Lab Midterm Review Solutions

November 3, 2021

Fundamentals of SuperCollider

1. Operator precedence in SuperCollider works left to right. The * operator does not have higher precedence than the + operator. Therefore, the answer is 14.

The Basics of Sound and Waveforms

1. The harmonic series expresses a particular mathematical relationship between a set of frequencies. The reason that this set is so important in sound is that our ears will perceive the set as a single note with a pitch equivalent to the fundamental frequency. The strength of the other frequencies changes the timbre of the note, not the pitch. Stronger harmonics roughly equate to a brighter or buzzier sound.

2. Perfect Fifths

   (a) 600Hz
   (b) $f_x * 1.5$
   (c) $f_x * 1.5^n$

3. $\sum_{n=1}^{\infty}(-1)^{(n+1)}\frac{\sin(2\pi fnt)}{n^4}$. Because n^4 grows more quickly than n and the amplitude of each partial is inversely proportional to n^4, then the partials of this waveform would be softer than those of a sawtooth wave. Therefore, this waveform would sound less bright or buzzy than a sawtooth wave.

Amplitude Envelopes

1. A fixed-time envelope is one in which all portions of the envelope have a fixed amount of time. A sustain-time envelope has a fixed-time for all portions of the envelope **except** for the sustain portion. The sustain portion in a sustain-time envelope will last indefinitely until triggered. In SuperCollider, a sustain-time envelope is implemented through a gate.

2. Setting the Done action to 2 in a SynthDef is necessary to free the Synth after it completes some particular action like an amplitude envelope. The audio serve has a finite amount of processing time to perform each synth and can potentially be overloaded if too many Synths are created.

Patterns

1. Notice that Pbind 2 will only produce one event and that Pbind 1 will produce an infinite number of events.

   (a) Pbind 1
   (b) Pbind 1
   (c) Pbind 2

(d) Pbind 2

(e) Neither

(f) Neither

(g) Pbind 1

2. The frequency played is 100Hz regardless of the order. A 'freq' key is only generated from the key 'midinote' when no key 'freq' is used in the Pbind. The default value for 'freq' is calculated based on 'midinote' (see Event page and lecture notes for more details), but by changing the value of 'key' to a fixed value like 100 here it overwrites the function used to calculate the value for 'freq' based on 'midinote'.

Digital World

1. A bandlimited oscillator is one that only contains a finite number of harmonics from a waveform with an infinite harmonic spectrum. A non-bandlimited oscillator is one that contains the entire harmonic spectrum. 'Saw' is an example of the former and 'LFSaw' is an example of the latter.

2. A wavetable of [0.5, 0.25, -0.5, 0.1].

   (a) Samples: [0.5, -0.5, 0.5, -0.5]

   (b) Samples: [0.5, 0.375, 0.25, -0.125]

3. A step-size of $s/2$ will produce a frequency an octave below. Remember the equation $s = \frac{N}{f_s} * f_x$. Dividing by two on both sides halves the step size and as a result halves the frequency f_x, equivalent to producing a frequency an octave below.

Modulation

1. No. Consider the case where the Nyquist Frequency is 1000Hz from a sample rate of 2000Hz. If the carrier has a frequency of 100Hz and the modulator has a frequency of 50Hz, that will produce frequencies of 50Hz, 100Hz, and 150Hz, all below the Nyquist frequency.

2.
$$\sin(20\pi t + \pi)\cos(10\pi t)$$
$$= [\sin(20\pi t)\cos(\pi) + \cos(20\pi t)\sin(\pi)]\cos(10\pi t)$$
$$= -\sin(20\pi t)\cos(10\pi t)$$
$$= -\frac{1}{2}[\sin(30\pi t) + \sin(10\pi t)]$$
$$= \frac{1}{2}[\sin(30\pi t + \pi) + \sin(10\pi t + \pi)]$$

The frequencies are 15Hz and 5Hz each with phase of π and amplitude of 0.5.

Delay and Filters

1. Consider the signal $x[n] = [0.5, 0.25, -0.5, 0.1]$

   (a) $y[n] = [0, 0.5, 0.25, -0.5] + [0, 0, 0.5, 0.25] = [0, 0.5, 0.75, -0.25]$

   (b) $y[n] = [0, 0.5, 0.75, 0.25]$

   (c) $y[n] = [0, 0.375, -0.125, -0.2]$

2. The cutoff frequency on a low pass filter controls where the frequencies start to be attenuated. A lower cutoff frequency removes more of the harmonics. In essence, the cutoff frequency controls the timbre of the sound but does not affect the pitch.

Reverb and Dynamics

1. Natural reverberation is close to "colorless", meaning that no particularly frequencies are accentuated. Allpass filters are built from a feedback delay network, meaning that they can produce the requisite echoes needed to create reverberation. Moreover, they have a flat amplitude response and can achieve the "colorless" property necessary for reverb.

2. Loudness depends on duration. Short blips of sound at the same amplitude will sound softer than a sustained sound of the sample amplitude up to a threshold of about 0.2/0.3 seconds.