

## Model Metrics:

|                                  | precision | recall   | f1-score |
|----------------------------------|-----------|----------|----------|
| <b>cnn_spectrogram_model</b>     | 0.382476  | 0.436457 | 0.396434 |
| <b>cnn_mfcc_model</b>            | 0.328554  | 0.357161 | 0.324103 |
| <b>random_forest_model</b>       | 0.302282  | 0.371758 | 0.305980 |
| <b>resnet_mfcc_model</b>         | 0.292270  | 0.333644 | 0.289393 |
| <b>mean_mfcc_nn_model</b>        | 0.304392  | 0.388999 | 0.285756 |
| <b>svm_model</b>                 | 0.261212  | 0.303996 | 0.250091 |
| <b>logistic_regression_model</b> | 0.249118  | 0.289352 | 0.215834 |

## Convolutional Neural Network with Mel-Frequency Spectrogram Features:

| classification Report: |           |        |          |         |
|------------------------|-----------|--------|----------|---------|
|                        | precision | recall | f1-score | support |
| 0                      | 0.45      | 0.65   | 0.53     | 705     |
| 1                      | 0.70      | 0.44   | 0.54     | 2163    |
| 2                      | 0.35      | 0.40   | 0.37     | 405     |
| 3                      | 0.61      | 0.71   | 0.65     | 562     |
| 4                      | 0.38      | 0.60   | 0.46     | 750     |
| 5                      | 0.26      | 0.23   | 0.24     | 193     |
| 6                      | 0.25      | 0.43   | 0.32     | 44      |
| 7                      | 0.06      | 0.04   | 0.05     | 294     |
| accuracy               |           |        | 0.49     | 5116    |
| macro avg              | 0.38      | 0.44   | 0.40     | 5116    |
| weighted avg           | 0.53      | 0.49   | 0.49     | 5116    |

## Convolutional Neural Network with Mel-Frequency Cepstral Coefficient Features:

| classification Report: |           |        |          |         |
|------------------------|-----------|--------|----------|---------|
|                        | precision | recall | f1-score | support |
| 0                      | 0.44      | 0.41   | 0.43     | 705     |
| 1                      | 0.67      | 0.39   | 0.49     | 2163    |
| 2                      | 0.20      | 0.47   | 0.28     | 405     |
| 3                      | 0.61      | 0.54   | 0.57     | 562     |
| 4                      | 0.35      | 0.56   | 0.43     | 750     |
| 5                      | 0.17      | 0.17   | 0.17     | 193     |
| 6                      | 0.11      | 0.25   | 0.15     | 44      |
| 7                      | 0.08      | 0.07   | 0.08     | 294     |
| accuracy               |           |        | 0.41     | 5116    |
| macro avg              | 0.33      | 0.36   | 0.32     | 5116    |
| weighted avg           | 0.49      | 0.41   | 0.43     | 5116    |

### Convolutional Neural Network with ResNet50 with MFCC Features:

| classification Report: |           |        |          |         |
|------------------------|-----------|--------|----------|---------|
|                        | precision | recall | f1-score | support |
| 0                      | 0.37      | 0.42   | 0.39     | 705     |
| 1                      | 0.60      | 0.32   | 0.42     | 2163    |
| 2                      | 0.19      | 0.27   | 0.22     | 405     |
| 3                      | 0.49      | 0.48   | 0.49     | 562     |
| 4                      | 0.32      | 0.50   | 0.39     | 750     |
| 5                      | 0.13      | 0.22   | 0.16     | 193     |
| 6                      | 0.06      | 0.39   | 0.10     | 44      |
| 7                      | 0.10      | 0.07   | 0.09     | 294     |
| accuracy               |           |        | 0.36     | 5116    |
| macro avg              | 0.28      | 0.34   | 0.28     | 5116    |
| weighted avg           | 0.43      | 0.36   | 0.37     | 5116    |

### Neural Network with Mean MFCC Value Features:

| classification Report: |           |        |          |         |
|------------------------|-----------|--------|----------|---------|
|                        | precision | recall | f1-score | support |
| 0                      | 0.41      | 0.42   | 0.42     | 717     |
| 1                      | 0.73      | 0.21   | 0.33     | 2137    |
| 2                      | 0.25      | 0.31   | 0.28     | 412     |
| 3                      | 0.35      | 0.69   | 0.47     | 552     |
| 4                      | 0.41      | 0.37   | 0.39     | 772     |
| 5                      | 0.12      | 0.37   | 0.19     | 182     |
| 6                      | 0.07      | 0.63   | 0.13     | 63      |
| 7                      | 0.07      | 0.10   | 0.09     | 281     |
| accuracy               |           |        | 0.33     | 5116    |
| macro avg              | 0.30      | 0.39   | 0.29     | 5116    |
| weighted avg           | 0.49      | 0.33   | 0.34     | 5116    |

### Logistic Regression with Mean MFCC Value Features:

|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 0.34      | 0.22   | 0.26     | 1413    |
| 1            | 0.66      | 0.24   | 0.35     | 4206    |
| 2            | 0.17      | 0.14   | 0.15     | 829     |
| 3            | 0.24      | 0.58   | 0.34     | 1168    |
| 4            | 0.39      | 0.35   | 0.37     | 1559    |
| 5            | 0.09      | 0.22   | 0.13     | 378     |
| 6            | 0.04      | 0.52   | 0.07     | 110     |
| 7            | 0.07      | 0.05   | 0.06     | 568     |
| accuracy     |           |        | 0.28     | 10231   |
| macro avg    | 0.25      | 0.29   | 0.22     | 10231   |
| weighted avg | 0.42      | 0.28   | 0.30     | 10231   |

# Random Forest with Mean MFCC Value Features:

|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 0.41      | 0.52   | 0.46     | 1413    |
| 1            | 0.69      | 0.31   | 0.43     | 4206    |
| 2            | 0.27      | 0.33   | 0.29     | 829     |
| 3            | 0.42      | 0.66   | 0.51     | 1168    |
| 4            | 0.36      | 0.52   | 0.43     | 1559    |
| 5            | 0.14      | 0.24   | 0.18     | 378     |
| 6            | 0.07      | 0.37   | 0.12     | 110     |
| 7            | 0.07      | 0.02   | 0.04     | 568     |
| accuracy     |           |        | 0.39     | 10231   |
| macro avg    | 0.30      | 0.37   | 0.31     | 10231   |
| weighted avg | 0.47      | 0.39   | 0.40     | 10231   |

# Support Vector Classifier with Mean MFCC Value Features:

|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 0.37      | 0.34   | 0.36     | 1413    |
| 1            | 0.63      | 0.25   | 0.36     | 4206    |
| 2            | 0.21      | 0.24   | 0.23     | 829     |
| 3            | 0.27      | 0.82   | 0.40     | 1168    |
| 4            | 0.35      | 0.34   | 0.34     | 1559    |
| 5            | 0.14      | 0.20   | 0.16     | 378     |
| 6            | 0.08      | 0.21   | 0.11     | 110     |
| 7            | 0.05      | 0.03   | 0.04     | 568     |
| accuracy     |           |        | 0.33     | 10231   |
| macro avg    | 0.26      | 0.30   | 0.25     | 10231   |
| weighted avg | 0.42      | 0.33   | 0.32     | 10231   |