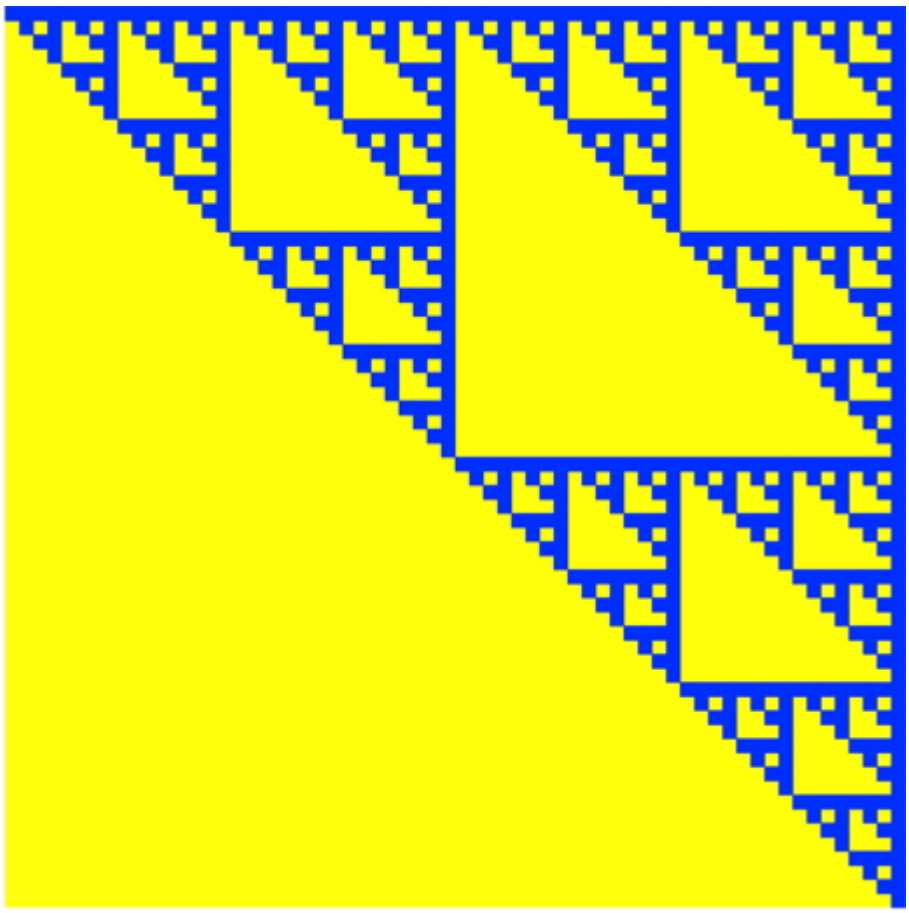
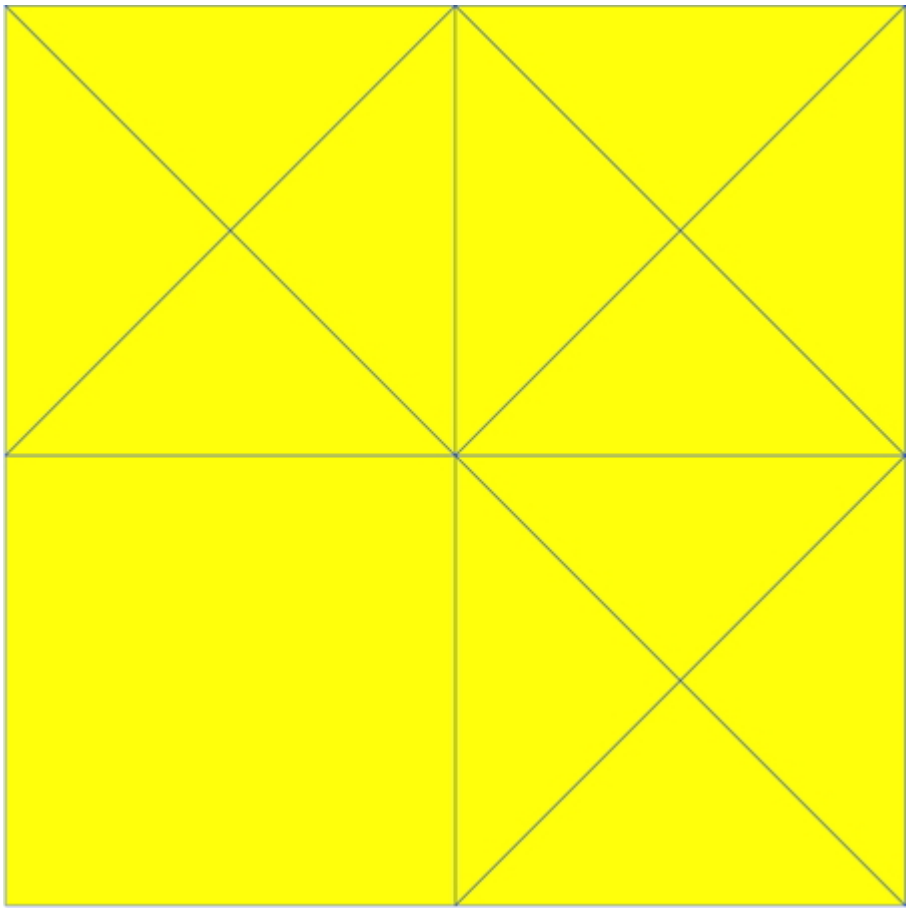
The Sierpinksi gasket

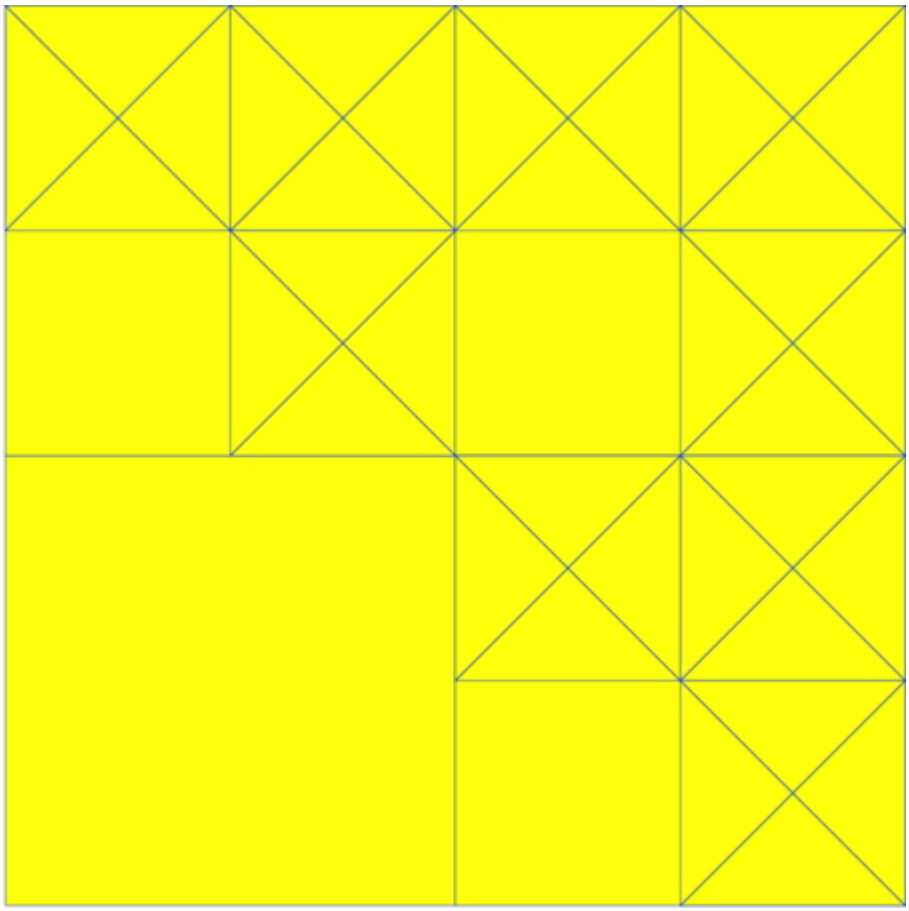
So far, the examples of recursion that we've seen require you to make one recursive call each time. But sometimes you need to make multiple recursive calls. Here's a good example, a mathematical construct that is a fractal known as a **Sierpinski gasket**:



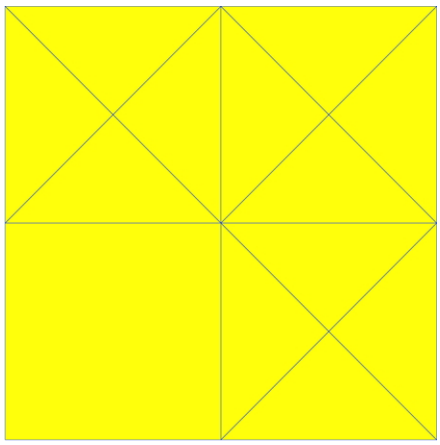
As you can see, it's a collection of little squares drawn in a particular pattern within a square region. Here's how to draw it. Start with the full square region, and divide it into four sections like so:



Take the three squares with an × through them—the top left, top right, and bottom right—and divide them into four sections in the same way:



Keep going. Divide every square with an × into four sections, and place an × in the top left, top right, and bottom right squares, but never the bottom left. Once the squares get small enough, stop dividing. If you fill in each square with an × and forget about all the other squares, you get the Sierpinski gasket. Step through the animation to see it in action.



To summarize, here is how to draw a Sierpinski gasket in a square:

1. Determine how small the square is. If it's small enough to be a base case, then just fill in the square. You get to pick how small "small enough" is.
2. Otherwise, divide the square into upper left, upper right, lower right, and lower left squares. Recursively "solve" three subproblems:
    1. Draw a Sierpinski gasket in the upper left square.
    2. Draw a Sierpinski gasket in the upper right square.
    3. Draw a Sierpinski gasket in the lower right square.

You need to make not just one, but three recursive calls. That is why we consider drawing a Sierpinski gasket to exhibit multiple recursion.

You can choose any three of the four squares in which you recursively draw Sierpinski gaskets. The result will just come out rotated by some multiple of 90 degrees from the drawing above. (If you recursively draw Sierpinski gaskets in any other number of the squares, you don't get an interesting result.)