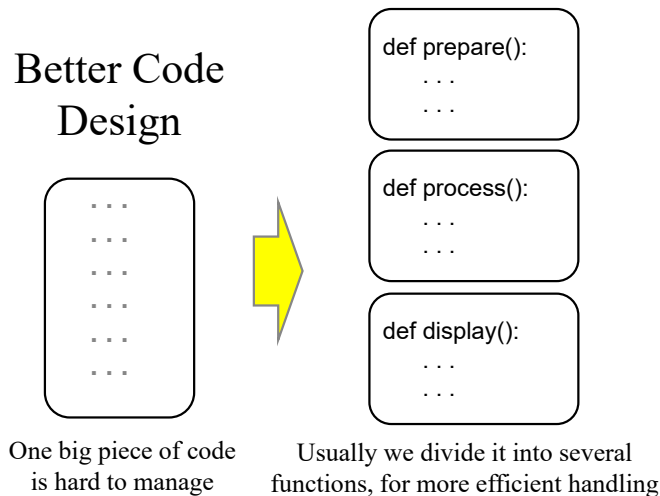COMP1021
Introduction to Computer Science

More on Functions

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Outcomes

- After completing this presentation, you are expected to be able to:

1. Explain the difference between local variables and global variables
2. Return values from a function using *return*
3. Stop a function by using the return command
4. Use a global variable to update data between the main part of a program and functions
5. Pass and return values to functions, to update data between the main part and functions

Better Code Design


```
def prepare():
    . . .
    . . .

def process():
    . . .
    . . .

def display():
    . . .
    . . .
```

One big piece of code is hard to manage

Usually we divide it into several functions, for more efficient handling

A Reminder - Making a Function

- To make a function in Python, we use the def command (**def**ine a function):

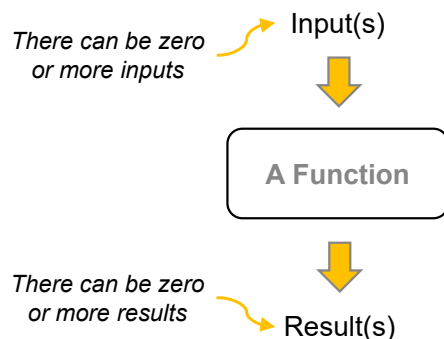*This is the name of the function (you need to put parentheses after the name)*

This is the code of the function

```
def greeting() :
    name = input("What is your name? ")
    print("Welcome " + name + "!")
```

- Then we can execute the function like this:

```
greeting()
```

A Python Function

There can be zero or more inputs

Input(s)

A Function

There can be zero or more results

Result(s)

Using Variables with the Same Name

- Let's consider this example:

The name *variable here is the value passed into the function*

The name *variable is also used in the main program*

```
def magic_mirror(name):
    if name == "Dave":
        print("What a good name!")
    else:
        print("How are you?")

name = input("What is your name? ")
magic_mirror(name)
```

- It can be quite confusing when variables with the same name appear in different places of the program
- Even though the variables have the same name, in this example they are **two different variables**

Local and Global Variables

- Local Variables
  - They are variables created inside a function
  - They work only inside the function where they are created
- Global Variables
  - They are variables created outside of any function
  - They work everywhere, including inside any function
- If a local variable and a global variable have the same name, priority is given to the local variable

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Local and Global Variables in the Example

- Looking at our example again:

*The local variable **name** works in this area*

```python
def magic_mirror(name):
    if name == "Dave":
        print("What a good name!")
    else:
        print("How are you?")

name = input("What is your name? ")
magic_mirror(name)
```

*The global variable **name** works in this area*

Using Different Names

- Having the same name for local and global variables is very confusing - we should use different names, for example:

```python
def magic_mirror(name):
    if name == "Dave":
        print("What a good name!")
    else:
        print("How are you?")

name_input = input("What is your name? ")
magic_mirror(name_input)
```

name_input *is used here, no more confusion!*

Changing Local Variables

- You need to be careful when you change a local variable:

```python
def magic_trick(money):
    if money < 1000:
        money = money + 500

money = int(input("How much do you have? "))
magic_trick(money)
print("You have $" + str(money) + " now!")
```

The local variable is changed in this line of code

```
How much do you have? 500
You have $500 now!
>>>
```

The global variable money *is not affected by the change inside the function*

Changing Global Variables inside a Function

- If you want a global variable to be changed by a function you need to tell Python using the `global` command, for example:

```python
def magic_trick():
    global money

    if money < 1000:
        money = money + 500

money = int(input("How much do you have? "))
magic_trick()
print("You have $" + str(money) + " now!")
```

We tell Python that when we refer to money *in the function, it means the global variable* money

This line changes the value of the global variable

Running the Example

- This is what we get if we run the example and then enter 500:

```
How much do you have? 500
You have $1000 now!
>>>
```

- If you remove the line 'global money' and then run the program again, you will get an error like this:

```
How much do you have? 500
Traceback (most recent call last):
  File "C:\global.py", line 6, in <module>
    magic_trick()
  File "C:\global.py", line 2, in magic_trick
    if money < 1000:
UnboundLocalError: local variable 'money' referenced before assignment
>>>
```
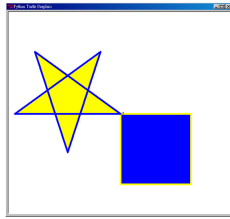
A Turtle Shape Example

- In this example, we first define one function:

```
forward_and_turn_right()
```

- This function will be used several times inside two other functions:

```
draw_square() and draw_star()
```

- This is a clever design because the same task, which is needed by two different functions, is written in one place

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The Turtle Shape Example: First Function

- The first function is used to draw a line and turn, using a certain length and angle

```
def forward_and_turn_right(length, angle):
    turtle.forward(length)
    turtle.right(angle)
```

Two values are passed into the function, separated by a comma

- This function will be used by two other functions, which will be shown in the next slides

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The Turtle Shape Example: Drawing a Square Function

- The second function draws a square using a given length of the sides and colours

```
def draw_square(length, line_colour, fill_colour):
    turtle.color(line_colour, fill_colour)

    turtle.begin_fill()
    for _ in range(4):
        forward_and_turn_right(length, 90)
    turtle.end_fill()
```

The first function is used here to draw a line and turn 90 degrees to the right

---

The Turtle Shape Example: Drawing a Star Function

- The third function draws a star using a given size and colours

```
def draw_star(length, line_colour, fill_colour):
    turtle.color(line_colour, fill_colour)

    turtle.begin_fill()
    for _ in range(5):
        forward_and_turn_right(length, 144)
    turtle.end_fill()
```

The first function again is used to draw a line but the turtle turns 144 degrees this time
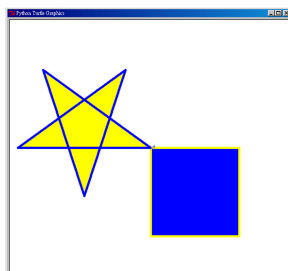

The Shape Example: The Main Part

- The main part of the program then uses the `draw_square()` and `draw_star()` functions to draw the two shapes in the turtle window:
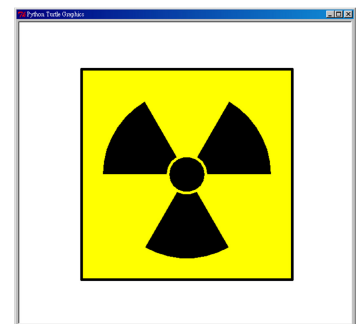
```
draw_square(200, \
    "yellow", "blue")

turtle.right(180)

draw_star(300, \
    "blue", "yellow")
```

Radioactive Symbol Example

- In the following larger example, we use functions to help create the warning symbol for radioactivity
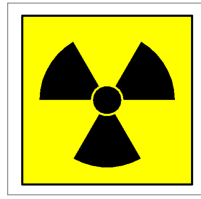
Radioactive Symbol 1/3

```
def square(length):
    # Draw a square of length pixels
    for i in range(4):
        turtle.forward(length)
        turtle.left(90)

def sector(radius, angle):
    # Draw part of a circle
    turtle.forward(radius)
    turtle.left(90)
    turtle.circle(radius, angle)
    turtle.left(90)
    turtle.forward(radius)
    turtle.left(180-angle)
```

```
def move(x, y):
    # Move forward and left
    turtle.up()
    turtle.forward(x)
    turtle.left(90)
    turtle.forward(y)
    turtle.right(90)
    turtle.down()
```

Radioactive Symbol 2/3

- Remember that, by default, (0, 0) is the middle of the screen

```
def draw_symbol(large_radius, small_radius, side):
    move(-(side/2), -(side/2))        } Defined in the previous slide

    turtle.color("black", "yellow")
    # Draw outer yellow square
    turtle.begin_fill()
    turtle.width(5)
    square(side)          } Defined in the
    turtle.end_fill()       previous slide

    move(side/2, side/2)

    # Draw the complete symbol
    turtle.color("yellow", "black")
    turtle.width(1)
```
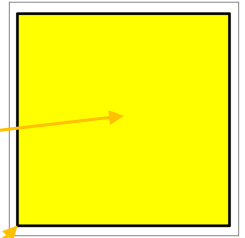
Radioactive Symbol 3/3

function draw_symbol() continued:
```
    # Draw three sections
    for i in range(3):
        turtle.begin_fill()
        sector(large_radius, 60)
        turtle.left(120)
        turtle.end_fill()

    turtle.forward(small_radius)
    turtle.left(90)

    # Draw centre circle
    turtle.width(5)
    turtle.begin_fill()
    turtle.circle(small_radius)
    turtle.end_fill()
```
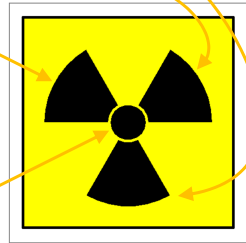*Defined previously {*

function draw_symbol() ends here

Defined last/this slide
```
# Main part of program
turtle.reset()
draw_symbol(160, 36, 400)
turtle.hideturtle()
turtle.done()
```

A Python Function

There can be zero or more inputs → Input(s)

A Function

There can be zero or more results → Result(s)

- Now we will consider this, which uses the `return` command

Returning Values from a Function

- The `return` command is usually used to return one or more values from a function
- The value(s) go from the function to the place where the function was executed
- For example, we can make a square function to calculate and return the square of a number

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

Calculating the Square of a Number

- Then we can use the square function like this:

```
input_number = \
    int(input("Please give me a number: "))

print("The square of the number is: ", end="")
print(square(input_number))
```
Run the function and print the result

- This is what we get if we enter 25:

```
Please give me a number: 25
The square of the number is: 625
>>>
```

Returning Multiple Things

- We can return more than one thing
- E.g. the following function returns two values:

```python
def get_info(current_year, year_of_birth):
    chinese_zodiac = [
        "Rat", "Ox", "Tiger", "Rabbit",
        "Dragon", "Snake", "Horse", "Sheep",
        "Monkey", "Rooster", "Dog", "Pig"
    ]

    age = current_year - year_of_birth
    animal = chinese_zodiac[ \
        (year_of_birth - 1960) % 12 ]

    return age, animal
```

Two values are returned in this example

Getting Multiple Results

- To get the two results from the function we use two variables, like this:

```python
year = int(input("Hi, what is the current year? "))
birthyear = int(input("When is your year of birth? "))

yourage, youranimal = get_info(year, birthyear)

print("You are", yourage)
print("Your animal is", youranimal)
```
```
Hi, what is the current year? 2021
When is your year of birth? 2001
You are 20
Your animal is Snake
```

Using the Return Command

- Whenever the `return` command is used the function will immediately stop running
- For example, here we stop the function when the value passed to the function is not appropriate:

```python
def donate(money):
    if money <= 0:
        return

    print("Thank you! You are so generous!")
```

If money *is not positive then stop the function here*

Stopping a Function Using Return

The complete program:

```
How much do you donate? -5000
Finished!
>>>
```
```
How much do you donate? 100
Thank you! You are so generous!
Finished!
>>>
```

```python
def donate(money):
    if money <= 0:
        return

    print("Thank you! You are so generous!")

donation = int(input("How much do you donate? "))
donate(donation)

print("Finished!")
```

If the return *command is executed then the function immediately finishes, and Python continues with any code under the place where the function was executed*

A Game

- Let's imagine you are developing a game
- The user has to shoot monsters, but cannot shoot boxes of medicine
- If a monster is shot, the player gets 100 points
- But if a box of medicine is shot, the player loses 500 points
- We need to make sure that the score is updated correctly

Sharing Data

```
def shoot_monster():
    . . .
    # Increase score by 100
    . . .
```

```
def shoot_medicine():
    . . .
    # Decrease score by 500
    . . .
```

```
# Main part of program
. . .
# Set score to zero
. . .
```

- The score needs to be changed in the functions and also the main part
- How can we handle it?
- Let's look at 2 approaches

Approach 1

```
# Main part of program
. . .
score = 0
. . .
shoot_monster()
. . .
shoot_medicine()
. . .
```

```
def shoot_monster():
    global score
    . . .
    score = score + 100
    . . .
```

```
def shoot_medicine():
    global score
    . . .
    score = score - 500
    . . .
```

- In the approach shown here the variable *score* is shared by the functions and the main part

Approach 1

```
# Main part of program
. . .
reset_score()
. . .
shoot_monster()
. . .
shoot_medicine()
. . .
```

```
def reset_score():
    global score
    score = 0
```

```
def shoot_monster():
    global score
    . . .
    score = score + 100
    . . .
```

```
def shoot_medicine():
    global score
    . . .
    score = score - 500
    . . .
```

- The main part of the program doesn't actually have to refer to the variable in any way
- Even if it doesn't, this approach will still work

Approach 2

```
# Main part of program
. . .
score = 0
. . .
score = shoot_monster(score)
. . .
score = shoot_medicine(score)
. . .
```

```
def shoot_monster(sc):
    . . .
    sc = sc + 100
    . . .
    return sc
```

```
def shoot_medicine(sc):
    . . .
    sc = sc - 500
    . . .
    return sc
```

- Here we pass the current value to the function, then the function changes the value and returns it, and the returned value goes back into the variable