LAB-07

AI IN SP

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A1. Use HMM for classification of your speech signal using STFT features.

In [1]:
```
!pip install hmmlearn
```

```
Collecting hmmlearn
  Downloading hmmlearn-0.3.2-cp39-cp39-win_amd64.whl (124 kB)
Requirement already satisfied: scikit-learn!=0.22.0,>=0.16 in c:\users\anvit\anaconda3\lib\site-packages (from hmmlearn) (1.0.2)
Requirement already satisfied: numpy>=1.10 in c:\users\anvit\anaconda3\lib\site-packages (from hmmlearn) (1.21.6)
Requirement already satisfied: scipy>=0.19 in c:\users\anvit\anaconda3\lib\site-packages (from hmmlearn) (1.7.3)
Requirement already satisfied: joblib>=0.11 in c:\users\anvit\anaconda3\lib\site-packages (from scikit-learn!=0.22.0,>=0.16->hmm
learn) (1.1.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\anvit\anaconda3\lib\site-packages (from scikit-learn!=0.22.0,>=
0.16->hmmlearn) (2.2.0)
Installing collected packages: hmmlearn
Successfully installed hmmlearn-0.3.2
```

In [2]:
```
import numpy as np
import librosa
import matplotlib.pyplot as plt
from hmmlearn import hmm
import IPython.display as ipd
import scipy.signal as signal
import scipy.io.wavfile as wavfile
from glob import glob
from scipy.signal import spectrogram
```

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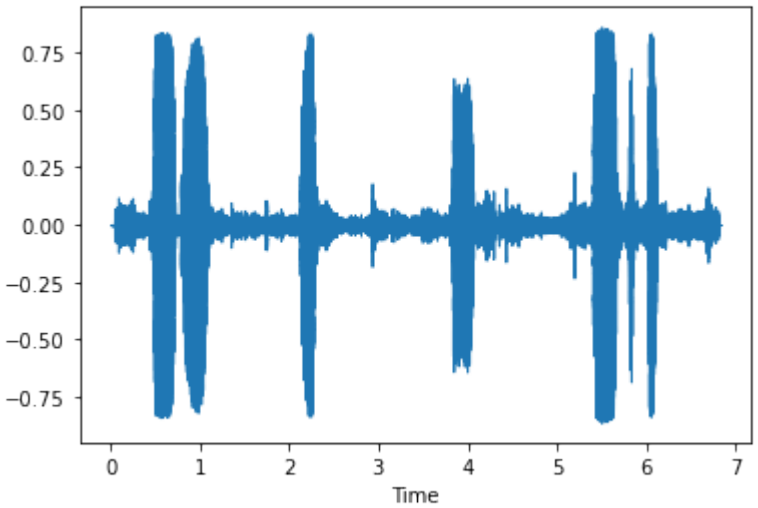
```
C:\Users\anvit\anaconda3\lib\site-packages\numpy\_distributor_init.py:30: UserWarning: loaded more than 1 DLL from .libs:
C:\Users\anvit\anaconda3\lib\site-packages\numpy\.libs\libopenblas.WCDJNK7YVMPZQ2ME2ZZHJJRJ3JIKNDB7.gfortran-win_amd64.dll
C:\Users\anvit\anaconda3\lib\site-packages\numpy\.libs\libopenblas.XWYDX2IKJW2NMTWSFYNGFUWKQU3LYTCZ.gfortran-win_amd64.dll
  warnings.warn("loaded more than 1 DLL from .libs:"
```

In [3]:
```
y, sr = librosa.load('sp2_anvith.wav')
librosa.display.waveshow(y)
```

Out[3]:
```
<librosa.display.AdaptiveWaveplot at 0x19bc4d43fa0>
```



In [4]:
```
a = glob('sp2_anvith.wav')
ipd.Audio(a[0])
```

Out[4]:

In [5]:
```
def load_audio(file_path):
    y, sr = librosa.load(file_path, sr=None)
    return y, sr

def stft_features(y, sr):
    stft = np.abs(librosa.stft(y))
```

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```
def train_hmm(features, n_components=3, n_iter=100):
    model = hmm.GaussianHMM(n_components=n_components, covariance_type="diag", n_iter=n_iter)
    model.fit(features)
    return model

def plot_stft(stft, sr):
    plt.figure(figsize=(12, 6))
    librosa.display.specshow(librosa.amplitude_to_db(stft, ref=np.max), sr=sr, x_axis='time', y_axis='log')
    plt.colorbar(format='%+2.0f dB')
    plt.title('STFT')
    plt.show()

def classify_signal(model, features):
    # Predict using the trained HMM model
    labels = model.predict(features.T)  # Transpose features to fit HMM's requirement
    return labels
```

In [7]:

```
def main():
    audio_file_path = "sp2_anvith.wav"

    # Load audio
    y, sr = load_audio(audio_file_path)

    # Extract STFT features
    stft = stft_features(y, sr)

    # Plot STFT
    plot_stft(stft, sr)

    # Train HMM
    model = train_hmm(stft.T)  # Transpose stft to fit HMM's requirement

    # Classify signal using trained HMM
    labels = classify_signal(model, stft)

    # Plot the classification result
    plt.figure(figsize=(12, 6))
    plt.plot(np.arange(len(labels)), labels, label='Classified State')
    plt.xlabel('Time')
    plt.ylabel('State')
    plt.title('HMM Classification Result')
    plt.legend()
```

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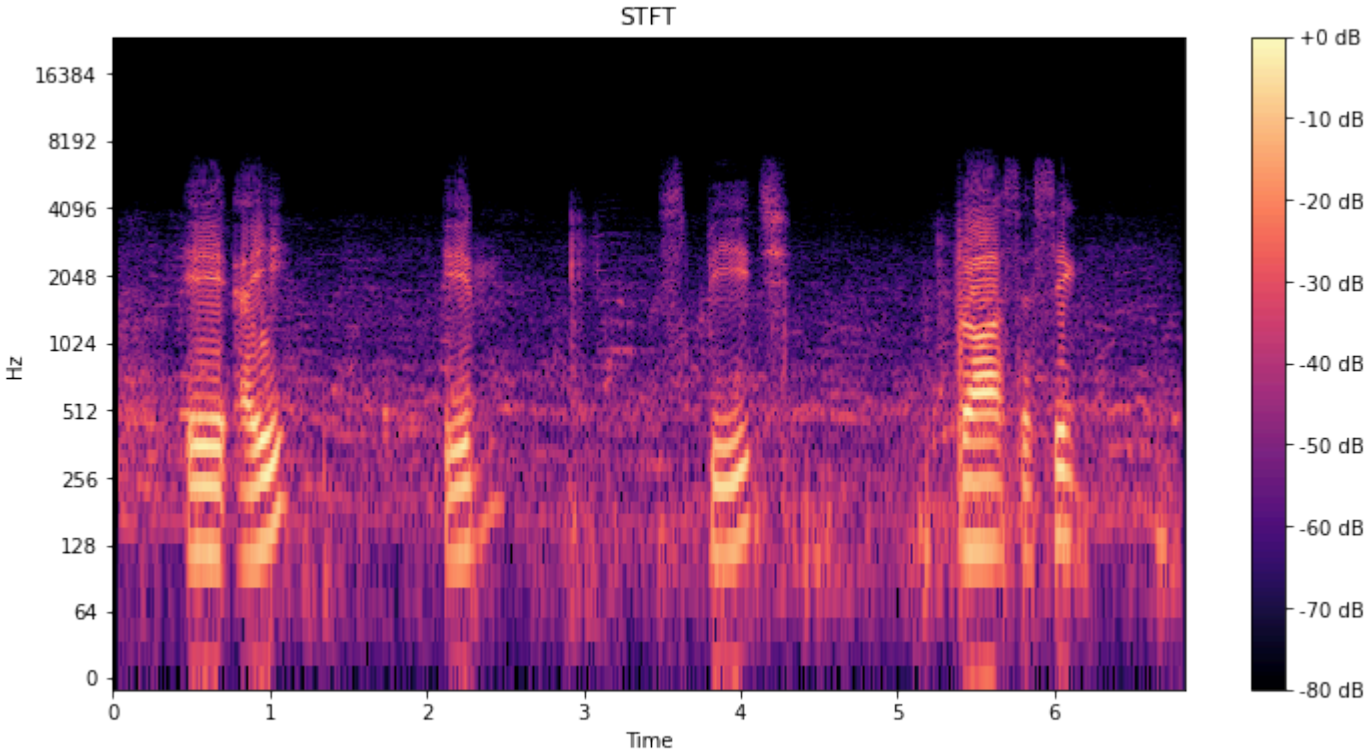
```
    # Print trained model parameters
    print("HMM Model Parameters:")
    print("Transition Matrix:")
    print(model.transmat_)
    print("Means:")
    print(model.means_)
    print("Covariances:")
    print(model.covars_)



if __name__ == "__main__":
    main()
```



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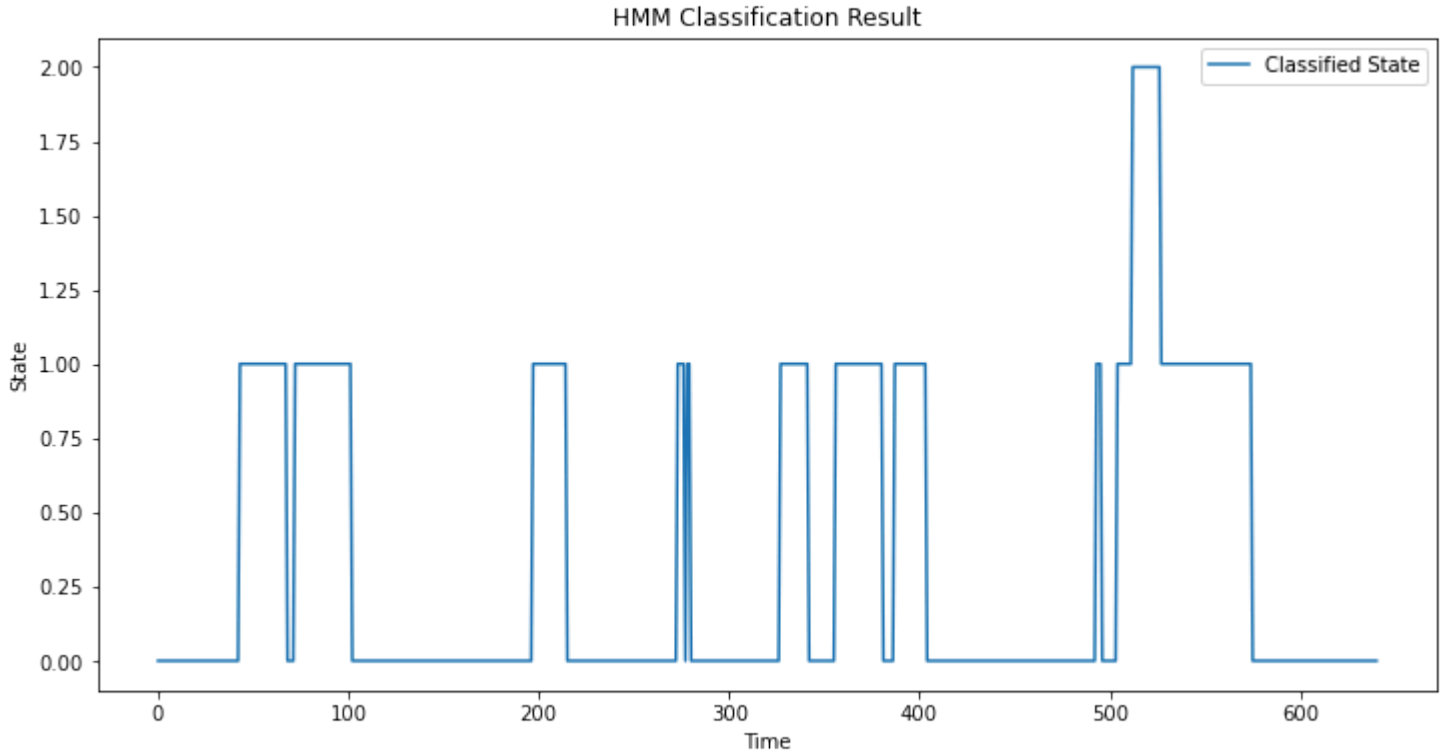

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```
HMM Model Parameters:
Transition Matrix:
[[0.97674419 0.02325581 0.        ]
 [0.05128205 0.94358974 0.00512821]
 [0.         0.06666667 0.93333333]]
Means:
[[3.75945091e-01 7.13998148e-01 1.31425853e+00 ... 2.08950845e-04
  2.02940554e-04 1.88202929e-04]
 [3.38396475e+00 3.60548168e+00 2.51506284e+00 ... 2.33075048e-04
  2.28716949e-04 1.97906488e-04]
 [1.78649486e+01 9.23238564e+00 1.72502662e+00 ... 2.07999447e-04
  2.22619645e-04 2.16238447e-04]]
Covariances:
[[[1.30705761e-01 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
   0.00000000e+00 0.00000000e+00]
  [0.00000000e+00 2.48790669e-01 0.00000000e+00 ... 0.00000000e+00
   0.00000000e+00 0.00000000e+00]
  [0.00000000e+00 0.00000000e+00 1.19774431e+00 ... 0.00000000e+00
   0.00000000e+00 0.00000000e+00]
  ...
  [0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 2.32144997e-05
   0.00000000e+00 0.00000000e+00]
  [0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
   2.32133488e-05 0.00000000e+00]
  [0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
   0.00000000e+00 2.32212795e-05]]

 [[1.96365337e+01 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
   0.00000000e+00 0.00000000e+00]
  [0.00000000e+00 1.00327685e+01 0.00000000e+00 ... 0.00000000e+00
   0.00000000e+00 0.00000000e+00]
  [0.00000000e+00 0.00000000e+00 2.96737240e+00 ... 0.00000000e+00
   0.00000000e+00 0.00000000e+00]
  ...
  [0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 5.12958089e-05
   0.00000000e+00 0.00000000e+00]
  [0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
   5.12969214e-05 0.00000000e+00]
  [0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
   0.00000000e+00 5.13044644e-05]]

 [[1.16830165e+01 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
```

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```
  [0.00000000e+00 5.13068700e+00 0.00000000e+00 ... 0.00000000e+00
```

```
 0.00000000e+00 0.00000000e+00]
[0.00000000e+00 0.00000000e+00 7.14130465e-01 ... 0.00000000e+00
 0.00000000e+00 0.00000000e+00]
...
[0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 6.66674549e-04
 0.00000000e+00 0.00000000e+00]
[0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
 6.66675144e-04 0.00000000e+00]
[0.00000000e+00 0.00000000e+00 0.00000000e+00 ... 0.00000000e+00
 0.00000000e+00 6.66715714e-04]]]
```

In [ ]:

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