

# Recommending Song Playlists



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# Automatic Playlist Continuation

🎵 Take a given playlist and recommend the next N songs



# Goal of the project

- Analyse track and playlist data to gain insights for later implementation in a music recommender system
- Utilise additionally scraped audio feature data
- Create an accurate and realistic music recommender and playlist continuation system
- Evaluate the new recommender system



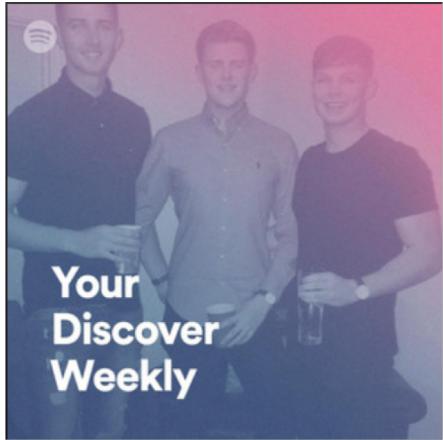
# Current Approaches to Music Recommendation

## Spotify

- spotify Ensemble of Collaborative and Content based recommendation
- spotify Track and artist information for item based similarity
- spotify Deep learning techniques to predict listening patterns
- spotify Human curated genres and recommendations
- spotify Deep audio features analysis

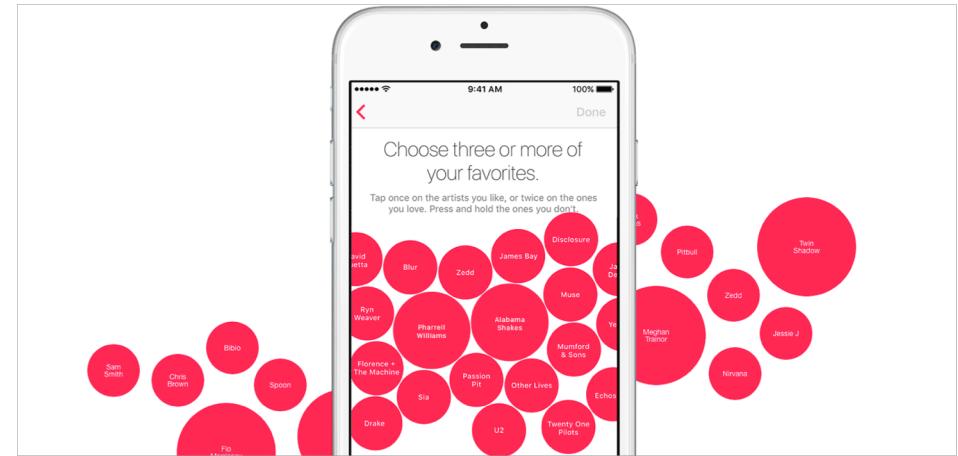


# Spotify's Discovery Weekly



- ⌚ Recommends newly released songs
- ⌚ Songs you have never heard before

# Apple's For You

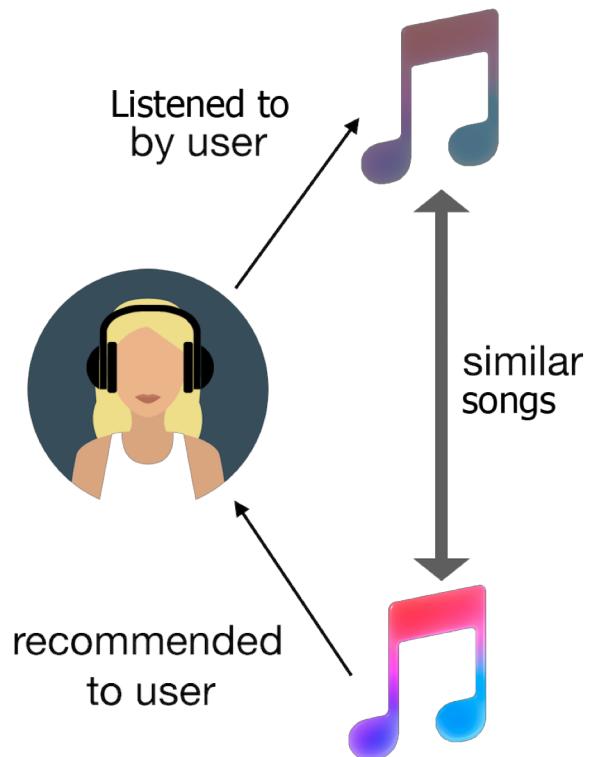


- 🎵 Asks for favorite artists
- 🎵 Recommends Songs you've heard before

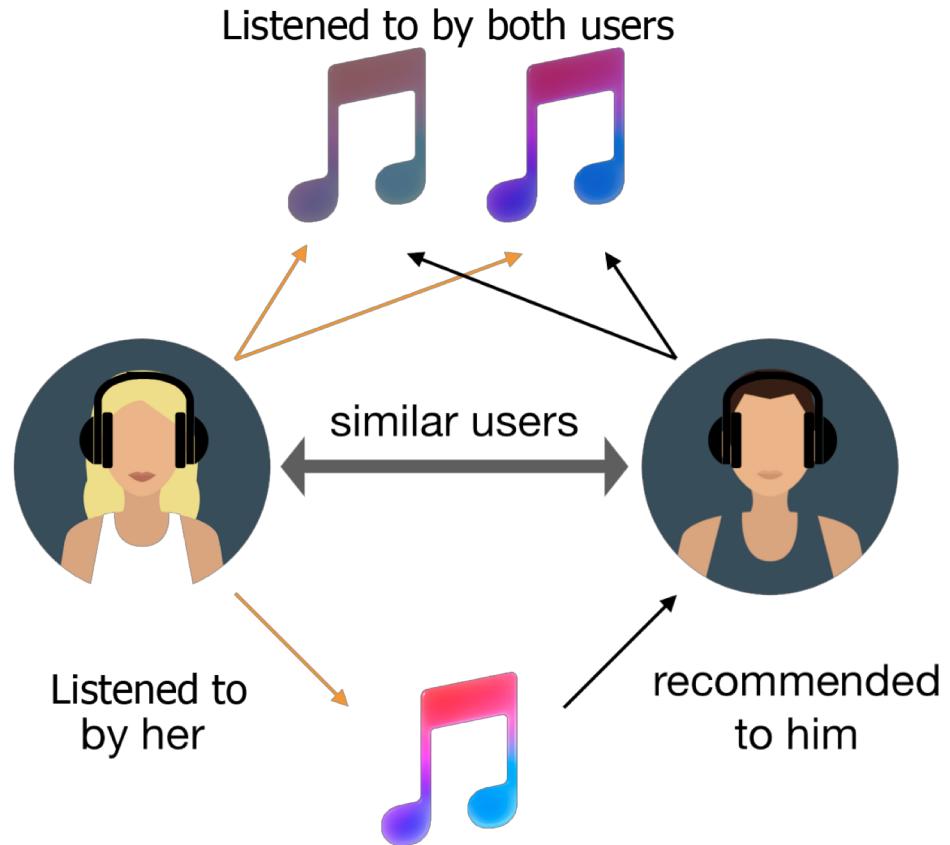


# Traditional recommendation approaches

## Content Based Recommendation



## Collaborative Filtering



# **My Recommender System Approach**

- Content-Based Recommender
- Playlist extension rather than typical song recommendation
- Emphasis on Audio Features
- Use of computed Audio Clusters
- Automatic Recommendations no human input



# Difficulty of Recommender Systems

- ⌚ It's difficult to get it right all the time even huge corporations like Spotify, Apple Music and Last FM can get it wrong
- ⌚ Recommendations can be good but it is user preference in the end
- ⌚ Cold start problem



# The Data

- ACM RecSys Challenge
  - Provided by Spotify in nested json files, 2017
    - 1 million unique playlists
    - 2.2 million unique songs from 295k artists
    - 66 million songs in total
    - Additionally scraped audio features



Playlist	Track	Track_elems
Playlist_id	Track_uri	Track_uri
P_name	Track_name	Playlist_id
Num_followers	Artist_name	position



# Audio Features

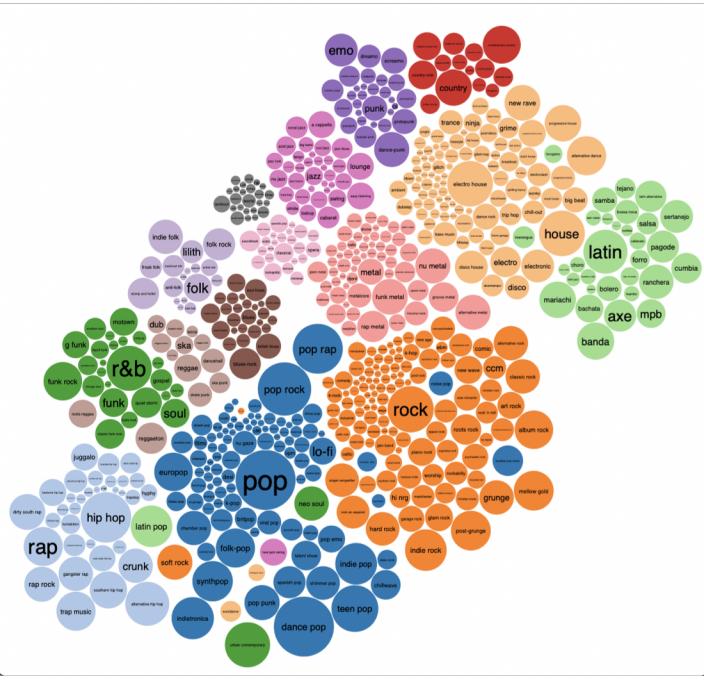
- >Main focus of this project
- Use of Audio Features not originally provided with the *ACM RecSys* dataset.
- Provides unique recommendations
- Recommendations stay true to the music rather than normal content based approaches
- Eliminates the cold start problem

**Audio\_Features.json**

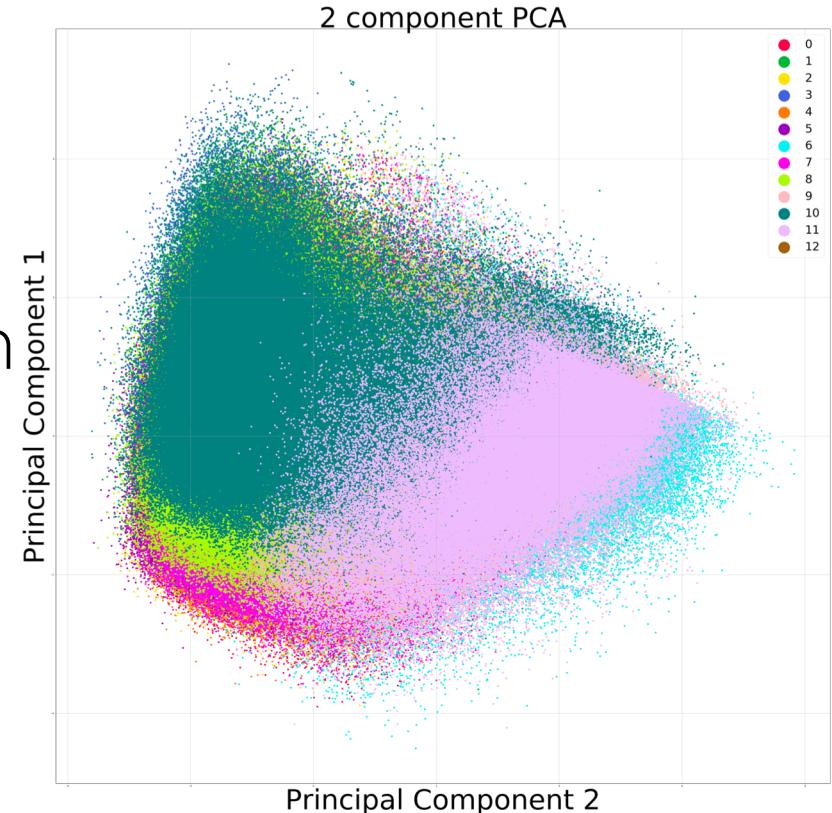
```
{"_id":  
  {"$oid":"5b2cff21aecd2a723459cd65"},  
  "id":1,  
  "track_uri":"0XLOf9LhyazPX9Ld8jPiUq",  
  "danceability":0.7079999627,  
  "energy":0.609999999998668,  
  "key":2,  
  "loudness":-4.5220000002416,  
  "mode":1,  
  "speechiness":0.05739999634,  
  "acousticness":0.02040001465,  
  "instrumentalness":4.4499974,  
  "liveness":0.06410000004197,  
  "valence":0.30499999999334,  
  "BPM":123.03799999999967,  
  "time_signature":4,  
}
```



# How do we group songs?

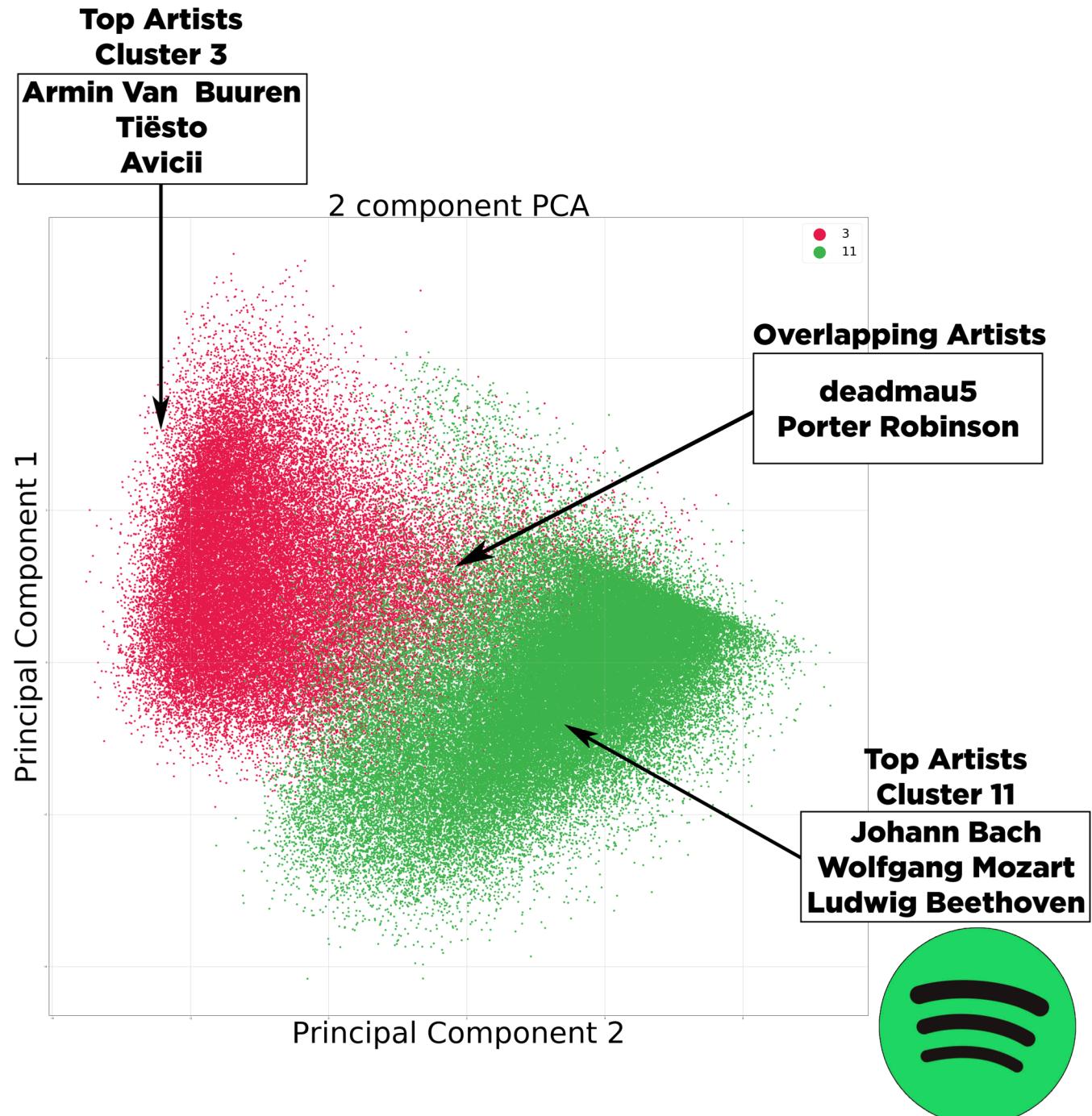


- Use Audio Features for groupings like genres
- Performed Information Gain for feature selection
- K-Means Clustering
- 12 Clusters
- Principal Component Analysis
- Audio Clusters (Computer Generated Genres)



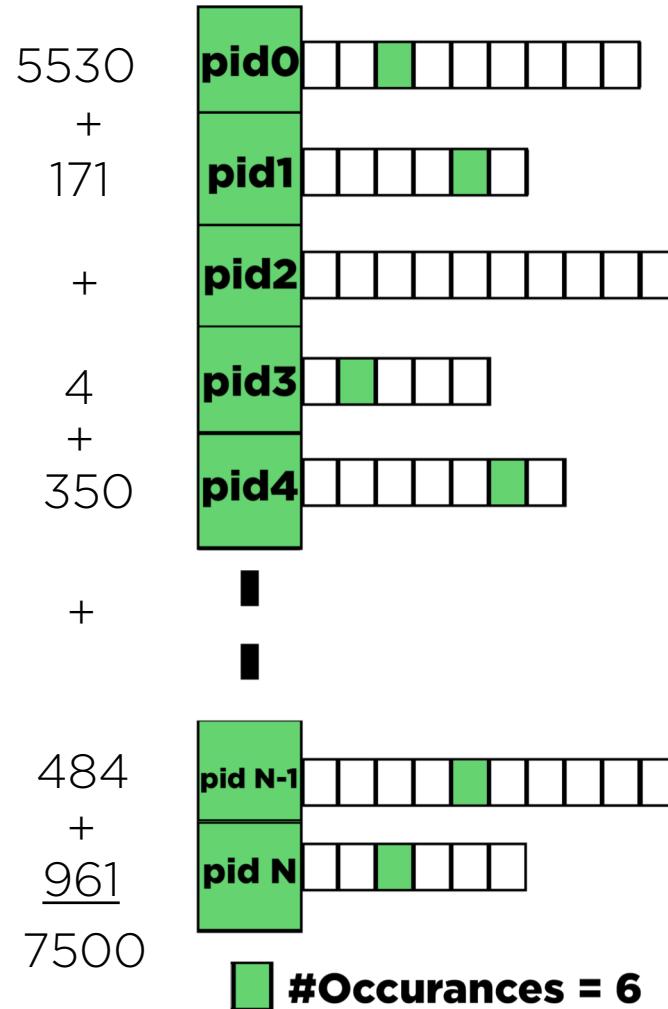
# Clustering

- Cluster 3 represents a DJ and Electronic Music
- Cluster 11 represents classical and instrumental music
- Overlapping artists are DJ's that songs contain little to no words

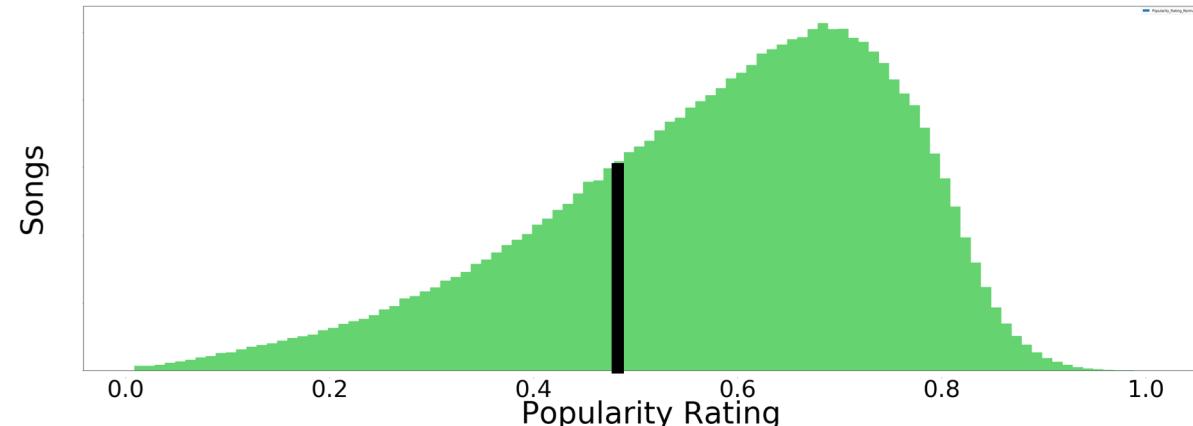


# Popularity Rankings

## #Followers



## Popularity Distribution



$$N = \text{TotalNumberOfSongs}$$

$$\frac{\text{weight}(\text{pow}(\text{Popularity}/\text{PopularityMax}), 0.05))}{(1-\text{weight})(\text{pow}(\text{NumberInclusionInPlaylists}/N), 0.1))}$$

$$\text{Popularity} = \frac{7500}{6} = 1250$$



# Building A Recommender System

## Cluster, Popularity and Audio Feature Recommender System

1. Use the audio features and two new features created

### Popularity and Clusters

2. Normalized all features
3. Cosine similarity [song to song]
4. Value for clusters use was PCA reduced Cluster Centres
5. After adding the two new features Precision and Recall increased



# How to Evaluate the Rec System?

## 1. Comparison

- spotify Recommendations
- Self Evaluation

## 2. Precision and Recall

- 100 random playlists
- Take a 70% train and 30% test set from each
- Predict the test data
- Perform Precision and Recall on the results



# My Rec System vs Spotify Rec System

Song: Strobe - deadmau5

track_name	cluster	Popularity_Rating_Normalized	artist_name	Strobe	deadmau5	For Lack Of A Bet...
Strobe - Radio Edit	2	0.584544	deadmau5	Strobe	deadmau5	For Lack Of A Bet...
<u>Strobe - Club Edit</u>	2	0.543267	<u>deadmau5</u>	<b>Recommended Songs ▲</b>		
See - Beacon Remix	2	0.359319	Tycho	Based on the songs in this playlist		
Cole's Memories - Original Mix	2	0.388374	Pyramid			
Need You Now	10	0.461531	Hot Chip	Some Chords	<u>deadmau5</u>	4x4=12
Paradise	2	0.489216	<u>Tiesto</u>	Finished Symphony - Deadr	Hybrid	Hybrid Re_Mixed - Ep 1
Super Skunk - Bart B More Remix	2	0.461389	Noir	Move For Me	Kaskade	Strobelite Seduction
Project T - <u>Martin Garrix Remix</u>	2	0.400204	Dimitri Vegas & Like Mike	Contact	Glenn Morrison	Contact / Hydrology
Bad Wings	2	0.492216	The Glitch Mob	Scary Monsters and Nice S	<u>Skrillex</u>	Scary Monsters and Nice ...
Terrors In My Head	2	0.483570	<u>deadmau5</u>	I Don't Care - Deadmau5 Re	Jørgensen, BSD	I Don't Care
deadmau5 Remix-Cubrik Re-Edit	2	0.459790	James Talk	Opus	Eric Prydz	Opus
				This Is Also The Hook	EXPLICIT	BSOD
						This Is The Hook



# My Rec System vs Spotify Rec System

Song: HUMBLE. – Kendrick Lamar

track_name	cluster	Popularity_Rating_Normalized	artist_name
HUMBLE.	1	1.000000	Kendrick Lamar
Make Me Proud	2	0.759047	<u>Drake</u>
Down In the DM	1	0.803678	Yo Gotti
Fuck Love (feat. Trippie Redd)	2	0.732923	XXXTENTACION
Hotline Bling	8	0.905389	<u>Drake</u>
Heartbeat	10	0.754374	Childish Gambino
Young Dumb & Broke	8	0.904611	Khalid
Blasé (feat. Future & Rae Sremmurd)	2	0.790751	Ty Dolla \$ign
Met Gala (feat. Offset)	8	0.736503	Gucci Mane
Lollipop	1	0.795179	<u>Lil Wayne</u>
Take Care	10	0.788150	<u>Drake</u>

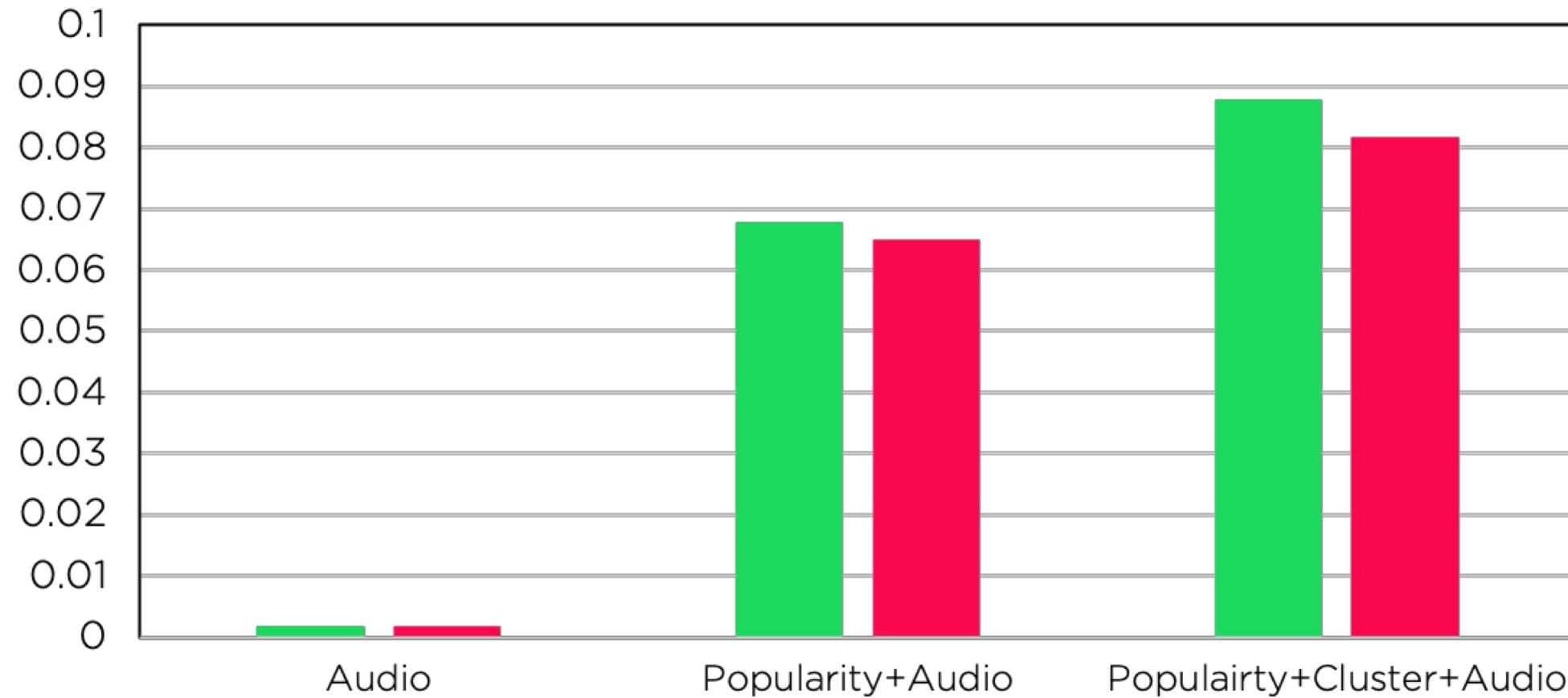
The image shows a Spotify interface for the song "HUMBLE." by Kendrick Lamar. At the top, it displays the song title, an explicit rating button, the artist name, and the album "DAMN.". Below this is a section titled "Recommended Songs" with a subtitle "Based on the songs in this playlist". A "REFRESH" button is located in the top right corner of this section. The recommended songs listed are:

- Bounce Back (Explicit) - Big Sean - I Decided.
- Pop Style (Explicit) - Drake - Views
- Tunnel Vision (Explicit) - Kodak Black - Painting Pictures
- Foreva (Explicit) - Cardi B - Gangsta Bitch Music Vol 1
- Chill Bill REMIX (Explicit) - Rob \$tone, DRAM, Denze... - Chill Bill REMIX
- I'm Me (Explicit) - Lil Wayne - Tha Carter III
- Peso (Explicit) - A\$AP Rocky - Peso
- Flexicution (Explicit) - Logic - Bobby Tarantino



# Recommender System Evaluation

■ Precision ■ Recall



Recommender System



# Possible Improvements

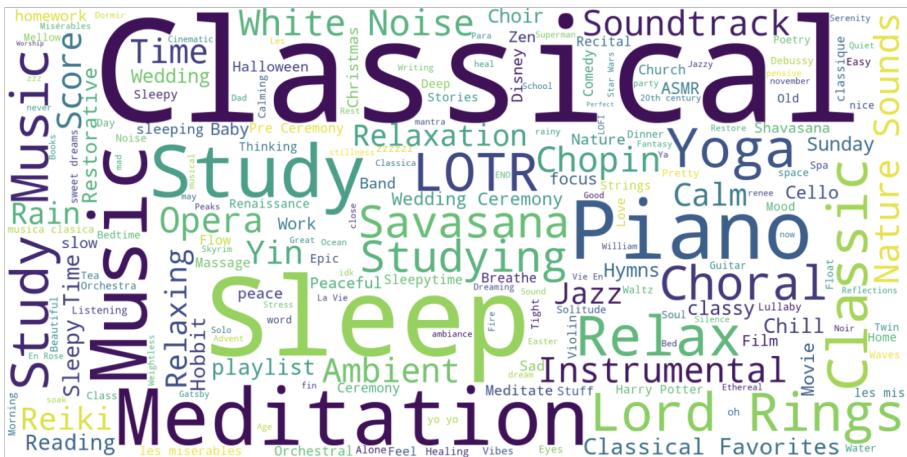
- spotify icon Weighting features
- spotify icon Adding new features in Rec System
- spotify icon Artist cosine similarity
- spotify icon Playlist inclusion cosine similarity
- spotify icon Human Evaluation
- spotify icon Limitations exist to my results



# Questions?



# Cluster Word Clouds



# Sleep and Relaxation Cluster



# Summer Chill Cluster



# Upbeat Workout Cluster

