SHFLA (Shoegaze Hierarchical Fractal Language Architecture)

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1 Abstract

This project (SHFLA) is the result of integrating multiple fields: Cognitive Musicology, Linguistics, Music Theory, and Computer Science. The product of this integration is a dynamic system actualized as fractal that continually adapts to a musical excerpt/piece/song, which is given by the user for the program to interpret through sequences of changing visual imagery. Our Github repository is available at https://github.com/Tetraslam/SHFLA.

2 Ideating Parameters

2.1 Brightness

The element of the visual brightness in the computer simulation corresponded with the musical "brightness" of the excerpt/piece/song at any given moment. We generally treated musical brightness as a function of the octave - how high or low the frequency of the overall sound was. Additionally, we also mapped the spectral centroid's brightness to this!

2.2 Contrast

The contrast range in the color gradients corresponds to each sound chunk's Fourier simplicity. Based on the complexity of the Fourier transform required to

```
spec_centroid = librosa.feature.spectral_centroid(y=y_mono, sr=sr)
mean_centroid = np.mean(spec_centroid)
```

reach the chunk's approximate waveform, the contrast increases or decreases.

2.3 Color

The RGB color palette of the simulation corresponded with the pitch key of the excerpt/piece/song, as well as its chroma:

```
dominant_chroma = np.argmax(mean_chroma)
target_hue = (dominant_chroma / 12.0 + color_phase) % 1.0
```

2.4 Edge Smoothness

The Edge Smoothness acted as a function of measurable consonance in music. Consonance in music theory is defined by the relative usage of chords and melodies with intervalically-consistent elements, or how well the notes in a melody lined up with the notes of a scale in a given key.

2.5 Edge Complexity

Conversely to the Edge Smoothness, the Edge Complexity corresponded with the dissonance of the piece at certain moments. Dissonance in music theoretical terms can essentially be defined as a lack of consonance.

2.6 Sphericality

Sphericality, in relation to fractals, refers to the spectral centroid's similarity to a circle. The more circular the set is, the more spherical it is. We refer to this sphericality as if it were 3-dimensional because the Julia set in particular encompasses the complex number dimension. Visually, more spherical fractals seem bulbous or more spacious. Such aesthetic elements seemed to relate to the music's "resonance" on a general level. The element of resonance as per auditory processing is the amount of vibration that is generated.

2.7 Asymmetry

Asymmetry of the fractal at any given moment was represented by how imbalanced the panning of the music was.

3 Turing Completeness

The definition of Turing-completeness in unconventional computing paradigms is often debated, but we believe that SHFLA makes a good case for it. Our reasoning encompasses 5 main components:

1. **Indefinitely iterative computational ability:** the main loop runs forever on arbitrarily-sized input which is streamed into it, and this is a key characteristic of Turing machines. It can perform operations on input for an indefinite amount of time.

2. **Conditional statements:** these allow intelligent computation of constructs based on runtime data, which is essential for simulating computational logic.

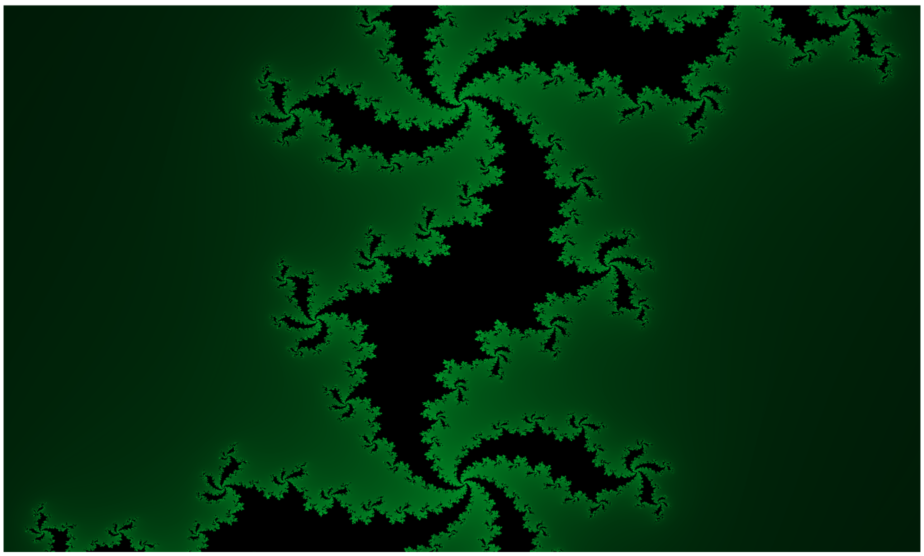
3. **Function definitions**: these are stored in "memory", which essentially consists of arrays containing previous chunks in the input. Since the fractal changes depending on not only the current chunk, but also previous chunks (the general "direction" or contour of the music), this equates to function definitions where one can get a desired output by defining chunks in such a way that it affects future output.

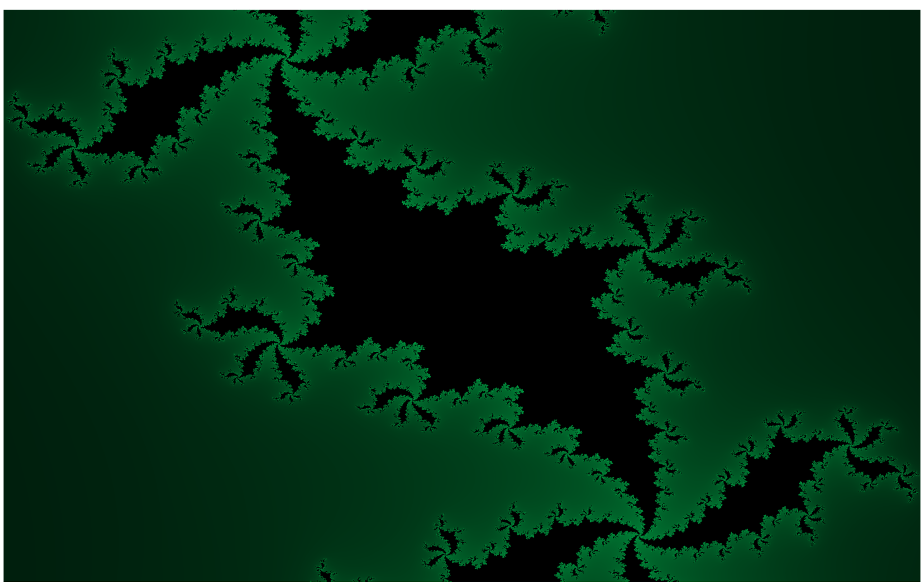
4. **Arbitrarily-Sized Data Manipulation:** as previously mentioned, chunks are stored in arrays representing a form of fractal memory. These arrays are then able to be manipulated into shapes, colors, and useful data/output depending on new chunks, creating a system of data manipulation entirely controllable by the user.

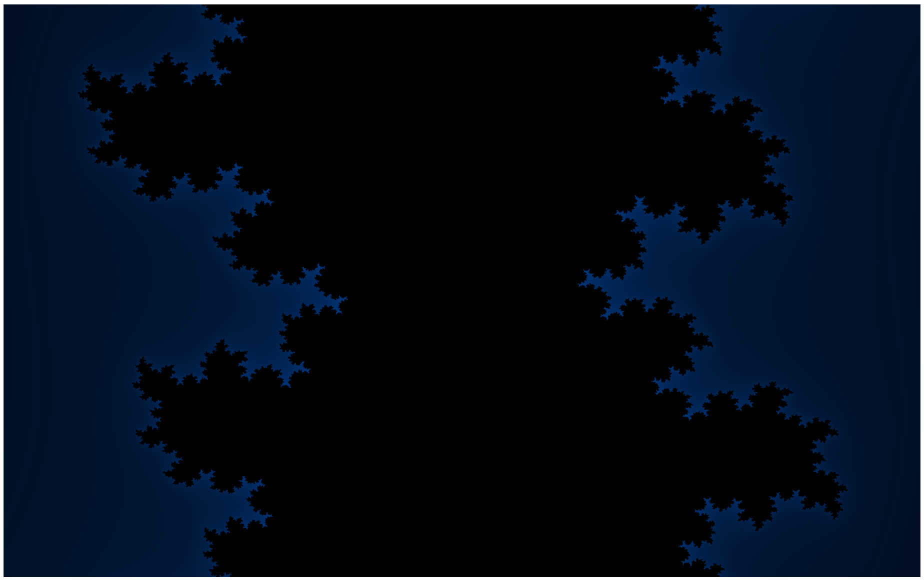
5. **Computational Completeness:** by generating fractals from arbitrarily-sized sound, SHFLA can perform non-trivial computations for an indefinite amount of time on arbitrarily sized data, meaning that it can simulate any other Turing Machine when given enough memory and computational power.

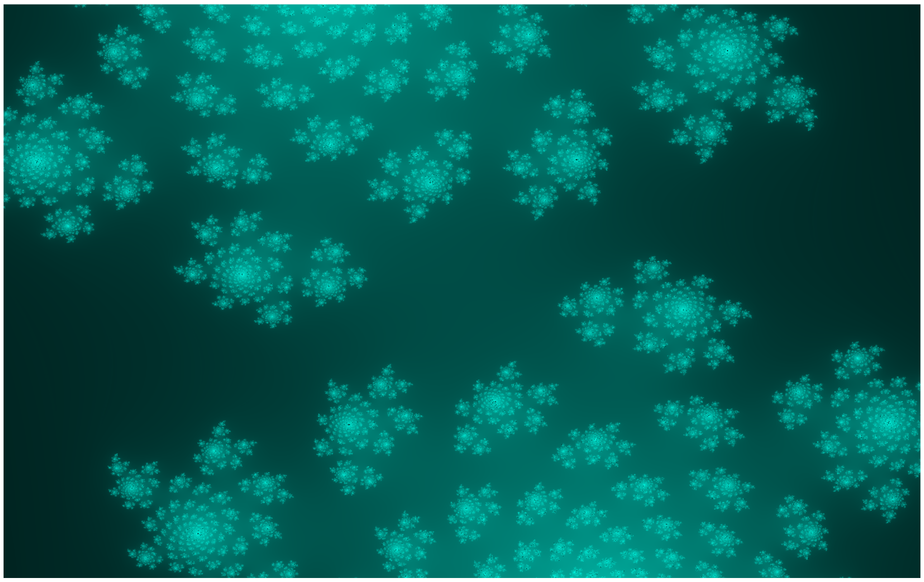
4 Results

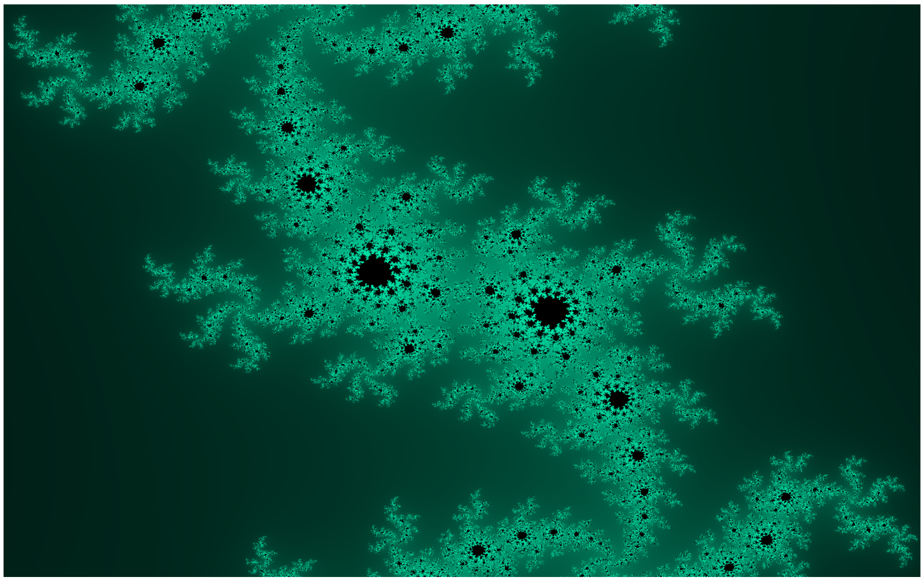
Here are some screenshots of the results obtained from our trials. Github repository available here.











5 Conclusion

Through this paper, we hope to propose a new computing paradigm which encompasses multiple senses as part of their computational representation of I/O. Further work would include explorations of translation and operative constraints.

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