Software Carpentry III: Defensive Programming & Testing

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Programming for Scientists

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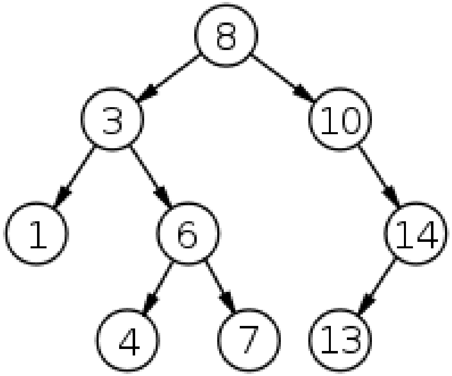
Set

How would we implement a set of numbers?

Set operations

- Create
- Add
- Remove
- Find

Binary Seach Trees



(Wikipedia)

Binary Search Tree Interface

- constructor: creates empty tree
- insert(value): inserts elements
- find(value) $\rightarrow$ boolean
- size() $\rightarrow$ number
- remove(value): removes a value

Defensive Programming

Defensive programming means writing code that will catch bugs early.

Assertions

```
def stddev(values):
    '''
    S = stddev(values)

    Compute standard deviation
    '''
    assert len(S) > 0, 'stddev: got empty list.'
    ...
```

Assertions

```
def stddev(values):
    '''
    S = stddev(values)

    Compute standard deviation
    '''
    if len(S) <= 0:
        raise AssertionError(
            'stddev: got empty list.')
    ...
```

```python
def factorial(N):
    '''
    fN = factorial(N)

    Returns the factorial of N.

    N must be equal or greater than zero.
    '''
    if N == 0:
        return 1.
    return N * factorial(N-1)
```

Preconditions

In computer programming, a precondition is a condition or predicate that must always be true just prior to the execution of some section of code.

(Wikipedia)

Preconditions

Other Languages

- C/C++ #include <assert.h>
- Java assert *pre-condition*
- Matlab `assert()` (in newer versions)
- … …

Assertions Are Not Error Handling!

- Error handling protect against outside events.
- Assertions should never be false.

Programming by Contract

1. pre-conditions.
2. post-conditions.
3. invariants.

Pre-condition

What must be true before calling a function.

Post-condition

What is true after calling a function.

Pre-conditions

Examples

- sort: element must be comparable.
- BST.add(val): element must be comparable to all elements in BST.
- BST.find(val): element must be comparable to all elements in BST.
- ...

Post-conditions

Examples

- sort: elements are in sorted order.
- BST.add(val): value is in tree.
- BST.remove(val): value is not in tree.
- ...

Invariants

Invariants make sense within the context of related functions.

Bacteria class

- sigma $>=$ 0

Binary Search Tree

- Items in left sub-tree are smaller than cur item.
- Items in right sub-tree are bigger than cur item.
- All items are comparable.

Testing

Do you test your code?

Unit Testing

```python
def test_stddev_const():
    assert stddev([1]*100) < 1e-3

def test_stddev_positive():
    assert stddev(range(20)) > 0.
```

Nosetest

Nose software testing framework:

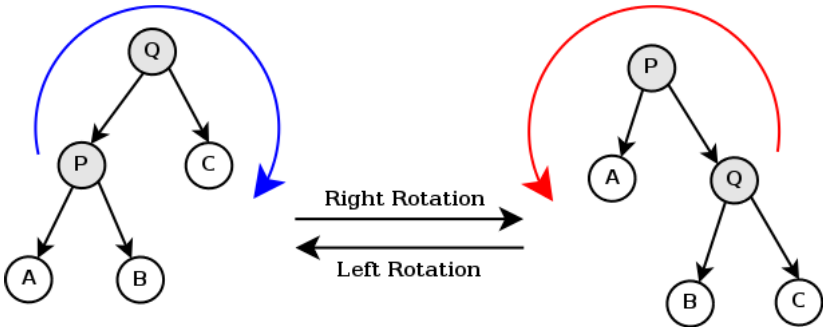
- Tests are named test_*something*.
- Conditions are asserted.

Software Testing Philosophies

1. Test everything. Test it twice.
2. Write tests first.
3. Regression testing.

Regression Testing

Make sure bugs only appear once!



(Wikipedia)