

# Module 2: Algorithm and Data Structures Lab

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v0.17

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## News

### 26/01/2017

- published solutions of [26/01/17 exam \(past-exams.html#2016-01-26\)](#)
- v0.17

### 23/01/2017

- Fixed many bugs in [graph \(graphs.html\)](#) reports of differences during testing
- v0.16

### 13/01/2017

- published solutions of [13/01/17 Midterm \(past-exams.html#2017-01-13-midterm\)](#)
- v0.15

### 10/01/2017

- Added a lot of material [on graphs \(graphs.html\)](#)
- v0.14

### 9/01/2017

- fixed broken link in Chapters to [Data Structures 2.2 for stacks and linked lists \(data-structures-2.html\)](#)
- 0.13.1

### 8/01/2017

- added looong intro to classes in [Data Structures 2.1: ComplexNumber \(data-structures-1.html\)](#)
- split Chapter 2: Data Structures into 2 parts, [2.1 for ComplexNumber \(data-structures-1.html\)](#) and [2.2 for stacks and linked lists. \(data-structures-2.html\)](#)
- v0.13

### 22/12/2016

- added graph exercises

# Exams

See exams schedule on [Alberto Montresor's site \(http://cricca.disi.unitn.it/montresor/teaching/scientific-programming/exams/\)](http://cricca.disi.unitn.it/montresor/teaching/scientific-programming/exams/)

## Exam modalities

Algolab exams are open book. You can bring a printed version of the material listed below.

Exam will take place in the lab with no internet access. You will only be able to access a folder with this documentation:

- [Sciprog Algolab website \(http://davidleoni.github.io/algolab\)](http://davidleoni.github.io/algolab)
- [Alberto Montresor slides \(http://cricca.disi.unitn.it/montresor/teaching/scientific-programming/\)](http://cricca.disi.unitn.it/montresor/teaching/scientific-programming/)
- [Stefano Teso slides \(http://disi.unitn.it/~teso/courses/sciprog/index.html\)](http://disi.unitn.it/~teso/courses/sciprog/index.html)
- [Python 2.7 documentation \(https://docs.python.org/2/\)](https://docs.python.org/2/)
  - In particular, [Unittest docs \(https://docs.python.org/2/library/unittest.html\)](https://docs.python.org/2/library/unittest.html)
- [The course book 'Problem Solving with Algorithms and Data Structures using Python' \(http://interactivepython.org/runestone/static/pythonds/index.html\)](http://interactivepython.org/runestone/static/pythonds/index.html)

So if you need to look up some Python function, please start today learning how to search documentation using the search functionality on Python website.

## Past exams

See page [here](#). ([past-exams.html](#))

([past-exams.html](#))

([past-exams.html](#))

([past-exams.html](#))

([past-exams.html](#))

([past-exams.html](#))

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([past-exams.html](#))

## Course website ([past-exams.html](#))

### Theory

See Alberto Montresor website:

<http://cricca.disi.unitn.it/montresor/teaching/scientific-programming>  
(<http://cricca.disi.unitn.it/montresor/teaching/scientific-programming>)

### Lab

[davidleoni.github.io/algolab](http://davidleoni.github.io/algolab) (<https://davidleoni.github.io/algolab>)

# Chapters

Worksheets are meant to be used online - pdf quality is not very good, if they result unreadable please tell me

0. [Testing \(testing.html\)](#) ([pdf \(pdf/testing.pdf\)](#))

1. [Lists \(lists.html\)](#) ([pdf \(pdf/lists.pdf\)](#))

2 Data Structures

2.1 [ComplexNumber \(data-structures-1.html\)](#) ([pdf \(pdf/data-structures-1.pdf\)](#))

2.2 [Stacks and linked lists \(data-structures-2.html\)](#) ([pdf \(pdf/data-structures-2.pdf\)](#))

3. [Trees \(trees.html\)](#) ([pdf \(pdf/trees.pdf\)](#))

4. [Graphs \(graphs.html\)](#) ([pdf \(pdf/graphs.pdf\)](#))

A. [Past exams \(past-exams.html\)](#)

## Commandments

**WARNING: If you don't follow the Commandments, bad things happen!**

### 1) You shall test!

To run tests, enter the following command in the terminal:

```
python -m unittest my-file
```

**WARNING: In the call above, DON'T append the extension *.py* to *my-file***

**WARNING: Still, on the hard-disk the file MUST be named with a *.py* at the end, like *my-file.py***

### 2. You shall also write on paper!

If staring at the monitor doesn't work, help yourself and draw a representation of the state of the program. Tables, nodes, arrows, all can help figuring out a solution for the problem.

### 3. You shall copy *\*exactly the same\** function definitions as in the exercises!

For example don't write :

```
def MY_selection_sort(A):
```

### 4. You shall never ever reassign function parameters:

```
def myfun(i, s, L, D):

    # You shall not do any of such evil, no matter what the type of the parameter is
    :
    i = 666          # basic types (int, float, ...)
    s = "666"        # strings
    L = [666]        # containers
    D = {"evil":666}  # dictionaries

    # For the sole case of composite parameters like lists or dictionaries,
    # you can write stuff like this IF AND ONLY IF the function specification
    # requires you to modify the parameter internal elements (i.e. sorting a list
    # or changing a dictionary field):

    L[4] = 2         # list
    D.my_field = 5    # dictionary
```

This also applies to class methods. Never ever write horrors such as:

```
class MyClass
    def my_method(self, x, y):
        self = {a:666} # since self is a kind of dictionary, you might be tempted to do
        like this
                                # but to the outside world this will bring no effect.
                                # For example, let's say somebody from outside makes a call like
        this:
                                #     mc = MyClass()
                                #     mc.my_method()
                                # after the call mc will not point to {a:666}
        self = ['666'] # self is only supposed to be a sort of dictionary and passed fr
        om outside
        self = 6       # self is only supposed to be a sort of dictionary and passed fr
        om outside
```

## 5. You shall never ever assign values to method calls:

### WRONG WRONG STUFF

```
my_fun() = 666
my_fun() = '666'
my_fun() = [666]
```

### CORRECT STUFF

With the assignment operator we want to store in the left side a value from the right side, so all of these are valid operations:

```
x = 5
y = my_fun()
z = []
z[0] = 7
d = {}
d["a"] = 6
```

Function calls such as `my_fun()` return instead results of calculations in a box that is created just for the purpose of the call and Python will just not allow us to reuse it as a variable. So whenever you see 'name()' at the left side, it *can't* be possibly followed by one equality = sign (but it can be followed by two equality signs == if you are performing a comparison).

## 6. You shall use *return* command only if you see written *return* in the pseudocode!

If there is no return in the pseudocode, the function is intended to return None. In this case you don't even need to write `return None`, as Python will do it implicitly for you.

# Slides

## Lab 1 Slides

3 Nov 2016

### Lab Goals

- Going from theory taught by Prof. Alberto Montresor to implementation
- Pseudo code --> Python

### How

- Hands-on approach
- Performance considerations
- Focus on correct code
- Few Python functions

### Lab Midterm?

Probably not. Still, will provide exam example.

## Lab 2 Slides

Date: Nov 11th, 2016

- More practical than last time!
- Finish `selection_sort` and gap implementation
- midlab pause ;-)
- implement a Python class

## Lab 3 Slides

Nov 17th, 2016

- Recursion
  - `gap_rec`, `binary_search_rec`
- `binary_search_iter`
- Will give you more tests
- Write also on paper!
- Copy *exactly the same* function definitions!
  - For example don't write `def MY_selection_sort(A):`
- use `return` command *only* if you see written `return` in the pseudocode!
  - If there is no `return` in the pseudocode, the function is intended to return `None`. In this case you don't even need to write `return None`, as Python will do it implicitly for you.

## Lab 4 Slides

Nov 18th, 2016

- Divide et Impera
  - `binary_search_iter`
- Implement `ComplexNumber` ( see [Chapter 2.1 \(data-structures-1.html\)](#) )

New Commandment:

You shall never ever reassign function parameters:

```
def myfun(L, i, s):  
  
    # You shall not do any of this evil:  
    L = [666]  
    i = 666  
    s = "666"
```

Previous commandments:

- You shall also write on paper!
- You shall copy exactly the same function definitions as in the exercises!
- For example don't write `def MY_selection_sort(A):`
- You shall use `return` command only if you see `Written return` in the pseudocode!
- If there is no `return` in the pseudocode, the function is intended to return `None`. In this case you don't even need to write `return None`, as Python will do it implicitly for you.

## Lab 5 slides

24 Nov 2016

- Implement `ComplexNumber` ( see [Chapter 2.1 \(data-structures-1.html\)](#) )
- Implement `Stack`

## Lab 6 slides

1 Dic 2016

- Implement `CappedStack` ( see [Chapter 2.2 \(data-structures-2.html\)](#) )
- Implement `UnorderedList`

## Lab 7 slides

- `UnorderedList`

## Lab 8 slides

- will start writing tests (will be required during exams)
- invariants in particular
- `UnorderedList` ( see [Chapter 2.2 \(data-structures-2.html\)](#) ) until `fast size()` and `append()` included

## Lab 9 slides

15 Dic 2016

- Implement `GenericTree`, see [Trees chapter \(trees.html\)](#)

## Lab 10 slides

19 Dic 2016

- GenericTree see [Graphs chapter \(graphs.html\)](#)

## Lab 11 slides

21 Dic 2016

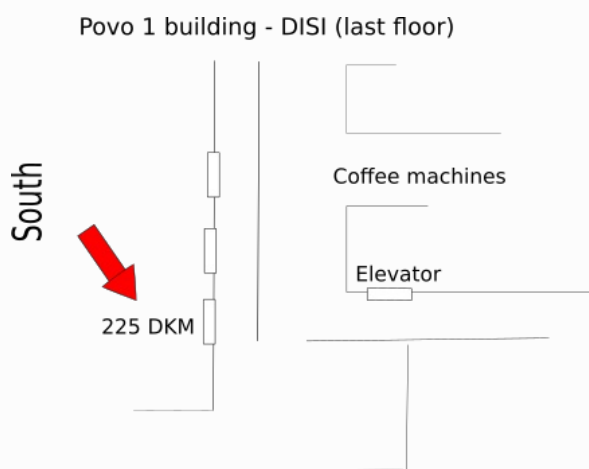
[Exam simulation \(exam-sim-2016-12-21.html\)](#) !

For exam solution, see Appendix A in [Chapters](#)

## Office hours

You can schedule a meeting by emailing me at david.leoni [AT] unitn.it , more or less I'm available every day until 19.00

Then you will find me in Povo 1 building at DISI, in room 226 DKM :



## Resources

- Online book: [Problem Solving with Algorithms and Data Structures using Python](#) (<http://interactivepython.org/runestone/static/pythonds/index.html>) by Brad Miller and David Ranum
- Theory slides (<http://cricca.disi.unitn.it/montresor/teaching/scientific-programming/slides/>) by Alberto Montresor
- Will try to be consistent with [other lab module notes](#) (<http://disi.unitn.it/~teso/courses/sciprogram/index.html>) of Stefano Teso and Toma Tebaldi
- [PythonTutor](http://www.pythontutor.com/visualize.html#mode=edit) (<http://www.pythontutor.com/visualize.html#mode=edit>), a visual virtual machine (*very useful!* can also be found in examples inside the book!)
- Source code (<https://github.com/DavidLeoni/algolab>) of these worksheets ([download zip](#) (<https://github.com/DavidLeoni/algolab/archive/master.zip>)), in Jupyter Notebook (<http://jupyter.org>) format.
- The internet ....

## Editors

- [Spyder](https://pythonhosted.org/spyder/) (<https://pythonhosted.org/spyder/>): Seems like a fine and simple editor
- [Jupyter Notebook](http://jupyter.org) (<http://jupyter.org>): Nice environment to execute Python commands and display results like graphs. Allows to include documentation in Markdown format