CSCI 141

Lecture 23
Mutable objects and Functions

Goals

- Understand how mutable objects interact with function calls and scope:
  - Objects do not live inside the "boxes" that define scope
  - References to objects can cross "box" boundaries.
- Be able to draw memory diagrams for programs that involve function calls and mutable objects.

Implications of Mutability

- Previously: more than one variable (or list element) can contain *references* to the same object.

- Up next:

  - **Variables obey scope** (i.e., live in a certain "box").

  - **Objects don't**: they exist outside the "box" framework.

  - References can cross "box" boundaries.

Reminder:
How to Execute Function Calls

```
def axpy(a, x, y):
    """ Return a*x + y """
    product = a * x
    result = product + y
    return result


a1 = 2
x1 = 3
print(axpy(a1, x1, 4))
print(a1)
```

Technically, global variables can be *read* but not *modified* from an inner scope.

In this class we'll always avoid referring to global variables from inside functions entirely.

1. Evaluate all arguments
2. Draw a local "box" inside the global one
3. Assign argument values to parameter variables in the local box
4. Execute the function body

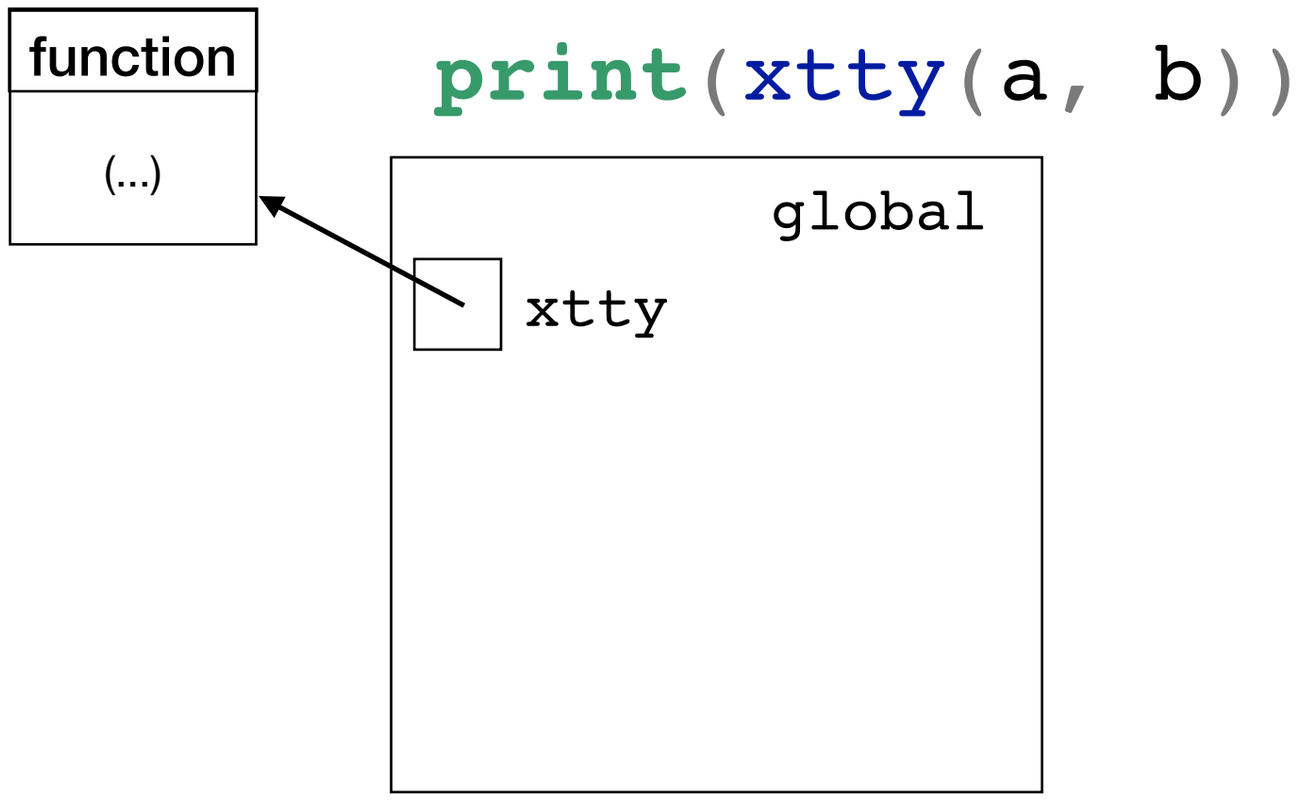
   If multiple variables exist with the same name, use the **innermost** one available.
5. When done, erase the local box
6. Replace the function call with its return value

Reminder: Function Calls

Execute this program:

```
def xtty(x, y):
    """ return x ** y """
    return x ** y

a = 3
b = 2
print(xtty(a, b))
```



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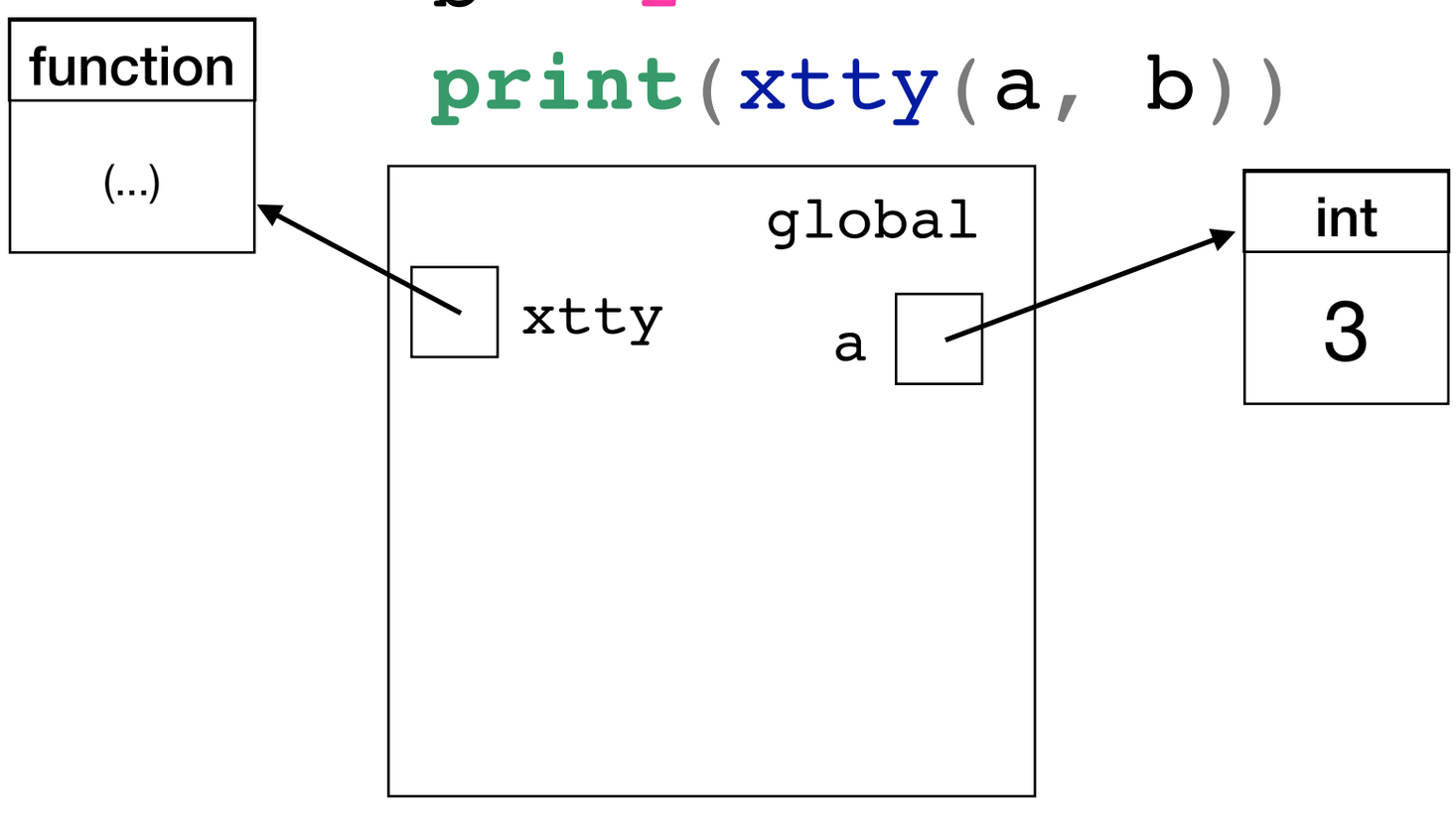

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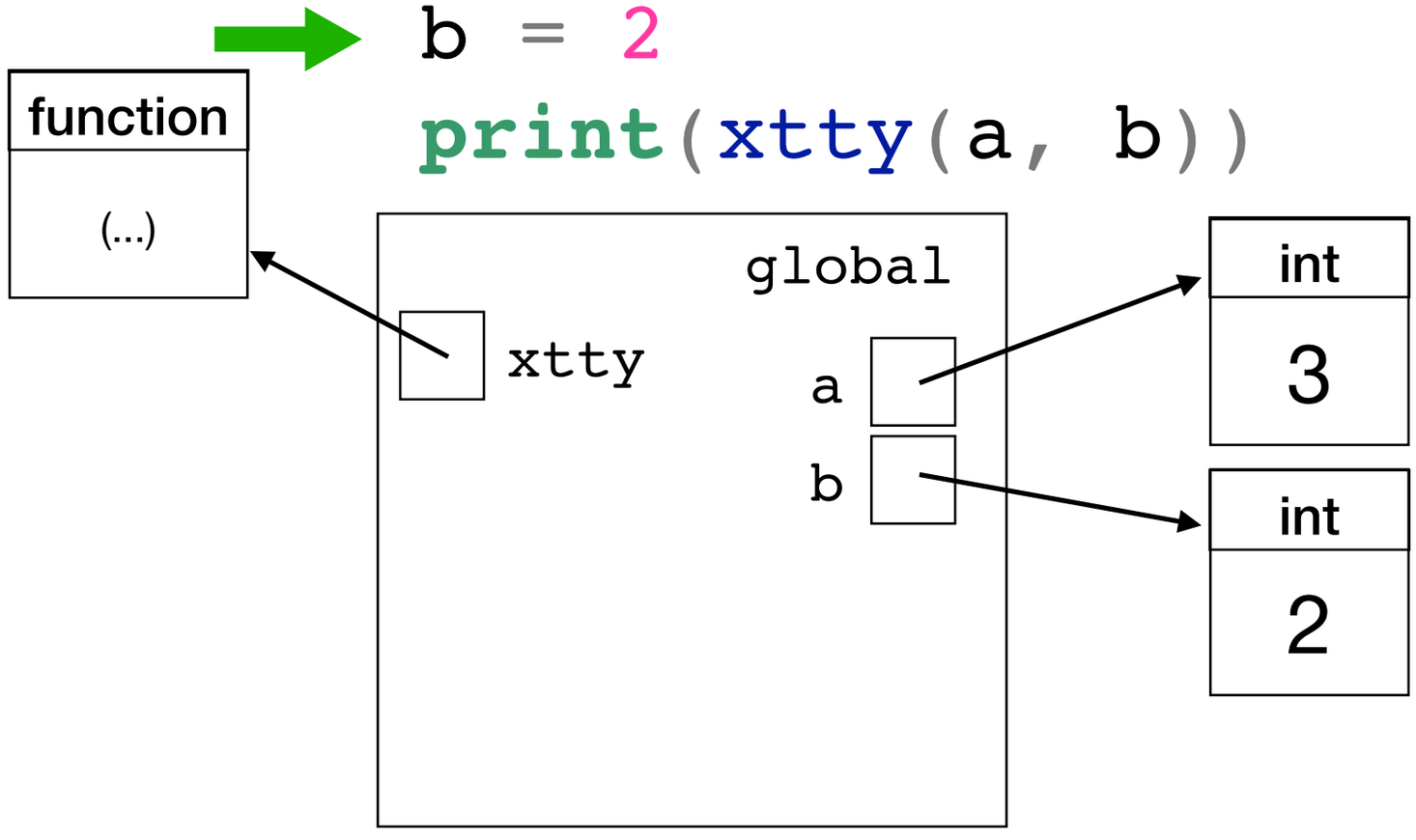

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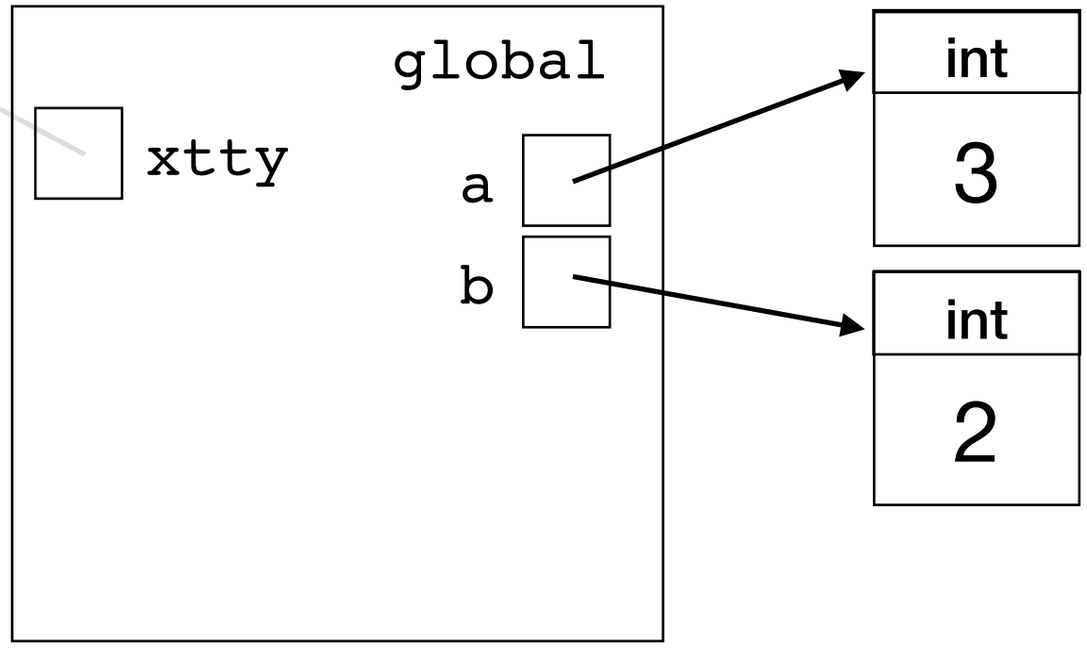

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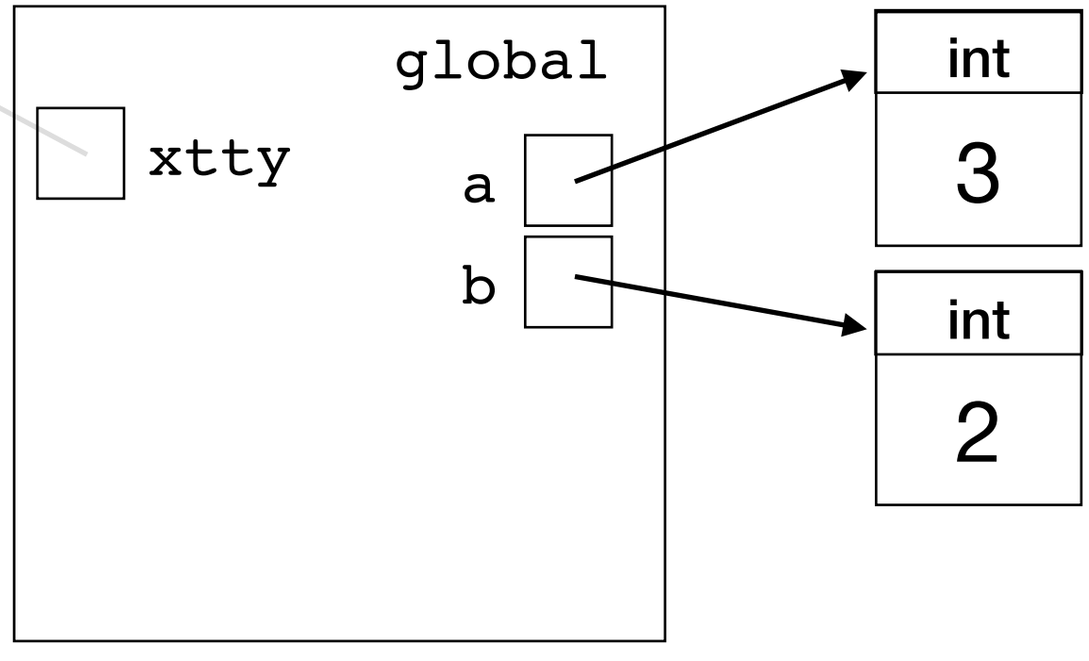

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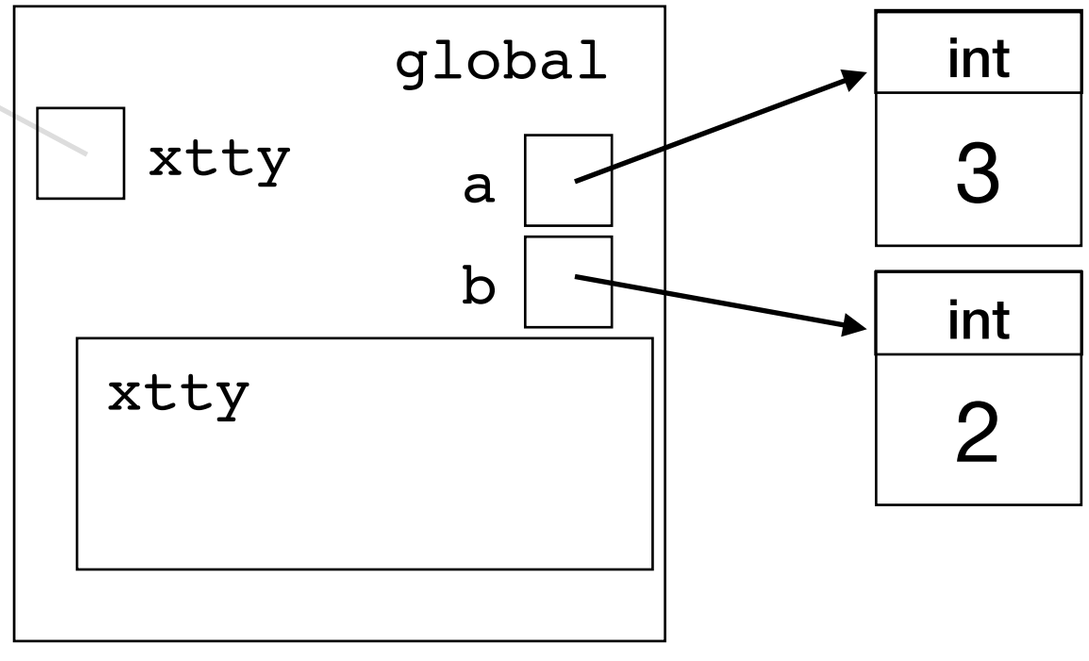

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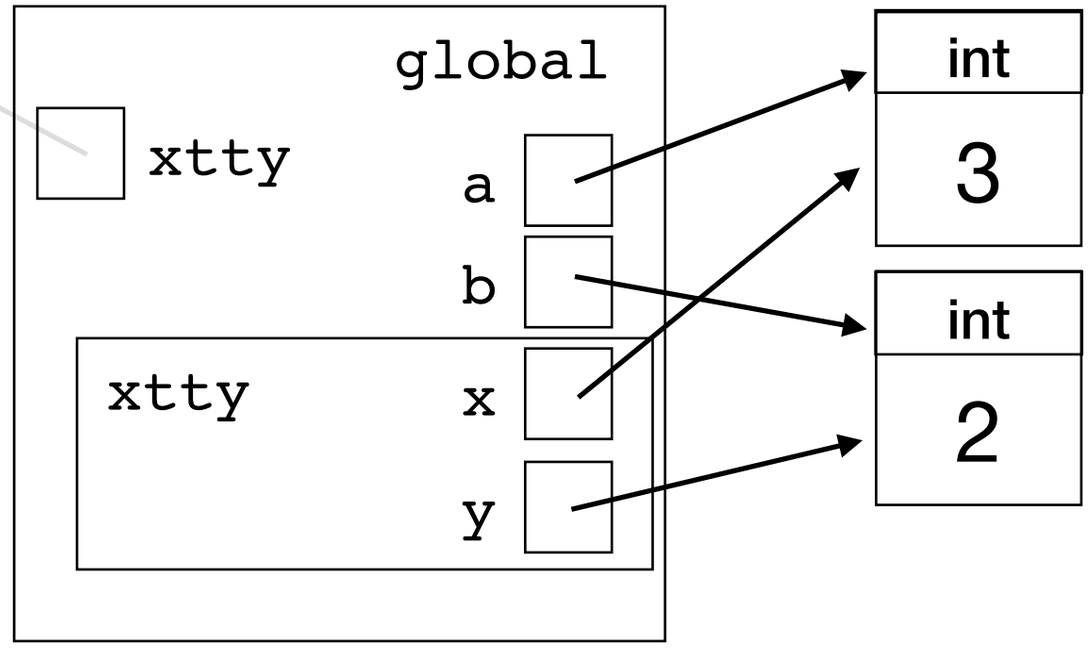

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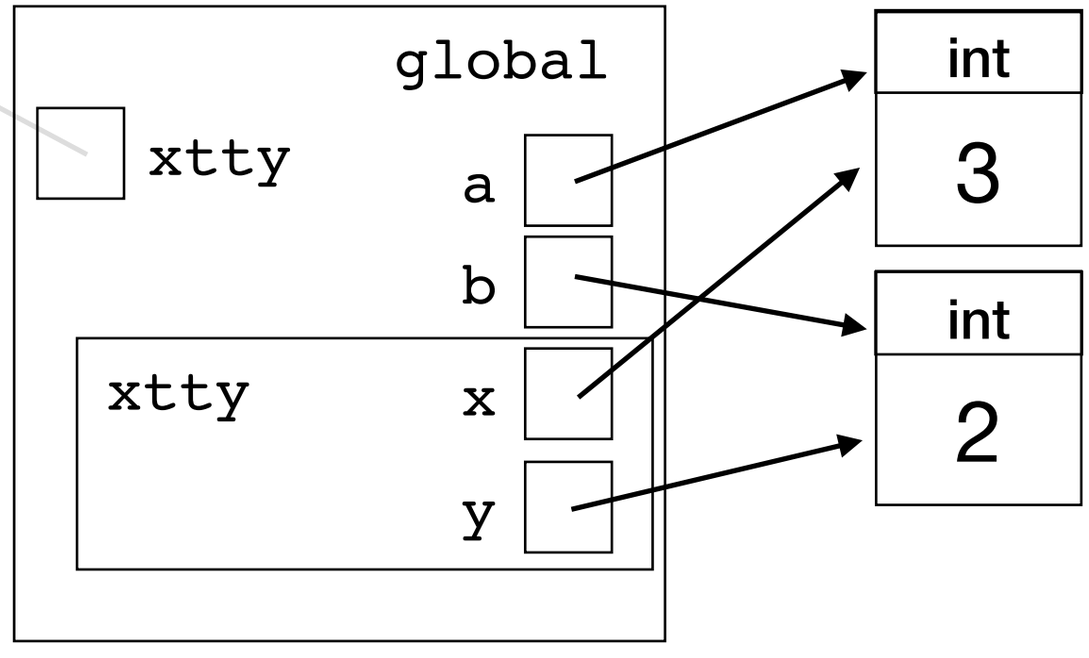

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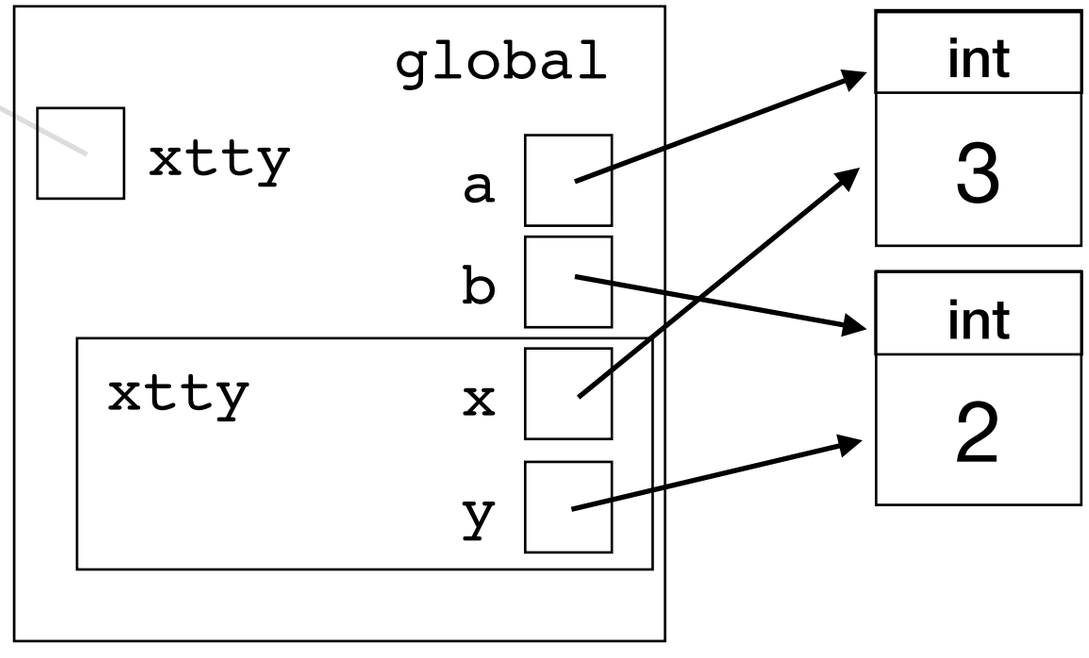

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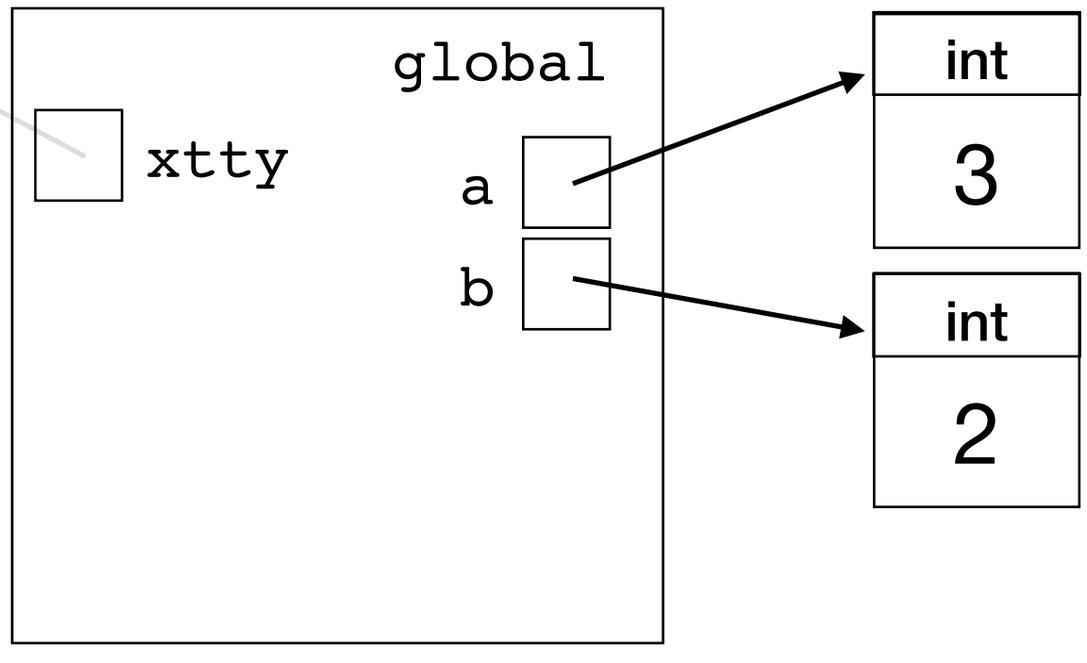


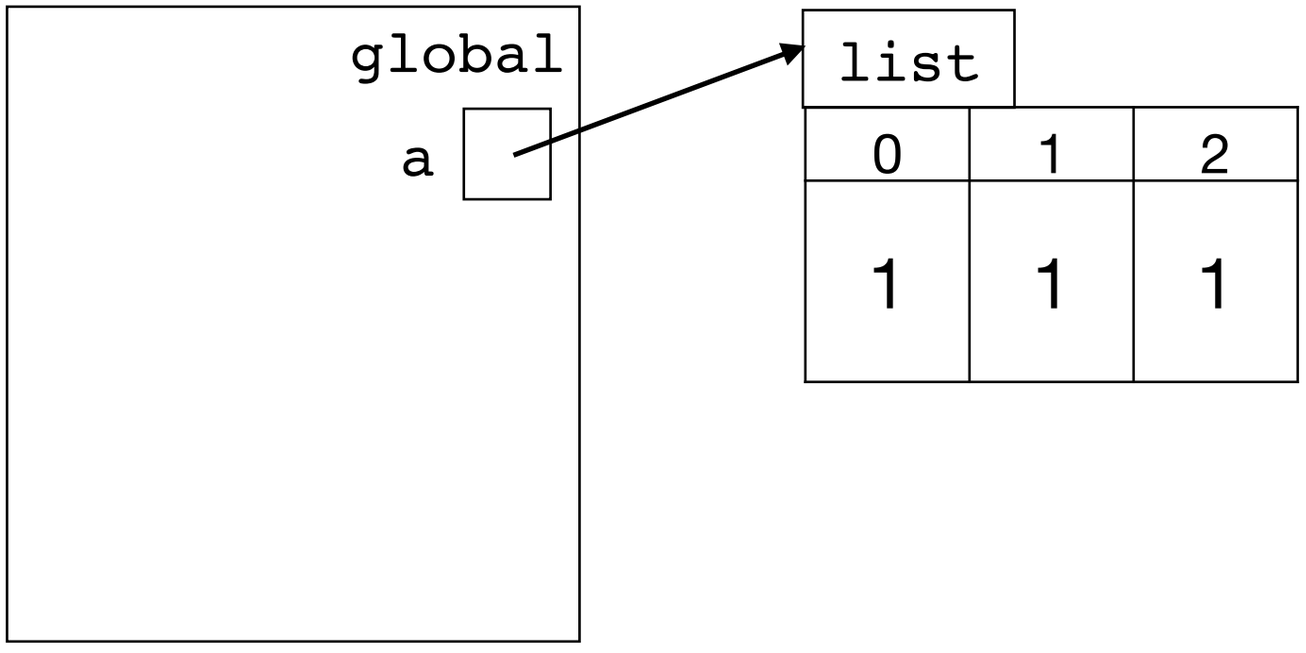
Mutable Objects and Functions

(or any mutable object!)

When you pass a list into a function, you're actually passing a *reference* to the list:

```
def z1(a_list):
    a_list[0] = 0

a = [1, 1, 1]
z1(a)
print(a)
```



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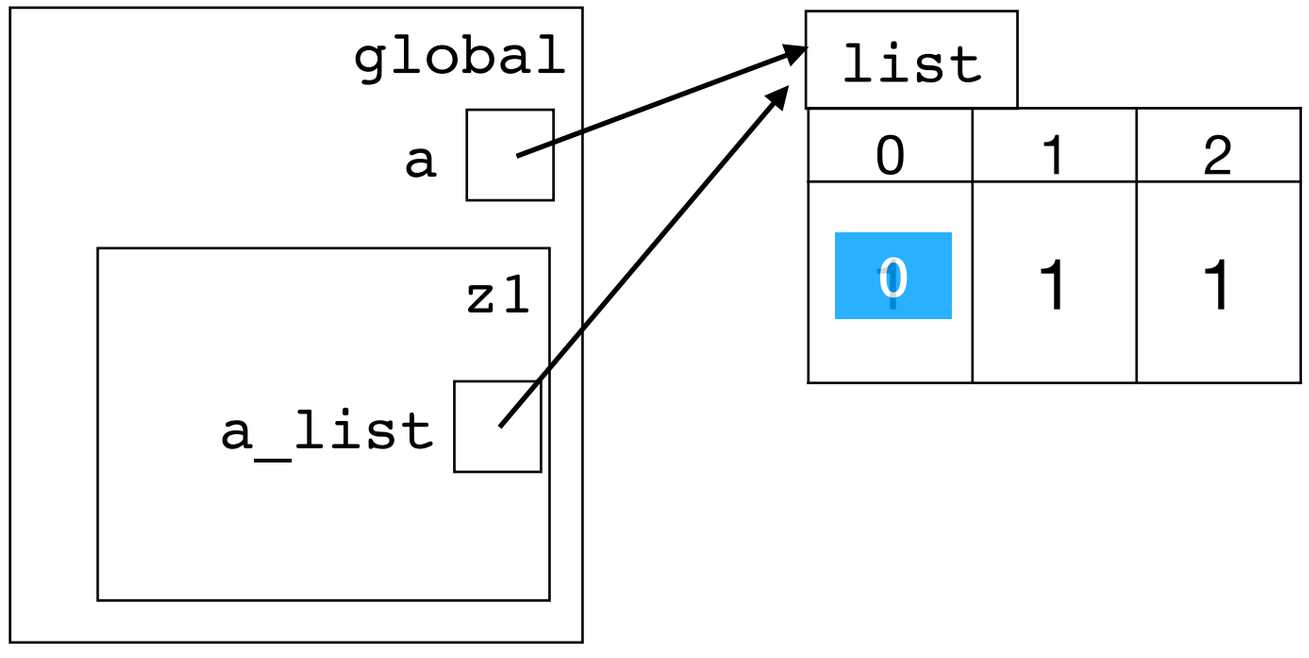

`a_list` points to the **same** object as the global variable `a`

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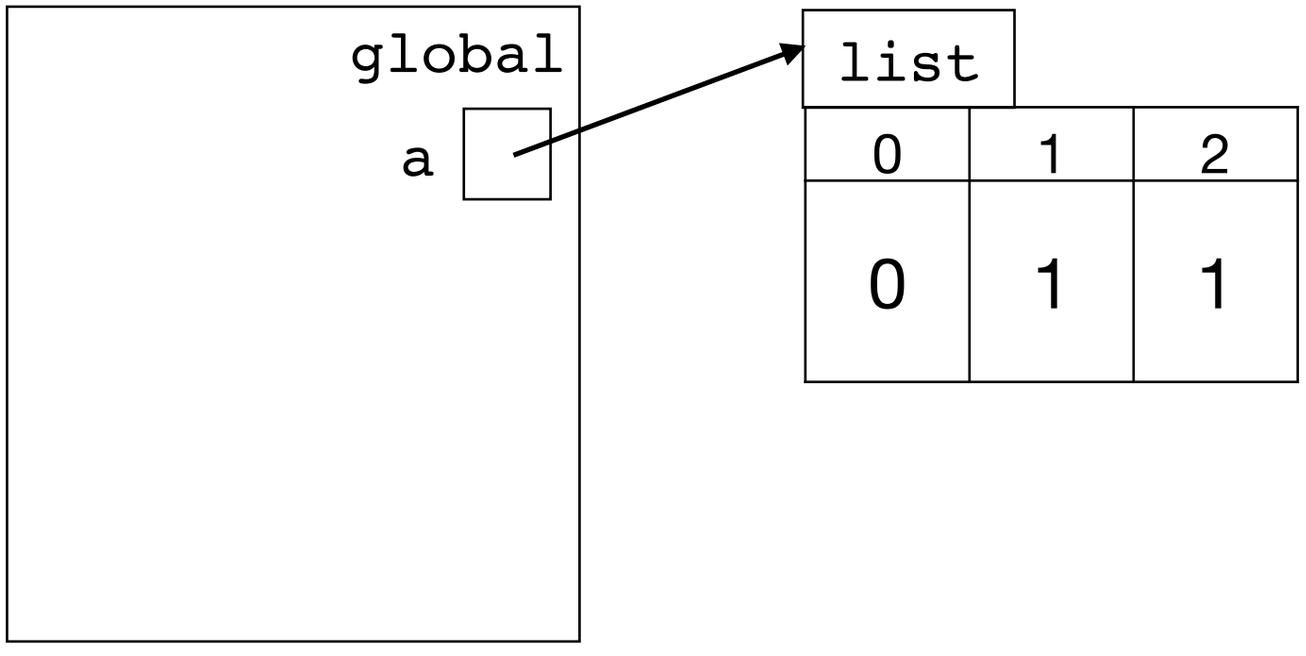

Mutable Objects and Functions

When you pass a list into a function, you're actually passing a *reference* to the list:

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def z2(a_list):
    a_list = []

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z2(a)
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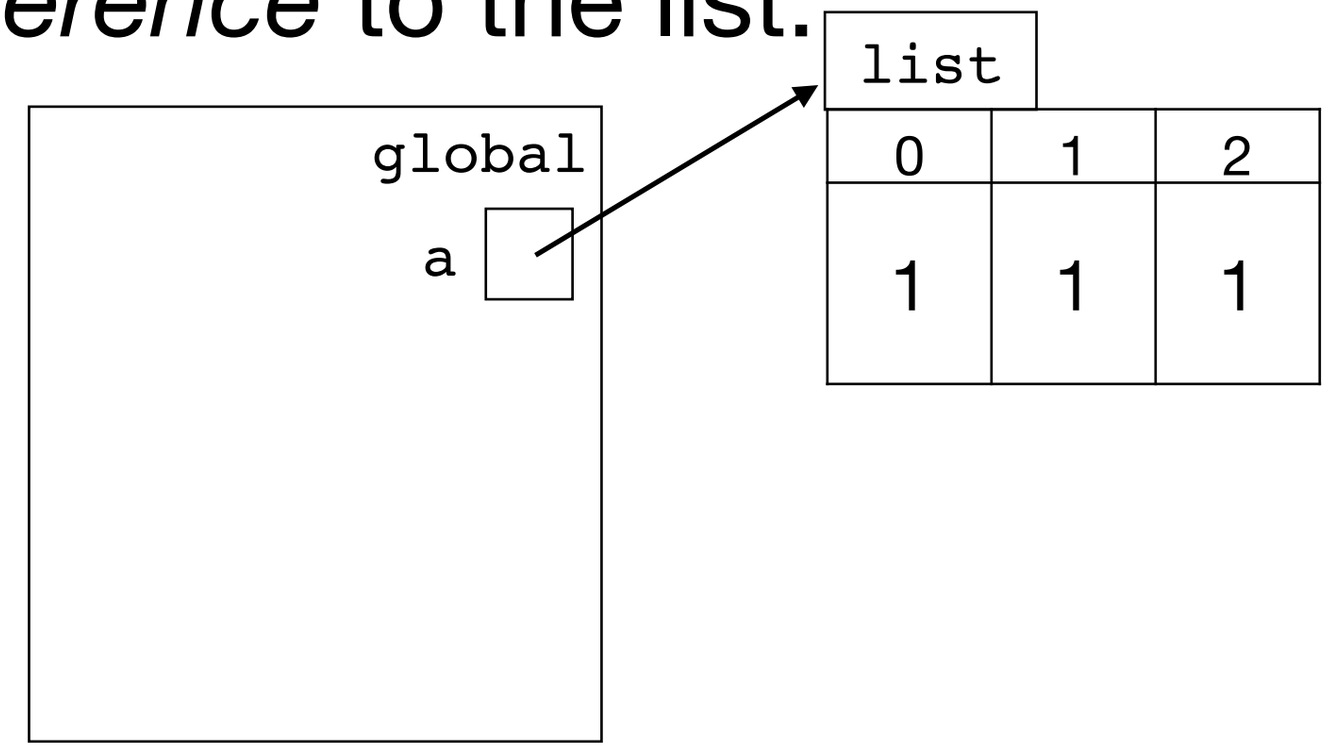

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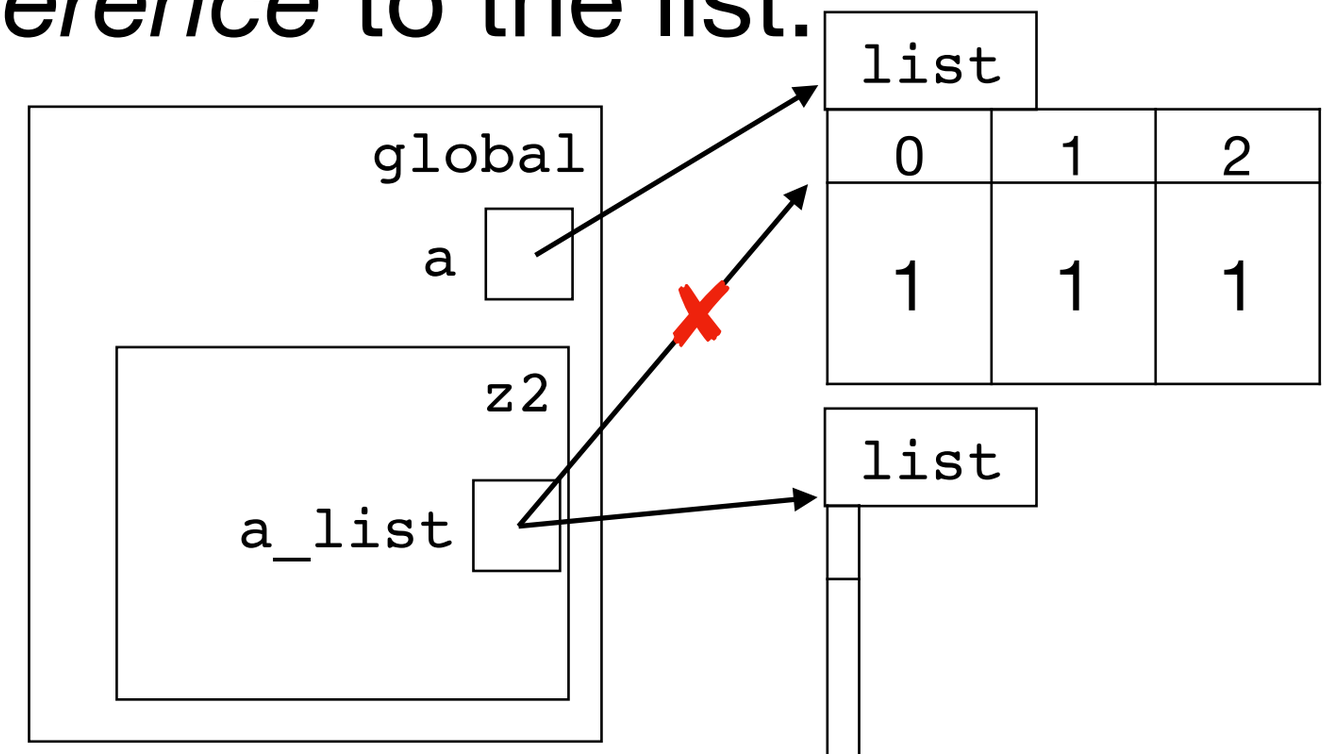

The local variable `a_list` is reassigned to point to a **new** (different) list

The list referenced by `a` is **unchanged**.

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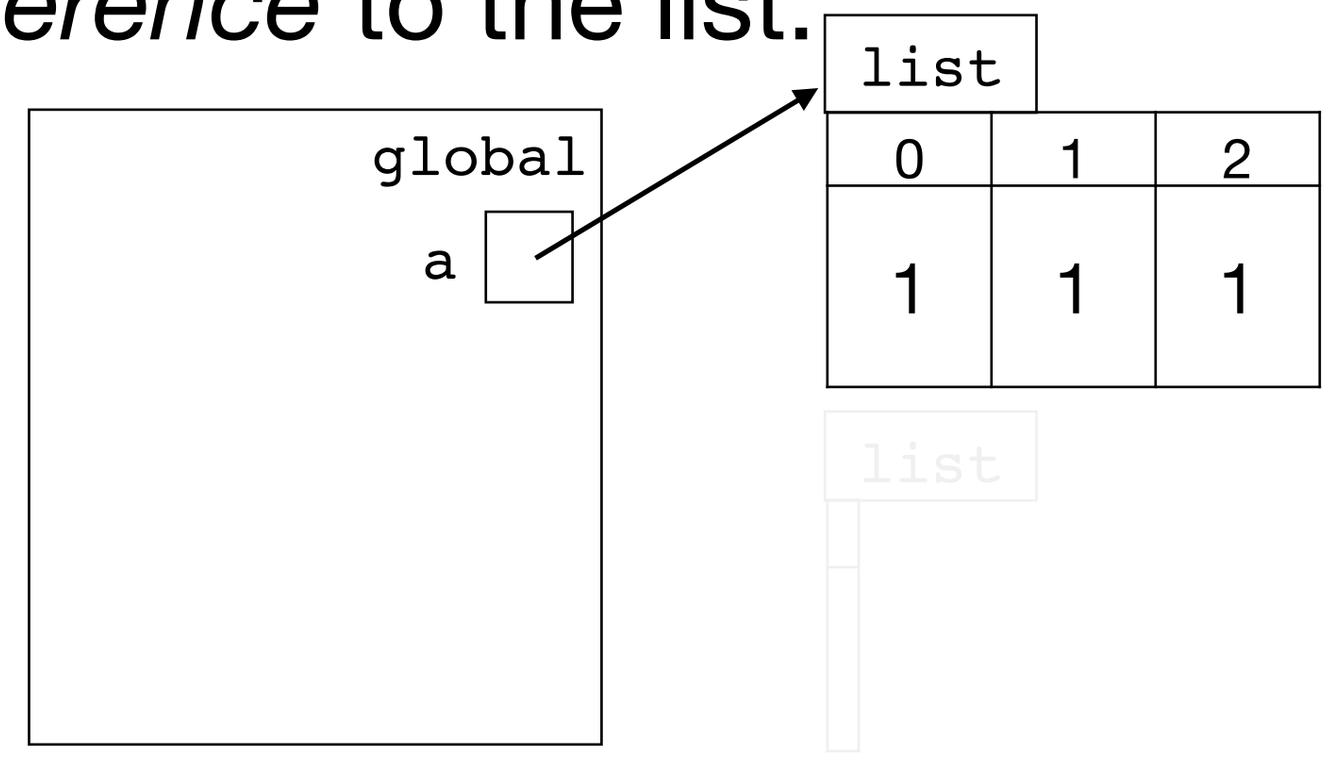

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    a_list = [x, x, x]
    return a_list
b = 2
a = z3(b)
print(a)
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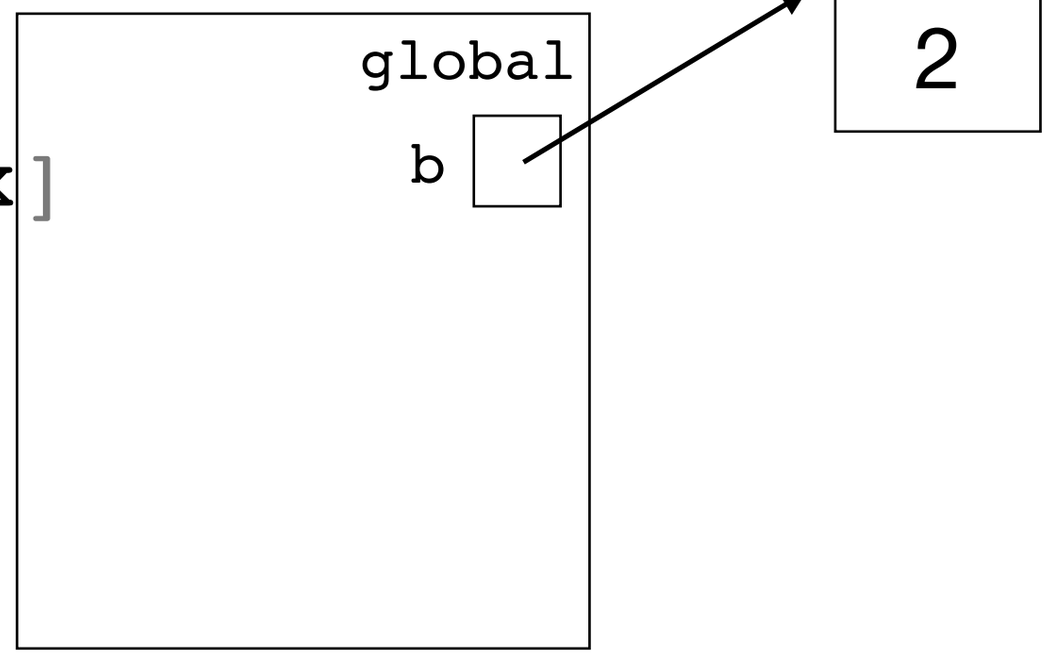

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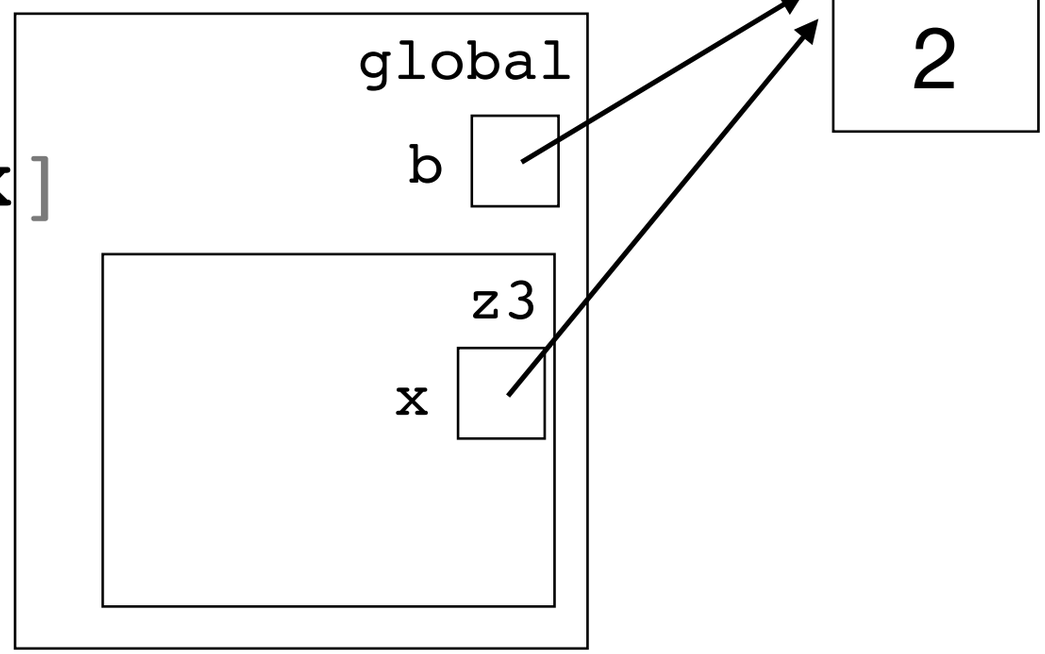

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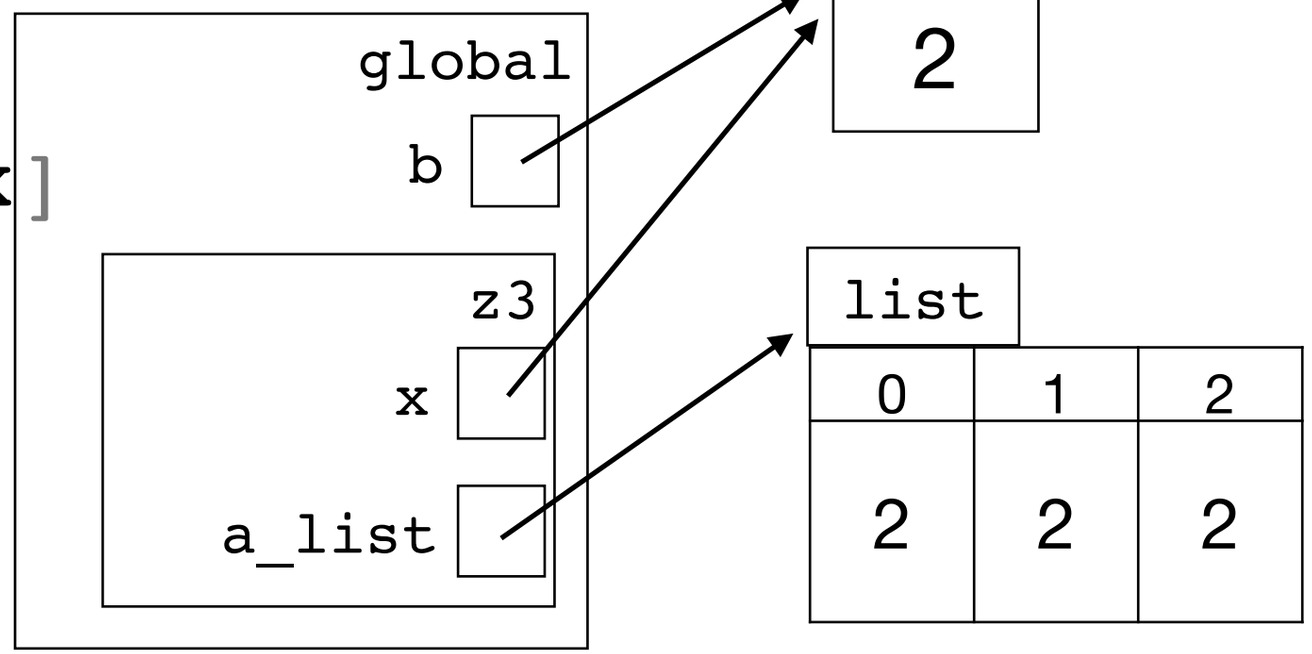

The function creates a **new** list, with the local variable `a_list` referring to it.

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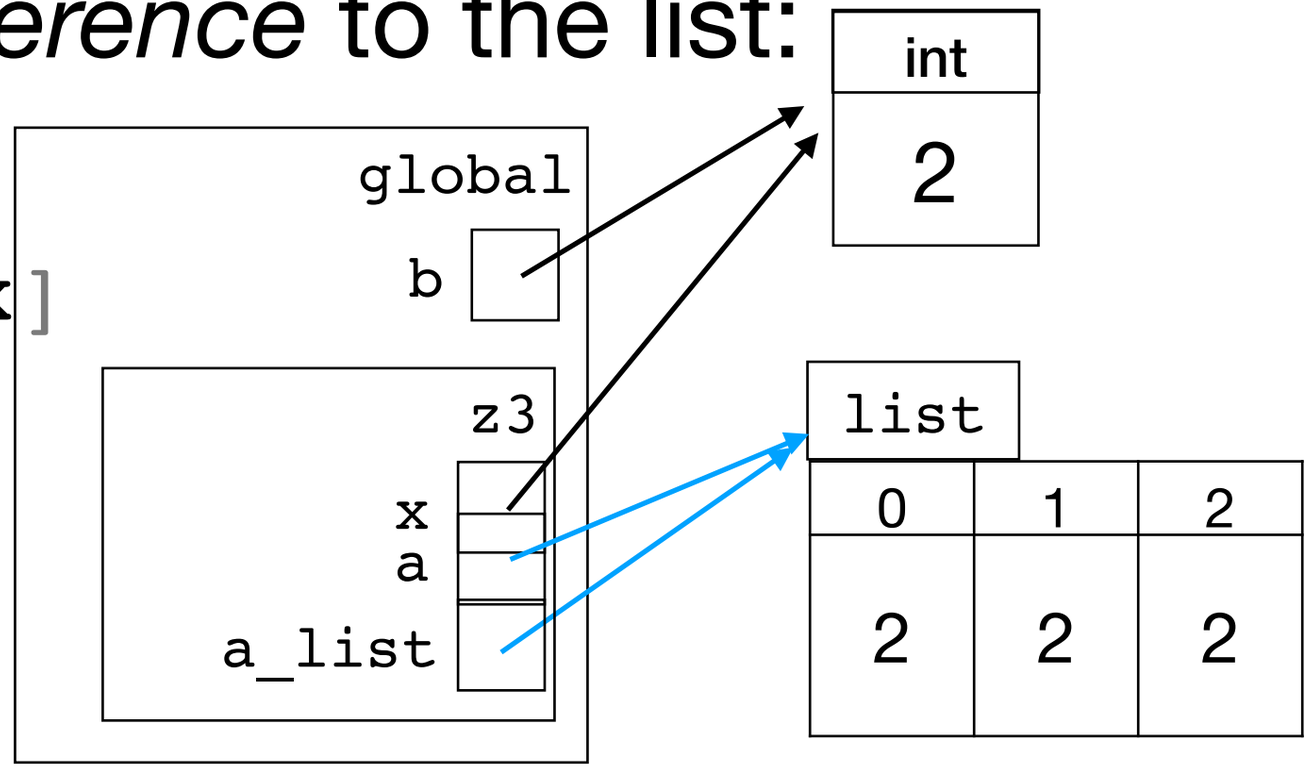

The function creates a **new** list, with the local variable `a_list` referring to it.

A **reference** to the list is returned and assigned to `a`.

Again, with context

- **Variables obey scope** (i.e., live in a certain "box").
- **Objects don't**: they exist outside the "box" framework.
- References can cross "box" boundaries.

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