

INTERNATIONAL INSTITUTE OF  
INFORMATION TECHNOLOGY

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H Y D E R A B A D

## **Project Report**

### **Music, Mind & Technology**

**Team - Frank and Charlie**

**Supreeth - 2020101021**

**Raj - 2020101049**

## **Project Overview:**

We started off analysing spotify data to understand various correlations between song features and its popularity. We then got interested in how the dominant key of a song affects its popularity. Later based on suggestions provided to us, we tried to identify the outlier songs of various feature distributions and understand their nature. So, even though the songs were outliers which didn't fit in the general trends, we wanted to explore the reason for that. So similar to the idea taught in the class regarding music perception we explored what emotions does these songs instigate in people, and importance of these emotions in explaining the popularity of the outlier songs.

## **Data used:**

We have used a spotify dataset consisting of 954 songs from the year 1990 to 2023 that are popular (songs that are streamed a significant number of times : above 10M streams) available online.

There are various important attributes of a song such as :

*Track Name,*

*Artist Name,*

*Release\_year,month,day,*

*In\_spotify\_playlists* : number of times that particular song is added to the spotify playlists. Similar attributes are

*In\_apple\_playlists,*

*In\_deezer\_playlists,*

*In\_spotify\_charts* : number of times that particular song appeared on the spotify trending charts. Similar attributes are

*In\_apple\_charts,*

*In\_deezer\_charts,*

*In\_shazam\_charts,*

*Streams*: number of times that particular song is streamed on the music platforms

*Bpm*: measure of tempo of song

*Key*: Most dominant key of a song

*Danceability\_ %:*

*Valence\_ %:*

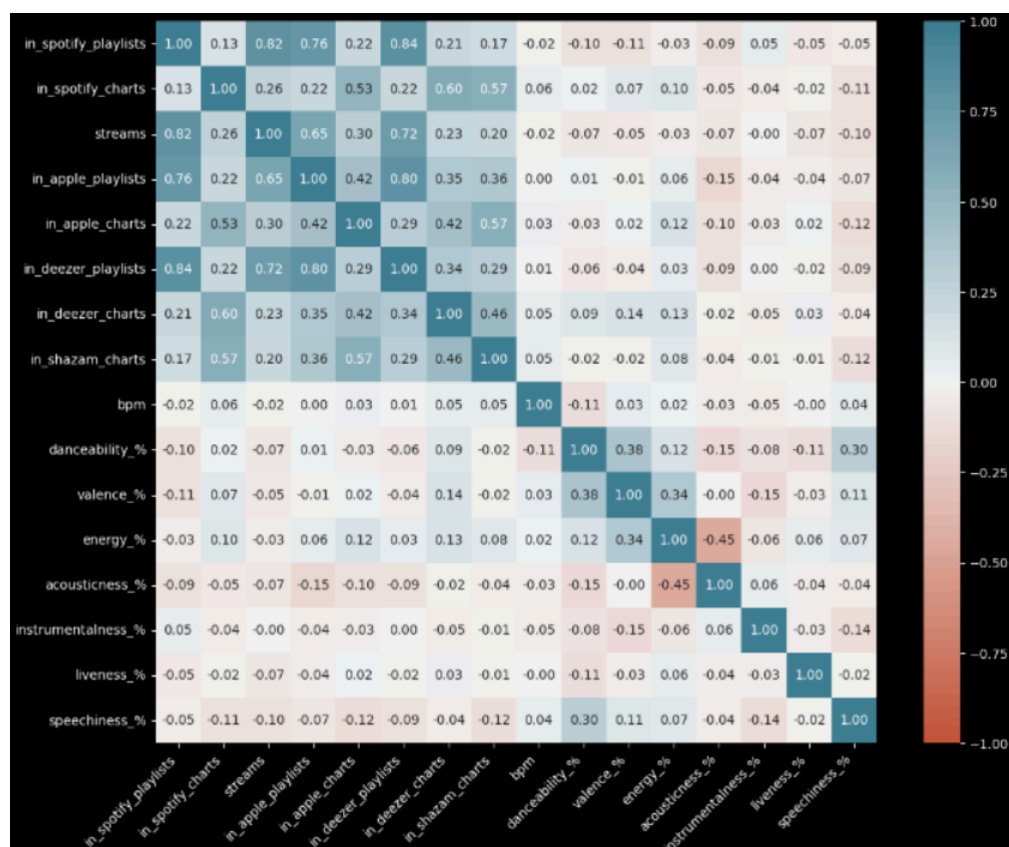
*Energy\_ %:*

*Acousticness\_ %:*

*Liveliness\_ %:*

## Exploratory Data Analysis:

We found that the distributions of various features like Energy,Danceability,Valence,etc are skewed. Hence we found the spearman correlations between various attributes of song.



We found that Energy and Acousticness have high negative correlation between them as expected. We

can clearly observe that the in\_spotify features are highly correlated with the others popularity metric features like In\_apple features, In\_shazam features, etc. Hence in the popularity estimation, comparison based on in\_spotify attributes alone is sufficient. We can also observe that Valence, Energy, Danceability have high correlations with popularity metric features compared with features like speechiness, liveliness. Then tried to understand how dominant key of a song have correlation with popularity and other important features that have correlations with popularity such as Energy, Valence.

## **ANOVA (Multi Factor)**

### *Danceability:*

Null Hypothesis ( $H_0$ ): There is no significant difference between the key groups and the danceability of a song.

Alternative Hypothesis ( $H_1$ ): There is a significant difference between the key groups and the danceability of a song.

### *Valence:*

Null Hypothesis ( $H_0$ ): There is no significant difference between the key groups and the valence of a song.

Alternative Hypothesis ( $H_1$ ): There is a significant difference between the key groups and the valence of a song.

### *Energy:*

Null Hypothesis ( $H_0$ ): There is no significant difference between the key groups and the energy of a song.

Alternative Hypothesis ( $H_1$ ): There is a significant difference between the key groups and the energy of a song.

### *Acousticness:*

Null Hypothesis ( $H_0$ ): There is no significant difference between the key groups and the acousticness of a song.

Alternative Hypothesis ( $H_1$ ): There is a significant difference between the key groups and the acousticness of a song.

### *Liveness:*

Null Hypothesis ( $H_0$ ): There is no significant difference between the key groups and the liveness of a song.

Alternative Hypothesis ( $H_1$ ): There is a significant difference between the key groups and the liveness of a song.

*Speechiness:*

Null Hypothesis ( $H_0$ ): There is no significant difference between the key groups and the speechiness of a song.

Alternative Hypothesis ( $H_1$ ): There is a significant difference between the key groups and the speechiness of a song.

Before running the ANOVA test, we checked if any assumptions are violated by our data.

First, as each row in our dataset consists of a unique song and its attributes. We can say that our data is independent.

Next, we found that our data is non-normal. This means that our assumption of normalcy has been violated. However, Blanca, et al. (2017) found that ANOVA is robust even with non-normal distributions.

## Results from ANOVA

danceability\_%:

F\_onewayResult(statistic=0.8432362179551636,  
pvalue=0.5869022081360808)

valence\_%:

F\_onewayResult(statistic=2.445137666403877,  
pvalue=0.00707043540015886)

energy\_%:

F\_onewayResult(statistic=1.6144704659176952,  
pvalue=0.09781096605056444)

acousticness\_%:

F\_onewayResult(statistic=1.570000568690842,  
pvalue=0.11085366514758706)

instrumentalness\_%:

F\_onewayResult(statistic=0.6127641471006814,  
pvalue=0.803821020494546)



liveness\_%:

F\_onewayResult(statistic=0.24364579423866667,  
pvalue=0.9916552641871839)

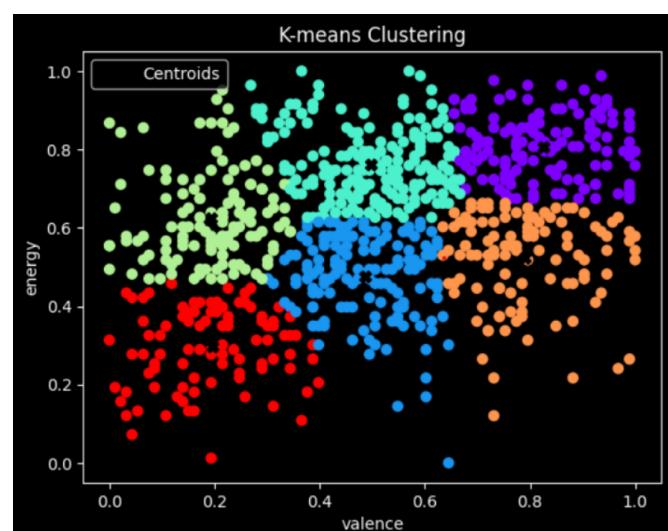
speechiness\_%:

F\_onewayResult(statistic=1.2134555214122336,  
pvalue=0.2781759888762393)

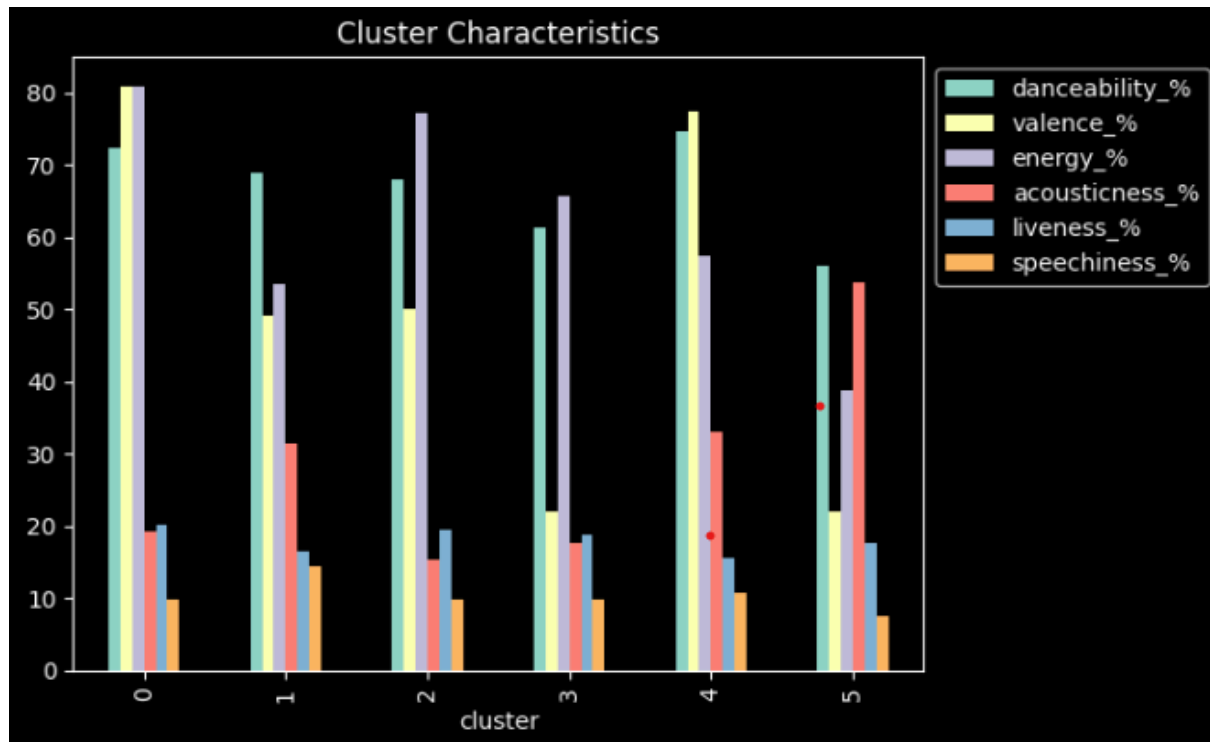
We conducted an ANOVA test to identify the features that would provide significant and inferrable results, with that being said, the significant audio features identified by the test are **'energy' and 'valence,'** which were then used as the primary references alongside the 'keys' variable during the data modeling process.

## Understanding Distribution of Most dominant key of songs:

To understand the distribution, we first clustered the data with

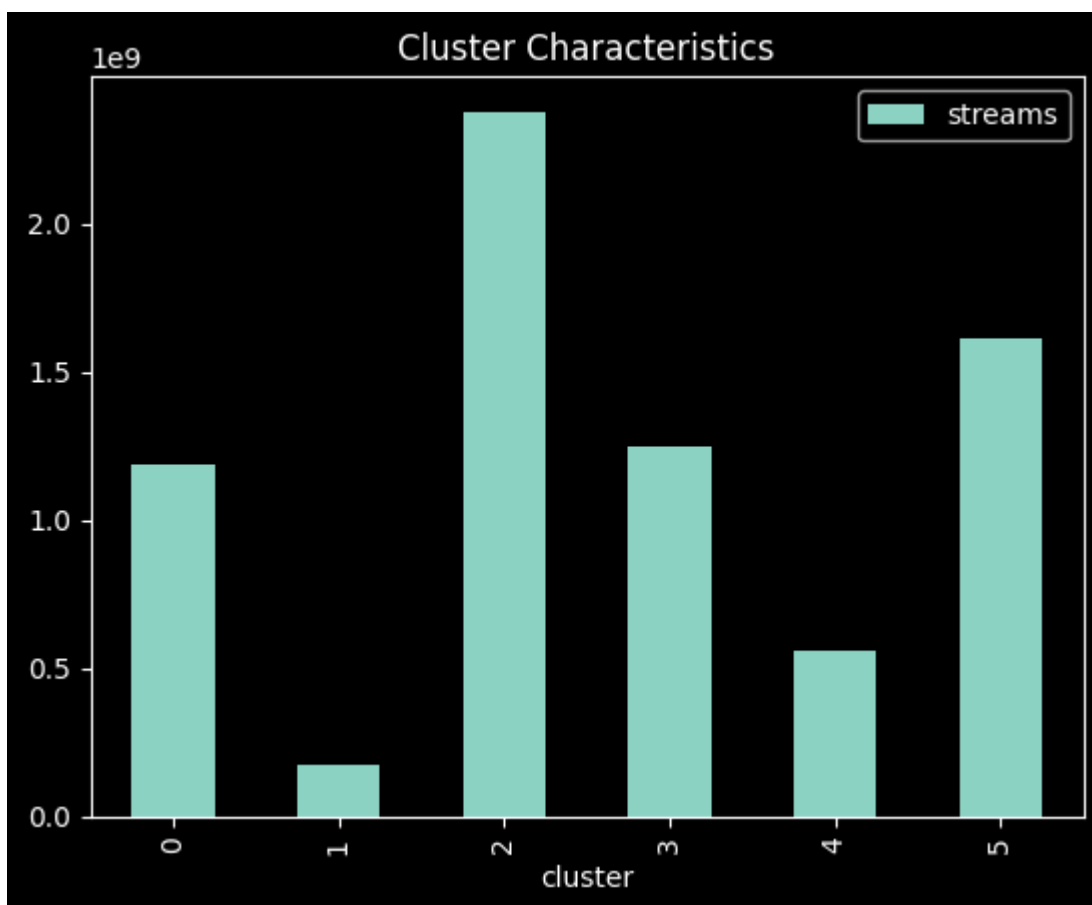


the features of Valence and Energy. We got 6 clusters. First the song attributes other than dominant key are distributed among clusters as follows.



Then we analysed the clusters separately and tried to understand how various dominant keys are distributed among the clusters. We represented key distributions of various clusters in pie charts. We made the following observations from the pie charts obtained:

- In most of the clusters, a large portion of the cluster is dominated by C# and a very least representation of D# .
- In cluster 5 of low valence and relatively low energy has the least representation of C# (most popular songs in C# are at least moderately valent or moderately energetic).
- In cluster 1 of medium valence and medium energy, there is relatively equal distribution of representation of various keys.



- As can be observed from above graph, In cluster 2 of high energy, medium valence, there is a very large representation of both C# and G# (around 55%) and this cluster has songs of very large average steam count when compared to different clusters.

Later with the help of suggestions provided to us, we changed our focus on outliers of various song feature distributions, and tried to understand the nature of outlier songs. Since we have already seen that the important features of a song are Energy, Valence, Danceability (because of danceability's relatively high correlation values).

## **Outlier songs:**

Since the song features have skewed distributions, their outliers are detected with IQR Based Filtering. We found 3 main outlier songs. They are :

- "Heart To Heart" by Mac DeMarco - an Energy Distribution outlier

- The Christmas song -Remastered by Nat King Cole -an outlier in Energy Distribution
- White Christmas by Bing Crosby -an outlier in Danceability Distribution

## Understanding the Outlier songs:

"Heart To Heart" by Mac DeMarco is characterised by mellow and laid-back musical style, characterised by slower tempos and softer instrumentation. The main reason for the popularity of the song "Heart to Heart" can be attributed to various social media platforms like TikTok, where the song has trended. The recommendation system played a key role in promoting the song and contributing to its trendiness.

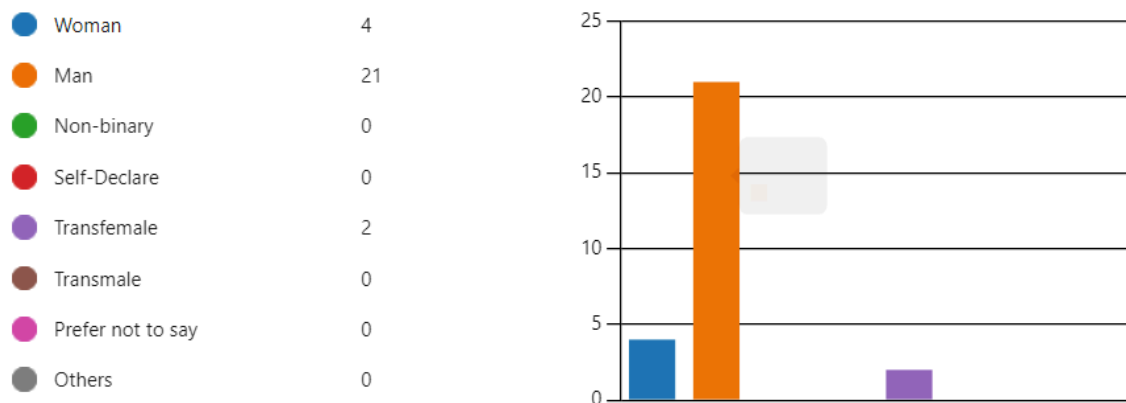
"The Christmas Song - Remastered" by Nat King Cole could be an outlier in energy as it is a classic Christmas song known for its soothing and nostalgic atmosphere, often associated with calm and reflective moments during the holiday season. Similar is the nature of the song White Christmas by Bing

Crosby. Also it is important to note that the artists of the above 2 songs are very popular in their periods.

## **Qualitative Analysis:**

We have conducted a survey and collected data from 27 people. In the survey we have Demographic details section to understand the nature of participants involved. Later we have recorded participant's response towards the song lyrics, what emotions they have felt after listening to the songs, and their familiarity of the song and the artists. Many aren't familiar with the artists because they are from different country and both festival songs are from a different period.

## **Participants Profiles:**

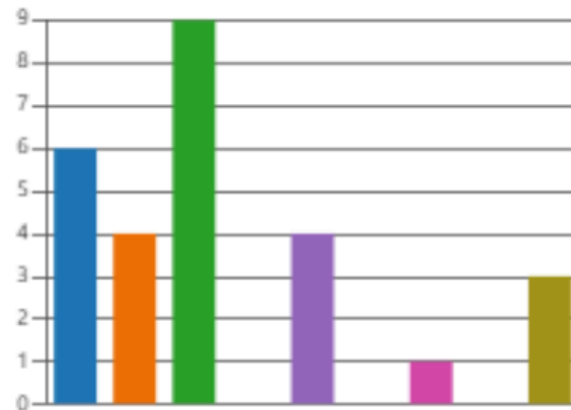
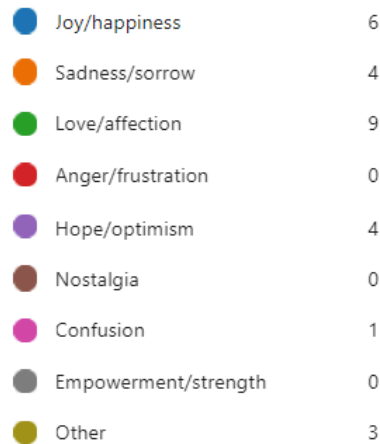


Out of them, 23 of them have no hearing problems and all of them have no hearing aids or cochlear implants to assist them in hearing. Almost all of them are around the age of 19-22.

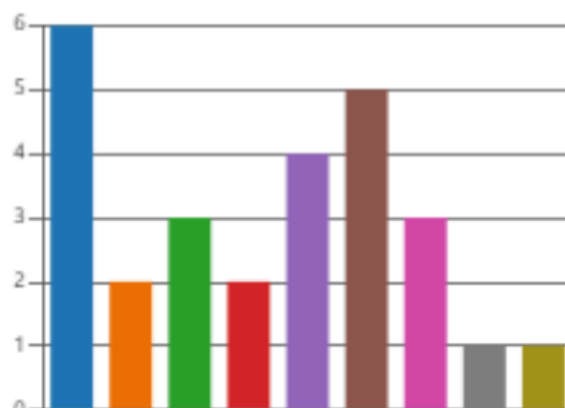
## “Heart To Heart” by Mac DeMarco

We have observed that a majority of the participants have felt Love/affection when they listen to the song, and only a few of them are familiar with the artist's work. This data confirms our analysis above to an extent. We have recorded how energetic do the participants perceive the overall vibe of this song, we have an average rating of 4.93, which shows that the

song is not much energetic in nature.(Can confirm the outlier nature).



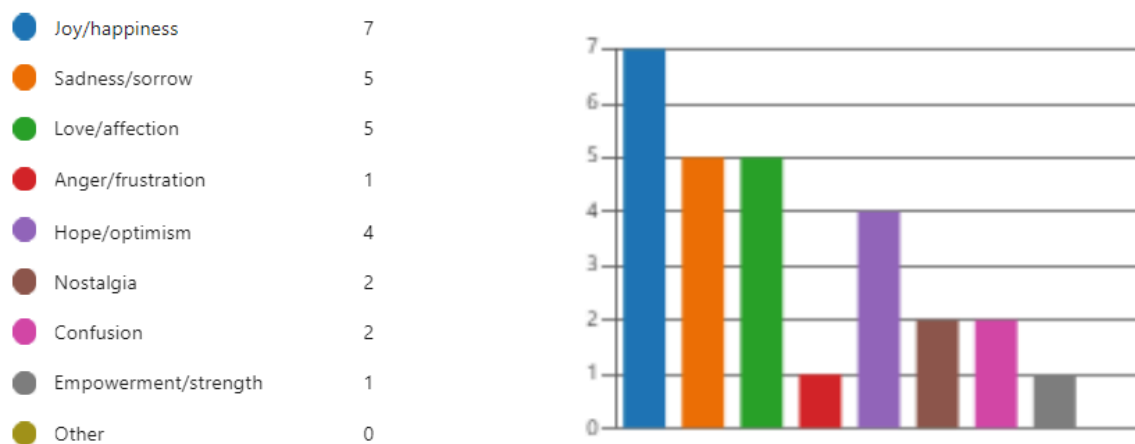
## White Christmas by Bing Crosby





We observed that the song has brought Joy/Happiness among many of its listeners, and there are significant number of people who have felt nostalgic which supports our understanding of it being an outlier. Danceability perceived by the participants is an average of 4.07 rating. This confirms the outlier nature to an extent but not completely.

## The Christmas song -Remastered by Nat King Cole



There are significant number of people who have responded that the song brings out Sadness/sorrow

emotion in them, which cannot be accounted for from our previous understanding, but the Joy/Happiness can be well explained. The average danceability of 4.84 shows how this song is classified as an outlier. (but not a very strong proof as 4.84 is just average danceability and not very low enough to be an outlier)

## **Conclusion:**

When assessing a song's popularity, merely examining its attributes such as energy and valence falls short. It's essential to delve deeper into the emotions the song invokes in listeners and how it resonates within their contexts. Understanding the lyrics and the emotional connections listeners forge with them, along with considering factors like seasonal relevance and artist familiarity, are vital elements in gauging a song's appeal and popularity.

## **Drawbacks and Limitations:**

The sample size or the number of participants was low ( $N = 27$ ), so the findings aren't very

generalizable. Also we have data of people from the 19-22 age group, but we need to account for the song's popularity among various other age groups.