

```
pip install librosa matplotlib
```

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Requirement already satisfied: librosa in /usr/local/lib/python3.10/dist-packages (0.10.1)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (3.7.1)
Requirement already satisfied: audioread>=2.1.9 in /usr/local/lib/python3.10/dist-packages (from librosa) (3.0.1)
Requirement already satisfied: numpy!=1.22.0,!=1.22.1,!=1.22.2,>=1.20.3 in /usr/local/lib/python3.10/dist-packages (from librosa) (1.26.4)
Requirement already satisfied: scipy>=1.2.0 in /usr/local/lib/python3.10/dist-packages (from librosa) (1.11.4)
Requirement already satisfied: scikit-learn>=0.20.0 in /usr/local/lib/python3.10/dist-packages (from librosa) (1.2.2)
Requirement already satisfied: joblib>=0.14 in /usr/local/lib/python3.10/dist-packages (from librosa) (1.3.2)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.10/dist-packages (from librosa) (4.4.2)
Requirement already satisfied: numba>=0.51.0 in /usr/local/lib/python3.10/dist-packages (from librosa) (0.58.1)
Requirement already satisfied: soundfile>=0.12.1 in /usr/local/lib/python3.10/dist-packages (from librosa) (0.12.1)
Requirement already satisfied: pooch>=1.0 in /usr/local/lib/python3.10/dist-packages (from librosa) (1.8.0)
Requirement already satisfied: soxr>=0.3.2 in /usr/local/lib/python3.10/dist-packages (from librosa) (0.3.7)
Requirement already satisfied: typing-extensions>=4.1.1 in /usr/local/lib/python3.10/dist-packages (from librosa) (4.9.0)
Requirement already satisfied: lazy-loader>=0.1 in /usr/local/lib/python3.10/dist-packages (from librosa) (0.3)
Requirement already satisfied: msgpack>=1.0 in /usr/local/lib/python3.10/dist-packages (from librosa) (1.0.7)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (1.2.0)
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Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (4.48.1)
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Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (23.2)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (9.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib) (3.1.1)
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Requirement already satisfied: llvmlite<0.42,>=0.41.0dev0 in /usr/local/lib/python3.10/dist-packages (from numba>=0.51.0->librosa) (0.42.0)
Requirement already satisfied: platformdirs>=2.5.0 in /usr/local/lib/python3.10/dist-packages (from pooch>=1.0->librosa) (4.2.0)
Requirement already satisfied: requests>=2.19.0 in /usr/local/lib/python3.10/dist-packages (from pooch>=1.0->librosa) (2.31.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7->matplotlib) (1.16.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn>=0.20.0->librosa) (3.2.0)
Requirement already satisfied: cffi>=1.0 in /usr/local/lib/python3.10/dist-packages (from soundfile>=0.12.1->librosa) (1.16.0)
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Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->pooch>=1.0->librosa) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->pooch>=1.0->librosa) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->pooch>=1.0->librosa) (2.2.1)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.19.0->pooch>=1.0->librosa) (2024.7.4)
```

```
pip install librosa soundfile
```

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```

```
import librosa
import librosa.display
import matplotlib.pyplot as plt
```

```
import IPython.display as ipd
import pandas as pd
from glob import glob
```

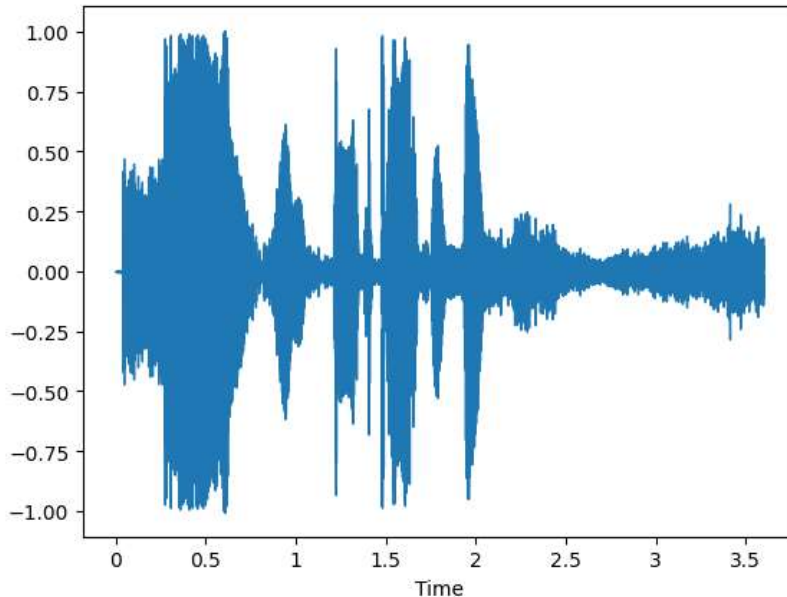
```
af = glob("/content/WhatsApp Audio 2024-02-05 at 13.37.51.wav")
ipd.Audio(af[0])
```

0:02 / 0:03

```
#file is the input audio file
file = '/content/WhatsApp Audio 2024-02-05 at 13.37.51.wav'
```

```
y, sr = librosa.load(file)
#displaying the waveform of audio
librosa.display.waveshow(y)
```

<librosa.display.AdaptiveWaveplot at 0x79520714bf70>



- 1) Find the first derivative of your speech signal with finite difference method.
 Listen to the first derivative signal and the original speech signal.

```
import numpy as np
import soundfile as sf

def finite_difference(signal, sampling_rate):
    dt = 1 / sampling_rate
    deriv = np.diff(signal) / dt
    return deriv

# Load the audio file
y_8k = librosa.resample(y, orig_sr=sr, target_sr= 40000)
y.shape, y_8k.shape

# Compute the first derivative of the audio signal
speech_derivative = finite_difference(y_8k, sr)

# saving the first derivative signal
output_file = 'speech_derivative.wav'
sf.write(output_file, speech_derivative, fs)
print(f"First derivative of the audio signal saved to {output_file}")

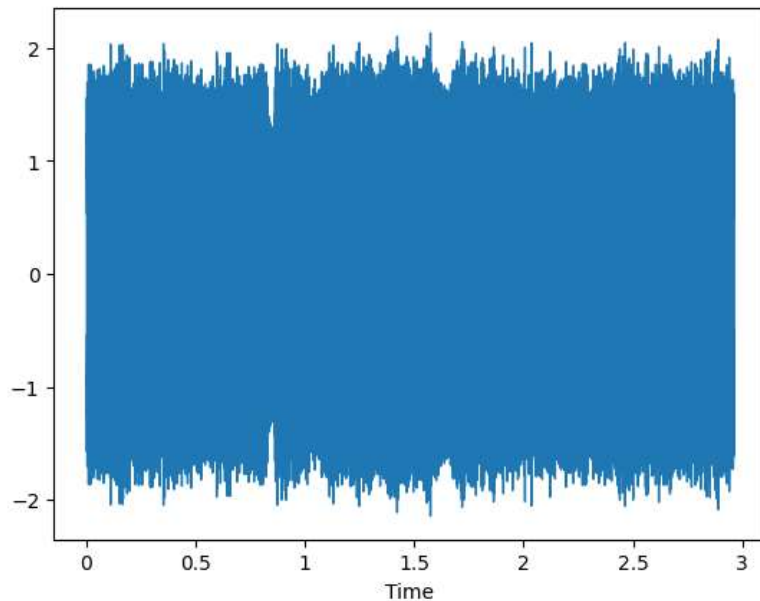
from IPython.display import Audio
audio_files_out = glob('speech_derivative.wav')
if len(audio_files_out) > 0:
    audio_file = audio_files_out[0]
    display(Audio(audio_file))
else:
    print("No audio file found.")
```

```
ys, sr = librosa.load('/content/speech_derivative.wav')
librosa.display.waveshow(ys)
```

First derivative of the audio signal saved to speech_derivative.wav

0:00 / 0:02

<librosa.display.AdaptiveWaveplot at 0x795205ce1f00>

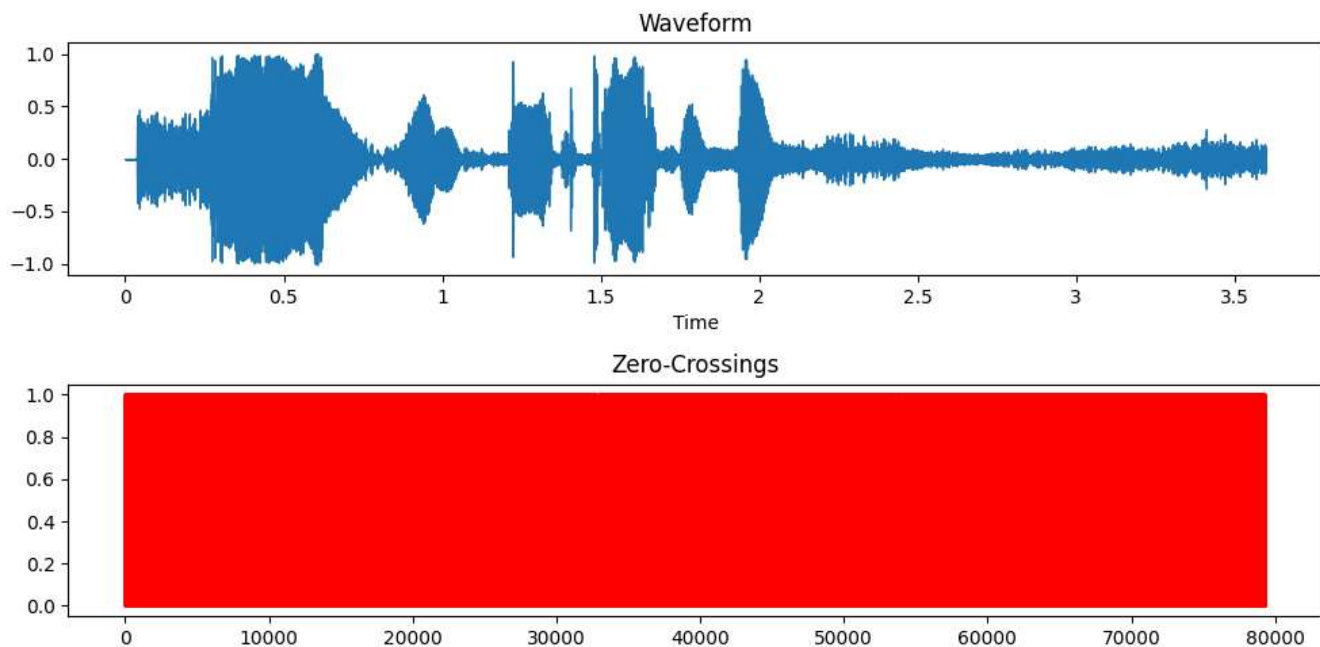


- 2) Detect the points of zero crossing in the first derivative signal. Compare the average
 ✓ length between two consecutive zero crossings for speech and silence regions. Observe the pattern.

```
import librosa
import librosa.display
import matplotlib.pyplot as plt

# Calculate zero-crossings
zero_crossings = librosa.zero_crossings(y, pad=False)

# Plot the waveform and zero-crossings
plt.figure(figsize=(10, 5))
plt.subplot(2, 1, 1)
librosa.display.waveshow(y, sr=sr)
plt.title('Waveform')
plt.subplot(2, 1, 2)
plt.plot(zero_crossings, color='r')
plt.title('Zero-Crossings')
plt.tight_layout()
plt.show()
```



```
import soundfile as sf

# Input and output file paths
input_file = "/content/WhatsApp Audio 2024-02-12 at 15.02.02.ogg"
output_file = "r3.wav"
```

```
data, samplerate = sf.read(input_file)
```

```
# Write the data to a WAV file
sf.write(output_file, data, samplerate)
```

```
print("Conversion complete.")
```

```
Conversion complete.
```

```
af = glob("/content/r1.wav")
ipd.Audio(af[0])
```

```
0:01 / 0:01
```

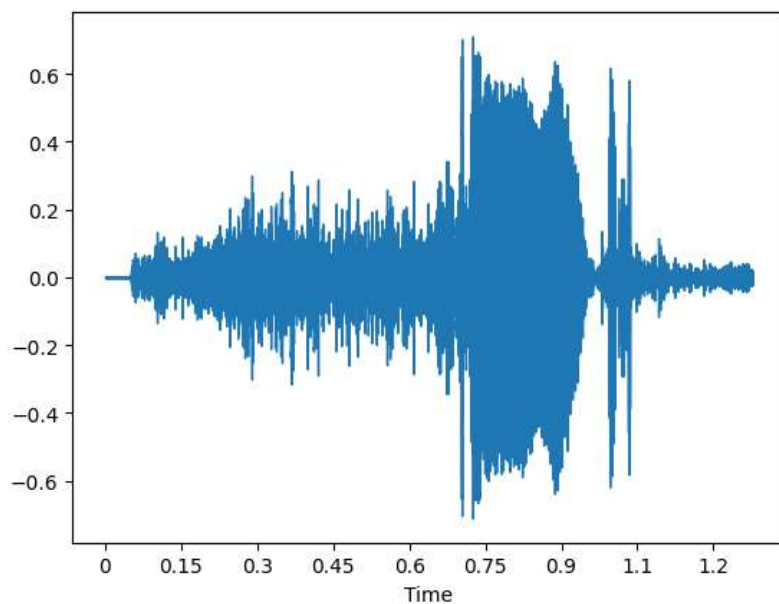
```
y5, sr = librosa.load('/content/r5.wav')
#displaying the waveform of audio
librosa.display.waveshow(y5)
```

```
l5 = len(y5)/sr
print("length of the signal in seconds",l5)
```

```
af5 = glob("/content/r5.wav")
ipd.Audio(af5[0])
```

length of the signal in seconds 1.2778684807256235

0:01 / 0:01



Signal difference length sampling rate

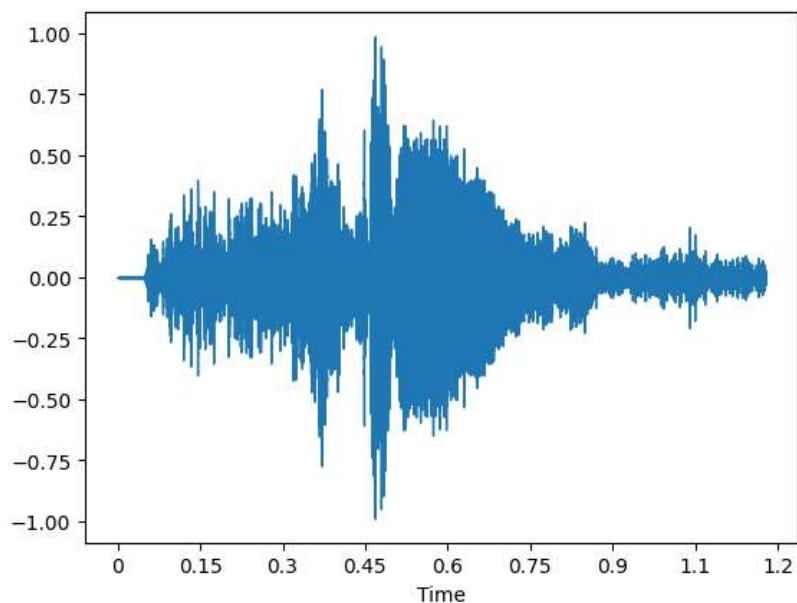
```
y2, sr2 = librosa.load('/content/r2.wav')
#displaying the waveform of audio
librosa.display.waveshow(y2)

l2 = len(y2)/sr
print("length of the signal in seconds",l2)
print("signal to noise ratio",sr2)

af2 = glob("/content/r2.wav")
ipd.Audio(af2[0])
```

length of the signal in seconds 1.1778231292517007
signal to noise ratio 22050

0:00 / 0:01



```
y3, sr = librosa.load('/content/r3.wav')  
#displaying the waveform of audio  
librosa.display.waveshow(y3)  
  
l3 = len(y3)/sr  
print("length of the signal in seconds",l3)  
  
af3 = glob("/content/r3.wav")  
ipd.Audio(af3[0])
```

length of the signal in seconds 1.6778231292517007

0:01 / 0:01

