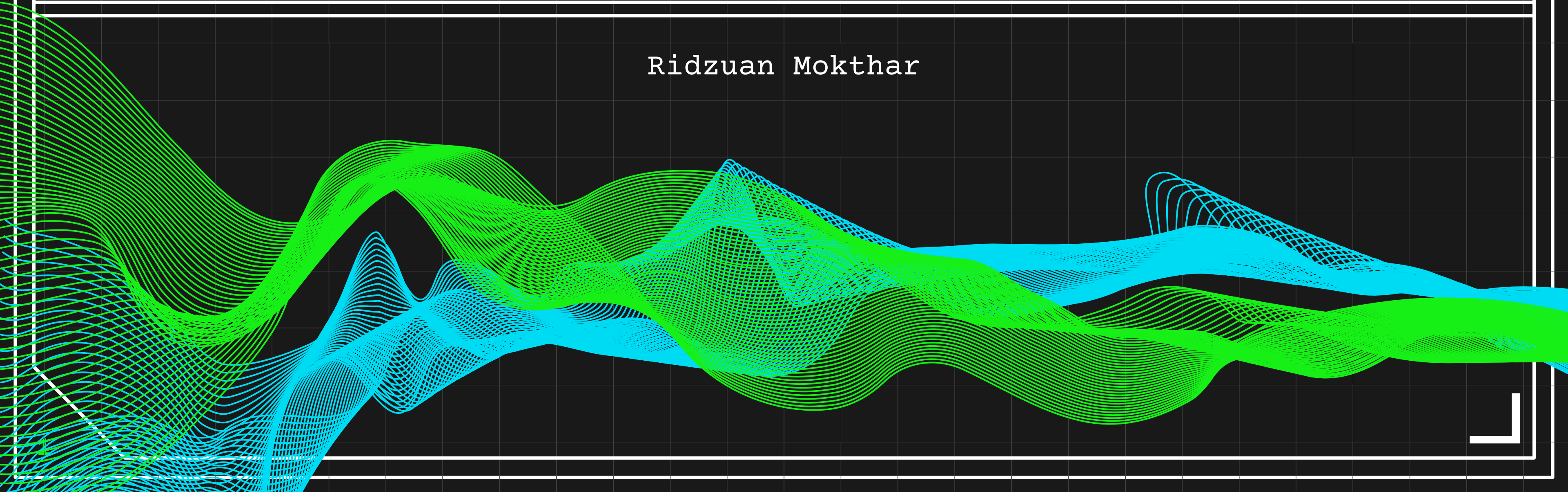
Audio Emotion Classification

Ridzuan Mokthar



Presentation Overview

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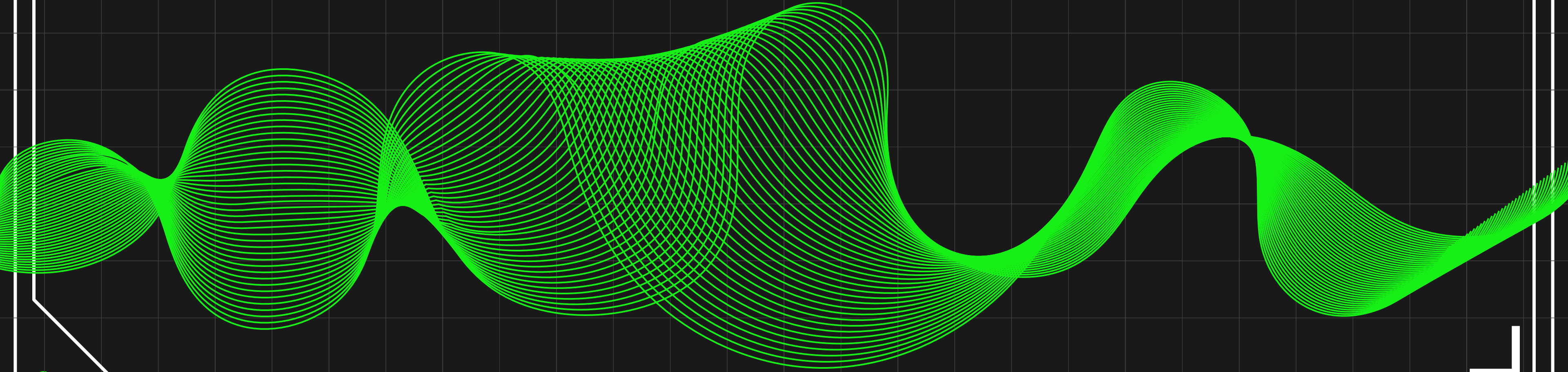
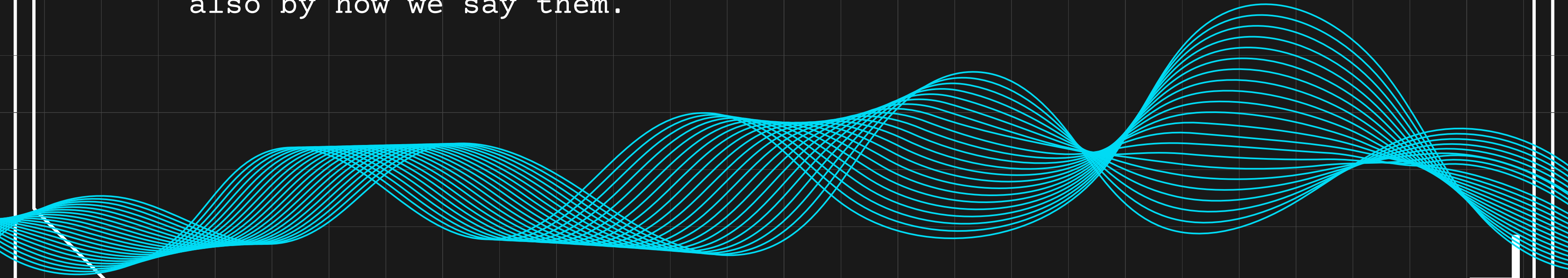
Background & Problem statement



Background

- Communication plays a vital role in building and maintaining relationships with one another.
- Emotional projection is one of the first telltale signs that we notice or observe during a conversation.
- Our emotions can not only be portrayed by what words we say but also by how we say them.



Identifying the Problem

Emotional quotient, Empathy and Alexithymia

- Low Emotional quotient (EQ) is the inability to distinguish emotions in both self and others.
- Cognitive Empathy is the lack of understanding for how others feel.
- Alexithymia is when a person has difficulty identifying and expressing emotions.

Why should we solve it

Foreseen inconveniences

- Poor performance at school or work from lack of communication, inability to express or understand their grievances.
- Degrading Physical & Mental well-being due to stress in turn may lead to a more serious situation such as depression or suicide.
- Failure to foster relationships may lead to them being dysfunctional.
- Low Social Intelligence due to absence of experience with people.
- Violent tendencies induced by stress or confusion

Solution & Benefits

How we plan to solve it?

- CNN Deep Learning
- Prediction Model to predict emotion from speech
- Application to provide educational aid

What are the benefits?

- Given the ability to identify root emotions.
- Improving and also further enforcing their knowledge related to emotions

Datasets

Toronto emotional speech set (TESS)

- 2800 audio files (WAV format)
- 2 voice actors (Old & Young)
- 7 emotions: anger, disgust, fear, happiness, neutral, surprise & sadness

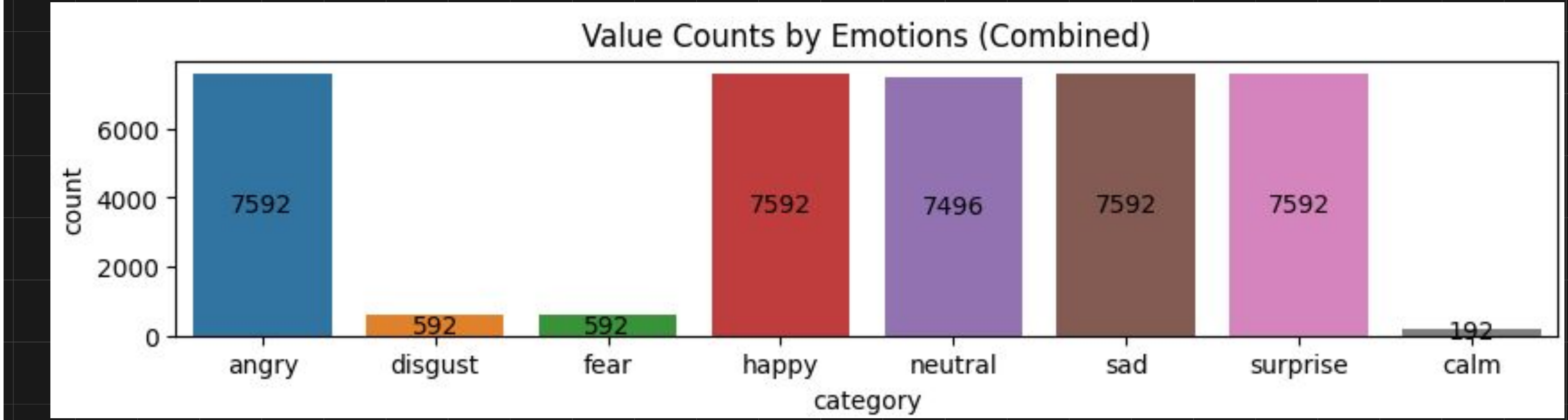
Emotional Speech Dataset (ESD)

- 35000 audio files (WAV format)
- 10 Mandarin & 10 English speakers
- 5 emotions: neutral, happy, angry, sad & surprise

Ryerson Aud-Vis DB of Emo Speech & Song (RAVDESS)

- 1440 audio files (WAV format)
- 24 voice actors (12 male & 12 female)
- 7 emotions: calm, happiness, sadness, anger, fear, disgust and surprise

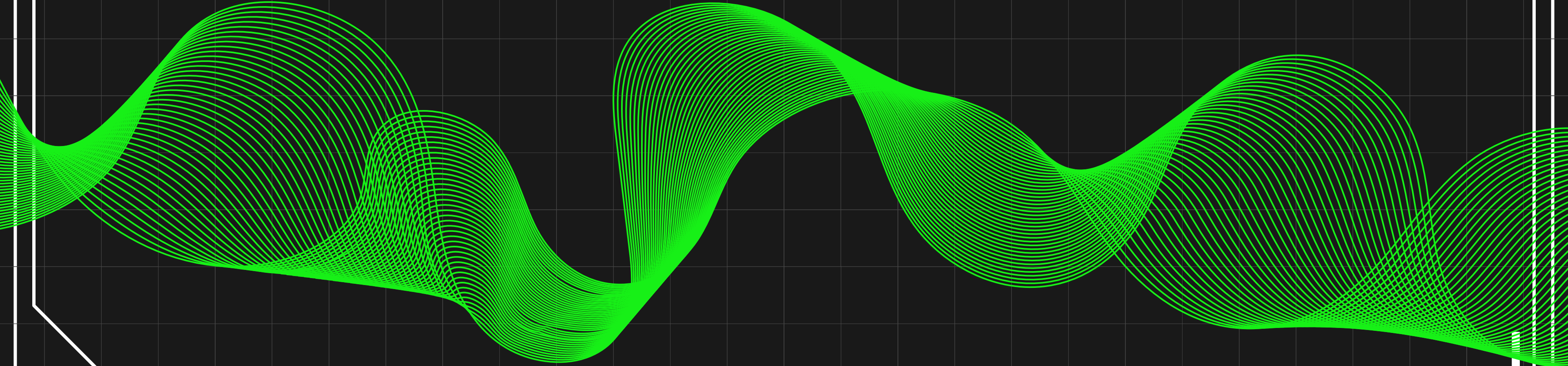
Datasets (Combined)



- Disgust, Fear, and Calm will be dropped due to low observation after combining the 3 dataset. Otherwise they will be noise and affect the model prediction capabilities.

02//

Preprocess & Feature Extraction

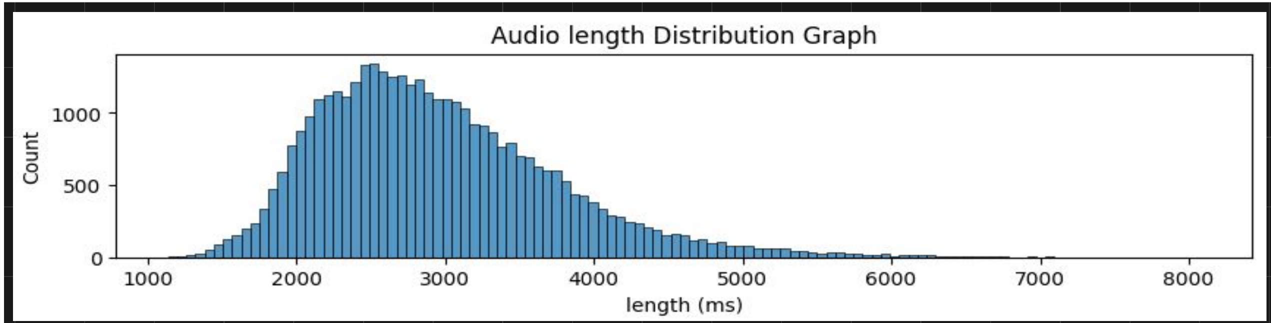


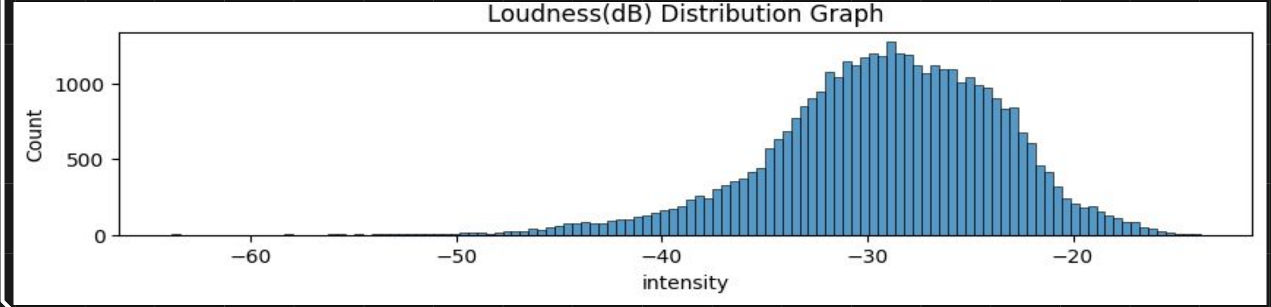
Audio data processing

Standardize basic Audio format/parameters using Librosa:

- Channels: 1 for mono
- Bit depth: 2 for 16-bit
- Sample rate: 22050 Hz

Metadata Inference





- Max audio length: 8080 ms
- Min audio length: 1139 ms

- Loudest audio: -14dBFS
- Softest audio: -64dBFS

Audio Feature Extraction

Features extracted and used for modeling:

1) Chroma energy normalized statistics (CENS)

2) Spectral Bandwidth

3) Spectral Centroid

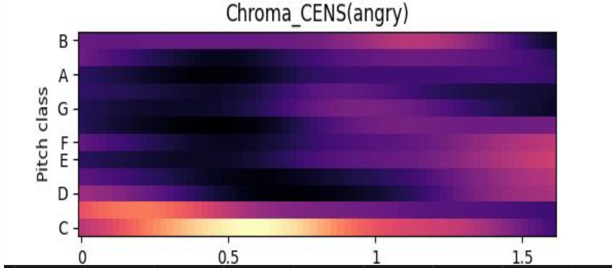
4) Mel-frequency cepstral coefficients (MFCC)

5) Root Mean Square Energy

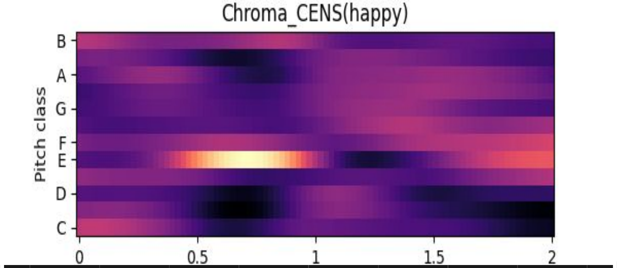
6) Tonal Centroid Features (Tonnetz)

Chroma energy norm statistics

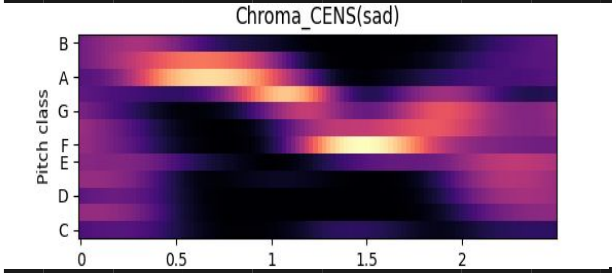
Anger



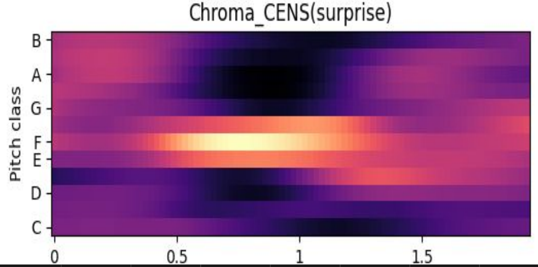
Happiness



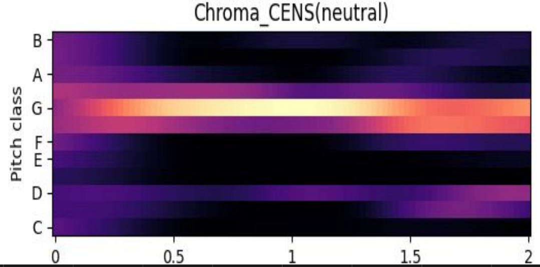
Sadness



Surprised



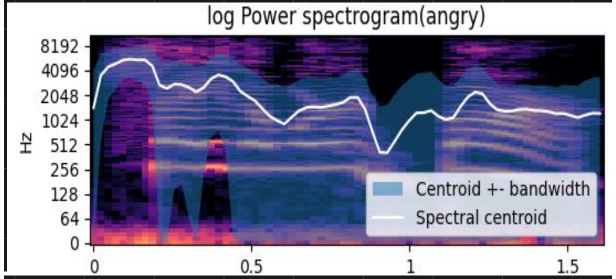
Neutral



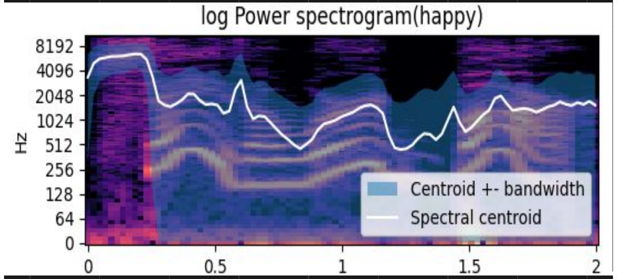
- When using CENS we can see certain pitch class are unique to each emotion.

Spectral Bandwidth + Centroid

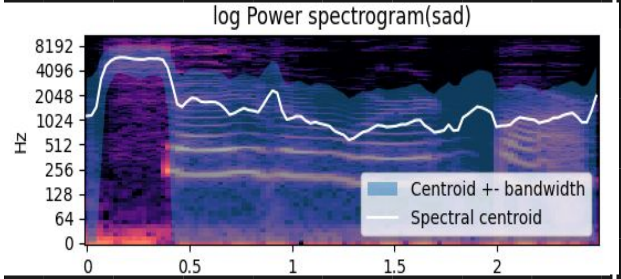
Anger



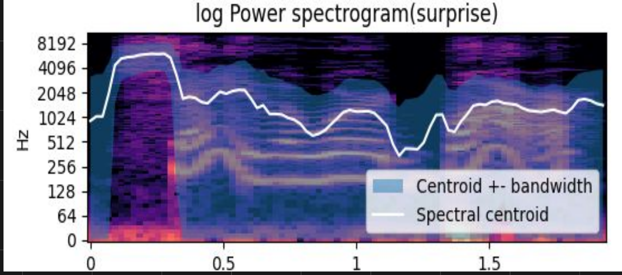
Happiness



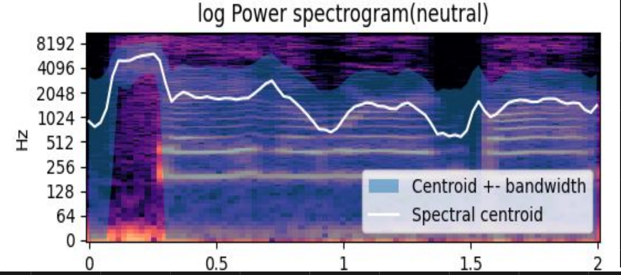
Sadness



Surprised



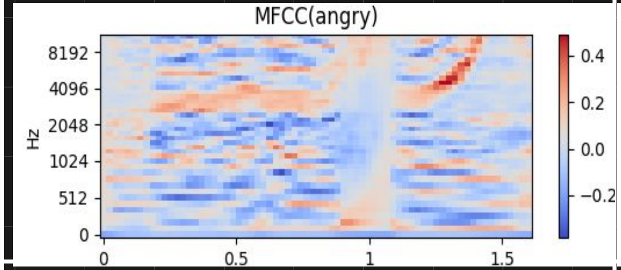
Neutral



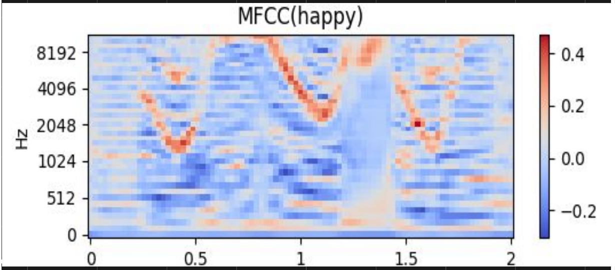
- From this single example we may not be able to visually differentiate between the emotions

Mel-frequency cepstral coef.

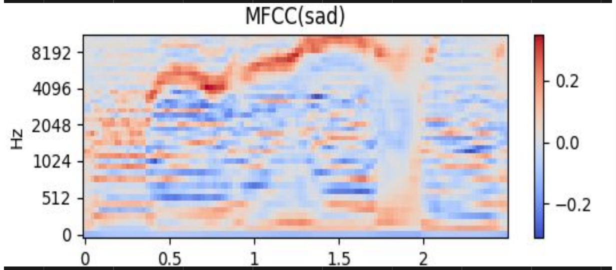
Anger



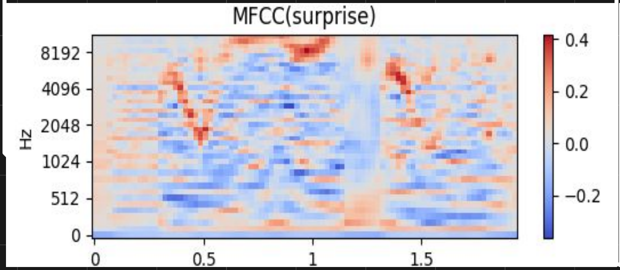
Happiness



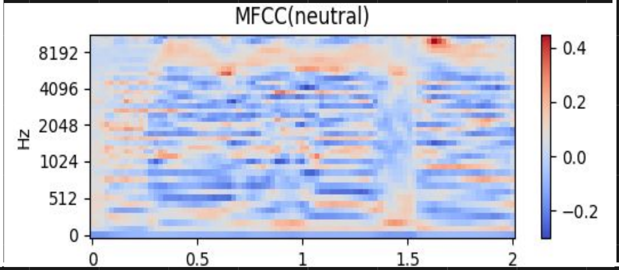
Sadness



Surprised



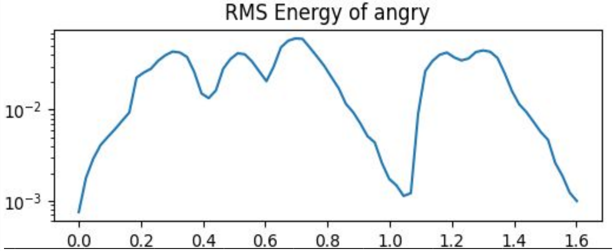
Neutral



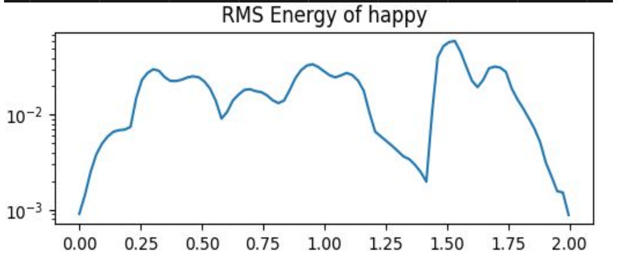
- MFCC holds the entirety of information related to the audio.

Root Mean Square Energy

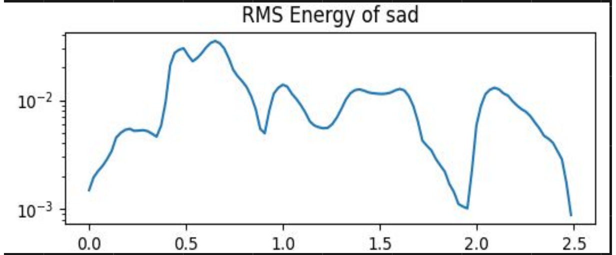
Anger



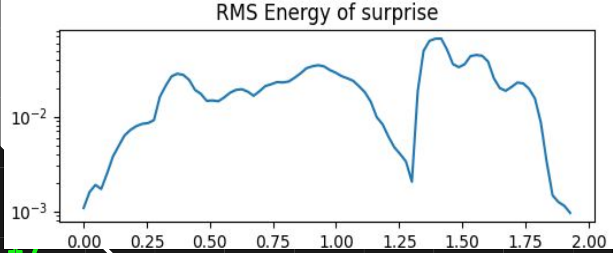
Happiness



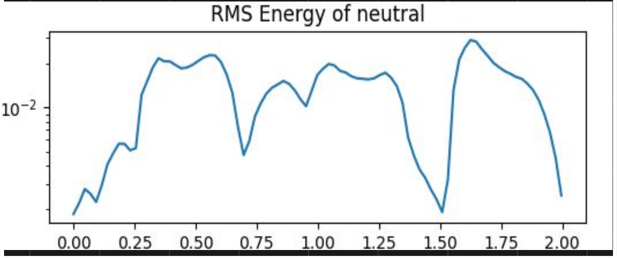
Sadness



Surprised



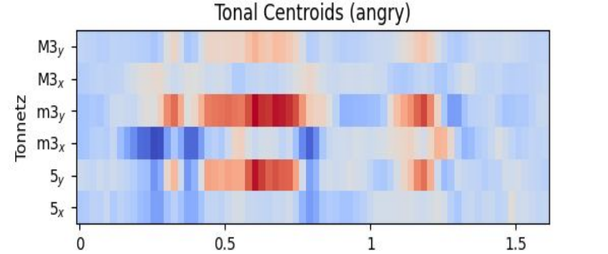
Neutral



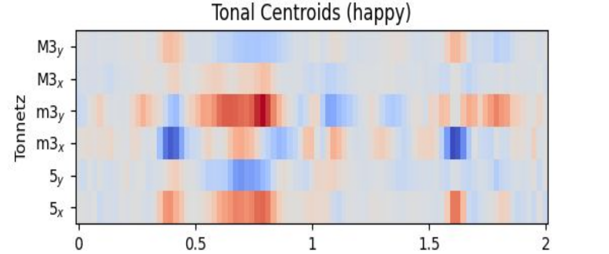
- We can see some minor difference between emotion when observing Peak to valley.

Tonal Centroid Features

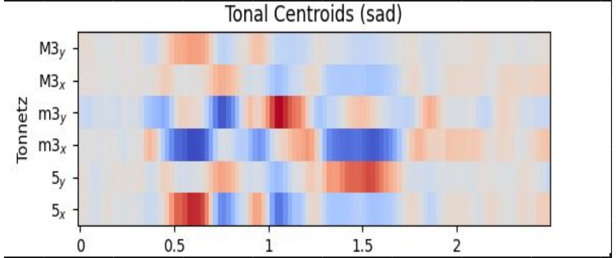
Anger



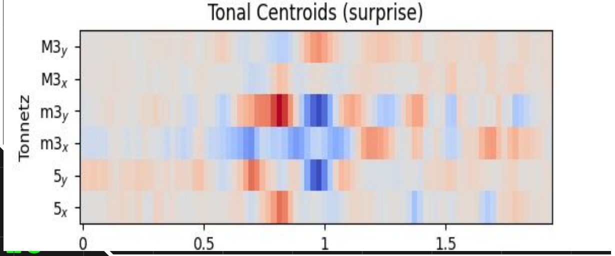
Happiness



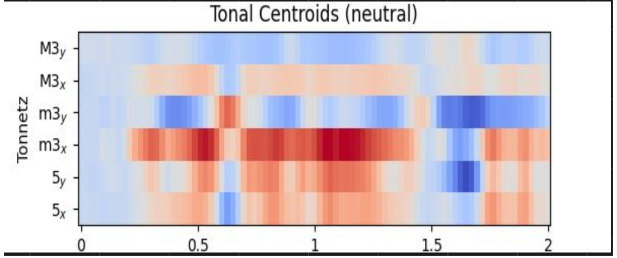
Sadness



Surprised



Neutral



- From here we can see tonal centroid features which are unique to the different emotion class

03//

Model Architecture & Evaluation

Model Metrics

Averaging Techniques for Multiclass classification

- Since our classes are balance we will be mostly looking at Macro average.
  - Macro Average : A simple arithmetic mean of all metrics across classes. This technique gives equal weights to all classes making it a good option for balanced classification tasks.

Metrics Scores

1) Macro Average Accuracy will be the main scoring metric to assess how well the model predict TP & TN.

2) Sub metric will be macro average of Precision & Recall

3) Additional metric is Matthew’s correlation coefficient, it ranges from -1 to 1 where 0 means the model is no better than random chance.

CNN Deep Learning Model

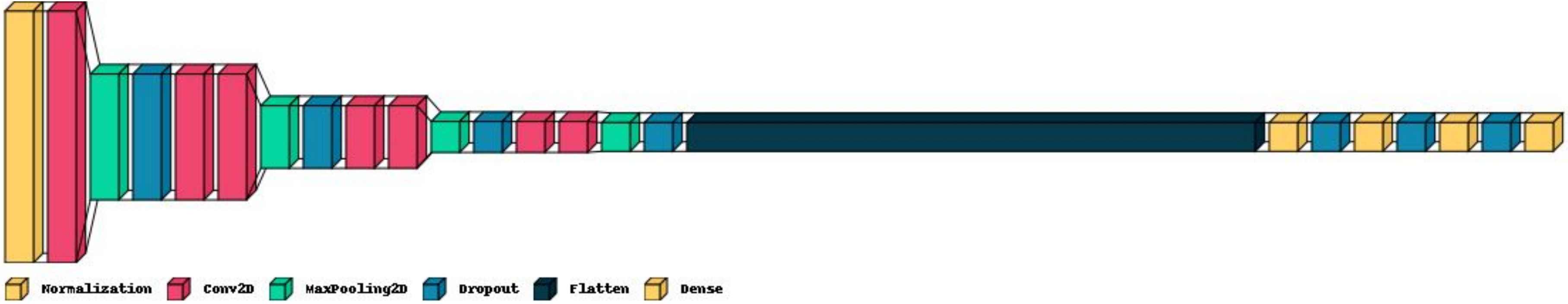
Why CNN Deep Learning was chosen?

- The Convolutional Neural Network built-in convolutional layer reduces the high dimensionality of images without losing its information.

Each Audio feature is a “grayscale image”

- For n features will be our n dimension of the “image” and will undergo convolution & max pooling.
  - The final output of the convolutional layer is an array vector of max values for each features
  - These vectors will be use to train a multi class model

CNN Architecture



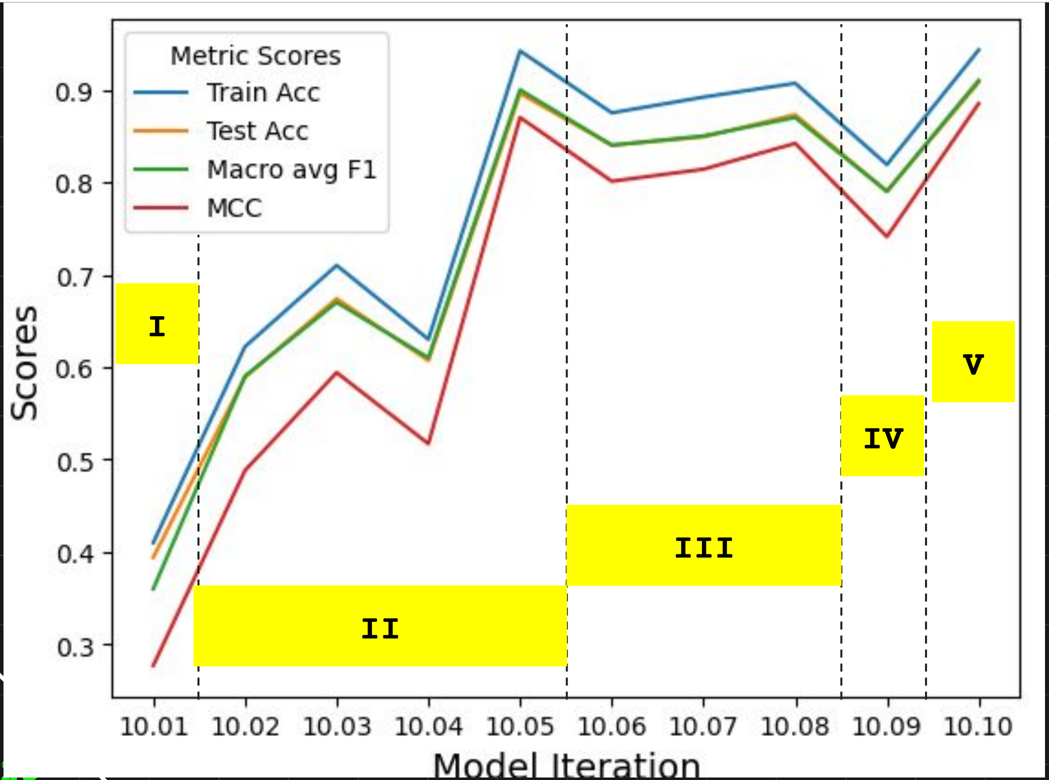
Layer info by colour

Conv(50) → Conv(50) … Conv(75) → Conv(75) … Conv(100) → Conv(100) … Conv(150)

MaxPooling(2,2) → MaxPooling(2,2) → MaxPooling(1,2) → MaxPooling(1,2)

Dense(128) → Dense(64) → Dense(32) → Dense(5, Softmax)

Model Road Map



I) Baseline model

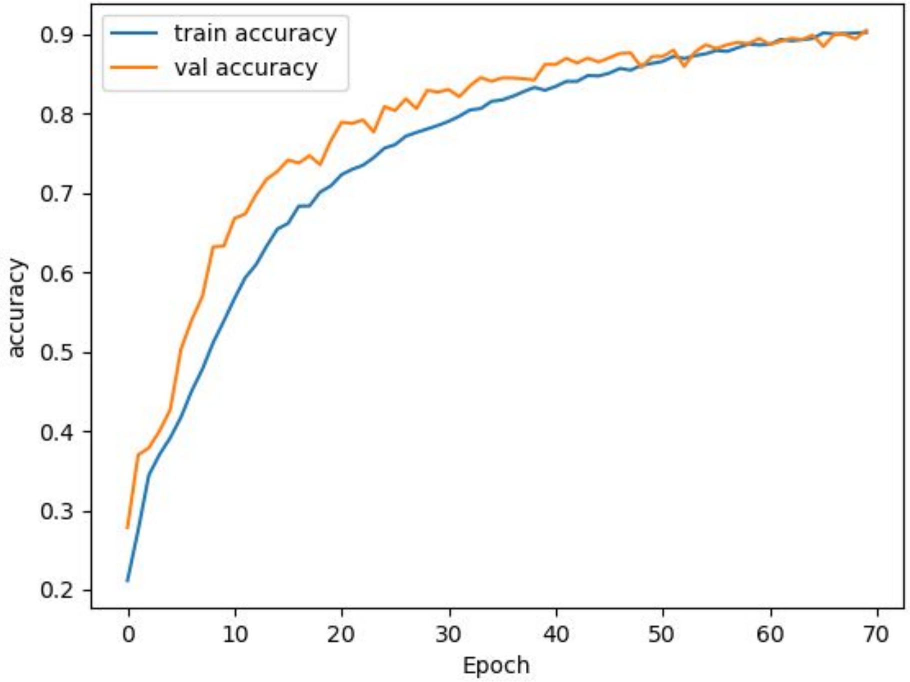
II) Adding more features
10.4 → 10.5 swap out features

III) Adding more features
10.5 → 10.8 swap out features

IV) Adding last feature

V) Change Optimizer to Adamax from Adam

Best Model Evaluation



Train Acc: 0.943

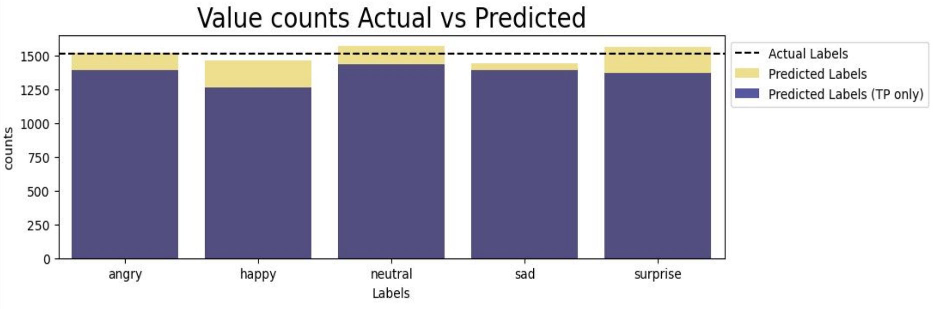
Test Acc: 0.908

Macro average F1-Score: 0.910

MCC: 0.885

Model is not overfitted

Best Model Evaluation

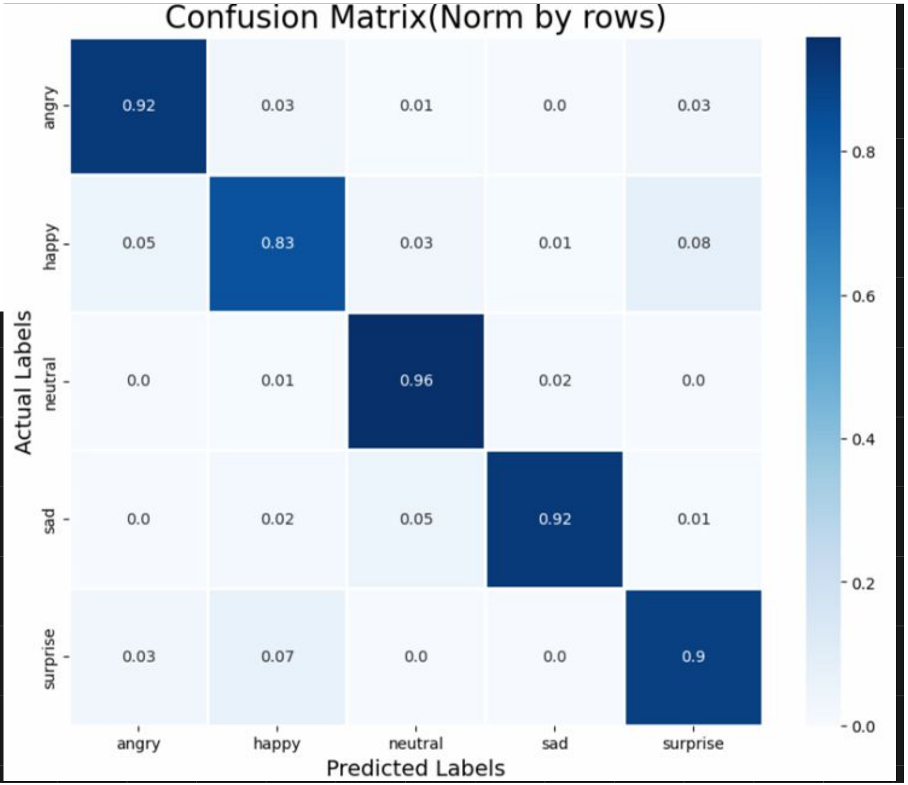


- Most misclassification are from happy & surprise

- Pleasant surprise can be indistinguishable with happy.

- Confusion Matrix Normalized by row (Recall)

- Recall for each class >80%



Application

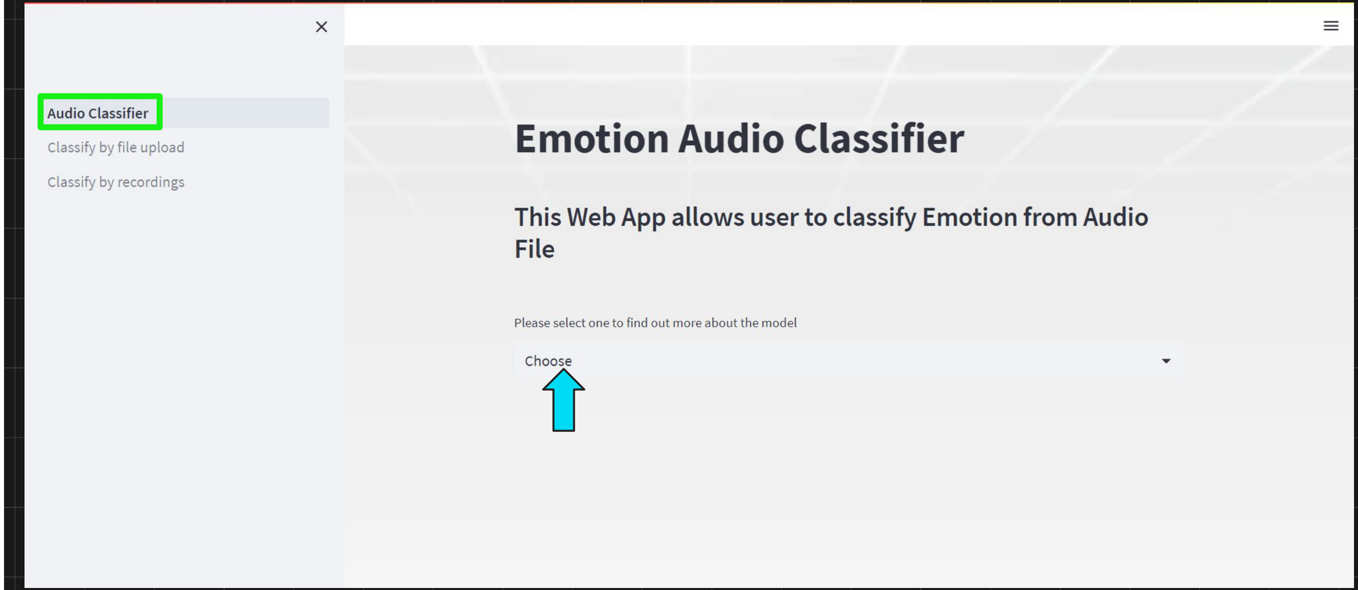
Part 1: classifier

- Two ways to classify audio
  - Upload file
  - Record file
- File uploaded will be preprocessed for prediction
- Predicted Emotion will be displayed

Part2: Scraping

- From Predicted class, get definition and examples.
- Video link for predicted emotion

Application (Main)



Emotion Audio Classifier

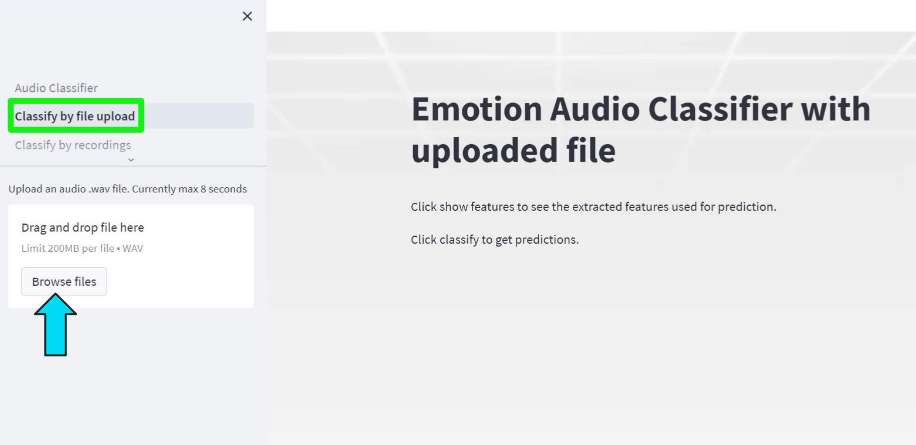
This Web App allows user to classify Emotion from Audio File

Please select one to find out more about the model

Choose

Application (Classifier)

File Upload route



Upload an audio .wav file. Currently max 8 seconds

Drag and drop file here

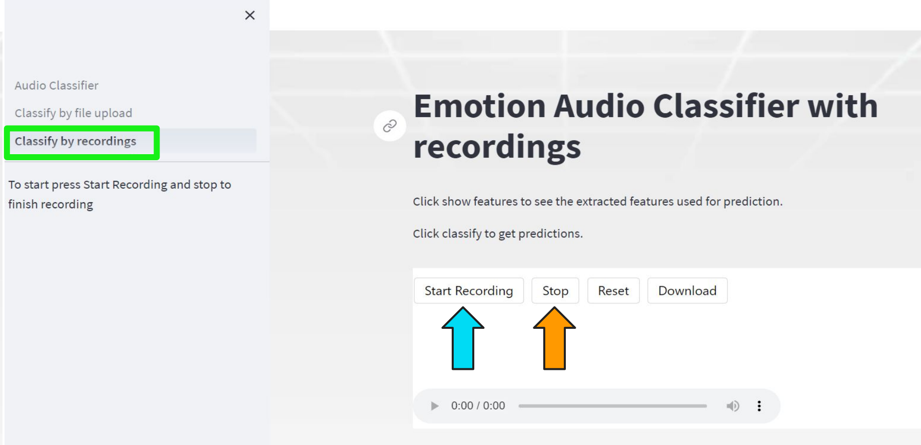
Limit 200MB per file • WAV

Emotion Audio Classifier with uploaded file

Click show features to see the extracted features used for prediction.

Click classify to get predictions.

File Record route



To start press Start Recording and stop to finish recording

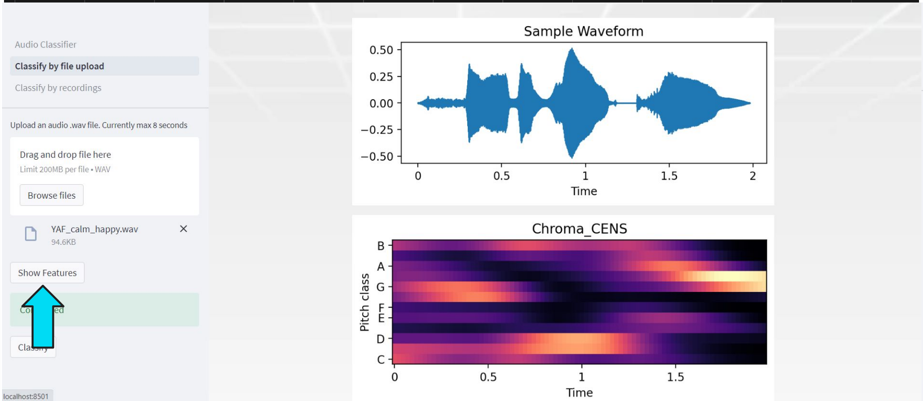
Emotion Audio Classifier with recordings

Click show features to see the extracted features used for prediction.

Click classify to get predictions.

Application (Classifier)

Show Features



Audio Classifier

Classify by file upload

Classify by recordings

Upload an audio .wav file. Currently max 8 seconds

Drag and drop file here

Limit 200MB per file • WAV

Browse files

YAF_calm_happy.wav
94.6KB

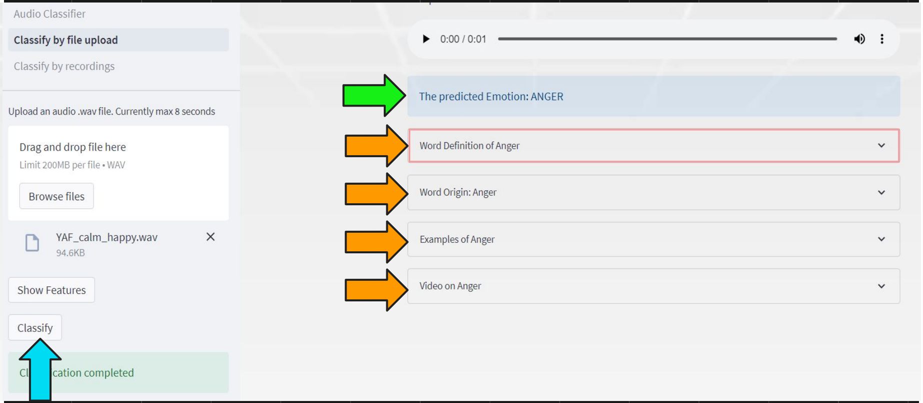
Show Features

Co ed

Classify

localhost:8501

Classify



Audio Classifier

Classify by file upload

Classify by recordings

Upload an audio .wav file. Currently max 8 seconds

Drag and drop file here

Limit 200MB per file • WAV

Browse files

YAF_calm_happy.wav
94.6KB

Show Features

Classify

Cl cation completed

0:00 / 0:01

The predicted Emotion: ANGER

Word Definition of Anger

Word Origin: Anger

Examples of Anger

Video on Anger

04//

Conclusion & Recommendations

Conclusion

Best Model (CNN)

- Optimizer Adamax
- 6 audio features
- Step up conv2d layers
- Step down dense layers

Application Benefits

- Improved emotional awareness
- Better Social Intelligence
- Overall lifestyle change

Recommendations

Automation implementation	**Deployment to Education sector**
- Taking advantage of computer resources to carry out basic repetitive task	- Learning aid - Promote social awareness
Integration to other services	**Other Applications**
- Networking systems where connecting and interaction with people with similar situations are possible.	- Customer services - Healthcare - Personal application

Limitations

5 Emotions	**More to English speaking accent**
Current model only able to predict the 5 basic emotions Anger, Happiness, Neutral, Sadness & Surprise	Data used to train the model is mainly English speaking accent.
Prediction are from whole audio	**Short sentence**
The audio are not segmented to analyse per word basis.	Model was trained with using short phrases instead of full sentences.

Thanks!

Do you have any questions?

https://github.com/Ridzuan-M

in https://www.linkedin.com/in/ridzuan-mokhtar