COMPSCI 1☺1

Principles of Programming

Lecture 8 – More practice defining functions, functions can call other functions, the scope of variables

Learning outcomes

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

- write functions which perform a task
- understand that a function can call another function
- understand the scope of variable
- always use excellent function names and variable names to ensure that the purpose of the function is clear

Recap

From lecture 7

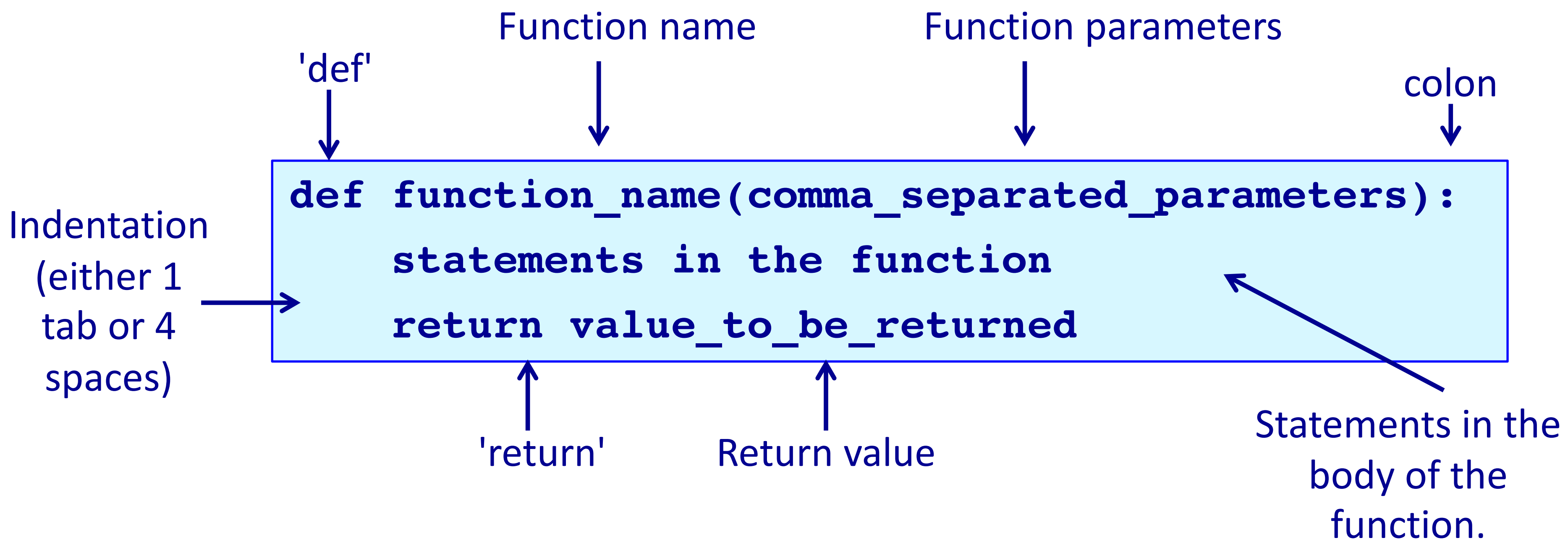
- functions which accept arguments (parameters) and return values can be defined
- calls to functions which have been defined cause the code inside the function to be executed
- we must use excellent function names and variable names to ensure that the purpose of the function is clear
- each function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

```
def add_yearly_interest(amount, percent_rate):
    interest = amount * percent_rate / 100
    interest = round(interest)
    return interest + amount

def get_discount_price(price):
    discount_price = price * 0.95
    return discount_price

interest_amount = add_yearly_interest(3000, 5)
full_price = 345.67
final_price = get_discount_price(full_price)
print(interest_amount, final_price)
```

```
3150 328.3865
```

Syntax of a Python function

A Python function has the following syntax:


Function name
Function parameters
'def'
colon
Indentation (either 1 tab or 4 spaces)
'return'
Return value
Statements in the body of the function.

```
def function_name(comma_separated_parameters):
    statements in the function
    return value_to_be_returned
```

Functions with no return statement

If a function does not need to return a result, then an optional **return statement** can be used as the last statement of the function (see lines 4 and 8).

```
1  def display_welcome(name):
2      message = "Welcome **" + name + "**"
3      print(message)
4      return

5  def display_cost(dollars, cents):
6      cost_str = "Cost is $" + str(dollars) + ":" + str(cents)
7      print(cost_str)
8      return

9  display_welcome("Sam")
10 print()
11 display_cost(15, 35)
```

```
Welcome **Sam**

Cost is $15:35
```

Functions with no return statement

If a function does not need to return a result, then the last statement (the return statement) can be omitted. The following program behaves in exactly the same way as the program on the previous slide.

```python
def display_welcome(name):
    message = "Welcome **" + name + "**"
    print(message)

def display_cost(dollars, cents):
    cost_str = "Cost is $" + str(dollars) + ":" + str(cents)
    print(cost_str)

display_welcome("Sam")
print()
display_cost(15, 35)
```

```
Welcome **Sam**

Cost is $15:35
```

Functions with no return statement

In Python, functions which do not explicitly return any value, in fact return the value **None** by default.

```
def display_welcome(name):
    message = "Welcome **" + name + "**"
    print(message)

def display_cost(dollars, cents):
    cost_str = "Cost is $" + str(dollars) + ":" + str(cents)
    print(cost_str)


print(display_welcome("Sam"))
print()
result = display_cost(15, 35)
print(result)
```

```
Welcome **Sam**
None

Cost is $15:35
None
```

See slide 14 of lecture 4:
None is a special value which can be assigned to a variable and it means that the variable is not referencing (pointing to) any object.

Functions with no parameters

Functions may not need to have any parameters inside the round brackets. If the function does not need to receive any information in order to do its job then there will not be any parameters in its parameter list.

```python
def display_intro():
    message = "Game of Nim"
    print(message)

def display_menu():
    print("1. Option 1")
    print("2. Option 2")
    print("3. exit")

display_intro()
print()
display_menu()
```

```
Game of Nim

1. Option 1
2. Option 2
3. exit
```

Python - indentation

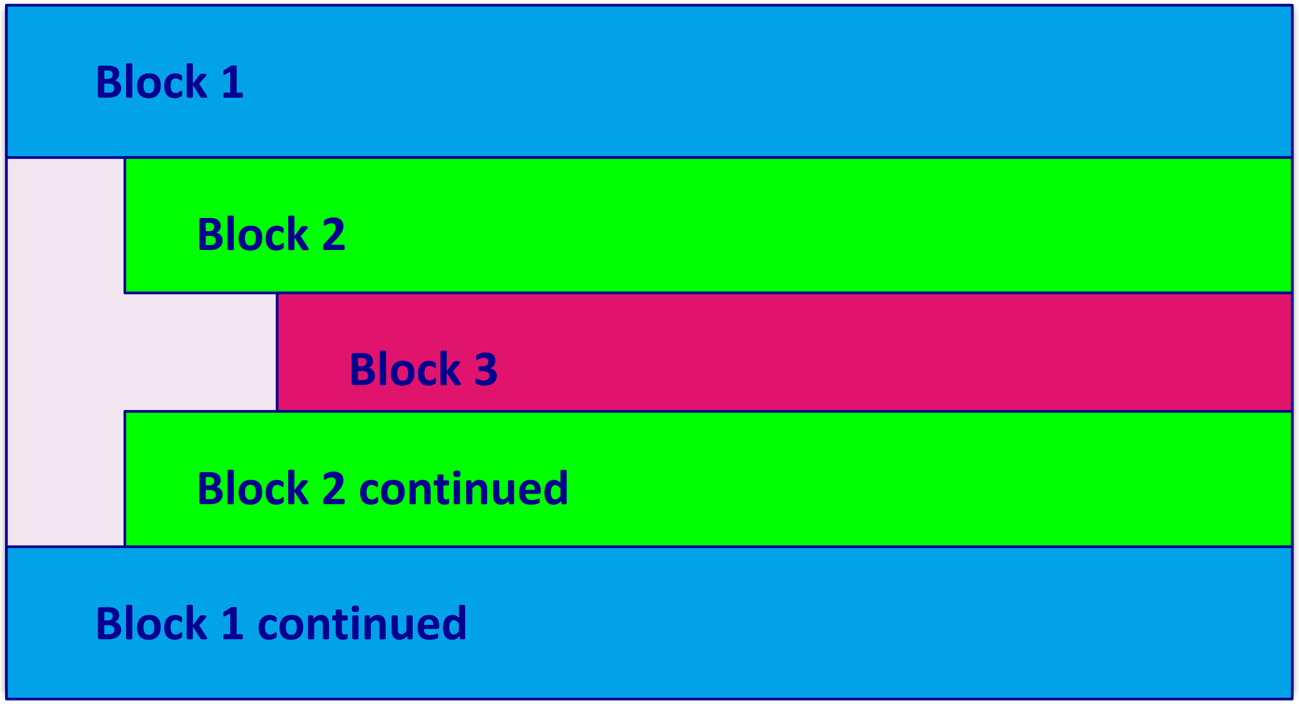
Python programs are structured through indentation

- All programming languages use blocks of code and in all programming languages, it is desirable that blocks of code be indented (this is a style requirement, not a language requirement). This principle makes it easier to read and understand code.
- In Python, indentation of blocks of code **is a language requirement** not a matter of style. All statements belonging to the same block of code have the same indentation, i.e., the statements within a block line up vertically. The block ends at a less indented line or at the end of the program. If a block has to be more deeply nested, it is simply indented further to the right.

```
import blah
n = blahblahblah
n = n + blahblahblah
blahblahblahblahblahblah:
    blahblahblah:
        c1 = blahblahblah
        c2 = blahblahblah
        blahblahblahblahblahblah:
            blahblahblah
            blahblahblah
print("The end")
```

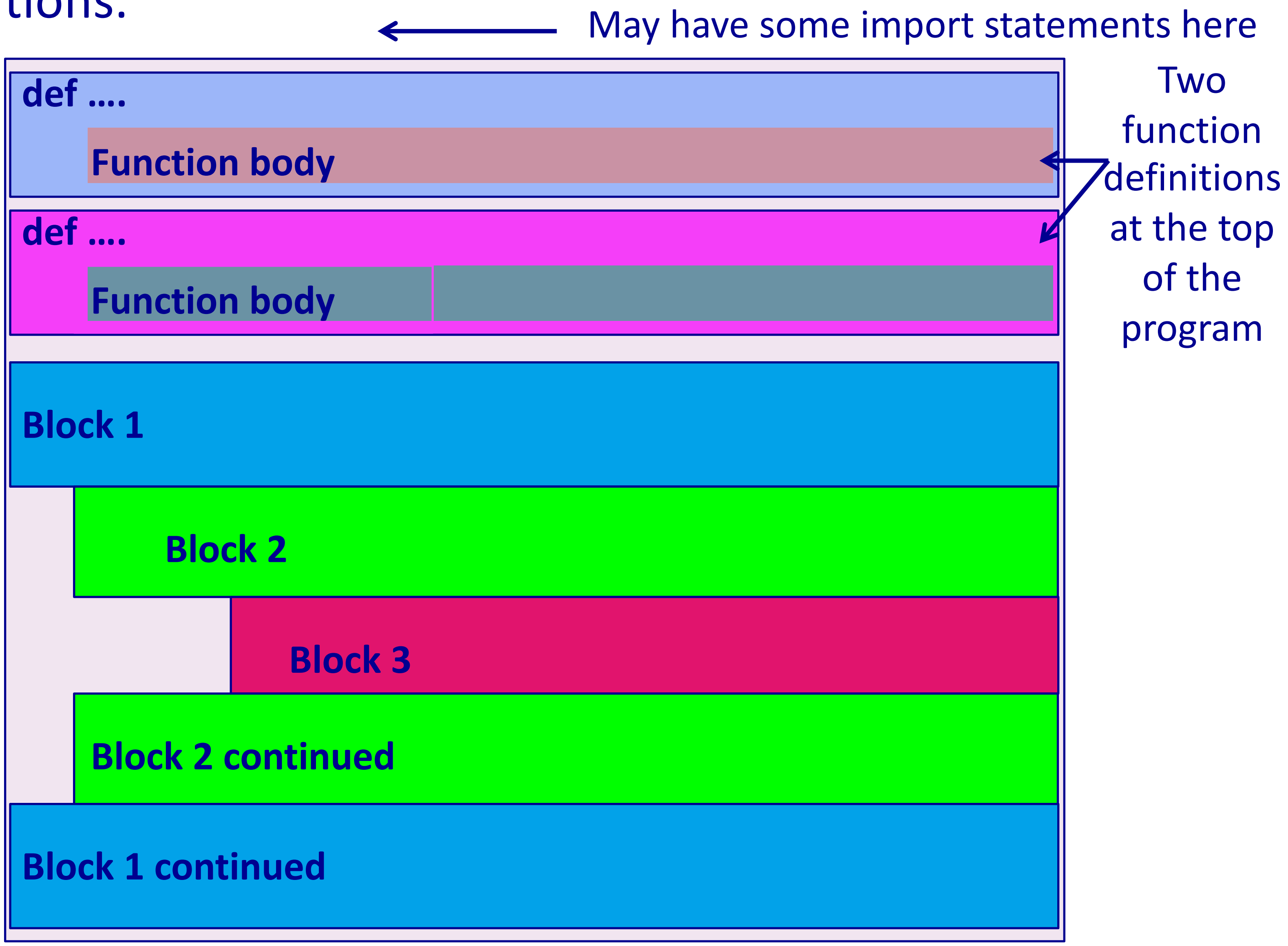
Python - indentation

Python code is structured through indentation. Below is a diagram showing the indentation of a Python program which contains no function definitions.



Python - indentation

Python code is structured through indentation. Below is a diagram showing the indentation of a Python program which contains two function definitions.



Python – indentation and colons

The use of colons (:) is another aspect of Python program syntax

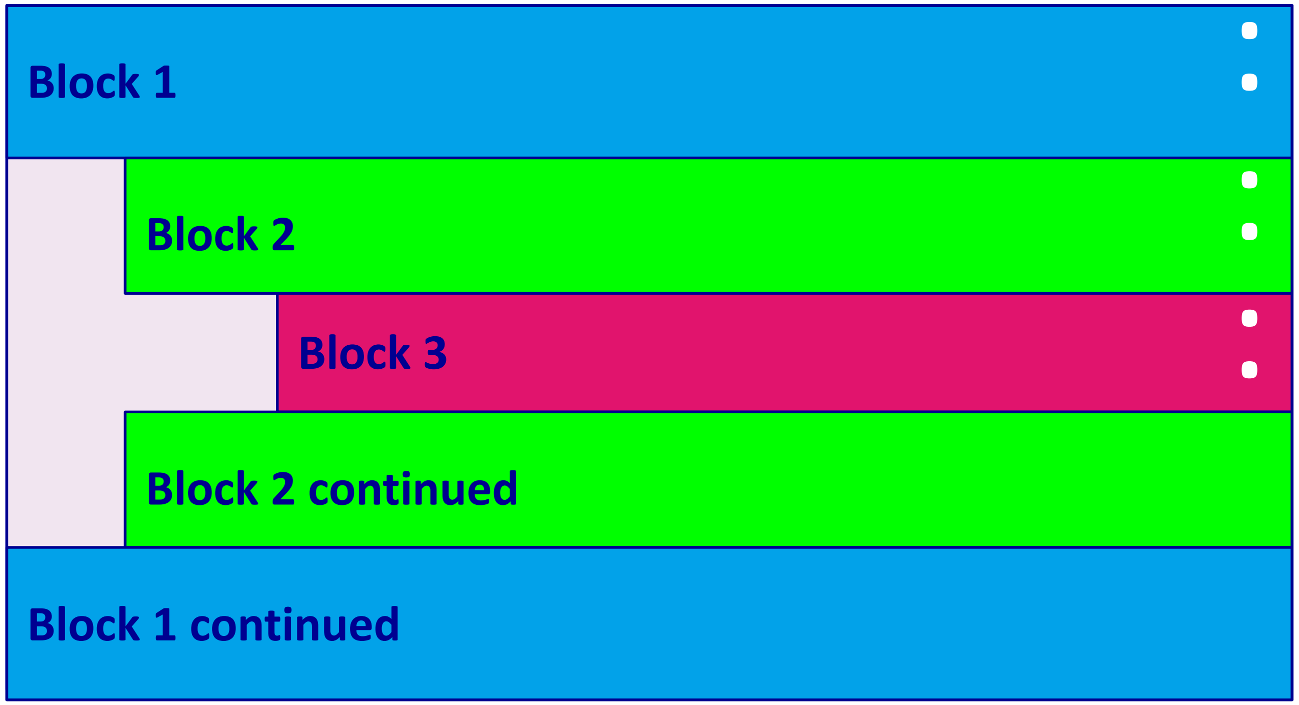
- The statement marking the beginning of an indented block ends with a colon.

```python
def display_intro():
    message = "Game of Nim"
    print(message)

def display_winner_details(winner, score):
    message = "*** " + winner.upper() + " (" + str(score) +
                                                          ") ***"
    print(message)


display_intro()
print()
display_winner_details("Joe Li", 56)
```

```
Game of Nim

*** JOE LI (56) ***
```

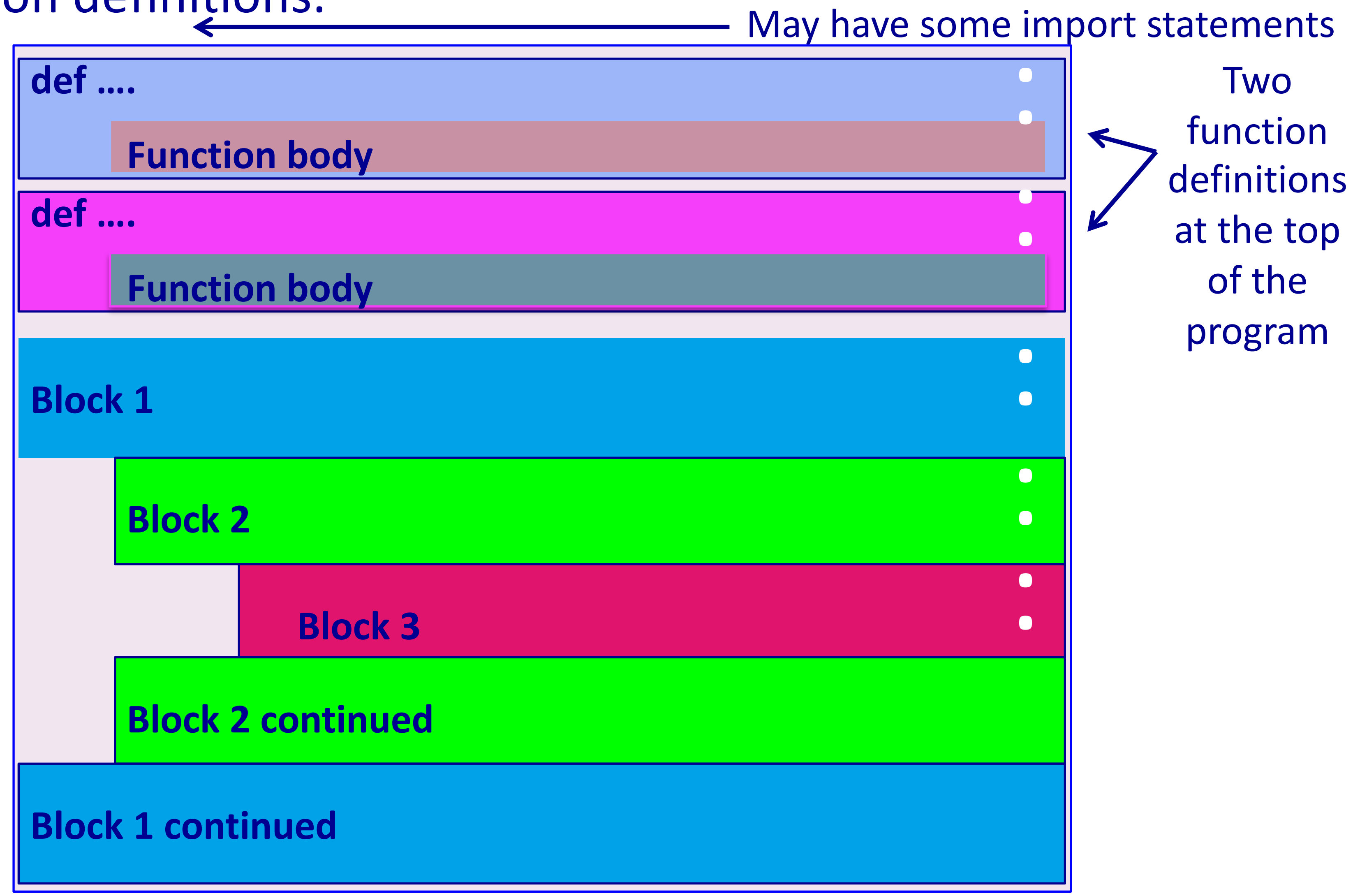
Python - colon

Each statement marking the beginning of an indented block ends with a colon, i.e., the line before the indentation. Below is a diagram showing the indentation of a Python program which contains no function definitions.



Python - indentation

Each statement marking the beginning of an indented block ends with a colon , i.e., the line before the indentation. Below is a diagram showing the indentation of a Python program which contains two function definitions.



Python – program execution

A Python program starts executing at the first unindented statement (**line 7** in the code below).

When the Python interpreter comes across statements (other than `def` or `import` ... or a few other keywords) which are written **in the left-most column** of the program, it will start the program by executing these statements.

```
1 def display_intro():
2     message = "Game of Nim"
3     print(message)

4 def display_winner_details(winner, score):
5      message = ("*** " + winner.upper() + " (" + str(score) +
                                                             ") ***")
6      print(message)

7 display_intro()
8 print()
9 display_winner_details("Jo Li", 56)
```

```
Game of Nim

*** JO LI (56) ***
```

Python – program execution

The following program will execute without error but there is no output.

```
1 def display_intro():
2     message = "Game of Nim"
3     print(message)

4 def display_winner_details(winner, score):
5      message = ("*** " + winner.upper() + " (" + str(score) +
                                                          ") ***")
6      print(message)
```

**The code in the two functions is looked at (parsed) by the interpreter.
You can verify this: put an error into one part of the function code (e.g., put
print(mes sage)
in line 6) and you will see that the interpreter will display the error.**

Local variables and their scope

When you set the value of a variable inside a function, the Python interpreter creates a **local variable** with that name.

In the following example, the variables: `message`, `author`, `length` and `symbols` are local variables defined inside the `display_intro()` function.

In a function, **local variables** exist from the moment they are set (used) until the end of the function block inside which they are used. For example the variable, `author`, exists (is **in scope**) from line 3 to line 9.

```
1  def display_intro():
2      message = "Game of Nim"
3      author = "by Adriana Ferraro"
4      length = max(len(message), len(author))
5      symbols = "*" * length
6      print(symbols)
7      print(message)
8      print(author)
9      print(symbols)

10 display_intro()
```

```
******************
Game of Nim
by Adriana Ferraro
******************
```

Variables – out of scope

When you try to use a variable which is **out of scope**, the interpreter will display an error message:

```
1  def display_intro():
2      message = "Game of Nim"
3      author = "by Adriana Ferraro"
4      length = max(len(message), len(author))
5      symbols = "*" * length
6      print(symbols)
7      print(message)
8      print(author)
9      print(symbols)

10 display_intro()
11 print(author)
```

```
******************
Game of Nim
by Adriana Ferraro
******************
Traceback (most recent call last):
  File "OutOfScopeExample.py", line 11,
in <module>
    print(author)
NameError: name 'author' is not defined
```

Exercise

Complete the output of the following program.

```
def display_intro():
    message = "Game of Nim by Adriana Ferraro"
    length = len(message)
    symbols = "*" * length
    print(symbols)
    print(message)
    print(symbols)

message = "bye bye!"
display_intro()
print(message)
```

```
******************************
Game of Nim by Adriana Ferraro
******************************
```

The scope of parameters

Parameters are the variables which are listed in the function header.

The **scope of parameters** is the same as for local variables, i.e., they exist from the moment they are set (at the beginning of the function execution) to the end of the function block inside which they are listed, i.e., until the end of the function definition. In the example below the parameters, `winner` and `score`, exist from line 1 to line 4.

```
1 def display_winner_details(winner, score):
2     message = "*** " + winner.upper() + " ("
3     message = message + str(score) + ") ***"
4     print(message)

5 display_winner_details("Joe Li", 56)
```

```
*** JOE LI (56) ***
```

Example with four function calls

```python
def get_winner_message(name):
    message = "*** Game of Nim: " + name + " is the winner ***"
    return message

def display_winner_details(score, winner_message):
    message = "(" + str(score) + " points)"
    number_of_blanks = (len(winner_message) - len(message)) // 2
    blanks = " " * number_of_blanks
    print(winner_message)
    print(blanks + message)

message = get_winner_message("Sam")
display_winner_details(66, message)
print()
message = get_winner_message("Helen")
display_winner_details(178, message)
```

```
*** Game of Nim: Sam is the winner ***
             (66 points)

*** Game of Nim: Helen is the winner ***
              (178 points)
```

Functions can make calls to other functions

```python
def get_winner_message(name):
    message = "*** Game of Nim: " + name + " is the winner ***"
    return message

def display_winner_details(winner, score):
    message = "(" + str(score) + " points)"
    winner_message = get_winner_message(winner)
    number_of_blanks = (len(winner_message) - len(message)) // 2
    blanks = " " * number_of_blanks
    print(winner_message)
    print(blanks + message)


display_winner_details("Sam", 66)
print()
display_winner_details("Helen", 178)
```

```
*** Game of Nim: Sam is the winner ***
              (66 points)

*** Game of Nim: Helen is the winner ***
               (178 points)
```

This program does exactly the same job as the program on the previous slide

Exercise

Complete the get_discount() function which returns the discount amount (a float rounded to 2 decimal places). The function is passed two parameters, the amount and the discount rate (an integer %).

```
def get_discount(amount, discount_rate):








discount_message = "Discount: $" + str(get_discount(234, 5))
print(discount_message)
discount_message = "Discount: $" + str(get_discount(125, 15))
print(discount_message)
```

```
Discount: $11.7
Discount: $18.75
```

Exercise

Complete the get_discount_message() function which returns a string made up of the rate of discount, the string "% Discount: $", and the discount amount. The function has two parameters, the discount amount and the rate of discount (a whole number).

```
def get_discount_message(discount_amt, rate):








discount_message = get_discount_message(11.7, 5)
print(discount_message)
discount_message= get_discount_message(98.55, 15)
print(discount_message)
```

```
5% Discount: $11.7
15% Discount: $98.55
```

Exercise

Complete the print_docket() function which prints the sales docket information (the format should be as shown in the example output shown). The function is passed two arguments, the price and the discount rate (an int %). Your function code **MUST** make a call to both the functions: get_discount() and get_discount_message().

```
def get_discount(amount, discount_rate):
    #code from slide 23
def get_discount_message(discount_amt, rate):
    #code from slide 24

def print_docket(price, percent_rate):




print_docket(234, 5)
print()
print_docket(657, 15)
```

```
Original price $234
5% Discount: $11.7
Price $222.3

Original price $657
15% Discount: $98.55
Price $558.45
```

Exercise

The following program prompts the user for a number of items to be packaged. Each box can hold 10 items. Any left over items require an extra box. The first 6 boxes cost $8 each and any boxes above the first 6, cost $5 each. The program executes as shown in the example outputs below. **Design the functions needed** to write this program and write the main code for this program, i.e., the"brains" of the program.

```
Enter number of items: 20

Items: 20
Boxes needed: 2
Cost: $16
```

```
Enter number of items: 36

Items: 36
Boxes needed: 4
Cost: $32
```

```
Enter number of items: 102

Items: 102
Boxes needed: 11
Cost: $73
```

```
Enter number of items: 65

Items: 65
Boxes needed: 7
Cost: $53
```

Exercise

From the previous slide.

```
Enter number of items: 102

Items: 102
Boxes needed: 11
Cost: $73
```

```
#write the main code below
items_per_box = 10
```

Show the errors

The following program has two errors. What are the errors? Write a correction for each error.

The desired output is shown below the program.

```
def display_winner_details(winner, score):
    message = "*** " + winner.upper() + " ("
    message = message + score + ") ***"
    print(message)

score = score + 50
display_winner_details("Joe Li", score)
print(score)
```

```
*** JOE LI (50) ***
50
```

Summary

In a Python program:

- functions can be used to perform various tasks
- a function can make calls to other functions
- the scope of variable needs to be understood
- It is important to always use excellent function names and variable names to ensure that the purpose of the function is clear

Examples of Python features used in this lecture

```
def display_welcome(name):
message = "Welcome **" + name + " **"
print(message)
return

def display_intro(name):
    local_variable = "Game of Nim"
    local_variable = local_variable + "by " + name
print(local_variable )


def display_menu():
print("1. Option 1")
print("2. Option 2")
print("3. exit")

display_menu()
display_welcome("Sam")
display_intro("Adriana Ferraro")
```