Generating Smooth Mood-Dynamic Playlists with Audio Features and KNN

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evoMUSART 2024



Oregon State University

Introduction



Tender
Raw, sentimental feels.
318,042 FOLLOWERS



Drifting Apart
Feelings fade, people change.
157,715 FOLLOWERS



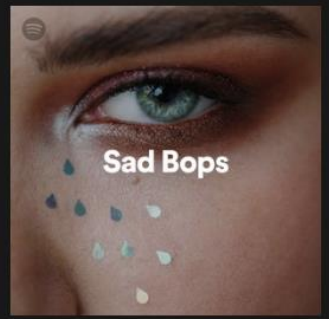
Down In The Dumps
The latest pop songs that are totally cry worthy.
524,476 FOLLOWERS



Confidence Boost
You're on top of the world. Don't forget it.



Tear Drop
Emo rap feelings for the misunderstood.
Cover: Juice WRLD



Sad Bops
For all of us dancing on our own.
268,819 FOLLOWERS



Mood Booster
Get happy with this pick-me-up playlist full of current feel-good songs!
5,706,063 FOLLOWERS



Feelin' Myself
When you feel like you're 100% that b**** Cover: Flo Milli
803,491 FOLLOWERS

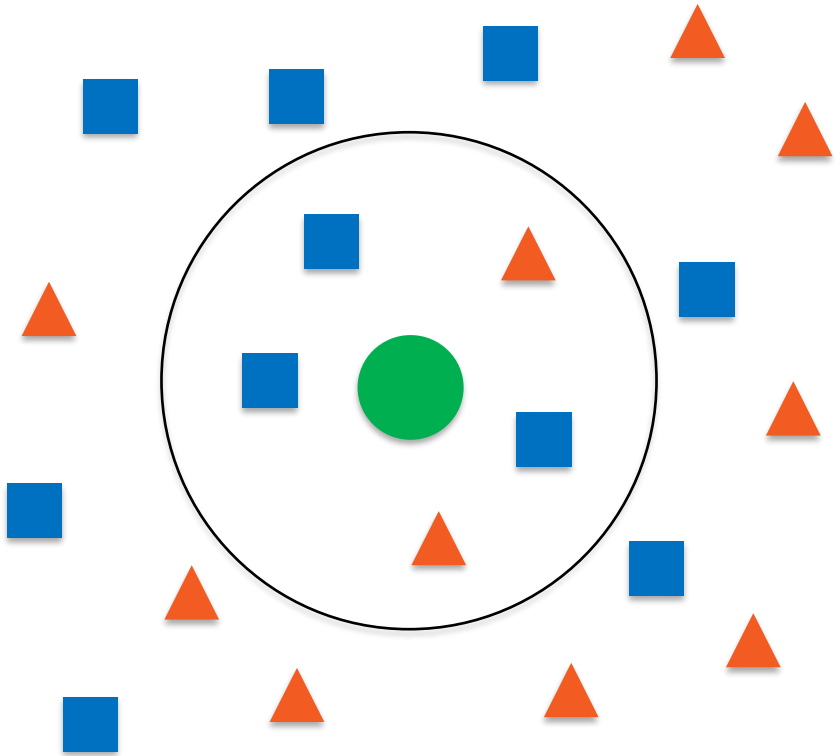
Automatic Playlists

Continuations

- Collaborative Filtering [11]
- Matrix Factorization, KNN [9]

Two-Stage Algorithms [15]

1. Recall candidates
2. Re-score to choose next song

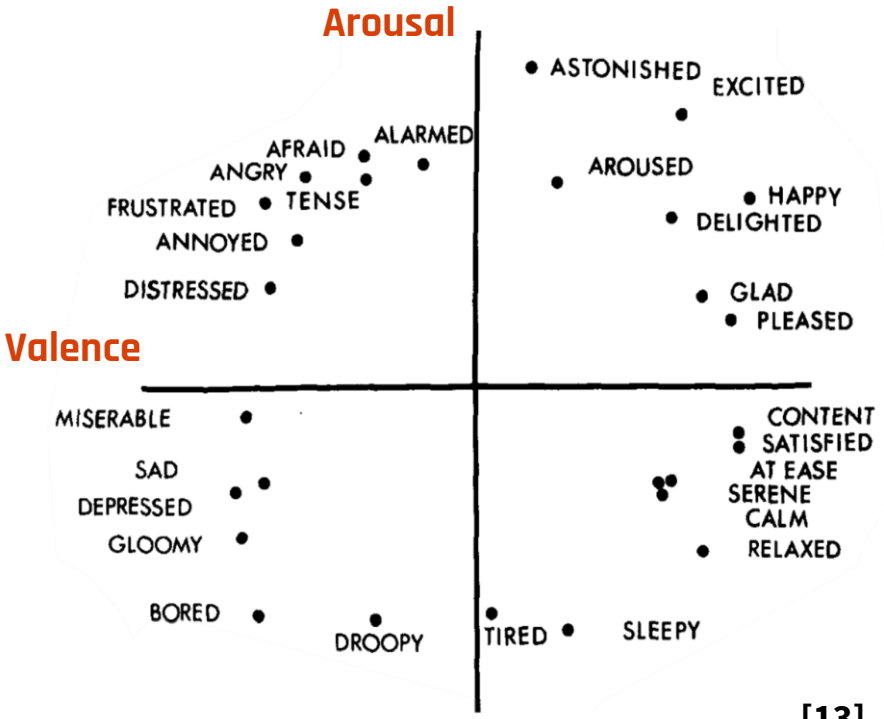


Mood Playlists

Predict emotion from data:

- Sensors → Random Forest [7]
- User writing → Graph [10]
- Facial expression → SVM [12]

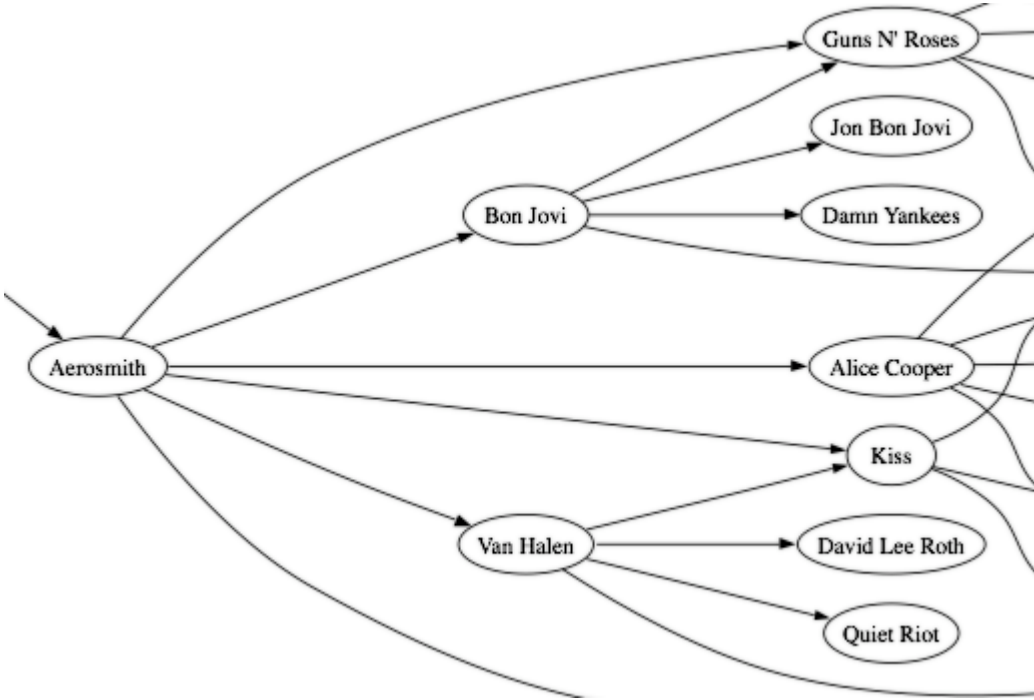
Choose “nearest” songs in emotional space [2]



[13]

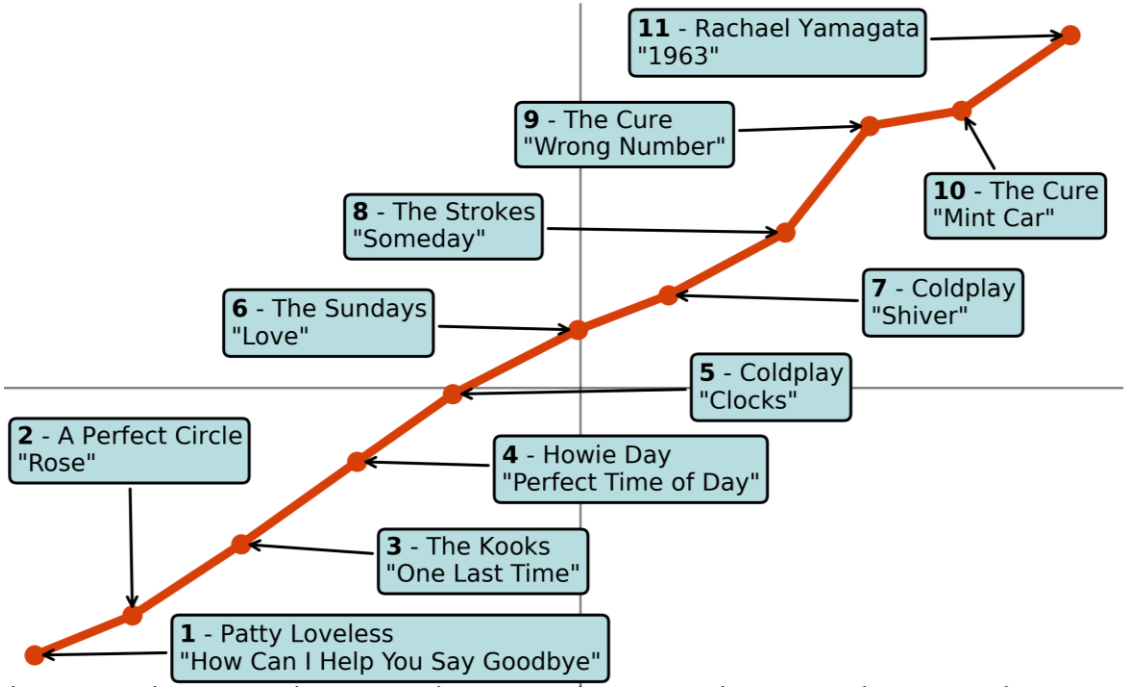
Dynamic Playlists

- Smooth transitions
- Existing playlist data [3]
- Similarity graphs [14]
- Gaussian models [6]



Our Playlist Approach

- Dynamic in mood [5]
- Emotion + Audio
- Two-stage KNN
- Smooth and Even



Datasets & Preprocessing

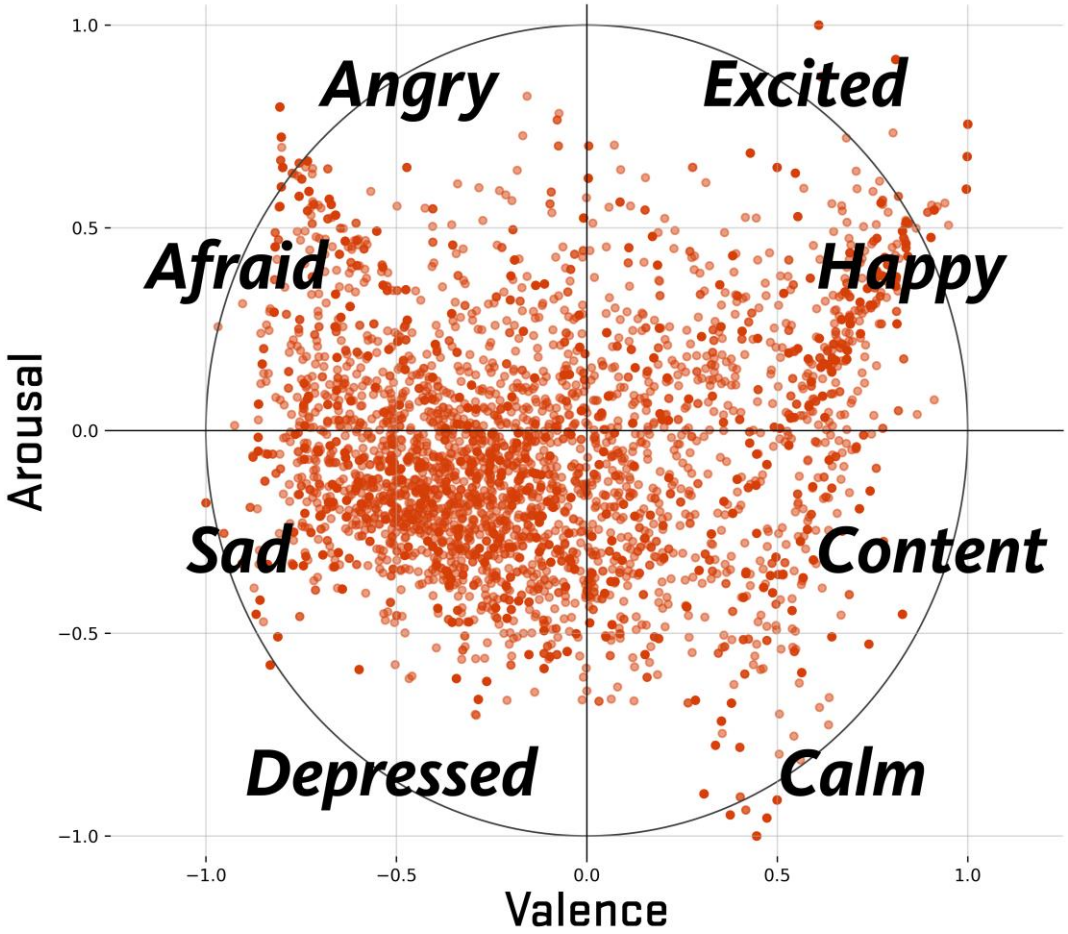
Deezer 2018

18,644 songs [4]

Valence-Arousal points

Synthetic dataset

2,720 unique points



Audio Feature Datasets

Spotify API

- **17,755 songs (95%)**
- **Audio-based features**
  - *Acousticness, Energy, Tempo, Liveness, Danceability*
- **Metadata**
  - *Popularity, Explicit Content*
- **15 features total**

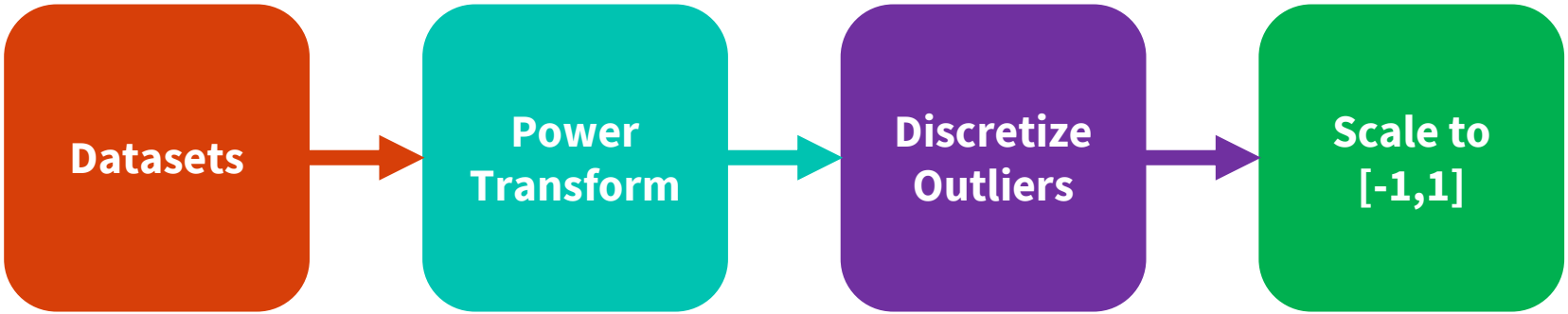
Million Song Dataset

- **44,745 unique artists [1]**
- **Song-level features**
  - *Key, Mode, Tempo, Time Signature*
- **Segment-level features**
  - *Loudness, Timbre*
- **78 features total**

Preprocessing

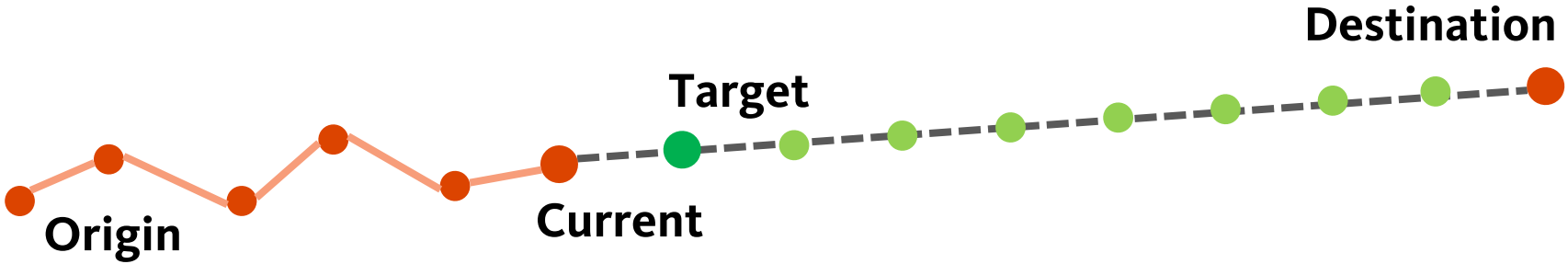
1. **PCA** to 12 dimensions
2. **Rescale** to normalize

Dataset	Features	Variance Retained
Spotify	15	96.7%
MSD	78	68.3%
All (Spotify + MSD)	93	62.7%



Mood-Dynamic Playlist Algorithm

Stage 1: KNN + Mood

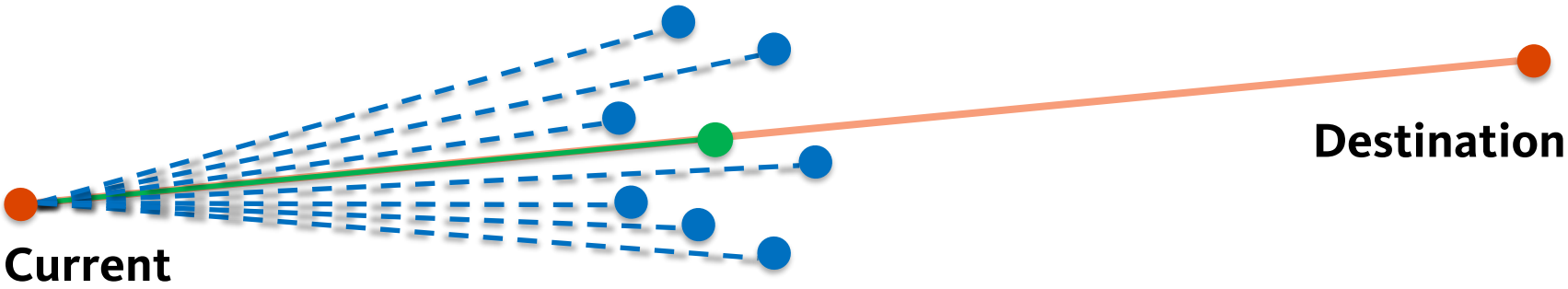


KNN of **P** unique Valence-Arousal points

Complexity: **O[P log P]**

$$S_t = S_c + \frac{S_f - S_c}{N}$$

Stage 2: Audio Distance

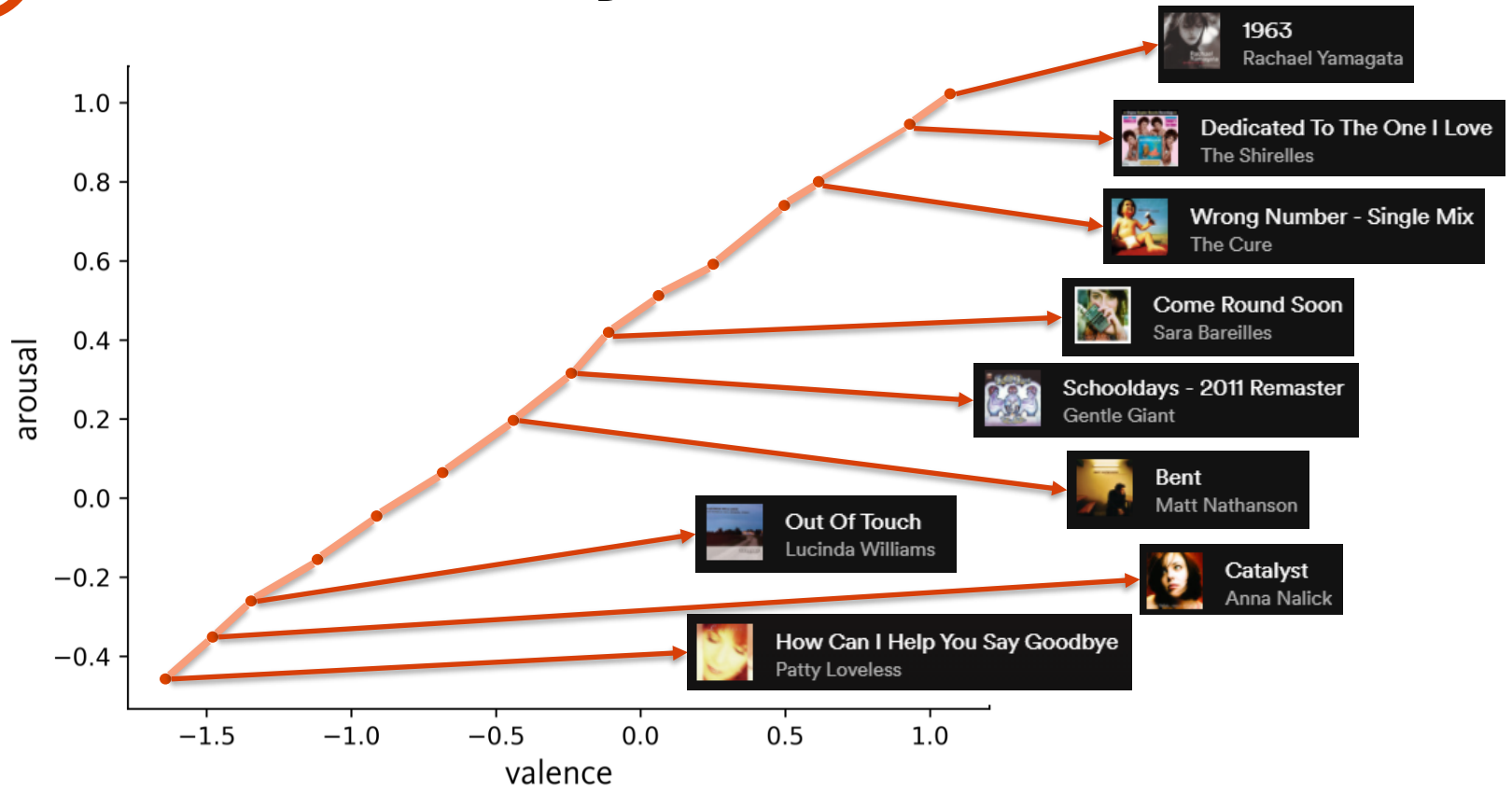


Distance scores, **K** songs, **D** audio features

Complexity: **O[KD]**

Total Complexity:
O[L P log P]

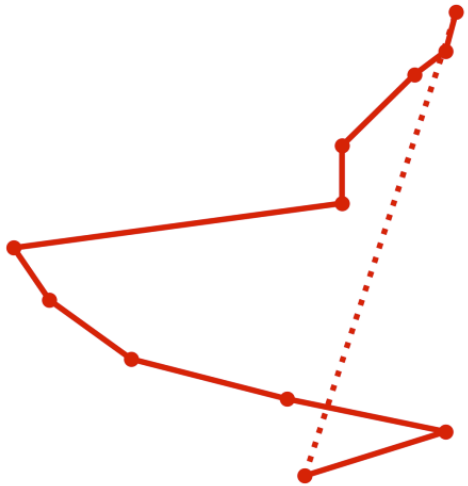
Example Playlist



Evaluation Metrics

Smoothness

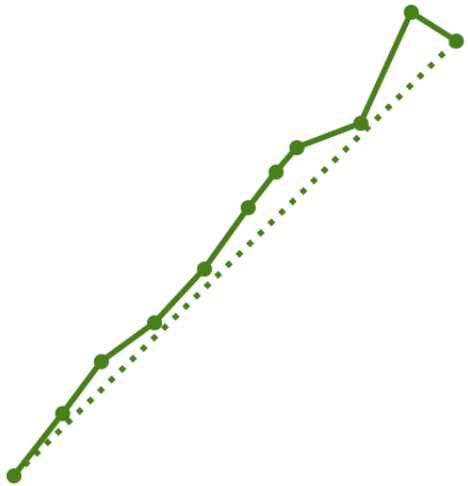
$$\rho_{AB} = |\frac{\mathrm{Cov}(A,B)}{\sigma_A \sigma_B}|$$



0.3



0.6



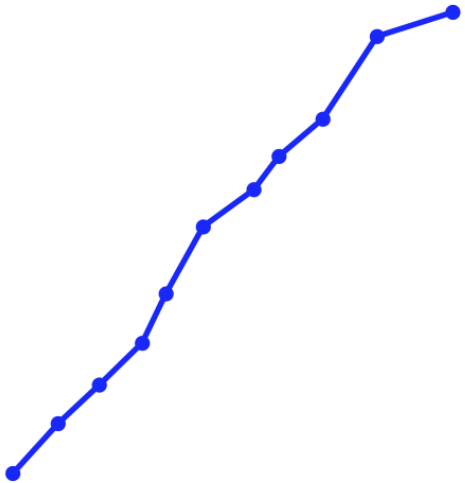
0.99

Evenness

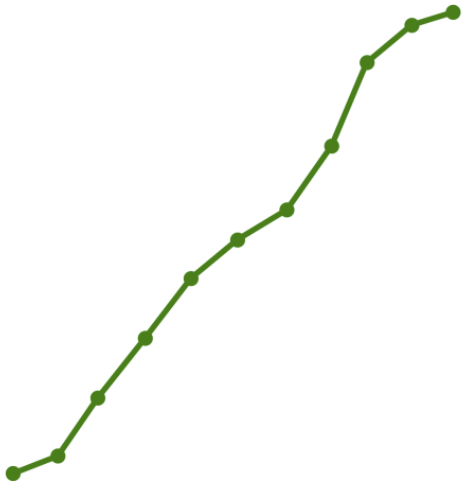
$$RMSE_k = \sqrt{\frac{||S_{k+1} - S_k||_2}{N}}$$



0.0007



0.0004



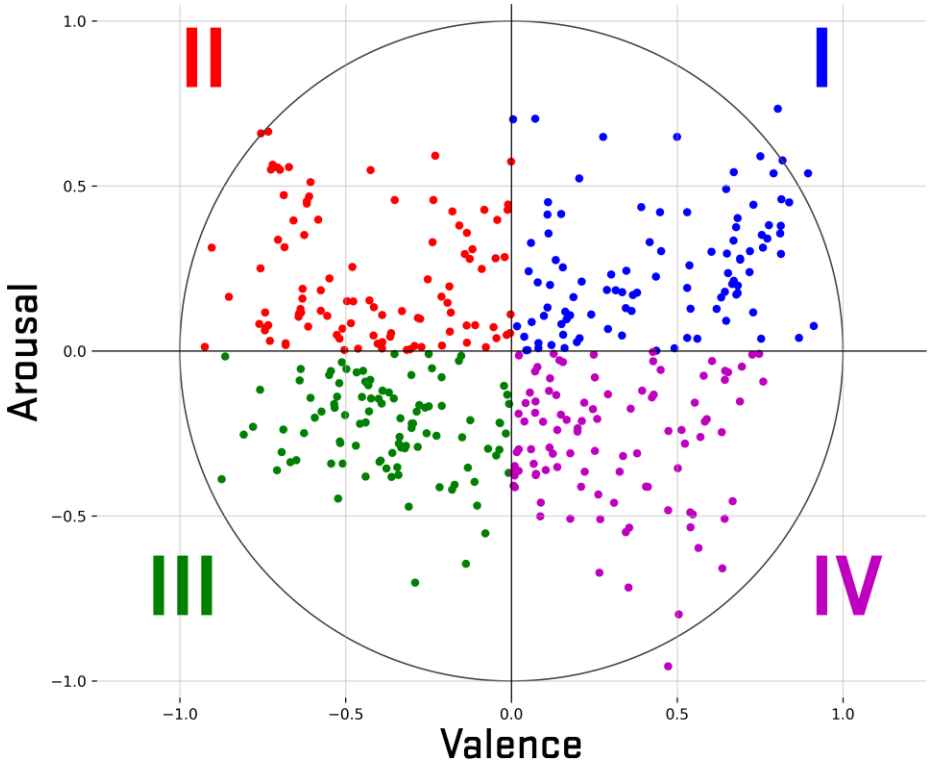
0.0001

Experiments & Results

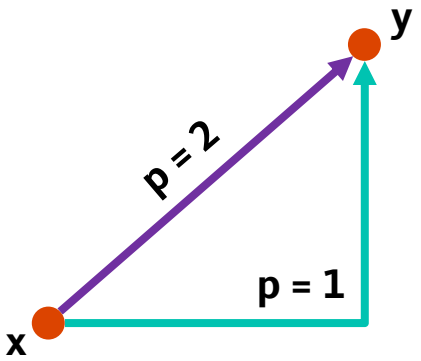
Design

Test across Deezer quadrants

- ***12** pairs of quadrants*
- ***100** start songs per quadrant*
- ***10,000** playlists per pair*
- ***120,000** playlists total*



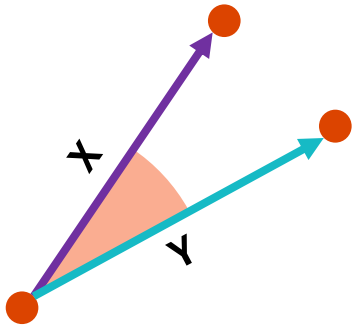
Distance Metrics



Minkowski Distance

Vector p-Norm

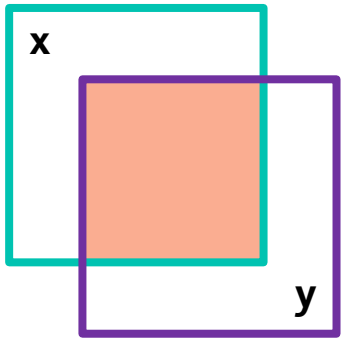
$$\left(\sum_{i=1}^{n} |x_i - y_i|^p\right)^{\frac{1}{p}}$$



Cosine Similarity

Angular distance

$$\frac{X * Y}{||X||\ ||Y||}$$

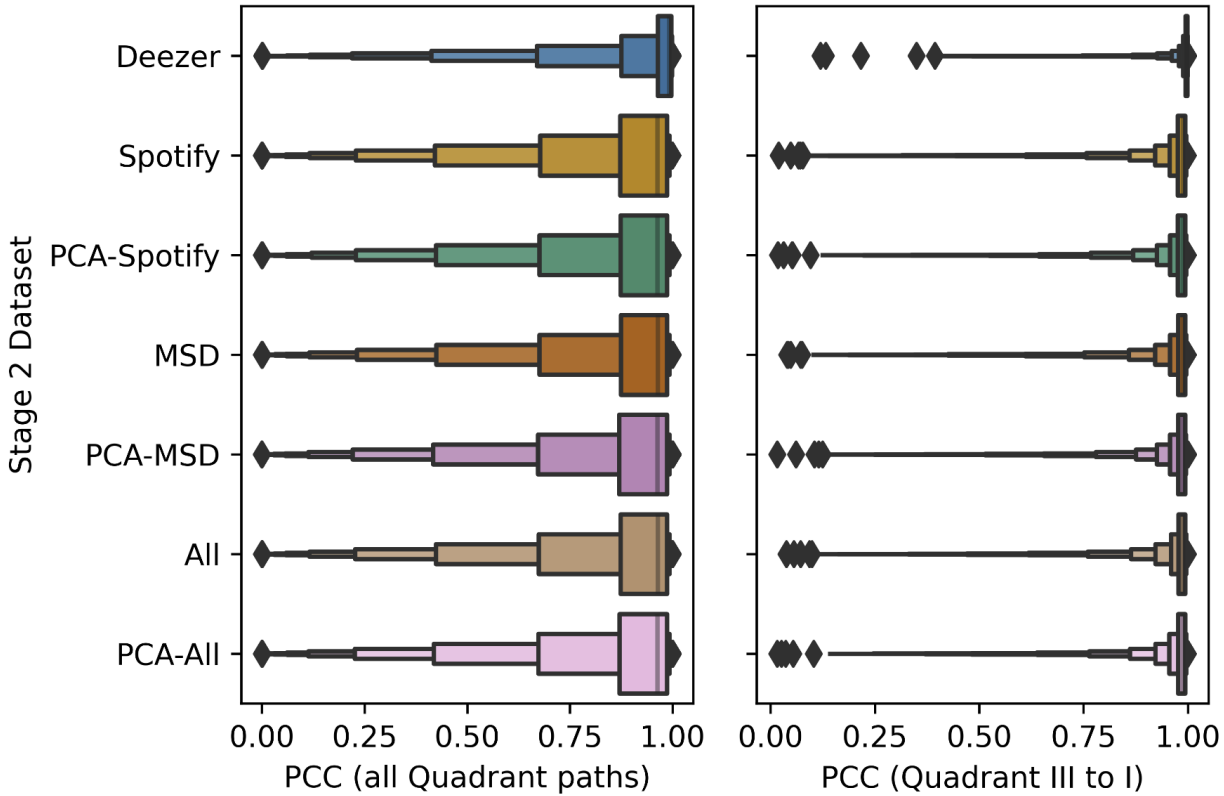


Jaccard Index

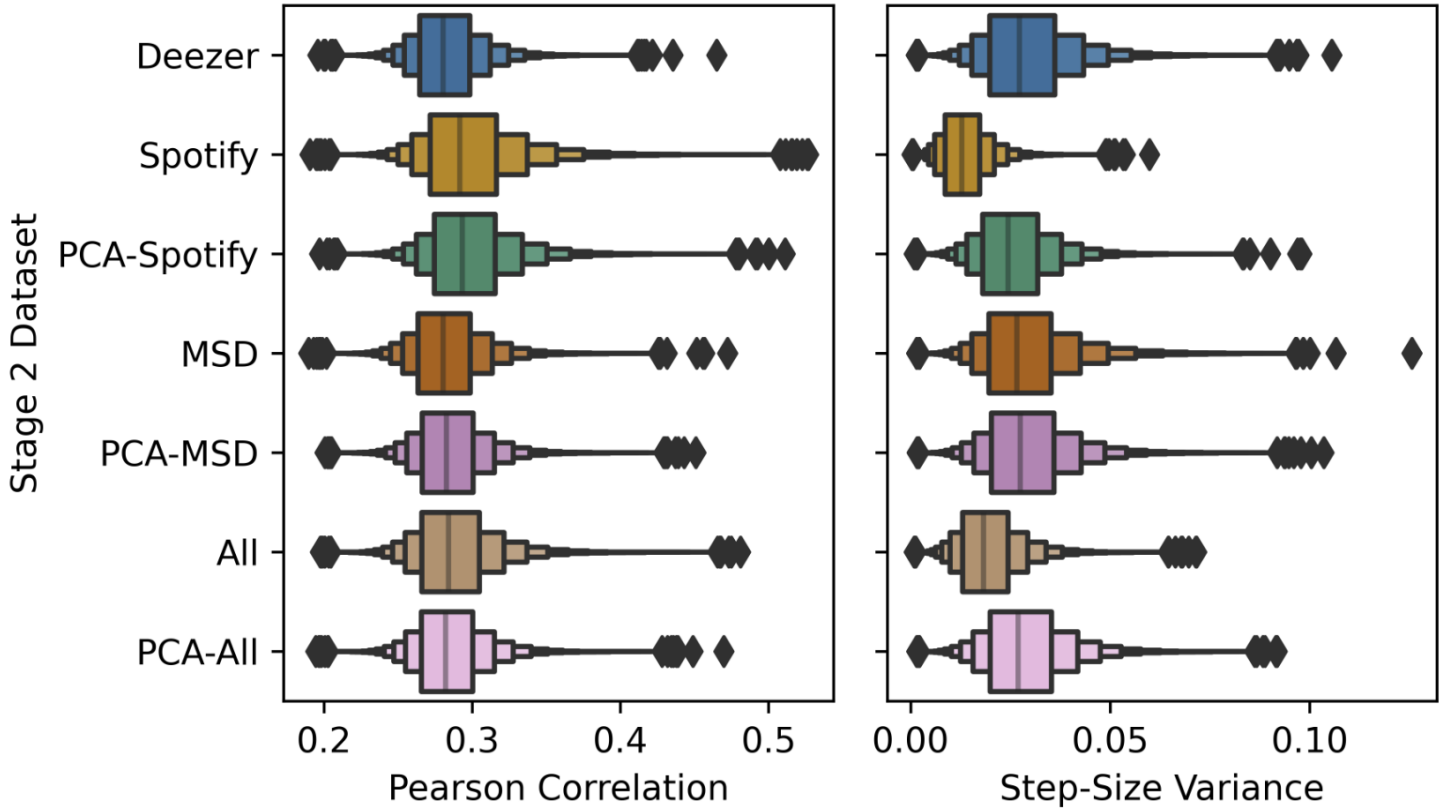
Intersection over Union

$$\frac{\sum_i \min(x_i, y_i)}{\sum_i \max(x_i, y_i)}$$

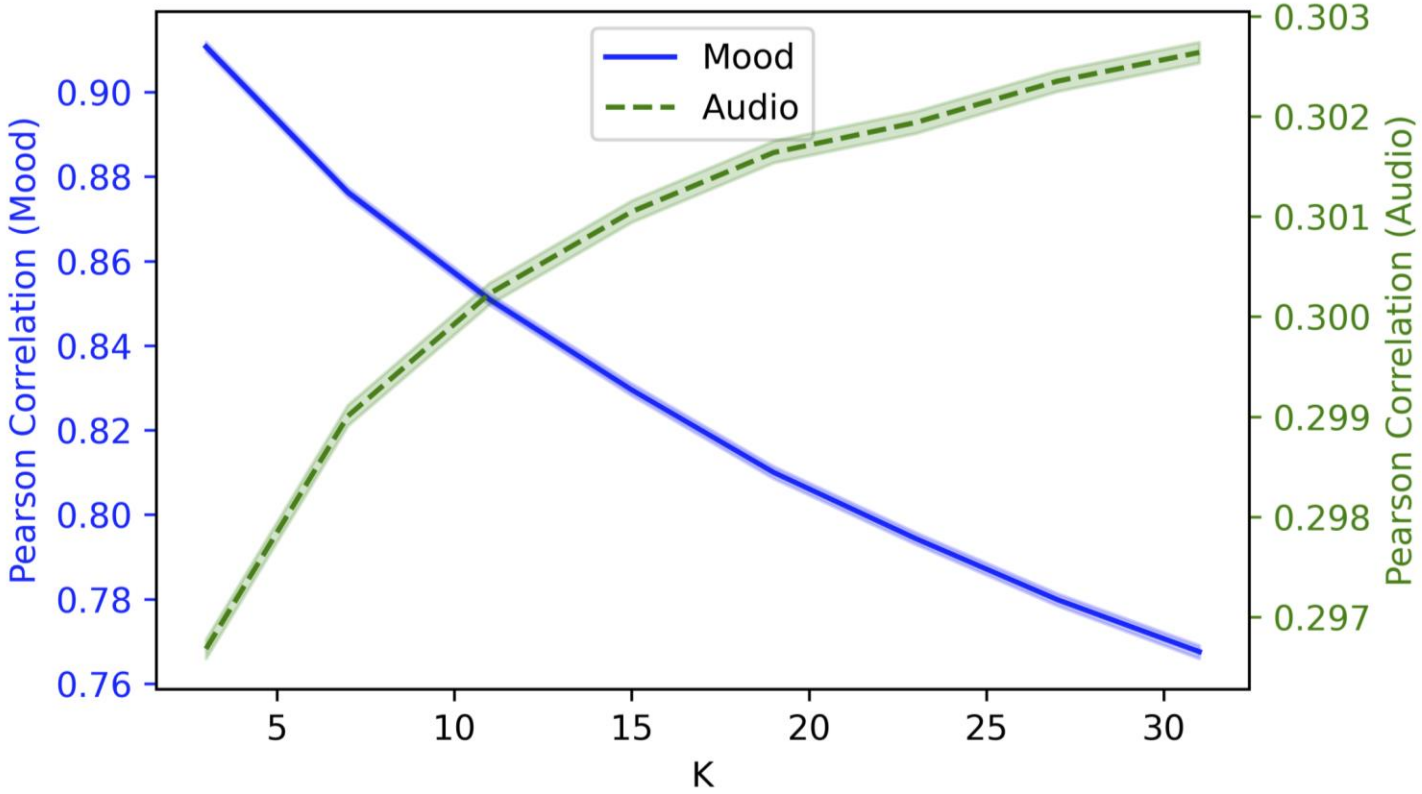
Audio Datasets in Mood



Audio Datasets (in Spotify feature space)



K-Values


Mood
Audio
Pearson Correlation (Mood)
Pearson Correlation (Audio)
0.90
0.88
0.86
0.84
0.82
0.80
0.78
0.76
0.303
0.302
0.301
0.300
0.299
0.298
0.297
5
10
15
20
25
30
K

Discussion & Conclusion

Findings

Successfully create playlists that change in mood and acoustics

Smooth and evenly-spaced path through song spaces

Defined metrics for smoothness and evenness

PCA, audio features fail to yield smoother playlists

Limitations

Synthetic nature of Deezer dataset [4]

Antiquity of existing datasets [1]

Future Work

Transitions ***between song segments***

Human subjects research

1. Ask users to report their mood
2. Create playlist to guide them towards a desired state
3. Request users to report mood after each song

Applications

Productivity or music therapy tool

Human-in-the-Loop Systems

- *Sensor emotion recognition [7]*
- *Reinforcement learning [8]*

Ethical considerations



Use our algorithm! Make a playlist here.

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Use our algorithm. Make a playlist!





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