Southwestern University

Breedesizer: Evolving Original Sounds With Neural Networks

Isabel Tweraser
Southwestern University

Introduction

Evolutionary computation is a powerful tool for optimization and problem-solving, but also has the power to create interesting aesthetically pleasing artifacts of various sorts. Breedesizer is a program that utilizes evolutionary computation to create original sounds [1].

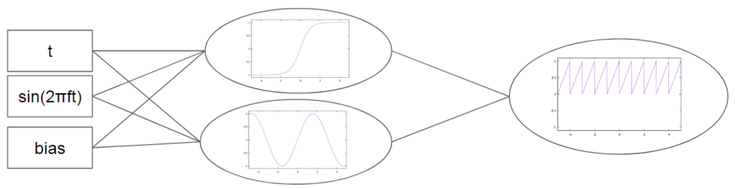
Much like the diverse traits that have come from generations of selective breeding seen in domesticated animals, users are able to harness and direct the powerful process of evolution to create novel sounds using Breedesizer. By combining a human's ability to discern and appreciate unique patterns along with computational evolution's ability to evolve new and novel sounds, an initial population of plain, simple sounds can be evolved into very interesting sounds easily. Recognizable songs can be played back using the generated sound as the "instrument" to provide more intriguing results for the user. The beauty of this interface is that it allows users to create novel sounds without using extensive sound production technology.

Networks Composing Patterns

Breedesizer creates sounds by evolving the structure of Compositional Pattern-Producing Networks (CPPNs), a form of neural network that can take advantage of the geometry of an input space and encode spatial intelligence [2].

The CPPN uses a time value, a periodic function of the time value, and a constant bias of 1.0 as inputs. These values then propagate through the CPPN to produce an amplitude value . The value corresponds to a single plot point on a sound wave that is generated one point at a time as CPPN is queried across increasing time values.

CPPNs can create such diverse patterns because they have multiple activation functions within each node of the network. The input to each function/node is a weighted sum of the incoming signals. These functions represent a variety of symmetric and repeating patterns, leading to the wide variety of sounds that can be produced.

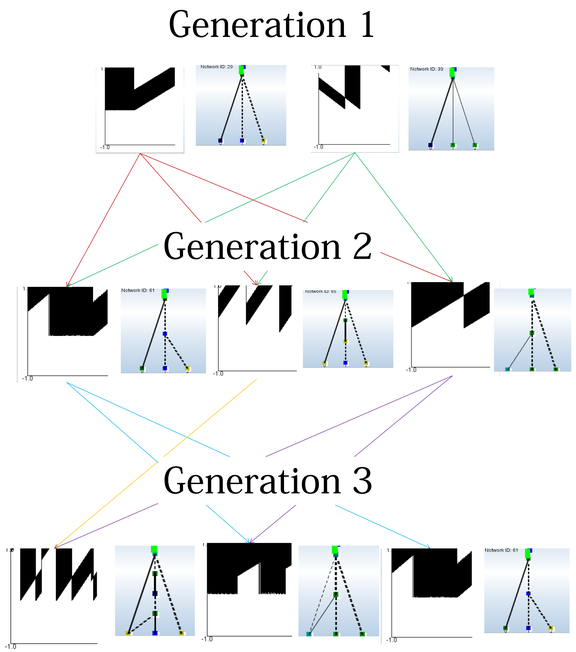


The above image depicts the process of inputs being manipulated by activation functions in nodes of a CPPN to generate an interesting output. The input t is the time, and f is the desired wave frequency.

Evolving Sounds

1. Start with an initial population of random CPPN genotypes.
2. These CPPN genotypes generate the first batch of sounds.
3. The user then picks his or her favorite sounds from the set.
4. Creation of the next generation of sounds occurs via crossover and/or mutation of the chosen parent genotypes, mimicking both sexual and asexual reproduction.
5. The next generation contains the selected parents, and offspring, which generate the next batch of sounds.

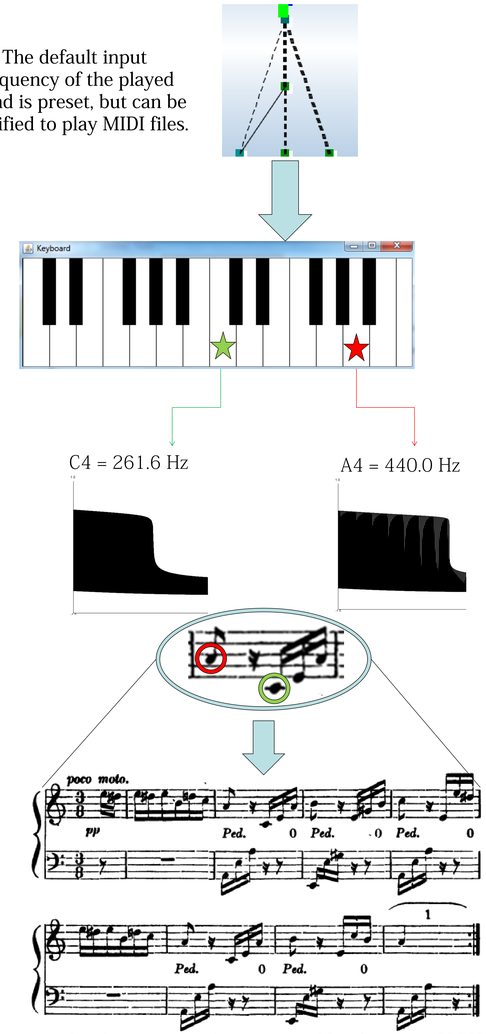
This process repeats over and over, as many times as the user wishes. There is no preset stopping point.



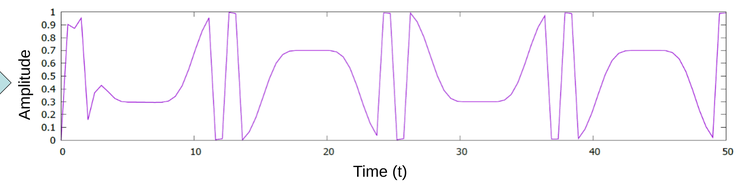
Both crossover and mutation occur over generations in interactive evolution. Crossover mixes links and nodes of parent genotypes, while mutation adds and changes nodes and links.

Playback at Different Frequencies

The default input frequency of the played sound is preset, but can be modified to play MIDI files.



Different amplitude waves can be generated by the same CPPN using different input frequencies. This means that the sound can be used as an instrument to play songs.



References

[1] Björn Þór Jónsson, Amy K. Hoover, and Sebastian Risi. 2015. Interactively Evolving Compositional Sound Synthesis Networks. Proceedings of the 2015 on Genetic and Evolutionary Computation Conference - GECCO 15 (2015). DOI:http://dx.doi.org/10.1145/2739480.2754796.
[2] Stanley, K.O. Compositional Pattern Producing Networks: A Novel Abstraction of Development. *Genetic Programming and Evolvable Machines Special Issue on Developmental Systems*, New York, 2008.