Functions

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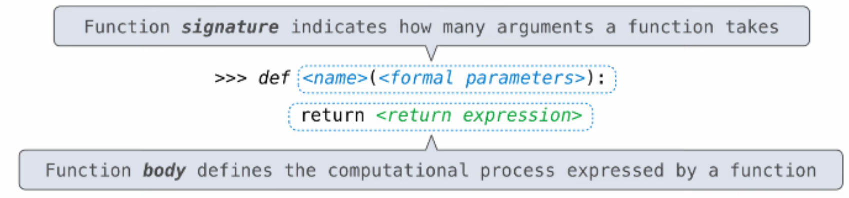
1 Defining Functions

While we can use assignment to bind names to values, we can use a **function definition** to bind names to *expressions*. The function definition consists of a **function signature** composed of a name and **formal parameters**, and a **function body** that defines the computational process of the function:



Function ***signature*** indicates how many arguments a function takes

```
>>> def <name>(<formal parameters>):
        return <return expression>
```

Function ***body*** defines the computational process expressed by a function

For example:

```
def square(x):
    return mul(x, x)
```

We can also define anonymous functions using lambda expressions.

1.1 Procedure for `def` Statements

Python also has an execution rule for evaluating function definitions:

1. Create a function with the given signature
2. Set the body of that function to be everything indented after the first line
3. Bind the name to that function in the current frame

1.2 Procedure for Calling User-Defined Functions

1. Add a **local frame**, forming a *new* environment
2. Bind the function's formal parameters to its arguments in that frame
3. Execute the body of the function in that new environment

A function's *signature* is important because it contains all the information needed to create a local frame. The environment we have now is the *local frame, followed by the global frame.*

1.3 Return Statements

A return statement completes the evaluation of a call expression and provide its value. When a `return` is reached, we switch back to the previous environment in which the function was called, and now `f(x)` in that environment has a value. This also implies that we can use `return` statements to end execution of a function, for example while doing iteration.

Only one return statement is ever executed while executing the body of a function. Functions without an explicit `return` statement will return `None`, which is a special value that represents nothing in Python.

2 Pure and Non-Pure Functions

Pure functions only *return values.* For example, the built-in function `abs` is a pure function, as in takes in an argument (e.g. -2) and returns a value (e.g. 2).

On the other hand, **non-pure functions** have *side effects*. For example, the `print` function is a non-pure function, as it has the side effect of displaying the output, and returns `None`. A **side effect** is not a value; it's anything that happens as a consequence of calling a function. Examples of side effects include I/O, modifying a non-locak variable, or raising errors/exceptions.

3 Higher-Order Functions

Sometimes, we may want to generalize *computational processes*, not just numbers, over different functions. To do this, we can use **higher-order functions**, which allow us to pass in functions as a formal parameter, or allow us to use functions as a return value.

For example, we can pass a function in as an argument:

```
def greet(func):
    return func("Hello")

def uppercase(text):
    return text.upper()

print(greet(uppercase))
```

We can also return a function:

```
def make_adder(n):
    def adder(k):
        return k + n
    return adder
```

3.1 Function Composition

We can use **function composition** to combine two different functions together. For example:

```
def square(x):
    return x * x

def triple(x):
    return 3 * x

def compose1(f, g):
    def h(x):
        return f(g(x))
    return h

squiple = compose1(square, triple)
```

Here, `compose1(square, triple)` composes the functions `square` and `triple` together and returns a function that would call `square(triple(x))`. We can also use this composition directly by, for example, evaluating `compose1(square, triple)(3)` which would return `81`.

3.2 Function Currying

The concept of **function currying** is where we take a function with several parameters, such as `add`, and split them into several function calls that each take one parameter, often accomplished using a higher-order function. For example:

```
def curry(f):
    def g(x):
        def h(y):
            return f(x, y)
        return h
    return g

m = curry(add)
```

We now have a function `m` that does the same thing as `add` but using currying. Instead of `add(2, 3)`, we can do `m(2)(3)`.