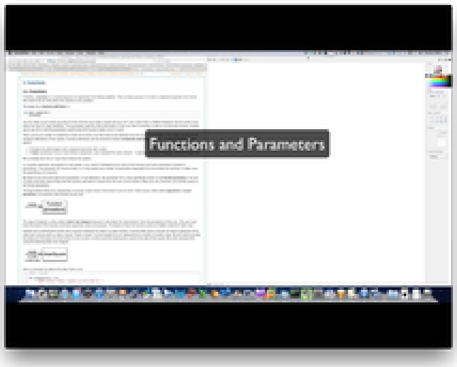
Functions



In Python, a **function** is a named sequence of statements that belong together. Their primary purpose is to help us organize programs into chunks that match how we think about the solution to the problem.

The syntax for a **function definition** is:

```
def name( parameters ):
    statements
```

You can make up any names you want for the functions you create, except that you can't use a name that is a Python keyword, and the names must follow the rules for legal identifiers that were given previously. The parameters specify what information, if any, you have to provide in order to use the new function. Another way to say this is that the parameters specify what the function needs to do it's work.

There can be any number of statements inside the function, but they have to be indented from the `def`. In the examples in this course, we will use the standard indentation of four spaces. Function definitions are the second of several **compound statements** we will see, all of which have the same pattern:

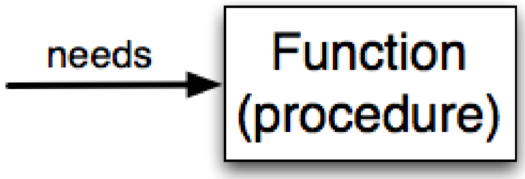
1. A header line which begins with a keyword and ends with a colon.
2. A **body** consisting of one or more Python statements, each indented the same amount – *4 spaces is the Python standard* – from the header line.

We've already seen the `for` loop which follows this pattern.

In a function definition, the keyword in the header is `def`, which is followed by the name of the function and some *parameters* enclosed in parentheses. The parameter list may be empty, or it may contain any number of parameters separated from one another by commas. In either case, the parentheses are required.

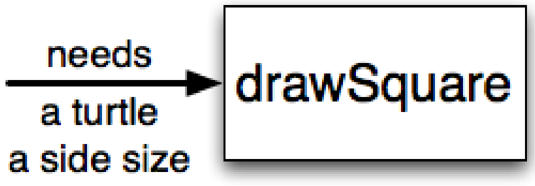
We need to say a bit more about the parameters. In the definition, the parameter list is more specifically known as the **formal parameters**. This list of names describes those things that the function will need to receive from the user of the function. When you use a function, you provide values to the formal parameters.

The figure below shows this relationship. A function needs certain information to do its work. These values, often called **arguments** or **actual parameters**, are passed to the function by the user.

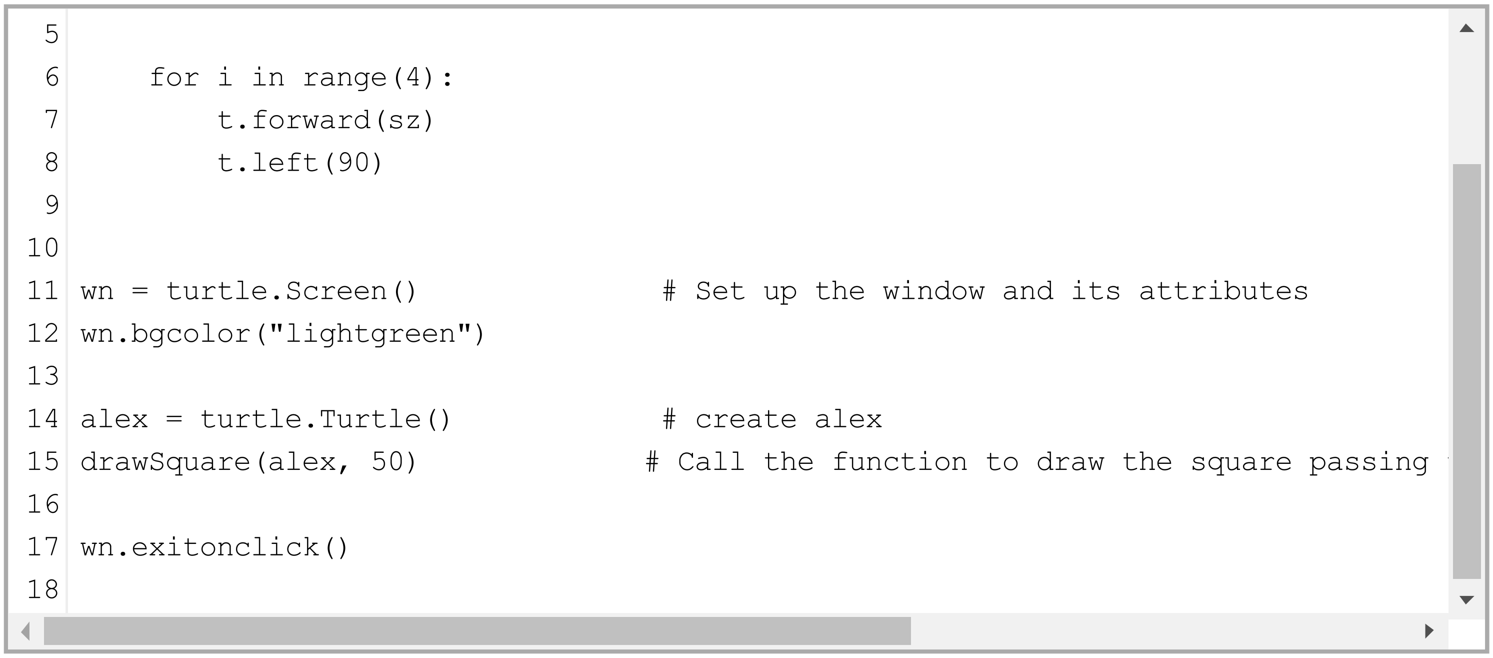


This type of diagram is often called a **black-box diagram** because it only states the requirements from the perspective of the user. The user must know the name of the function and what arguments need to be passed. The details of how the function works are hidden inside the “black-box”.

Suppose we’re working with turtles and a common operation we need is to draw squares. It would make sense if we did not have to duplicate all the steps each time we want to make a square. “Draw a square” can be thought of as an *abstraction* of a number of smaller steps. We will need to provide two pieces of information for the function to do its work: a turtle to do the drawing and a size for the side of the square. We could represent this using the following black-box diagram.



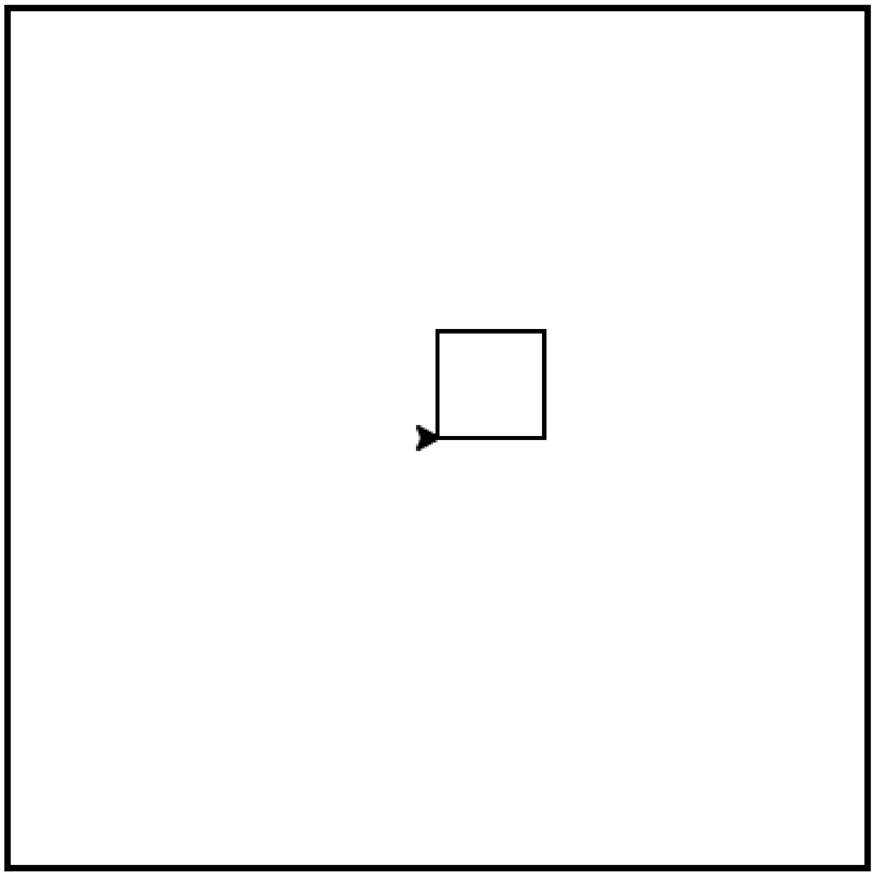
Here is a program containing a function to capture this idea. Give it a try.



```

    for i in range(4):
        t.forward(sz)
        t.left(90)


wn = turtle.Screen()              # Set up the window and its attributes
wn.bgcolor("lightgreen")

alex = turtle.Turtle()            # create alex
drawSquare(alex, 50)             # Call the function to draw the square passing

wn.exitonclick()

```

ActiveCode: 1 (ch04_1)

Run



This function is named `drawSquare` . It has two parameters — one to tell the function which turtle to move around and the other to tell it the size of the square we want drawn. In the function definition they are called `t` and `sz` respectively. Make sure you know where the body of the function ends — it depends on the indentation and the blank lines don't count for this purpose!

docstrings

If the first thing after the function header is a string (some tools insist that it must be a triple-quoted string), it is called a **docstring** and gets special treatment in Python and in some of the programming tools.

Another way to retrieve this information is to use the interactive interpreter, and enter the expression `<function_name>.__doc__` , which will retrieve the docstring for the function. So the string you write as documentation at the start of a function is retrievable by python tools *at runtime*. This is different from comments in your code, which are completely eliminated when the program is parsed.

By convention, Python programmers use docstrings for the key documentation of their functions.

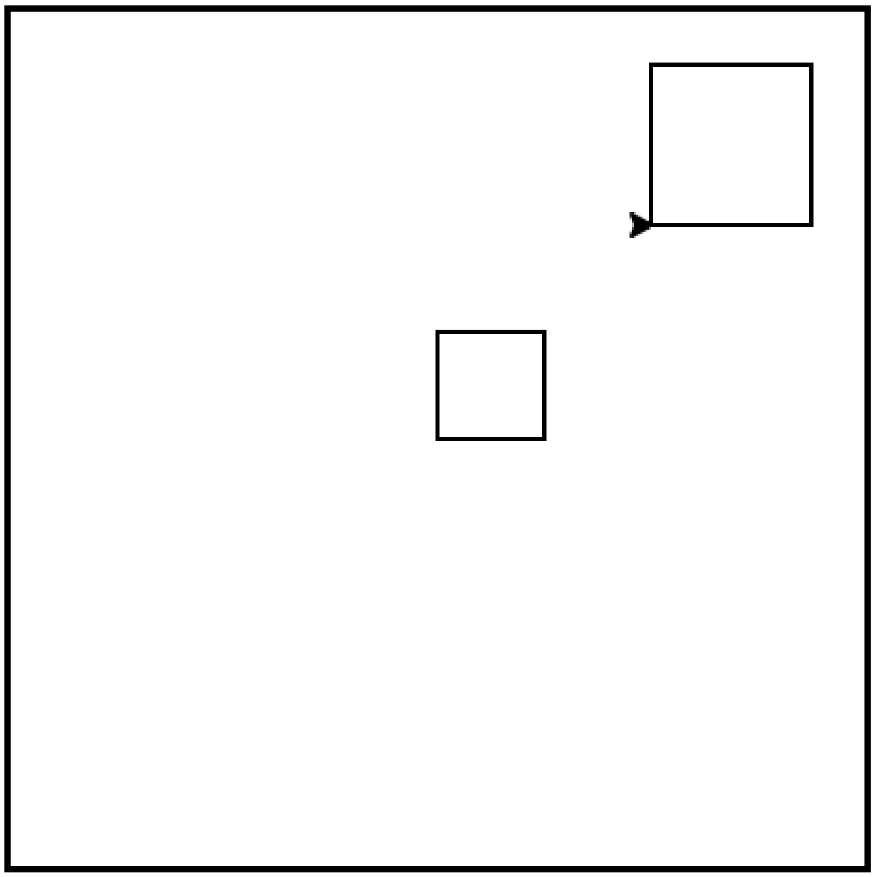
Defining a new function does not make the function run. To do that we need a **function call**. This is also known as a **function invocation**. We've already seen how to call some built-in functions like `print` , `range` and `int` . Function calls contain the name of the function to be executed followed by a list of values, called *arguments*, which are assigned to the parameters in the function definition. So in the second to the last line of the program, we call the function, and pass `alex` as the turtle to be manipulated, and 50 as the size of the square we want.

Once we've defined a function, we can call it as often as we like and its statements will be executed each time we call it. In this case, we could use it to get one of our turtles to draw a square and then we can move the turtle and have it draw a different square in a different location. Note that we lift the tail so that when `alex` moves there is no trace. We put the tail back down before drawing the next square. Make sure you can identify both invocations of the `drawSquare` function.

```

wn = turtle.Screen()           # Set up the window and its attributes
wn.bgcolor("lightgreen")

alex = turtle.Turtle()         # create alex
drawSquare(alex, 50)           # Call the function to draw the square

alex.penup()
alex.goto(100,100)
alex.pendown()

drawSquare(alex,75)            # Draw another square

wn.exitonclick()

```

ActiveCode: 2 (ch04_1a)

Run

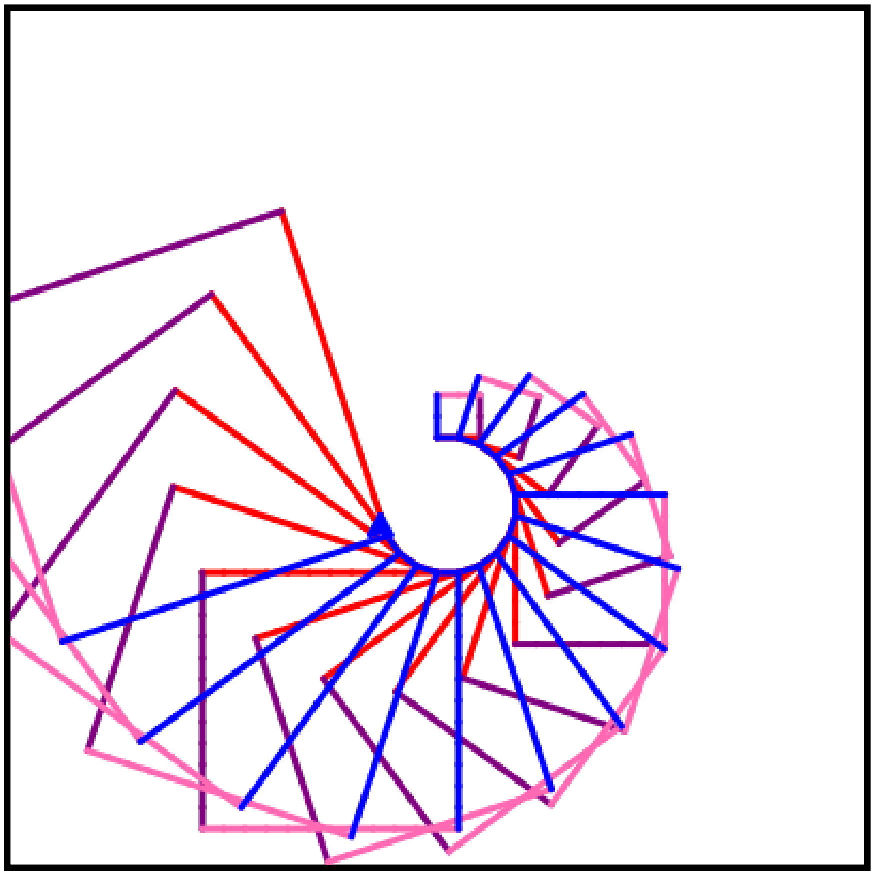


In the next example, we’ve changed the `drawSquare` function a little and we get `tess` to draw 15 squares with some variations. Once the function has been defined, we can call it as many times as we like with whatever actual parameters we like.

```
wn = turtle.Screen()             # Set up the window and its attributes
wn.bgcolor("lightgreen")

tess = turtle.Turtle()           # create tess and set some attributes
tess.pensize(3)

size = 20                        # size of the smallest square
for i in range(15):
    drawMulticolorSquare(tess, size)
    size = size + 10             # increase the size for next time
    tess.forward(10)             # move tess along a little
    tess.right(18)               # and give her some extra turn

wn.exitonclick()

```

ActiveCode: 3 (ch04_2)

Run



Note

This workspace is provided for your convenience. You can use this activecode window to try out anything you like.

```

```

ActiveCode: 4 (scratch_05_01)

Run

Check your understanding

func-1: What is a function in Python?

[✓ a) A named sequence of statements.]

b) Any sequence of statements.

c) A mathematical expression that calculates a value.

d) A statement of the form x = 5 + 4.

Check Me Compare Me

Correct!! Yes, a function is a named sequence of statements.

func-2: What is one main purpose of a function?

a) To improve the speed of execution

[✓ b) To help the programmer organize programs into chunks that match how they think about the solution to the problem.]

c) All Python programs must be written using functions

d) To calculate values.

Check Me Compare Me

Correct!! While functions are not required, they help the programmer better think about the solution by organizing pieces of the solution into logical chunks that can be reused.

func-3: Which of the following is a valid function header (first line of a function definition)?

[✓ a) def drawCircle(t):]

b) def drawCircle:

c) drawCircle(t, sz):

d) def drawCircle(t, sz)

Check Me Compare Me

Correct!! A function may take zero or more parameters. It does not have to have two. In this case the size of the circle might be specified in the body of the function.

func-4: What is the name of the following function?

```
def drawSquare(t, sz):
    """Make turtle t draw a square of with side sz."""
    for i in range(4):
        t.forward(sz)
        t.left(90)
```

a) def drawSquare(t, sz)

b) drawSquare

c) drawSquare(t, sz)

d) Make turtle t draw a square with side sz.

Check Me Compare Me

func-5: What are the parameters of the following function?

```
def drawSquare(t, sz):
    """Make turtle t draw a square of with side sz."""
    for i in range(4):
        t.forward(sz)
        t.left(90)
```

○ a) i

○ b) t

[✓ c) t, sz]

○ d) t, sz, i

Check Me | Compare Me

Correct!! Yes, the function specifies two parameters: t and sz.

func-6: Considering the function below, which of the following statements correctly invokes, or calls, this function (i.e., causes it to run)? Assume we already have a turtle named alex.

```
def drawSquare(t, sz):
    """Make turtle t draw a square of with side sz."""
    for i in range(4):
        t.forward(sz)
        t.left(90)
```

○ a) def drawSquare(t, sz)

○ b) drawSquare

○ c) drawSquare(10)

○ d) drawSquare(alex, 10):

[✓ e) drawSquare(alex, 10)]

Check Me | Compare Me

Correct!! Since alex was already previously defined and 10 is a value, we have passed in two correct values for this function.

func-7: True or false: A function can be called several times by placing a function call in the body of a loop.

[✓ a) True]

b) False

Check Me Compare Me

Correct!! Yes, you can call a function multiple times by putting the call in a loop.