audio_descriptors_and_segmentation

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0.1 Audio descriptors and segmentation

In this notebook we are going to look at audio descriptors that are relativelyt popular in scientific papers dealing with voice / gender recognition. Majority of features, short of pitch, have been retrieved through Yaafe: http://yaafe.sourceforge.net/features.html

```
In [1]: import logging
        import numpy as np
        import pandas as pd
        import yaafelib
        import librosa
        import aubio
        import matplotlib.pyplot as plt
        import dsp

        %matplotlib inline
```

Description of the *featurespecs* can be found on the web page

```
In [5]: featurespecs = \
            ['LSF: LSF blockSize={} stepSize={}',
             'SpectralDecrease: SpectralDecrease blockSize={} stepSize={}',
             'SpectralFlatness: SpectralFlatness blockSize={} stepSize={}',
             'SpectralFlux: SpectralFlux blockSize={} stepSize={}',
             'SpectralSlope: SpectralSlope blockSize={} stepSize={}',
             'SpectralRolloff: SpectralRolloff blockSize={} stepSize={}',
             'SpectralShapeStatistics: SpectralShapeStatistics blockSize={} stepSize={}',
             'MFCC: MFCC blockSize={} stepSize={}',
             'SpectralVariation: SpectralVariation blockSize={} stepSize={}']

        path = '/home/tracek/Data/gender/Voxforge/ablackball-20121113-vvk/wav/a0333.wav'

        find_salient = False
        sr = 16000
        block_size = 1024
        nfft = 512
```

0.1.1 Segmentation

Since we are going to aggregate numbers, it is important that we run calculations over actual voice. Non-voice regions of audio samples, typically in the beginning and end of a recording, are the regions where speaker has either not speaking yet or has finished speaking already. These regions are not necessarily silent: they can contain various types of noise, like white noise, background noise, electronic noise etc. Not removing them severely affects features that can be extracted from the audio. Let's take as an example MFCC: Mel-frequency cepstral coefficients (https://en.wikipedia.org/wiki/Mel-frequency_cepstrum)

```
In [26]: def get_onsets(signal, sr, nfft, hop, onset_detector_type='hfc', onset_threshold=0.01):
             onsets = []

             onset_detector = aubio.onset(onset_detector_type, nfft, hop, sr)
             onset_detector.set_threshold(onset_threshold)

             signal_windowed = np.array_split(signal, np.arange(hop, len(signal), hop))

             for frame in signal_windowed[:-1]:
                 if onset_detector(frame):
                     onsets.append(onset_detector.get_last())
             return np.array(onsets[1:])

         def get_start_end_samples(y, sr, nfft, hop,  onset_detector_type='hfc', onset_threshold
             onsets_fw = get_onsets(y, sr, nfft, hop, onset_detector_type, onset_threshold)
             onsets_bw = get_onsets(y[::-1], sr, nfft, hop, onset_detector_type, onset_threshold
             onsets_bw_rev = (len(y) - np.array(onsets_bw)[::-1])
             return onsets_fw[0], onsets_bw_rev[-1]



         def get_salient_region(y, sr, start, end, start_buffer=0.0, end_buffer=0.0):
             salient_start = max(0, start - int(start_buffer * sr))
             salient_end = min(len(y), end + int(end_buffer * sr))
             return y[salient_start:salient_end]

         def plot_feature(feature, y_len):
             x_spacing = np.linspace(0, y_len, len(feature))

             no_figures = feature.shape[1]
             if no_figures == 1:
                 plt.figure(figsize=(15,5))
                 plt.plot(x_spacing, feature)
             else:
                 f, ax = plt.subplots(no_figures, 1, sharex=True, figsize=(15,15))
                 for idx in range(no_figures):
                     ax[idx].plot(x_spacing, feature[:, idx])
             plt.xlabel('time')
```

```
In [27]: feature_plan = yaafelib.FeaturePlan(sample_rate=sr, normalize=True)
```

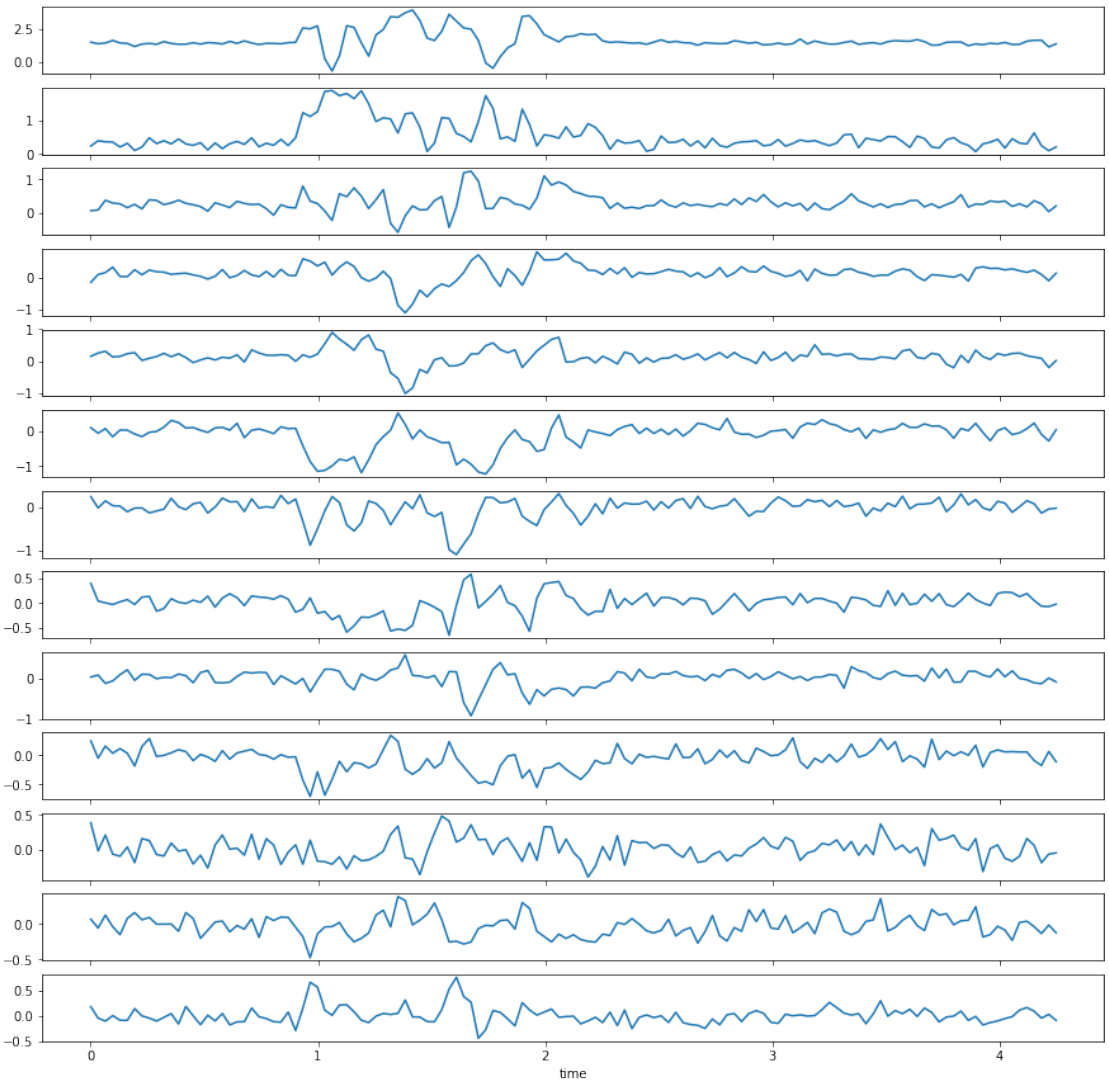
```
         for featurespec in featurespecs:
             feature = featurespec.format(block_size, block_size // 2)
             assert feature_plan.addFeature(feature), 'Failed to load %s feature' % feature
             logging.info('Feature %s loaded', feature)

         engine = yaafelib.Engine()
         engine.load(feature_plan.getDataFlow())
```

```
Out[27]: True
```

```
In [28]: y, sr = librosa.load(path, sr=sr)
         y = librosa.util.normalize(y)
         if find_salient:
             y_start, y_end = get_start_end_samples(y.astype('float32'), sr, nfft=nfft, hop=nfft
             y = get_salient_region(y, sr, start=y_start, end=y_end, start_buffer=0.2, end_buffe
```

```
In [29]: feats = engine.processAudio(y.reshape(1, -1))
         x_shape_expected = next(iter(feats.values())).shape[0] # random item
         for name, feat in feats.items():
             if feat.shape[0] != x_shape_expected:
                 print('Feature {} is messed up. Expected {} got {}'.format(name, x_shape_expect
```

```
In [30]: plot_feature(feats['MFCC'], len(y) / sr)
```



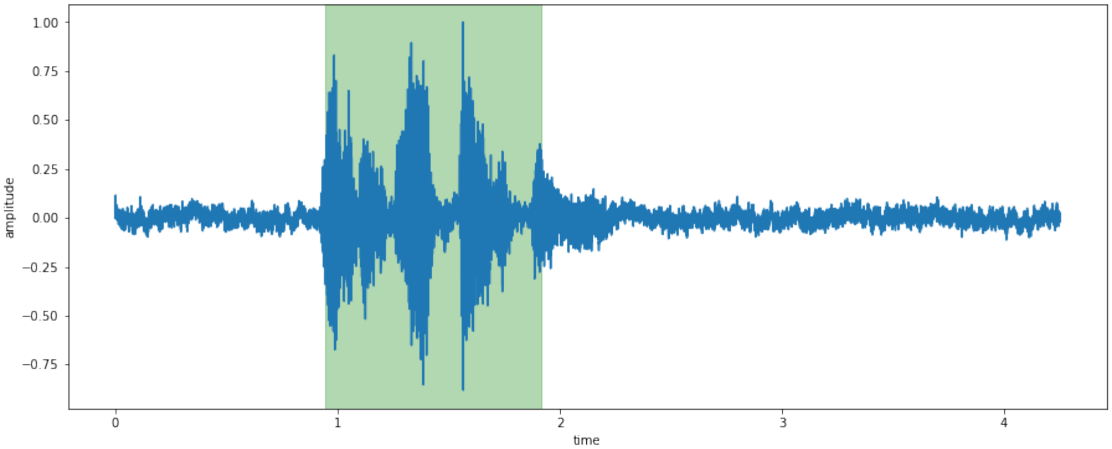
It is clear from visual inspection that MFCC has high variance with human voice and low outside. Taking simple mean or median would severely distort the result.

```
In [31]: y_start, y_end = get_start_end_samples(y.astype('float32'), sr, nfft=nfft, hop=nfft //
         print('Start: ', y_start / sr)
         print('End: ', y_end / sr)
```

```
Start:  0.94575
End:  1.91875
```

```
In [42]: plt.figure(figsize=(15,6))
         plt.plot(np.linspace(0, len(y)/sr, len(y)), y)
         plt.axvspan(xmin=y_start / sr, xmax=y_end / sr, color='green', alpha=0.3)
         plt.xlabel('time')
         plt.ylabel('amplitude')
```

```
Out[42]: Text(0,0.5,'amplitude')
```



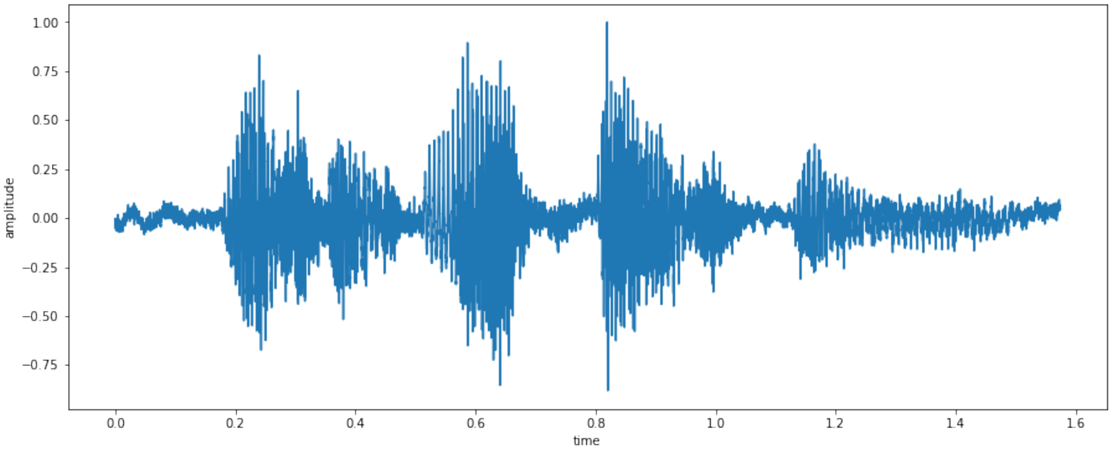
0.2 Beauty!

Our onset detectors did a good job. Add some margin and we're good

```
In [43]: y = get_salient_region(y, sr, start=y_start, end=y_end, start_buffer=0.2, end_buffer=0.
```

```
In [45]: plt.figure(figsize=(15,6))
         plt.plot(np.linspace(0, len(y)/sr, len(y)), y)
         plt.xlabel('time')
         plt.ylabel('amplitude')
```

```
Out[45]: Text(0,0.5,'amplitude')
```


amplitude
time