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Tutorial 2 – Week 3

We'll be starting at the 10 minute mark

if nothing else, write #cleancode

Introduction – TA

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Current studies: Second year MASc BME student

Research/other interests: Signal analysis and machine learning for biosignals

Agenda

1. Lab 1 Review
   a) Review of errors
2. Lecture Review
   a) Defining and using functions
   b) Functions: Tips & Misconceptions
   c) Built-in functions
   d) Importing and Using Modules
3. Practice Questions
4. Questions?

Upon completing this tutorial, the students should be able to:

Learning Objectives

1. Understand the general concept of "function"
2. Recognize Python function calls
3. Recognize Python function definitions
4. Know how to define a function (header + body)
5. Understand the use of Python `return` statement
6. Know how to return a value from a function using a return statement
7. Understand the general concept of "variable scope"
8. Understand the general concept of built-in "function"
9. Know how to import modules
10. Know how to access a function defined in a module they imported

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Review of Lab 1

Errors

if nothing else, write #cleancode

Lab 1: Review of Errors[1]

Command	Action
`alex.up()`	Lift the tail (stop drawing)
`alex.down()`	Lower the tail (start drawing)
`alex.right(d)`	Turn right by *d* degrees
`alex.left(d)`	Turn left by *d* degrees
`alex.forward(s)`	Move *s* steps in the current direction
`alex.backward(s)`	Move *s* steps backwards with the current heading
`alex.setheading(d)`	Change heading to direction *d* (0: east, 90: north, 180: west, 270: south)
`alex.goto(x, y)`	Move to coordinates *(x, y)*
`alex.circle(r, d)`	Move in circle with r radius for *d* degrees (counterclockwise if *d* > 0)

Syntax Errors: *occur when your code breaks the syntactic rules of the language (e.g., your code contains unbalanced brackets, identifiers, such as variable or function names, that do not obey the rules)*

Added comma missing between arguments

- ***Example:*** **`alex.circle(50 180)`**
  - ***Corrected version:*** **`alex.circle(50, 180)`**
  - ***Explanation:*** *a syntax rule was broken, more specifically the* ***RULE*** *that function arguments must be separated by commas*

Lab 1: Review of Errors[2]

Semantic Errors: occur when the semantic rules of the language are broken (e.g., calling a function with the wrong argument type or with the wrong number of arguments)

Command	Action
`alex.up()`	Lift the tail (stop drawing)
`alex.down()`	Lower the tail (start drawing)
`alex.right(d)`	Turn right by *d* degrees
`alex.left(d)`	Turn left by *d* degrees
`alex.forward(s)`	Move *s* steps in the current direction
`alex.backward(s)`	Move *s* steps backwards with the current heading
`alex.setheading(d)`	Change heading to direction *d* (0: east, 90: north, 180: west, 270: south)
`alex.goto(x, y)`	Move to coordinates *(x, y)*
`alex.circle(r, d)`	Move in circle with r radius for *d* degrees (counterclockwise if *d* > 0)

Removed argument

- **Example:** `alex.up(5)`
  - **Corrected version:** `alex.up()`
  - **Explanation:** a semantic rule was broken, i.e., method `up()` was called with the wrong number of arguments, more specifically `up()` accepts fewer arguments than were passed to it.

Lab 1: Review of Errors[3]

Command	Action
`alex.up()`	Lift the tail (stop drawing)
`alex.down()`	Lower the tail (start drawing)
`alex.right(d)`	Turn right by *d* degrees
`alex.left(d)`	Turn left by *d* degrees
`alex.forward(s)`	Move *s* steps in the current direction
`alex.backward(s)`	Move *s* steps backwards with the current heading
`alex.setheading(d)`	Change heading to direction *d* (0: east, 90: north, 180: west, 270: south)
`alex.goto(x, y)`	Move to coordinates *(x, y)*
`alex.circle(r, d)`	Move in circle with r radius for *d* degrees (counterclockwise if *d* > 0)

Logical Errors: occur when the meaning/semantics of a program is not the intended one (e.g., a mathematical formula is implemented incorrectly, a block of instructions is mis-indented)

- **Example:** `alex.right(2 * math.pi)`
  - **Corrected version:** `alex.right( 360 )`
  - **Explanation:** a higher level semantic rule was broken, i.e., function `right()` assumes that the values passed to it represent angles expressed in **degrees** (not **radians !)** and was passed a value that represents the value of an angle expressed in radians.

Corrected the value of the argument

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Review of Lecture

Defining and Using functions

if nothing else, write #cleancode

Defining Functions

Function Elements:

1. Header
2. Body
   - Docstring
   - Statements implementing the purpose (intended semantics) of the function

Practice question:

I implement a function that calculates the area of a rectangle.

Week3.py

function_name

```
#function syntax

def function_name (parameters): #function heading
    #docstring
    '''
    Type contract (ie all input parameter types -> return type
    Describe your function here
    '''

    # function body goes here


    # return statement at the end to exit the function
```

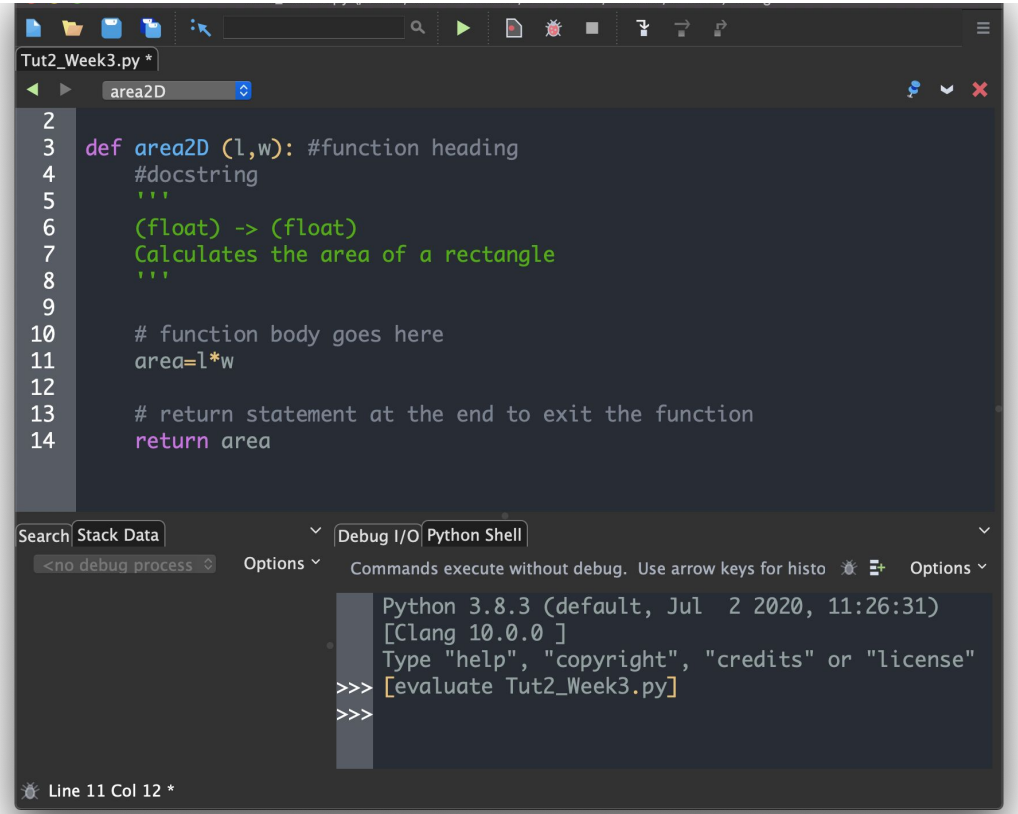
Example of a function

Function Elements:

1. Header
2. Body
   - Docstring
   - Statements implementing the purpose (intended semantics) of the function

Questions:

- What happens when I run this code?
- How do/can I use this function ?



Calling functions

Note: variables `length` and `width` are **parameters** of the `area2D` function.

Questions:

- Q1: Why isn't the area of the rectangle with length 5 and with 7 displayed in the Python shell?
- Q2. How can I display the value returned by the function `area2D` ?

(bottom)

```
#function syntax
def area2D(l,w): #function heading
    #docstring
    '''
    (float), (float) -> (float)
    Calculates the area of a rectangle
    '''

    #function body goes here
    area=l*w

    #return statement at the end to exit the function
    return area

length=5
width=7
area2D(length,width) #calling your funciton
```

Functions and variables

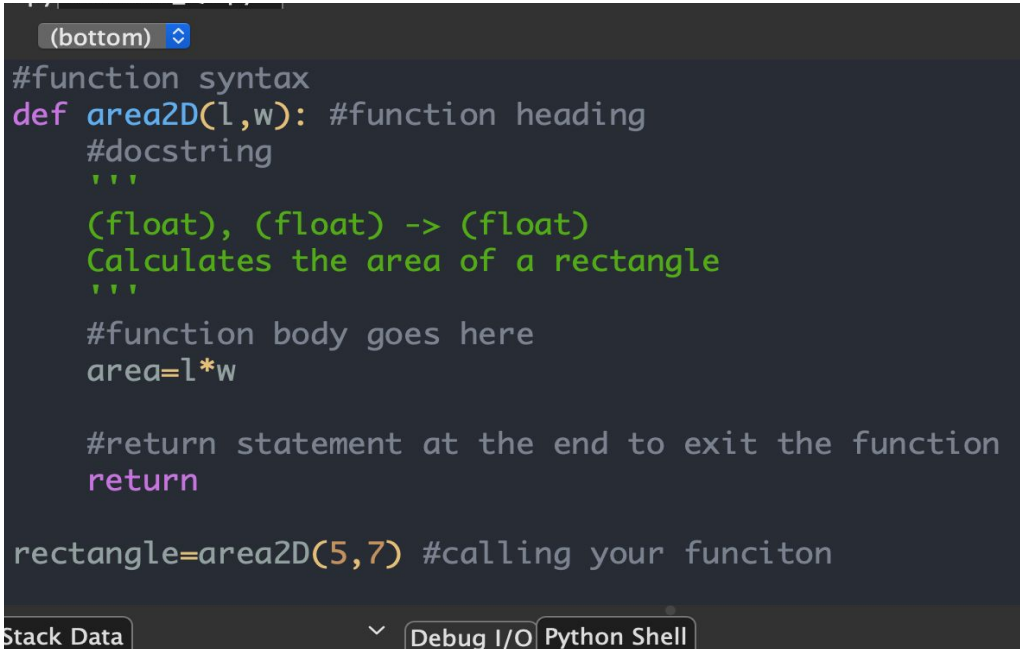
- **Q1 Answer:** the value returned by the function **`area2D`** is "stored" in variable **`rectangle`**, but the program does not contain an instruction for displaying the value of variable **`rectangle`**.

- Try typing the following statements in the python shell to see what happens.

```
>>> print(rectangle)
>>> rectangle
```

- Try adding the following statements to the Python script:

```
print(rectangle)
rectangle
```



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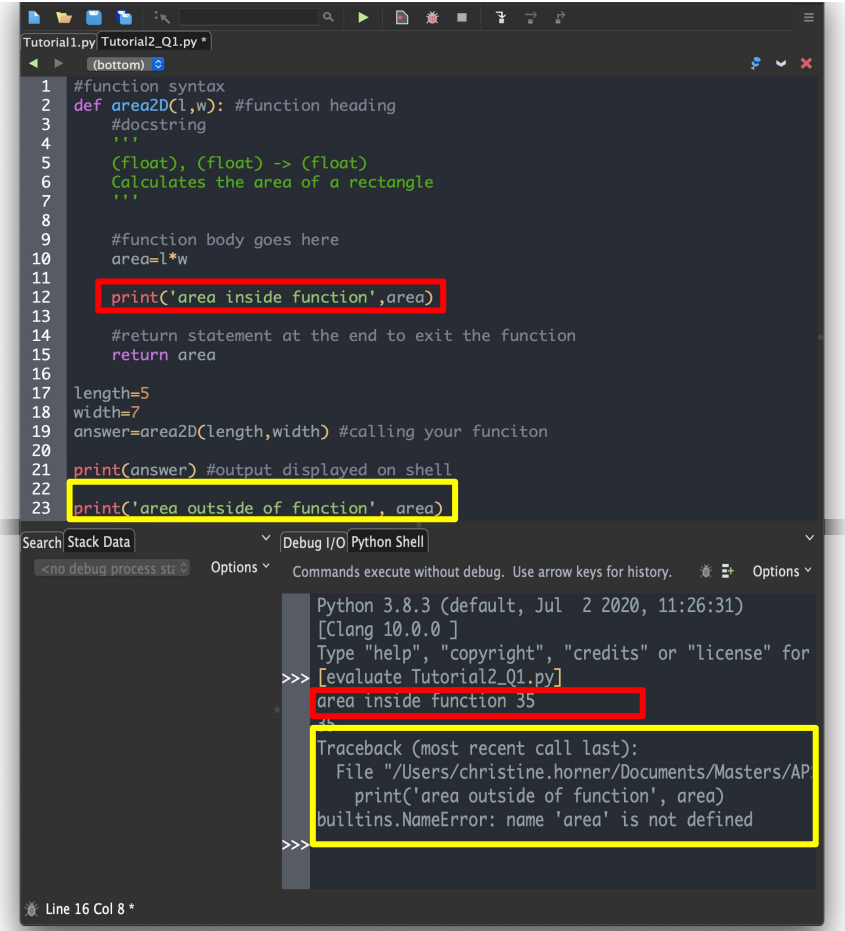
Review of Lecture

Functions: Tips & Misconceptions

Variable Scope

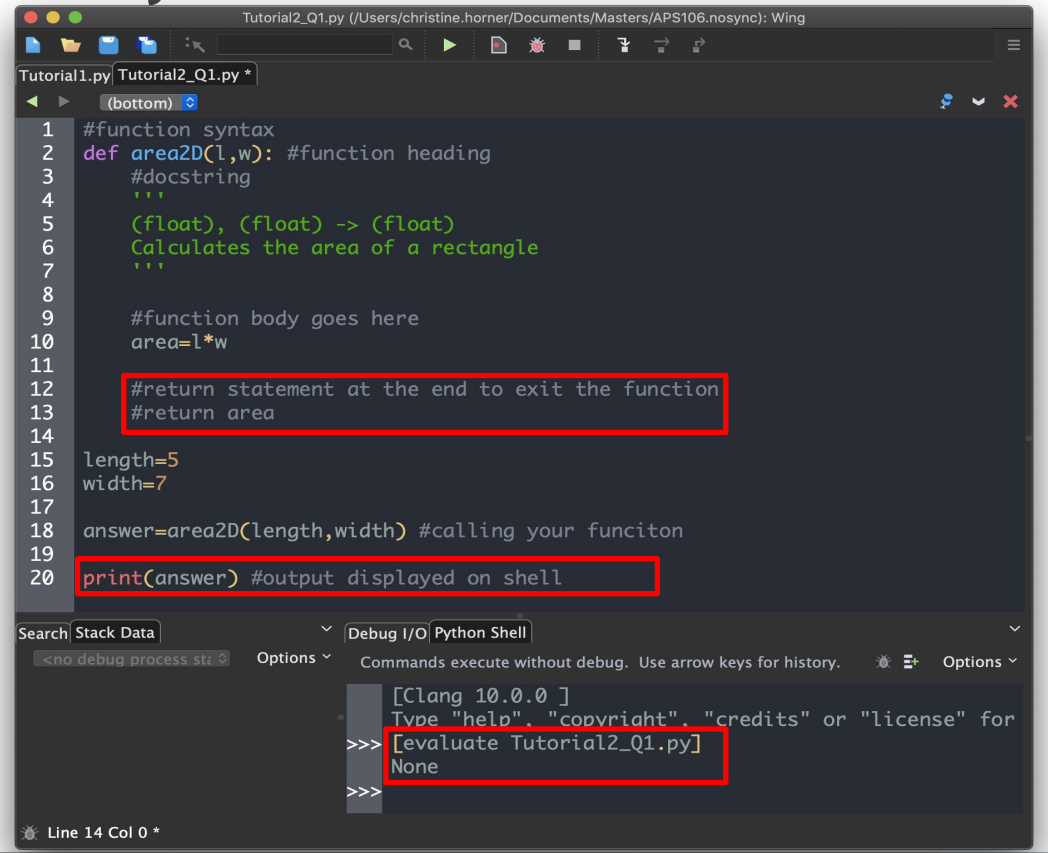
- Variables declared and initialized **inside** a function are only accessible, aka visible, within the body of the function.

- Their values can be accessed from inside the function, e.g., they can be displayed in the shell by passing them as arguments to `print()` (red case), but cannot be accessed from outside the function, e.g., from the main program body (yellow case)



Python Functions Always Return a Value ![1]

A Python function whose body does not contain a `return` statement will return by default the value **`None`**.

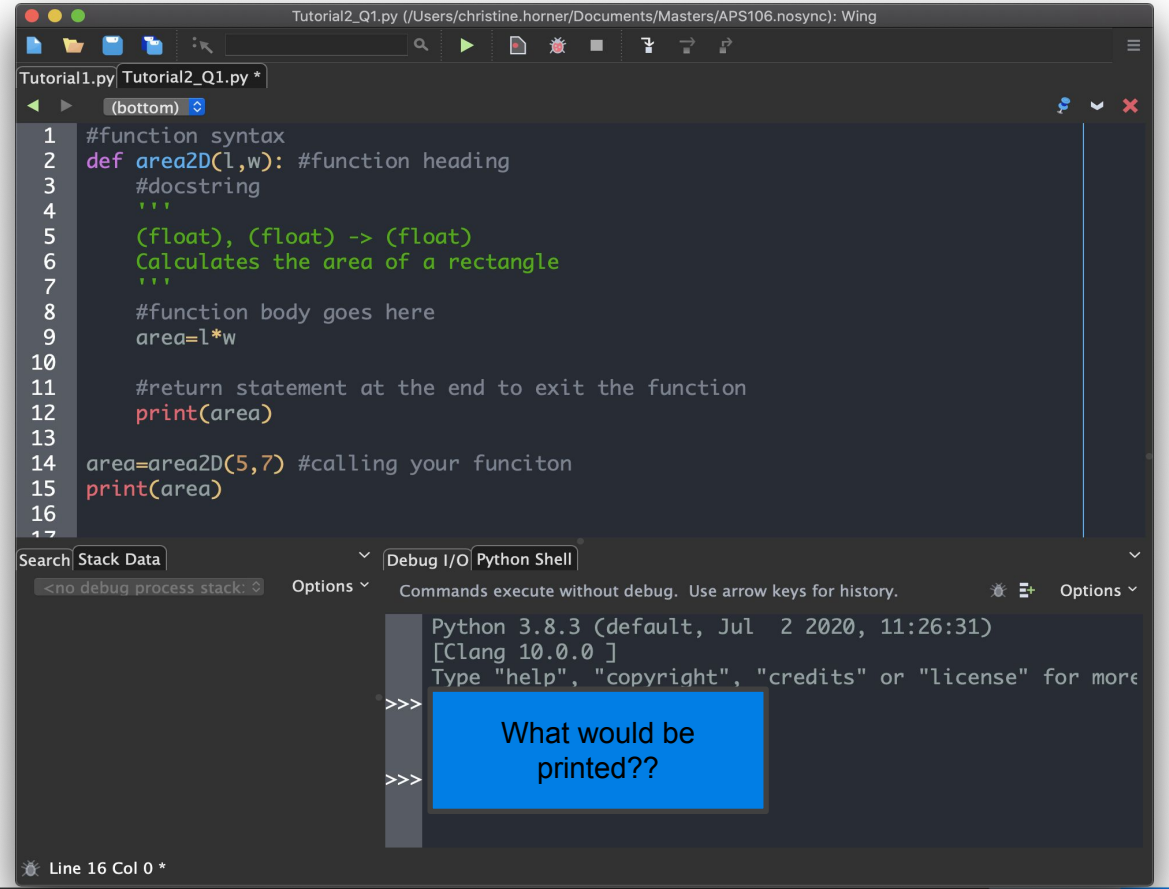


Python Functions Always Return a Value !^{2}

What would be printed in the Python shell ?

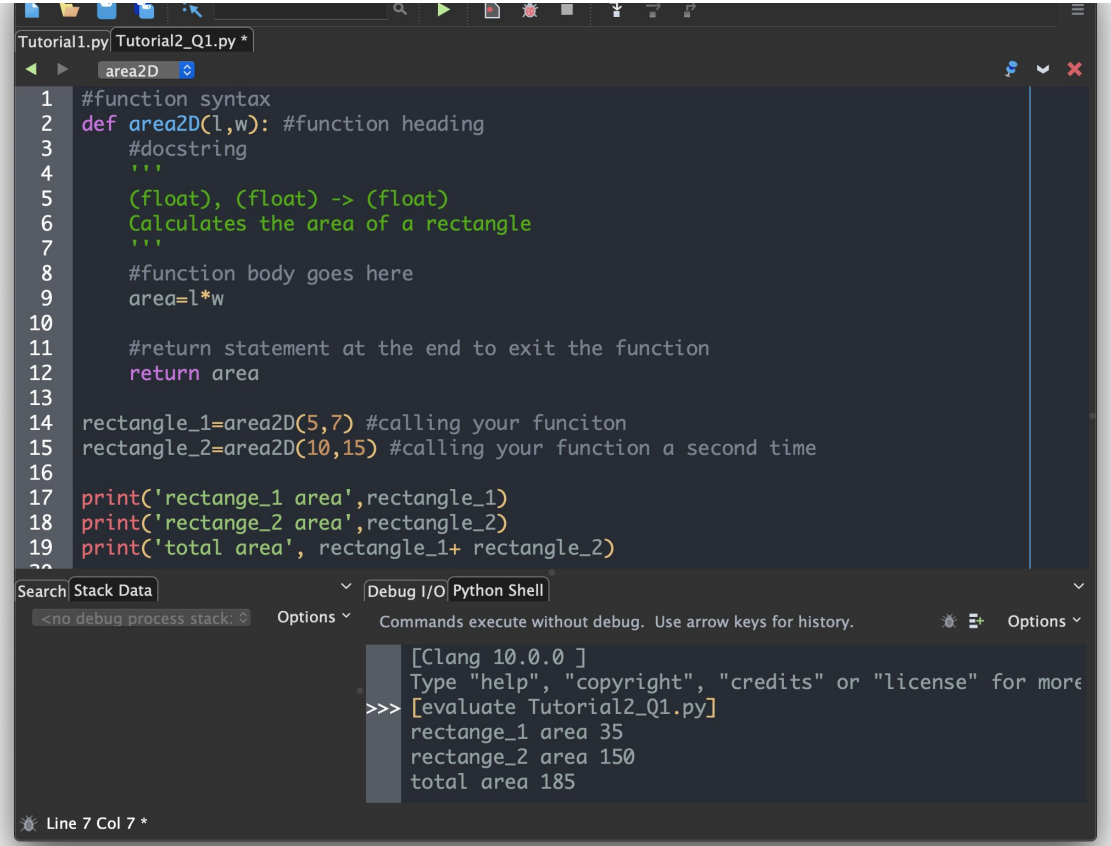
If you get this, you understand how functions work ☺️

If not, ask more questions !



When Do We Need to Use `return` Statements?

What if you wanted to find the total area of two rectangles ?



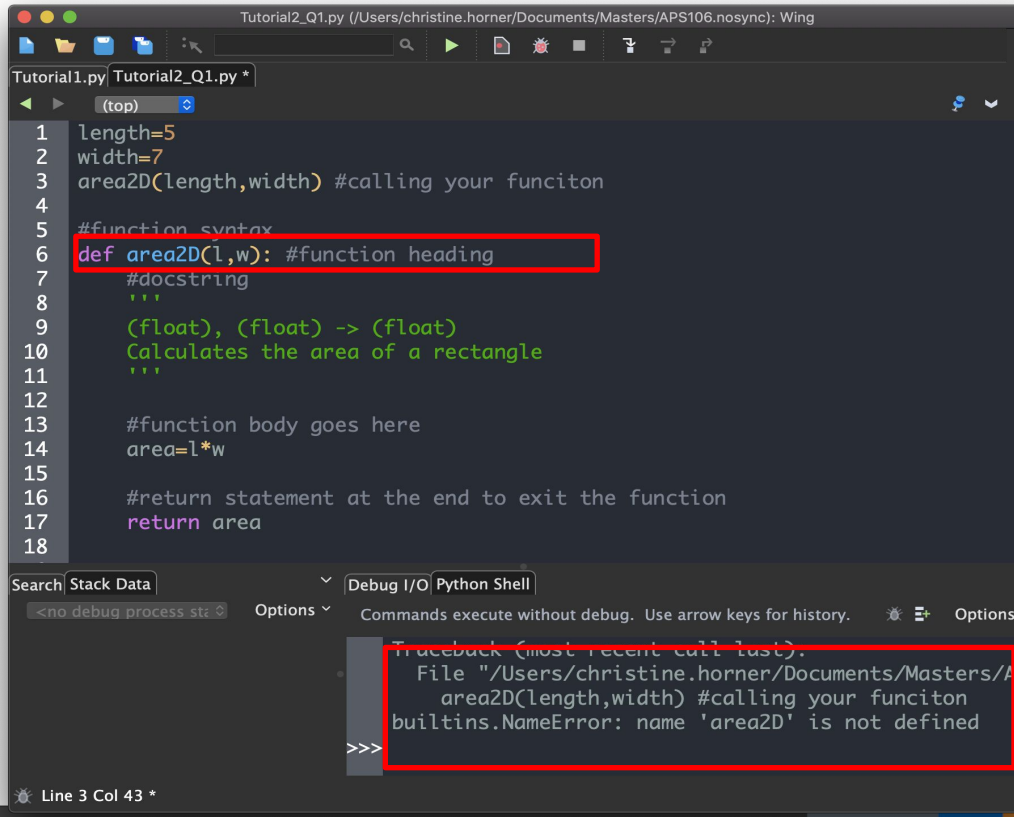
Functions must be defined before being called...

or you will get an error !

The error message is telling us that Python has no idea what `area2D` is.

This is a semantic error caused by the programmer calling a function before it was defined.

⇒ Remember that the Python interpreter runs your code line by line. The statement containing the definition of `area2D` had not been reached at the time the statement in line 3 was executed.



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Review of Lecture

Built-in Functions

if nothing else, write #cleancode

Lecture Content: Built-in Functions![1]

Built-in Functions: functions that come pre-packaged with a Python implementation

```
abs(-23)
abs(56.24)
type('hello')
```

```
int(4.2)
float(8)
id(4)
```

- Other built in functions can be found here: https://docs.python.org/3.8/library/functions.html
- Use `help()` to look up the documentation for a function, e.g., `help(abs)`

Lecture Content: Functions[2]

`input( [ prompt ])`

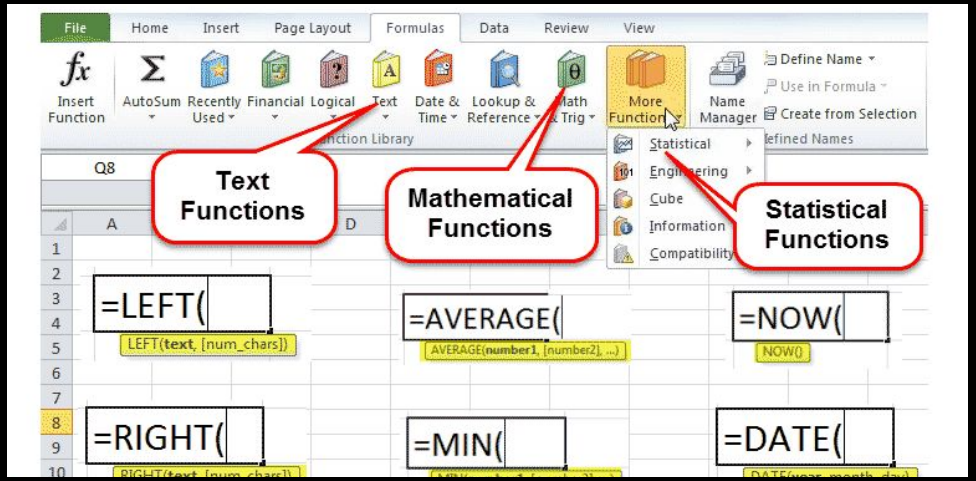
- If the *prompt* argument is present, it is written to standard output. The function then reads the line entered by the user in the command line/shell, converts it to a string (stripping a trailing newline), and returns that.
  - Depending on how we want to process the value entered by the user in our code, we may need to explicitly convert the string returned by `input()` using typecasting

`print( *objects, sep=' ', end='\n', file=sys.stdout, flush=False)`

- Print *objects* to the text stream *file*, separated by *sep* and followed by *end*.
  - *sep*, *end*, *file*, and *flush*, if present, must be given as keyword arguments.

Examples of functions you might have used...

- Excel!



- Think of your favourite apps on your phone

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Importing and Using Modules

if nothing else, write #cleancode

Python Modules

- Various statements, including function and class definitions (which will be introduced in later lectures) can be stored in separate Python files, called **modules**.

- To get access to the functions defined in a module, you need to import the module.
  - Typical form of importing a module:

```
import module_name
```

  - To access a function within a module:

```
module_name.function_name
```

Python's Built-in modules Modules

- Built-in modules we use in this course: **`math`** and **`csv`**.
- Example:

```
import math

print(math.abs(-4))
```

  - There are many other cool, open source Python libraries, e.g., NumPy, Pandas, scikit-learn, but we won't cover them in this course and you are not allowed to use them in lab assignments or exams!

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Practice Problems

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What is printed when this code is run?

ⓘ Start presenting to display the poll results on this slide.

Review Practice Problem 1

```
# Function practice problem 1
def my_func():
    x = 1
    print (x)
    x = x + 1
    return x

x = 4
print(x)
x = my_func()
print(x)
```

What is printed when this code is run?

4,5,5
4,1,4
4,1,2
4,1,1
None of the above

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What is the mistake in this code?

ⓘ Start presenting to display the poll results on this slide.

Review Practice Problem 2

(bottom)

```
#function syntax
def area2D (l,w): #function heading
    #docstring
    '''
    (float) -> (float)
    Calculates the area of a rectangle
    '''

    # function body goes here
    area=l*w

    # return statement at the end to exit the function
    return area


l=input('enter length: ') #input from user
w=input('enter width: ') #input from user

answer=area2D(l,w) #calling your function

print(answer) #output displayed on shell
```

What is the mistake in this code?

Coding Problem 1

Write a function to convert an angle expressed in degrees to radians.

HINT: You can import modules. Are there any built-in functions from the `math` module that can help ?

Things to consider before you start writing your code:

1. What would be the parameters of your function?
2. What should the function output?

Coding Problem 2

Write a function with 3 inputs: the minimum speed limit and maximum speed limit of that street, as well as your current speed

Return a number to the user telling them whether they are obeying speed limit rules (number itself), and if not, which speed limit they are breaking (minimum or maximum)

Hint:
There are functions that take in values and return their minimum and maximum

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Any questions?

ⓘ Start presenting to display the poll results on this slide.