CSIT110

Fundamental Programming with Python

Function

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In this lecture

- Function and its terminologies
  - Arguments
  - Return values
- Recursion
- Some useful functions
- Importing modules

Function

1. Definition

Specifies the behaviour of the function

2. Calls

Call for action -
execute the behaviour

Function Definition - Syntax

Use comma to separate each value

```
def function_name(arg1, arg2, arg3, …, argN):

    … perform a certain task …

    return value1, value2, value3, …, valueM
```

Function Definition

Same meaning:

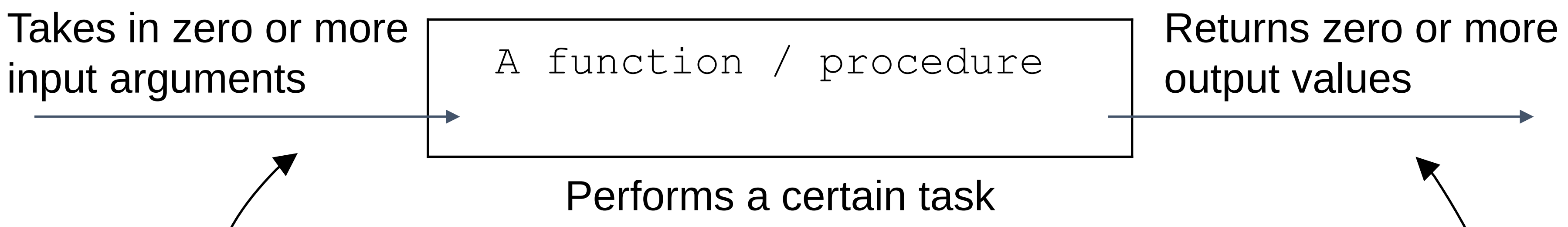
- Parameters
- Arguments

```
def function_name(arg1, arg2, arg3, …, argN):

    … perform a certain task …

    return value1, value2, value3, …, valueM
```

Return values

Practically similar but
Function – returns value(s)
Procedure / Sub-routine – does not return anything
Method – a function that is linked to a class object

Function Definition


Takes in zero or more input arguments
A function / procedure
Returns zero or more output values
Performs a certain task

We will need to feed the arguments to the function when we call it

We can save the values that are returned

Function - Calls

1. Function name followed by a pair of round bracket

```
function()
```

2. Feed in the arguments as defined in the definition

```
function_name(arg1, arg2)
```

3. Store any return values to a variable

```
variable_name = function_name(arg1, arg2)
```

Function - Calls

If a function has 0 arguments and returns 0 values

```
function_name()
```

If a function has 2 arguments and returns 1 value

```
variable_name = function_name(arg1, arg2)
```

If a function has 2 arguments and returns 2 values

```
var1, var2 = function_name(arg1, arg2)
```

If a function has 3 arguments and returns 0 values

```
function_name(arg1, arg2, arg3)
```

Scope

Denotes the part of the program where the name binding is valid.

-Local scope

-Global scope

```
x = 1

def assign_value(num):
    x = num
    print(x)

assign_value(10)
print(x)
```

```
10
1
```

```


def assign_value(num):
    x = num


assign_value(10)
print(x)
```

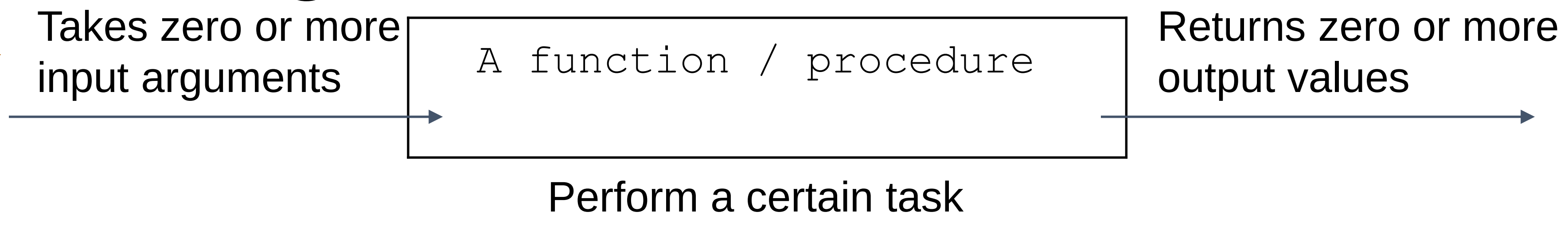
```
NameError! x is not
defined
```

```
x = 1

def print_x():
    print(x)


print_x()
print(x)
```

```
1
1
```

variables created in a function lives locally in the function   -->   local scope
variables created outside a function* lives globally --> global scope

Function design


Takes zero or more input arguments
A function / procedure
Returns zero or more output values
Perform a certain task

When we design a function, we need to ask the following questions:

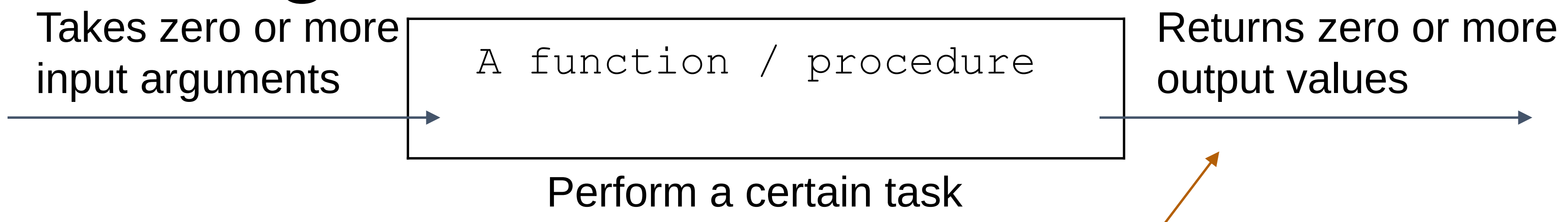
- What information does the function need to know in order to do its job?

  This will determine how many input arguments the function takes in

  For example, if the job of a function is to add two numbers, then this function needs to know the two numbers. So the function will have 2 input arguments.

```
# calculate sum of two numbers
def add_two_numbers(number1, number2):
    ...
```

Function design


Takes zero or more input arguments
A function / procedure
Returns zero or more output values
Perform a certain task

When we design a function, we need to ask the following questions:

- What information does the function give back?

  This will determine the number of return values

  For example, if the job of a function is to add two numbers, then this function will give back the sum. So the function will return 1 value.

```python
# calculate sum of two numbers
def add_two_numbers(number1, number2):
    number_sum = number1 + number2
    return number_sum
```

Example: Marks and grades

At a fictional college, the following grading scheme is used:

Mark	Grade
100 - 80	A
79 - 60	B
59 - 40	C
39 - 0	D

```
Please enter mark: 90
Mark 90, Grade A
```

```
Please enter mark: 62
Mark 62, Grade B
```

```
Please enter mark: 5
Mark 5, Grade D
```

Example: Marks and grades

```python
# calculate grade based on mark
def calculate_grade(mark: int)-> str:
    grade = "frog"
    return grade
```

```python
# ask user to enter mark
mark_input = input("Please enter mark: ")
mark = int(mark_input)

# determine grade based on mark
grade = calculate_grade(mark)

# display mark and grade
print(f"Mark {mark}, Grade {grade}")
```

```
Please enter mark: 90
Mark 90, Grade frog
```

Example: Marks and grades

```python
# calculate grade based on mark
def calculate_grade(mark: int)-> str:
    grade = "frog"
    return grade
```

rewrite

```python
def calculate_grade(mark: int)-> str:
    #grade A: 100-80, B: 79-60, C: 59-40, D: 39-0

    if (mark >= 80):
        grade = "A"
    elif (mark >= 60):
        grade = "B"
    elif (mark >= 40):
        grade = "C"
    else:
        grade = "D"

    return grade
```

```
Please enter mark: 90
Mark 90, Grade A
```

Example: Marks and grades

```python
def calculate_grade(mark: int) -> str:
    if (mark >= 80):
        grade = "A"
    elif (mark >= 60):
        grade = "B"
    elif (mark >= 40):
        grade = "C"
    else:
        grade = "D"
    return grade
```

this is the same

```python
def calculate_grade(mark: int) -> str:
    if (mark >= 80):
        return "A"
    elif (mark >= 60):
        return "B"
    elif (mark >= 40):
        return "C"
    return "D"
```

Example: Marks and grades

```
def calculate_grade(mark: int)-> str:
    ...

    return grade
```

- How many input arguments/parameters does this function take? And why?
    - This function takes 1 input argument / parameter.
    - Reason: in order to determine the grade, the function needs to know the mark.

- How many output values does this function return?
    - This function returns 1 value (which is the grade).

Hello!

```
Enter first name: John
Enter last name: Smith
Hello John Smith!
```

```python
# ask user for name
first_name, last_name = ask_name()

# display greeting
say_hello(first_name, last_name)
```

Hello!

```python
# ask user for name
def ask_name():
    first_name = "Finley"
    last_name = "Fish"
    return first_name, last_name
```

```python
# display greeting
def say_hello(first_name: str, last_name: str):
    print(f"Hello {first_name} {last_name}!")
```

```python
# ask user for name
first_name, last_name = ask_name()

# display greeting
say_hello(first_name, last_name)
```

```
Hello Finley Fish!
```

Hello!

```python
# ask user for name
def ask_name():
    first_name = input("Enter first name: ")
    last_name = input("Enter last name: ")
    return first_name, last_name
```

```python
# display greeting
def say_hello(first_name: str, last_name: str):
    print(f"Hello {first_name} {last_name}!")
```

```python
# ask user for name
first_name, last_name = ask_name()

# display greeting
say_hello(first_name, last_name)
```

```
Enter first name: John
Enter last name: Smith
Hello John Smith!
```

Hello!

```
# ask user for name
def ask_name():
    ...

    return first_name, last_name
```

- How many input arguments/parameters does this function take? And why?
  - This function takes 0 input arguments / parameters.
  - Reason: the function does not need to know anything to perform its task!

- How many output values does this function return?
  - This function returns 2 values (which are the first and last name).

Hello!

```
# ask user for name
def ask_name():
    ...

    return first_name, last_name
```

```
# ask user for name
first_name, last_name = ask_name()

# display greeting
say_hello(first_name, last_name)
```

- Why do we have to write
  `first_name, last_name = ask_name()` ?
    - Reason: the function returns 2 values, so we need to save them into 2 variables `first_name` and `last_name`

Hello!

```
# display greeting
def say_hello(first_name: str, last_name: str):
    print(f"Hello {first_name} {last_name}!")
```

- How many input arguments/parameters does this function take? And why?
  - This function takes 2 input arguments / parameters.
  - Reason: the function needs to know both first name and last name to display the greeting message.

- How many output values does this function return?
  - This function returns 0 values. That is why we do not need to use the **`return`** statement.

Example: Expanding a word

```
Enter a word: Meow
Enter expand factor: 4
Here you go: MMMMeeeeoooowwww
```

```
Enter a word: Cat
Enter expand factor: 2
Here you go: CCaatt
```

```
Enter a word: Dog
Enter expand factor: 1
Here you go: Dog
```

```
Enter a word: Frog
Enter expand factor: 0
Here you go:
```

Example: Expanding a word

```
Enter a word: Cat
Enter expand factor: 2
Here you go: CCaatt
```

```
Initially set expand_word = ""

original letter   expand
     C              CC     expand_word = "CC"
     a              aa     expand_word = "CCaa"
     t              tt     expand_word = "CCaatt"
```

Example: Expanding a word

```
Enter a word: Cat
Enter expand factor: 2
Here you go: CCaatt
```

```
# ask user for input
word, multiplicity = ask_input()

# expand the word
new_word = expand(word, multiplicity)

# display the result
print("Here you go: " + new_word)
```

Example: Expanding a word

```
# ask user for input
def ask_input():
    word = "text given by user"
    multiplicity = 5
    return word, multiplicity
```

```
# expand the word
def expand(word: str, multiplicity: int)-> str:
    result = "expanded word"
    return result
```

```
# ask user for input
word, multiplicity = ask_input()

# expand the word
new_word = expand(word, multiplicity)

# display the result
print("Here you go: " + new_word)
```

Example: Expanding a word

```python
# ask user for input
def ask_input():
    word = "text given by user"
    multiplicity = 5
    return word, multiplicity
```

$\downarrow$ rewrite

```python
def ask_input():
    # ask a word
    word = input("Enter a word: ")

    # ask expand factor
    user_input = input("Enter expand factor: ")
    multiplicity = int(user_input)

    return word, multiplicity
```

Example: Expanding a word

```
# expand the word
def expand(word: str, multiplicity: str) -> str:
    result = "expanded word"
    return result
```

rewrite

```
def expand(word: str, multiplicity: str) -> str:
    # initialize result as empty string
    result = ""
    for i in range(0, len(word)):
        # get the ith letter from the word
        letter = word[i]
        # multiply the letter
        letter_multiply = letter * multiplicity
        # adding the expanded letter to the result
        result = result + letter_multiply

    return result
```

Part 2

Default arguments

Function arguments can have default values. If the function is called without an argument, the argument gets its default value.

```python
# display a welcome message
def welcome(name, greeting="Hi"):
    print(f"{greeting} {name}!")
```

```python
welcome("John", "Hello")
   → Hello John!

welcome("Mary", greeting="It is nice to meet you")
   → It is nice to meet you Mary!

# this one using default value:
welcome("Paul")
   → Hi Paul!
```

Positional vs optional arguments

When an argument has a default value, it becomes an **optional argument**

Arguments without default values are called **positional arguments** and is required when the function is called.

Named arguments

```python
# display a welcome message
def welcome(name, greeting="Hi"):
    print(f"{greeting} {name}!")
```

Positional arguments have to be given in order. If you want to jumble the sequence or specify some optional arguments, you have to feed in the arguments as **named arguments.**

```
>>> welcome(greeting="It is nice to meet you", name="Mary")
Output → It is nice to meet you Mary!
```

Recursion

A recursive function is a function that **calls itself.**

```
def recursive_fcn(n):
    recursive_fcn(n+n)
    return
```

A recursive function usually has two steps:

- Base step: deals with **small cases**
- Recursion step: how a general case can be **derived from smaller cases**

Example: Factorial function

```
1! = 1
2! = 2
3! = 6
4! = 24
5! = 120
6! = 720
7! = 5040
8! = 40320
9! = 362880
```

Example: Factorial function

1! = 1 $\longrightarrow$ one factorial

2! = 1 x 2 = 2 $\longrightarrow$ two factorial

3! = 1 x 2 x 3 = 6

4! = 1 x 2 x 3 x 4 = 24 $\longrightarrow$ four factorial

If we know 4! = 24,
how can we calculate 5! ?

5! = 4! x 5 = 24 x 5 = 120

Example: Factorial function

$1! = 1 \longrightarrow$ one factorial

$2! = 1 \times 2 = 2 \longrightarrow$ two factorial

$3! = 1 \times 2 \times 3 = 6$

$4! = 1 \times 2 \times 3 \times 4 = 24 \longrightarrow$ four factorial

In general, if we know factorial(n-1),
we can calculate factorial(n) as:

factorial(n) = n x factorial(n-1)

Example: Factorial function

```
# recursive factorial function
def factorial(n):
    if (n==1):
        return 1
    else:
        return n * factorial(n-1)
```

base step

Example: Factorial function

```
# recursive factorial function
def factorial(n):
    if (n==1):
        return 1
    else:
        return n * factorial(n-1)
```

recursive step

E.g. factorial(4)

```
n = 4, compute factorial(4-1)
     |    n = 3, compute factorial(3-1)
     |         |   n = 2, compute factorial(2-1)
     |         |        |    n = 1, return 1
     |         |        + return 2  # 2 = 2 * 1
     |         + return 6  # 6 = 3 * 2
     + return 24 # 4 * 6
```

Example: Factorial function

```python
# recursive factorial function
def factorial(n):
    if (n==1):
        return 1
    else:
        return n * factorial(n-1)

for i in range(1,10):
    print(f"{i}! = {factorial(i)}")
```

```
1! = 1
2! = 2
3! = 6
4! = 24
5! = 120
6! = 720
7! = 5040
8! = 40320
9! = 362880
```

Some useful built-in functions

Useful functions: `round`

```python
number = 28.30188679245283

rounded_number = round(number)
rounded_number = round(number, 1)
rounded_number = round(number, 2)
rounded_number = round(number, 3)
rounded_number = round(number, 4)
rounded_number = round(number, 5)
rounded_number = round(number, 6)
```

```
28
28.3
28.30
28.302
28.3019
28.30189
28.301887
```

Useful functions: `min` and `max`

```
num1 = 1.5
num2 = 5
num3 = 3

min_num = min(num1, num2, num3)        ──────→ 1.5

max_num = max(num1, num2, num3)        ──────→ 5

print(f"min of {num1}, {num2}, {num3} is {min_num}")

print(f"max of {num1}, {num2}, {num3} is {max_num}")
```

Importing modules

The `random.randint` function

import a python module called `random`

```
import random

for i in range(0, 10):
    random_number = random.randint(1, 6)
    print(f"Dice result: {random_number}")
```

generate a random integer between 1 and 6

```
Dice result: 3
Dice result: 2
Dice result: 4
Dice result: 1
Dice result: 3
Dice result: 1
Dice result: 3
Dice result: 1
Dice result: 6
Dice result: 5
```

`random.randint(lower_bound, upper_bound)`

generates a random integer between **`lower_bound`** and **`upper_bound`**

Any questions?