1 Code journal: Sierpinski Triangle in Python

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1.1 The Sierpinski Triangle

The **Sierpinski Triangle** is basically a fractal set with the general shape of a triangle. Each triangle is composed of three smaller triangles, and the more iterations, the more sub triangles there will be.

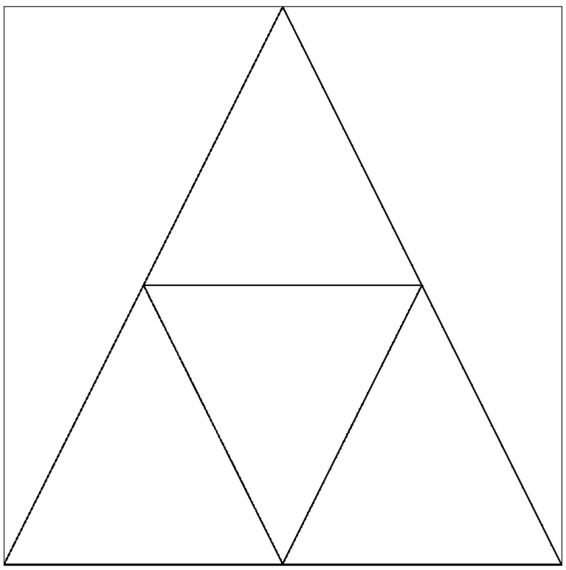


Figure 1: Sierpinski Triangle, 1 iteration

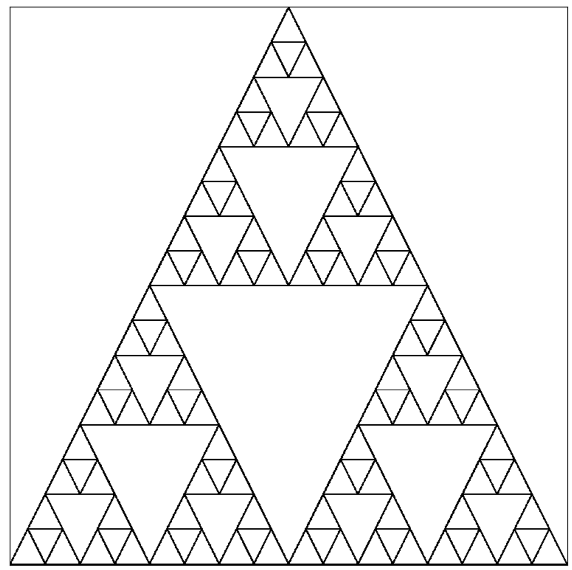
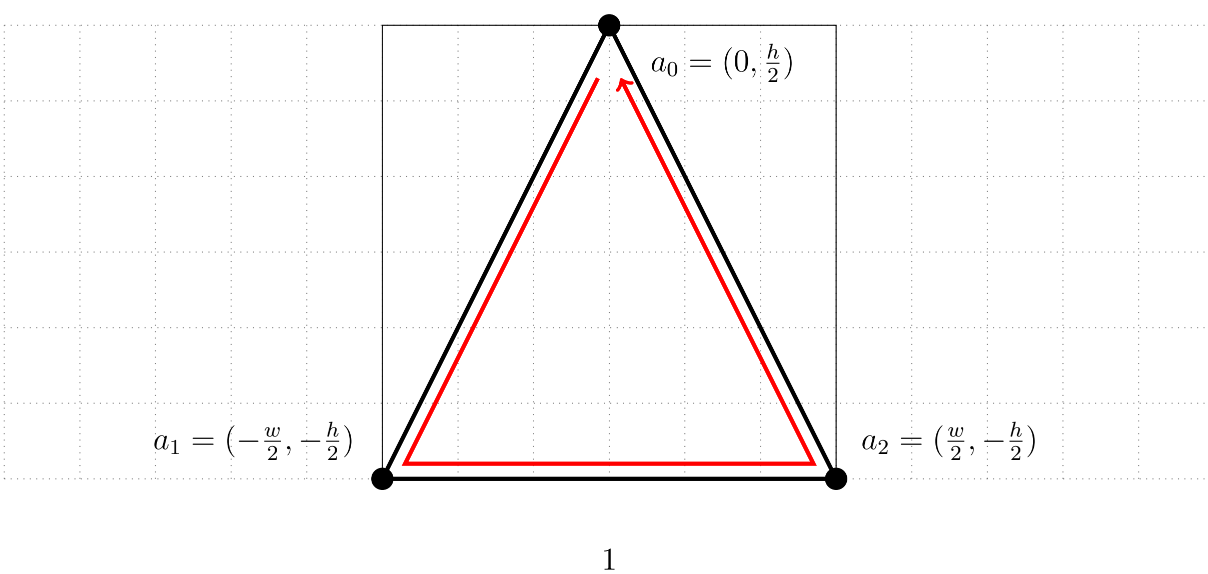


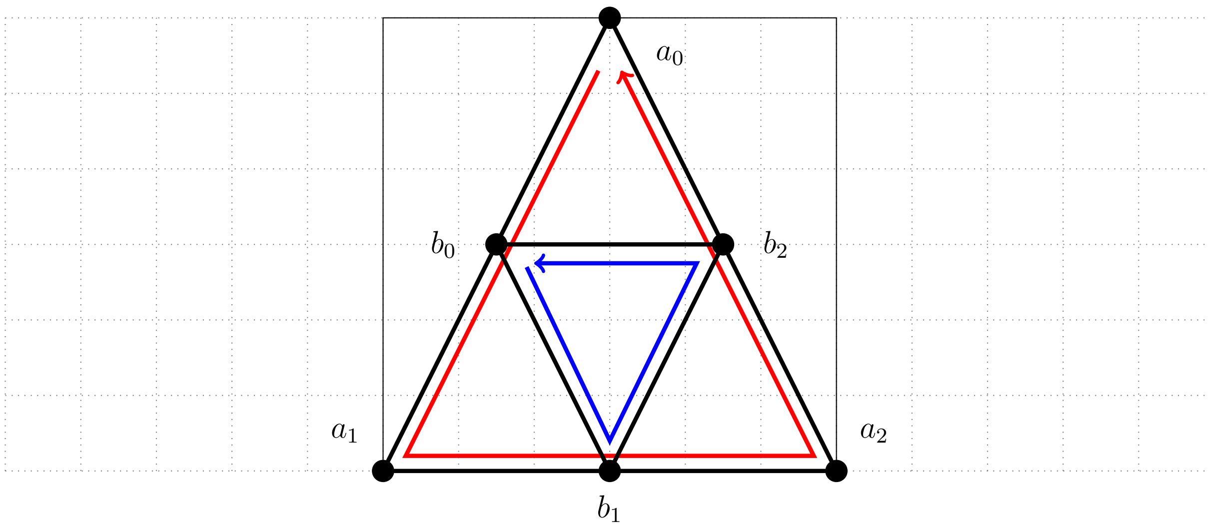
Figure 2: Sierpinski Triangle, 4 iterations

1.2 Setting the Base Triangle

If the fractal is going to be painted on an image, the first thing is to define the base triangle (biggest triangle) points. Let's take a 6x6 pixel image, **centered** in a cartesian plane.



Then, the approach that will be **recursively** used is the following idea: for each triangle a, a sub-triangle b must be painted using the **3 middle points** that exist in each of the 3 edges of said main triangle. The new sub-triangle vertices will form the triangle following also the **counter-clockwise** orientation shown in the previous diagram. Such ideas will look as follows, if only the first iteration is done.



1.3 Generating the Recursive Sequence

Thus, following both arrows of each triangle and its child triangle, the points are stored in a `vertex list`, the indexed vertex sequence would go: `0 -> 1, 1 -> 2, 2 -> 0`, which in a loop that draws lines from p_0 to p_1 with iterator i would be better expressed as `vertex[i] -> vertex[(i + 1) % 3]`. This would draw both the triangle and its sub-triangle lines. Then, we just need to order the logic as a **recursive** function where its stop condition would be whenever the **N iterations** are completed. Each iteration is understood as the drawing of a base triangle a and a sub-triangle b. The algorithm went as below.

```
def iterate(tri_pts, curr_thick, curr_iter):
    curr_iter += 1
    if curr_iter <= num_iter:
        for i in range(len(tri_pts)):
            ln.line(tri_pts[i], tri_pts[(i + 1) % len(tri_pts)], curr_thick, color, img)
        new_tri = []
        for i in range(len(tri_pts)):
            mid = [int((tri_pts[i][0] + tri_pts[(i + 1) % len(tri_pts)][0]) / 2.0),
                int((tri_pts[i][1] + tri_pts[(i + 1) % len(tri_pts)][1]) / 2.0)]
            new_tri.append(mid)
        for i in range(len(new_tri)):
            ln.line(new_tri[i], new_tri[(i + 1) % len(new_tri)], curr_thick, color, img)
        curr_thick *= dt
        for i in range(len(tri_pts)):
            sub_tri = [tri_pts[i], new_tri[i], new_tri[(i + 2) % len(tri_pts)]]
            iterate(sub_tri, curr_thick, curr_iter)
    else:
        return
```

1.4 Program Output

After defining the function `iterate()`, what is left is just to call it in a structure similar to the one below.

```
thick = 5; dt = 1
num_iter = 4; curr_iter = 0

base_triangle = [[0, int(h/2.0 - thick/2.0)], [int(w/2.0 - thick/2.0),
    -1*int(h/2.0 - thick/2.0)], [-1*int(w/2.0 - thick/2.0), -1*int(h/2.0 - thick/2.0)]]
iterate(base_triangle, thick, curr_iter)
```

This generated a Sierpinski Triangle with custom thickness, iterations and thickness reduction (dt). A sample output was the following.

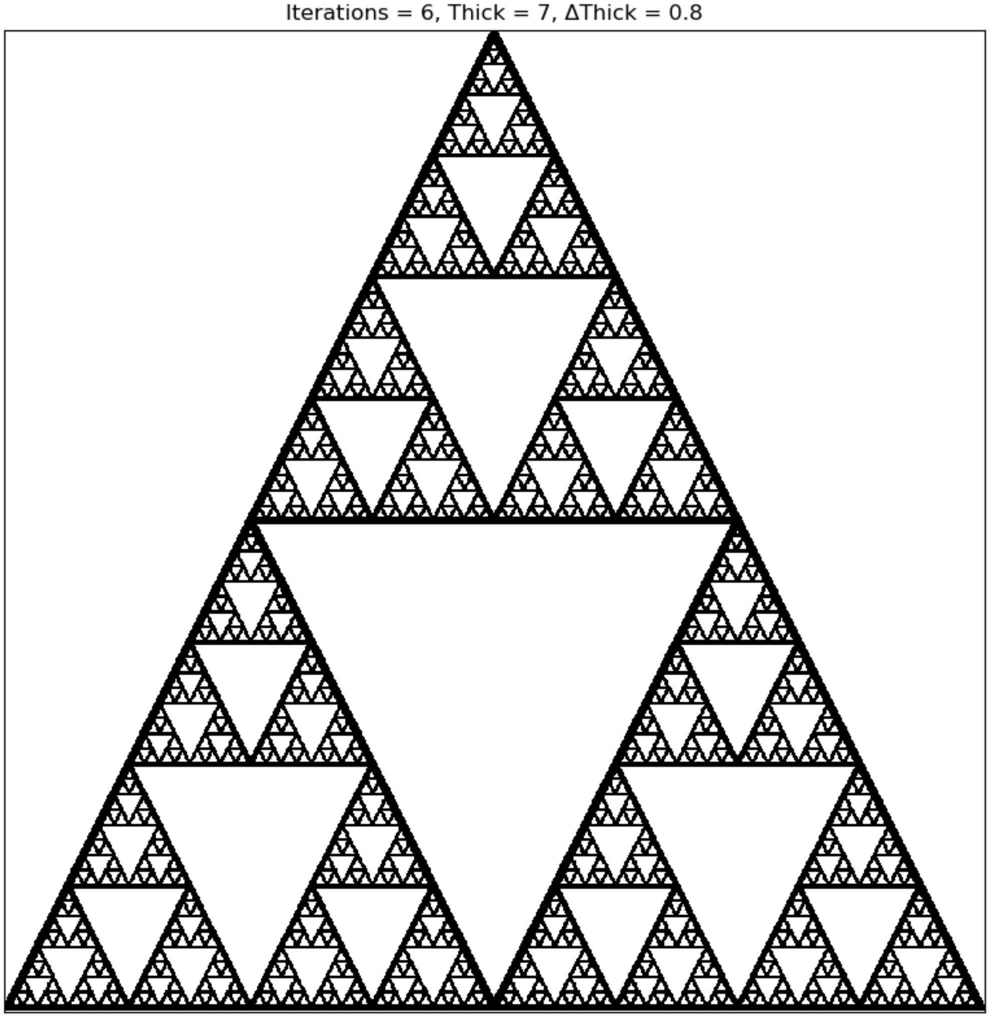


Figure 3: Sierpinski Triangle implementation in Python 3