Lecture 4

Defining Functions

Announcements for this Lecture

To Do This Week

- Complete Quiz 0!
  - No quiz; can't take course
  - This week is last chance
- Also do the survey
- Read Sections 3.5 – 3.13

Today's Lab

- Like last week's lab
  - Still using a worksheet
  - But also writing code
  - Show both for credit
- Prep. for Assignment 1
  - Finish Part 4 in Lab!
  - Okay to do rest at home

[xkcd.com]

One-on-One Sessions

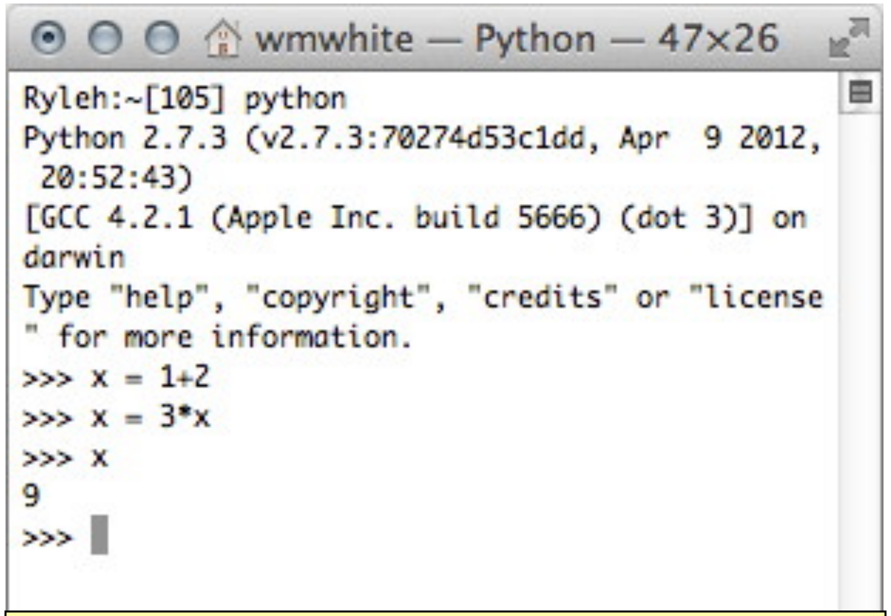
- Starting next week: 1/2-hour one-on-one sessions
  - Bring computer and work with instructor, TA or consultant
  - Hands on, dedicated help with Lab 2 and/or Lab 3
  - To prepare for assignment, **not for help on assignment**
- **Limited availability: we cannot get to everyone**
  - **Students with 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 **THURSDAY**

Recall: Modules

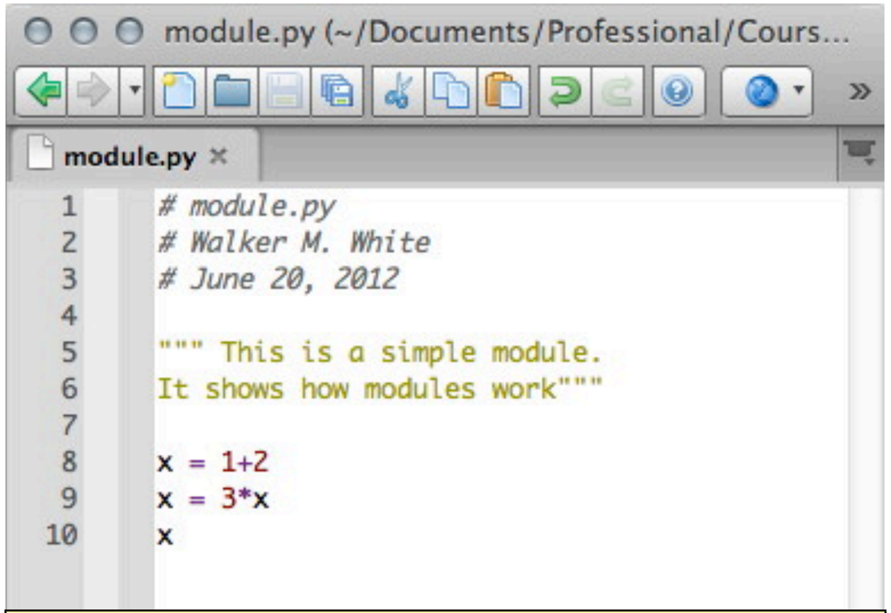
- Modules provide extra functions, variables
  - **Example**: math provides math.cos(), math.pi
  - Access them with the `import` command
- Python provides a lot of them for us
- **This Lecture**: How to make modules
  - Komodo Edit to *make* a module
  - Python to *use* the module

Two different programs

Python Shell vs. Modules



```
Ryleh:~[105] python
Python 2.7.3 (v2.7.3:70274d53c1dd, Apr  9 2012,
 20:52:43)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on
darwin
Type "help", "copyright", "credits" or "license
" for more information.
>>> x = 1+2
>>> x = 3*x
>>> x
9
>>> 
```



```
# module.py
# Walker M. White
# June 20, 2012

""" This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
x
```

- Launch in command line
- Type each line separately
- Python executes as you type

- **Write in a text editor**
  - We use Komodo Edit
  - But anything will work
- Run module with `import`

Using a Module

Module Contents

```
# module.py

""" This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
x
```

Single line comment
(not executed)

Docstring (note the Triple Quotes)
Acts as a multiple-line comment
Useful for *code documentation*

Commands
Executed on import

Not a command.
import **ignores this**

Using a Module

Module Contents

```
# module.py

""" This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
x
```

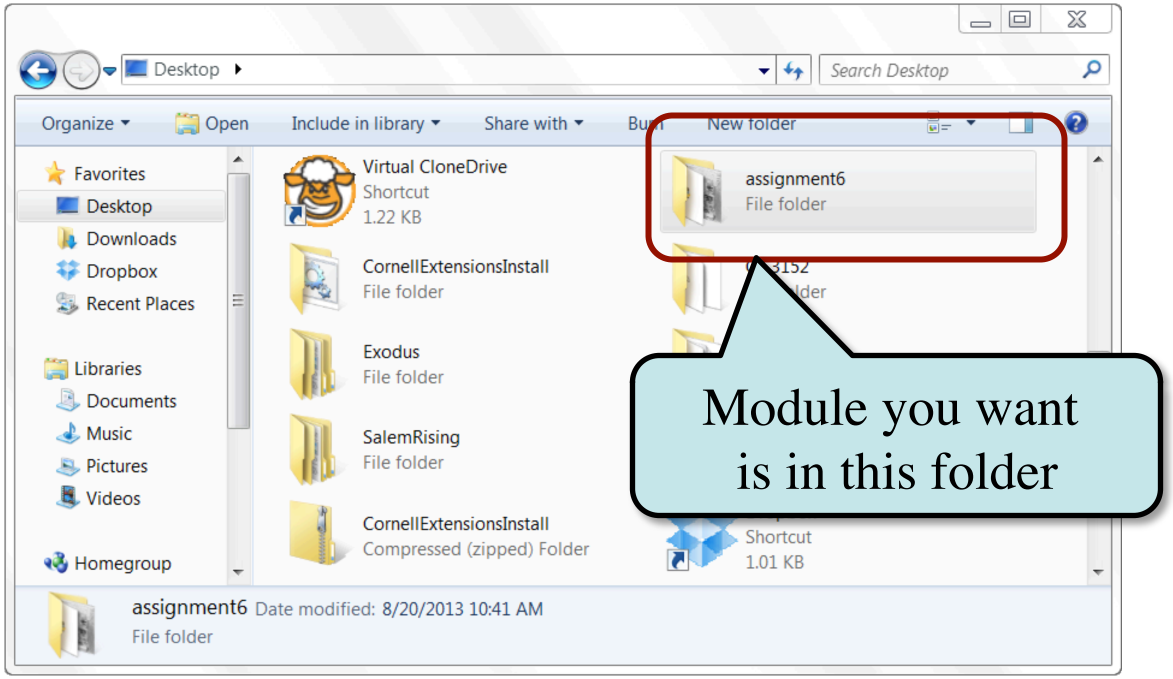
Python Shell

```
>>> import module
>>> x
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'x' is not defined
>>> module.x
9
>>> help(module)
```

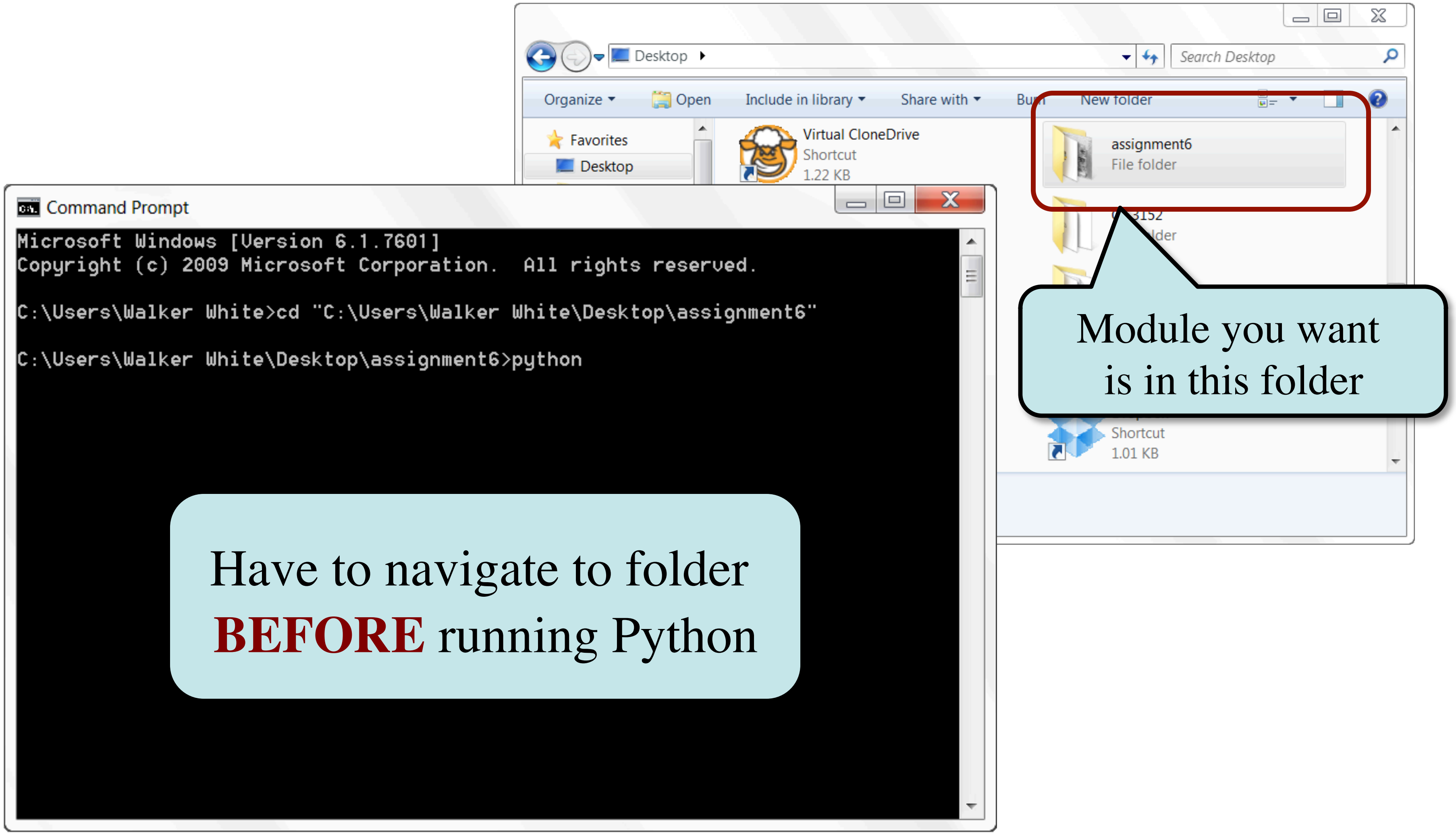
"**Module data**" must be prefixed by module name

Prints **docstring** and module contents

Modules Must be in Working Directory!



Modules Must be in Working Directory!



```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\Walker White>cd "C:\Users\Walker White\Desktop\assignment6"

C:\Users\Walker White\Desktop\assignment6>python
```

Module you want is in this folder

Have to navigate to folder **BEFORE** running Python

We Write Programs to Do Things

- Functions are the **key doers**

Function Call

- Command to **do** the function

```
greet('Walker')
```

argument to assign to n

Function Definition

- Defines what function **does**

```
def greet(n):
    print 'Hello '+n+'!'
```

Function **Header**

declaration of **parameter** n

Function **Body** (indented)

- **Parameter**: variable that is listed within the parentheses of a method header.
- **Argument**: a value to assign to the method parameter when it is called

Anatomy of a Function Definition

name

parameters

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

    Precondition: n is a string
    representing a person's name"""
    print 'Hello '+n+'!'
    print 'How are you?'
```

Function **Header**

Docstring
Specification

Statements to
execute when called

The vertical line
indicates indentation

Use vertical lines when you write Python on **exams** so we can see indentation

Procedures vs. Fruitful Functions

Procedures

- Functions that **do** something
- Call them as a **statement**
- Example: `greet('Walker')`

Fruitful Functions

- Functions that give a **value**
- Call them in an **expression**
- Example: `x = round(2.56,1)`

Historical Aside

- Historically "function" = "fruitful function"
- But now we use "function" to refer to both

The **return** Statement

- Fruitful functions require a **return statement**
- **Format**: return <*expression*>
  - Provides value when call is used in an expression
  - Also stops executing the function!
  - Any statements after a **return** are ignored
- **Example**: temperature converter function

```
def to_centigrade(x):
    """Returns: x converted to centigrade"""
    return 5*(x-32)/9.0
```

Functions and Modules

- Purpose of modules is **function definitions**
  - Function definitions are written in module file
  - Import the module to call the functions
- Your Python workflow (right now) is

1. Write a function in a module (a .py file)
2. Open up the command shell
3. Move to the directory with this file
4. Start Python (type `python`)
5. Import the module
6. Try out the function

Aside: Constants

- Modules often have variables outside a function
  - We call these global variables
  - Accessible once you import the module
- Global variables should be **constants**
  - Variables that never, ever change
  - Mnemonic representation of important value
  - **Example**: `math.pi`, `math.e` in `math`
- In this class, constant names are **capitalized**!
  - So we can tell them apart from non-constants

Module Example: Temperature Converter

```
# temperature.py
"""Conversion functions between fahrenheit and centrigrade"""

# Functions
def to_centigrade(x):
    """Returns: x converted to centigrade"""
    return 5*(x-32)/9.0

def to_fahrenheit(x):
    """Returns: x converted to fahrenheit"""
    return 9*x/5.0+32

# Constants
FREEZING_C = 0.0    # temp. water freezes
```

Style Guideline: Two blank lines between function definitions

Example from Previous Slides (Online)

```
def second_in_list(s):
    """Returns: second item in comma-separated list

    The final result does not have any whitespace on edges

    Precondition: s is a string of items separated by a comma."""
    startcomma = s.index(',')
    tail = s[startcomma+1:]
    endcomma = tail.index(',')
    item = tail[:endcomma].strip()
    return item
```

See commalist.py

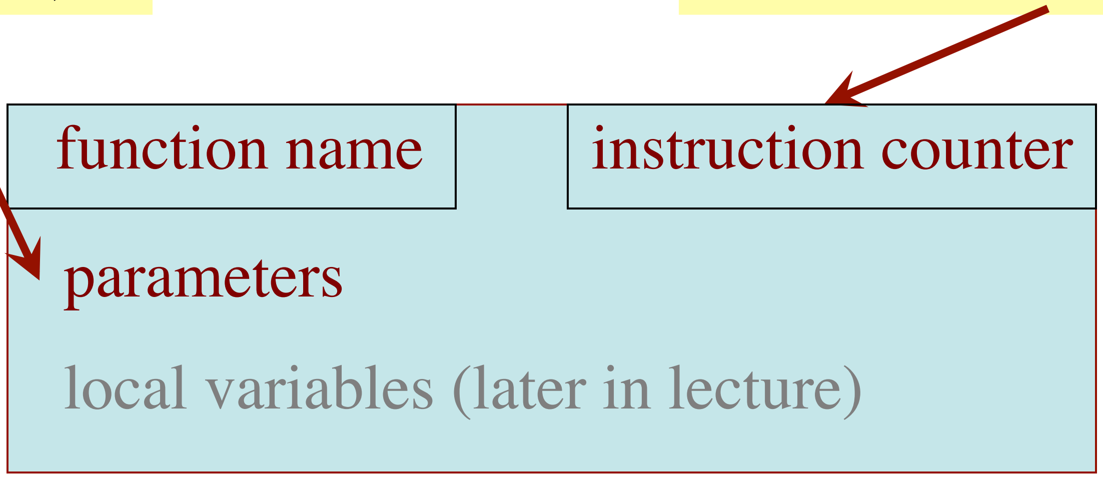
How Do Functions Work?

Draw template on a piece of paper

- **Function Frame**: Representation of function call
- A **conceptual model** of Python

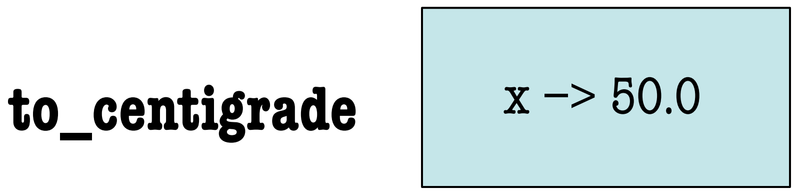
Draw parameters as variables (named boxes)

- Number of statement in the function body to execute next
- **Starts with 1**

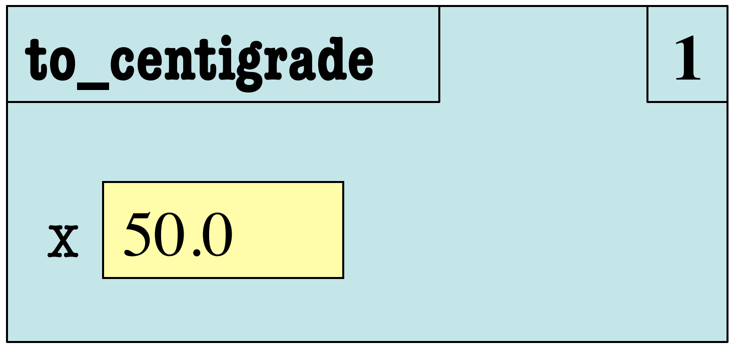


Text (Section 3.10) vs. Class

Textbook



This Class



Definition:

```
def to_centigrade(x):
    return 5*(x-32)/9.0
```

Call: to_centigrade(50.0)

Example: to_centigrade(50.0)

1. Draw a frame for the call
2. Assign the argument value to the parameter (in frame)
3. Execute the function body
   - Look for variables in the frame
   - If not there, look for global variables with that name
4. Erase the frame for the call

```
def to_centigrade(x):
1     return 5*(x-32)/9.0
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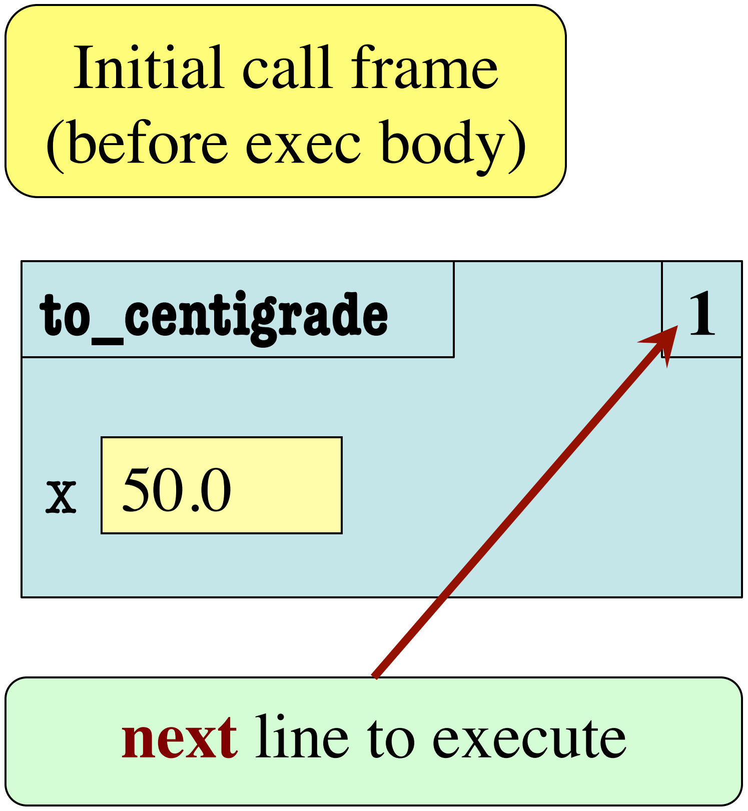

Example: to_centigrade(50.0)

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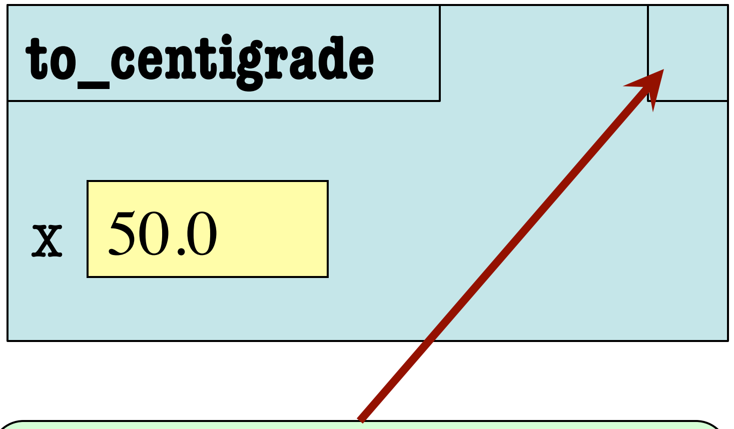
Executing the return statement



The return terminates; no next line to execute

Example: to_centigrade(50.0)

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def to_centigrade(x):
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```

ERASE WHOLE FRAME

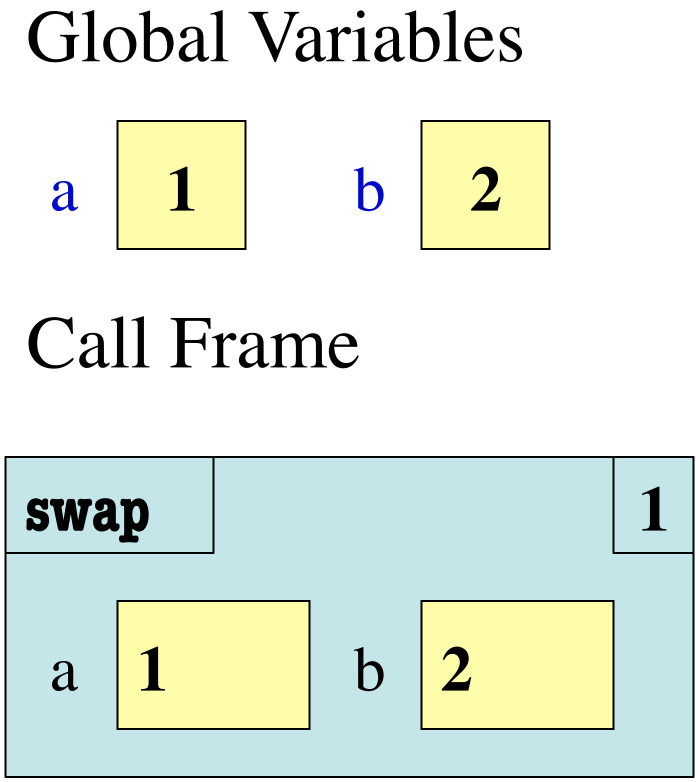
But don't actually erase on an exam

Call Frames vs. Global Variables

- This does not work:

```
  def swap(a,b):
      """Swap vars a & b"""
1     tmp = a
2     a = b
3     b = tmp
```

```
>>> a = 1
>>> b = 2
>>> swap(a,b)
```



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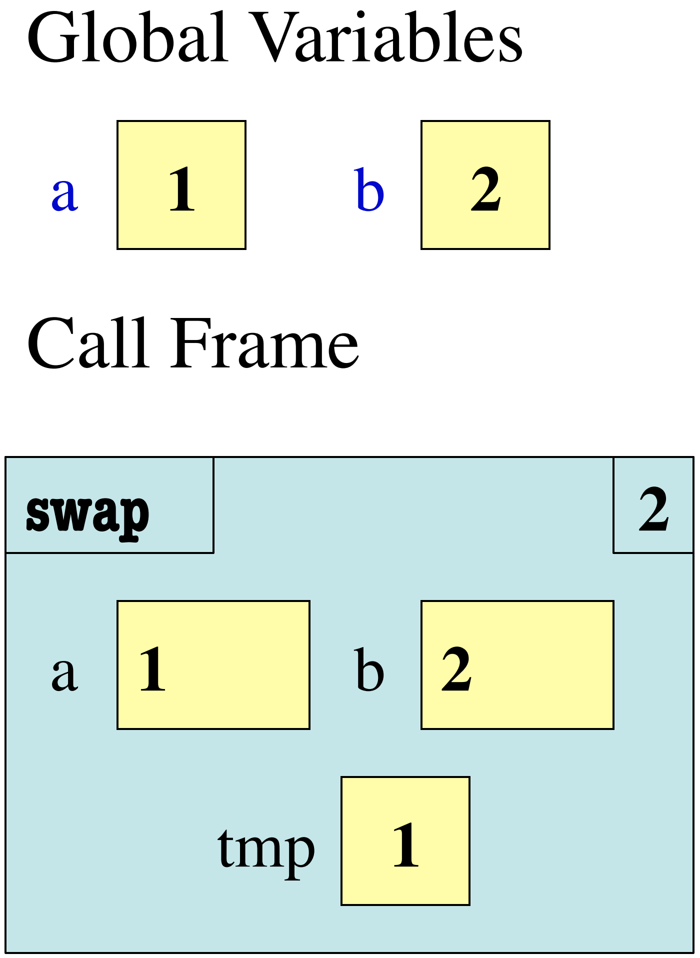

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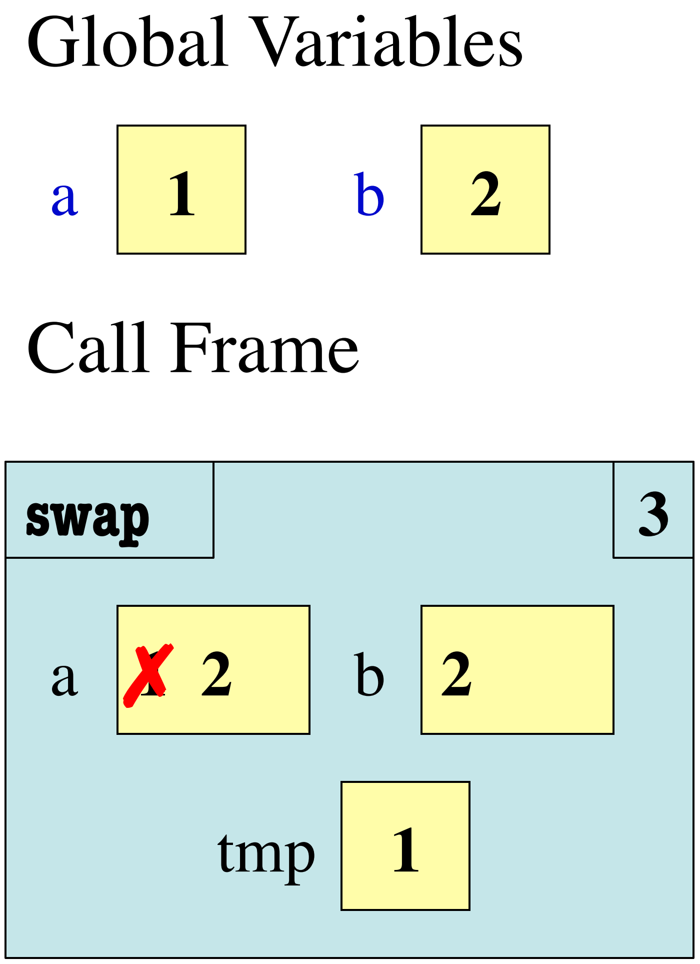

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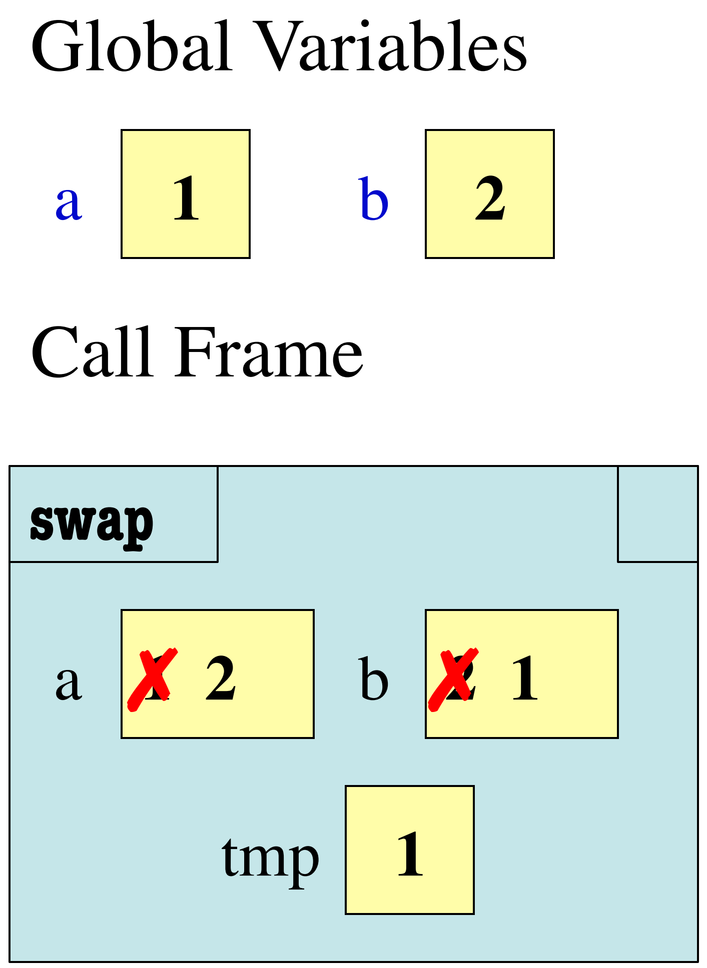

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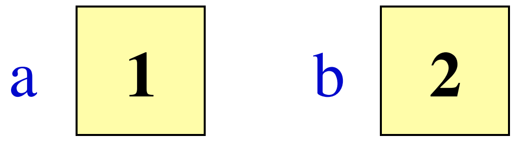
Global Variables



Call Frame