

# Algolab Exam

## Scientific Programming Module 2 Algorithms and Data Structures

Thursday 8th, June 2017

## Introduction

- Taking part to this exam erases any vote you had before, both lab and theory
- If you don't ship or you don't pass this lab part, you lose also the theory part.
- Log into your computer in *exam mode*, it should start Ubuntu
- To edit the files, you can use any editor of your choice: *Editra* seems easy to use, you can find it under *Applications->Programming->Editra*. Others could be *GEdit* (simpler), or *PyCharm* (more complex).

## Allowed material

There won't be any internet access. You will only be able to access:

- [Sciprog Algolab worksheets \(index.html\)](#)
- [Alberto Montresor slides](#)  
([../montresor/Montresor%20sciprog/cricca.disi.unitn.it/montresor/teaching/scientific-programming/slides/index.html](#))
- [Stefano Teso docs](#) ([../teso/disi.unitn.it/\\_teso/courses/sciprog/index.html](#))
- Python 2.7 documentation : [html](#) ([../python-docs/html/index.html](#)) [pdf](#) ([../python-docs/pdf](#))
  - In particular, [Unittest docs](#) ([../python-docs/html/library/unittest.html](#))
- The course book *Problem Solving with Algorithms and Data Structures using Python* [html](#) ([../pythonds/index.html](#)) [pdf](#) ([../pythonds/ProblemSolvingwithAlgorithmsandDataStructures.pdf](#))

## Grading

- The grade of this lab part will range from 0 to 30. Total grade for the module will be given by the average with the theory part of Alberto Montresor.
- Correct implementations with the required complexity grant you full grade.
- Partial implementations *might* still give you a few points. If you just can't solve an exercise, try to solve it at least for some subcase (i.e. array of fixed size 2) commenting why you did so.
- One bonus point can be earned by writing stylish code. You got style if you:
  - do not infringe the [Commandments](#) ([../algolab/index.html#Commandments](#))
  - write [pythonic code](#) (<http://docs.python-guide.org/en/latest/writing/style>)
  - avoid convoluted code like i.e.

```
if x > 5:
    return True
else:
    return False
```

when you could write just

```
return x > 5
```

!!!!!!! WARNING !!!!!!!

!!!!!!! \*\*ONLY\*\* IMPLEMENTATIONS OF THE PROVIDED FUNCTION SIGNATURES  
WILL BE EVALUATED !!!!!!!

For example, if you are given to implement:

```
def cool_fun(x):  
    raise Exception("TODO implement me")
```

and you ship this code:

```
def cool_fun_non_working_trial(x):  
    # do some absurdity  
  
def cool_fun_a_perfectly_working_trial(x):  
    # a super fast, correct and stylish implementation  
  
def cool_fun(x):  
    raise Exception("TODO implement me")
```

We will assess only the latter one `cool_fun(x)`, and conclude it doesn't work at all :P !!!!!!!

Still, you are allowed to define any extra helper function you might need. If your `cool_fun(x)` implementation calls some other function you defined like `my_helper` here, it is ok:

```
def my_helper(y,z):  
    # do something useful  
  
def cool_fun(x):  
    my_helper(x,5)  
  
# this will get ignored:  
def some_trial(x):  
    # do some absurdity
```

## What to do

In </usr/local/esame> (</usr/local/esame>) you should find a file named `algotlab-17-06-08.zip`. Download it and extract it on your desktop. The content should be like this:

```
algotlab-17-06-08  
| - FIRSTNAME-LASTNAME-ID  
    | - exercise1.py  
    | - exercise2.py  
    | - exercise3.py
```

2) Check this folder also shows under `/var/exam`. TODO

3) Rename `FIRSTNAME-LASTNAME-ID` folder: put your name, lastname and id number, like `john-doe-432432`

From now on, you will be editing the files in that folder. At the end of the exam, that is what will be evaluated.

4) Edit the files following the instructions in this worksheet for each exercise.

**WARNING: *DON'T* modify function signatures! Just provide the implementation.**

**WARNING: *DON'T* change the existing test methods, just add new ones !!! You can add as many as you want.**

**WARNING: *DON'T* create other files. If you still do it, they won't be evaluated.**

**IMPORTANT: Pay close attention to the comments of the functions.**

**IMPORTANT: if you need to print some debugging information, you *are allowed* to put extra print statements in the function bodies.**

**WARNING: even if print statements are allowed, be careful with prints that might break your function, i.e. avoid stuff like this: `print 1/0`**

3) Every exercise should take max 25 mins. If it takes longer, leave it and try another exercise.

**WARNING: MAKE SURE ALL EXERCISE FILES AT LEAST COMPILE !!!  
10 MINS BEFORE THE END OF THE EXAM I WILL ASK YOU TO DO A FINAL CLEAN UP OF THE CODE**

## 1) SortedStack

You are given a class SortedStack that models a simple stack. This stack is similar to the CappedStack you already saw in class, the differences being:

- *it can only contain integers*, trying to put other type of values will raise a ValueError
- *integers must be inserted sorted in the stack*, either ascending or descending
- there is no cap

Example:

Ascending:	Descending
8	3
5	5
3	8

In [5]:

```
from exercisel_solution import *
```

To create a SortedStack sorted in ascending order, just call it passing True:

In [6]:

```
s = SortedStack(True)
print s
```

SortedStack (ascending): elements=[]

In [7]:

```
s.push(5)
print s
```

SortedStack (ascending): elements=[5]

In [8]:

```
s.push(7)
print s
```

SortedStack (ascending): elements=[5, 7]

In [9]:

```
print s.pop()
```

7

In [10]:

```
print s
```

SortedStack (ascending): elements=[5]

In [11]:

```
print s.pop()
```

5

In [12]:

```
print s
```

SortedStack (ascending): elements=[]

For descending order, pass False when you create it:

In [13]:

```
sd = SortedStack(False)
sd.push(7)
sd.push(5)
sd.push(4)
print(sd)
```

SortedStack (descending): elements=[7, 5, 4]

## 1.0) test SortedStack

Now open the file `exercise1.py` and check your environment is working fine, by trying to run the tests only for `SortedStackTest`, which tests already implemented methods like `pop`, `push`, etc ... : these tests should all pass, if they don't, tell your instructor.

**Notice that exercise1 is followed by a dot and test class name: `.SortedStackTest`**

```
python -m unittest exercise1.SortedStackTest
```

## 1.1) transfer

Now implement the transfer function. **NOTE:** function is external to class SortedStack.

```
def transfer(s):  
    """ Takes as input a SortedStack s (either ascending or descending) and  
        returns a new SortedStack with the same elements of s, but in reverse order.  
        At the end of the call s will be empty.
```

Example:

s	result
2	5
3	3
5	2

```
    """
```

```
    raise Exception("TODO IMPLEMENT ME !!")
```

### Testing

Once done, running this will run only the tests in TransferTest class and hopefully they will pass.

**Notice that exercise1 is followed by a dot and test class name .TransferTest :**

```
python -m unittest exercise1.TransferTest
```

## 1.2) merge

Implement following merge function. **NOTE:** function is external to class SortedStack.

```
def merge(s1,s2):  
    """ Takes as input two SortedStacks having both ascending order,  
        and returns a new SortedStack sorted in descending order, which will be the sorted merge  
        of the two input stacks. MUST run in  $O(n1 + n2)$  time, where  $n1$  and  $n2$  are  $s1$  and  $s2$  sizes.
```

If input stacks are not both ascending, raises ValueError.  
At the end of the call the input stacks will be empty.

Example:

s1 (asc)	s2 (asc)	result (desc)
5	7	2
4	3	3
2		4
		5
		7

```
    """
```

```
    raise Exception("TODO IMPLEMENT ME !!")
```

**Testing:** python -m unittest exercise1.MergeTest

## 2) UnorderedList

Start editing file exercise2.py, which contains a simplified versioned of the UnorderedList we saw in the labs.

In [17]:

```
from exercise2_solution import *
```

## 2.1) panino

Implement following panino function. **NOTE:** the function is external to class UnorderedList.

```
def panino(lst):
    """ Returns a new UnorderedList having double the nodes of provided lst
        First nodes will have same elements of lst, following nodes will
        have the same elements but in reversed order.

        For example:

        >>> panino(['a'])
        UnorderedList: a,a

        >>> panino(['a','b'])
        UnorderedList: a,b,b,a

        >>> panino(['a','b','c'])
        UnorderedList: a,b,c,c,b,a

    """
    raise Exception("TODO IMPLEMENT ME !")
```

**Testing:** python -m unittest exercise2.PaninoTest

## 2.2) norep

Implement the method norep:

```
def norep(self):
    """ Removes all the consecutive repetitions from the list.
        Must perform in O(n), where n is the list size.

        For example, after calling norep:

        'a','a','b','c','c','c' will become 'a','b','c'

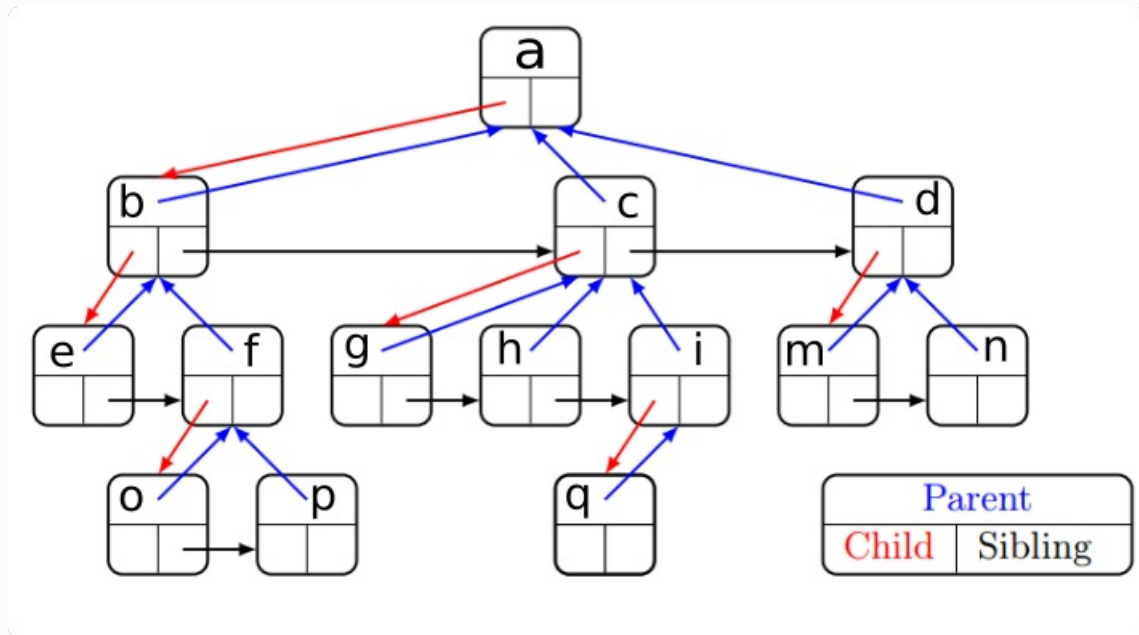
        'a','a','b','a' will become 'a','b','a'

    """
    raise Exception("TODO IMPLEMENT ME !")
```

**Testing:** python -m unittest exercise2.NorepTest

### 3) GenericTree

Start editing file exercise3.py, which contains a simplified versioned of the GenericTree we saw in the labs.



Start editing file exercise3.py

In [20]:

```
from exercise3_solution import *
```

#### 3.1) ancestors

Implement the method ancestors:

```
def ancestors(self):
    """ Return the ancestors up until the root as a Python list.
        First item in the list will be the parent of this node.

        NOTE: this function return the *nodes*, not the data.
    """

    raise Exception("TODO IMPLEMENT ME !")
```

**Testing:** `python -m unittest exercise3.AncestorsTest`

**Examples:**

- ancestors of p: f, b, a
- ancestors of h: c, a
- ancestors of a: empty list

## 3.2) leftmost

Implement the method leftmost:

```
def leftmost(self):
    """
        Return the leftmost node of the root of this node. To find it, from
        current node you need to reach the root of the tree and then from
        the root you need to follow the _child chain until a node with no children is
        found.

        If self is already the root, or the root has no child, raises LookupError.

        NOTE: this function return a *node*, not the data.

    """
    raise Exception("TODO IMPLEMENT ME !")
```

**Testing:** `python -m unittest exercise3.LeftmostTest`

**Examples:**

```
- leftmost of p: e
- leftmost of h: e
- leftmost of e: raise LookupError
```

## 3.3) common\_ancestor

Implement the method common\_ancestor:

```
def common_ancestor(self, gt2):
    """ Return the first common ancestor of current node and the provided gt2 node
        If gt2 is not a node of the same tree, raises LookupError

        NOTE: this function returns a *node*, not the data.

        Ideally, this method should perform in  $O(h)$  where  $h$  is the height of the tree.
        (Hint: you should use a Python Set). If you can't figure out how to make it
        that fast, try to make it at worst  $O(h^2)$ 

    """
    raise Exception("TODO IMPLEMENT ME !")
```

**Testing:** `python -m unittest exercise3.CommonAncestorTest`

**Examples:**

```
- common ancestor of g and i: c
- common_ancestor of g and q: c
- common_ancestor of e and d: a
```