61A Lecture 2

Friday, January 23, 2015

Announcements

- Starting next week, submitting labs & attending section will provide a midterm safety net
- Homework 1 is due next Wednesday 1/28
  - All homework is graded on effort; you must make progress on each problem to earn 2/2
  - Homework Party on Tuesday 1/27 5-6:30pm in 2050 VLSB
- Quiz 1 released next Wednesday 1/28 is due next Thursday 1/29 (graded on correctness)
- Ask questions about lab and homework assignments in office hours! (cs61a.org/weekly.html)
  - 2 locations in Bechtel Engineering Center (Map: http://goo.gl/dAcHXf)
  - 11-2 & 3-5 on Monday, 11-6 on Tuesday & Thursday, 11-2 & 3-4 on Wednesday, 11-1 on Friday
- You **need** to register a class account (Lab 0); that's how we track assignments
  - Please register even if you're on the waitlist or applying for concurrent enrollment

Names, Assignment, and User-Defined Functions

(Demo)

Types of Expressions

Primitive expressions: `2` (Number or Numeral), `add` (Name), `'hello'` (String)

Call expressions:

```
max      (   2      ,   3      )
Operator     Operand    Operand
```

An operand can also be a call expression

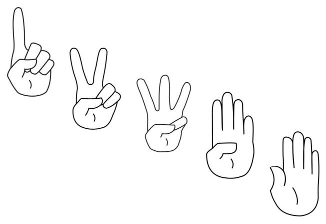
```
max(min(pow(3, 5), -4), min(1, -2))
```

Discussion Question 1

What is the value of the final expression in this sequence?

```
>>> f = min
>>> f = max
>>> g, h = min, max
>>> max = g
>>> max(f(2, g(h(1, 5), 3)), 4)
```

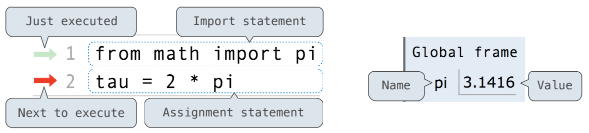
???



Environment Diagrams

Environment Diagrams

Environment diagrams visualize the interpreter's process.



```
from math import pi
tau = 2 * pi
```

Global frame: pi 3.1416

Code (left):

Statements and expressions

Arrows indicate evaluation order

Frames (right):

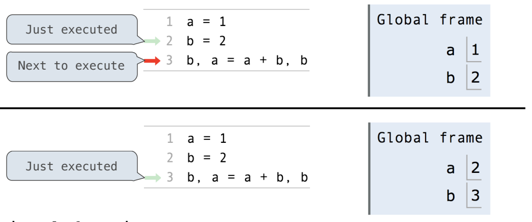
Each name is bound to a value

Within a frame, a name cannot be repeated

(Demo)

Interactive Diagram

Assignment Statements



```
a = 1
b = 2
b, a = a + b, b
```

Global frame: a 1, b 2

Global frame: a 2, b 3

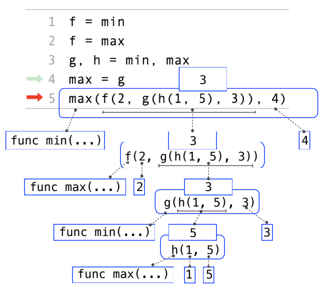
Execution rule for assignment statements:

1. Evaluate all expressions to the right of = from left to right.
2. Bind all names to the left of = to those resulting values in the current frame.

Interactive Diagram

Discussion Question 1 Solution

(Demo)



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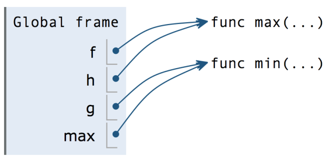

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Interactive Diagram

Defining Functions

Defining Functions

Assignment is a simple means of abstraction: binds names to values

Function definition is a more powerful means of abstraction: binds names to expressions

Function *signature* indicates how many arguments a function takes

```
>>> def <name>(<formal parameters>):
        return <return expression>
```

Function *body* defines the computation performed when the function is applied

Execution procedure for def statements:

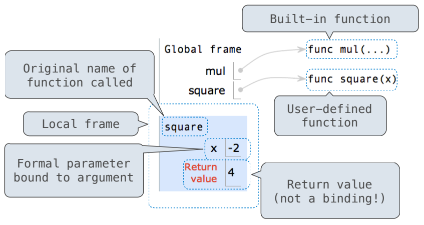
1. Create a function with signature <name>(<formal parameters>)
2. Set the body of that function to be everything indented after the first line
3. Bind <name> to that function in the current frame

Calling User-Defined Functions

Procedure for calling/applying user-defined functions (version 1):

1. Add a local frame, forming a new environment
2. Bind the function's formal parameters to its arguments in that frame
3. Execute the body of the function in that new environment

```
from operator import mul
def square(x):
    return mul(x, x)
square(-2)
```



Interactive Diagram

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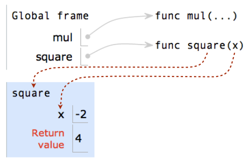


A function's signature has all the information needed to create a local frame

Interactive Diagram

Looking Up Names In Environments

Every expression is evaluated in the context of an environment.

So far, the current environment is either:

- The global frame alone, or
- A local frame, followed by the global frame.

Most important two things I'll say all day:

An environment is a sequence of frames.

A name evaluates to the value bound to that name in the earliest frame of the current environment in which that name is found.

E.g., to look up some name in the body of the square function:

- Look for that name in the local frame.
- If not found, look for it in the global frame.
(Built-in names like "max" are in the global frame too, but we don't draw them in environment diagrams.)

(Demo)

Print and None

(Demo)

None Indicates that Nothing is Returned

The special value None represents nothing in Python

A function that does not explicitly return a value will return None

Careful: None is *not displayed* by the interpreter as the value of an expression

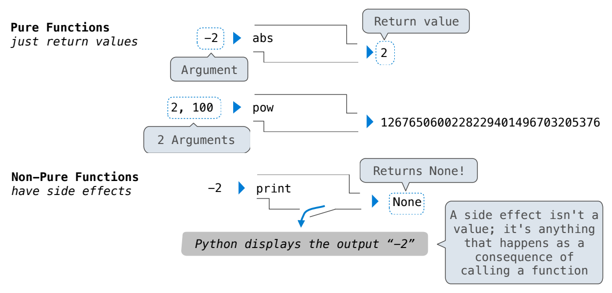
```
>>> def does_not_square(x):
...     x * x
...
>>> does_not_square(4)
>>> sixteen = does_not_square(4)
>>> sixteen + 4
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: unsupported operand type(s) for +: 'NoneType' and 'int'
```

No **return**

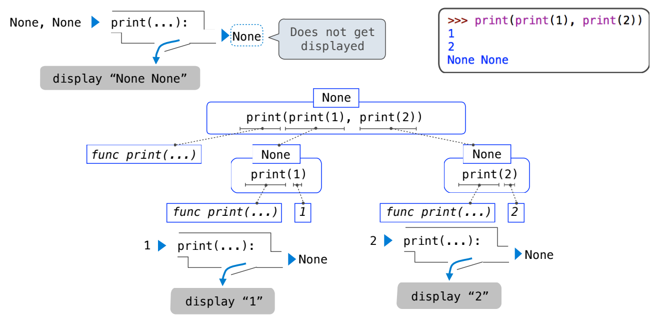
None value is not displayed

The name **sixteen** is now bound to the value **None**

Pure Functions & Non-Pure Functions



Nested Expressions with Print



```
>>> print(print(1), print(2))
1
2
None None
```