

Demo 14 Exercises: Block filtering

DSP Lab (ECE 4163 / ECE 6183)

2021

Demo files

```
demo_filter.py
demo_filter_blocks.py
demo_filter_blocks_corrected.py
demo_filter_blocks_mtlb.m
myfunctions.py
author.wav
```

In previous demos we used the Matlab function `filter` to implement a difference equation. In Python, a similar function called `lfilter` is available in the SciPy library for scientific computing. (Here `lfilter` means *linear* filter.)

<http://docs.scipy.org/doc/scipy/reference/signal.html>

To avoid transient artifacts at the start of each block, we specify the initial states `zi` in the `lfilter` function as the final states `zf` from the previous block.

Exercises

1. The Matlab function `butter` gives the coefficients of a digital Butterworth filter. For example, a band-pass filter with a pass-band from 500 Hz to 1000 Hz can be obtained in Matlab using:

```
[b, a] = butter(2, [500 1000]*2/Fs)
```

What is the order of this filter?

In Python, there is also a function `butter` in the SciPy library `scipy.signal`. Verify that the Python function gives the same coefficients as the Matlab function.

2. Modify the demo program `demo_filter_blocks_corrected.py` to plot both the live input and output *signals* in real-time in a figure window. (Use different colors for the input and output, or plot the two signals in separate subplots). Also, change the block length to be at least 15 milliseconds while keeping the block length to be a power of 2 (use the fact that the sampling rate is 16000 samples/second). What is your block length?

3. Same as the previous exercise, but instead of plotting the signals, plot the live *frequency spectra* (Fourier transforms) of both the input and output signals in real-time. The Fourier transform should be computed using the FFT. How is the spectrum of the output signal related to the spectrum of the input signal?
4. Same as the previous exercise, but take the input from the microphone instead of the wave file. What is your block length? How is the spectrum of the output signal related to the spectrum of the input signal? SUBMIT