In [124]:
```python
import os
import numpy as np
import librosa
from sklearn.mixture import GaussianMixture
import pickle
```

In [125]:
```python
SR = 16000
WINDOW_LENGTH = 0.02
HOP_LENGTH = 0.01
N_MFCC = 13
FMAX=None
```

In [126]:
```python
def extract_mfcc(file_path, sr=SR, window_length=WINDOW_LENGTH, hop_length=HOP_LENGTH, n_mfcc=N_MFCC, fmax=FMAX):
    y, sr = librosa.load(file_path, sr=sr)
    mfcc = librosa.feature.mfcc(y=y, sr=sr, n_mfcc=n_mfcc,
                                n_fft=int(sr * window_length),
                                hop_length=int(sr * hop_length),
                                fmax=fmax)
    return mfcc.T
```

In [127]:
```python
def train_gmm_for_speaker(data_folder):
    speakers = os.listdir(data_folder)
    gmm_models = {}

    for speaker in speakers:
        speaker_path = os.path.join(data_folder, speaker)
        if os.path.isdir(speaker_path):
            mfccs = []
            for file in os.listdir(speaker_path):
                file_path = os.path.join(speaker_path, file)
                if file_path.endswith('.wav'):
                    mfcc = extract_mfcc(file_path)
                    mfccs.append(mfcc)
            mfccs = np.vstack(mfccs)
            gmm = GaussianMixture(n_components=16, covariance_type='diag', n_init=3)
            gmm.fit(mfccs)
            gmm_models[speaker] = gmm

    return gmm_models
```

In [129]:
```python
def predict_speaker(gmm_models, file_path):
    mfcc = extract_mfcc(file_path)
    best_speaker = None
    highest_score = float('-inf')

    for speaker, gmm in gmm_models.items():
        score = gmm.score(mfcc)
        if score > highest_score:
            highest_score = score
            best_speaker = speaker

    return best_speaker
```

In [130]:
```python
data_folder = r"C:\Users\User\Desktop\speech technologies\16000_pcm_speeches"
gmm_model_path = 'gmm_models.pkl'
```

In [131]:
```python
gmm_models = train_gmm_for_speaker(data_folder)
with open(gmm_model_path, 'wb') as f:
    pickle.dump(gmm_models, f)
```

```
C:\Users\User\anaconda\lib\site-packages\librosa\feature\spectral.py:2143: UserWarning: Empty filters detected in mel frequency
basis. Some channels will produce empty responses. Try increasing your sampling rate (and fmax) or reducing n_mels.
  mel_basis = filters.mel(sr=sr, n_fft=n_fft, **kwargs)
C:\Users\User\anaconda\lib\site-packages\librosa\feature\spectral.py:2143: UserWarning: Empty filters detected in mel frequency
basis. Some channels will produce empty responses. Try increasing your sampling rate (and fmax) or reducing n_mels.
  mel_basis = filters.mel(sr=sr, n_fft=n_fft, **kwargs)
C:\Users\User\anaconda\lib\site-packages\librosa\feature\spectral.py:2143: UserWarning: Empty filters detected in mel frequency
basis. Some channels will produce empty responses. Try increasing your sampling rate (and fmax) or reducing n_mels.
  mel_basis = filters.mel(sr=sr, n_fft=n_fft, **kwargs)
C:\Users\User\anaconda\lib\site-packages\librosa\feature\spectral.py:2143: UserWarning: Empty filters detected in mel frequency
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basis. Some channels will produce empty responses. Try increasing your sampling rate (and fmax) or reducing n_mels.
  mel_basis = filters.mel(sr=sr, n_fft=n_fft, **kwargs)
```

In [132]:
```python
with open(gmm_model_path, 'rb') as f:
    gmm_models = pickle.load(f)
```

In [134]:
```python
sample_file_path = r"C:\Users\User\Desktop\speech technologies\16000_pcm_speeches\other\exercise_bike.wav"
predicted_speaker = predict_speaker(gmm_models, sample_file_path)
print(f'The predicted speaker is: {predicted_speaker}')
```

```
The predicted speaker is: other
```

```
C:\Users\User\anaconda\lib\site-packages\librosa\feature\spectral.py:2143: UserWarning: Empty filters detected in mel frequency
basis. Some channels will produce empty responses. Try increasing your sampling rate (and fmax) or reducing n_mels.
  mel_basis = filters.mel(sr=sr, n_fft=n_fft, **kwargs)
```

In [ ]: