# Ava McCormack 99121093 CIS4930 Individual Coding Assignment Spring 2023

#### 1. Problem Statement

In this assignment, I was given 4 folders with an assigned emotion each containing 100 audio files. Given the training data, I must build an audio emotion recognition model that is able to detect sentiment given an audio file. To achieve this goal, I used several different audio feature extraction methods and applied them to several different models.

## 2. Data Preparation

First, I read the 400 audio files using librosa by retrieving information such as signal and sample rate and kept them separated by emotion. I also created several plots just to be able to visualize each emotion which is included in my ipynb file.

#### Feature Extraction

I extracted 4 features: Zero Crossing Rate, Loudness, MFCC, and Chroma Vector. Each feature was extracted and saved in a dataframe that contained all 100 files of each respective emotion.

After building those 4 dataframes, I needed to scale the values from -1 to 1.

After scaling, I averaged features every 10 windows for each file.

Following that I needed to average all features in all files by the time windows. I also combined all data into one data frame and assigned a number for each emotion  $\{angry = 0, fear = 1, happy = 2, sad = 3\}$ . This simplified the data and allowed for a much simpler model building stage.

Originally, I had included window in this large array and included it into the model; however, I realized all the models were getting practically the same values. I then took away window and got varying results as expected.

I also realized while model testing that I needed to split the data before averaging the files by window.

After making those changes, I built and tested my models. The scores, however, were quite poor so I reconstructed my data again. (See here for more)

# 3. Model Development

- Model Training
  - I used 4 models: k-Nearest Neighbors, Decision Trees, Naïve Bayes, and Random Forest. I applied each of my 4 extraction features to each model in order to compare and contrast the differences between different models with the same feature extraction methods and the same models with different feature extraction methods. I also created models with all four features.
- Model Evaluation :

### **Comparing Different Models with all Features:**

$\top \top \top \top \top \top \top$	precision	recall	f1-score	support	Decision Tree
	2.25				Accuracy is 0.30
0	0.25	0.73	0.37	11	
1 2	0.75 0.17	0.27 0.09	0.40 0.12	11 11	F1-Score for predicting 'Angry' is 0.37
3	0.17 0.50	0.09	0.12	11	F1-Score for predicting 'Fear is 0.40
3	0.50	0.05	0.15	11	F1-Score for predicting 'Happy is 0.12
accuracy			0.30	44	F1-Score for predicting 'Sad is 0.15
macro avg	0.42	0.30	0.26	44	, ,
weighted avg	0.42	0.30	0.26	44	
+ $+$ $+$ $+$ $+$	precision	recall	f1-score	support	KNN
0	0.00	0.00	0.00	11	Accuracy is 0.23
	0.24	0.91	0.38	11	F1-Score for predicting 'Angry' is 0
2	0.00	0.00	0.00	11	F1-Score for predicting 'Fear is 0.38
3	0.00	0.00	0.00	11	F1-Score for predicting 'Happy is 0
accuracy			0.23	44	F1-Score for predicting 'Sad is 0
macro avg	0.06	0.23	0.09	44	1 1-3core for predicting Sad is 0
weighted avg	0.06	0.23	0.09	44	
	precision	recall	f1-score	support	
					Naïve Bayes
0	0.25	0.09	0.13	11	Accuracy is 0.34
1	0.00	0.00	0.00	11	F1-Score for predicting 'Angry' is 0.13
2	0.26	0.45	0.33	11	
3	0.47	0.82	0.60	11	F1-Score for predicting 'Fear is 0
			0.34		F1-Score for predicting 'Happy is 0.33
accuracy	0.25	0.74	0.34	44	F1-Score for predicting 'Sad is 0.60
macro avg weighted avg	0.25 0.25	0.34 0.34	0.27 0.27	44 44	
weighted avg	0.23	0.34	0.27	44	
	precision	recall	f1-score	support	Random Forest
					Accuracy is 0.32
0	0.40	0.36	0.38	11	
1	0.33	0.55	0.41	11	F1-Score for predicting 'Angry' is 0.38
2	0.20	0.27	0.23	11	F1-Score for predicting 'Fear is 0.41
3	1.00	0.09	0.17	11	F1-Score for predicting 'Happy is 0.23
					F1-Score for predicting 'Sad is 0.17
accuracy	2.42	0.30	0.32	44	·
macro avg	0.48	0.32	0.30	44	
weighted avg	0.48	0.32	0.30	44	

The best accuracy (of 0.45) was actually found in the models with only the zero crossing rate feature. The rest of the models performed quite poorly including the one above so I decided to go back and reevaluate how I was getting data. I decided that instead of averaging files by window size, I would just average all window sizes for each file. This resulted in more values and better model scores overall.

I will forego placing the rest of the scores; however, they are still in the ipynb.

#### **NEW DATASETS MODEL EVALUATION**

**Comparing Different Models with all Features:** 

Recuracy   Recuracy		precision	recall	f1-score	support	Decision Tree
1						Accuracy is 0.72
1						F1-Score for predicting 'Angry' is 0.68
3   0.91   0.97   0.94   30   F1-Score for predicting 'Happy is 0.76   F1-Score for predicting 'Sad is 0.94   F1-Score for predicting 'Angry' is 0.68   F1-Score for predicting 'Angry' is 0.68   F1-Score for predicting 'Happy is 0.47   F1-Score for predicting 'Sad is 0.54   F1-Score for predicting 'Sad is 0.55   F1-Score for predicting 'Sad is 0.57   F1-Score for predicting 'Fear is 0.57   F1-Score for predicting 'Happy is 0   F1-Score for predicting 'Sad is 0.67   F1-Score for predicting 'Angry' is 0.82   F1-Score for predicting 'Angry' is 0.82   F1-Score for predicting 'Sad is 0.98   F1-Score						
Precision   Prec						
### Accuracy ### Accuracy is 0.72	3	0.91	0.97	0.94	30	F1-Score for predicting 'Happy is 0.76
	255110251			0.72	120	F1-Score for predicting 'Sad is 0.94
		0.72	0.72			·
	_					
Accuracy is 0.53    0						
0		precision	recall	f1-score	support	KNN
0						Accuracy is 0.53
2   0.47   0.47   0.47   30   30   30   30   64   0.47   0.54   30   30   30   64   0.47   0.54   30   30   30   64   0.47   0.54   30   30   30   64   0.47   0.54   30   51   120   30   30   30   52   0.53   0.51   120   30   30   30   30   30   30   30		0.57	0.87		30	•
3						
						F1-Score for predicting 'Fear is 0.35
Compact   Comp	3	0.64	0.47	0.54	30	F1-Score for predicting 'Happy is 0.47
	255117251			A E2	120	
		0.52	A 53			1 1-ocore for predicting odd is 0.54
Precision   Prec	_					
0   0.86   0.60   0.71   30   Accuracy is 0.57     1   0.50   0.67   0.57   30   F1-Score for predicting 'Angry' is 0.71     2   0.00   0.00   0.00   30   F1-Score for predicting 'Fear is 0.57     3   0.51   1.00   0.67   30   F1-Score for predicting 'Happy is 0     accuracy	weighted dvg	0.52	0.55	0.51	120	
1		precision	recall	f1-score	support	Naïve Bayes
1		0.05	0.50	0.74	30	Accuracy is 0.57
2   0.00   0.00   0.00   30   30   51   1.00   0.67   30   51   1.00   0.67   30   51   52   52   52   52   52   52   52						
3   0.51   1.00   0.67   30   F1-Score for predicting Fear is 0.57   F1-Score for predicting 'Happy is 0   F1-Score for predicting 'Sad is 0.67   F1-Score for predicting 'Angry' is 0.82   F1-Score for predicting 'Angry' is 0.82   F1-Score for predicting 'F1-Score for predicting 'S1-Score for predicting 'S1-Sc						
### F1-Score for predicting 'Happy is 0   F1-Score for predicting 'Sad is 0.67						F1-Score for predicting 'Fear is 0.57
accuracy macro avg   0.47   0.57   0.49   120     F1-Score for predicting 'Sad is 0.67		0.51	1.00	0.07	50	F1-Score for predicting 'Happy is 0
	accuracy			0.57	120	
precision recall f1-score support   Random Forest     0	macro avg	0.47	0.57	0.49	120	1 1-3core for predicting 3ad is 0.07
Random Forest  0 0.74 0.93 0.82 30 Accuracy is 0.86  1 0.79 0.73 0.76 30 F1-Score for predicting 'Angry' is 0.82  2 0.96 0.80 0.87 30 F1-Score for predicting 'Fear is 0.76  3 1.00 0.97 0.98 30 F1-Score for predicting 'Happy is 0.87  accuracy macro avg 0.87 0.86 0.86 120 F1-Score for predicting 'Sad is 0.98	weighted avg	0.47	0.57	0.49	120	
Random Forest  0 0.74 0.93 0.82 30 Accuracy is 0.86  1 0.79 0.73 0.76 30 F1-Score for predicting 'Angry' is 0.82  2 0.96 0.80 0.87 30 F1-Score for predicting 'Fear is 0.76  3 1.00 0.97 0.98 30 F1-Score for predicting 'Happy is 0.87  accuracy macro avg 0.87 0.86 0.86 120 F1-Score for predicting 'Sad is 0.98	1					
0 0.74 0.93 0.82 30 Accuracy is 0.86 1 0.79 0.73 0.76 30 F1-Score for predicting 'Angry' is 0.82 2 0.96 0.80 0.87 30 F1-Score for predicting 'Fear is 0.76 3 1.00 0.97 0.98 30 F1-Score for predicting 'Happy is 0.87 F1-Score for predicting 'Happy is 0.87 F1-Score for predicting 'Sad is 0.98		precision	recall	f1-score	support	Random Forest
1 0.79 0.73 0.76 30 F1-Score for predicting 'Angry' is 0.82 0.96 0.80 0.87 30 F1-Score for predicting 'Fear is 0.76 F1-Score for predicting 'Fear is 0.76 F1-Score for predicting 'Happy is 0.87 macro avg 0.87 0.86 0.86 120 F1-Score for predicting 'Sad is 0.98		0.74	0.03	0.00	20	
2 0.96 0.80 0.87 30 F1-Score for predicting Angry is 0.82 3 1.00 0.97 0.98 30 F1-Score for predicting 'Fear is 0.76 F1-Score for predicting 'Happy is 0.87    Continue of the predicting angry is 0.82   F1-Score for predicting 'Fear is 0.76						•
3 1.00 0.97 0.98 30 F1-Score for predicting 'Fear is 0.76 F1-Score for predicting 'Happy is 0.87 macro avg 0.87 0.86 0.86 120 F1-Score for predicting 'Sad is 0.98						F1-Score for predicting 'Angry' is 0.82
F1-Score for predicting 'Happy is 0.87  macro avg 0.87 0.86 0.86 120  F1-Score for predicting 'Sad is 0.98						F1-Score for predicting 'Fear is 0.76
macro avg 0.86 0.86 120 F1-Score for predicting 'Sad is 0.98		2100				
macro avg 0.87 0.86 0.86 120 F1-Score for predicting Sad is 0.98	accuracy			0.86	120	
weighted avg 0.87 0.86 0.86 120		0.87	0.86	0.86	120	F1-Score for predicting 'Sad is 0.98
	weighted avg	0.87	0.86	0.86	120	

Already, we can see much better scores.

The model with the highest accuracy when fitted with all features was Random Forest 0.86 The model with the lowest accuracy when fitted with all features was KNN with 0.53

## **Comparing Different Models with Loudness:**

	Dinoroni	Modelo	WILL LO	uuiiess.	
	precision	recall	f1-score	support	Decision Tree
					Accuracy is 0.41
0	0.25	0.30	0.27	30	F1-Score for predicting 'Angry' is 0.27
1 2	0.24 0.70	0.17 0.47	0.20 0.56	30	
3	0.70 0.49	0.47	0.58	30 30	F1-Score for predicting 'Fear is 0.20
3	0.43	0.70	0.30	שכ	F1-Score for predicting 'Happy is 0.56
accuracy			0.41	120	F1-Score for predicting 'Sad is 0.58
macro avg	0.42	0.41	0.40	120	. •
weighted avg	0.42	0.41	0.40	120	
	precision	recall	f1-score	support	KNN
	0.34	0.40	0.37	30	Accuracy is 0.46
0 1	0.34 0.29	0.40 0.33	0.37	30 30	F1-Score for predicting 'Angry' is 0.37
	0.29 0.75	0.40	0.31 0.52	30 30	
3	0.60	0.70	0.65	30	F1-Score for predicting 'Fear is 0.31
' ' '	0.00	0.70	0.03	50	F1-Score for predicting 'Happy is 0.52
accuracy			0.46	120	F1-Score for predicting 'Sad is 0.65
macro avg	0.50	0.46	0.46	120	
weighted avg	0.50	0.46	0.46	120	
1					
	precision	recall	f1-score	support	Naïve Bayes
0					
	0.00	0.00	0.00	20	Accuracy is 0.25
	0.00	0.00	0.00	30 30	Accuracy is 0.25 F1-Score for predicting 'Angry' is 0
1	0.00	0.00	0.00	30	F1-Score for predicting 'Angry' is 0
					F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0
1 2	0.00 0.00	0.00 0.00	0.00 0.00	30 30	F1-Score for predicting 'Angry' is 0
1 2	0.00 0.00	0.00 0.00	0.00 0.00	30 30	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0
accuracy	0.00 0.00	0.00 0.00 1.00 0.25	0.00 0.00 0.40	30 30 30 120 120	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0
1 2 3 accuracy	0.00 0.00 0.25	0.00 0.00 1.00	0.00 0.00 0.40 0.25	30 30 30 120	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0
accuracy	0.00 0.00 0.25 0.06 0.06	0.00 0.00 1.00 0.25 0.25	0.00 0.00 0.40 0.25 0.10 0.10	30 30 30 120 120 120	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40
accuracy	0.00 0.00 0.25	0.00 0.00 1.00 0.25	0.00 0.00 0.40 0.25 0.10	30 30 30 120 120	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0
accuracy macro avg weighted avg	0.00 0.00 0.25 0.06 0.06	0.00 0.00 1.00 0.25 0.25	0.00 0.40 0.25 0.10 0.10	30 30 30 120 120 120 support	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest
accuracy macro avg weighted avg	0.00 0.00 0.25 0.06 0.06 precision	0.00 0.00 1.00 0.25 0.25 recall	0.00 0.40 0.25 0.10 0.10 f1-score	30 30 30 120 120 120 support	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest Accuracy is 0.41
accuracy macro avg weighted avg	0.00 0.00 0.25 0.06 0.06 precision 0.25 0.24	0.00 0.00 1.00 0.25 0.25 recall 0.30 0.17	0.00 0.40 0.25 0.10 0.10 f1-score 0.27 0.20	30 30 30 120 120 120 support	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest Accuracy is 0.41 F1-Score for predicting 'Angry' is 0.27
accuracy macro avg weighted avg	0.00 0.00 0.25 0.06 0.06 precision	0.00 0.00 1.00 0.25 0.25 recall	0.00 0.40 0.25 0.10 0.10 f1-score	30 30 30 120 120 120 support	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest Accuracy is 0.41 F1-Score for predicting 'Angry' is 0.27 F1-Score for predicting 'Fear is 0.20
accuracy macro avg weighted avg	0.00 0.00 0.25 0.06 0.06 precision 0.25 0.24 0.70	0.00 0.00 1.00 0.25 0.25 recall 0.30 0.17 0.47	0.00 0.40 0.25 0.10 0.10 f1-score 0.27 0.20 0.56	30 30 30 120 120 120 support 30 30 30	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest Accuracy is 0.41 F1-Score for predicting 'Angry' is 0.27
accuracy macro avg weighted avg	0.00 0.00 0.25 0.06 0.06 precision 0.25 0.24 0.70	0.00 0.00 1.00 0.25 0.25 recall 0.30 0.17 0.47	0.00 0.40 0.25 0.10 0.10 f1-score 0.27 0.20 0.56	30 30 30 120 120 120 support 30 30 30	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest Accuracy is 0.41 F1-Score for predicting 'Angry' is 0.27 F1-Score for predicting 'Fear is 0.20 F1-Score for predicting 'Happy is 0.56
accuracy macro avg weighted avg  0 1 2 3 accuracy macro avg	0.00 0.25 0.06 0.06 precision 0.25 0.24 0.70 0.49	0.00 0.00 1.00 0.25 0.25 recall 0.30 0.17 0.47 0.70	0.00 0.40 0.25 0.10 0.10 f1-score 0.27 0.20 0.56 0.58	30 30 30 120 120 120 support 30 30 30 30 120 120	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest Accuracy is 0.41 F1-Score for predicting 'Angry' is 0.27 F1-Score for predicting 'Fear is 0.20
accuracy macro avg weighted avg  0 1 2 3	0.00 0.25 0.06 0.06 precision 0.25 0.24 0.70 0.49	0.00 0.00 1.00 0.25 0.25 recall 0.30 0.17 0.47	0.00 0.40 0.25 0.10 0.10 f1-score 0.27 0.20 0.56 0.58	30 30 30 120 120 120 support 30 30 30 30	F1-Score for predicting 'Angry' is 0 F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0.40  Random Forest Accuracy is 0.41 F1-Score for predicting 'Angry' is 0.27 F1-Score for predicting 'Fear is 0.20 F1-Score for predicting 'Happy is 0.56

The model with the highest accuracy when fitted with Loudness was KNN 0.46 The model with the lowest accuracy when fitted with Loudness was Naïve Bayes with 0.25

# **Comparing Different Models with Zero-Crossing Rate:**

						Decision Tree
		precision	recall	f1-score	support	
	0	0.33	0.30	0.32	30	Accuracy is 0.44
	1	0.39	0.37	0.38	30	F1-Score for predicting 'Angry' is 0.32
	2	0.34	0.37	0.35	30	F1-Score for predicting 'Fear is 0.38
	3	0.67	0.73	0.70	30	F1-Score for predicting 'Happy is 0.35
						F1-Score for predicting 'Sad is 0.70
accura		0.42	0.44	0.44 0.44	120	l 1 Coole for predicting Cad to 0.70
macro a		0.43 0.43	0.44 0.44	0.44	120 120	
Weighted	**8	0.43	0.44	0.44	120	
		precision	recall	f1-score	support	KNN
						Accuracy is 0.45
	0 1	0.31	0.43 0.37	0.36	30	F1-Score for predicting 'Angry' is 0.36
	2	0.48 0.30	0.37	0.42 0.32	30 30	F1-Score for predicting 'Fear is 0.42
	3	0.91	0.53	0.77	30	
' '						F1-Score for predicting 'Happy is 0.32
accura	асу			0.45	120	F1-Score for predicting 'Sad is 0.77
macro a	_	0.50	0.45	0.47	120	
weighted a	avg	0.50	0.45	0.47	120	
		precision	recall	f1-score	support	Naïve Bayes
						Accuracy is 0.25
	0 1	0.25 0.00	1.00	0.40	30	•
	- 1		0.00	0.00	30	F1-Score for predicting 'Angry' is 0.40
				a aa		
	2	0.00 0.00	0.00 0.00	0.00 0.00	30 30	F1-Score for predicting 'Fear is 0
	2	0.00	0.00	0.00 0.00	30	F1-Score for predicting 'Fear is 0
accura	2	0.00	0.00		30	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0
macro a	2 3 acy	0.00 0.00 0.06	0.00 0.00 0.25	0.00 0.25 0.10	30 30 120 120	F1-Score for predicting 'Fear is 0
	2 3 acy	0.00 0.00	0.00 0.00	0.00 0.25	30 30 120	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0
macro a	2 3 acy	0.00 0.00 0.06	0.00 0.00 0.25 0.25	0.00 0.25 0.10	30 30 120 120	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0
macro a	2 3 acy	0.00 0.00 0.06 0.06	0.00 0.00 0.25 0.25	0.00 0.25 0.10 0.10	30 30 120 120 120	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0  Random Forest
macro a	2 3 acy avg avg	0.00 0.00 0.06 0.06 precision	0.00 0.00 0.25 0.25 recall	0.00 0.25 0.10 0.10 f1-score	30 30 120 120 120 support	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0
macro a	2 3 acy avg avg	0.00 0.00 0.06 0.06 precision 0.33 0.39	0.00 0.00 0.25 0.25 recall 0.30 0.37	0.00 0.25 0.10 0.10 f1-score 0.32 0.38	30 30 120 120 120 support 30 30	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0  Random Forest Accuracy is 0.44
macro a	2 3 acy avg avg avg 1 2	0.00 0.00 0.06 0.06 precision 0.33 0.39 0.34	0.00 0.00 0.25 0.25 recall 0.30 0.37	0.00 0.25 0.10 0.10 f1-score 0.32 0.38 0.35	30 30 120 120 120 support 30 30 30	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0  Random Forest Accuracy is 0.44 F1-Score for predicting 'Angry' is 0.32
macro a	2 3 acy avg avg	0.00 0.00 0.06 0.06 precision 0.33 0.39	0.00 0.00 0.25 0.25 recall 0.30 0.37	0.00 0.25 0.10 0.10 f1-score 0.32 0.38	30 30 120 120 120 support 30 30	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0  Random Forest Accuracy is 0.44 F1-Score for predicting 'Angry' is 0.32 F1-Score for predicting 'Fear is 0.38
macro a	2 3 acy avg 0 1 2 3	0.00 0.00 0.06 0.06 precision 0.33 0.39 0.34	0.00 0.00 0.25 0.25 recall 0.30 0.37	0.00 0.25 0.10 0.10 f1-score 0.32 0.38 0.35	30 30 120 120 120 support 30 30 30	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0  Random Forest Accuracy is 0.44 F1-Score for predicting 'Angry' is 0.32 F1-Score for predicting 'Fear is 0.38 F1-Score for predicting 'Happy is 0.35
macro a	2 3 acy avg avg 0 1 2 3	0.00 0.00 0.06 0.06 precision 0.33 0.39 0.34 0.67	0.00 0.00 0.25 0.25 recall 0.30 0.37	0.00 0.25 0.10 0.10 f1-score 0.32 0.38 0.35 0.70	30 30 120 120 120 support 30 30 30	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0  Random Forest Accuracy is 0.44 F1-Score for predicting 'Angry' is 0.32 F1-Score for predicting 'Fear is 0.38
macro a weighted a	2 3 acy avg 0 1 2 3 acy	0.00 0.00 0.06 0.06 precision 0.33 0.39 0.34 0.67	0.00 0.00 0.25 0.25 recall 0.30 0.37 0.37	0.00 0.25 0.10 0.10 f1-score 0.32 0.38 0.35 0.70	30 30 120 120 120 support 30 30 30 30	F1-Score for predicting 'Fear is 0 F1-Score for predicting 'Happy is 0 F1-Score for predicting 'Sad is 0  Random Forest Accuracy is 0.44 F1-Score for predicting 'Angry' is 0.32 F1-Score for predicting 'Fear is 0.38 F1-Score for predicting 'Happy is 0.35

The model with the highest accuracy when fitted with zero-crossing was KNN 0.45
The model with the lowest accuracy when fitted with zero-crossing was Naïve Bayes with 0.25

## **Comparing Different Models with MFCC:**

Companing	Different	Models	***************************************	00.	
	precision	recall	f1-score	support	Decision Tree
	0.53	0.77	0.63	30	Accuracy is 0.45
1	0.53 0.32	0.77 0.27	0.63 0.29	30 30	F1-Score for predicting 'Angry' is 0.63
2	0.30	0.27	0.28	30	F1-Score for predicting 'Fear is 0.29
3	0.60	0.50	0.55	30	F1-Score for predicting 'Happy is 0.28
accuracy			0.45	120	F1-Score for predicting 'Sad is 0.55
macro avg	0.44	0.45	0.44	120	
weighted avg	0.44	0.45	0.44	120	
	precision	recall	f1-score	support	KNN
					Accuracy is 0.42
0	0.55	0.87	0.68	30	-
1	0.26	0.23	0.25	30	F1-Score for predicting 'Angry' is 0.68
3	0.36 0.46	0.40 0.20	0.38 0.28	30 30	F1-Score for predicting 'Fear is 0.25
	0.40	0.20	0.20	שכ	F1-Score for predicting 'Happy is 0.38
accuracy			0.42	120	F1-Score for predicting 'Sad is 0.28
macro avg	0.41	0.42	0.40	120	. 5
weighted avg	0.41	0.42	0.40	120	
			£1		N. " . B.
	precision	recall	f1-score	support	Naïve Bayes
0	0.54	0.93	0.68	30	Accuracy is 0.51
1	0.38	0.17	0.23	30	F1-Score for predicting 'Angry' is 0.68
2	0.41	0.40	0.41	30	F1-Score for predicting 'Fear is 0.23
3	0.62	0.53	0.57	30	F1-Score for predicting 'Happy is 0.41
			0. [1	120	
accuracy macro avg	0.49	0.51	0.51 0.47	120 120	F1-Score for predicting 'Sad is 0.57
weighted avg	0.49	0.51	0.47	120	
	precision	recall	f1-score	support	Random Forest
	0.53	0.77	0.63	70	Accuracy is 0.45
1	0.53 0.32	0.77 0.27	0.63 0.29	30 30	F1-Score for predicting 'Angry' is 0.63
2	0.30	0.27	0.28	30	
3	0.60	0.50	0.55	30	F1-Score for predicting 'Fear is 0.29
					F1-Score for predicting 'Happy is 0.28
accuracy			0.45	120	F1-Score for predicting 'Sad is 0.55
macro avg	0.44	0.45	0.44	120	, ,
weighted avg	0.44	0.45	0.44	120	

The model with the highest accuracy when fitted with MFCC was Naïve Bayes 0.51 The model with the lowest accuracy when fitted with MFCC was KNN with 0.42

## **Comparing Different Models with Chroma:**

	Dinorona				Decision Tree
	precision	recall	f1-score	support	
0	0.52	0.53	0.52	30	Accuracy is 0.40
	0.32	0.30	0.34	30	F1-Score for predicting 'Angry' is 0.52
2	0.34	0.40	0.37	30	F1-Score for predicting 'Fear is 0.34
3	0.35	0.37	0.36	30	F1-Score for predicting 'Happy is 0.37
					F1-Score for predicting 'Sad is 0.36
accuracy	0.40	0.40	0.40 0.40	120 120	F1-3core for predicting Sad is 0.30
macro avg weighted avg	0.40 0.40	0.40 0.40	0.40	120	
weighted dvg	0.40	0.40	0.40	120	
	precision	recall	f1-score	support	KNN
					Accuracy is 0.36
0	0.45	0.67	0.54	30	F1-Score for predicting 'Angry' is 0.54
1 2	0.21 0.36	0.20 0.30	0.20 0.33	30 30	
3	0.36	0.27	0.33	30	F1-Score for predicting 'Fear is 0.20
	0.50	0.27	0.51	30	F1-Score for predicting 'Happy is 0.33
accuracy			0.36	120	F1-Score for predicting 'Sad is 0.31
macro avg	0.35	0.36	0.34	120	, ,
weighted avg	0.35	0.36	0.34	120	
	precision	recall	f1-score	support	Neive Bevee
	pi ccision	· ccull	11 30010	Suppor C	Naïve Bayes
0	0.45	0.97	0.61	30	Accuracy is 0.42
1	0.00	0.00	0.00	30	F1-Score for predicting 'Angry' is 0.61
2	0.00	0.00	0.00	30	F1-Score for predicting 'Fear is 0
3	0.38	0.70	0.49	30	F1-Score for predicting 'Happy is 0
accuracy			0.42	120	
macro avg	0.21	0.42	0.28	120	F1-Score for predicting 'Sad is 0.49
weighted avg	0.21	0.42	0.28	120	
1					
	precision	recall	f1-score	support	Random Forest
0	0.52	0.53	0.52	30	Accuracy is 0.40
1	0.32	0.30	0.34	30	•
2	0.34	0.40	0.37	30	F1-Score for predicting 'Angry' is 0.52
3	0.35	0.37	0.36	30	F1-Score for predicting 'Fear is 0.34
					F1-Score for predicting 'Happy is 0.37
accuracy			0.40	120	F1-Score for predicting 'Sad is 0.36
macro avg	0.40 0.40	0.40 0.40	0.40 0.40	120 120	The state of the s
weighted avg	0.40	0.40	0.40	120	

The model with the highest accuracy when fitted with Chroma was Naïve Bayes 0.42 The model with the lowest accuracy when fitted with Chroma was KNN 0.36

If we compare the modified data to the original, we will see an increase of up to 54% in accuracy. The only models with accuracy scores that decreased were three of the Zero-Crossing Feature models; however, the scores were only decreased by 0.01, 0.01, 0.9 and the increase to one was .20.

Now, we will summarize the results of the modified data models.

The **overall best model**, Random Forest fitted with all features, had an accuracy score of 0.86 The **best single feature model**, Naïve Bayes fitted with MFCC, had an accuracy score of 0.51

#### **Comparing Same Model with Different Features:**

**ALL models** with all features performed best with accuracy scores of 0.72, 0.53, 0.57, and 0.86

If we look at just individual features:
Decision Tree with MFCC - 0.45
KNN with Loudness - 0.46
Naïve Bayes with MFCC - 0.51
Random Forest with MFCC - 0.45

#### 4. Discussion

- My best model performs with an accuracy of 86%.
- Some problems I ran into during this assignment, was the vast amount of data.
- I also had trouble trying to transform the data into the appropriate format.
- I would realize I had gone wrong somewhere while observing the results of model testing and fix my data
- I also had issues with figuring out how to apply the extracted features to the classifiers I have used previously. This ended up being quite simple, but I was unsure how to approach it at first.

## 5. Appendix

Colab: <a href="https://colab.research.google.com/drive/1GpuQHtSQifkt0KZ8ESmneOlS-bZ120SX?usp=sharing">https://colab.research.google.com/drive/1GpuQHtSQifkt0KZ8ESmneOlS-bZ120SX?usp=sharing</a>