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
  - Pulsar to *make* a module
  - Python to *use* the module

Two different programs

1

We Write Programs to Do Things

- Functions are the **key doers**

Function Call

- Command to **do** the function

```
>>> plus(23)
24
>>>
```

Function Definition

- Defines what function **does**

```
def plus(n):
    return n+1
```

Function **Header**

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

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Anatomy of a Function Definition

```
def plus(n):
    """Returns the number n+1

       Parameter n: number to add to
       Precondition: n is a number"""
    x = n+1
    return x
```

name

parameters

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

3

The `return` Statement

- **Format**: return <*expression*>
  - Used to evaluate ***function call*** (as 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
```

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A More Complex Example

Function Definition

```
def foo(a,b):
    """Return something
       Param a: number
       Param b: number"""
    x = a
    y = b
    return x*y+y
```

Function Call

```
>>> x = 2
>>> foo(3,4)
```

x ?

What is in the box?

A: 2
B: 3
C: 16
D: Nothing!
E: I do not know

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Understanding How Functions Work

- **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**

function name | instruction counter

parameters

local variables (later in lecture)

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Text (Section 3.10) vs. Class

Textbook	This Class
to_centigrade: x –> 50.0	to_centigrade 1: x 50.0

Definition:

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

Call: to_centigrade(50.0)

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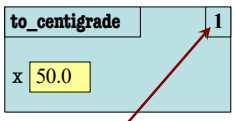
Example: to_centigrade(50.0)

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

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

Initial call frame (before exec body)



next line to execute

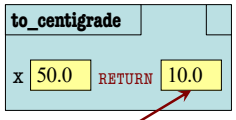
8

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

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

Executing the return statement



Return statement creates a special variable for result

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Call Frames vs. Global Variables

The specification is a **lie**:

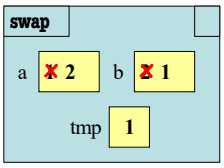
```
def swap(a,b):
    """Swap global a & b"""
1   tmp = a
2   a = b
3   b = tmp
```

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

Global Variables

a 1 b 2

Call Frame



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Exercise Time

Function Definition

```
def foo(a,b):
    """Return something
       Param x: a number
       Param y: a number"""
1   x = a
2   y = b
3   return x*y+y
```

Function Call

```
>>> x = foo(3,4)
```

What does the frame look like at the **start**?

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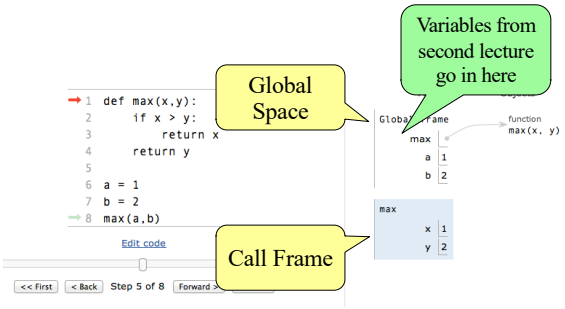
Visualizing Frames: The Python Tutor



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