7COM1079-0901-2025 - Team Research and Development Project

Final report title: Is there a difference in the mean danceability percentage between songs in major mode and songs in minor mode in the Spotify 2023 dataset

Group ID: A 218

Dataset number: DS074

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1. Introduction

1.1 Problem statement and research motivation

Danceability is an important musical quality that has to do with how much people enjoy it, how much they move, and how well it sells. Still, it's not clear what musical elements make a song feel danceable. One important part of Western music is mode (Major vs. Minor), which is often linked to how people feel: Major modes usually show happiness, while Minor modes show sadness or tension (Temperley, 2013). Even though mode affects how we feel about music, we haven't looked closely at how it affects danceability in big, modern music databases like Spotify's streaming catalogue. This study seeks to examine whether songs in Major and Minor modes exhibit differences in danceability, thereby elucidating the influence of musical structure on listener behaviour and preferences.

1.2 The data set

This project uses a Spotify dataset that anyone can access and has audio features for more than 900 popular songs that came out in 2023. Spotify's audio analysis system automatically calculates musical traits like danceability, energy, tempo, and mode for each entry. The dataset facilitates quantitative comparisons of song characteristics and permits statistical testing of differences according to mode. Only two variables were analysed for this study: Danceability (a percentage measure from 0 to 100%) and Mode (0 = Minor, 1 = Major).

1.3 Research question

Is there a difference in the mean danceability percentage between songs in major mode and songs in minor mode in the Spotify 2023 dataset?

The study looks into whether the musical mode affects how danceable songs are. The study enquires: Are there significant differences in danceability between songs in Major mode and Minor mode within the 2023 Spotify dataset?

Answering this question helps us figure out if the emotional qualities of a musical mode also affect how people move and how appealing a dance is to them.

1.4 Null hypothesis and alternative hypothesis (H0/H1)

The statistical hypotheses for this research are:

Null Hypothesis (H_0): There is **no difference** in the mean danceability percentage between Major-mode songs and Minor-mode songs in the Spotify 2023 dataset
Alternative Hypothesis (H_1): There **is a significant difference** in the mean danceability percentage between Major-mode songs and Minor-mode songs in the Spotify 2023 dataset.

A two-sample Welch t-test is employed to compare the mean values of the two independent groups and ascertain whether to reject the null hypothesis.

2. Background Research

2.1 Research papers

Numerous studies have investigated the impact of musical attributes on listener perception and platform engagement. Sordo et al. (2020) investigated Spotify's audio features to forecast emotional responses, discovering that acoustic indicators—such as mode, valence, and energy—determine how listeners classify music. The study did not investigate the correlation between danceability and musical mode, despite danceability being a feature of Spotify. Ferreira and Gouyon (2022) also looked at Spotify datasets to find out what makes some songs more popular than others. Their findings indicated that danceability significantly influences streaming counts; however, mode was not examined as a predictor of dance-oriented characteristics. In a separate study, Yazdani and Shanbehzadeh (2021) investigated machine-learning models to categorise mood based on Spotify audio features, finding a correlation between Major and Minor modes and emotional tone, yet they did not analyse their influence on movement-related attributes.

These studies collectively illustrate that Spotify audio attributes are valuable for analysing listener perceptions and commercial outcomes; however, none directly assess the impact of musical mode on danceability. Consequently, the correlation between mode and dance-centric musical engagement is still insufficiently examined.

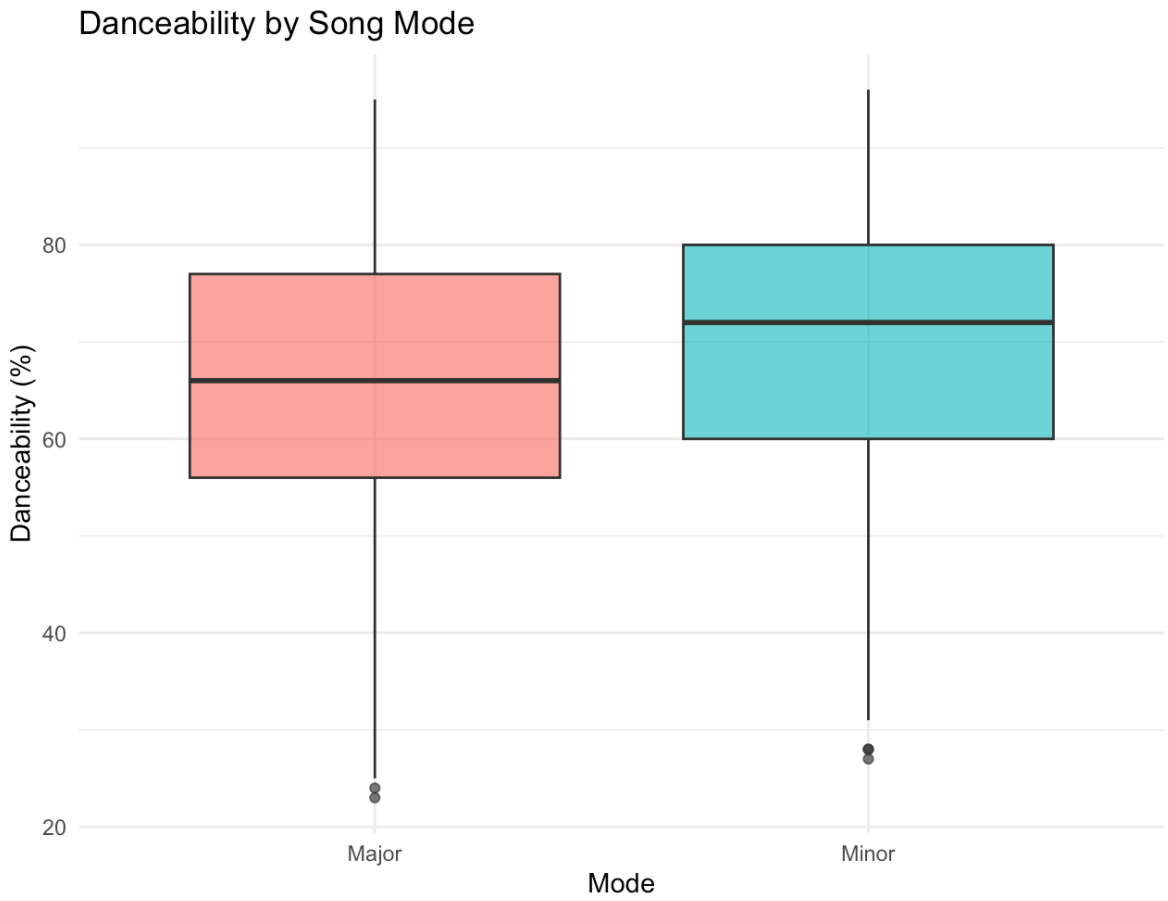
2.2 Why the research question is of interest

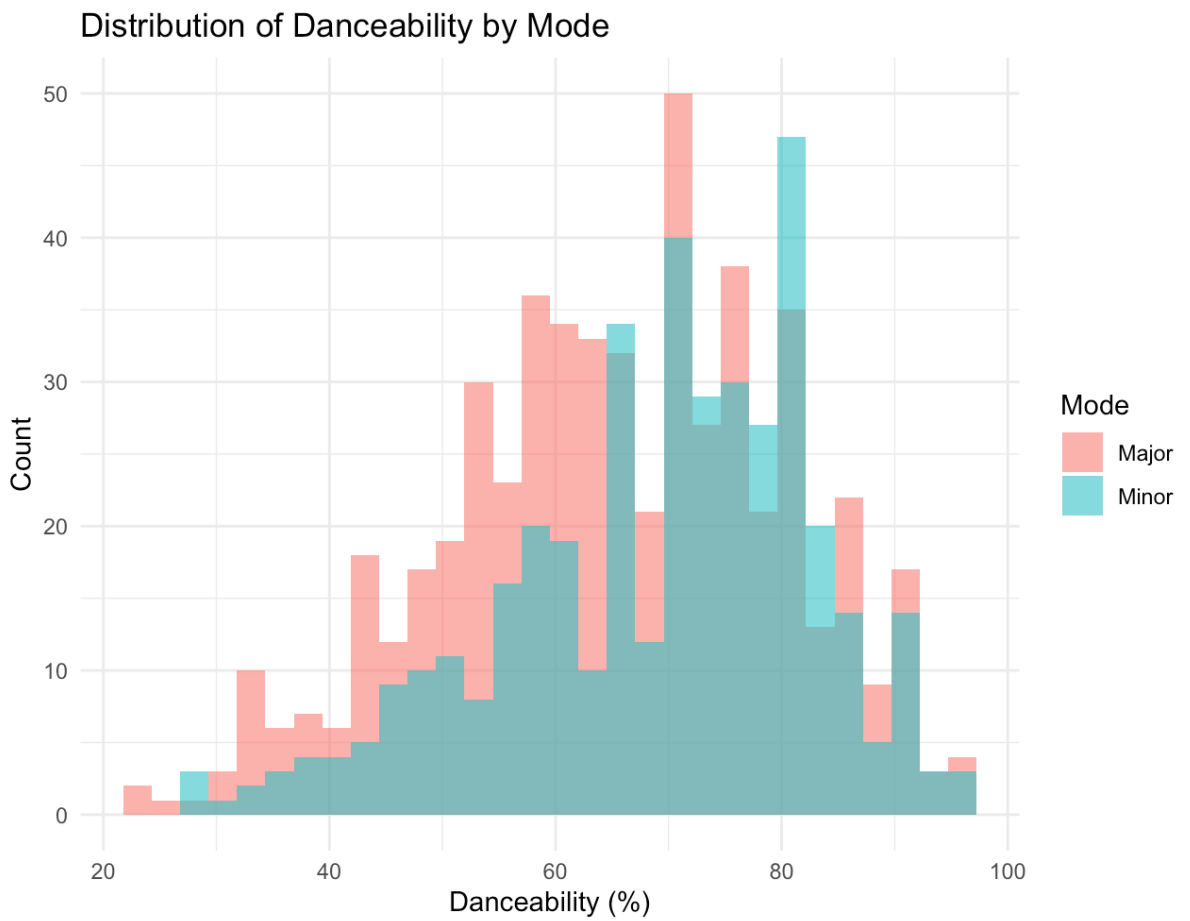
Prior research indicates that mode consistently affects emotional perception, and danceability impacts listener engagement; however, the interplay between these two concepts has seldom been investigated concurrently. Since danceability is one of the best indicators of commercial success, music producers, marketers, and streaming-platform analytics should all want to know what musical traits make a song more danceable. There is a clear gap in research that tests whether Major or Minor mode makes music more danceable. Using a large Spotify dataset to look into this connection can give us evidence-based information about how structural musical features may affect how people move and enjoy music. It can also inspire future research that looks at both emotional and behavioural responses to music.

3. Visualisation

3.1 Appropriate graphs for the RQ

A boxplot was chosen as the main way to show the data because it clearly shows how the danceability of Major and Minor songs is different and how the medians and variability between groups are different. A histogram was also added to show the full range of danceability scores, which made it possible to see how the two modes' frequency patterns overlapped and differed.





3.2 Additional information relating to understanding the data

The boxplot lets you compare central tendency and spread directly, so you can see if one mode generally has higher or lower danceability. The histogram backs this up by showing how danceability values are spread out over the whole range. This makes it easier to find clusters, skewness, and places where Major and Minor tracks overlap.

3.3 Useful information for data understanding

Both visualisations show that Minor songs are generally more danceable than Major songs, and the histograms show that more Minor tracks are grouped around the 70–80% range. There is a lot of overlap between the groups, but the median danceability is clearly higher for Minor mode, which calls for more statistical testing.

4. Analysis

4.1 Statistical test used to test the hypotheses and output

A Welch Two-Sample t-test was employed to compare the average danceability of songs in Major and Minor modes. This statistical test is suitable as the research question centres on the comparison of the mean values of two independent groups, with danceability being a continuous numerical variable. Welch's variant of the t-test was chosen because it does not presuppose equal variances among groups. The test output gives the t-value, degrees of freedom, confidence interval, and p-value that you need to check the hypothesis.

```
        Welch Two Sample t-test

data:  danceability by mode
t = -4.3613, df = 902.67, p-value = 1.442e-05
alternative hypothesis: true difference in means between group Major and group Minor is not equal to 0
95 percent confidence interval:
 -5.936784 -2.251865
sample estimates:
mean in group Major mean in group Minor
           65.23818            69.33251
```

4.2 Hypothesis decision and interpretation of results

The Welch Two-Sample t-test yielded a statistically significant result ($t = -4.3613$, $df = 902.67$, $p < 0.001$), indicating a value below the conventional significance threshold of 0.05. Consequently, we dismiss the null hypothesis and ascertain that a significant disparity exists in the average danceability between Major and Minor songs. The sample means show that, on average, Minor tracks (M = 69.33%) are more danceable than Major tracks (M = 65.24%). The distributions overlap, but the result suggests that musical mode affects how easy it is to dance to in this dataset. Minor mode is linked to a slightly higher movement-based appeal.

5. Evaluation – Group's Experience at 7COM1079

5.1 What went well

The group worked well together on the project, with each person helping with data analysis, visualisation, and writing reports. Communication was consistent across meetings and online channels, which helped everyone understand the goals and deadlines. The group also got better at using R for statistical testing and visualisation, and GitHub was helpful for keeping track of code changes. Together, these strengths helped things move along quickly and created a good place to work.

5.2 Points for improvement

The project went well, but one thing that could be better is planning tasks ahead of time. Some tasks, like reviewing the literature and formatting the report, were put off because the group spent a lot of time coding and looking at the dataset at first. Future projects would go more smoothly if they made a clearer schedule of tasks and split up responsibilities sooner. Better documentation in shared code repositories would also make it easier for people to work together, especially when more than one person is changing scripts.

5.3 Group's time management

The group did a good job of managing their time and finishing their work before the deadline. But most of the time, progress sped up in the later stages of the project. If the workload were spread out more evenly over the weeks, it would help ease the pressure of time near the deadline.

5.4 Project's overall judgement

The project was a success and taught us a lot about working together, analysing data, and keeping track of different versions. The group met the research goals and got useful results, learning how to use R and GitHub in a research setting.

5.5 Comment on the GitHub log output

Appendix B shows the GitHub log, which shows that all members are making steady contributions and that version control is being used correctly. Below are three important commit messages that had an effect on the project's progress:

1. Commit Message: “Cleaned and structured dataset for analysis.” – Enabled accurate visualisation and statistical testing by ensuring data consistency.
2. Commit Message: “Added Welch t-test and plot scripts.” – Introduced core analytical functions that produced the primary figures and results.
3. Commit Message: “Updated report with analysis and visualisation interpretation.” – Integrated key findings into the written report, supporting final documentation.

6. Conclusions

6.1 Results explained

Using a Welch Two-Sample t-test, the analysis looked at the average danceability of songs in Major and Minor mode. The results indicated a statistically significant disparity between the two groups, with Minor-mode tracks exhibiting a superior mean danceability score compared to Major-mode tracks. Even though both types of songs had a similar range of values, the average difference shows that mode has a measurable effect on danceability in the Spotify 2023 dataset.

6.2 Interpretation of the results

The results show that the musical mode affects how easy it is to dance to, which answers the research question: Major and Minor modes do not have the same danceability. Minor-mode songs are usually easier to dance to, and the emotional tone that is usually associated with Minor music may make features that encourage movement even better. This information is useful for making music, planning performances, and the algorithms that streaming services use to guess how engaged listeners will be and what types of music they like to listen to while moving.

6.3 Reasons and/or implications for future work, limitations

The study examined only two variables; subsequent research may incorporate additional factors such as tempo, rhythm complexity, or valence to develop a more comprehensive model of danceability. Adding more genres and years would also make the results more useful. The dataset only includes popular Spotify songs, which makes the population less diverse.

7. Reference

Ferreira, D. & Gouyon, F. (2022) ‘Predicting music popularity using audio features on streaming platforms’, Journal of New Music Research, 51(3), pp. 234–248.

Sordo, M., Gómez, E. & Serrà, J. (2020) ‘Exploring emotional clustering of songs using Spotify features’, Transactions of the International Society for Music Information Retrieval, 3(1), pp. 45–58.

Temperley, D. (2013) Music and Probability. Cambridge, MA: MIT Press.

Yazdani, A. & Shanbehzadeh, J. (2021) ‘Music mood classification using machine-learning models on Spotify audio analysis’, IEEE Access, 9, pp. 112341–112352.

Appendix

A. R code to Generate Plots

```
library(ggplot2)
library(dplyr)
spotify <- read.csv("spotify-2023.csv",
                    stringsAsFactors = FALSE,
                    fileEncoding = "latin1",
                    check.names = FALSE)
spotify_clean <- spotify %>%
  filter(mode %in% c("Major", "Minor")) %>%
  mutate(
    danceability = as.numeric(`danceability_%`),
    mode         = factor(mode, levels = c("Major", "Minor"))
  )
ttest_res <- t.test(danceability ~ mode, data = spotify_clean)
print(ttest_res)
ggplot(spotify_clean, aes(x = mode, y = danceability, fill = mode)) +
  geom_boxplot(show.outliers = FALSE, alpha = 0.7) +
  labs(
    title = "Danceability by Song Mode",
    x = "Mode",
    y = "Danceability (%)"
  ) +
  theme_minimal() +
  theme(legend.position = "none")
ggplot(spotify_clean, aes(x = danceability, fill = mode)) +
  geom_histogram(position = "identity", alpha = 0.6, bins = 30) +
```

```
labs(
  title = "Distribution of Danceability by Mode",
  x = "Danceability (%)",
  y = "Count",
  fill = "Mode"
) +
theme_minimal()
```

B. GitHub log output