Assignment 4

In [ ]:
```
import warnings
warnings.filterwarnings('ignore')
```

File 1: Star Wars

In [ ]:
```
import librosa
audio_path = 'StarWars60.wav'
x , sr = librosa.load(audio_path)
```

In [ ]:
```
import IPython.display as ipd
ipd.Audio(audio_path)
```

Out[ ]: 0:00 / 1:00

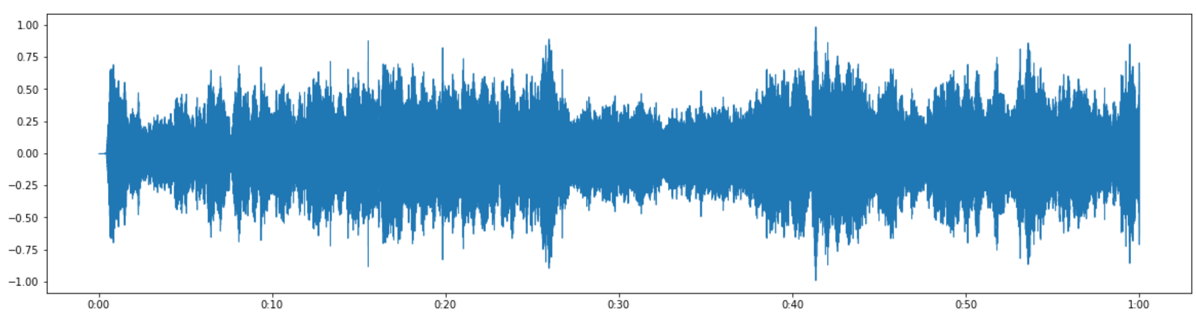
Visualizing Audio

In [ ]:
```
%matplotlib inline
import sklearn
import matplotlib.pyplot as plt
import librosa.display
```

waveform

In [ ]:
```
plt.figure(figsize=(20, 5))
librosa.display.waveshow(x, sr=sr)
```

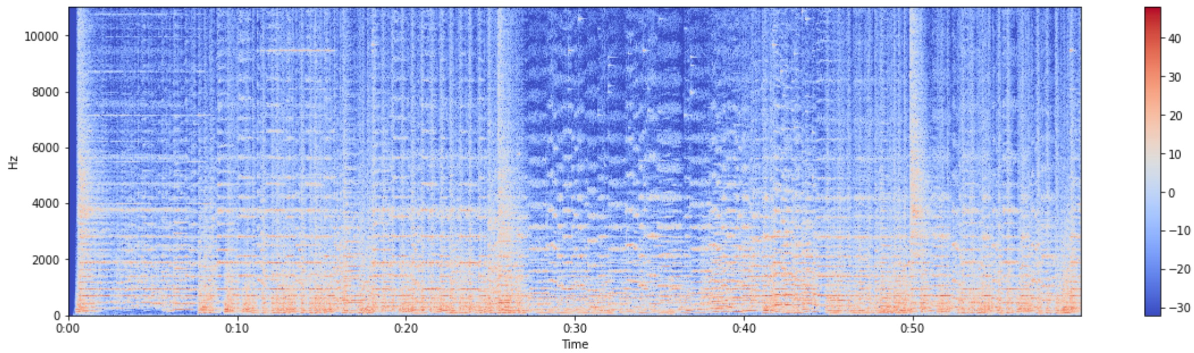
Out[ ]:
```
<librosa.display.AdaptiveWaveplot at 0x1b58c95bc10>
```



Spectogram

In [ ]:
```
X = librosa.stft(x)
Xdb = librosa.amplitude_to_db(abs(X))
plt.figure(figsize=(20, 5))
librosa.display.specshow(Xdb, sr=sr, x_axis='time', y_axis='hz')
plt.colorbar()
```

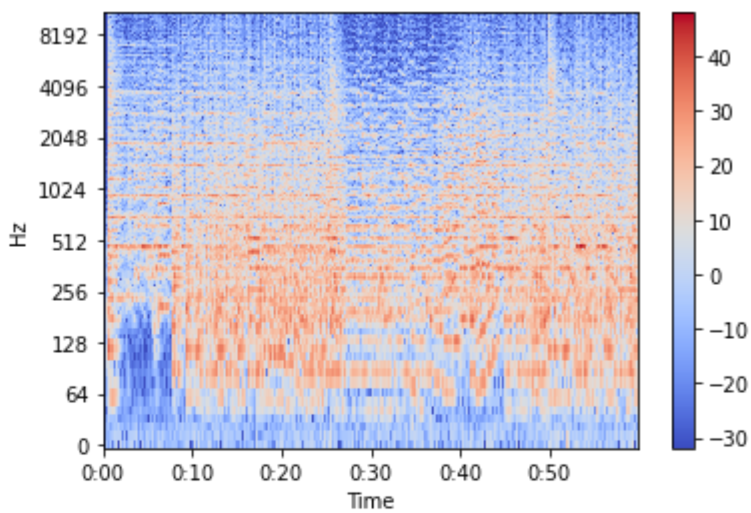
Out[ ]:
```
<matplotlib.colorbar.Colorbar at 0x1b58f4bf280>
```



Log Frequency axis

In [ ]:
```
librosa.display.specshow(Xdb, sr=sr, x_axis='time', y_axis='log')
plt.colorbar()
```

Out[ ]:
```
<matplotlib.colorbar.Colorbar at 0x1b5820c3550>
```



Create Audio Signal

In [ ]:
```
import numpy as np
sr = 22050 # sample rate
T = 5.0    # seconds
t = np.linspace(0, T, int(T*sr), endpoint=False) # time variable
x = 0.5*np.sin(2*np.pi*220*t)# pure sine wave at 220 Hz
```

In [ ]:
```
ipd.Audio(x, rate=sr) # load a NumPy array
```

Out[ ]: 0:00 / 0:05

In [ ]:
```python
import soundfile as sf
sf.write('./tone_440.wav', x, sr) # writing wave file in tone440.wav format
```

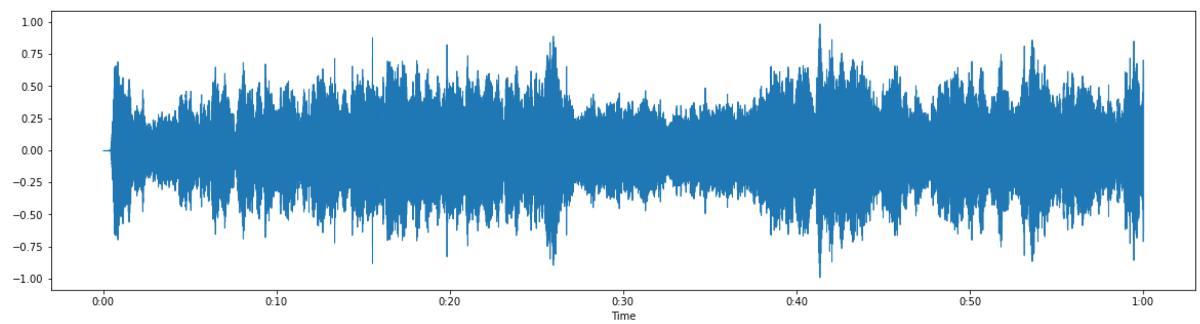
Feature Extraction

In [ ]:
```python
x, sr = librosa.load('./StarWars60.wav')
ipd.Audio(x, rate=sr)
```

Out[ ]: 0:00 / 1:00

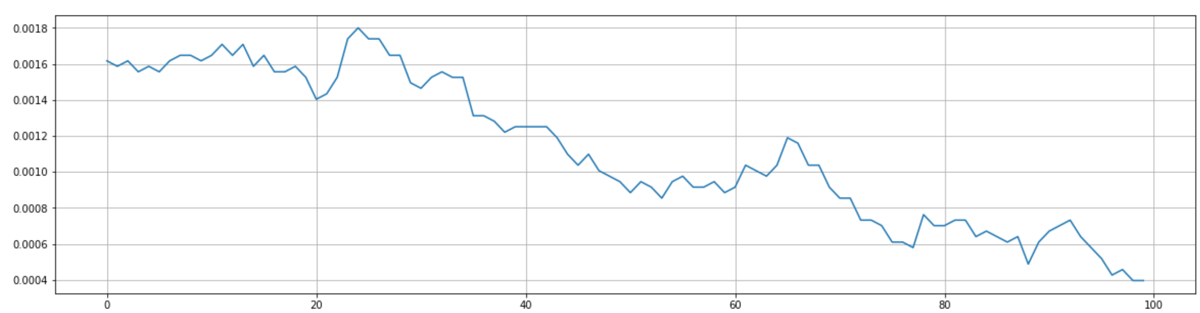
In [ ]:
```python
#Plot the signal:
plt.figure(figsize=(20, 5))
librosa.display.waveshow(x, sr=sr)
```

Out[ ]: <librosa.display.AdaptiveWaveplot at 0x1b590fccd90>



1. Zero Crossing Rate

In [ ]:
```python
n0 = 9000
n1 = 9100
plt.figure(figsize=(20, 5))
plt.plot(x[n0:n1])
plt.grid()
```



In [ ]:
```python
zero_crossings = librosa.zero_crossings(x[n0:n1], pad=False)
zero_crossings.shape
```

Out[ ]: (100,)

In [ ]:
```
print(sum(zero_crossings))
```

```
0
```

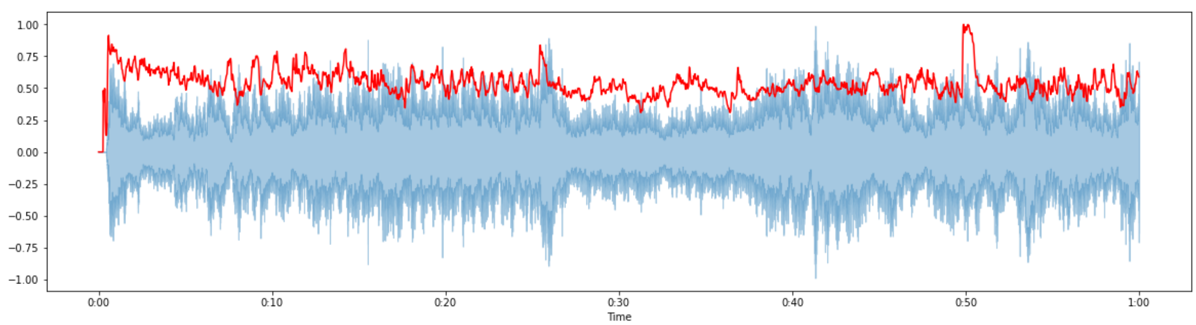
1. Spectral Centroid

In [ ]:
```
spectral_centroids = librosa.feature.spectral_centroid(x, sr=sr)[0]
spectral_centroids.shape
```

Out[ ]:
```
(2584,)
```

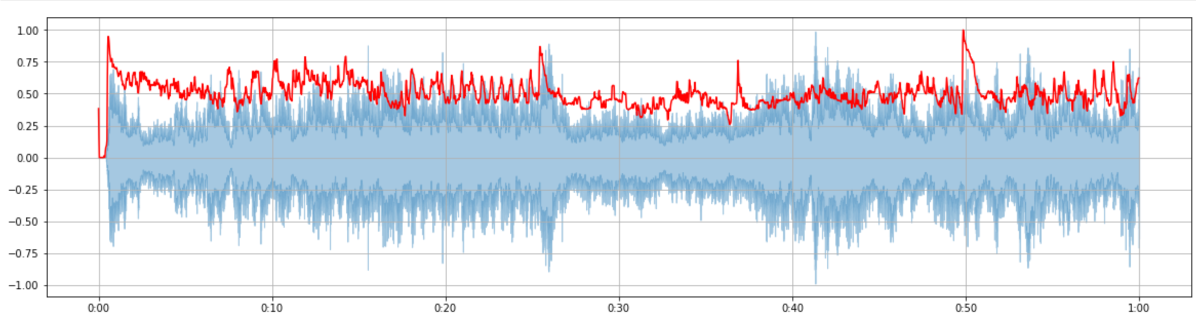
In [ ]:
```
# Computing the time variable for visualization
plt.figure(figsize=(20,5))
frames = range(len(spectral_centroids))
t = librosa.frames_to_time(frames)

# Normalising the spectral centroid for visualisation
def normalize(x, axis=0):
    return sklearn.preprocessing.minmax_scale(x, axis=axis)

#Plotting the Spectral Centroid along the waveform
librosa.display.waveshow(x, sr=sr, alpha=0.4)
plt.plot(t, normalize(spectral_centroids), color='r')
```

Out[ ]:
```
[<matplotlib.lines.Line2D at 0x1b59b748ca0>]
```



3.Spectral Rolloff

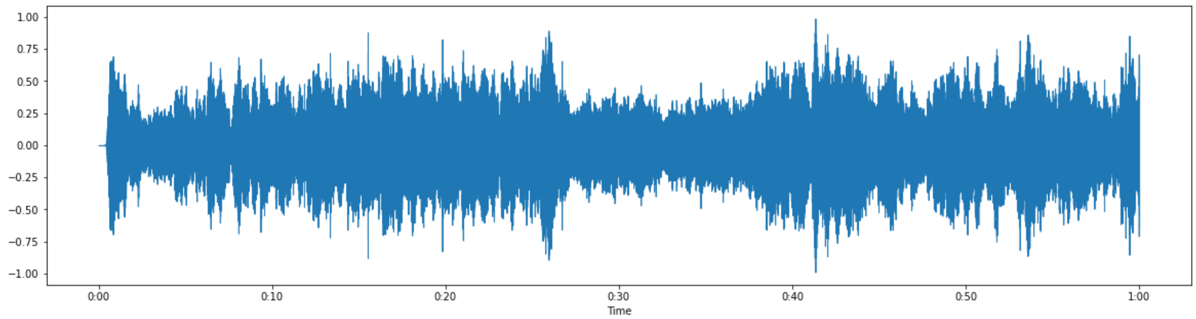
In [ ]:
```
plt.figure(figsize=(20,5))
spectral_rolloff = librosa.feature.spectral_rolloff(x+0.01, sr=sr)[0]
librosa.display.waveshow(x, sr=sr, alpha=0.4)
plt.plot(t, normalize(spectral_rolloff), color='r')
plt.grid()
```



4.MFCC

In [ ]:
```
plt.figure(figsize=(20,5))
x, fs = librosa.load('StarWars60.wav')
librosa.display.waveshow(x, sr=sr)
```

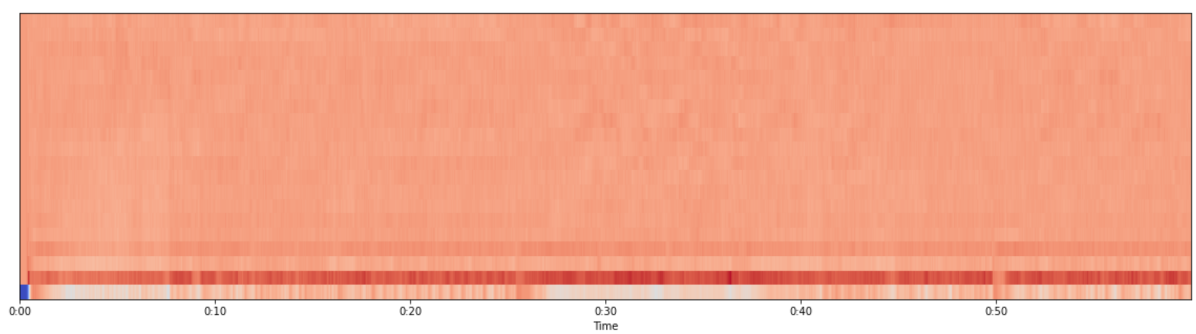
Out[ ]:
```
<librosa.display.AdaptiveWaveplot at 0x1b59d872530>
```



In [ ]:
```
# MFCC
plt.figure(figsize=(20,5))
mfccs = librosa.feature.mfcc(x, sr=sr)
print(mfccs.shape)

librosa.display.specshow(mfccs, sr=sr, x_axis='time')
```

```
(20, 2584)
```

Out[ ]:
```
<matplotlib.collections.QuadMesh at 0x1b5a7087550>
```



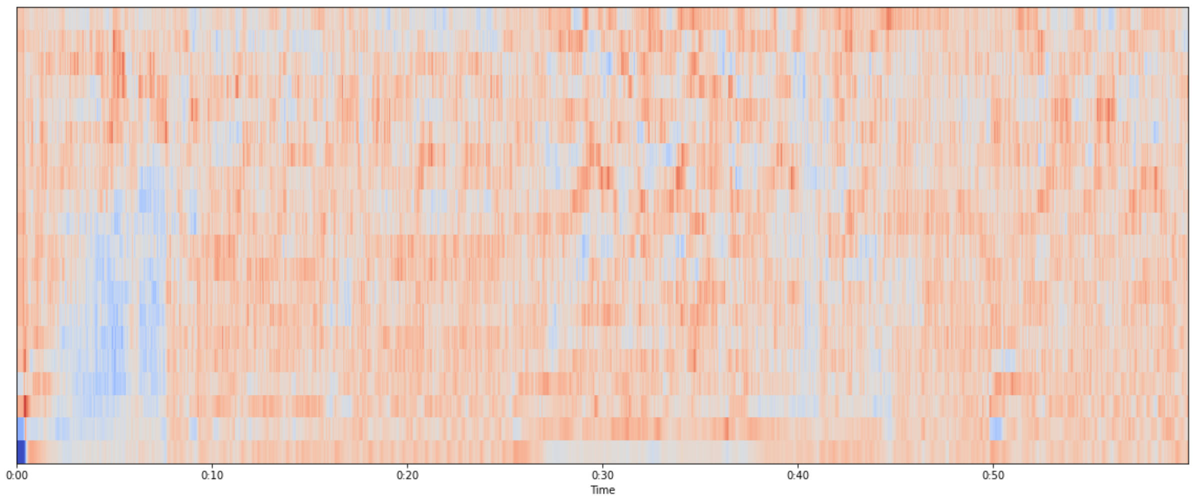
Feature scaling

In [ ]:
```
mfccs = sklearn.preprocessing.scale(mfccs, axis=1)
print(mfccs.mean(axis=1))
print(mfccs.var(axis=1))
```

```
[ 5.9051040e-09  1.1810208e-08 -5.9051040e-09 -5.9051040e-09
 -1.1810208e-08  0.0000000e+00 -1.7715312e-08  1.1810208e-08
  0.0000000e+00  8.8576559e-09  1.1810208e-08  0.0000000e+00
 -4.4288280e-09 -8.8576559e-09 -5.9051040e-09 -5.9051040e-09
  0.0000000e+00  1.1810208e-08  1.1810208e-08  0.0000000e+00]
[1.        1.        1.        1.        1.        1.0000001 0.9999999
 0.9999999 1.        1.        1.0000001 1.        1.        1.
 0.9999999 1.        1.        1.        1.        1.0000001]
```

In [ ]:
```
plt.figure(figsize=(20,8))
librosa.display.specshow(mfccs, sr=sr, x_axis='time')
```

Out[ ]:
```
<matplotlib.collections.QuadMesh at 0x1b5a70ec130>
```



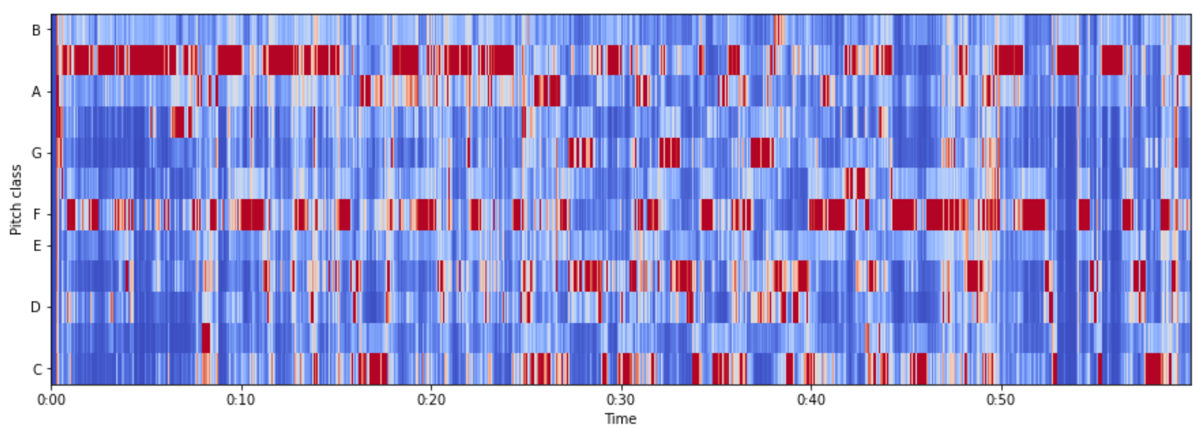
Chroma Frequencies

In [ ]:
```python
# Loadign the file
x, sr = librosa.load('StarWars60.wav')
ipd.Audio(x, rate=sr)
```

Out[ ]: 0:00 / 1:00

In [ ]:
```python
hop_length = 512
chromagram = librosa.feature.chroma_stft(x, sr=sr, hop_length=hop_length)
plt.figure(figsize=(15, 5))
librosa.display.specshow(chromagram, x_axis='time', y_axis='chroma', hop_length=hop
```

Out[ ]:
```
<matplotlib.collections.QuadMesh at 0x1b5a7141360>
```



Writing to CSV file

In [ ]:
```python
import csv
```

In [ ]:
```
header = 'songname chroma_stft rmse spectral_centroid spectral_bandwidth rolloff ze
for i in range(1, 21):
    header += f' mfcc{i}'
header += ' label'
header = header.split()
```

In [ ]:
```
file = open('dataset.csv', 'w', newline='')
with file:
    writer = csv.writer(file)
    writer.writerow(header)

genre = 'classical'
songname = 'StarWars60.wav'
songtitle = 'StarWars60.wav'
y, sr = librosa.load(songname, mono=True, duration=30)
chroma_stft = librosa.feature.chroma_stft(y=y, sr=sr)
rmse = librosa.feature.rms(y=y)
spec_cent = librosa.feature.spectral_centroid(y=y, sr=sr)
spec_bw = librosa.feature.spectral_bandwidth(y=y, sr=sr)
rolloff = librosa.feature.spectral_rolloff(y=y, sr=sr)
zcr = librosa.feature.zero_crossing_rate(y)
mfcc = librosa.feature.mfcc(y=y, sr=sr)
to_append = f'{songtitle} {np.mean(chroma_stft)} {np.mean(rmse)} {np.mean(spec_cent


for e in mfcc:
    to_append += f' {np.mean(e)}'
to_append += f' {genre}'
file = open('dataset.csv', 'a', newline='')
with file:
    writer = csv.writer(file)
    writer.writerow(to_append.split())
```

File 2: Pink Panther

In [ ]:
```
import librosa
audio_path2 = 'PinkPanther60.wav'
x , sr = librosa.load(audio_path2)
```

In [ ]:
```
import IPython.display as ipd
ipd.Audio(audio_path2)
```

Out[ ]:

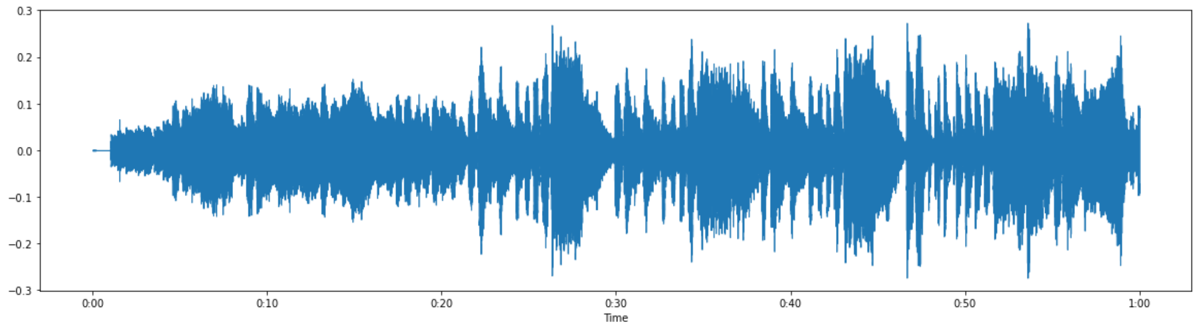
0:00 / 1:00

Visualizing Audio

waveform

In [ ]:
```
plt.figure(figsize=(20, 5))
librosa.display.waveshow(x, sr=sr)
```

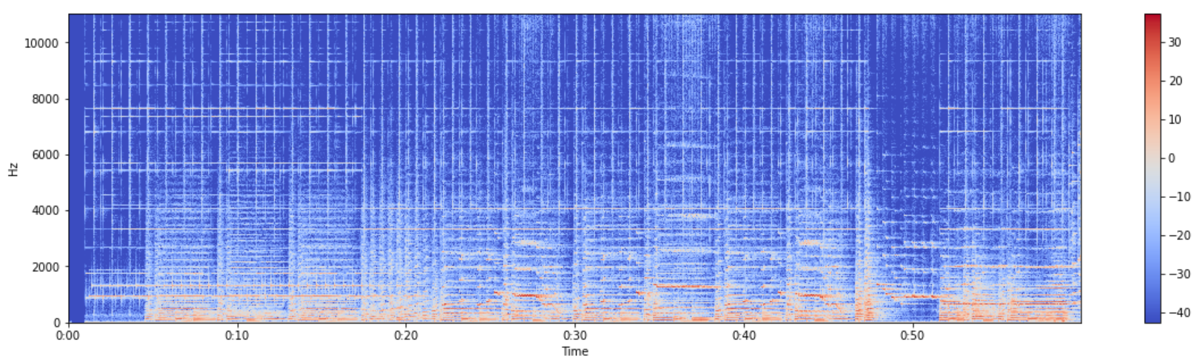
Out[ ]: <librosa.display.AdaptiveWaveplot at 0x1b5b9af4910>



spectogram

```
In [ ]: X = librosa.stft(x)
        Xdb = librosa.amplitude_to_db(abs(X))
        plt.figure(figsize=(20, 5))
        librosa.display.specshow(Xdb, sr=sr, x_axis='time', y_axis='hz')
        plt.colorbar()
```

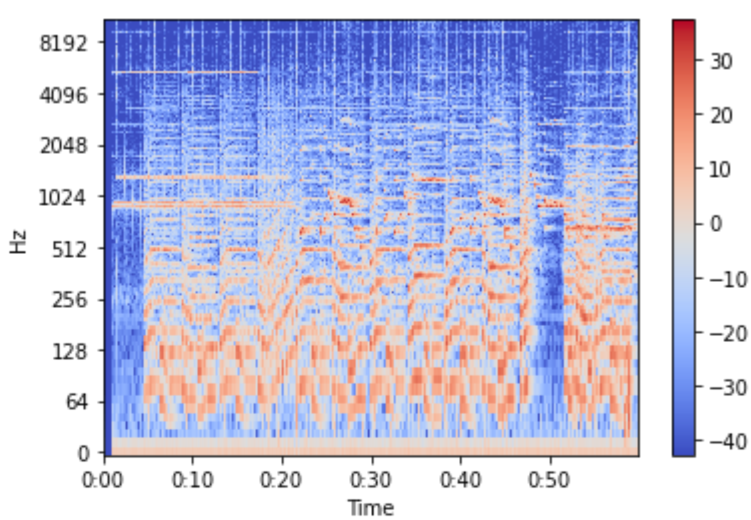
Out[ ]: <matplotlib.colorbar.Colorbar at 0x1b5ba111ff0>



log frequency axis

```
In [ ]: librosa.display.specshow(Xdb, sr=sr, x_axis='time', y_axis='log')
        plt.colorbar()
```

Out[ ]: <matplotlib.colorbar.Colorbar at 0x1b591b2cdc0>



Feature Extraction

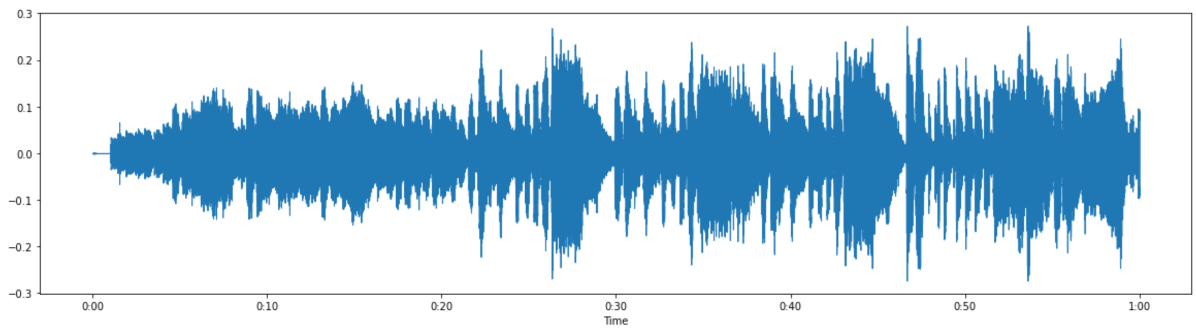
In [ ]:
```
x, sr = librosa.load('PinkPanther60.wav')
ipd.Audio(x, rate=sr)
```

Out[ ]:

0:00 / 1:00

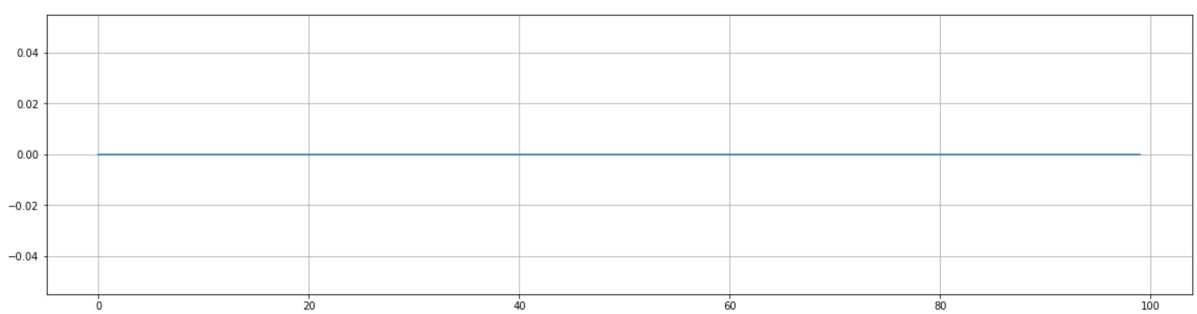
In [ ]:
```
#Plot the signal:
plt.figure(figsize=(20, 5))
librosa.display.waveshow(x, sr=sr)
```

Out[ ]:
```
<librosa.display.AdaptiveWaveplot at 0x1b591be87c0>
```



1. Zero Crossing Rate

In [ ]:
```
n0 = 9000
n1 = 9100
plt.figure(figsize=(20, 5))
plt.plot(x[n0:n1])
plt.grid()
```



In [ ]:
```
zero_crossings = librosa.zero_crossings(x[n0:n1], pad=False)
zero_crossings.shape
```

Out[ ]:
```
(100,)
```

In [ ]:
```
print(sum(zero_crossings))
```

```
0
```

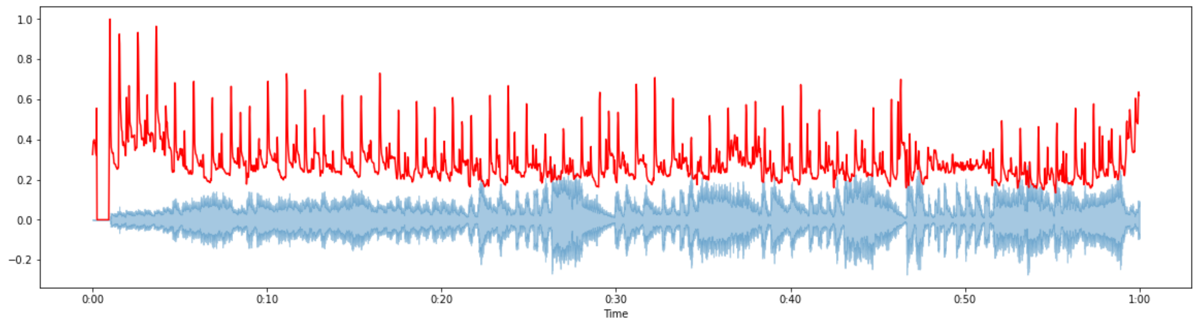
2.Spectral Centroid

In [ ]:
```
spectral_centroids = librosa.feature.spectral_centroid(x, sr=sr)[0]
spectral_centroids.shape
```

Out[ ]:
```
(2584,)
```

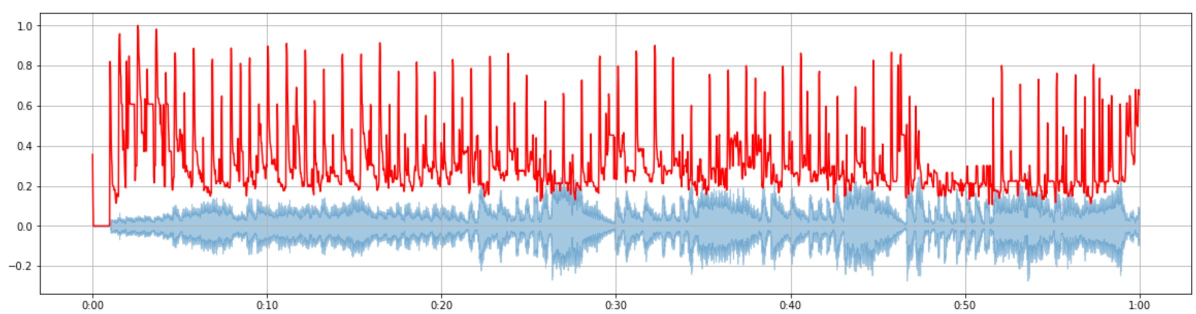
In [ ]:
```
# Computing the time variable for visualization
plt.figure(figsize=(20,5))
frames = range(len(spectral_centroids))
t = librosa.frames_to_time(frames)

# Normalising the spectral centroid for visualisation
def normalize(x, axis=0):
    return sklearn.preprocessing.minmax_scale(x, axis=axis)

#Plotting the Spectral Centroid along the waveform
librosa.display.waveshow(x, sr=sr, alpha=0.4)
plt.plot(t, normalize(spectral_centroids), color='r')
```

Out[ ]:
```
[<matplotlib.lines.Line2D at 0x1b591ca7bb0>]
```



3.Spectral Rolloff

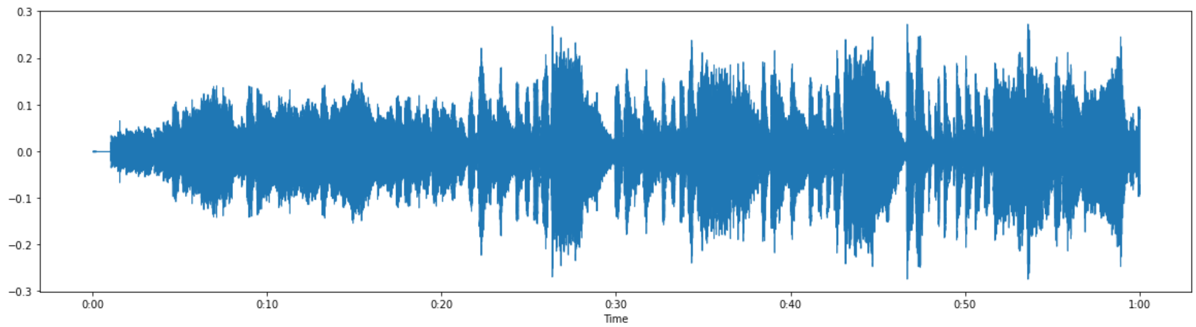
In [ ]:
```
plt.figure(figsize=(20,5))
spectral_rolloff = librosa.feature.spectral_rolloff(x+0.01, sr=sr)[0]
librosa.display.waveshow(x, sr=sr, alpha=0.4)
plt.plot(t, normalize(spectral_rolloff), color='r')
plt.grid()
```



4.MFCC

In [ ]:
```
plt.figure(figsize=(20,5))
x, fs = librosa.load('PinkPanther60.wav')
librosa.display.waveshow(x, sr=sr)
```

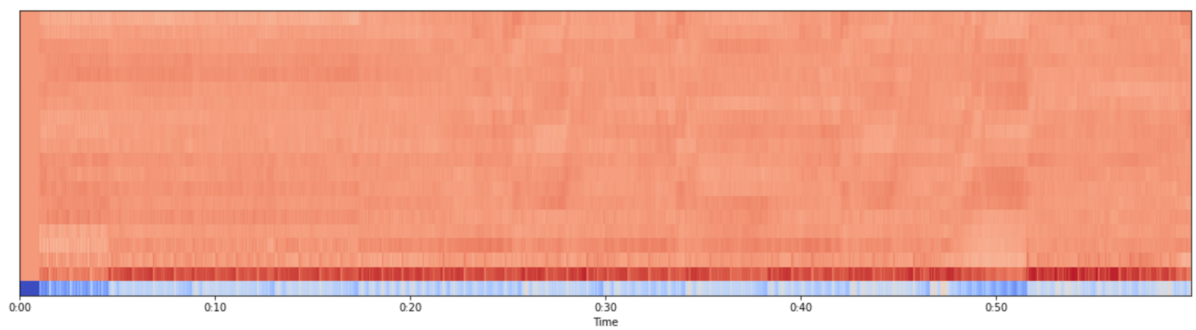
Out[ ]:
```
<librosa.display.AdaptiveWaveplot at 0x1b591d8d1e0>
```



In [ ]:
```
# MFCC
plt.figure(figsize=(20,5))
mfccs = librosa.feature.mfcc(x, sr=sr)
print(mfccs.shape)

librosa.display.specshow(mfccs, sr=sr, x_axis='time')
```

```
(20, 2584)
```

Out[ ]:
```
<matplotlib.collections.QuadMesh at 0x1b5bb8141f0>
```



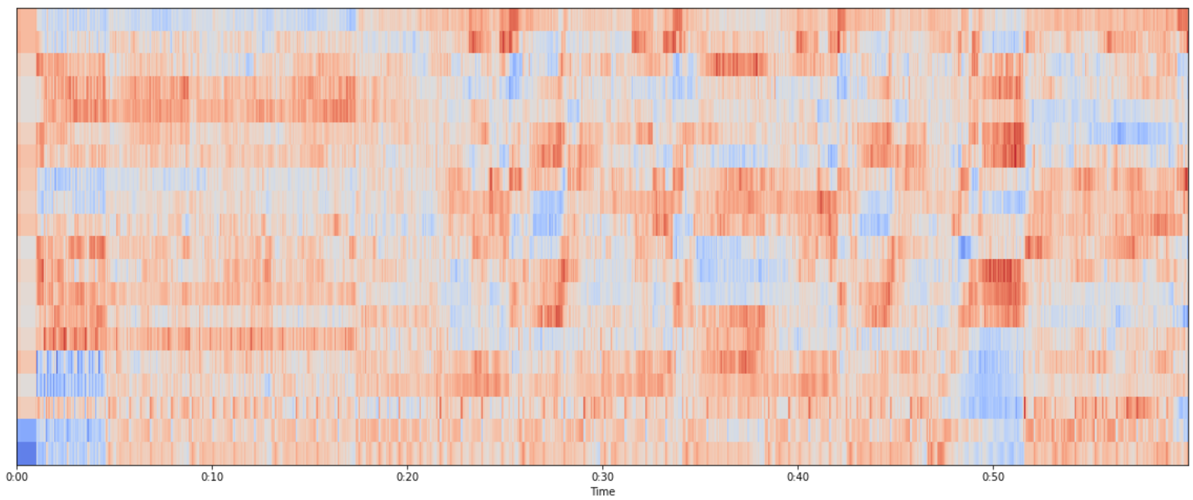
Feature Scaling

In [ ]:
```
mfccs = sklearn.preprocessing.scale(mfccs, axis=1)
print(mfccs.mean(axis=1))
print(mfccs.var(axis=1))
```

```
[ 1.1810208e-08 -1.1810208e-08 -2.9525520e-09  1.1810208e-08
 -2.3620416e-08 -1.1810208e-08  2.0667864e-08  1.1810208e-08
  0.0000000e+00  1.1810208e-08  0.0000000e+00  0.0000000e+00
  0.0000000e+00 -5.9051040e-09  0.0000000e+00  0.0000000e+00
  2.3620416e-08  5.9051040e-09 -1.1810208e-08  2.3620416e-08]
[0.9999998 1.        0.9999998 1.        0.9999999 1.        0.9999999
 0.9999999 0.9999999 1.        1.0000001 1.        1.        1.0000001
 0.9999999 0.9999999 1.        0.9999999 1.        1.        ]
```

In [ ]:
```
plt.figure(figsize=(20,8))
librosa.display.specshow(mfccs, sr=sr, x_axis='time')
```

Out[ ]:
```
<matplotlib.collections.QuadMesh at 0x1b5bb865120>
```



Chroma Frequencies

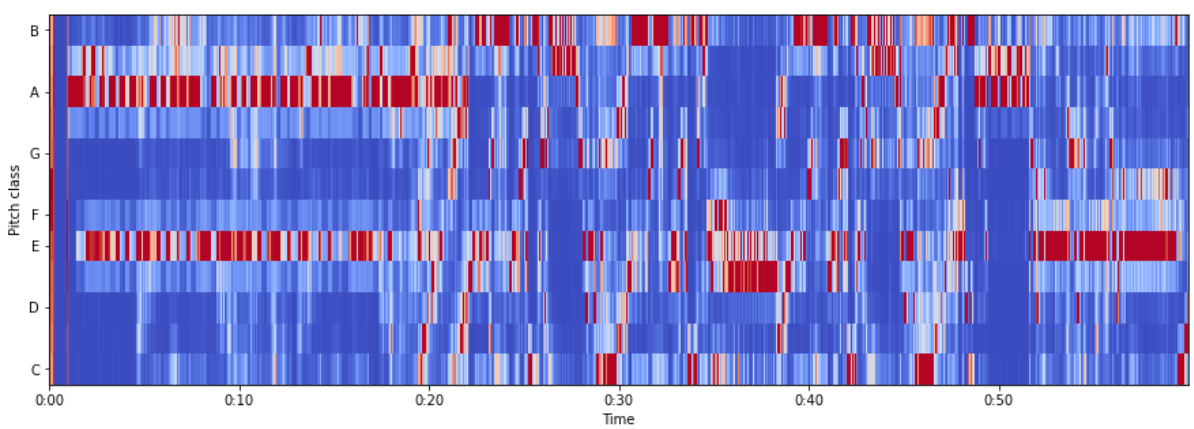
In [ ]:
```
# Loadign the file
x, sr = librosa.load('PinkPanther60.wav')
ipd.Audio(x, rate=sr)
```

Out[ ]:

0:00 / 1:00

In [ ]:
```
hop_length = 512
chromagram = librosa.feature.chroma_stft(x, sr=sr, hop_length=hop_length)
plt.figure(figsize=(15, 5))
librosa.display.specshow(chromagram, x_axis='time', y_axis='chroma', hop_length=hop
```

Out[ ]:
```
<matplotlib.collections.QuadMesh at 0x1b5bb8adb10>
```



In [ ]:

```
genre = 'pop'
songname = 'PinkPanther60.wav'
songtitle = 'PinkPanther60.wav'
y, sr = librosa.load(songname, mono=True, duration=30)
chroma_stft = librosa.feature.chroma_stft(y=y, sr=sr)
rmse = librosa.feature.rms(y=y)
spec_cent = librosa.feature.spectral_centroid(y=y, sr=sr)
spec_bw = librosa.feature.spectral_bandwidth(y=y, sr=sr)
rolloff = librosa.feature.spectral_rolloff(y=y, sr=sr)
zcr = librosa.feature.zero_crossing_rate(y)
mfcc = librosa.feature.mfcc(y=y, sr=sr)
to_append = f'{songtitle} {np.mean(chroma_stft)} {np.mean(rmse)} {np.mean(spec_cent


for e in mfcc:
    to_append += f' {np.mean(e)}'
to_append += f' {genre}'
file = open('dataset.csv', 'a', newline='')
with file:
    writer = csv.writer(file)
    writer.writerow(to_append.split())
```

In [ ]:

In [ ]:

In [ ]: