In [ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

In [ ]:
```
# Usual Libraries
import pandas as pd
import numpy as np
import seaborn as sns
import os
import matplotlib.pyplot as plt
%matplotlib inline
import sklearn

# Librosa (the mother of audio files)
import librosa
import librosa.display
import IPython.display as ipd
import warnings
warnings.filterwarnings('ignore')
```

Initial Audio Analysis

In [ ]:
```
#loading audio file
y, sr = librosa.load('/content/drive/MyDrive/genres_original/blues/blues.00000

print('\nNumerical Features :', y)
print('\n shape of the converted Audio files :', np.shape(y))
print('\n Sample Rate (Hz):', sr)

print('Length of the Audio File in seconds:', len(y)/sr)
```

```
Numerical Features : [ 0.00732422  0.01660156  0.00762939 ... -0.05560303 -0.0
6106567
 -0.06417847]

 shape of the converted Audio files : (661794,)

 Sample Rate (Hz): 22050
Length of the Audio File in seconds: 30.013333333333332
```

In [ ]:
```
#Trimming silence
audio_file, _ = librosa.effects.trim(y)

print('Audio File:', audio_file, '\n')
print('Audio File shape:', np.shape(audio_file))
```

```
Audio File: [ 0.00732422  0.01660156  0.00762939 ... -0.05560303 -0.06106567
 -0.06417847]

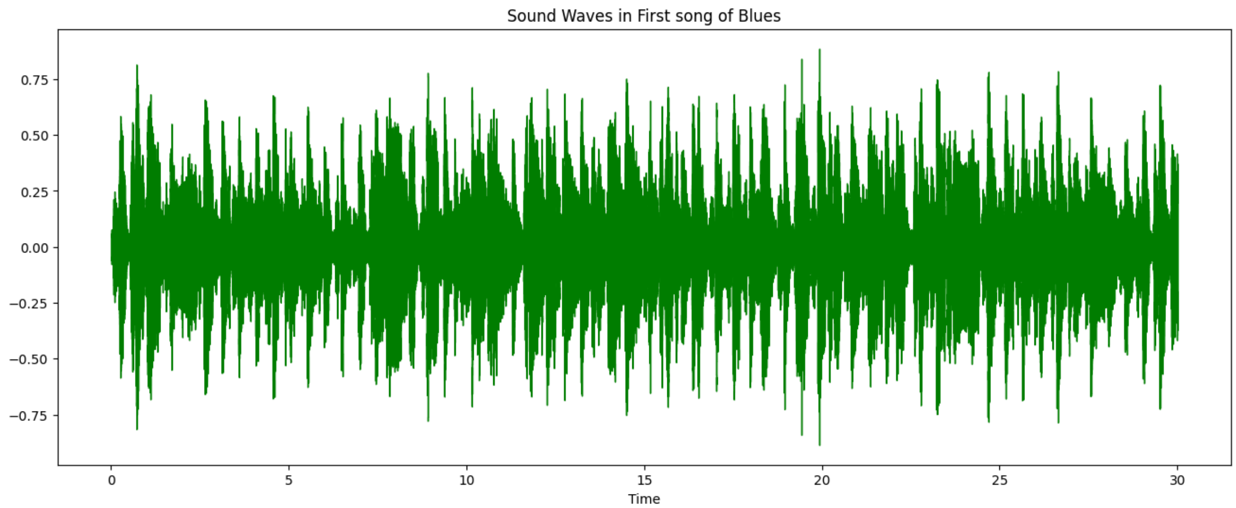
Audio File shape: (661794,)
```

Visual representation of Audio File

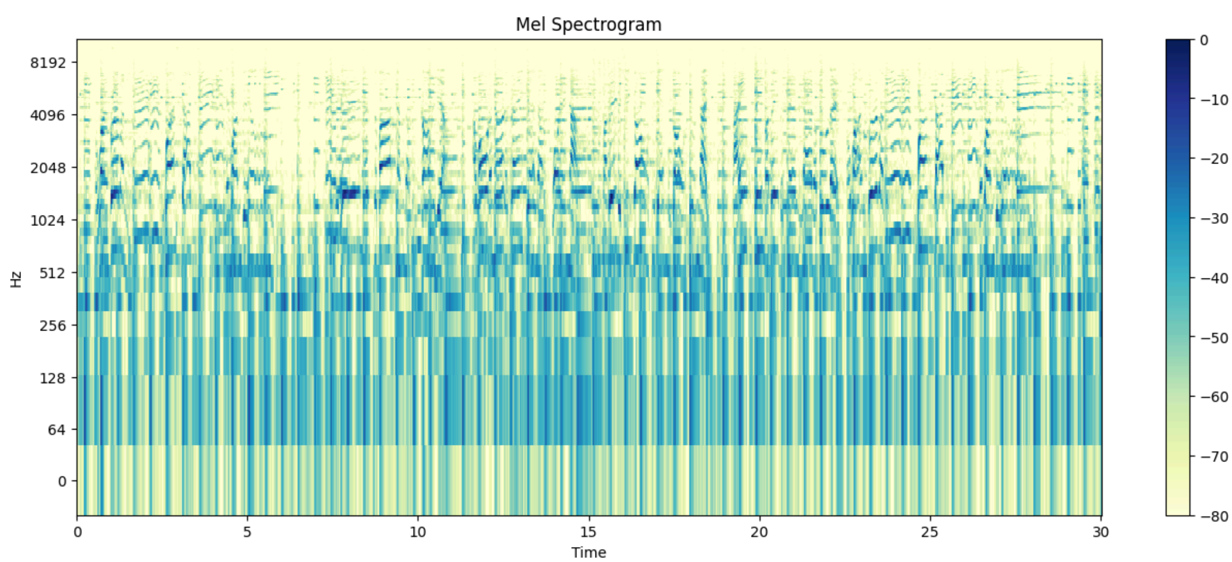
In [ ]:
```
filelocation='/content/drive/MyDrive/genres_original'
hop_length=512
```

```
genre_names = ["blues", "classical", "country", "disco", "hiphop", "jazz", "me
```

In [ ]:
```
plt.figure(figsize = (16, 6))
librosa.display.waveshow(y = audio_file, sr = sr, color = "green");
plt.title("Sound Waves in First song of Blues");
```



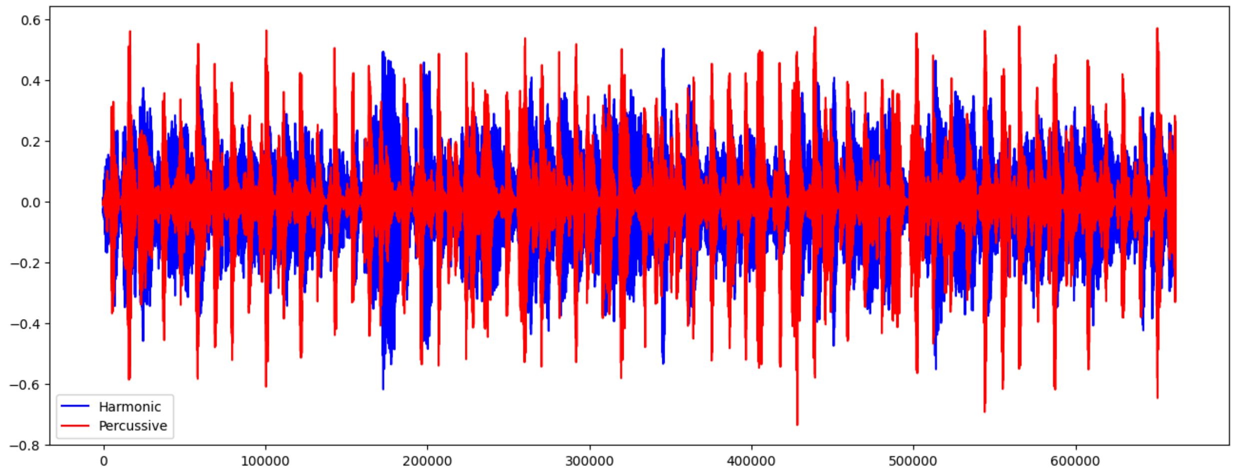
In [ ]:
```
#Mel spectogram
S = librosa.feature.melspectrogram(y=y, sr=sr)
S_DB = librosa.amplitude_to_db(S, ref=np.max)
plt.figure(figsize=(16, 6))
librosa.display.specshow(S_DB, sr=sr, hop_length=512, x_axis='time', y_axis='l
plt.colorbar()
plt.title("Mel Spectrogram",)
plt.show()
```



Harmonic and precussive components

In [ ]:
```
harm,perc = librosa.effects.hpss(audio_file)
plt.figure(figsize = (16, 6))
plt.plot(harm, color='blue',label='Harmonic');
plt.plot(perc, color='red',label='Percussive')
```

```
plt.legend()
plt.show()
```



In [ ]:
```
#Tempo analysis
tempo, _ = librosa.beat.beat_track(y=y, sr=sr)
print('Beats per Minute is ',tempo)
```

```
Beats per Minute is  123.046875
```

Feature Engineering

In [ ]:
```
#Extracting MFCCs
mfcc = librosa.feature.mfcc(y=y, sr=sr, hop_length=512, n_mfcc=13)
mfcc.shape
mfcc.T[0:1200,:].shape
```

Out[ ]:
```
(1200, 13)
```

In [ ]:
```
mfcc
```

Out[ ]:
```
array([[-2.40635422e+02, -2.11214355e+02, -1.93908890e+02, ...,
        -1.09999146e+02, -8.68144302e+01, -8.40735855e+01],
       [ 9.96476364e+01,  1.01042831e+02,  1.02243965e+02, ...,
         1.50079346e+02,  1.38948669e+02,  1.38309769e+02],
       [-7.40327501e+00, -8.35852528e+00,  1.91543472e+00, ...,
        -5.07951355e+01, -3.65361443e+01, -2.81363564e+01],
       ...,
       [-2.22809958e+00, -4.09619999e+00, -9.18501282e+00, ...,
        -1.21473036e+01, -9.28038597e+00, -1.04724808e+01],
       [-3.98046923e+00,  1.07179761e+00, -2.12721896e+00, ...,
         6.25275517e+00,  2.70401812e+00,  4.79288101e-02],
       [-9.62531447e-01, -1.38649821e+00, -3.84490538e+00, ...,
         4.95667553e+00, -2.70487618e+00, -6.35826874e+00]], dtype=float32)
```

In [ ]:
```
spectral_center = librosa.feature.spectral_centroid(y=y, sr=sr, hop_length=512
spectral_center.shape
```

Out[ ]:
```
(1, 1293)
```

In [ ]:
```
chroma = librosa.feature.chroma_stft(y=y, sr=sr, hop_length=512)
chroma.shape
```

Out[ ]:
```
(12, 1293)
```

In [ ]:
```
spectral_contrast = librosa.feature.spectral_contrast(y=y, sr=sr, hop_length=51
spectral_contrast.shape
```

Out[ ]:
```
(7, 1293)
```

Batch processing of audio files for feature extraction

In [ ]:
```
data=np.zeros((50, 128, 33), dtype=np.float64)
data.shape
```

Out[ ]:
```
(50, 128, 33)
```

In [ ]:
```
x=librosa.feature.melspectrogram(y=y, sr=sr, n_mels=128)
x.shape
```

Out[ ]:
```
(128, 1293)
```

In [ ]:
```
q=librosa.feature.melspectrogram(y=y, sr=sr)
q.shape
```

Out[ ]:
```
(128, 1293)
```

In [ ]:
```
genres_dir = "/content/drive/MyDrive/genres_original"
data = np.zeros((999,512,33), dtype=np.float64)
target=[]
# List of genre names
genre_names = ["blues", "classical", "country", "disco", "hiphop", "jazz", "me
i=0
for genre in genre_names:
    genre_path = os.path.join(genres_dir, genre)

    # Loop through each file in the genre folder
    for filename in os.listdir(genre_path):
        file_path = os.path.join(genre_path, filename)
        y, sr = librosa.load(file_path)
        y, _ = librosa.effects.trim(y)
        mfcc = librosa.feature.mfcc(y=y, sr=sr, hop_length=512, n_mfcc=13)
        spectral_center = librosa.feature.spectral_centroid(y=y, sr=sr, hop_le
        chroma = librosa.feature.chroma_stft(y=y, sr=sr, hop_length=512)
        spectral_contrast = librosa.feature.spectral_contrast(y=y, sr=sr, hop_
        target.append(genre)
        data[i, :, 0:13] = mfcc.T[0:512,:]
        data[i, :, 13:14] = spectral_center.T[0:512, :]
        data[i, :, 14:26] = chroma.T[0:512, :]
        data[i, :, 26:33] = spectral_contrast.T[0:512, :]
        print("Numerical features extracted from audio file %i of %i." % (i + 1
        i+=1
```

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Numerical features extracted from audio file 999 of 999.
```

In [ ]:

```
y=np.zeros((999,10))
for i,genre in enumerate(target):
  ind=genre_names.index(genre)
  y[i,ind]=1
```

In [ ]:

```
y
```

Out[ ]:

```
array([[1., 0., 0., ..., 0., 0., 0.],
       [1., 0., 0., ..., 0., 0., 0.],
       [1., 0., 0., ..., 0., 0., 0.],
       ...,
       [0., 0., 0., ..., 0., 0., 1.],
       [0., 0., 0., ..., 0., 0., 1.],
       [0., 0., 0., ..., 0., 0., 1.]])
```

In [ ]:

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.models import Sequential
```

```
from tensorflow.keras.layers import Conv1D, MaxPooling1D, LSTM, Dense, Flatten
from tensorflow.keras.optimizers import Adam
```

In [ ]:
```
from sklearn.model_selection import StratifiedKFold
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv1D, MaxPooling1D, LSTM, Dense, Flatten
from tensorflow.keras.optimizers import Adam

# Define the number of folds
n_splits = 5

# Initialize StratifiedKFold
skf = StratifiedKFold(n_splits=n_splits, shuffle=True, random_state=42)

# Initialize lists to store evaluation metrics for each fold
acc_per_fold = []
loss_per_fold = []

# Iterate over each fold
# Convert multilabel-indicator to single-label format
y_single_label = np.argmax(y, axis=1)

for fold_index, (train_index, val_index) in enumerate(skf.split(data, y_single_
    print(f"Training on Fold {fold_index + 1}")

    # Split data into train and validation sets for this fold
    x_train_fold, x_val_fold = data[train_index], data[val_index]
    y_train_fold, y_val_fold = y[train_index], y[val_index]

    # Define the model
    model = Sequential()
    model.add(Conv1D(filters=256, kernel_size=3, activation='relu', input_shape
    model.add(MaxPooling1D(pool_size=2))
    model.add(Conv1D(filters=128, kernel_size=3, activation='relu'))
    model.add(MaxPooling1D(pool_size=2))
    model.add(LSTM(units=64, dropout=0.2, recurrent_dropout=0.2, return_sequen
    model.add(LSTM(units=32, dropout=0.2, recurrent_dropout=0.2))
    model.add(Dropout(0.5))
    model.add(Dense(units=10, activation='softmax'))

    # Compile the model
    model.compile(loss='categorical_crossentropy', optimizer=Adam(), metrics=[

    # Train the model
    history = model.fit(x_train_fold, y_train_fold, batch_size=35, epochs=400,

    # Evaluate the model on the validation set
    scores = model.evaluate(x_val_fold, y_val_fold, verbose=0)

    # Append evaluation metrics to lists
    acc_per_fold.append(scores[1] * 100)  # Accuracy
    loss_per_fold.append(scores[0])  # Loss

    print(f"Validation Accuracy: {scores[1] * 100:.2f}%")
    print(f"Validation Loss: {scores[0]:.4f}")

# Print average metrics across all folds
print(f"\nAverage Validation Accuracy: {sum(acc_per_fold) / len(acc_per_fold):
print(f"Average Validation Loss: {sum(loss_per_fold) / len(loss_per_fold):.4f}"
```

```
Training on Fold 1
WARNING:tensorflow:Layer lstm will not use cuDNN kernels since it doesn't meet the criteria. It will use a generic GPU kernel as fallback when running on GPU.
WARNING:tensorflow:Layer lstm_1 will not use cuDNN kernels since it doesn't meet the criteria. It will use a generic GPU kernel as fallback when running on GPU.
```

In [ ]:
```python
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv1D, MaxPooling1D, LSTM, Dense, Flatten
from tensorflow.keras.optimizers import Adam

# Define the model
model = Sequential()

# Add Convolutional layers
model.add(Conv1D(filters=256, kernel_size=3, activation='relu', input_shape=(5
model.add(MaxPooling1D(pool_size=2))
model.add(Conv1D(filters=128, kernel_size=3, activation='relu'))
model.add(MaxPooling1D(pool_size=2))

# Flatten the output for LSTM
#model.add(Flatten())

# Reshape for LSTM input
#model.add(Reshape((32, 120)))  # Reshape to (timesteps, features)

# Add LSTM layers
model.add(LSTM(units=64, dropout=0.2, recurrent_dropout=0.2, return_sequences=
model.add(LSTM(units=32, dropout=0.2, recurrent_dropout=0.2))

# Add Dropout for regularization
model.add(Dropout(0.5))

# Output layer
model.add(Dense(units=10, activation='softmax'))

# Compile the model with a lower learning rate
opt = Adam()
model.compile(loss='categorical_crossentropy', optimizer=opt, metrics=['accura

# Print model summary
model.summary()
```

In [ ]:
```python
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(data, y, test_size=0.25, ra
```

In [ ]:
```python
genre_names = ["blues", "classical", "country", "disco", "hiphop", "jazz", "me
```

In [ ]:
```python
batch_size = 35  # num of training examples per minibatch
num_epochs = 400
history = model.fit(x_train, y_train, batch_size=batch_size, epochs=num_epochs

# Calculate the mean training accuracy
mean_training_accuracy = np.mean(history.history['accuracy'])
print("Mean Training Accuracy:", mean_training_accuracy)
```

In [ ]:
```
import math
# score, accuracy = model.evaluate(
#     x_test, y_test, batch_size=batch_size, verbose=1
# )

num_batches = len(x_test) // batch_size
accuracies = []

for i in range(num_batches):
    start = i * batch_size
    end = (i + 1) * batch_size
    batch_x = x_test[start:end]
    batch_y = y_test[start:end]
    _, batch_accuracy = model.evaluate(batch_x, batch_y, verbose=0)
    accuracies.append(batch_accuracy)

mean_test_accuracy = np.mean(accuracies)
print("Mean Test Accuracy:", mean_test_accuracy)
```

In [ ]:
```
model.save('m01.h5')
```

In [ ]:
```
```