COMPSCI 101

Principles of Programming

Lecture 7 – Defining functions

Learning outcomes

At the end of this lecture, students should be able to:

- define a function which is passed parameters and returns values
- make calls to functions which have been defined
- use descriptive function and variable names to ensure that the purpose of the function is clear

Recap

From lecture 6

- get user input from the keyboard
- generate a random number
- convert between types

```
1  import random
2
3  dice1 = random.randrange(1, 7)
4  age = random.randrange(66, 99)
5
6  user_input = input("Enter age: ")
7  user_age = int(user_input)
8
9  cost = input("Enter cost $")
10 cost = float(cost)
11
12 price = cost  + 32.45
13 message = "Final price $" + str(price)
14 print(message)
```


Python in-built functions

Functions are like small programs which perform useful tasks. So far we have used several Python built-in functions, e.g., `len()`, `min()`, `round()`, `max()`, `input()`.

```
1 print(min(5, 78, 15))
2 print(max(5, 78))
3 length = len("ABCDE")
4 print(length)
```

```
5
78
7
```

On line 1, the program **makes a call** to the `min()` function, on line 2 the program **makes a call** to the `max()` function and on line 3 the program **makes a call** to the `len()` function.

All three functions **return** an integer (the result of the function code being executed). On lines 1 and 2, the returned value is printed. On line 3 the returned value is assigned to the variable, `length`.

Reuse code

One of the aims when writing programs is to reuse code as much as possible.

```
1 name  = input("Enter name: ")

2 age = int(input("Enter age: "))

3 bday_month = input("Enter birthday month: ")
```

Whenever we **make a call** to a function, the code inside the function definition is executed and the call we make is replaced by the result of the function (i.e., replaced by the value **returned** by the function).

Generalise

Another aim when writing programs is to generalise the solution so it can be used over and over with different values.

NOT A GOOD WAY TO PROGRAM!

```
area = 5 * 10
print("Area of a rectangle with width 5 and height 10:", area)
```

```
Area of a rectangle with width 5 and height 10: 50
```

The above solution is not useful if we want to calculate the area of rectangles of different sizes. A more general (and more useful) solution:

```
width = 5
height = 10
area = width * height
output_str = ("Area of a rectangle with width " + str(width) +
              " and height " + str(height) + ":")
print(output_str, area)
```

```
Area of a rectangle with width 5 and height 10: 50
```


Exercise

What is undesirable about this code (continues onto the next slide)?

```
import random
current_score = 0
num = 1
dice1 = random.randrange(1, 7)
dice2 = random.randrange(1, 7)
current_score = current_score + dice1 + dice2
result_str = (str(num) + ". You threw a " + str(dice1) +
      " and a " + str(dice2) + "  Score: " + str(current_score))
print(result_str)
num = 2
dice1 = random.randrange(1, 7)
dice2 = random.randrange(1, 7)
current_score = current_score + dice1 + dice2
result_str = (str(num) + ". You threw a " + str(dice1) +
      " and a " + str(dice2) + "  Score: " + str(current_score))
print(result_str)
```

```
1. You threw a 4 and a 6   Score: 10
2. You threw a 3 and a 5   Score: 18
3. You threw a 3 and a 2   Score: 23
4. You threw a 6 and a 6   Score: 35
```

Exercise continued

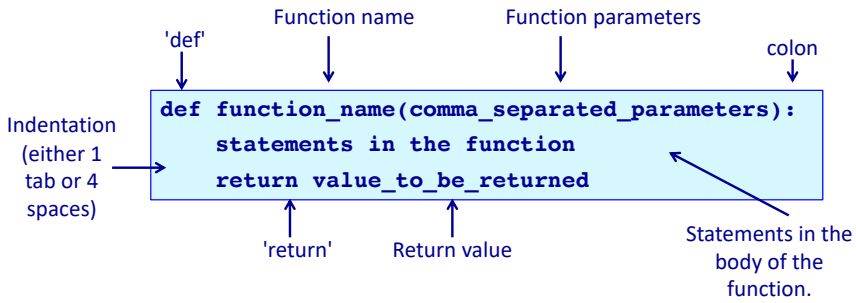
```
1. You threw a 4 and a 6   Score: 10
2. You threw a 3 and a 5   Score: 18
3. You threw a 3 and a 2   Score: 23
4. You threw a 6 and a 6   Score: 35
```

```
num = 3
dice1 = random.randrange(1, 7)
dice2 = random.randrange(1, 7)
current_score = current_score + dice1 + dice2
result_str = (str(num) + ". You threw a " + str(dice1) +
      " and a " + str(dice2) + "  Score: " + str(current_score))
print(result_str)

num = 4
dice1 = random.randrange(1, 7)
dice2 = random.randrange(1, 7)
current_score = current_score + dice1 + dice2
result_str = (str(num) + ". You threw a " + str(dice1) +
      " and a " + str(dice2) + "  Score: " + str(current_score))
print(result_str)
```

Syntax of a Python function

A Python function has the following syntax:



Functions - example

The function defined below calculates the total number of minutes. The function is passed two **parameters**: the hours and the minutes.

```
def get_minutes(hours, minutes):
    total = hours * 60 + minutes
    return total
```

The code in a function is not executed until the function is called:

```
1  def get_minutes(hours, minutes):
2      total = hours * 60 + minutes
3      return total
4  total_minutes = get_minutes(3, 44)
5  print("1.", total_minutes, " minutes")
6  print("2.", get_minutes(5, 0), " minutes")
7  print("3.", get_minutes(11, 540), " minutes")
```

```
1. 224  minutes
2. 300  minutes
3. 1200  minutes
```

There are **three calls** to the get_minutes() function (on lines 4, 6 and 7).

Functions – things to note

```
1  def get_minutes(hours, minutes):
2      total = hours * 60 + minutes
3      return total
4  total_minutes = get_minutes(3, 44)
5  print(total_minutes, " minutes")
```

```
224  minutes
```

- In the function call (line 4), there must be the **same number of arguments** passed to the function as the function requires (the expected parameters are on line 1 inside the parentheses). The order of the arguments is important.
- In the program, the function definition (lines 1, 2 and 3) must occur before any of the calls to the function (line 4).

This requirement will change – see lecture 9.

- In the function definition (lines 1, 2 and 3), the **return statement** is the last statement (line 3) of the function.

Functions – the return statement

```
1  def get_minutes(hours, minutes):
2      total = hours * 60 + minutes
3      return total
4  total_minutes = get_minutes(3, 44)
5  print(total_minutes, " minutes")
```

```
224  minutes
```

- In the function definition (lines 1, 2 and 3), the **return statement** is always the last statement (line 3). When the return statement is reached, the function stops executing returning the value (the variable, total, in the example above) to the function call. Control goes back to the function call (the right hand side of line 4) and the program continues executing at line 4 followed by line 5.
- All the statements inside the function are **indented** (either one tab or 4 spaces). This is the **body of the function**.

Functions - example

The following function (lines 1, 2, 3) converts degrees Celsius to degrees Fahrenheit using the formula:

Celsius to Fahrenheit : °F=(°C × 1.8) + 32

```
1 def celsius_to_f(celsius):
2     farenheit = celsius * 9 / 5 + 32
3     return farenheit

4 celsius = 34
5 print(1,"celsius",celsius,"= fahrenheit",celsius_to_f(celsius))

6 celsius = 15
7 print(2,"celsius",celsius,"= fahrenheit",celsius_to_f(celsius))

8 celsius = 21
9 print(3,"celsius",celsius,"= fahrenheit",celsius_to_f(celsius))
```

```
1 celsius 34 = fahrenheit 93.2
2 celsius 15 = fahrenheit 59.0
3 celsius 21 = fahrenheit 69.8
```


Functions – use clear function names

```
1 def get_minutes(hours, minutes):
2     total = hours * 60 + minutes
3     return total
```

- When defining functions always use self-documenting function names and, as in all code, use **self-documenting** variable names. You should always write code which is clear and easy to understand.
- All functions should be clear and aim to perform only one task.

Exercise

Define the `get_result1()` function which is **passed** three whole numbers. The function **returns** the sum of the two bigger numbers.

```
print("1.", get_result1(1, 2, 3))
print("2.", get_result1(11, 12, 3))
print("3.", get_result1(6, 2, 5))
```

```
1. 5
2. 23
3. 11
```


Exercise

Define the `get_result2()` function which is **passed** two strings. The function **returns** the number of characters in the longer of the two strings.

```
print("1.", get_result2("Flibbertigibbet", "Rigmarole"))
print("2.", get_result2("Mollycoddle", "Cat"))
print("3.", get_result2("Skullduggery", "Canoodle"))
```

```
1. 15
2. 11
3. 12
```

Exercise

Define the `get_result3()` function which is **passed** one string. The function **returns** a string made up of the last character followed by the first character (both in uppercase characters).

```
print("1.", get_result3("crudivorE"))
print("2.", get_result3("OrnerY"))
print("3.", get_result3("brouhaha"))
```

```
1. EC
2. YO
3. AB
```


Exercise

Define the `required_boxes()` function which is passed a total number of items and the maximum number of items which fit into one box. The function returns the total number of boxes required (any leftovers always require an extra box).

```
boxes_needed1 = required_boxes(30, 16)
boxes_needed2 = required_boxes(20, 3)
boxes_needed3 = required_boxes(30, 10)

print("1.", "Boxes:", boxes_needed1)
print("2.", "Boxes:", boxes_needed2)
print("3.", "Boxes:", boxes_needed3)
```

```
1. Boxes: 2
2. Boxes: 7
3. Boxes: 3
```


Summary

In a Python program:

- functions which accept parameters and return values can be defined
- calls to functions which have been defined cause the code inside the function to be executed
- we must use meaningful names and variable names to ensure that the purpose of the function is clear
- Each function performs one task

Examples of Python features used in this lecture

```
def get_dice_total():
    dice1 = random. randrange(1, 7)
    dice2 = random. randrange(1, 7)
    return dice1 + dice2

def celsius_to_f(celsius):
    farenheit = celsius * 9 / 5 + 32
    return farenheit

dice_throw = get_dice_total()
farenheit = celsius_to_f(34)
```