Duki	spotify:artist:1bA	argentine hip hop	https://i.scdn.co/i		0 TOP 5	25/11/2021	7
spotify:track:3Gd		32 C. Tangana		1 C. Tangana	spotify:artist:5TY	urbano español	https://i.scdn.co/i		0 Demasiadas Mujeres	26/02/2021	14
spotify:track:2oR		35 Salastibbron		1 Salastibbron	spotify:artist:3WF	pop argentino	https://i.scdn.co/i		0 TITAN	14/10/2021	1
spotify:track:1Pn		37 Salastibbron		1 Salastibbron	spotify:artist:3WF	pop argentino	https://i.scdn.co/i		0 TURROMANTIKO	12/01/2022	1
spotify:track:1sjx		38 Trueno		1 Trueno	spotify:artist:2x7	argentine hip hop	https://i.scdn.co/i		0 DANCE CRIP	17/11/2021	1
spotify:track:5yE		39 Sebastian Yatra		1 Sebastian Yatra	spotify:artist:07Y	latin	https://i.scdn.co/i		0 Tacones Rojos	28/01/2022	17
spotify:track:1fK		40 Ke Personajes		1 Ke Personajes	spotify:artist:06C		0 https://i.scdn.co/i		0 Si No Te Tengo / Ángel / Aquello Que Pasó	17/08/2021	1
spotify:track:7ka		41 Tiago PZK		1 Tiago PZK	spotify:artist:5Y3	trap argentino	https://i.scdn.co/i		0 Hablando De Love	17/03/2022	1
spotify:track:2rG		49 Ryan Castro		1 Ryan Castro	spotify:artist:7jK	trap colombiano	https://i.scdn.co/i		0 Jordan	30/04/2021	1
spotify:track:2JP		58 Bad Bunny		1 Bad Bunny	spotify:artist:4q3	latin	https://i.scdn.co/i		0 Yonaguni	04/06/2021	1
spotify:track:5uH		64 WOS		1 WOS	spotify:artist:5YC	trap argentino	https://i.scdn.co/i		0 MELÓN VINO	04/10/2019	7
spotify:track:3rW		65 Rauw Alejandro		1 Rauw Alejandro	spotify:artist:1mc	trap latino	https://i.scdn.co/i		0 Todo De Ti	10/12/2021	14
spotify:track:4rSj		66 Bad Bunny		1 Bad Bunny	spotify:artist:4q3	latin	https://i.scdn.co/i		0 A Tu Merced	29/02/2020	20
spotify:track:75H		67 Nathy Peluso		1 Nathy Peluso	spotify:artist:3VI	rap latina	https://i.scdn.co/i		0 VIVIR ASÍ ES MORIR DE AMOR	10/12/2021	1
spotify:track:2Xjf		70 Daddy Yankee		1 Daddy Yankee	spotify:artist:4VA	trap latino	https://i.scdn.co/i		0 RUMBATÓN	25/03/2022	19
spotify:track:5jW		73 Paulo Londra		1 Paulo Londra	spotify:artist:3vQ	trap latino	https://i.scdn.co/i		0 Tal Vez	23/05/2019	18
spotify:track:1Hv		77 EL NOBA		1 EL NOBA	spotify:artist:5Mh	cumbia 420	https://i.scdn.co/i		0 Tarro Chelo	30/06/2021	1
spotify:track:4bF		79 Ingratax		1 Ingratax	spotify:artist:6ZY	concurso de tale	https://i.scdn.co/i		0 Perris	09/07/2021	1
spotify:track:2O9		82 WOS		1 WOS	spotify:artist:5YC	trap argentino	https://i.scdn.co/i		0 ALMA DINAMITA	21/05/2020	4
spotify:track:7hf		83 Jona Mix		1 Jona Mix	spotify:artist:7R6	cumbia 420	https://i.scdn.co/i		0 Cosas Malas - Remix	11/06/2021	1
spotify:track:2tfJ		84 Natalie Perez		1 Natalie Perez	spotify:artist:1Y9	pop argentino	https://i.scdn.co/i		0 Detox	04/11/2020	8
spotify:track:2FY		86 ROSALÍA		1 ROSALÍA	spotify:artist:7fD	r&b en español	https://i.scdn.co/i		0 SAOKO	18/03/2022	16
spotify:track:4Hz		89 Maluma		1 Maluma	spotify:artist:1rH	trap latino	https://i.scdn.co/i		0 Sobrio	09/07/2021	1

Fig. 31: Spotify Weekly Top 200 Songs Streaming Data.

artist_img	collab	track_name	release_date	album_num_trac	album_cover	source	peak_rank	previous_rank	weeks_on_chart	streams	week
https://i.scdn.co/i		0 Plan A	23/03/2022	1	https://i.scdn.co/i	WEA Latina	1	1	4	3003411	2022-04-14
https://i.scdn.co/i		0 ARRANCARMELO	06/04/2022	1	https://i.scdn.co/i	DOGUITO Reco	2	129	2	2512175	2022-04-14
https://i.scdn.co/i		0 Chance	06/04/2022	2	https://i.scdn.co/i	WEA Latina	3	59	2	2408983	2022-04-14
https://i.scdn.co/i		0 Una Noche en Medellín	21/01/2022	1	https://i.scdn.co/i	Nabru Records L	5	5	8	2080139	2022-04-14
https://i.scdn.co/i		0 cuatro veinte	24/03/2022	1	https://i.scdn.co/i	Sony Music Latir	6	9	3	1923270	2022-04-14
https://i.scdn.co/i		0 As It Was	31/03/2022	1	https://i.scdn.co/i	Columbia	6	6	2	1555631	2022-04-14
https://i.scdn.co/i		0 Te Mentiría	09/12/2021	14	https://i.scdn.co/i	Leader Music	14	16	47	1272870	2022-04-14
https://i.scdn.co/i		0 Felices x Siempre	22/02/2022	1	https://i.scdn.co/i	300 Entertainme	11	15	8	1149490	2022-04-14
https://i.scdn.co/i		0 Envolver	12/04/2022	15	https://i.scdn.co/i	Warner Records	13	17	6	1104997	2022-04-14
https://i.scdn.co/i		0 La Trampa es Ley	10/02/2022	1	https://i.scdn.co/i	WEA Latina	2	21	9	1076236	2022-04-14
https://i.scdn.co/i		0 El Mismo Aire	13/11/2020	18	https://i.scdn.co/i	Leader Music ba	16	25	70	1068521	2022-04-14
https://i.scdn.co/i		0 Fuera del mercado	17/02/2022	16	https://i.scdn.co/i	Atlantic Records	26	49	3	1029069	2022-04-14
https://i.scdn.co/i		0 TOP 5	25/11/2021	7	https://i.scdn.co/i	CALE PLAY Rec	3	23	20	1004471	2022-04-14
https://i.scdn.co/i		0 Demasiadas Mujeres	26/02/2021	14	https://i.scdn.co/i	Sony Music Entc	31	31	9	870219	2022-04-14
https://i.scdn.co/i		0 TITAN	14/10/2021	1	https://i.scdn.co/i	WM Argentina	2	29	20	838194	2022-04-14
https://i.scdn.co/i		0 TURROMANTIKO	12/01/2022	1	https://i.scdn.co/i	WM Argentina	28	33	11	819773	2022-04-14
https://i.scdn.co/i		0 DANCE CRIP	17/11/2021	1	https://i.scdn.co/i	© ℗ 2022 Sur (	3	36	21	814714	2022-04-14
https://i.scdn.co/i		0 Tacones Rojos	28/01/2022	17	https://i.scdn.co/i	UMLE - Latino	21	38	25	805602	2022-04-14
https://i.scdn.co/i		0 Si No Te Tengo / Ángel / Aquello Que Pasó	17/08/2021	1	https://i.scdn.co/i	Ke Personajes	29	37	31	803350	2022-04-14
https://i.scdn.co/i		0 Hablando De Love	17/03/2022	1	https://i.scdn.co/i	WEA Latina	29	34	4	798293	2022-04-14
https://i.scdn.co/i		0 Jordan	30/04/2021	1	https://i.scdn.co/i	King Records	49	54	8	643830	2022-04-14
https://i.scdn.co/i		0 Yonaguni	04/06/2021	1	https://i.scdn.co/i	Rimas Entertainr	3	57	45	519093	2022-04-14
https://i.scdn.co/i		0 MELÓN VINO	04/10/2019	7	https://i.scdn.co/i	DOGUITO Reco	7	111	107	461156	2022-04-14
https://i.scdn.co/i		0 Todo De Ti	10/12/2021	14	https://i.scdn.co/i	Sony Music Latir	1	68	47	442122	2022-04-14
https://i.scdn.co/i		0 A Tu Merced	29/02/2020	20	https://i.scdn.co/i	Rimas Entertainr	61	66	18	434258	2022-04-14
https://i.scdn.co/i		0 VIVIR ASÍ ES MORIR DE AMOR	10/12/2021	1	https://i.scdn.co/i	Sony Music Entc	24	52	18	428590	2022-04-14
https://i.scdn.co/i		0 RUMBATÓN	25/03/2022	19	https://i.scdn.co/i	Republic Record	56	65	3	417719	2022-04-14
https://i.scdn.co/i		0 Tal Vez	23/05/2019	18	https://i.scdn.co/i	WEA Latina	1	71	126	410708	2022-04-14
https://i.scdn.co/i		0 Tarro Chelo	30/06/2021	1	https://i.scdn.co/i	Kriterio Music	33	74	33	403333	2022-04-14
https://i.scdn.co/i		0 Perris	09/07/2021	1	https://i.scdn.co/i	Room28	13	79	38	399384	2022-04-14
https://i.scdn.co/i		0 ALMA DINAMITA	21/05/2020	4	https://i.scdn.co/i	DOGUITO Reco	28	168	21	396272	2022-04-14
https://i.scdn.co/i		0 Cosas Malas - Remix	11/06/2021	1	https://i.scdn.co/i	JonaMix	36	81	26	394305	2022-04-14
https://i.scdn.co/i		0 Detox	04/11/2020	8	https://i.scdn.co/i	Natalie Perez	66	91	31	392266	2022-04-14
https://i.scdn.co/i		0 SAOKO	18/03/2022	16	https://i.scdn.co/i	Columbia	81	86	8	384584	2022-04-14
https://i.scdn.co/i		0 Sobrio	09/07/2021	1	https://i.scdn.co/i	Sony Music Latir	22	88	40	381405	2022-04-14

Fig. 32: Spotify Weekly Top 200 Songs Streaming Data.

TABLE I: Table Type Styles

Table Head	Table Column Head		
	Table column subhead	*Subhead*	*Subhead*
copy	More table copy[a]		

[a]Sample of a Table footnote.

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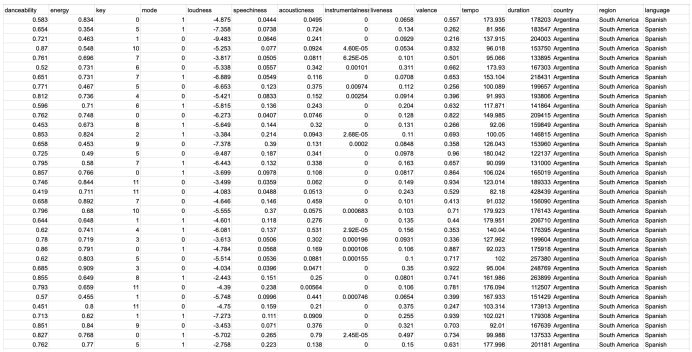

danceability	energy	key	mode	loudness	speechiness	acousticness	instrumentalness	liveness	valence	tempo	duration	country	region	language
0.583	0.834	0	1	-4.675	0.0444	0.0495	0	0.0658	0.557	173.935	178203	Argentina	South America	Spanish
0.654	0.354	5	1	-7.358	0.0738	0.724	0	0.134	0.262	81.956	183547	Argentina	South America	Spanish
0.721	0.463	1	0	-9.483	0.0646	0.241	0	0.0929	0.216	137.915	204003	Argentina	South America	Spanish
0.87	0.548	10	0	-5.253	0.077	0.0824	4.60E-05	0.0534	0.832	96.018	153700	Argentina	South America	Spanish
0.761	0.696	7	0	-3.817	0.0505	0.0811	6.25E-05	0.101	0.501	95.066	133895	Argentina	South America	Spanish
0.52	0.731	6	0	-5.338	0.0557	0.342	0.00101	0.311	0.662	173.93	167303	Argentina	South America	Spanish
0.651	0.731	7	1	-6.889	0.0549	0.116	0	0.0708	0.653	153.104	218431	Argentina	South America	Spanish
0.771	0.467	5	0	-6.653	0.123	0.375	0.00974	0.112	0.256	100.089	199657	Argentina	South America	Spanish
0.812	0.736	4	0	-5.421	0.0833	0.152	0.00254	0.0914	0.396	91.993	193808	Argentina	South America	Spanish
0.596	0.71	6	1	-5.815	0.136	0.243	0	0.204	0.632	117.871	141864	Argentina	South America	Spanish
0.762	0.748	0	0	-6.273	0.0407	0.0746	0	0.128	0.822	149.985	209415	Argentina	South America	Spanish
0.453	0.673	8	1	-5.649	0.144	0.32	0	0.131	0.266	92.06	159849	Argentina	South America	Spanish
0.853	0.824	2	1	-3.384	0.214	0.0943	2.68E-05	0.11	0.693	100.05	146815	Argentina	South America	Spanish
0.658	0.453	9	0	-7.378	0.39	0.131	0.0002	0.0848	0.358	126.043	153960	Argentina	South America	Spanish
0.725	0.49	5	0	-9.487	0.187	0.341	0	0.0978	0.96	180.042	122137	Argentina	South America	Spanish
0.795	0.58	7	1	-6.443	0.132	0.338	0	0.163	0.657	90.099	131000	Argentina	South America	Spanish
0.857	0.766	0	1	-3.699	0.0978	0.108	0	0.0817	0.864	106.024	165019	Argentina	South America	Spanish
0.746	0.844	11	0	-3.499	0.0359	0.062	0	0.149	0.934	123.014	189333	Argentina	South America	Spanish
0.419	0.711	11	0	-4.083	0.0488	0.0513	0	0.243	0.529	82.18	428439	Argentina	South America	Spanish
0.658	0.892	7	0	-4.646	0.146	0.459	0	0.101	0.413	91.032	156090	Argentina	South America	Spanish
0.796	0.68	10	0	-5.555	0.37	0.0575	0.000683	0.103	0.71	179.923	176143	Argentina	South America	Spanish
0.644	0.648	1	1	-4.601	0.118	0.276	0	0.135	0.44	179.951	206710	Argentina	South America	Spanish
0.62	0.741	4	1	-6.081	0.137	0.531	2.92E-05	0.156	0.353	140.04	176395	Argentina	South America	Spanish
0.78	0.719	3	0	-3.613	0.0506	0.302	0.000196	0.0931	0.336	127.962	199604	Argentina	South America	Spanish
0.86	0.791	0	1	-4.784	0.0568	0.169	0.000106	0.106	0.887	92.023	175918	Argentina	South America	Spanish
0.62	0.803	5	0	-5.514	0.0536	0.0881	0.000155	0.1	0.717	102	257380	Argentina	South America	Spanish
0.685	0.909	3	0	-4.034	0.0396	0.0471	0	0.35	0.922	95.004	248769	Argentina	South America	Spanish
0.855	0.649	8	1	-2.443	0.151	0.25	0	0.0801	0.741	161.986	263899	Argentina	South America	Spanish
0.793	0.659	11	0	-4.39	0.238	0.00564	0	0.106	0.781	176.094	112507	Argentina	South America	Spanish
0.57	0.455	1	0	-5.748	0.0996	0.441	0.000746	0.0654	0.399	167.933	151429	Argentina	South America	Spanish
0.451	0.8	11	0	-4.75	0.159	0.21	0	0.375	0.247	103.314	173913	Argentina	South America	Spanish
0.713	0.62	1	1	-7.273	0.111	0.0909	0	0.255	0.939	102.021	170308	Argentina	South America	Spanish
0.851	0.84	9	0	-3.453	0.071	0.376	0	0.321	0.703	92.01	167639	Argentina	South America	Spanish
0.827	0.768	0	1	-5.702	0.265	0.79	2.45E-05	0.497	0.734	99.988	137533	Argentina	South America	Spanish
0.762	0.77	5	1	-2.758	0.223	0.138	0	0.15	0.631	177.998	201181	Argentina	South America	Spanish

Fig. 33: Spotify Weekly Top 200 Songs Streaming Data.

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