

Synesthete: A deep learning engine that sees sound

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Project Overview

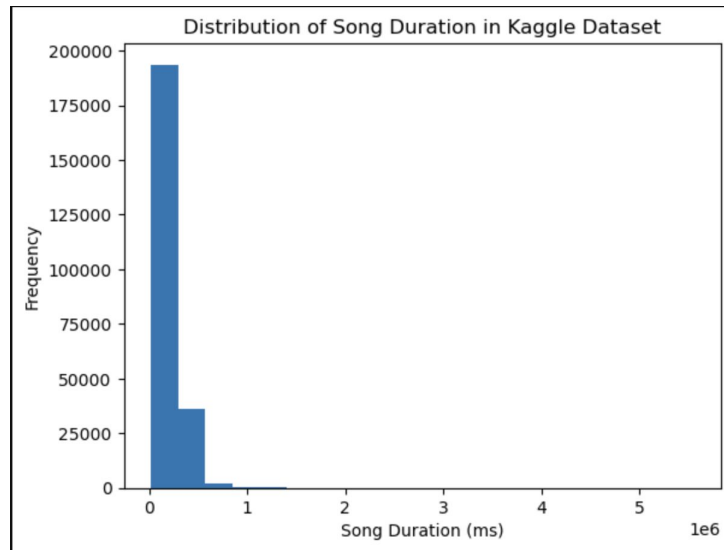
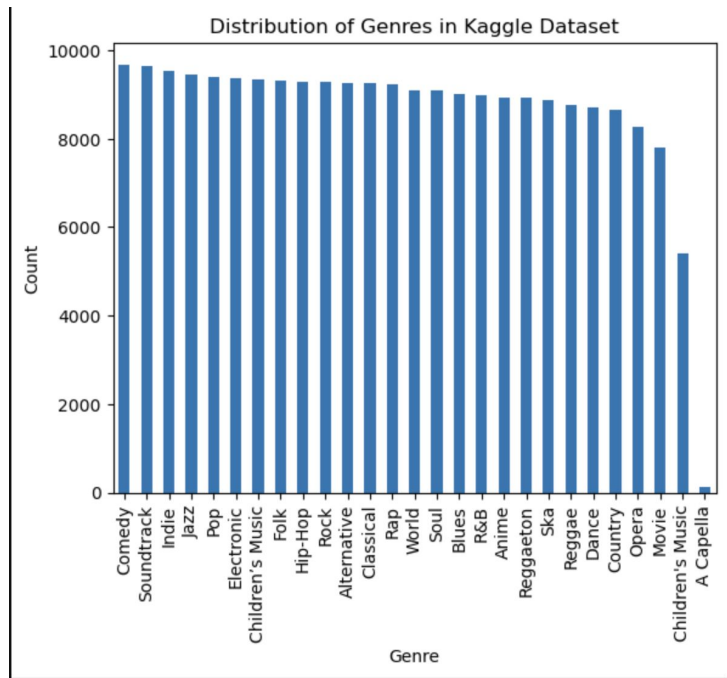
- **Problem Statement:** Recommend similar songs to a user based on a single audio track as an input. The audio can come via a pre-saved audio file or as a recording in real time.
- **Proposed Solution:** Vectorize audio data and calculate cosine similarity. Then present the user with the **top ten** matches based on that similarity. Two models would be created to start with. One would use only pairwise cosine similarity and the other would use a CNN in conjunction with cosine similarity.
- **Potential Impact:** Provide the user tools to find similar artists via a standalone app or create value-add for existing app.

Data Overview and Preprocessing

- Kaggle Data
 - 232,725 rows each representing a song
 - No Nulls - very clean
- Vectorized MP3s
 - 11578
- Encoded MP3s using Librosa package
 - Mel Spectrum
 - Mel Frequency Cepstral Coefficients (MFCC)
 - Chroma Vector
 - Tonnetz Spectrum
- Set `track_id` to category in order to set hierarchy for ordering `track_id` when constructing a playlist

Findings from EDA

Kaggle Dataset



Findings from EDA (cont.)

Kaggle Dataset - Duplication of track_id

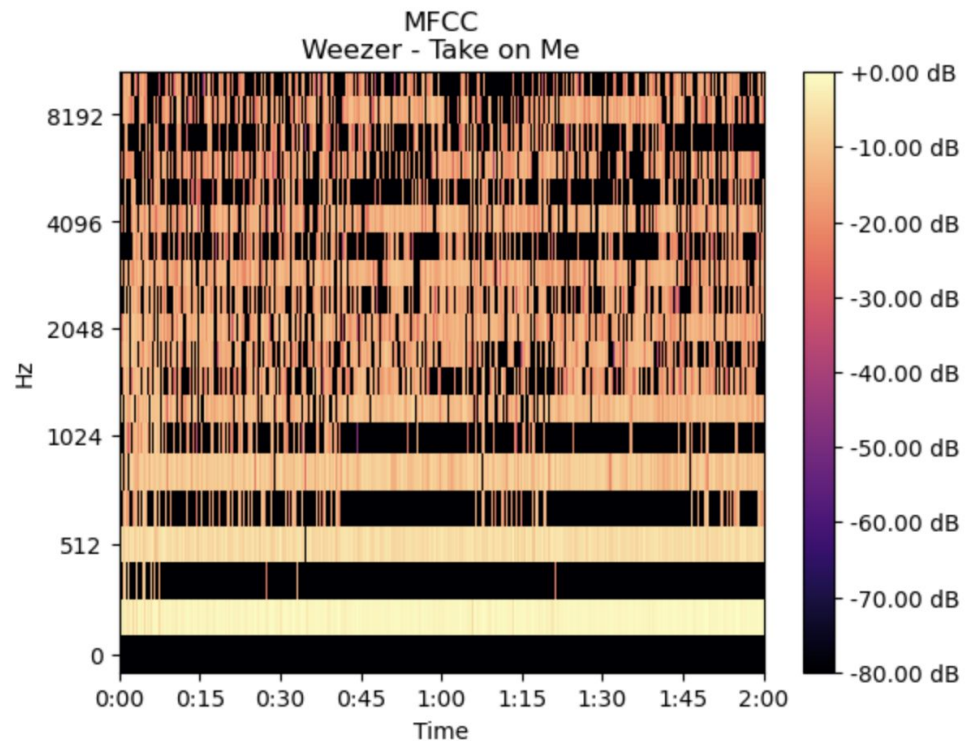
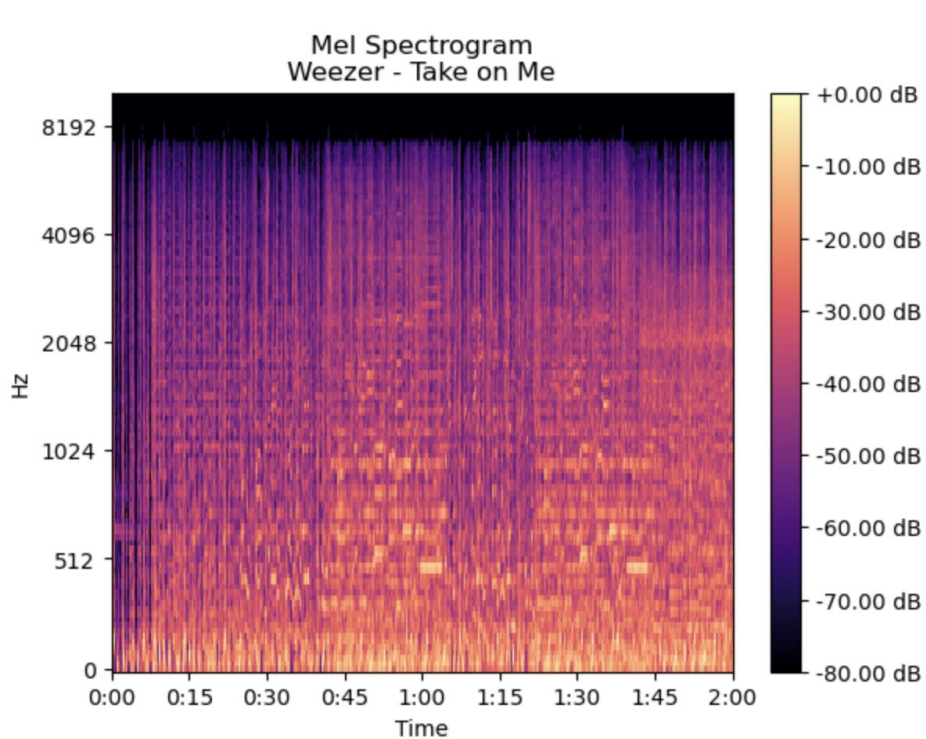
```
kaggle_df.track_id.value_counts(ascending=False).head() # some of the track_ids appear more than once
# This seemed odd considering that the track_id should be a unique identifier.
```

```
3R73Y7X53MIQZWnKloWq5i    8
0wY9rA9fJkuESyYm9uzVK5    8
6sVQNUvcVFTXvIk3ec0ngd    8
0UE0RhnrRaEYsiYgXpyLoZc    8
6Aite2Iej1QKlaofpjCzWl    8
Name: track_id, dtype: int64
```

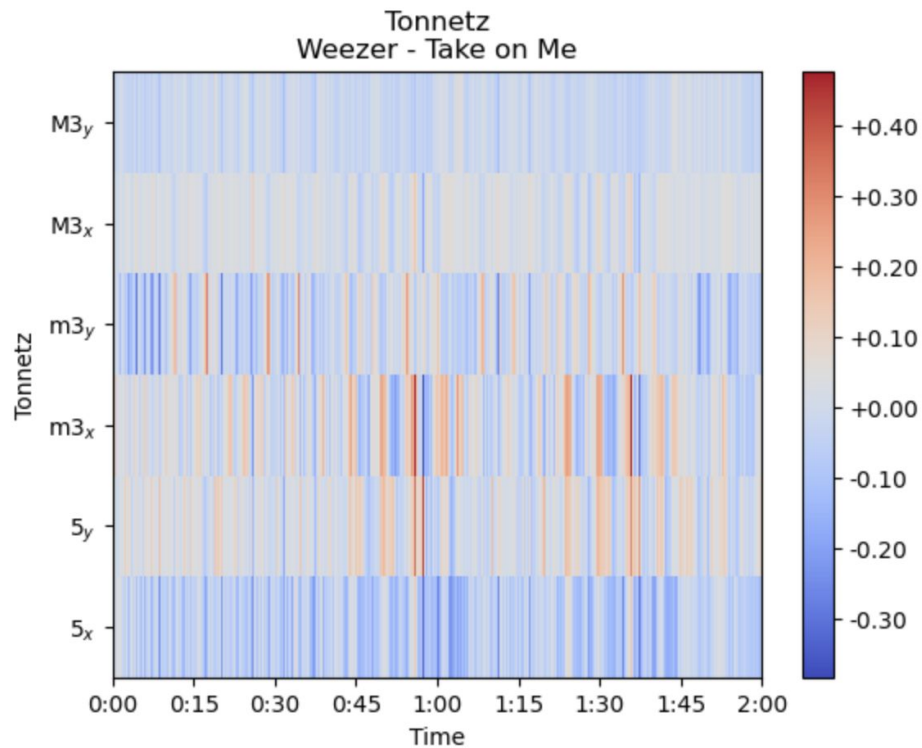
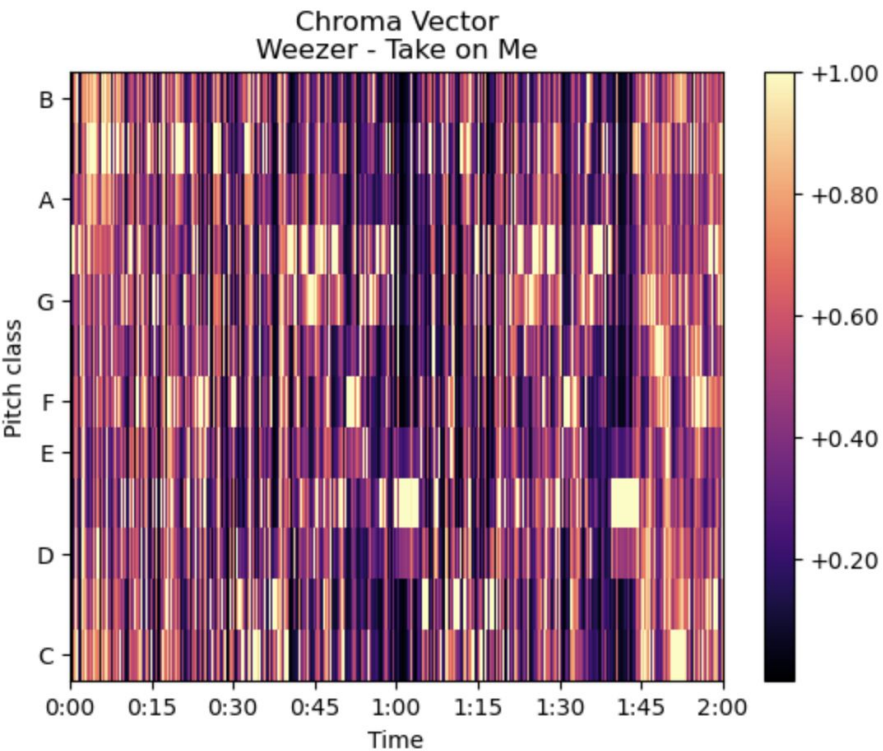
```
kaggle_df.loc[kaggle_df.track_id == "3R73Y7X53MIQZWnKloWq5i"]
# This shows that a single track id does correspond to a single song, but that the song can repeat within the data set
# based on the genre. All of the other columns are the same though.
```

	genre	artist_name	track_name	track_id	popularity	acousticness	danceability	duration_ms	energy	instrumentalness	key	liveness
5506	Alternative	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	50	0.08	0.65	125133	0.38	0.00	C#	0.00
15615	Dance	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	61	0.08	0.65	125133	0.38	0.00	C#	0.00
41367	Folk	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	61	0.08	0.65	125133	0.38	0.00	C#	0.00
55106	R&B	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	61	0.08	0.65	125133	0.38	0.00	C#	0.00
77769	Children's Music	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	61	0.08	0.65	125133	0.38	0.00	C#	0.00
94721	Indie	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	61	0.08	0.65	125133	0.38	0.00	C#	0.00
149585	Pop	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	61	0.08	0.65	125133	0.38	0.00	C#	0.00
225238	Rock	Toro y Moi	Monte Carlo (feat. WET)	3R73Y7X53MIQZWnKloWq5i	61	0.08	0.65	125133	0.38	0.00	C#	0.00

Findings from EDA (cont.)



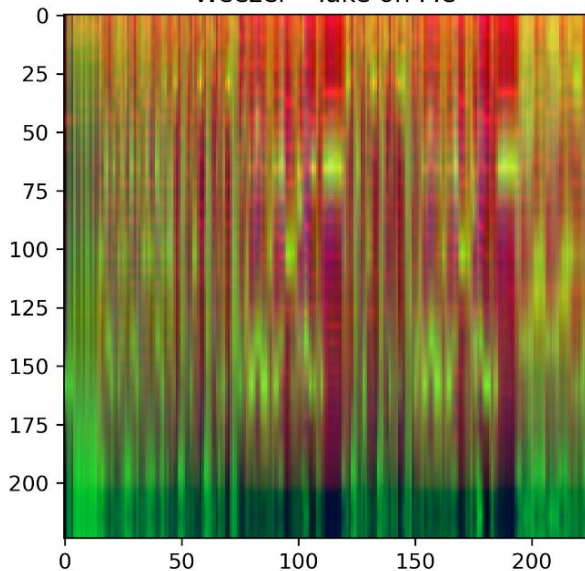
Findings from EDA (cont.)



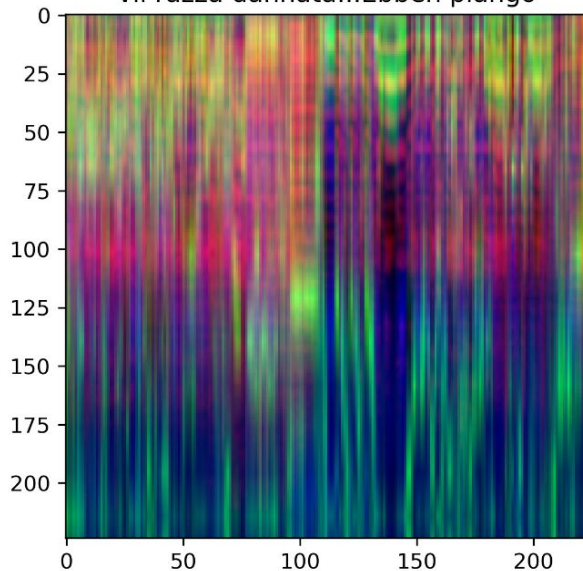
Findings from EDA (cont.)

Visualization of CNN Audio Images

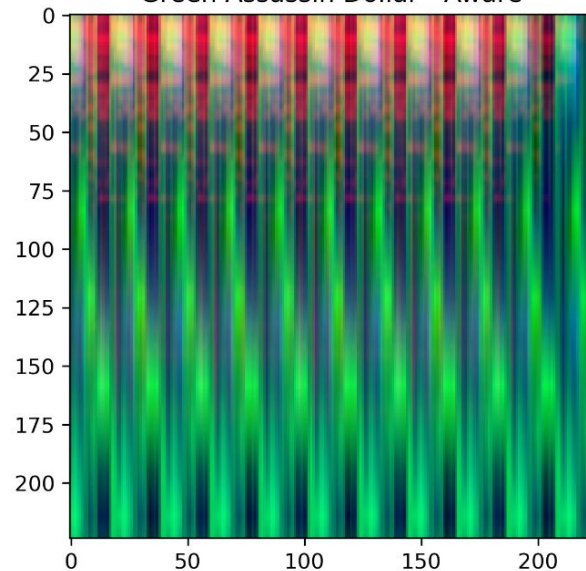
Weezer - Take on Me



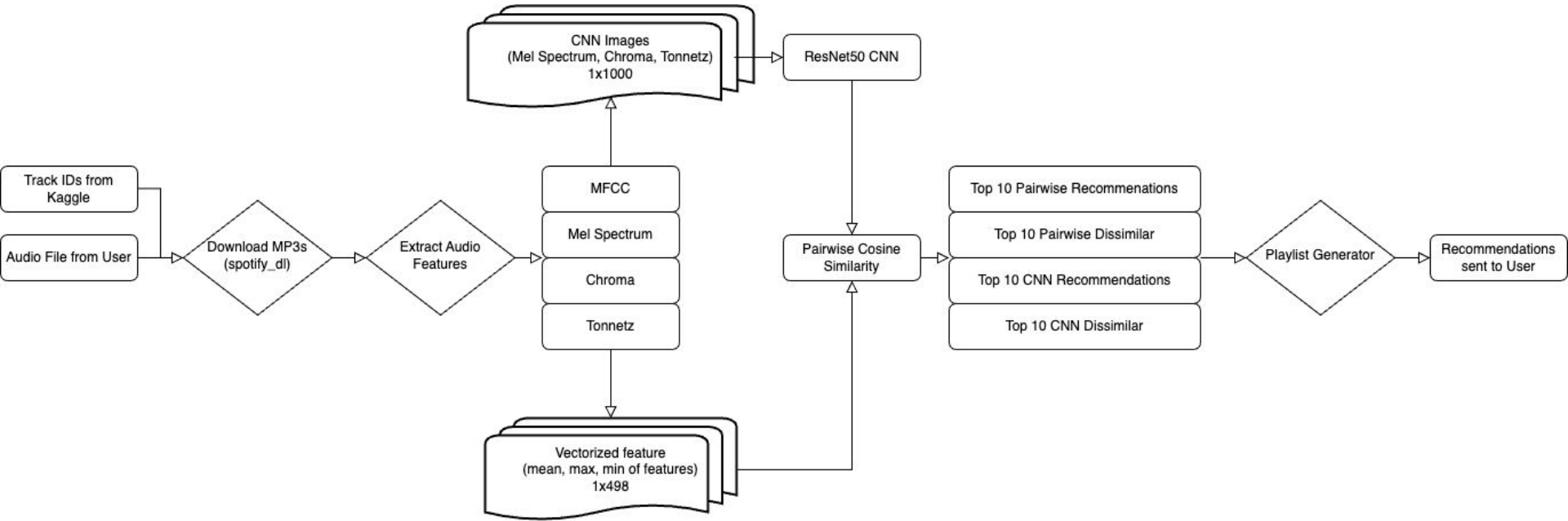
LSO -
Rigoletto Act 2 Cortigiani,
vil razza dannata...Ebben piango



Green Assassin Dollar - Aware

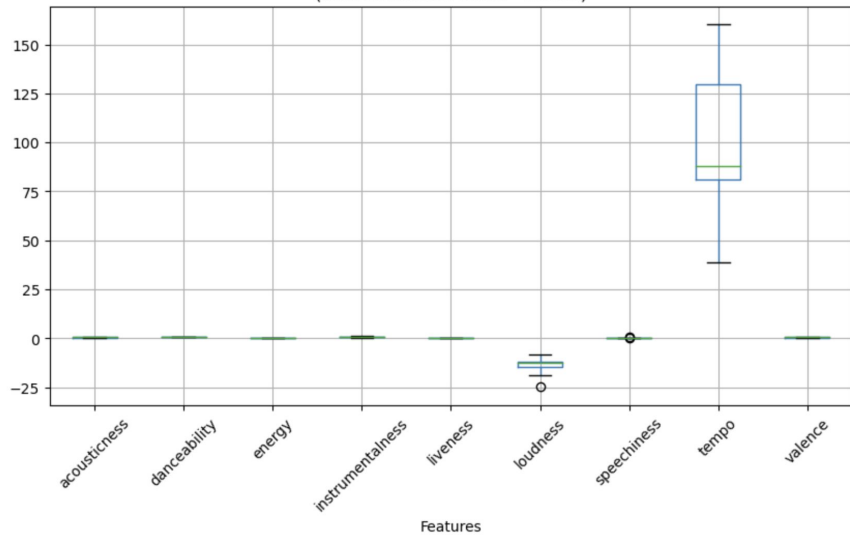


Modeling Procedure

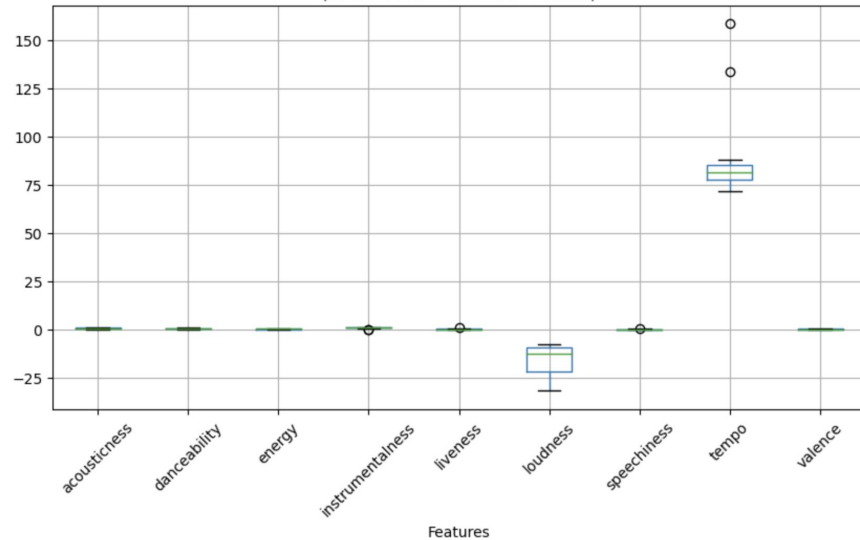


Model Comparison and Interpretation

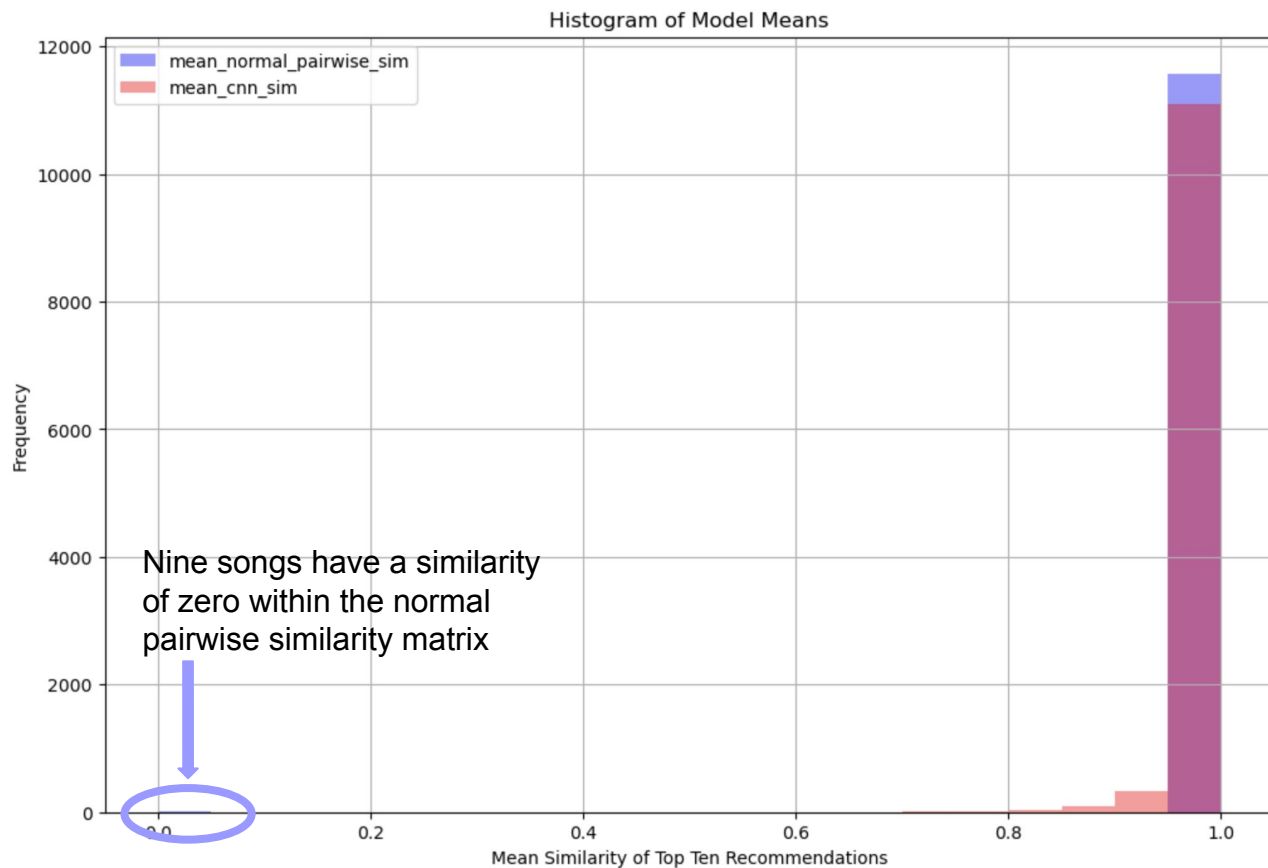
Boxplots of Numerical Features for Normal Pairwise Song Recommendations for 2QbR9yeeX7XHznRZwsyh3F
(Green Assassin Dollar - Aware)



Boxplots of Numerical Features for CNN Song Recommendations for 2QbR9yeeX7XHznRZwsyh3F
(Green Assassin Dollar - Aware)



Model Comparison and Interpretation (cont.)



Model Comparison and Interpretation (cont.)

Public Playlist






DEMO - Pairwise Recommendation Playlist for Track 2QbR9yeeX7XHznRZwsyh3F

These are the top 10 pairwise matches for track 2QbR9yeeX7XHznRZwsyh3F by cosine similarity in descending order.

Vivas Kaul • 11 songs, 25 min 32 sec

Enhance Download Share ...

Custom order

#	Title	Album	Date added	
1	 Aware Green Assassin Dollar	Seed.T6pe	3 days ago	1:14
2	 Recogneyes BluntOne	Layers of the Self	3 days ago	1:40
3	 Ghost Train Haze BluntOne	Forest Walk	3 days ago	1:53
4	 Loverboy The Marias	Superclean, Vol. II	3 days ago	1:13
5	 Loved Ones BluntOne	Loved Ones	3 days ago	1:40

Public Playlist






DEMO - CNN Recommendation Playlist for Track 2QbR9yeeX7XHznRZwsyh3F

These are the top 10 CNN matches for track 2QbR9yeeX7XHznRZwsyh3F by cosine similarity in descending order.

Vivas Kaul • 11 songs, 1 hr 33 min

Enhance Download Share ...

Custom order

#	Title	Album	Date added	
1	 Aware Green Assassin Dollar	Seed.T6pe	3 days ago	1:14
2	 Mirror Mujo, Made in M	Collabs	3 days ago	1:34
3	 Alpha Marc Streitenfeld	The Grey	3 days ago	2:16
4	 Sahasrara BluntOne	Lost & Found	3 days ago	1:36
5	 Strapped ASAP Twelvyy	12	3 days ago	3:18

App Design

- Streamlit/Flask App
 - Return playlists (similar or dissimilar, normal or CNN)
 - This could be done via a post request or as a dashboard in streamlit using a search
 - Song/Artist search
 - Same as above, this could be setup to use a built-in string function or regex
 - User could search for a song within the database and return a set of tracks
 - Artist search let the user select a track before results are returned
- Backend
 - Similarity data
 - Sorted similarity data
 - Kaggle data
 - Subset to training tracks

Future Improvements

- Determine Evaluation Metric for Model
 - Spotify recommendation engine via API
 - Source song-recommendation playlist co-occurrence (Market Basket Analysis)
- Testing Different Models
 - Clustering (DBSCAN, K-Means)
 - Alterations to CNN
 - Layers and Neurons
 - Reinforcement Learning
 - Conversion to supervised learning problem via user feedback
- Productionize Models
 - Streamlit/Flask App
 - Containerize and mount in Cloud
 - AWS - EC2 and ECR

Questions?