In [1]:
```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MaxAbsScaler
import tensorflow.keras as keras
import matplotlib.pyplot as plt
import librosa, IPython
import librosa.display as lplt

import IPython.display as ipd
from IPython.display import Audio
```

1. Load And Arrange The Data

The data set is included a .csv file with the extracted features:

In [2]:
```
df = pd.read_csv('features_30_sec.csv')
```

Check If The Data Is Balanced:

Class Balance:

In [3]:
```
df.label.value_counts().reset_index()
```

Out[3]:

	label	count
0	blues	100
1	classical	100
2	country	100
3	disco	100
4	hiphop	100
5	jazz	100
6	metal	100
7	pop	100
8	reggae	100
9	rock	100

We have exactly 100 samples out of each class.

In [4]:
```
data = df.iloc[:,1:59];
```

2. Pre-Processing:

Scale the data to prevent feature imbalances:

In [277…
```
data_scaler = MaxAbsScaler().fit(data);
```

In [278…
```
scaled_data = data_scaler.transform(data);
```

In [279…
```
scaled_data.astype('float64', casting = 'same_kind');
```

Data Augmentation

will be implemented in the "Fighting Overfitting" scripts

3. Data Visualization:

Load samples from the data set

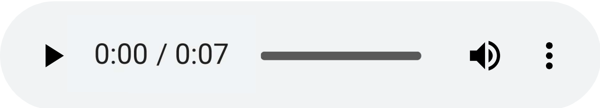
In [8]:
```
hiphop_sample, hiphop_sr = librosa.load('hiphop_sample.wav', duration = 7.0);
rock_sample, rock_sr = librosa.load('rock_sample.wav', duration = 7.0);
```

Play the samples

In [9]:
```
print("Hip Hop Sample:");
ipd.Audio(hiphop_sample,rate = hiphop_sr)
```

```
Hip Hop Sample:
```

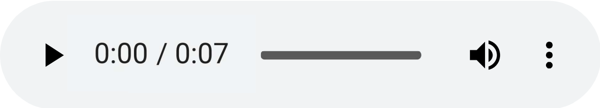
Out[9]:



In [10]:
```
print("Rock Sample:");
ipd.Audio(rock_sample,rate = rock_sr)
```

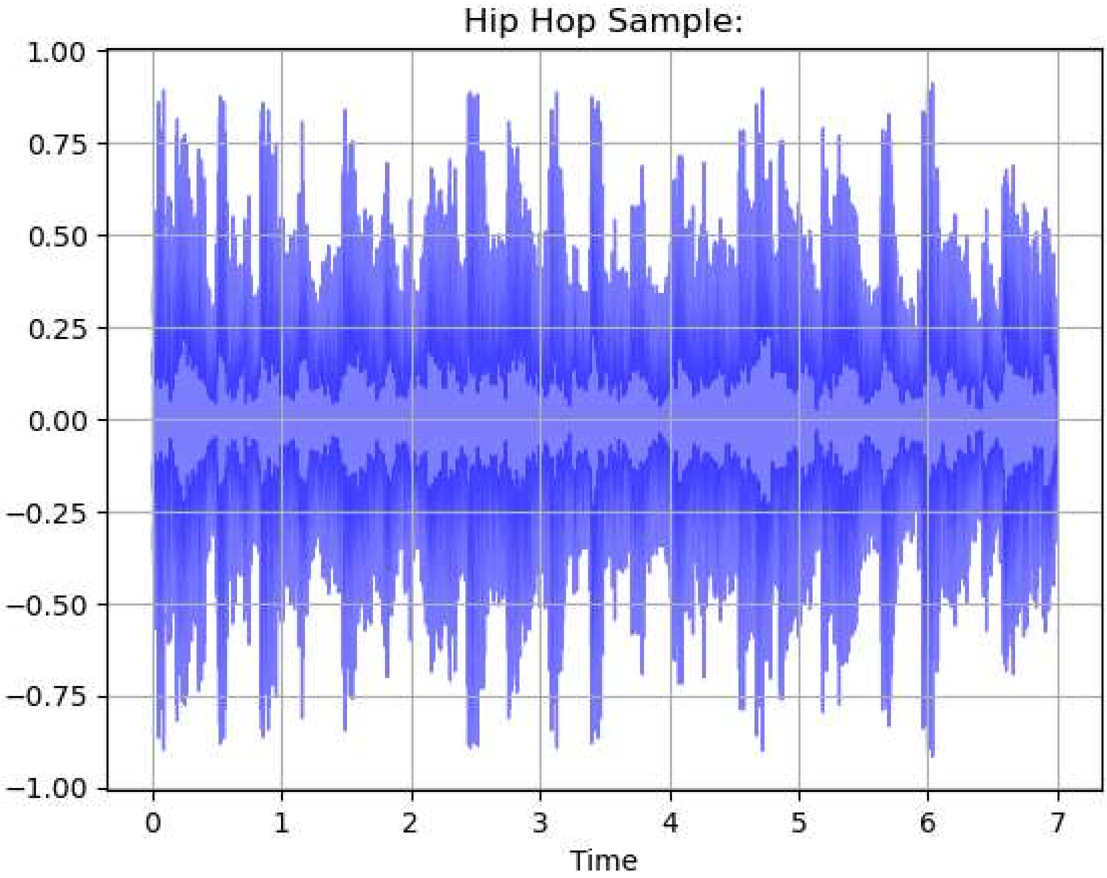
```
Rock Sample:
```

Out[10]:



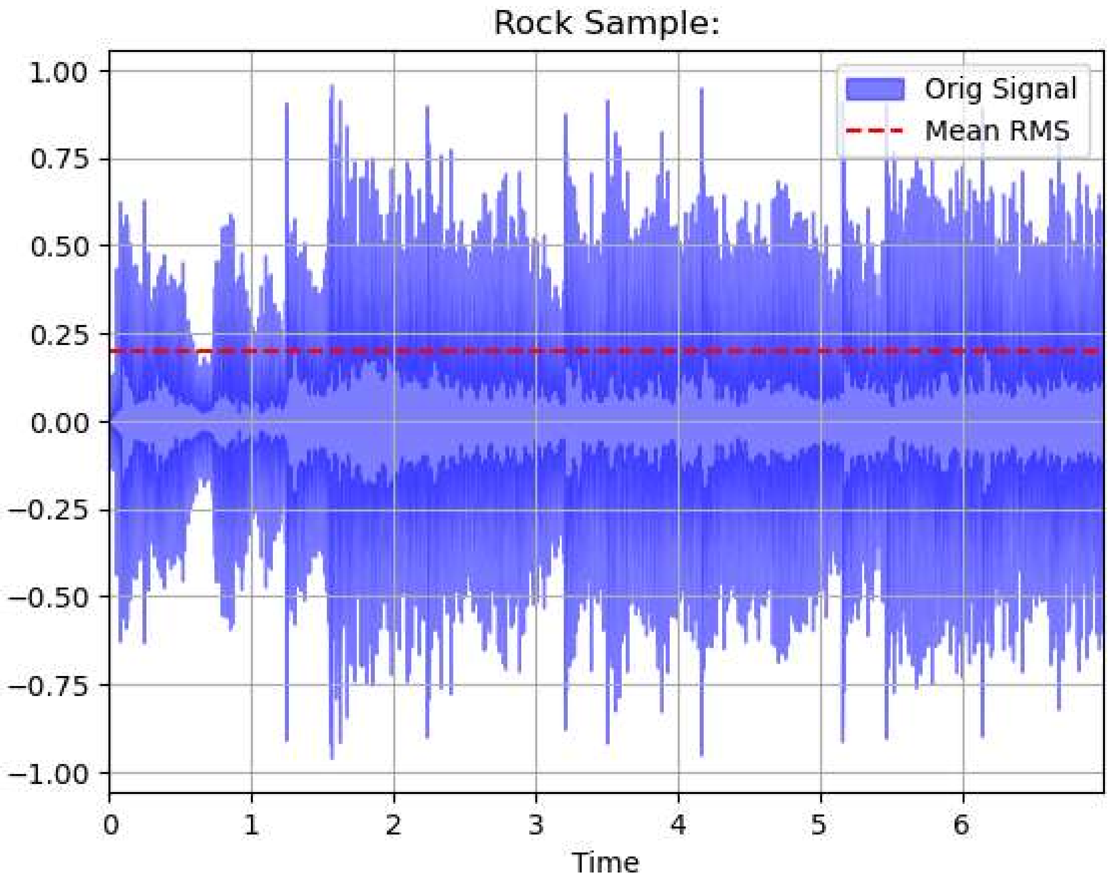
Plot the waveform of the sample:

In [17]:
```
plt.figure()
librosa.display.waveshow(hiphop_sample, color = "blue", alpha = 0.5)
plt.title("Hip Hop Sample:");
plt.grid()
plt.show()
```



In [228…

```
plt.figure()
librosa.display.waveshow(rock_sample, color = "blue", alpha = 0.5,label = "Orig Sig
rms_ = librosa.feature.rms(y=rock_sample)
plt.axhline(y=rms_[0].mean(), color='r', linestyle='--', label = "Mean RMS")
plt.legend()
plt.title("Rock Sample:")
plt.grid()

plt.autoscale(enable=True, axis='x', tight=True)
plt.show()
```

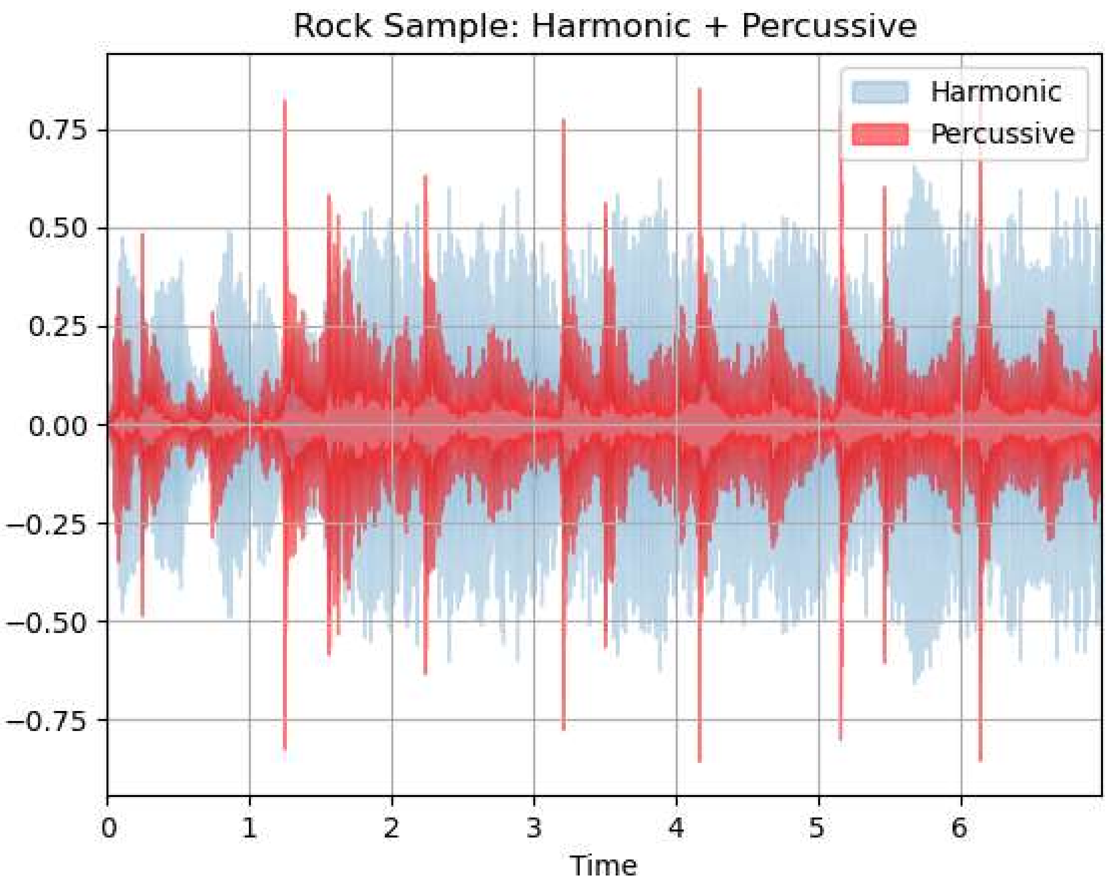


Feature Visualization: MFCC's, Chromagrams, Etc.

Seperation of Harmonic and Percussive Signals

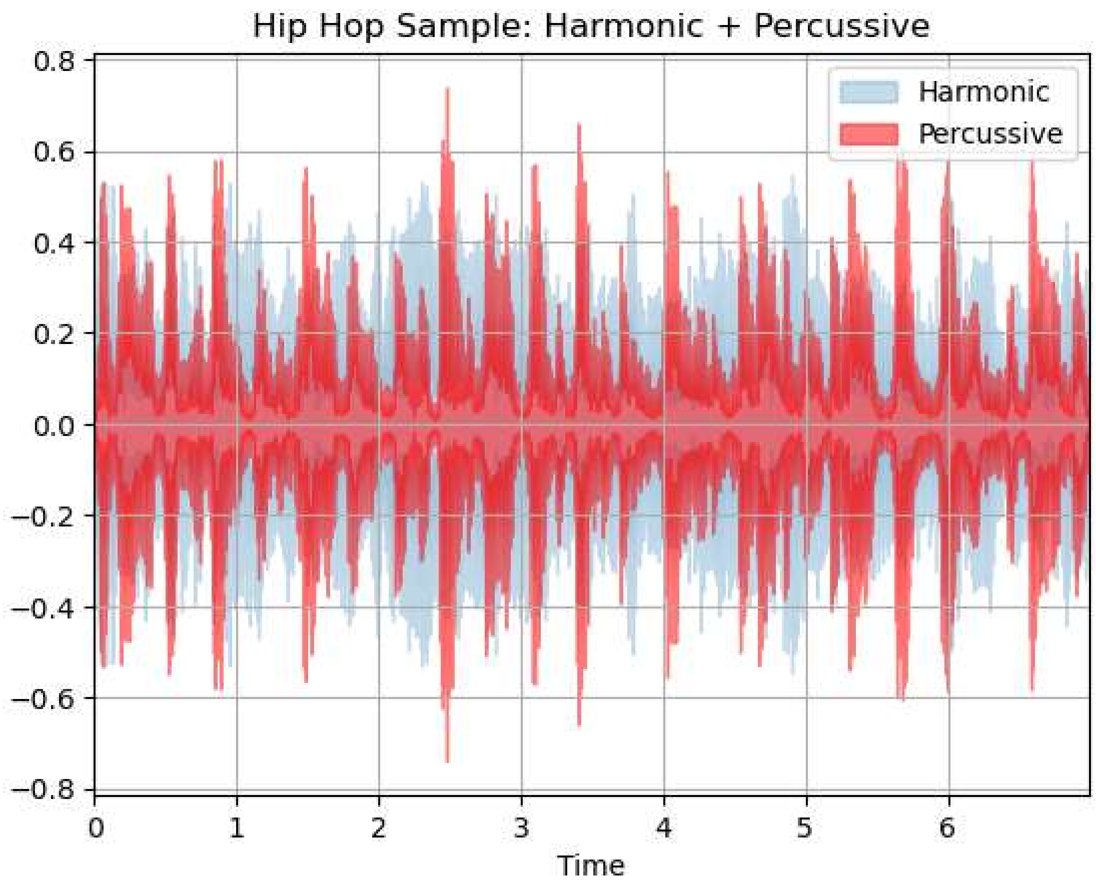
In [229…

```
y1_harmonic, y1_percussive = librosa.effects.hpss(rock_sample)
plt.figure()
librosa.display.waveshow(y1_harmonic, sr=rock_sr, alpha=0.25, label = "Harmonic")
librosa.display.waveshow(y1_percussive, sr=rock_sr, color='r', alpha=0.5, label = '
plt.title('Rock Sample: Harmonic + Percussive')

plt.grid()
plt.legend()
plt.autoscale(enable=True, axis='x', tight=True)
plt.show()
```



In [230…

```
y2_harmonic, y2_percussive = librosa.effects.hpss(hiphop_sample)
plt.figure()
librosa.display.waveshow(y2_harmonic, sr=hiphop_sr, alpha=0.25, label = "Harmonic")
librosa.display.waveshow(y2_percussive, sr=hiphop_sr, color='r', alpha=0.5, label =
plt.title('Hip Hop Sample: Harmonic + Percussive')

plt.grid()
plt.legend()
plt.autoscale(enable=True, axis='x', tight=True)
plt.show()
```



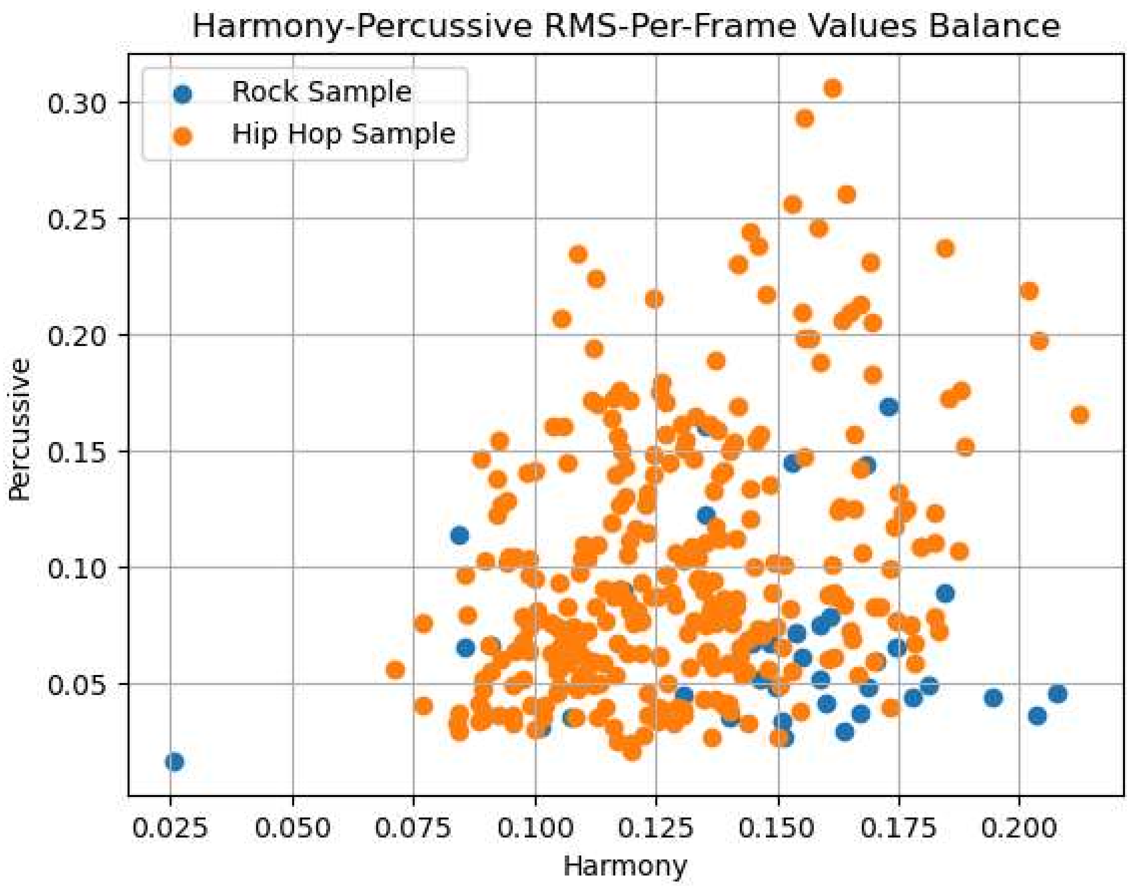
Mean Value of Harmony and Rhythmic Components of Signal

In [232…

```
hop_length = 512;
n_fft = 2048;
```

In [233…

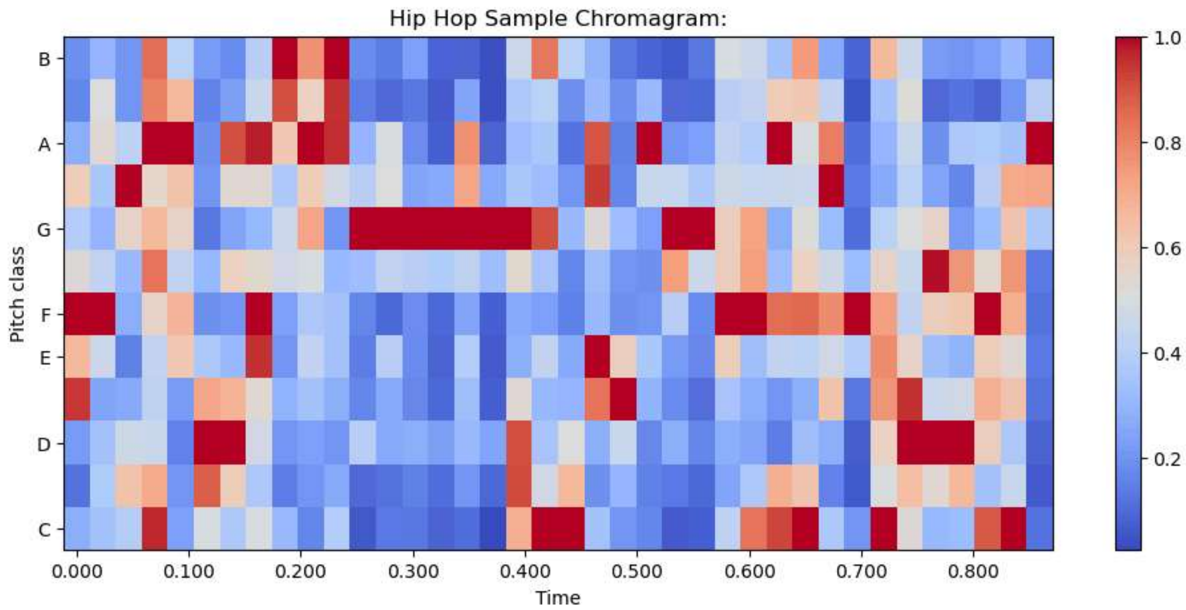
```
rock_harmony_rms = librosa.feature.rms(y=y1_harmonic,hop_length=8*hop_length)
rock_rhythmic_rms = librosa.feature.rms(y=y1_percussive,hop_length=8*hop_length)
plt.scatter(rock_harmony_rms,rock_rhythmic_rms, label = "Rock Sample")
plt.title("Harmony-Percussive RMS-Per-Frame Values Balance")
plt.xlabel("Harmony")
plt.ylabel("Percussive")


hiphop_harmony_rms = librosa.feature.rms(y=y2_harmonic)
hiphop_rhythmic_rms = librosa.feature.rms(y=y2_percussive)
plt.scatter(hiphop_harmony_rms,hiphop_rhythmic_rms,label = "Hip Hop Sample")
plt.legend()
plt.grid()
plt.show()
```



Chromagrams:

In [234…

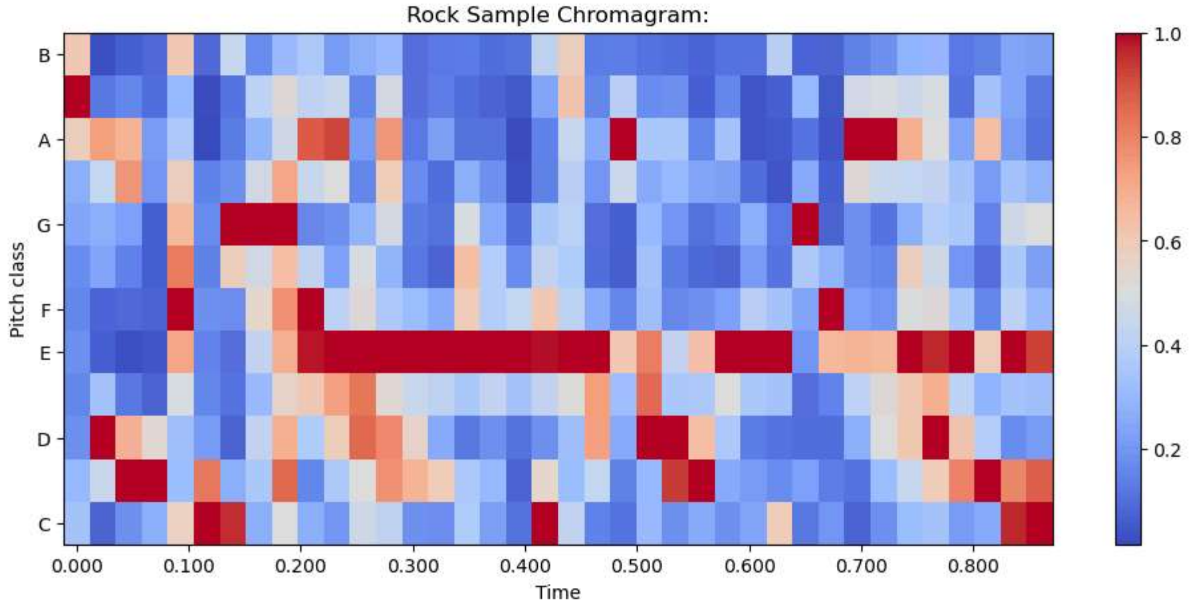
```
hiphop_chromagram = librosa.feature.chroma_stft(y=hiphop_sample, sr=hiphop_sr, hop_

plt.figure(figsize=(12,5))
librosa.display.specshow(hiphop_chromagram, x_axis='time', y_axis='chroma', hop_ler
plt.colorbar()
plt.title("Hip Hop Sample Chromagram:");
```



In [235…

```
rock_chromagram = librosa.feature.chroma_stft(y=rock_sample, sr=rock_sr, hop_length

plt.figure(figsize=(12,5))
librosa.display.specshow(rock_chromagram, x_axis='time',y_axis = 'chroma',hop_lengt
```

```
plt.colorbar()
plt.title("Rock Sample Chromagram:");
```

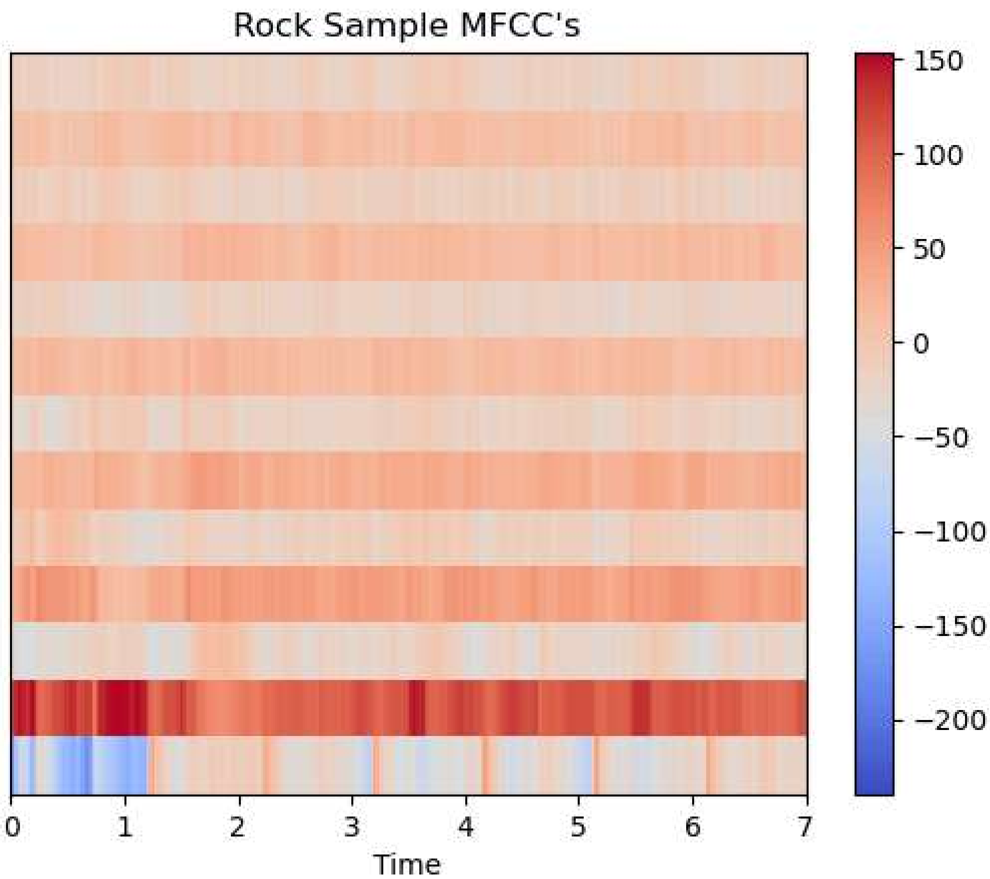


We can also further investigate the mean and variance of the chromograms (in the actual data set, the mean and variance of the chromogram is calculated)

Calculate MFCC's:

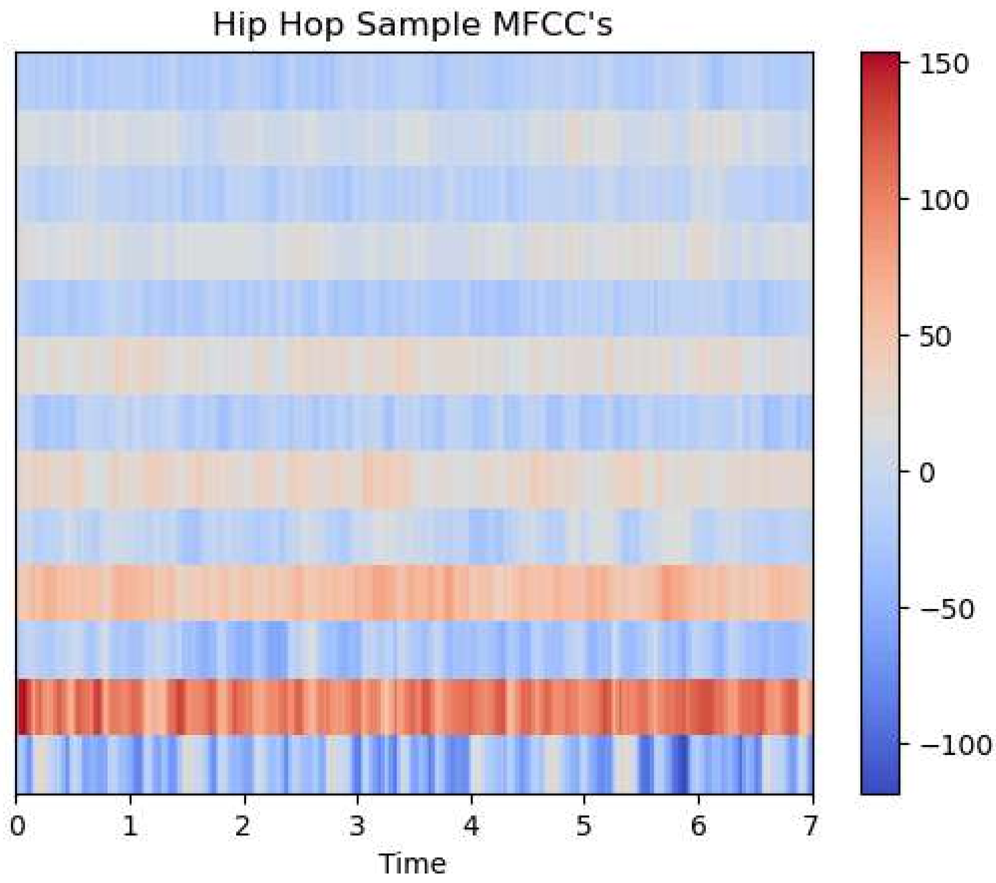
In [169…

```
rock_sample_mfccs = librosa.feature.mfcc(y=rock_sample, sr=rock_sr, n_mfcc=13,hop_l
plt.figure()
librosa.display.specshow(rock_sample_mfccs, x_axis='time');
plt.colorbar()
plt.title("Rock Sample MFCC's");
```



In [170…

```
hiphop_sample_mfccs = librosa.feature.mfcc(y=hiphop_sample, sr=hiphop_sr, n_mfcc=13
plt.figure()
librosa.display.specshow(hiphop_sample_mfccs, x_axis='time');
plt.colorbar()
plt.title("Hip Hop Sample MFCC's");
```

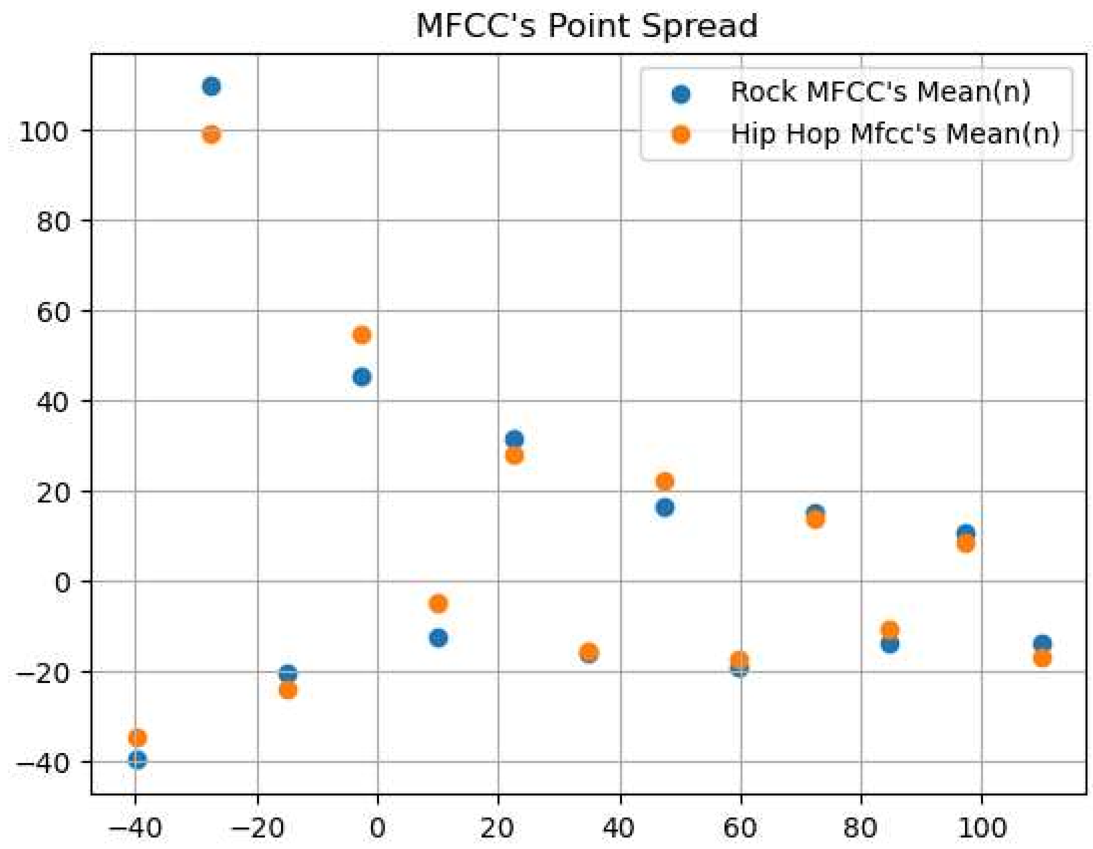


In [171…

```
rock_sample_mfcc_mean = np.mean(rock_sample_mfccs,axis=1);
hiphop_sample_mfcc_mean = np.mean(hiphop_sample_mfccs,axis=1);
```

In [172…

```
tmp = np.append(rock_sample_mfcc_mean,hiphop_sample_mfcc_mean);
lower_lim = min(tmp);
upper_lim = max(tmp);
x_ = np.linspace(lower_lim,upper_lim,len(rock_sample_mfcc_mean));
plt.scatter(x_,rock_sample_mfcc_mean,label = "Rock MFCC's Mean(n)");
plt.scatter(x_,hiphop_sample_mfcc_mean, label = "Hip Hop Mfcc's Mean(n)");

plt.title("MFCC's Point Spread")
plt.legend()
plt.grid()
plt.show()
```



Spectral Centroid:

In [196…

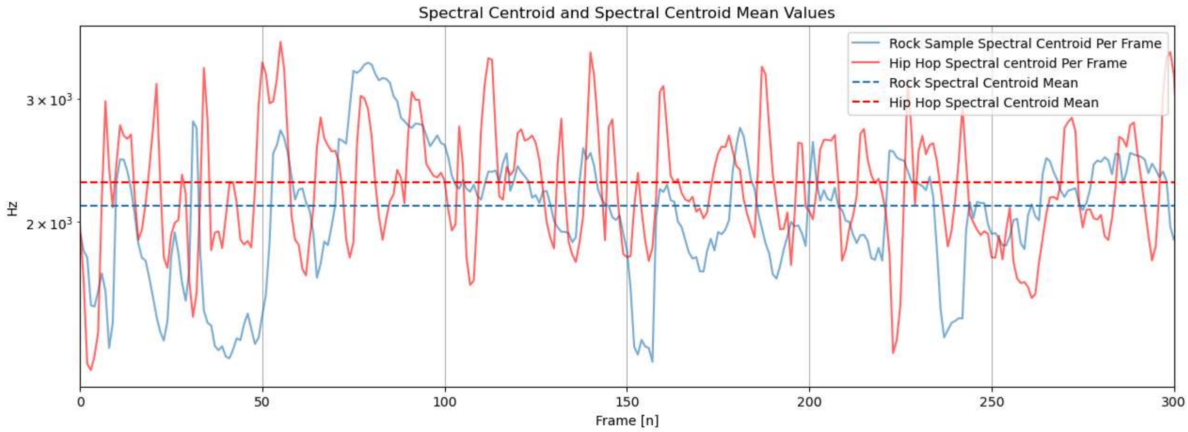
```
rock_sample_spectral_cent = librosa.feature.spectral_centroid(y=rock_sample, sr=roc
hiphop_sample_spectral_cent = librosa.feature.spectral_centroid(y=hiphop_sample, sr
```

In [197…

```
rock_sample_spectral_cent_mean = rock_sample_spectral_cent.mean()
hiphop_sample_spectral_cent_mean = hiphop_sample_spectral_cent.mean()
```

In [224…

```
plt.figure(figsize=(15,5))
plt.semilogy(rock_sample_spectral_cent,alpha = 0.6, label='Rock Sample Spectral Cen
plt.semilogy(hiphop_sample_spectral_cent,color="red",alpha = 0.6, label='Hip Hop Sp

plt.axhline(rock_sample_spectral_cent_mean, linestyle='--', label = "Rock Spectral
plt.axhline(hiphop_sample_spectral_cent_mean,color="red", linestyle='--', label = '

plt.xlim([0,300])
plt.ylabel("Hz");
plt.xlabel("Frame [n]");
plt.title("Spectral Centroid and Spectral Centroid Mean Values");
plt.legend();
plt.grid();
```

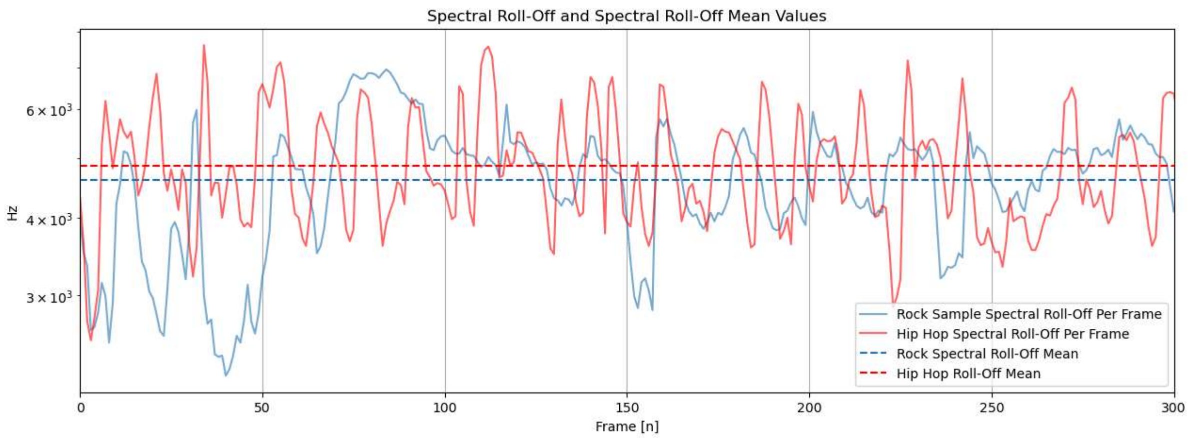


Spectral Rolloff:

In [225…
```
rock_sample_spectral_rolloff = librosa.feature.spectral_rolloff(y=rock_sample, sr=r
hiphop_sample_spectral_rolloff = librosa.feature.spectral_rolloff(y=hiphop_sample,
```

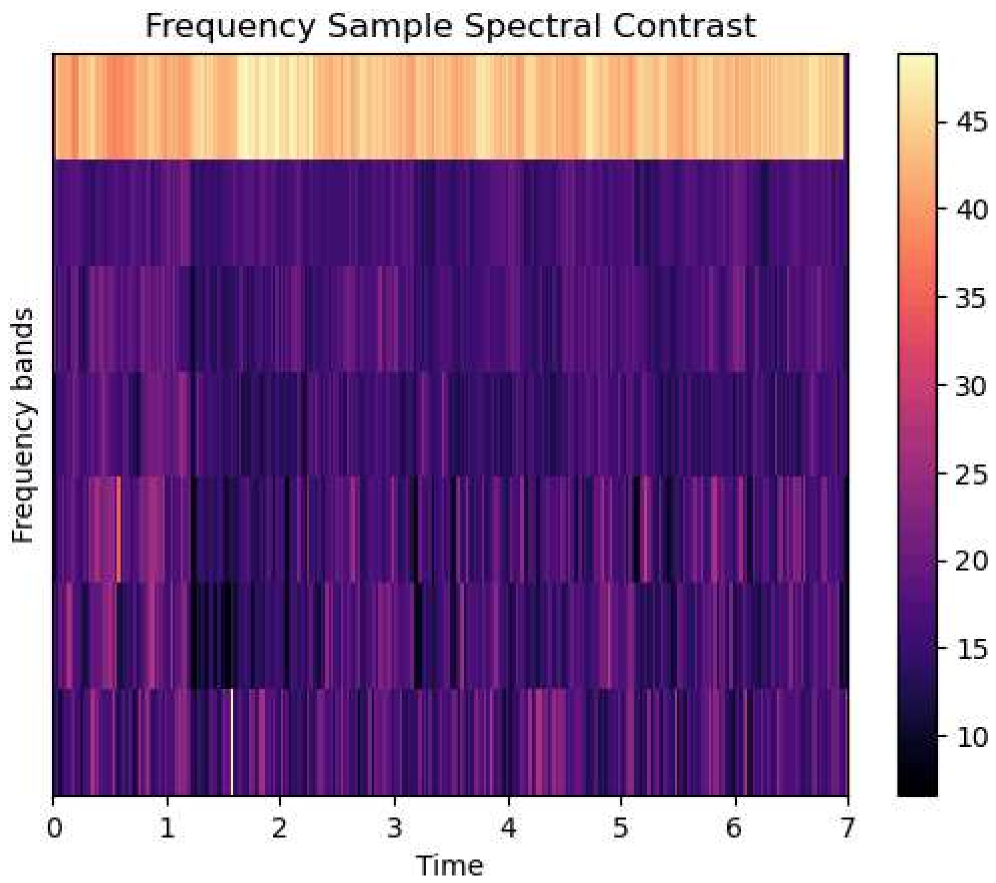
In [226…
```
rock_sample_spectral_rolloff_mean = rock_sample_spectral_rolloff.mean()
hiphop_sample_spectral_rolloff_mean = hiphop_sample_spectral_rolloff.mean()
```

In [275…
```
plt.figure(figsize=(15,5))
plt.semilogy(rock_sample_spectral_rolloff,alpha = 0.6, label='Rock Sample Spectral
plt.semilogy(hiphop_sample_spectral_rolloff,color="red",alpha = 0.6, label='Hip Hop

plt.axhline(rock_sample_spectral_rolloff_mean, linestyle='--', label = "Rock Spectr
plt.axhline(hiphop_sample_spectral_rolloff_mean,color="red", linestyle='--', label

plt.xlim([0,300])
plt.ylabel("Hz");
plt.xlabel("Frame [n]");
plt.title("Spectral Roll-Off and Spectral Roll-Off Mean Values");
plt.legend();
plt.grid();
```



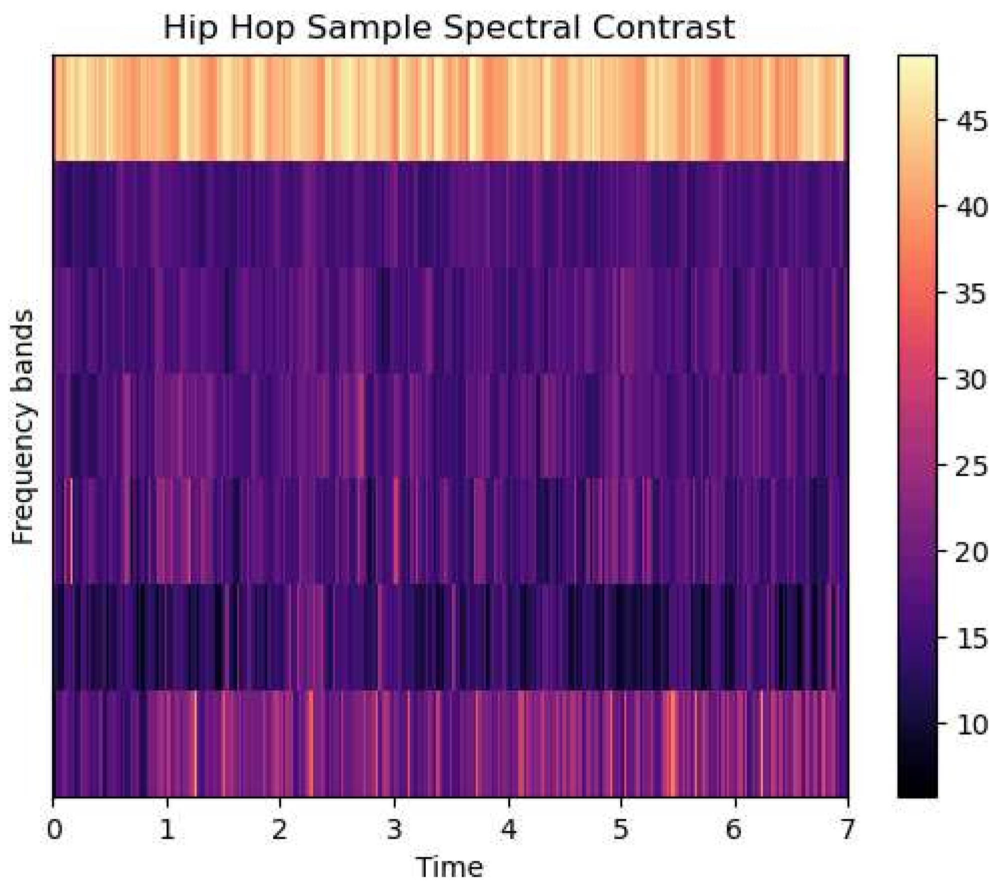
Spectral Contrast:

In [247…
```
rock_sample_spectral_contrast=librosa.feature.spectral_contrast(y=rock_sample,sr=ro
plt.figure();
librosa.display.specshow(rock_sample_spectral_contrast, x_axis='time');
plt.colorbar();
plt.ylabel('Frequency bands');
plt.title('Frequency Sample Spectral Contrast');
```



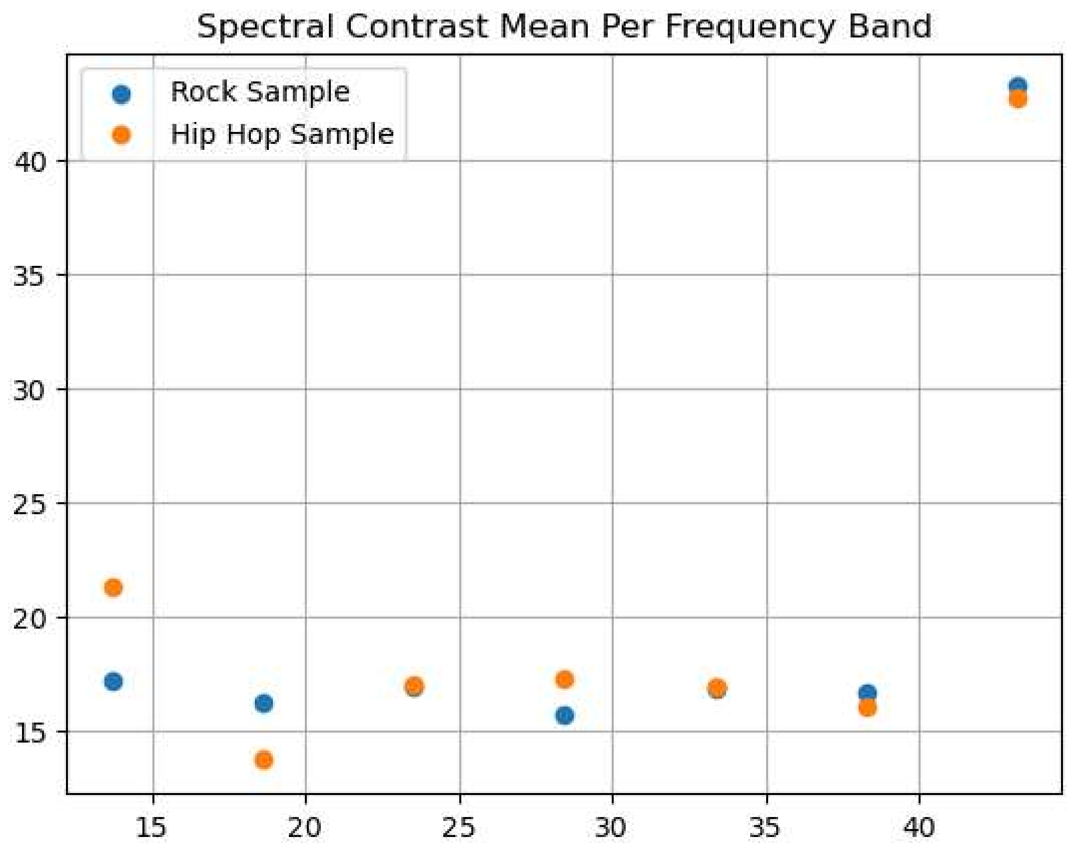
In [248…

```
hiphop_sample_spectral_contrast=librosa.feature.spectral_contrast(y=hiphop_sample,s
plt.figure();
librosa.display.specshow(hiphop_sample_spectral_contrast, x_axis='time');
plt.colorbar();
plt.ylabel('Frequency bands');
plt.title('Hip Hop Sample Spectral Contrast');
```



In [250…
```
rock_sample_spectral_contrast_mean = rock_sample_spectral_contrast.mean(axis=1)
hiphop_sample_spectral_contrast_mean = hiphop_sample_spectral_contrast.mean(axis=1)
```

In [254…
```
tmp = np.append(rock_sample_spectral_contrast_mean,hiphop_sample_spectral_contrast_
lower_lim = min(tmp);
upper_lim = max(tmp);

x_ = np.linspace(lower_lim,upper_lim,len(rock_sample_spectral_contrast_mean));

plt.scatter(x_,rock_sample_spectral_contrast_mean,label="Rock Sample");
plt.scatter(x_,hiphop_sample_spectral_contrast_mean,label="Hip Hop Sample");
plt.grid();
plt.legend();
plt.title("Spectral Contrast Mean Per Frequency Band");
```

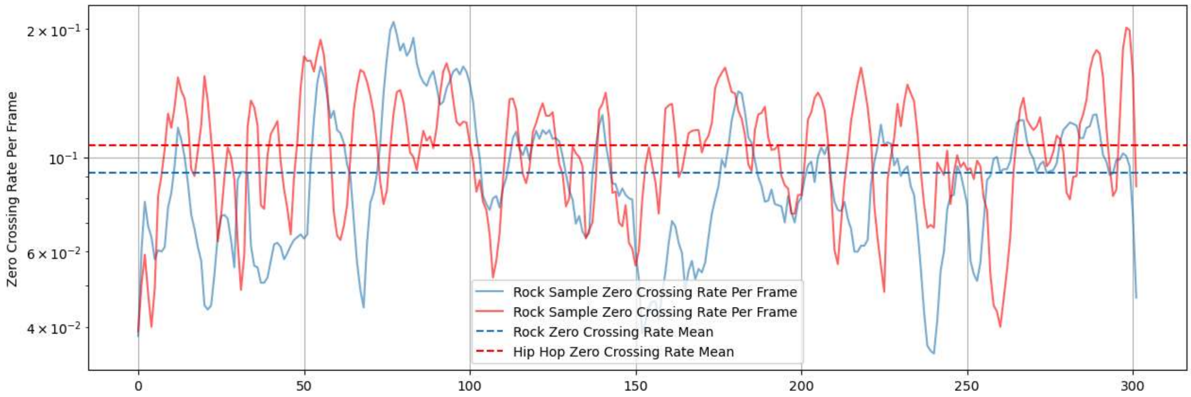


Zero Crossing Rate:

In [267…
```
rock_sample_zrate=librosa.feature.zero_crossing_rate(rock_sample).T;
hiphop_sample_zrate=librosa.feature.zero_crossing_rate(hiphop_sample).T;
```

In [268…
```
rock_sample_zero_crossing_rate_mean = rock_sample_zrate.mean()
hiphop_sample_zero_crossing_rate_mean = hiphop_sample_zrate.mean()
```

In [276…
```
plt.figure(figsize=(15,5));
plt.semilogy(rock_sample_zrate,alpha=0.6,label="Rock Sample Zero Crossing Rate Per
plt.semilogy(hiphop_sample_zrate,alpha=0.6,color="red",label="Rock Sample Zero Cros
plt.ylabel('Zero Crossing Rate Per Frame');

plt.axhline(rock_sample_zero_crossing_rate_mean, linestyle='--', label = "Rock Zerc
plt.axhline(hiphop_sample_zero_crossing_rate_mean,color="red", linestyle='--', labe

plt.grid();
plt.legend();
```



The data presented above is being calculated for each audio sample and store in a .csv file, among with the labeling of each sample.