

# Extracting frequency domain features

We discussed earlier how to convert a signal into the frequency domain. In most modern speech recognition systems, people use frequency-domain features. After you convert a signal into the frequency domain, you need to convert it into a usable form. **Mel Frequency Cepstral Coefficients (MFCC)** is a good way to do this. MFCC takes the power spectrum of a signal and then uses a combination of filter banks and discrete cosine transform to extract features. If you need a quick refresher, you can check out <http://practicalcryptography.com/miscellaneous/machine-learning/guide-mel-frequency-cepstral-coefficients-mfccs>. Make sure that the `python_speech_features` package is installed before you start. You can find the installation instructions at <http://python-speech-features.readthedocs.org/en/latest>. Let's take a look at how to extract MFCC features.

## How to do it...

1. Create a new Python file, and import the following packages:

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.io import wavfile
from features import mfcc, logfbank
```

2. Read the `input_freq.wav` input file that is already provided to you:

```
# Read input sound file
sampling_freq, audio = wavfile.read("input_freq.wav")
```

3. Extract the MFCC and filter bank features:

```
# Extract MFCC and Filter bank features
mfcc_features = mfcc(audio, sampling_freq)
filterbank_features = logfbank(audio, sampling_freq)
```

4. Print the parameters to see how many windows were generated:

```
# Print parameters
print '\nMFCC:\nNumber of windows =', mfcc_features.shape[0]
print 'Length of each feature =', mfcc_features.shape[1]
print '\nFilter bank:\nNumber of windows =',
filterbank_features.shape[0]
print 'Length of each feature =', filterbank_features.shape[1]
```

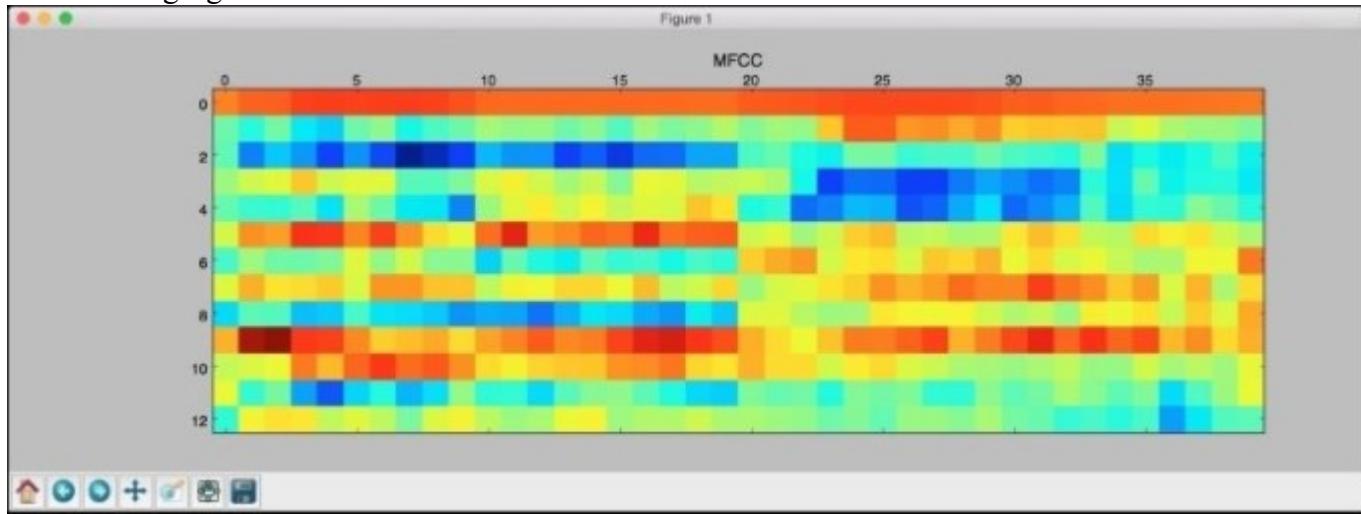
5. Let's visualize the MFCC features. We need to transform the matrix so that the time domain is horizontal:

```
# Plot the features
mfcc_features = mfcc_features.T
plt.matshow(mfcc_features)
plt.title('MFCC')
```

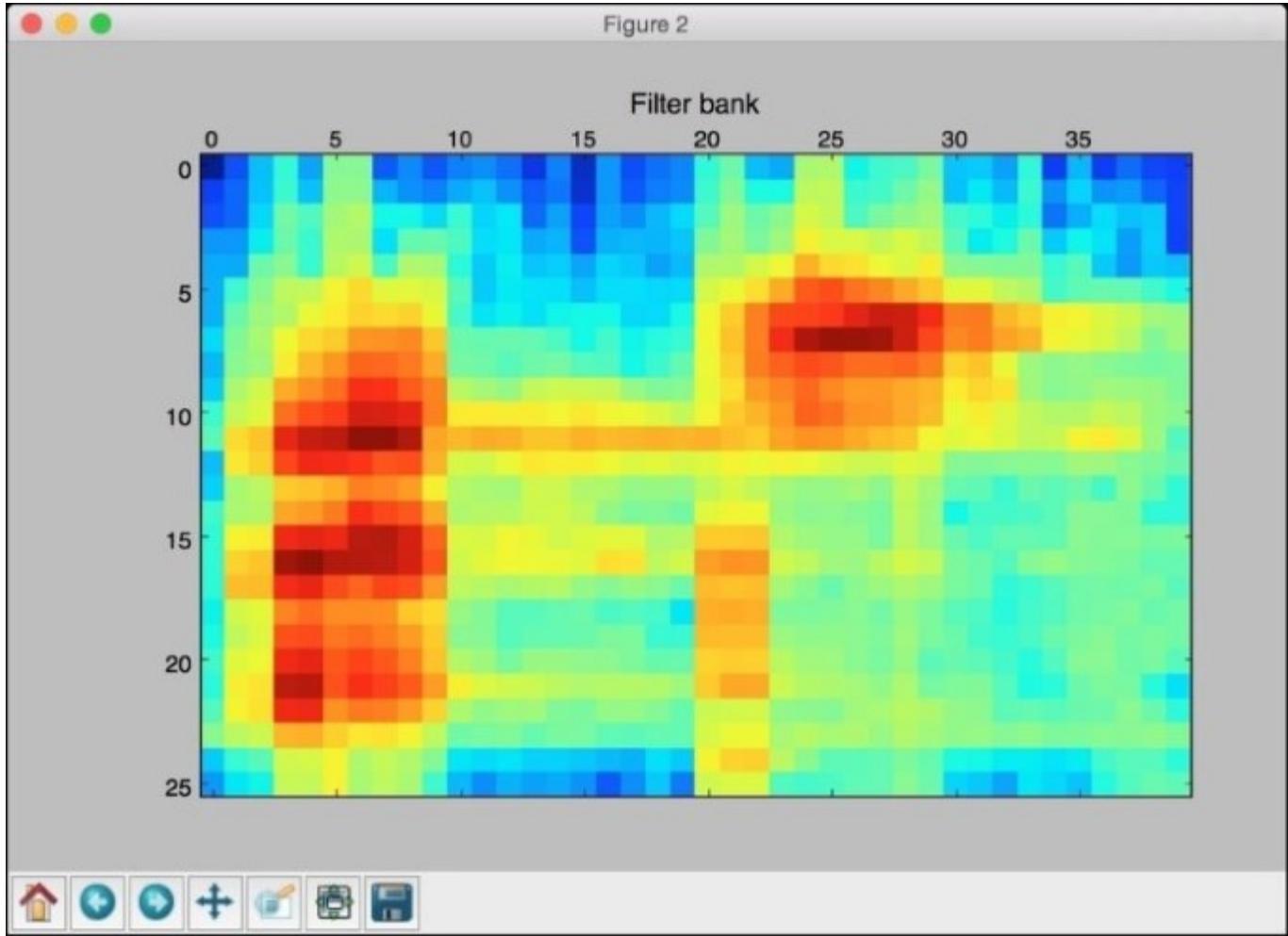
6. Let's visualize the filter bank features. Again, we need to transform the matrix so that the time domain is horizontal:

```
filterbank_features = filterbank_features.T  
plt.matshow(filterbank_features)  
plt.title('Filter bank')  
  
plt.show()
```

7. The full code is in the `extract_freq_features.py` file. If you run this code, you will get the following figure for MFCC features:



8. The filter bank features will look like the following:



9. You will get the following output on your Terminal:

```
MFCC:  
Number of windows = 40  
Length of each feature = 13  
  
Filter bank:  
Number of windows = 40  
Length of each feature = 26
```