Math 495R Homework 23

Since it is the last Tuesday lab of the semester, we will do something a little more fun. An important tool used in this lab is the turtle drawing tool. You can find the documentation for turtle at:

https://docs.python.org/3.3/library/turtle.html?highlight=turtle#

Here are a few commands that you should be aware of

- forward(len) draws a line of length len in the direction that the pen is set
- backward(len) draws a line of length len in the direction opposite that the pen is set
- left(n) turns the pen n degrees to the left
- right(n) turns the pen n degrees to the right
- penup() lifts the pen from the drawing surface (allowing you to move it without making a line)
- pendown() sets the pen on the drawing surface.
- done() must be called at the end of each drawing

In the jupyter notebook file found on learning suite you will see an example that draws a triangle. In this lab we will investigate drawing fractals based on the Van Koch curve.

NOTE: You may have to restart your jupyter notebook kernel after a drawing is made. This can be done from the menus.

(1) Write a function `one_step` that takes in a single argument, the length of one line segment in the Koch curve. Create a picture that looks like:

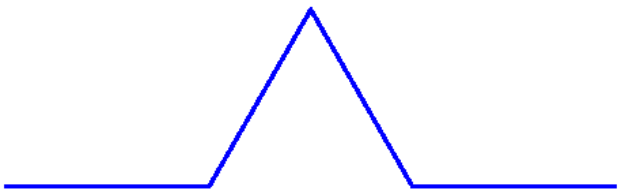

FIGURE 1. First order Koch curve

(2) Write a new function `kcurve` that takes in two arguments, the length of one line segment and the order. As a first step (i.e., if order = 1) you should draw the curve shown in figure 1. Then, using the idea of recursion, modify your code so that it can draw a curve of arbitrary order.

(3) The Curves you have drawn have all had contraction factor of 3. In reality the contraction order can be any real number in the interval $[2, 4)$. Write a new function `kcurve_arbitrary` that takes in three arguments, the length of one line segment, the contraction factor, and the order. To see what these curves look like for different contraction factors, see Figures 5 and 6.

(4) (bonus). Using the code you write create either a Koch snowflake or a Koch Island.

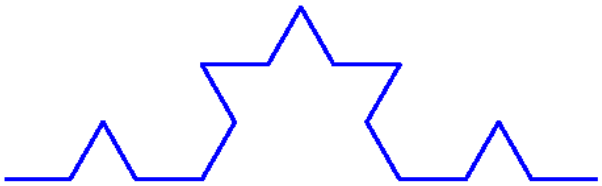

FIGURE 2. Second order Koch curve

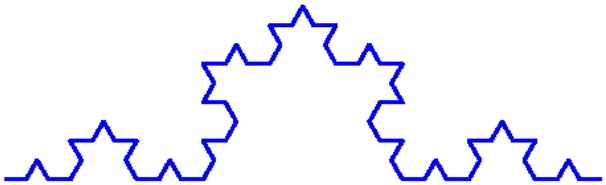

FIGURE 3. Third order Koch curve

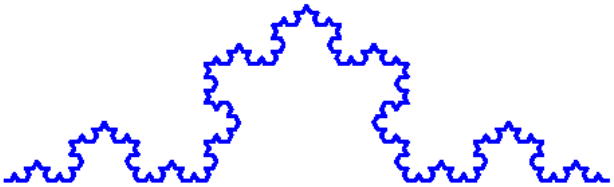

FIGURE 4. Fourth order Koch curve

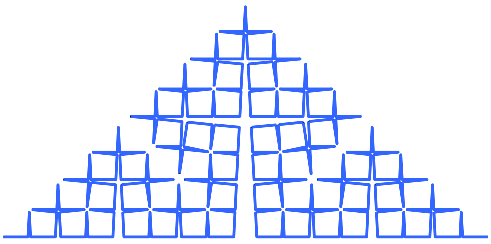

FIGURE 5. Curve with contraction factor equal to 2.1

FIGURE 6. Curve with contraction factor equal to 3.5

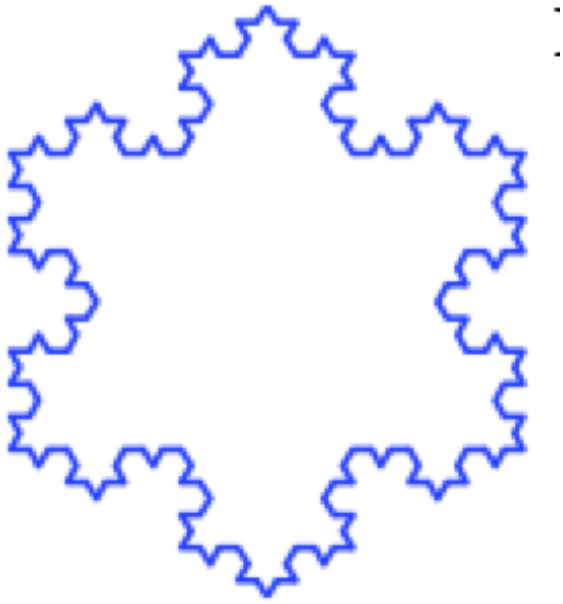

FIGURE 7. Koch snowflake

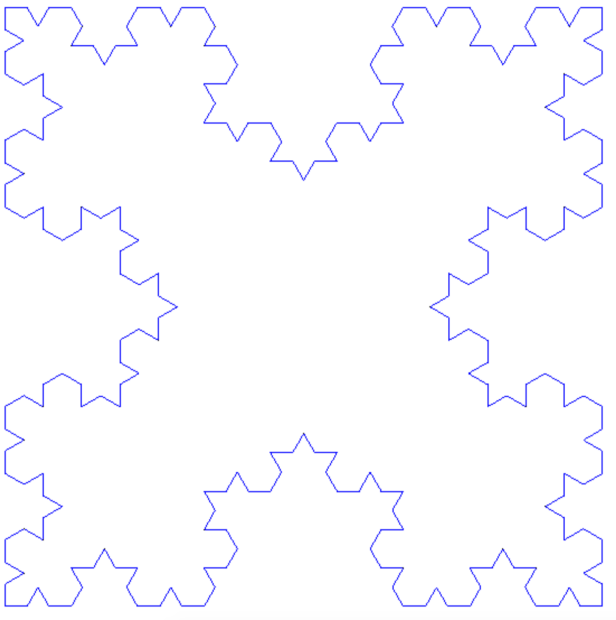

FIGURE 8. Koch Island