

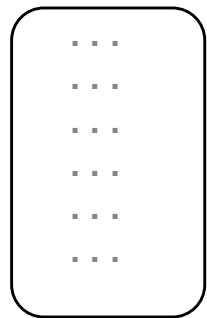
More on Functions

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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



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 (**define** a function):

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

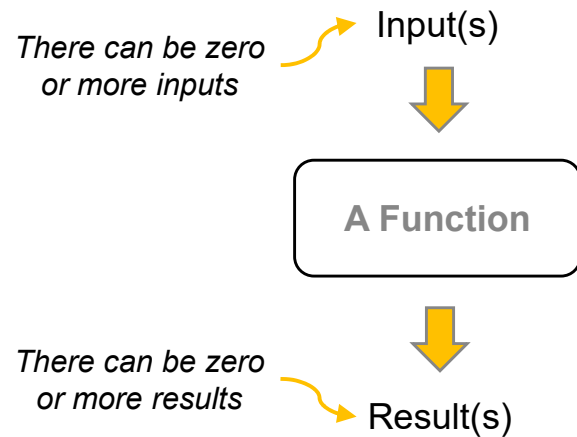
```
def greeting():  
    name = input("What is your name? ")  
    print("Welcome " + name + "!!")
```

This is the code of the function

- Then we can execute the function like this:

```
greeting()
```

A Python Function



Using Variables with the Same Name

- Let's consider this example:

The name variable here is the value passed into the function

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

The name variable is also used in the main program

```
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

Local and Global Variables in the Example

- Looking at our example again:
- The local variable **name** works in this area*

```
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:

```
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!

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Changing Local Variables

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

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

The local variable is changed in this line of code

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

```
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:

```
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:
- 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  
You have $1000 now!  
>>>
```

```
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  
>>>
```

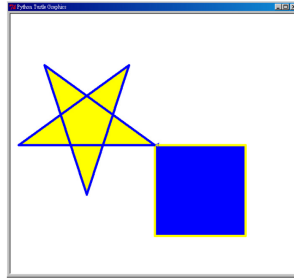
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A Turtle Shape Example

- 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



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

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

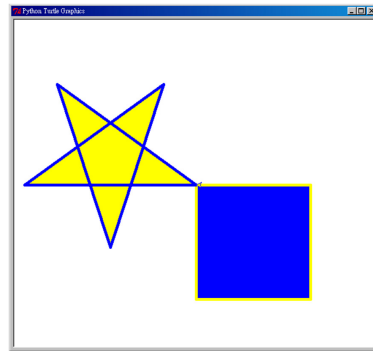
The Shape Example: The Main Part

- 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")

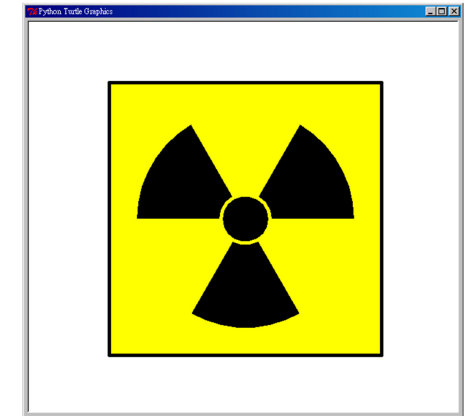
turtle.right(180)

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



Radioactive Symbol Example

- In the following larger example, we use functions to help create the warning symbol for radioactivity

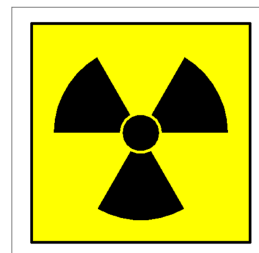


Radioactive Symbol 1/3

```
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

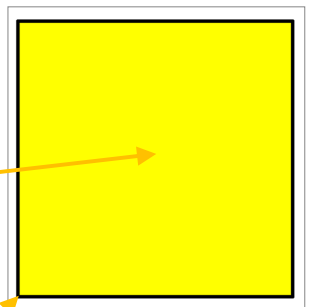
- Remember that, by default, (0, 0) is the middle of the screen

```
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 previous slide
    turtle.end_fill()

    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()
    Defined previously { sector(large_radius, 60)
    turtle.left(120)
    turtle.end_fill()

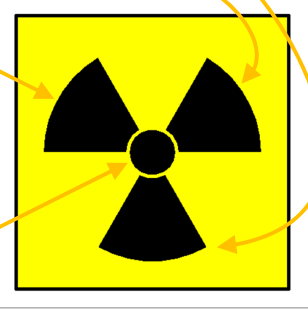
    turtle.forward(small_radius)
    turtle.left(90)

# Draw centre circle
turtle.width(5)
turtle.begin_fill()
turtle.circle(small_radius)
turtle.end_fill()
```

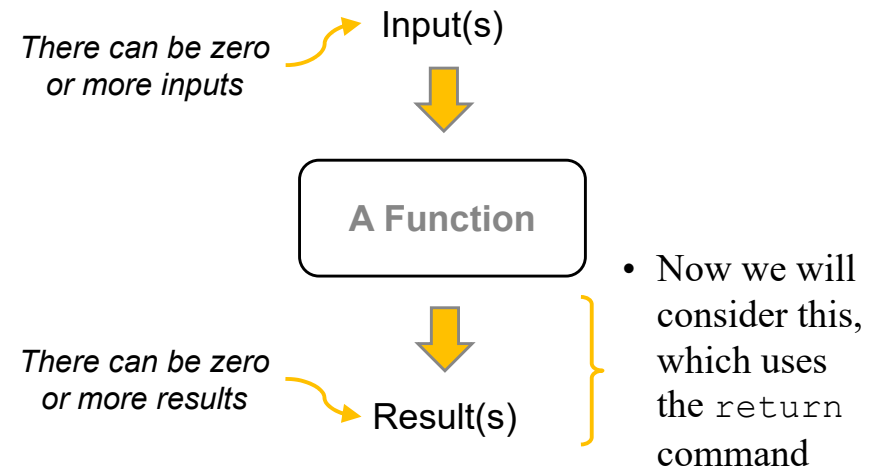
function draw_symbol() ends here

Defined last/this slide

```
# Main part of program
turtle.reset()
draw_symbol(160, 36, 400)
turtle.hideturtle()
turtle.done()
```



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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
```

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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:

```
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:

```
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
```

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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:

```
def donate(money):
    if money <= 0:
        return
    print("Thank you! You are so generous!")
```

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

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Stopping a Function Using Return

The complete program:

```
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!")
```

```
How much do you donate? -5000
Finished!
>>>
```

```
How much do you donate? 100
Thank you! You are so generous!
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

```
# Main part of program
```

```
...
score = 0
...
shoot_monster()
...
shoot_medicine()
...
```

Approach 1

```
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

```
# Main part of program
```

```
...
reset_score()
...
shoot_monster()
...
shoot_medicine()
...
```

Approach 1

```
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

Main part of program

```
...  
score = 0  
...  
score = shoot_monster(score)  
...  
score = shoot_medicine(score)  
...
```

- 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

Approach 2

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

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