

# Control flow

Inteligencia Artificial en los Sistemas de Control Autónomo  
Máster en Ciencia y Tecnología desde el Espacio

Departamento de Automática

## Objectives

1. Understand control flow in Python
2. Understand functions and its syntax in Python
3. Design elemental algorithms
4. Implement elemental algorithms in Python

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## 1. Conditions and loops

- if Statements
- for Statements
- Branching statements
- pass Statements

## 2. Functions

- Defining functions
- Global and local variables
- Default argument values
- Keyword arguments

## 3. Coding conventions

- Documentation strings
- Coding style

## 4. Examples

- Example 1
- Example 2

# Conditions and loops

## if Statements (I)

Conditional statements implement decision making

- It is based on a condition
- The result is boolean
- Remember: Indentation defines the body code

```
temperature = float(input('What is the
    temperature? '))
if temperature > 70:
    print('Wear shorts. ')
else:
    print('Wear long pants. ')
print('Get some exercise outside.')
```

Good practice: The usage of `else` is optional, try to avoid it!

# Conditions and loops

## if Statements (II)

Many times decisions are not binary (true/false): `elif`

- Conditions are evaluated until first true
- If all conditions are false, then it executes `else`
- `else` is optional (try not to use it!)

### elif Statement

```
if [condition1]:
    # Some code here
elif [condition2]:
    # Some other code
elif [condition3]:
    # Some other code
else:
    # More code
```

# Conditions and loops

## if Statements (III)

### Complex if Statement

```
x = int(input("Please enter an integer: "))

if x < 0:
    x = 0
    print('Negative changes to zero')
elif x == 0:
    print('Zero')
elif x == 1:
    print('Single')
else:
    print('More')

print(x)
```

# Conditions and loops

## for Statements (I)

- Sometimes we have to repeat a task: Loops
  - Other languages iterate over a condition
  - For instance, in C: `for (i=0; i<10; i++)`
- Two loop statements in python: `while` and `for`
- In Python, `for` iterates over a sequence (lists or strings)
  - In each iteration, it assigns a sequence value to a variable

### for Statement example

```
list = [ 'cat ', 'window ', 'dog ' ]

for x in list:
    print(x)
```

### for Statement example

```
string = "Hello word"

for x in string:
    print(x)
```

# Conditions and loops

## for Statements (II)

Sometimes, we need to iterate over a sequence of numbers

- `range(n)`: It returns a sequence  $0, \dots, n - 1$

### `range()` example

```
for i in range(5):  
    print(i)
```

### Alternative notation

```
a = [ 'Mary ', 'had ', 'a ' ]  
  
for i in range(len(a)):  
    print(i, a[i])
```



# Conditions and loops

## Branching statements (I)

We do not always want to iterate over the loop

- `break`: Exit the loop
- `continue`: Jump to next iteration
- `break` and `continue` are valids in loops

### break use

```
for i in foo:
    # Some code
    if i == 3:
        break
    # More code
```

### continue use

```
for i in foo:
    # Some code
    if i == 3:
        continue
    # More code
```

# Conditions and loops

## Branching statements (II)

### Break example

```

number = int(input('Enter a number: '))

if number > 1:
    is_prime = True
    for divider in range(2, number):
        if number % divider == 0:
            is_prime = False
            break
    else:
        is_prime = False

if is_prime:
    print('The number {0} is prime.' .format(number))
else:
    print('The number {0} not is prime.' .format(number))

```

# Conditions and loops

## Branching statements (III)

### What this is doing?

```
for i in range(2, 10):  
    for x in range(2, i):  
        if i % x == 0:  
            print(i, 'equals ', x, '*', i//x)  
            break  
        else:  
            print(i, ' is prime number')
```

# Conditions and loops

## pass statements

`pass`: A statement that does nothing ...

- ... yes, nothing
- It is used to avoid compilation errors
- Code bodies that do nothing

### Example 1

```
# Infinite loop
# waiting an
# interrupt

while True:
    pass
```

### Example 2

```
# Empty class

class MyEmptyClass:
    pass
```

### Example 3

```
def initlog(*args):
    # Ignore function
    pass
```

# Functions

## Defining functions (I)

**Function:** A piece of code that can be used several times

- Lazy programmers are good programmers
- Code reuse

Functions can be used with parameters

- Define a function before using it

### Function 1

```
def printHello():
    print("Hello")

printHello()
```

### Function 2

```
def printTwice(string):
    print(string)
    print(string)

printTwice(string)
```

Hint: If you have to use code more than once, place it in a function

# Functions

## Defining functions (II)

A function may be as complex as needed

### Fibonacci series function

```
#!/usr/bin/python

a, b = 0, 1 # Init variables

while b < 10: # This is a loop
    print("b = ", b)
    print("a = ", a) # Indentation is very important
                      here!
    a, b = b, a+b
```

How it works? Example: Calculation of  $\text{fib}(4)$

New Python elements:

- docstrings, for automatic documentation
- Keywords arguments

# Functions

## Defining functions (III)

Boring (albeit useful) fact: A function is just another variable

```
>>> fib
<function fib at 0x1006771e0>
>>> f = fib
>>> f(100)
0 1 1 2 3 5 8 13 21 34 55 89
>>> f
<function fib at 0x1006771e0>
```

# Functions

## Defining functions (IV)

Python functions can return values

### Return Fibonacci series

```
def fib2(n):
    """ Print a Fibonacci series up to n """
    result = [] # Declare a new list
    a, b = 0, 1
    while a < n:
        result.append(a) # Add to the list
        a, b = b, a+b
    return result
```

New Python features

- The return statement
- Adding elements to a list



# Functions

## Defining functions (V)

Example:

### Conversion of degrees

```
def fahrenheit_centigrados(x):
    """ Conversion de grados Farenheit a Centigrados """
    return (x - 32) * (5 / 9.0)

def centigrados_fahrenheit(x):
    """ Conversion de grados Centigrados a Farenheit """
    return (x * 1.8) + 32
```

# Functions

## Global and local variables (I)

Variable scope:

- **Global variables:** Defined outside of the functions.
  - Can be read within and outside the functions.
- **Local variables:** Defined within of a function, including formal parameters.
  - Invisibles outside the function.

### Example

```
a = 5

def f():
    a = 2
    print(a) # 2
    return

f()
print(a) # 5
```

# Functions

## Global and local variables (II)

It is possible to modify the global object within a function?

### Example 1

```
a = 5

def f():
    a = 2
    print(a) # 2
    return

f()
print(a) # 5
```

### Example 2

```
a = 5

def f():
    global a
    a = a - 1
    return

f()
print(a)
```

# Functions

## Global and local variables (III)

### Example 3

```
def increase(p):
    p = p + 1
    return p

a = 1
b = increase(a)

print('a:', a)
print('b:', b)
```

# Functions

## Global and local variables (IV)

To modify a global object in a function, it must be declared using the statement `global`.

### use of `global` statement

```
a = 5

def f():
    global a
    a = 0
    print(a)
    return

f()
print(a)
```

Write-protection:

- The immutable variables (numbers, strings, tuples) → **yes**.
- The mutable variables (lists, dictionaries) → **no**.

# Functions

## Global and local variables (V)

Examples:

### Example 1

```
lista = [ "Juan", "Pepe" ]

def f():
    lista.pop()

print( lista )
f()
print( lista )
```

### Ejemplo 2

```
lista = [ "Juan", "Pepe" ]

def f():
    lista = [ "Maria" ]

print( lista )
f()
print( lista )
```

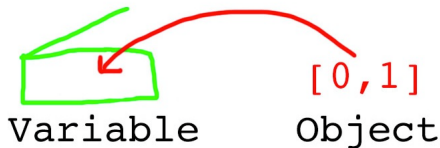
What will happen if the list `lista` is declared as global?

# Functions

## Global and local variables (VI)

### Parameter passing in Python

- Python is **pass-by-object-reference**.
  - A variable and an object are different things.
  - A function receives a reference to (and will access) the same object in memory as used by the caller.
  - The function provides its own box and creates a new variable for itself.



Source

# Functions

## Global and local variables (VII)

### Parameter passing in Python

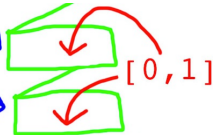
```
def append(list):
```

```
    list.append(1)
```

```
list = [0]
```

```
append(list)
```

```
print list
```



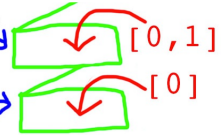
```
def reassign(list):
```

```
    list = [0, 1]
```

```
list = [0]
```

```
reassign(list)
```

```
print list
```



Want to know more? [Click here!](#)

### Pass-by-object-reference

Object references are passed by value



# Functions

## Global and local variables (VIII)

### Summary:

- **Global objects:** Objects defined outside the function.
- **Local objects:** Objects defined within the function.
- **Global objects** can always be read within a function.
- Modification of a global object, `object`, within a function:
  - If `object` is **immutable** → Use `global object` within the function.
  - If `object` is **mutable** →
    - If you want to change by an assignment → Use `global object` within the function.
    - If you want to change **using methods** → It is not necessary to use `global object` within the function.

# Functions

## Default argument values (I)

Python supports default arguments:

- Powerful and simple feature.
- Simpler (and more flexible) function calls.

```
def ask_ok(prompt, retries=4, complaint="Yes or no"):
    while True:
        ok = input(prompt)
        if ok in ('y', 'ye', 'yes'):
            return True
        if ok in ('n', 'no', 'nop', 'nope'):
            return False
        retries = retries - 1
        if retries < 0:
            raise IOError('refusenik user')
    print(complaint)
```

# Functions

## Default argument values (II)

### New Python features

- The `in` keyword
- Exceptions (error handling)

The function can be invoked in several ways:

- `ask_ok('Do you really want to quit')`
- `ask_ok('OK to overwrite the file?', 2)`
- `ask_ok('OK to overwrite the file?', 2, 'Come on, yes or no!')`

# Functions

## Keyword arguments

Function arguments can be named:

- It overrides classic positional arguments.
- Order does not matter.
- Positional arguments must be first.

```
def foo(bar, baz):
    print(bar, baz)

foo(1, 2)
foo(baz = 2, bar = 1)
```

```
def foo(bar = "hello", baz = "bye"):
    print(bar, baz)

foo()
foo("hi")
foo(baz = "hi")
```

Arbitrary number of arguments:

- Arguments as `*arg1` and `**arg2`
- Do not worry about it ... right now.

# Coding conventions

## Documentation strings (I)

Documentation is important:

- Q: Will you remember why did you wrote that crazy code line?
- A: No, so you must document your code.
- A: Yes, no programmer likes documentating his code.

Python provides automatic documentation features:

- It can be accessed with `foo.__doc__` (version 3.X)

```
>>> print(print.__doc__)
print(value, ..., sep=' ', end='\n', file=sys.stdout, flush=False)
```

Prints the values to a stream, or to `sys.stdout` by default.

Optional keyword arguments:

**file:** a file-like object (stream); defaults to the current `sys.stdout`.

**sep:** string inserted between values, default a space.

**end:** string appended after the last value, default a newline.

**flush:** whether to forcibly flush the stream.

# Coding conventions

## Documentation strings (II)

Documentation conventions:

- The first line should be a summary.
- The second line should be blank.
- One or more lines with detailed description (arguments, side effects, etc).
- Respect indentation.

```
def my_function():
    """Do nothing, but document it.

    No, really, it doesn't do anything
    """
    pass

print(my_function.__doc__)
```

# Coding conventions

## Coding style (I)

Make your code easy to read using good coding style.

Python coding style convention:

- 4-space indentation, with no tabs.
- Maximum 79 characters per code line.
- Separate functions and classes with white lines.
- Separate large code blocks with white lines.
- Use docstrings.
- Operators spacing: `a = f(1, 2) + g(3, 4).`
- Proper use of capitals:
  - Classes: `CamelCase`
  - Methods and functions: `lower_case_with_underscores()`

Want to know more? [Click here!](#)

# Examples

## Example 1: Matrices addition

```
X = [[12, 7, 3],  
     [4, 5, 6],  
     [7, 8, 9]]  
  
Y = [[5, 8, 1],  
     [6, 7, 3],  
     [4, 5, 9]]  
  
result = [[0, 0, 0],  
          [0, 0, 0],  
          [0, 0, 0]]  
  
# iterate through rows  
for i in range(len(X)):  
    # iterate through columns  
    for j in range(len(X[0])):  
        result[i][j] = X[i][j] + Y[i][j]  
  
for r in result:  
    print(r)
```



# Examples

## Example 2: Calculator

```
def add(x, y):  
    """This function adds two numbers"""  
    return x + y  
  
def subtract(x, y):  
    """This function subtracts two numbers"""  
    return x - y  
  
def multiply(x, y):  
    """This function multiplies two numbers"""  
    return x * y  
  
# take input from the user  
print("Select operation.")  
print("1. Add")  
print("2. Subtract")  
print("3. Multiply")  
  
choice = input("Enter choice (1/2/3):")  
num1 = int(input("Enter first number: "))  
num2 = int(input("Enter second number: "))  
  
if choice == '1':  
    print(num1, "+", num2, "=", add(num1, num2))  
elif choice == '2':  
    print(num1, "-", num2, "=", subtract(num1, num2))  
elif choice == '3':  
    print(num1, "*", num2, "=", multiply(num1, num2))  
else:  
    print("Invalid input")
```

# Bibliographic references I



[van Rosum, 2012] G. van Rossum, Jr. Fred L. Drake.  
Python Tutorial Release 3.2.3, chapter 4.  
Python Software Foundation, 2012.



[Bahit, 2008] E. Bahit.  
Curso: Python para principiantes.  
Creative Commons Atribución-NoComercial 3.0, 2012.



[Swaroop, 2008] C H. Swaroop.  
A Byte of Python.  
Creative Commons Attribution-ShareAlike 3.0, 2008.



[Pilgrim, 2004] M. Pilgrim.  
Dive into Python.  
Ed. Prentice Hall, 2004.