Music 147 - Topics, Lessons, and Activities (Brainstorm)

# Red = Alex

# Music Theory for Programmers

• Pitch and frequency: What is frequency? What is a complex tone? What is a harmonic tone? What is the harmonic series? What is fundamental frequency? What is pitch? What is a (chromatic) scale? How are the frequencies of the equal tempered twelve-tone scale derived?)

• MIDI note numbers

• Pitch classes

• Keys, scales, chords

• Rhythm: Duration (time units), inter-onset interval, beat (periodic occurrences of onsets), tempo, tempo-relative timing, divisions of beats, groupings of beats (meter and time signature), underlying pulse, ticks, the standard sixteen-pulse grid/sequencer, syncopation, backbeat.

Form/structure?

# Fundamentals of Digital Audio

Sampling theorem

Sampling rate; Aliasing

Bit precision

# HTML, CSS and JavaScript - Basics

Essential HTML (tags)

Essential CSS (styles)

Simple HTML5 audio: the <audio> element

# Max/MSP Basics

The dataflow model of Max messages

Max Messages vs. MSP audio signals

MIDI in Max

Encapsulation and abstraction in Max

The Max scheduler and queue, and the MSP thread

The Max transport

# Sampling

AIFF/WAVE file format

Recording into a sound file

Recording into RAM  
Simple playback

Altered playback

Granulation, concatenative synthesis

# Fundamentals of Synthesis

• Generating a sinusoid mathematically

• Filling and using a wavetable: allocating memory, filling memory, lookup, increments for obtaining frequencies, interpolation methods (linear, polynomial, etc.)

• The Music-N unit generator model: compare with the modular analog synthesizer  
• Envelope generator: ADSR as applied to amplitude and eventually other parameters

• Modulation: LFO, classic waveforms

• Amplitude modulation: tremolo, ring modulation

• Frequency modulation: vibrato, bend/portamento, audio-rate FM synthesis

• Additive synthesis

• Hybrid synthesis (eventually, after sampling)

• Subtractive synthesis (eventually, after filters)

• Waveshaping

• Phase distortion  
• Granular synthesis

# Delay and delay-based effects

Circular buffer (understanding, building, using)

Delay usages: short, medium, long (5-20, 20-200, 200-2000ms)

Comb filtering (<30ms with feedback)

Flanging

Chorusing

Reverberation

* Schroeder model
* Feedback delay network model
* Impulse response convolution

# Filters

Basic principles of digital filters

The most basic lowpass filter

The general filtering equation explained

FIR and IIR filters

* Resonant lowpass filter
* Resonant bandpass filter
* Etc.

Comb filtering

Biquad filter  
State-variable filter

# MIDI

What is MIDI, and why do we use it?

MIDI specification

Most useful MIDI channel messages

MIDI System Common messages

MIDI System Exclusive message format

Examples for algorithmic composition

Examples for interactive performance

MIDI file specification

- File formats

- PPQ

- Nibbles

- Delta times

- Variable-length quantity

# Advanced Max/MSP Audio Tricks

poly~

pfft~

Max for Live

gen~

# Web Audio API

The audio context (network)  
AudioNode object types

Audio playback with processing

Audio synthesis (constructing a synthesis algorithm)

Timing in Web Audio

MIDI in Web Audio

# Other

• Basic wave types (sine, square, triangle, saw)

• Basic noise types (white, pink, brown, etc.)

• Using basic waves or noise as control oscillators

• Randomness, filtering randomness

• MIDI (Musical Instrument Digital Interface)

• Algorithmic composition

• Interface and design issues in audio and music software

• Programming audio processes in Max/MSP

• Programming audio in HTML 5 with the Web Audio API

• Managing audio and MIDI file formats

• Managing I/O streams

• Interpolation, for both audio and control signals:

* For control signals: linear, exponential, spline, easing functions, etc.
* For audio: 2-point and 4-point polynomial

• Control functions and low-frequency oscillators for frequency and amplitude modulation

• Windows and envelopes in the time domain

• Convolution

• Panning, localization, and spatialization

• Amplitude compression and expansion

• Fourier analysis and resynthesis, cross-synthesis, and time compression/expansion

# Potential Tasks (i.e. HW assignments)

-Web-based keyboard

-Guitar hero clone (play sound files, synchronize timing)

-Voice memo app (to learn how to record)

-OWL Pedal? (make a guitar effect? Works with pd, Gen, and C I think)

-Make a generative/algorithmic composition that will run (and stop itself) with the click of a button

-Control the ‘amount’ of randomness in a given system (totally random pitch to a set scale?)

-Create a series of modular effects (delay, chorus, flanger, etc) than can be turned on and off

-Be able to control ‘degrees of randomness’ within a patch

-GUI exercises (make a patch that is intuitive or able to be used by a complete stranger)