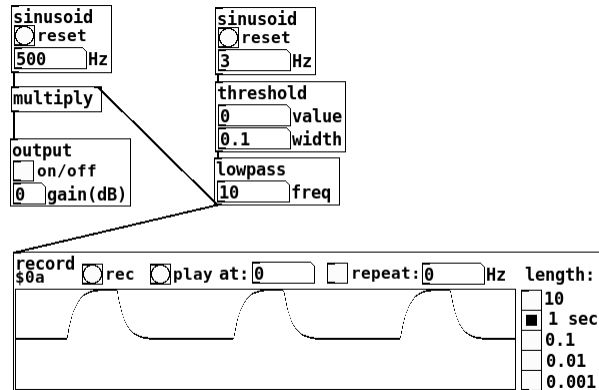


Lab: *Low-pass filtering as a smoothing operation.*

Perhaps the most fundamental and important tool in dealing with sounds is controlling amplitudes by applying a gain to a signal. You do this any time you change the volume on your phone, for example. It's not as simple as it sounds. If you change the gain of an amplifier too quickly the sound will not just change amplitude but will often make an audible clicking sound as it does so. This is a major problem if the quality of the sound matters.

Here is a patch to demonstrate/test this idea:



The three objects on the left are a straightforward sinusoid with amplitude control via a “multiply” object. On the left, we’re generating a signal to turn the sinusoid on and off, by thresholding another, slow sinusoid (the one at top left.) The threshold signal is a series rectangular pulses, three per second, each one 0.1 seconds long.

We’re using a “lowpass” object to smooth the edges of the pulses. The cutoff frequency of the low-pass filter determines the sharpness of the edges. In the picture above, the cutoff frequency is set very low to exaggerate this effect so that you can see it. You might want to try values between 2 and 20 Hz. to see how they affect the picture you get from the “record” object at bottom.

The assignment is to find out how much smoothing you need to be able to turn the sinusoid on and off without hearing an audible “click” or “pop”. This will turn out to depend on the frequency of the sinusoid.

First, set the frequency of the sinusoid (at upper left) to 2000. Adjust the low-pass filter’s cutoff frequency to 20000 Hz. (essentially no filtering at all) and enjoy the clicks. Then drop the frequency to 5000, 2000, 1000, 500, etc., until you find the value at which you just hear a sinusoid turning on and off without artifacts. (Don’t be a perfectionist... you can always convince yourself you hear a clock or pop, just get it so that it’s not easily audible.)

Now do the same thing with the sinusoid set to 500 Hz, and finally repeat the experiment after replacing the sinusoid with a “noise” object. What are the three values you had to set the low-pass filter to to hear “clean” turn-ons and turn-offs for the three situations (2000, 500, noise)?