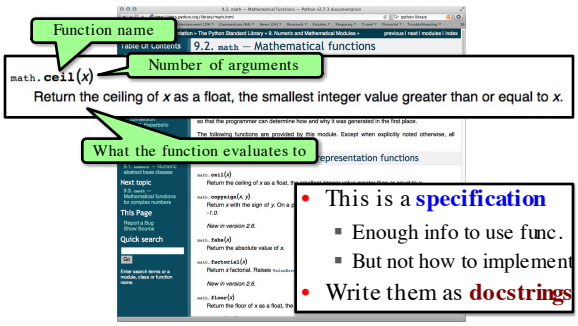
One-on-One Sessions

- Starting tomorrow: 1/2-hour one-on-one sessions
  - Bring computer to work with instructor, TA or consultant
  - Hands on, dedicated help with Lab 2 and/or Lab 3
  - To prepare for assignment, **not for help on assignment**
- **Limited availability: we cannot get to everyone**
  - Students with experience or confidence should hold back
- Sign up online in CMS: first come, first served
  - Choose assignment One-on-One
  - Pick a time that works for you; will add slots as possible
  - Can sign up starting at 1pm **TODAY**

Recall: The Python API



Anatomy of a Specification

```
def greet(n):
    """Prints a greeting to the name n

    Greeting has format 'Hello <n>!'
    Followed by conversation starter.

    Parameter n: person to greet
    Precondition: n is a string"""
    print 'Hello '+n+'!'
    print 'How are you?'
```

One line description, followed by blank line

More detail about the function. It may be many paragraphs.

Parameter description

Precondition specifies assumptions we make about the arguments

Anatomy of a Specification

```
def to_centigrade(x):
    """Returns x converted to centigrade

    Value returned has type float."""

    Parameter x: temp in fahrenheit
    Precondition: x is a float
    return 5*(x-32)/9.0
```

"Returns" indicates a fruitful function

More detail about the function. It may be many paragraphs.

Parameter description

Precondition specifies assumptions we make about the arguments

Preconditions

- Precondition is a promise
  - If precondition is true, the function works
  - If precondition is false, no guarantees at all
- Get **software bugs** when
  - Function precondition is not documented properly
  - Function is used in ways that violates precondition

```
>>> to_centigrade(32)
0.0
>>> to_centigrade(212)
100.0
>>> to_centigrade('32')
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "temperature.py", line 19 ...
TypeError: unsupported operand type(s)
for -: 'str' and 'int'
```

Precondition violated

Test Cases: Finding Errors

- **Bug**: Error in a program. (Always expect them!)
- **Debugging**: Process of finding bugs and removing them.
- **Testing**: Process of analyzing, running program, looking for bugs.
- **Test case**: A set of input values, together with the expected output.

Get in the habit of writing test cases for a function from the function's specification —even *before* writing the function's body.

```
def number_vowels(w):
    """Returns: number of vowels in word w.

    Precondition: w string w/ at least one letter and only letters"""
    pass  # nothing here yet!
```

Representative Tests

- Cannot test all inputs
  - "Infinite" possibilities
- Limit ourselves to tests that are **representative**
  - Each test is a significantly different input
  - Every possible input is similar to one chosen
- An art, not a science
  - If easy, never have bugs
  - Learn with much practice

Representative Tests for `number_vowels(w)`

- Word with just one vowel
  - For each possible vowel!
- Word with multiple vowels
  - Of the same vowel
  - Of different vowels
- Word with only vowels
- Word with no vowels

Unit Test: A Special Kind of Module

- A unit test is a module that tests another module
  - It **imports the other module** (so it can access it)
  - It **imports the `cornelltest` module** (for testing)
  - It **defines one or more test procedures**
    - Evaluate the function(s) on the test cases
    - Compare the result to the expected value
  - It has special code that **calls the test procedures**
- The test procedures use the `cornelltest` function

```
def assert_equals(expected,received):
    """Quit program if expected and received differ"""
```

Testing last_name_first(n)

```
# test procedure
def test_last_name_first():
    """Test procedure for last_name_first(n)"""
    result = name.last_name_first('Walker White')
    cornelltest.assert_equals('White, Walker', result)
    result = name.last_name_first('Walker          White')
    cornelltest.assert_equals('White, Walker', result)

# Execution of the testing code
test_last_name_first()
print 'Module name is working correctly'
```

Call function on test input

Compare to expected output

Quits Python if not equal

Message will print out only if no errors.

Modules vs. Scripts

Module

- Provides functions, constants
  - **Example**: temperature.py
- import it into Python
  - In interactive shell…
  - or other module
- All code is either
  - In a function definition, or
  - A variable assignment

Script

- Behaves like an application
  - **Example**: helloApp.py
- Run it from command line
  - `python helloApp.y`
  - No interactive shell
  - `import` acts "weird"
- Commands *outside* functions
  - Does each one in order

Modules/Scripts in this Course

- Our modules consist of
  - Function definitions
  - "Constants" (global vars)
  - **Optional** script code to call/test the functions
- All **statements** must
  - be inside of a function or
  - assign a constant or
  - be in the application code
- `import` will only use the definitions, not app code

```
# temperature.py
...
# Functions
def to_centigrade(x):
    """Returns: x converted to C"""
...
# Constants
FREEZING_C = 0.0   # temp. water freezes
...
# Application code
if __name__ == '__main__':
    assert_floats_equal(0.0,to_centigrade(32.0))
    assert_floats_equal(100,to_centigrade(212))
    assert_floats_equal(32.0,to_fahrenheit(0.0))
    assert_floats_equal(212.0,to_fahrenheit(100.0))
```

Finding the Error

- Unit tests cannot find the source of an error
- Idea: "Visualize" the program with print statements

```
def last_name_first(n):
    """Returns: copy of <n> in form <last>, <first>"""
    end_first = n.find(' ')
    print end_first
    first = n[:end_first]
    print 'first is '+`first`
    last  = n[end_first+1:]
    print 'last is '+`last`
    return last+', '+first
```

Print variable after each assignment

Optional: Annotate value to make it easier to identify