

Introduction to Computer Programming

Week 4.1: Functions



Functions

A **function** is a collection of operations that have been given a name

- These operations can involve variable assignment, mathematical operations, loops, if-else statements, etc

Functions are the building blocks of Python programs

- They can be thought of as mini-programs that carry out specific tasks (e.g. square a number)

Python comes with a number of built-in functions

- `max(L)` computes the maximum entry in a list of numbers called *L*

We can also write our own functions in Python

- We could write a function `is_prime(n)` that determines whether an integer *n* is prime

What are the benefits of writing our own functions?

- It reduces the need to copy and paste code that does the same operation, making code more reusable
- It makes programs easy to maintain, more readable, and easier to understand

An analogy with mathematical functions

In maths, we often work with functions of the form $y = f(x)$, where

- *x* is an input (e.g. a number)
- *f* is the function which carries out operations on *x*, such as x^2 or $\sin(x)$
- *y* is the output, that is, the result of carrying out the operations on *x*

Functions in Python work in the same way, but are much more powerful:

- Python functions take inputs which can be ints, floats, lists, dicts, etc!
- They can carry out multiple operations that aren't necessarily mathematical
- And they may produce no outputs, one output, or many outputs

Some programming terminology

Inputs to functions are called **arguments**

When we run or execute a function, we say that we are **calling** the function

Defining our own functions

Every function definition is of the form

```
def name_of_function(arg1, arg2, ...):  
    # indented block of code
```

The key ingredients are:

- `def` is a keyword that tells Python we are defining a function
- *name_of_function* is the name of the function
- *arg1, arg2, ...* are comma-separated arguments (inputs) that we provide to the function
- Round brackets that surround the arguments, followed by a colon
- A block of indented code

Example: Let's write a function that doubles the value of a number *x* and prints the result:

```
In [4]: def double(x):  
        print(2*x)
```

Once a function is defined, it can be used. For example:

```
In [5]: double(4)
```

8

```
In [15]: var = 6  
         double(var)
```

12

Example: Write a function without any arguments that prints 'Hello'

```
In [6]: def print_hello():  
        print('Hello')
```

print_hello()

Hello

Example: Write a function that prints all of the entries in a list that is provided as an argument

```
In [1]: def print_list(L):  
        for l in L:  
            print(l)  
  
L = ['Python', '3', 'is', 'super', 'fun']  
print_list(L)
```

Python

3

is

super

fun

Creating output using return

We often want to save the result of a function by assigning it to a new variable.

This is possible using the `return` keyword

```
def name_of_function(arg1, arg2, ...):  
    # indented block of code  
  
    return val_to_output
```

When `name_of_function` is called, it **returns** (or outputs) the value of *val_to_output*, which can then be assigned to a new variable using

```
saved_output = my_function(arg1, arg2, ...)
```

Example: Write a function that doubles the value of a number *x* and returns the results

```
In [7]: def double(x):  
        d = 2 * x  
        return d  
  
y = double(3)  
print(y)  
print(2*y)
```

6

12

Returning multiple outputs

It is possible to return multiple values by creating a tuple out of them

Example: Write a function called `sum_prod` that returns the sum and product of two numbers

```
In [20]: def sum_prod(x, y):  
        return (x + y, x * y)
```

There are two ways we can run this function and save the output:

```
In [22]: def sum_prod(x, y):  
        return (x + y, x * y)  
  
# save the output as a tuple  
output = sum_prod(3, 6)  
print(output)  
  
# save the output as two numbers  
(s, p) = sum_prod(3, 6)  
print(s)  
print(p)
```

(9, 18)

9

18

More about the return keyword

The `return` keyword is optional, but it can play two important roles in functions:

1. It is used to define the output of a function, if there is any
2. It is used to exit a function prematurely (similar to `break` in loops)

The second point means the `return` statement is useful in controlling the flow of functions that involve `if` statements

Consider the following function:

```
In [8]: def my_function(x):  
        print('x equals', x)  
        return  
        print('2x equals', 2 * x)
```

When the function is called, it proceeds through each statement until the `return` keyword is encountered, at which point the function terminates, and any values that follow `return` are returned as outputs

```
In [9]: my_function(2)
```

x equals 2

Since there is nothing that follows `return` in this example, the function does not output anything

Example: Write a function that determines whether an integer is even. If so, the function returns the boolean `True`. Otherwise, the function returns the boolean `False`.

```
In [3]: def is_even(n):  
        if n % 2 == 0:  
            return True  
        else:  
            return False  
  
n = 4  
print(is_even(n))  
  
m = 55  
print(is_even(m))
```

True

False

Good programming practice - docstrings

Python programs often involve many user-defined functions, and it can be difficult to remember what they do and how they should be used.

A **docstring** is text in triple quotation marks placed below the name of the function that explains what it does.

```
In [10]: def square(x):  
        """  
        Computes the square of a real number x and returns its value  
        """  
        return x * x
```

Python's `help` function can be used to print the docstring:

```
In [11]: help(square)
```

Help on function square in module __main__:

```
square(x)  
    Computes the square of a real number x and returns its value
```

Summary

- A function is a group of code that has been given a name
- They can take input and produce output
- Functions are defined using the `def` keyword
- Output is producing using the `return` keyword
- Docstrings are helpful for explaining what a function does and how to use it