L-Systems/Fractal Assignment

What's It All About?

This assignment affords you an opportunity to generate a musical composition via an L-system of your own design, to generate an image via an L-system of your own design, to simulate a Barnett Newman line via a given L-system, to consider fractals as cognitive infrastructure, and to consider fractals in science and technology.

Problem 1: MxM Facilitated L-System Composition

Simply generate one L-system composition by mimicking the method that I demonstrated in class, and that I re- counted in L-system Lesson 3 "Compositional Method with MxM for L-Systems", which summarizes the sanctioned L-system composition method. When you turn in your work for this composition, you need to do two things:

1. (a) A title for your composition

   Gloomy

   (b) A description (in terms of symbols and productions and start symbol) of your L-System.

   Symbols: {A,B,C,D}

   Productions:

   A → A B

   B → D C

   C → B C

   D → A A

   Start:

   C

(c) The sequence of generations up to and including the one you determined to work with.

G0: C (1S = 0A 0B 1C 0D)

G1: B C (2S = 0A 1B 1C 0D)

G2: D C B C (4S = 0A 1B 2C 1D)

G3: A A B C D C B C (8S = 2A 2B 3C 1D)

G4: A B A B D C B C A A B C D C B C (16S = 4A 5B 5C 2D)

G5: A B D C A B D C A A B C D C B C A B A B D C B C A A B C D C B C (32S = 8A 9B 10C 5D)

G6: A B D C A A B C A B D C A A B C A B A B D C B C A A B C D C B C A B D C A B D C A A B C D C B C A B A B D C B C A A B C D C B C (64S = 18A 18B 19C 9D)

G7: A B D C A A B C A B A B D C B C A B D C A A B C A B A B D C B C A B D C A B D C A A B C D C B C A B A B D C B C A A B C D C B C A B D C A B D C A A B C A B A B D C B C A A B C D C B C A B D C A B D C A A B C D C B C A B A B D C B C A A B C D C B C (128S = 36A 37B 37C 18D)

(d) The Clay code for your composition.

PATTERN >> SA SB SD SC SA SA SB SC SA SB SA SB SD SC SB SC SA SB SD SC SA SA SB SC SA SB SA SB SD SC SB SC SA SB SD SC SA SA SB SC SD SC SB SC SA SB SA SB SD SC SB SC SA SA SB SC SD SC SB SC SA SB SD SC SA SA SB SC SA SB SD SC SA SA SB SC SA SB SA SB SD SC SB SC SA SA SB SC SD SC SB SC SA SB SD SC SA SB SD SC SA SA SB SC SD SC SB SC SA SB SA SB SD SC SB SC SA SA SB SC SD SC SB SC

SA >> RP PLAY LP

SB >> X2 3RP PLAY S2 3LP

SC >> X3 2RP PLAY S3 2LP

SD >> 2LP PLAY 2RP

-MIDI

(e) A reference to the MP3 file for your composition.

https://drive.google.com/file/d/1hlLALm028_AHSjx4epg8pJWoiMdJQfMD/view?usp=sharing

Problem 2: TGR Rendered L-System Image:

1. A definition of your L-system.

    Random L-System:

    Alphabets: { A, B, C, D}

    Production:

    A → B A

    B → C

    C → A A

    D → D B

    Start: C

2. A small number of generations.

    G0: C

    G1: A A

    G2: B A B A

    G3: C B A C B A

    G4: A A C B A A A C B A

    G5: B A B A A A C B A B A B A A A C B A

3. A definition of your mapping from the L-system symbols to the Turtle graphic command symbols.

    A → L F

    B → R F F

    C → L F R

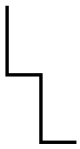
    D → R F L

4. The images corresponding to the small number of generations.

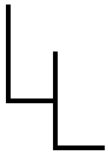
G0: L F R

G1: L F L F

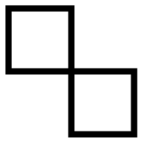
G2: R F F L F R F F L F



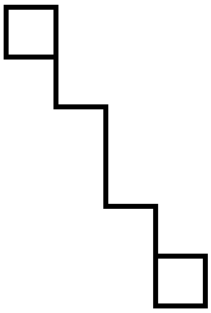
G3: L F R R F F L F L F R R F F L F



G4: L F L F L F R R F F L F L F L F L F R R F F L F



G5: R F F L F R F F L F L F L F L F R R F F L F R F F L F R F F L F L F L F L F R R F F L F



Problem 3: L-System Simulation of a Barnett Newman Line

1. Write down the fifth generation of this L-system.

Start: M

G0: M

G1: R M

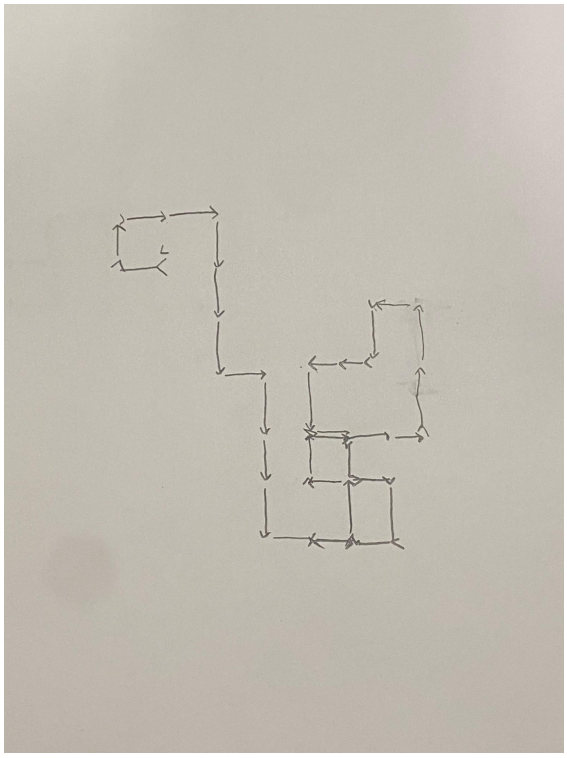
G2: L R R M

G3: M L L R L R R M

G4: R M M L M L L R M L L R L R R M

G5: L R R M R M M L R M M L M L L R R M M L M L L R M L L R L R R M

2. Draw the fifth generation



L F R F R F F R F F F L F R F F F L F F L F L F R F R F F F L F F L F L F R F F L F L F R F L F R F R F F

Problem 4: Fractals as a Cognitive Infrastructure

Q1: How are fractals characteristized?

A1: Fractals are characterized by what the author call “fractal dimension”. The dimension of a straight line is one and of a rectangle is two. An increase in fractal dimension and the closer to two the fractal dimension is, the more fractal the thing is.

Q2:Where can fractals be found?

A2: Fractals can be found within us and all around us, from music to literature to nature. It seems that humans effortlessly recognize and produce fractals. In nature, fractals can be found in lightning and waterfall, and even the spiral arms of our galaxy, the milky way. Within out bodies, fractal networks can be observed and it maximizes surface areas which helps distribute oxygen, cells, and signals.

Q3: What do fractals do to humans?

A3: An example of what fractals can do for humans is the experiment done by Roger Ulrich, where patients with the same procedure and controlled environment and condition, with the distinct difference of window scenario, where some facing a brick wall, and the others facing a natural view. We established in the previous question that fractals are present in nature, and the patients with the natural view, tend to recover faster. Art with nature as its subject also tends to help lower stress and anxiety.

Q4: What did Flatow compare fractals, some sort of signature, to that distinguished each painter and their paintings?

A4: Flatow compared the fractals of different painters to unique fingerprints, where each painter have their own geometric fractals on their paintings. Dr. Taylor adds that they are indeed unique and people actually use fractal analysis to distinguish work of art.

Q5: What does Dr. Taylor suggests how someone can decompose their artwork into fractal components?

A5: The first challenge would be to take a very high quality photograph of the artwork since fractals are about zooming at a high magnification. Then software packages are needed, and Dr. Taylor suggests one called Benoit, and even Adobe photoshop with plugins.

Q6: What are examples of fractals within humans?

A6: The lungs are fractals, automatic processes that we’re not consciously controlling, this relates to the first reference regarding unconscious fractals. The way we balance ourselves can also be seen as fractals.

Fractals as a Cognitive Infrastructure

Fractals are all around us, and even within us. From the trees and clouds we see everyday, to the lungs and brains within us, and automatic processes along with fractal networks allowing us to be and stay alive. Fractals can be characterized by “fractal dimensions”, which ranges from one to two, with one being barely fractal and as it gets closer to two, the more fractal the thing is.

Fractals were found to be able to lower stress and anxiety. Furthermore, in an experiment done by Roger Ulrich, who separated patients under similar influence with most aspects controlled, into rooms with windows that either faced a brick wall or with a natural view. The patients in the rooms that has the windows facing a natural view, was found to recover faster and required less pain medication than the patients who’s windows faced brick walls. Esther Sternberg, who is an immunologist states that, “The parts of the brain that recognize a beautiful view are very rich in endorphins, a feel-good, anti-pain molecule”, which can be a reason why patients with the natural view was able to recover faster and required less pain medications.

Fractals can also be found in human made things such as music, art, and literature. Interestingly enough, fractal analysis can be used to distinguish a piece of art. Geometric fractals observed in paintings were described as signature and similar to a fingerprint, which makes it possible to distinguish the painter of that painting. A piece of art can be decomposed into fractal components by first obtaining a very high-quality

photograph, then with the help of a software package, such as Benoit, or Adobe Photoshop with plug-ins.

Jackson Pollock is a famous example of fractals work. With his earlier piece of work, the fractal dimensions were close to 1. But over a decade, it was able to get pass 1.7, and some wonder if it was strictly intuitive, how can someone like Jackson Pollock perfect it when he probably does not know what fractals are.

Sources:

Cepelewicz, Jordana. “Is Consciousness Fractal?” *Nautilus* | *Science Connected*, 14 Sept. 2021, http://nautil.us/issue/47/consciousness/is-consciousness-fractal.

“Jackson Pollock Fractals.” *NPR*, NPR, 15 Dec. 2006, https://www.npr.org/transcripts/6631149.

Problem 5: L-Systems in Science and Technology

We can find applications of fractals with scientific or technology flavor. Four examples are:

1) Digital games and video games with landscapes
    a) A chess board with an 8 x 8 grid, if you zoom into a white square, you will find another 8 x 8 grid, and within each of those squares is another 8 x 8, and so on.
2) Antennae
    a) Fractal antennae are capable of operating at high efficiency at multiple frequencies with their self similar design(according to the good people of Quora). It is also compact thanks to its fractal shape.
3) Computer chip cooling circuit etched in fractal branching pattern
    a) This device channels liquid nitrogen across the surface to keep the chip cool
4) Fractal geometry allows us to compress images, and fractal compression technology.
    a) Fractal images are stored as mathematical formulas instead of bit maps (https://www.wired.com/1993/05/fractal/)

I was surprised to find fractals in all of these examples, and it only shows how fractals are all around us and the importance of it.