PLTW COMPUTER SCIENCE

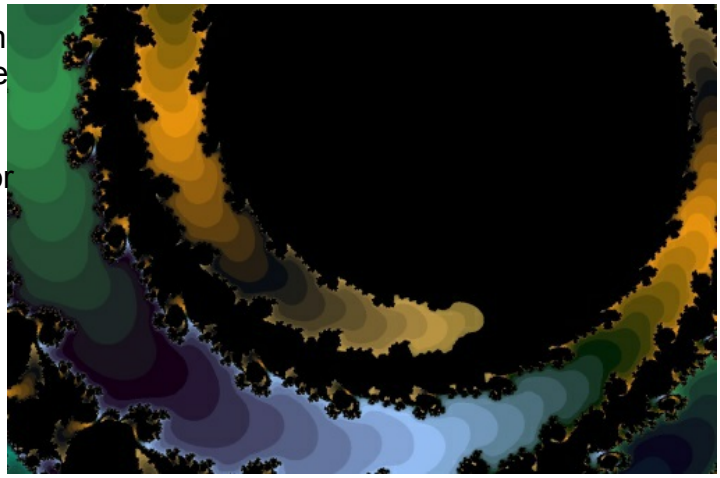
Activity 4.2.4

# Beauty in Chaos and Fractals

### Introduction

People in all careers can now use simulation to better predict the effects of a decision. Simulation and modeling can also be used to understand the phenomena being simulated.

Fractals have been shown to be useful models for effects of nature as various as the formation of mountains and growth of trees.



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### Materials

- Paper and a writing utensil
- Computers with NetLogo and XaoS installed

# Procedure

## Part I: XaoS

1. Form pairs as directed by your teacher. Meet or greet each other to practice professional skills.
2. Open the XaoS program as directed by your instructor.
3. In the menu, navigate to **Help > Tutorials > Introduction to Fractals > The Whole Story**.
4. Watch this tutorial on fractals through “Chapter 2 – Julia” and answer the following questions:
    - What is meant by the phrase **self similar**?
    - What is meant by the phrase **infinite detail**, with respect to fractals?
    - Describe in your own words the procedure for creating one fractal of your own choosing.
    - Name three shapes from nature that can be modeled well using fractals

5. Use the tutorials to guide you through learning the features of the XaoS program. Produce three unique images that you find beautiful using the features of XaoS to share with your class as directed by your instructor.

## Part II: Fractals in NetLogo

6. Open the DLA Simple model in NetLogo by selecting **File > Models Library** and then choosing **Sample Models > Chemistry & Physics > Diffusion Limited Aggregation > DLA Simple.**
7. Use the Info tab of NetLogo to find out more about this model and answer the following questions:
    - How does this model use fractals?
    - What natural phenomena can this model be used to simulate?
    - Choose one of the natural phenomena in the previous question and explain why you do or do not believe that the way this model works is accurate in the details of how that phenomenon is created in the real world.
8. Examine the Interface and Code tabs of this simulation and try to predict, with your partner, how the turtles in this simulation will behave.
    - Describe the algorithm used to determine how an individual turtle will move in this simulation.
    - The simulation always begins with one green patch in the middle of the viewport; the rest of the patches start out black. Explain what you think the effect of the variable wiggle-angle will have on the behavior of the simulation as a whole.
9. Run the simulation a few times with different values of wiggle-angle and num-particles. What do you observe?
10. Create a BehaviorSpace experiment to verify your hypotheses. Record the settings you used for your experiment.
11. Create a data visualization that explains the conclusions that you reached from your experiment.

### Conclusion

1. What understandings of the different models of fractals were you able to gain using the XaoS program that you couldn't have without using a similar tool?
2. How could a simulation like DLA Simple be used in the real world by someone in a career of interest to you?
3. How would the DLA Simple simulation have been different if it were completely deterministic rather than stochastic?