PROGRAMMING AND ELECTRONICS (DATA SONIFICATION)
(Sonic and Visual Representation of Data)

MUSI GR 6602
Course Level: Graduate
Prerequisites: Instructor permission, some experience with python or other text-based coding language.
Credits: 3

The working title of this course is “Sonic and Visual Representation of Data.” Humans are currently producing enormous amounts of complex data representing complex phenomena (including but not limited to our own activities), but we lag behind in our ability to perceive and understand the patterns in the data. Our auditory and visual perception systems are optimized for different kinds of spatial and temporal patterns, that we process simultaneously to understand our immediate surroundings. How can we use these capabilities to better understand processes that are beyond the range of our direct perception, but we can measure indirectly with a vast range of sensors? Using python and RTcmix, we will implement a wide range of ways of generating sound and visual animations of the same data, with which we will construct movies. Questions of how to design and tune these representations to bring out patterns in the data, based on the nature of human perception and also aesthetic choices, will be discussed throughout. How might these questions of pattern perception vary (or not) for scientific and artistic intents? Students will select datasets they want to explore early on, and will develop and build these projects over the semester. While the course is taught using python and RTcmix, and prior experience in python is encouraged, students may use other sonic/visual coding environments such as Unity or max/msp/pd for their projects. Hardware for VR/AR and spatialized sound will be available for class use at the CMC.

Schedule and Syllabus
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0. (Jan 23) Intro class-- perception of pattern in data; capabilities of our sonic and visual perception systems. Class structure.

PART I: Methods bootcamp

1. (Jan 30) Machinery: setup of your python and jupyter notebook, class codes on github, etc. Intro to sonification (direct and indirect spectrum). Basics of sonification, generating tones, beeps, noise. Direct sonification of natural oscillatory signals (earthquakes, tides). Spectrograms, filtering. Envelopes.
Exercise 1: compose a short piece with oscillators and envelopes, adding and concatenating !

2. (Feb 6) Indirect Sonification. Intro to frequency relationships, a bit on the physics of sound, and on ``music theory''. Install RTcmix. Writing RTcmix scores in python. Make "Breathalyzer" data. Begin interpolation and mapping methods.
Exercise 2: compose several pieces with your breathalyzer data, OR generating your own patterns of note sequences.

3. (Feb 13) More tonal representation/granular synthesis. Intro to object oriented programming for moving beeps. What sound qualities convey motion better?
Exercise 3: Make moving beeps (stereo or more) using breathalyzer data.

4. (Feb 20) Animation Intro (moving dots, shapes, colors, pitch wheels, etc...) Putting them together: Sound + animation = movie.
Exercise 4: make a simple animation with your breathalyzer data.

5. (Feb 27) Animation 2: Object oriented animation and sound.
Exercise 5: Groups make movies with multi-track breathalyzer data,

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PART II: Projects part 1: working with your data and first level movies.

6. (Mar 5) Presentations on your ideas for project data sets. Getting data into python (or Unity).

7. (Mar 12) **Workshop:** Making sure everybody's data is read in to python or Unity and can make movies.

[Spring Break: March 16-20]

8. (Mar 26) Machine Learning 1. Patterns, features, unsupervised clustering using the original and new breathalyzer data. How can clustering results be incorporated into visual and sonic aesthetic choices?

9. (Apr 2) **Presentations** of each person/project's initial legends and movies, discussion of questions of patterns in the data.

PART III: Projects part 2: aesthetics and meaning

10. (Apr 9) Machine Learning 2. Supervised learning, neural networks. Sound source motion and 3-D spatialization (spatial perception through audio).

11. (Apr 16) Aesthetics questions, other sonification methods TBD

12. (Apr 23) Aesthetics questions 2

13. (April 30) Workshop (Ben away)

14: (May 5?) **Final presentation party, with Brad's and maybe Seth's classes**

Class structure

These are not "rules"-- they are the structure of the class, which is designed to help focus your learning of the tools, to help you and us identify what you don't understand early on, so that you are freer to do a project that you will find satisfying.

This is a project class. The "bootcamp" part will constitute half your grade. Each of the 5 exercises must be completed (ideally by the next week, but extensions can happen, but all must be completed by Spring Break), producing a short audio or video file and the notebook or script that you wrote to make it, to be sent to us by email, and shared with the class if you want. So, each exercise is 10% or up to 10 points. They will be loosely graded on how much effort you put in to building something that goes beyond the code in the notebook, scaled to our sense of your ease with coding. But they should not take much time.. All the structured work is weighted in the beginning of the class, so that you can focus unstructured work in Parts II and III on your projects.

Group projects will ALWAYS be encouraged, but you may work alone if you really want to. Attendance is required, and if you need to miss a class, please let me and Mary know before hand. The second half of your grade will be based on the effort that you put into your project, and the final project.