

Exam Simulation Solution

Scientific Programming Algolab

Wednesday 21 Dec 2016

1) Insertion sort solution

In [2]:

```
import unittest

def insertion_sort(A):
    """ Sorts in-place list A with insertion sort. """
    for i in range(1, len(A)):
        temp = A[i]
        j = i
        while j > 0 and A[j-1] > temp:
            A[j] = A[j-1]
            j -= 1
        A[j] = temp

class InsertionSortTest(unittest.TestCase):

    def test_zero_elements(self):
        v = []
        insertion_sort(v)
        self.assertEqual(v, [])

    def test_return_none(self):
        self.assertEqual(None, insertion_sort([2]))

    def test_one_element(self):
        v = ["a"]
        insertion_sort(v)
        self.assertEqual(v, ["a"])

    def test_three_elements(self):
        v = [1, 3, 2]
        insertion_sort(v)
        self.assertEqual(v, [1, 2, 3])

    def test_two_elements(self):
        v = [2, 1]
        insertion_sort(v)
        self.assertEqual(v, [1, 2])

    def test_piccinno_list(self):
        v = [23, 34, 55, 32, 7777, 98, 3, 2, 1]
        insertion_sort(v)
        vcopy = v[:]
        vcopy.sort()
        self.assertEqual(v, vcopy)
```

2) Rev and copy Solution

In [3]:

```
import unittest

class Node:
    """ A Node of an UnorderedList. Holds data provided by the user. """

    def __init__(self, initdata):
        self._data = initdata
        self._next = None

    def get_data(self):
        return self._data

    def get_next(self):
        return self._next

    def set_data(self, newdata):
        self._data = newdata

    def set_next(self, newnext):
        self._next = newnext

class UnorderedList:
    """
        This is a stripped down version of the UnorderedList seen in the lab
    """

    def __init__(self):
        self._head = None

    def to_python(self):
        """ Returns this UnorderedList as a regular Python list. This method
            is very handy for testing. """
        python_list = []
        current = self._head

        while (current != None):
            python_list.append(current.get_data())
            current = current.get_next()
        return python_list

    def __str__(self):
        current = self._head
        strings = []

        while (current != None):
            strings.append(str(current.get_data()))
            current = current.get_next()

        return "UnorderedList: " + ",".join(strings)

    def add(self, item):
        """ Adds item at the beginning of the list """

        new_head = Node(item)
        new_head.set_next(self._head)
        self._head = new_head
```

```
self._head = new_head
```

```
def remove(self, item):
```

```
    """ Removes first occurrence of item from the list
```

```
        If item is not found, raises an Exception.
    """
```

```
    current = self._head
    prev = None
```

```
    while (current != None):
```

```
        if (current.get_data() == item):
```

```
            if prev == None: # we need to remove the head
                self._head = current.get_next()
```

```
            else:
```

```
                prev.set_next(current.get_next())
```

```
                current = current.get_next()
```

```
            return # Found, exits the function
```

```
        else:
```

```
            prev = current
```

```
            current = current.get_next()
```

```
    raise Exception("Tried to remove a non existing item! Item was: " + str(item
```

```
))
```

```
def rev(self):
```

```
    """ Returns a *new* UnorderedList, which is the reversed version of this one
    .
```

```
    Function must run in  $O(n)$ , and try to make this function as fast as possible,
    without using python lists or extra fields.
```

```
    Usage example:
```

```
>>> lst = UnorderedList()
```

```
>>> lst.add('c')
```

```
>>> lst.add('b')
```

```
>>> lst.add('a')
```

```
>>> print lst
```

```
UnorderedList: 'a','b','c'
```

```
>>> print lst.rev()
```

```
UnorderedList: 'c','b','a'
```

```
>>> print lst
```

```
UnorderedList: 'a','b','c'
```

```
    """
```

```
    ret = UnorderedList()
```

```
    current = self._head
```

```
    while current != None:
```

```
        ret.add(current.get_data())
```

```
        current = current.get_next()
```

```
    return ret
```

```
def copy(self):
```

```
    """ Return a *copy* of this UnorderedList in  $O(n)$ 
```

```
    NOTE: since we are making a copy, the output of this function
```

```
    won't contain any Node instance from the original list. Still, new Node
    instances will point to the same data items of the original list
```

```
    Example (for more examples look at the tests):
```

Example (for more examples look at the tests):

```
>>> orig = new UnorderedList()
>>> orig.add('c')
>>> orig.add('a')
>>> print orig
UnorderedList: 'a','c'
>>> cp = orig.copy()
>>> print cp
UnorderedList: 'a','c'
>>> cp.remove('c')
>>> print cp
UnorderedList: 'a'
>>> print orig
UnorderedList: 'a','c'
"""
```

```
# this could be faster and occupy less memory, but it's still O(n) ;-)
return self.rev().rev()
```

```
class UnorderedListTest(unittest.TestCase):
```

```
    """ Test cases for UnorderedList
```

```
    """
```

```
def test_init(self):
```

```
    ul = UnorderedList()
```

```
def test_str(self):
```

```
    ul = UnorderedList()
```

```
    self.assertTrue('UnorderedList' in str(ul))
```

```
    ul.add('z')
```

```
    self.assertTrue('z' in str(ul))
```

```
    ul.add('w')
```

```
    self.assertTrue('z' in str(ul))
```

```
    self.assertTrue('w' in str(ul))
```

```
def test_add(self):
```

```
    """ Remember 'add' adds stuff at the beginning of the list ! """
```

```
    ul = UnorderedList()
```

```
    self.assertEqual(ul.to_python(), [])
```

```
    ul.add('b')
```

```
    self.assertEqual(ul.to_python(), ['b'])
```

```
    ul.add('a')
```

```
    self.assertEqual(ul.to_python(), ['a', 'b'])
```

```
def test_remove_empty_list(self):
```

```
    ul = UnorderedList()
```

```
    with self.assertRaises(Exception):
```

```
        ul.remove('a')
```

```
def test_remove_one_element(self):
```

```
    ul = UnorderedList()
```

```
    ul.add('a')
```

```
    with self.assertRaises(Exception):
```

```
        ul.remove('b')
```

```
    ul.remove('a')
```

```
    self.assertEqual(ul.to_python(), [])
```

```
def test_remove_two_element(self):
```

```
    ul = UnorderedList()
```

```
    ul.add('a')
```

```

        ul.add('b')
        ul.add('a')
        with self.assertRaises(Exception):
            ul.remove('c')
        ul.remove('b')
        self.assertEqual(ul.to_python(), ['a'])
        ul.remove('a')
        self.assertEqual(ul.to_python(), [])

    def test_remove_first_occurrence(self):
        ul = UnorderedList()
        ul.add('b')
        ul.add('b')
        with self.assertRaises(Exception):
            ul.remove('c')
        ul.remove('b')
        self.assertEqual(ul.to_python(), ['b'])
        ul.remove('b')
        self.assertEqual(ul.to_python(), [])

    def test_rev_empty(self):
        ul = UnorderedList()

        self.assertEqual([], ul.to_python())
        self.assertEqual([], ul.rev().to_python())

    def test_rev_one(self):
        ul = UnorderedList()
        ul.add('a')
        self.assertEqual(['a'], ul.to_python())
        self.assertEqual(['a'], ul.rev().to_python())

    def test_rev_three(self):
        ul = UnorderedList()
        ul.add('c')
        ul.add('b')
        ul.add('a')
        self.assertEqual(['a', 'b', 'c'], ul.to_python())
        self.assertEqual(['c', 'b', 'a'], ul.rev().to_python())

    def test_copy_empty(self):
        orig = UnorderedList()

        cp = orig.copy()
        self.assertEqual([], cp.to_python())

        orig.add('a')
        self.assertEqual(['a'], orig.to_python())
        self.assertEqual([], cp.to_python())

    def test_copy_one(self):
        orig = UnorderedList()
        orig.add('b')

        cp = orig.copy()
        self.assertEqual(['b'], cp.to_python())

        orig.add('a')
        self.assertEqual(['a', 'b'], orig.to_python())
        self.assertEqual(['b'], cp.to_python())
        orig.remove('b')
        self.assertEqual(['a'], orig.to_python())

```

```
self.assertEqual(['a'], orig.to_python())
self.assertEqual(['b'], cp.to_python())
```

```
def test_copy_two(self):
    orig = UnorderedList()
    orig.add('c')
    orig.add('b')

    cp = orig.copy()
    self.assertEqual(['b', 'c'], cp.to_python())

    orig.add('a')
    self.assertEqual(['a', 'b', 'c'], orig.to_python())
    self.assertEqual(['b','c'], cp.to_python())

    orig.remove('c')
    self.assertEqual(['a', 'b'], orig.to_python())
    self.assertEqual(['b','c'], cp.to_python())
```

In [4]:

```
algolab.run(UnorderedListTest)
```

.....

Ran 13 tests in 0.024s

OK

In [5]: