[FIM] FONDAMENTI DI INFORMATICA
per medicina e chirurgia high tech

L02: Control FLow

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Algorithm

- An algorithm is a sequence of instructions that allows to solve a specific task

- An algorithm can be written in different ways:
  - Natural language
  - Flowchart
  - Pseudocode

- Let's look at these three alternatives through the following example: an algorithm that returns the maximum number in a sequence of integers and its position in the sequence

Natural Language

- Given in input a sequence of integer S
- Scan the sequence one element at a time
- Each time keep track of the greatest element encountered so far and its index
- After scanning the whole sequence the current greatest element is the greatest in the sequence
- Return the greatest value and its index

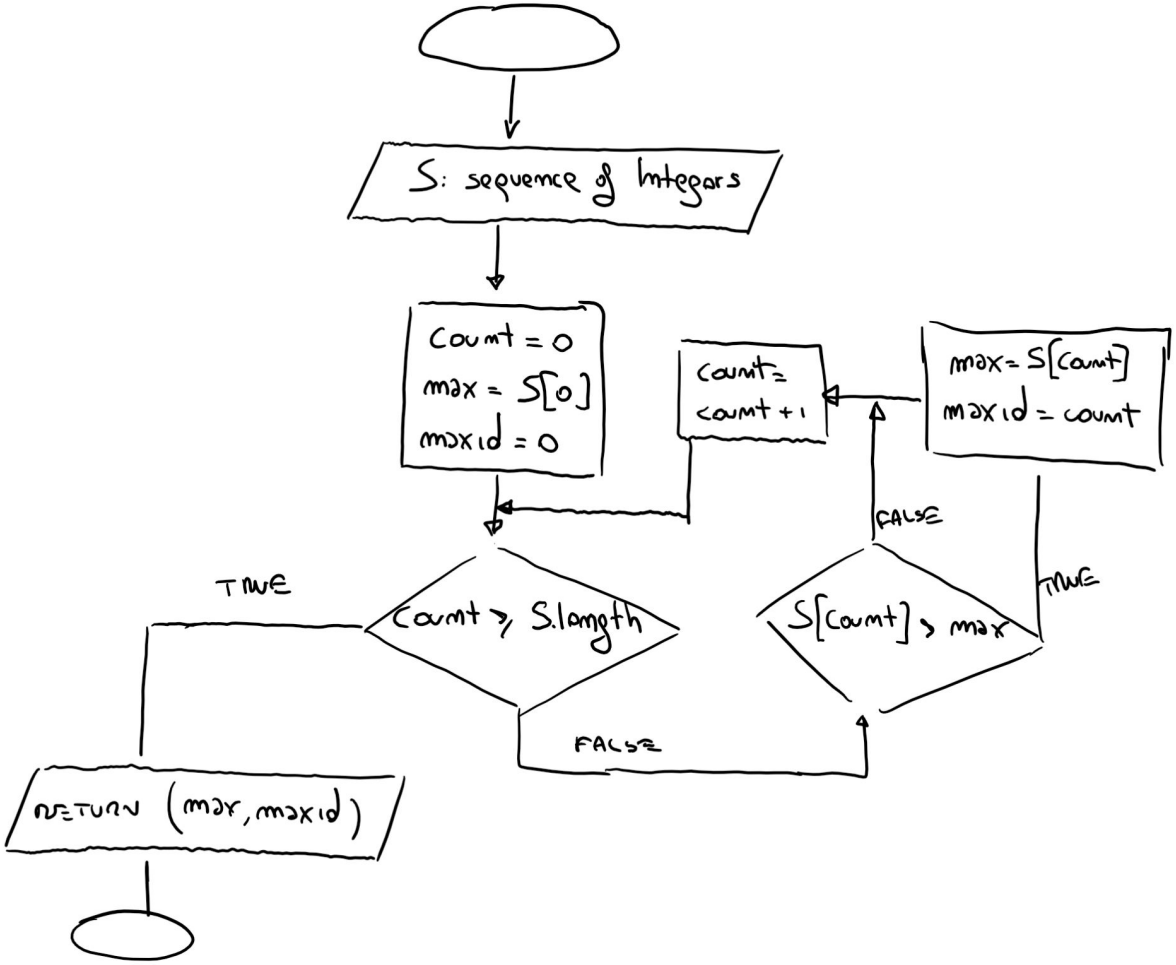
Flowchart

- A flowchart is a graphical representation of an algorithm. It uses the following symbols to describe the process/data flow

Symbol	Symbol Name	Purpose
	Start/Stop	Used at the beginning and end of the algorithm to show start and end of the program.
	Process	Indicates processes like mathematical operations.
	Input/ Output	Used for denoting program inputs and outputs.
	Decision	Stands for decision statements in a program, where answer is usually Yes or No.
	Arrow	Shows relationships between different shapes.

Image credit: https://www.tutorialspoint.com/programming_methodologies/programming_methodologies_flowchart_elements.htm

Flowchart - Example



Program

- A program is a set of instructions written according to the syntax of the programming language

- The syntax specifies which are the valid statements

- For example in Python the rules for variable names are:
  - A variable name must start with a letter or the underscore character
  - A variable name cannot start with a number
  - A variable name can only contain alpha-numeric characters and underscores (A-z, 0-9, and _)
  - Variable names are case-sensitive (age, Age and AGE are three different variables)

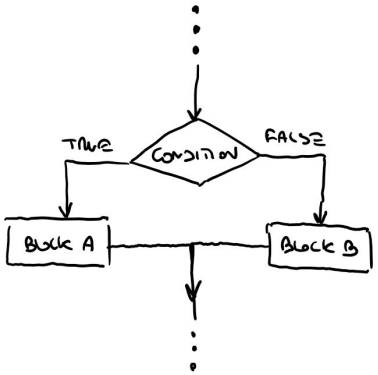
- Open and closed parenthesis should match

- Etc

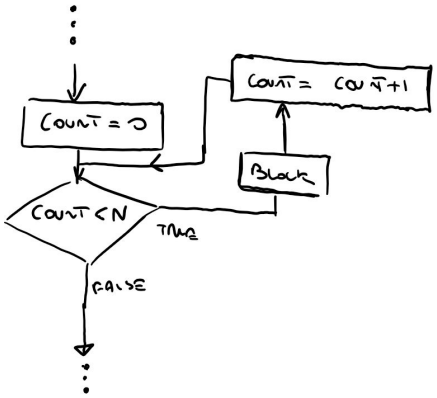
Control Flow

- In programming languages there are some statements that allow to change the flow of the execution according to the value of a conditional expression
- The if statement forks the execution according to the value of a conditional expression
- The for loop repeats a block of code for a fixed number of times
- The while loop repeats a block of code until a condition is verified

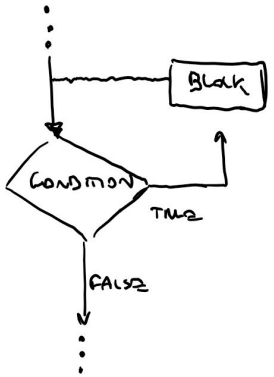
If statement



For loop



While loop



Pseudocode

- An algorithm written in pseudocode uses the control flow statements common in every programming language
- Augmented with natural language or mathematical notation
- Easier to understand than programming language code

```
Input: S → Sequence of integers

max ← S[0]
max_id ← 0

for each element of S, e ← S[i]:
        if e > max
                then max ← S[i], max_id ← i

return max, max_id
```

if statement

```
>>> x = int(input("Please enter an integer: "))
Please enter an integer: 42
>>> if x < 0:
...     x = 0
...     print('Negative changed to zero')
... elif x == 0:
...     print('Zero')
... elif x == 1:
...     print('Single')
... else:
...     print('More')
...
More
```

In Python, a block of code is denoted with indentation (tab). The block is executed only if the condition “x<0” is evaluated to True

Shorthand for “else if”. The instruction print(“zero”) is executed only if the condition x<0 is false and the condition x==0 is true. The instruction print(“single”) is executed only if the conditions x<0 and x==0 are both false and the condition x==1 is true.

The else statement is referred to the last if. The block is executed only if the other conditions are all false

while Statement

- The while loop has the following syntax:

  while condition:

  block

- The code block is executed until the condition is evaluated to true

- be sure that eventually the condition will become true, otherwise the loop never terminates

```
>>> n = 10
>>> n_fact = 1
>>> while n>0:
...     n_fact *= n
...     n -=1
...
>>> n_fact
3628800
```

for Statement

- The for loop has the following syntax:

  for elem in iterable:
  code block

- an iterable is a container object that can return its elements one at a time
- elem is a variable to which the elements of the iterable are assigned one at a time
- the block after the for cycle is executed for each element of the iterable, and the current element is stored in elem

```
>>> # Measure some strings:
... words = ['cat', 'window', 'defenestrate']
>>> for w in words:
...     print(w, len(w))
...
cat 3
window 6
defenestrate 12
```

```
>>> for i in range(5):
...     print(i)
...
0
1
2
3
4
```

```
>>> a = ['Mary', 'had', 'a', 'little', 'lamb']
>>> for i in range(len(a)):
...     print(i, a[i])
...
0 Mary
1 had
2 a
3 little
4 lamb
```

First Python Program

- Now we have all the ingredients to write a python program to find the smallest element in a list and its index

```
>>> l = [7,9,1,5,3,2]
>>> min = l[0]
>>> min_id = 0
>>> for i in range(len(l)):
...     if l[i] < min:
...             min = l[i]
...             min_id = i
...
>>> min
1
>>> min_id
2
>>>
```

Exercises

- Write function that reverses a list, preferably in place
- Write a function that checks whether an element occurs in a list
- Write a function that combines two lists by alternatingly taking elements, e.g. [a,b,c], [1,2,3] → [a,1,b,2,c,3]
- Write a function that merges two sorted lists into a new sorted list. [1,4,6],[2,3,5] → [1,2,3,4,5,6]. You can do this quicker than concatenating them followed by a sort
- Write a function that rotates a list by k elements. For example [1,2,3,4,5,6] rotated by two becomes [3,4,5,6,1,2]. Try solving this without creating a copy of the list. How many swap or move operations do you need?
- Write a function that takes a number and returns a list of its digits. So for 2342 it should return [2,3,4,2]
- Write a function that takes a list of numbers, a starting base b1 and a target base b2 and interprets the list as a number in base b1 and converts it into a number in base b2 (in the form of a list-of-digits). So for example [2,1,0] in base 3 gets converted to base 10 as [2,1]

https://adriann.github.io/programming_problems.html