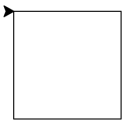
Turtle

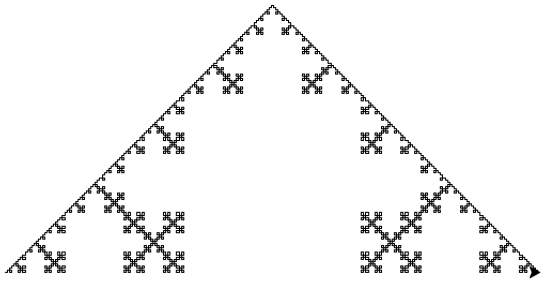
You may have seen turtle or superlogo as a kid. Turtle is a simple programming environment, which is a visual and intuitive way to practice algorithm structure. The basic moves of the turtle are moving forward and turning. For example, drawing a square:

```
import turtle as t
for _ in range(4):
   t.fd(100)
   t.right(90)
t.done()
```



We create a variation on the Koch snowflake using turtle. See also the example here:
`openbookproject.net/thinkcs/python/english3e/recursion.html`
Instead of triangles, we use a square shape as the basis of the fractal. Try to come up with more variations yourself.

```
def koch_square(n,L):
        if n==0:
            t.fd(l)
        else:
            koch_square(n-1,L/3)
            t.left(90)
            koch_square(n-1,L/3)
            t.right(90)
            koch_square(n-1,L/3)
            t.right(90)
            koch_square(n-1,L/3)
            t.left(90)
            koch_square(n-1,L/3)
koch_square(5,500);t.done()
```



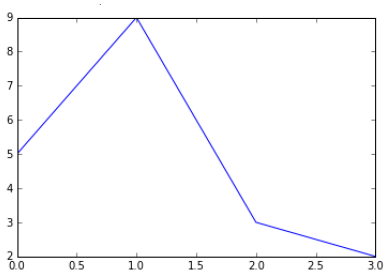
Exercises

- Use `t.begin_fill()` and `t.end_fill()` to create a function check(n), which draws an $n \times n$ black and white checkerboard.
- Use turtle to draw a colorful Sierpinski triangle.
- Create a function ngon(n), which draws a regular n-gon.
- Create a function star(n), which draws a symmetric, n-pointed star.

Matplotlib and pyplot

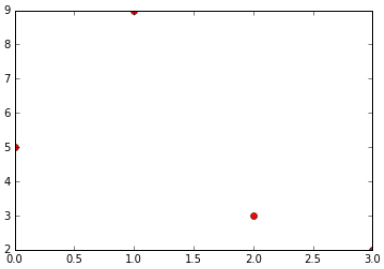
We will be working a lot with matplotlib and pyplot, and its most basic function: plot(), which takes as input a list of x-coordinates and y-coordinates, and plots those points. In its most basic form, it plots them and connectes them by a line:

```
import matplotlib.pyplot as plt
plt.plot([0,1,2,3],[5,9,3,2])
```



We can also specify the linestyle. For example, we can ask for discrete points (o for bullets), and specify a color (r for red):

```
plt.plot([0,1,2,3],[5,9,3,2],'ro')
```



To make our plot more readable, we can change the axes range, and add a title and axis labels. We can also plot multiple plots in the same figure, by adding them to the same execution. For example:

```
plt.plot([0,1,2,3],[5,9,3,2])
plt.plot([0,1,2,3],[5,9,3,2],'ro')
plt.axis([-1,4,0,10])
plt.title('My plot')
plt.xlabel('horizontal')
plt.ylabel('vertical')
```

Exercises

- Use plt.plot() to draw a sin(x) function. Do this by plotting many points, which together look like a smooth line.
- Use plt.plot() to write a function that draws regular n-gons. You will do this in a very different way from the way you did this in turtle.