Mapping Chaotically Generated Synthesizers to Real World Instruments with Machine Learning and Harmonic Analysis

Musical instruments have taken numerous forms over the past thousand years, each one holding a distinct use, history, timbre, range and purpose. We, as humans, experience these instruments through the sensation of sound which is the periodic vibration of air molecules around us. In modern times, musical instruments need not be physical vessels of wood, metal, strings or canvas, but can rather be generated through use of other means such as a computer synthesizer or otherwise.

In some cases, these random, obscure signals may produce waveforms that strongly resemble physical instruments. Often, this may be easy for a human to detect this relation, but with the digital age, comes the need for computers to classify large quantities of these sounds accurately. By using physics principles and machine learning classifier algorithms, a program will be constructed to systematically classify a chaotic synthesizer to a real-world instrument.

In this project, I will construct of a Python program that will classify chaotically generated synthesizer signals based on their time and frequency spectra and map them to real-world instruments, in the hope of building a classifier that will be consistent with the human perception. This will be done by assembling a library of audio waveform files as training data and a selection of labeled chaotically generated waveforms as testing data. Once the accuracy of the classifier has been validated, the program will be able to map any arbitrary waveform to a musical instrument. A completed project will contain the following:

* 1. A set of chaotically synthesized signals classified as real world instruments
  2. A program that can map any arbitrary waveform to a real-world instrument (and/or perhaps classify it as unlike any instrument)
  3. A comprehensive connection as to why machine learning is the valid approach to solving this problem
  4. A comparison between machine learning and standard algorithmic classification methods as well as a comparison to human results.

This study will provide an in-depth analysis into the world of modern signal processing through use of machine learning and neural network algorithms. This project opens the door to a wide range of uses in the professional music and signal processing industry. Small slices of audio information can be classified and mapped to known segments of audio. In the future, related and modified algorithms could be used for electric circuit signal processing, human voice recognition, professional audio editing, and so forth.

In that time, I have amalgamated several physical and digital resources under the topics of machine learning, artificial intelligence, and neural networks. Additionally, I have begun the construction of a digital library of audio wave forms to serve as a training dataset. I similarly have a collection of generated waveforms provided by Dr. Short to serve as a testing data set.

Work will be constructed around an 8 to 12 hour work week schedule. By the end of Spring 2020 I will have constructed the first draft of the program that can read though several categories of musical instruments and classify an arbitrary waveform into one or more of those categories. The results of this project will be summarized and likely be presented at the Spring 2020 URC and/or for a peer review colloquium.

*[To include]*

*Sentence or two on chaos?*

*Method of attack?*

*Single Final Output product?*