61A Lecture 5

Wednesday, September 11

Announcements

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- Solutions to homeworks: http://inst.eecs.berkeley.edu/~cs61a/fa13/hw/solutions

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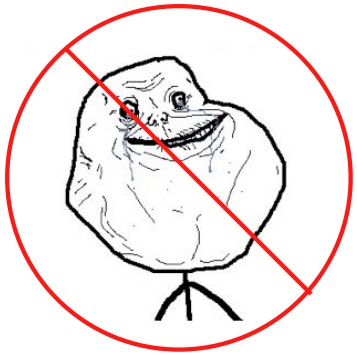

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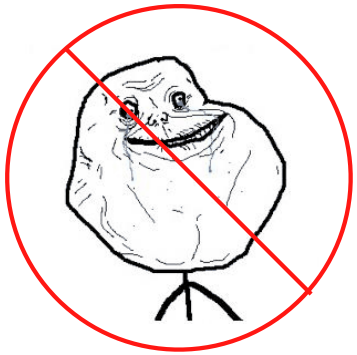

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(demo)

Names can be Bound to Functional Arguments

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1  def apply_twice(f, x):
2      return f(f(x))
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4  def square(x):
5      return x * x
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7  result = apply_twice(square, 2)
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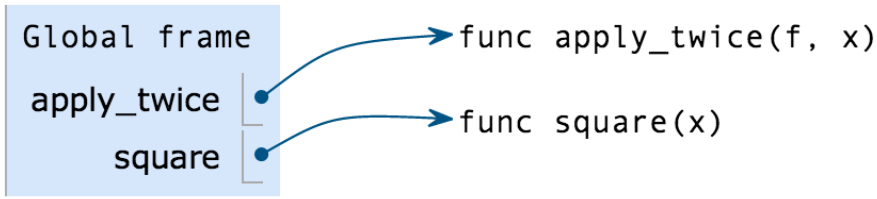

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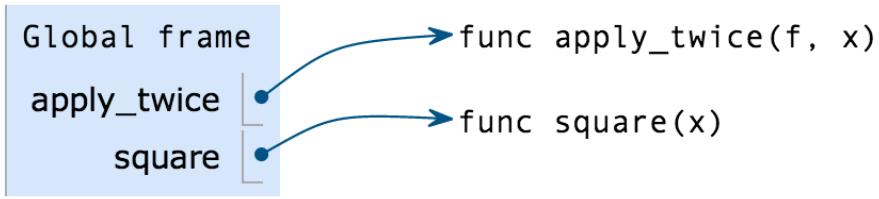

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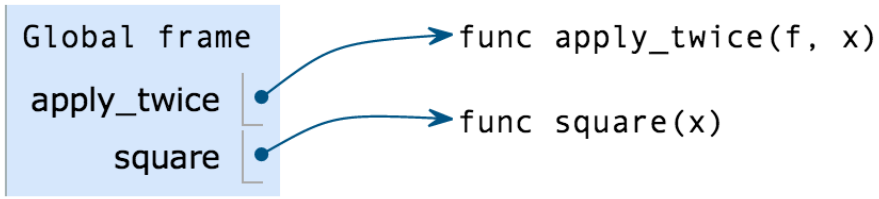

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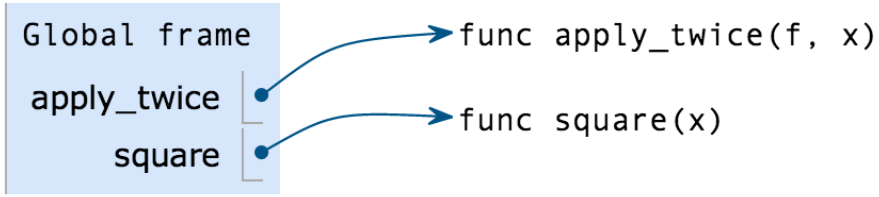

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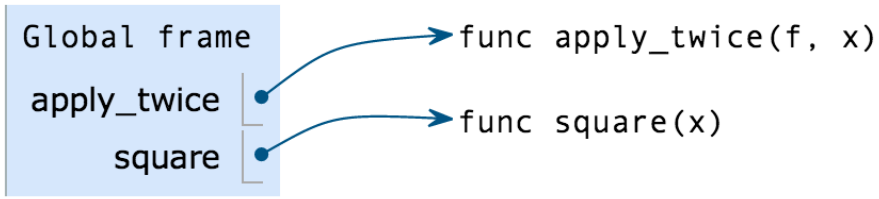

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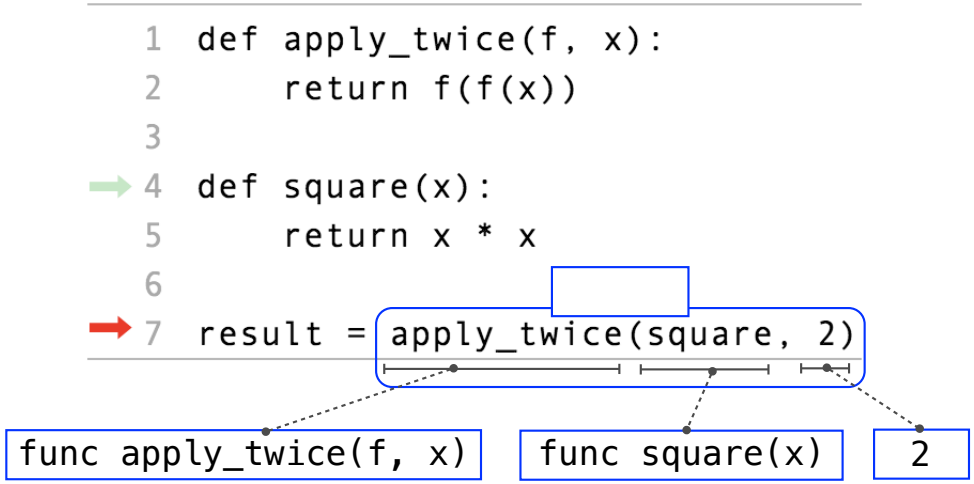

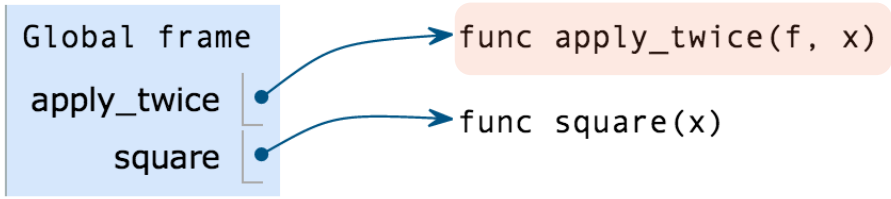

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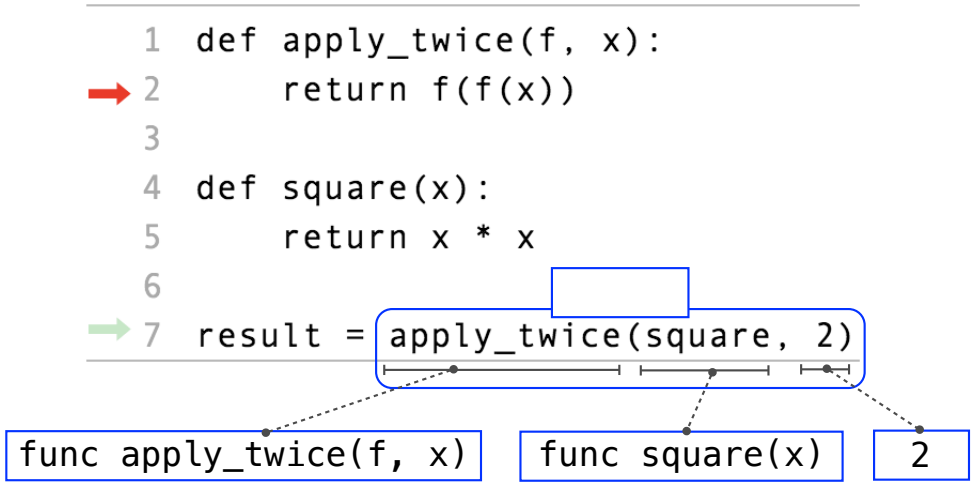

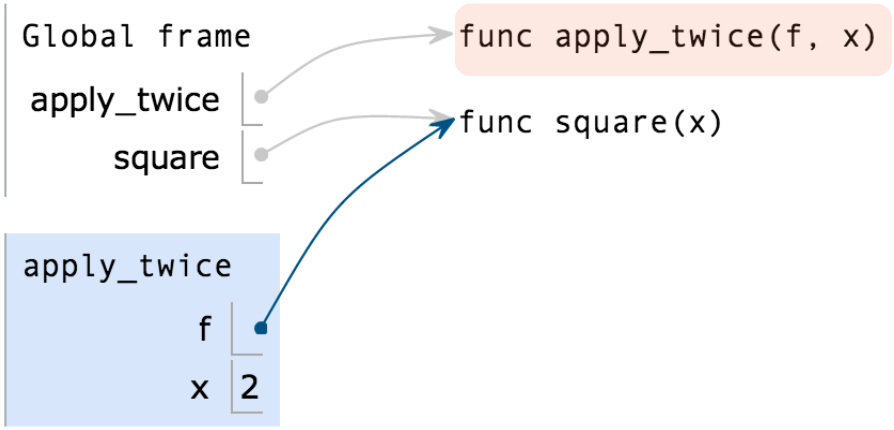

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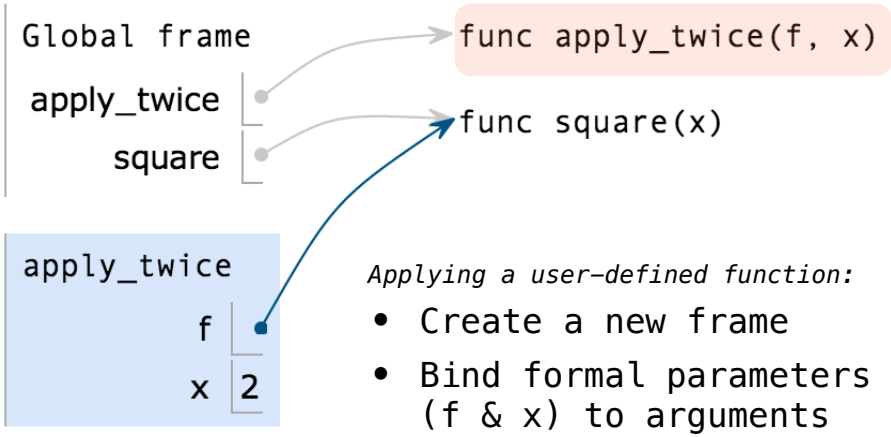

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- Bind formal parameters (f & x) to arguments
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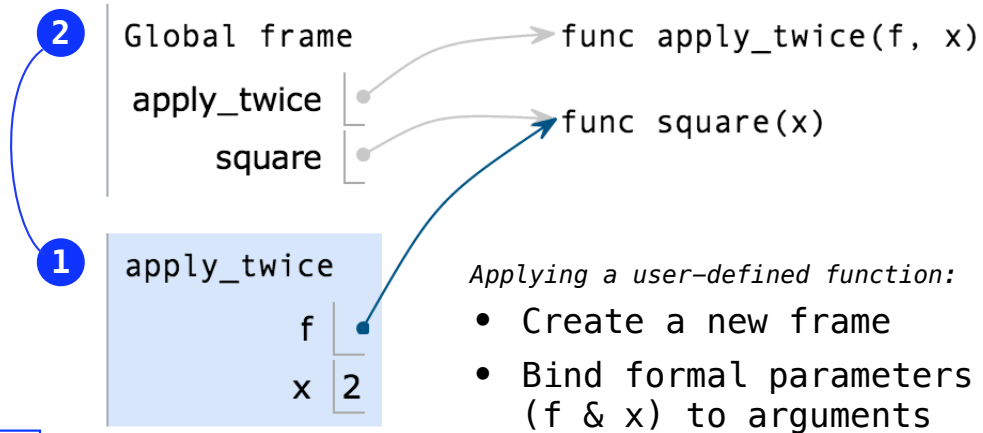

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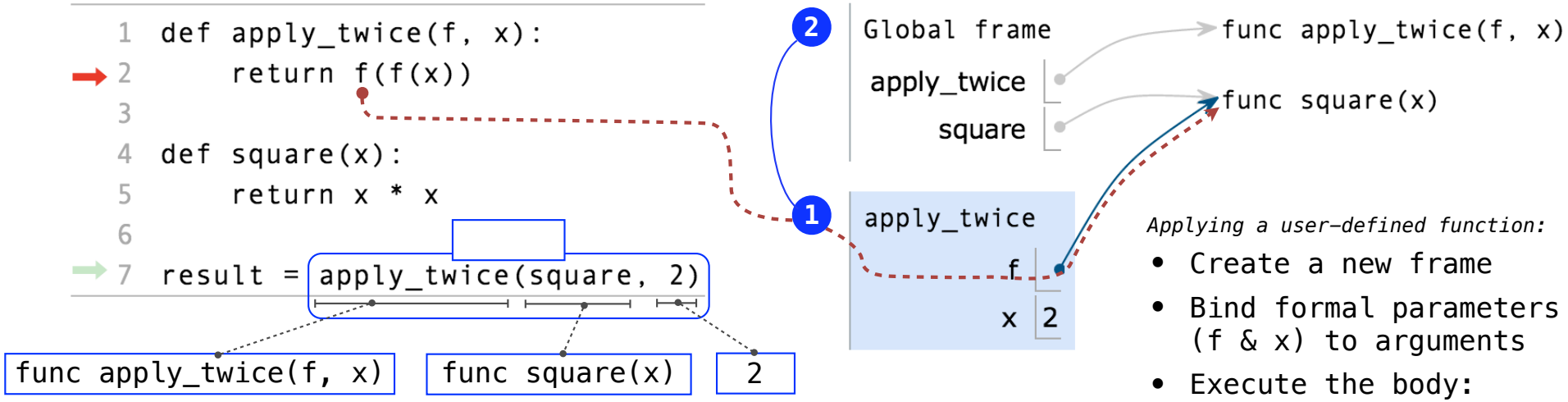

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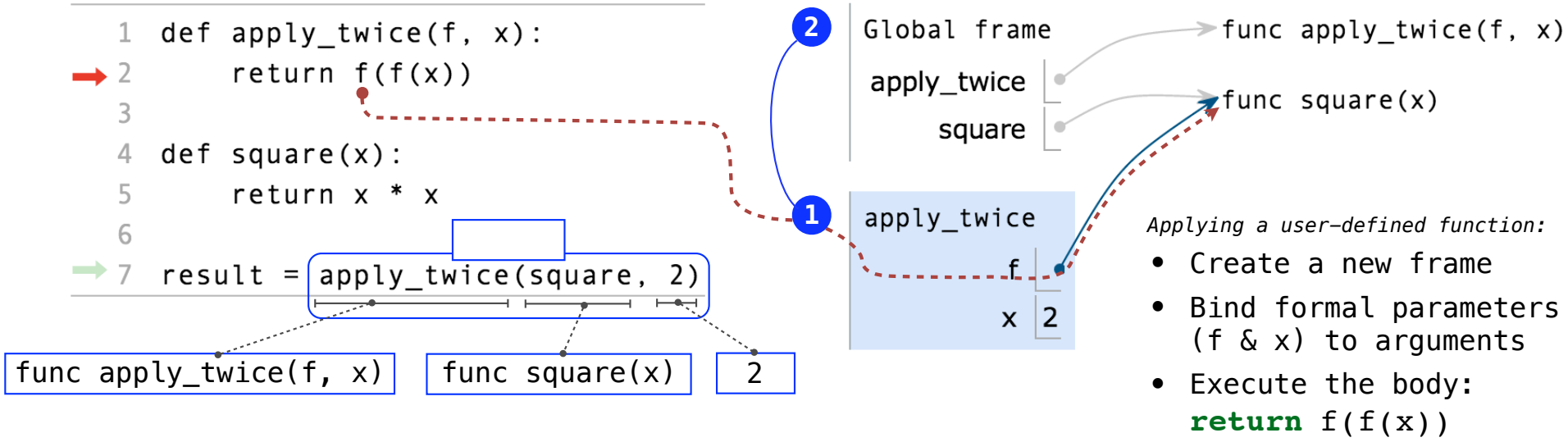

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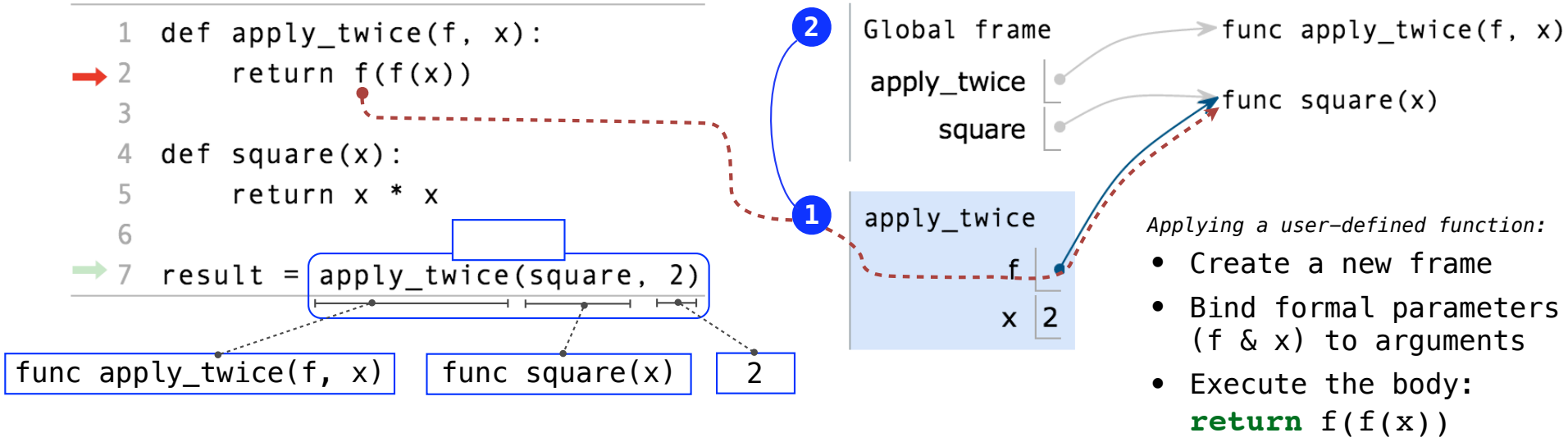

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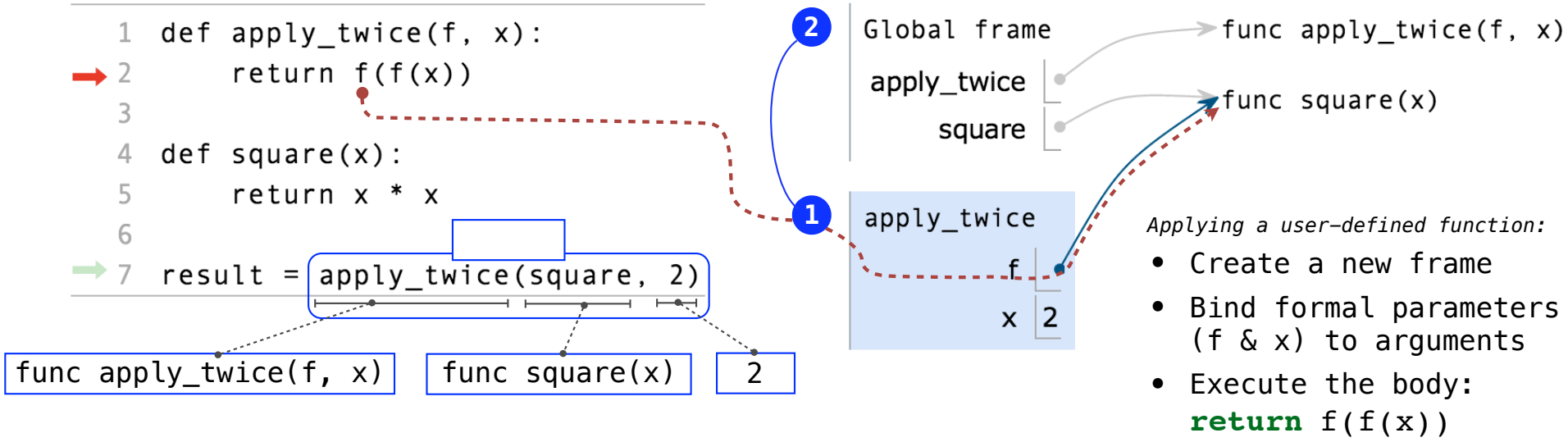

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- Names can refer to functions (just as they can refer to any values).
- Multiple names can all refer to the same function, even in different frames.

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Discussion Question

What is the value of the final expression below?

```
def repeat(f, x):
    while f(x) != x:
        x = f(x)
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def g(y):
    return (y + 5) // 3

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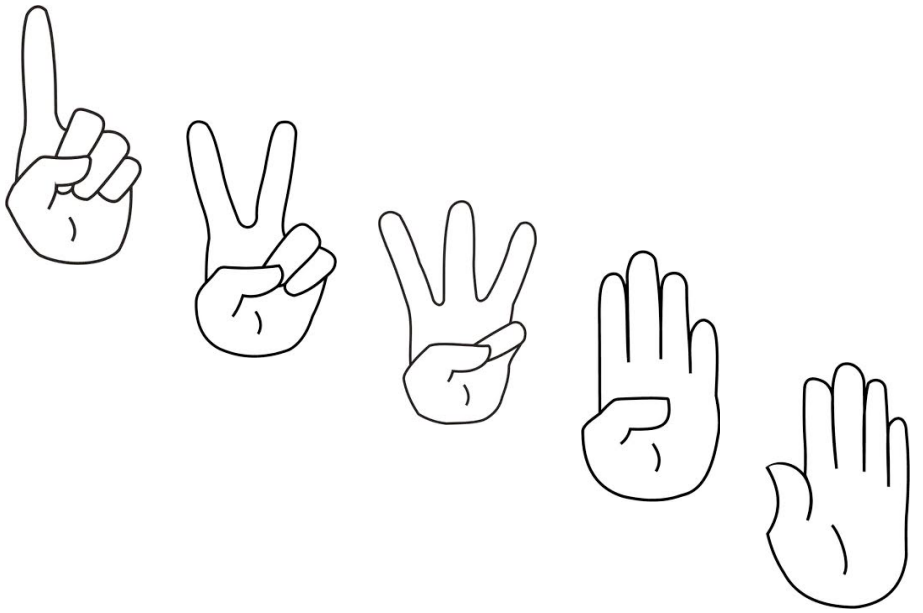

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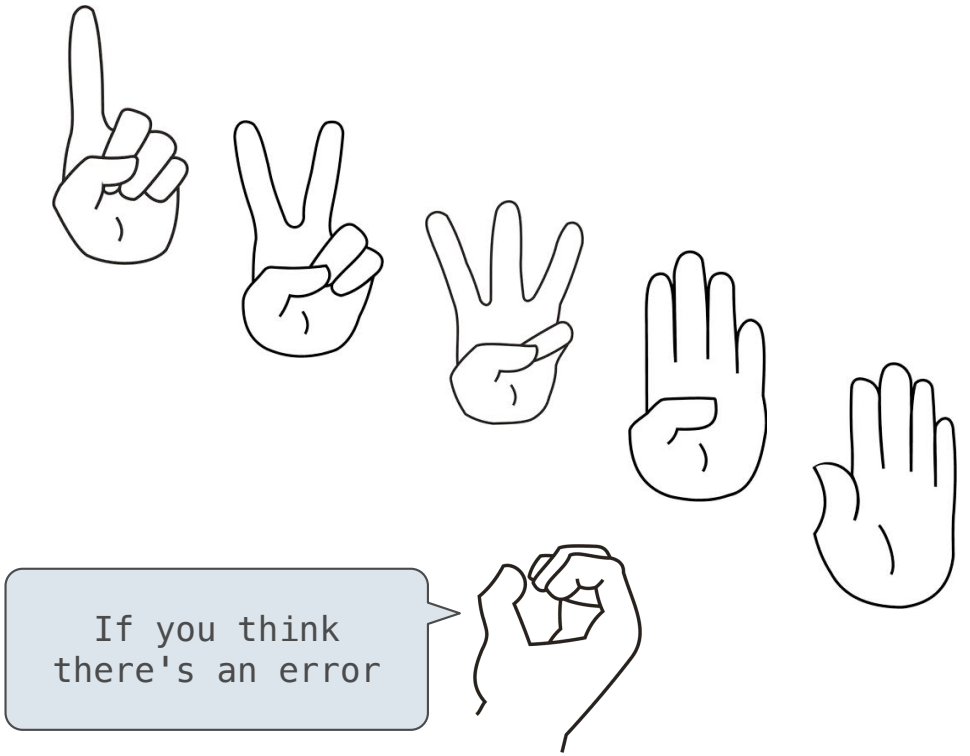

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Environments for Nested Definitions

(Demo)

Environment Diagrams for Nested Def Statements

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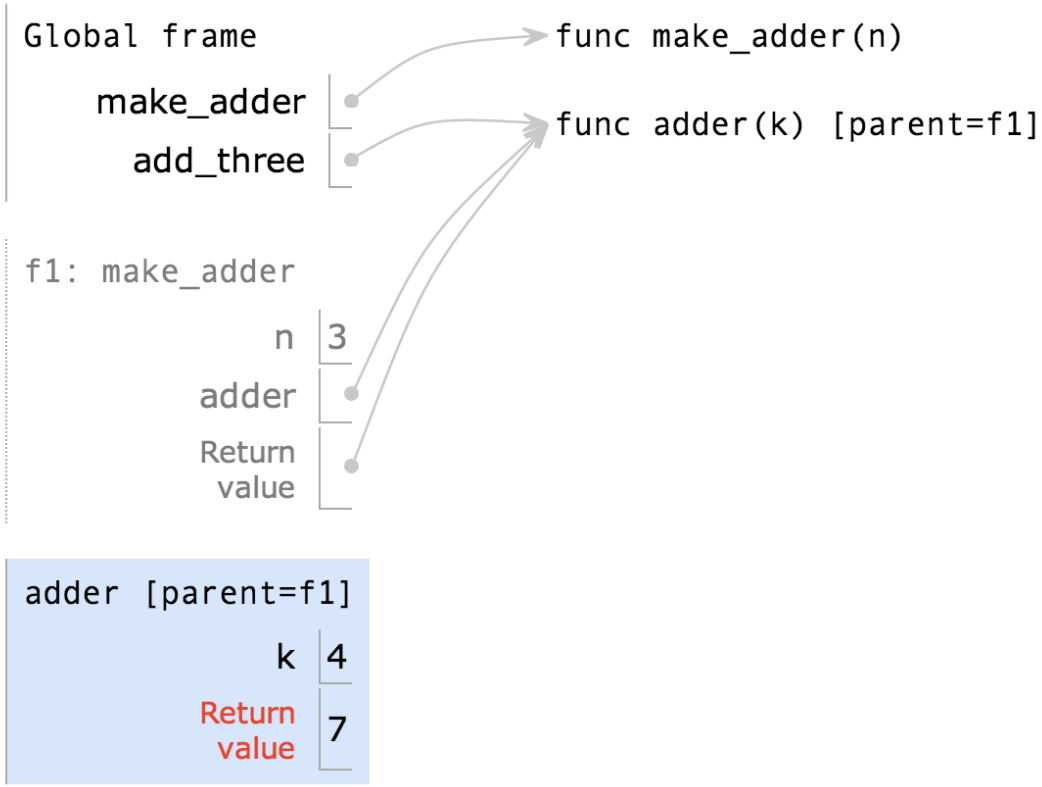

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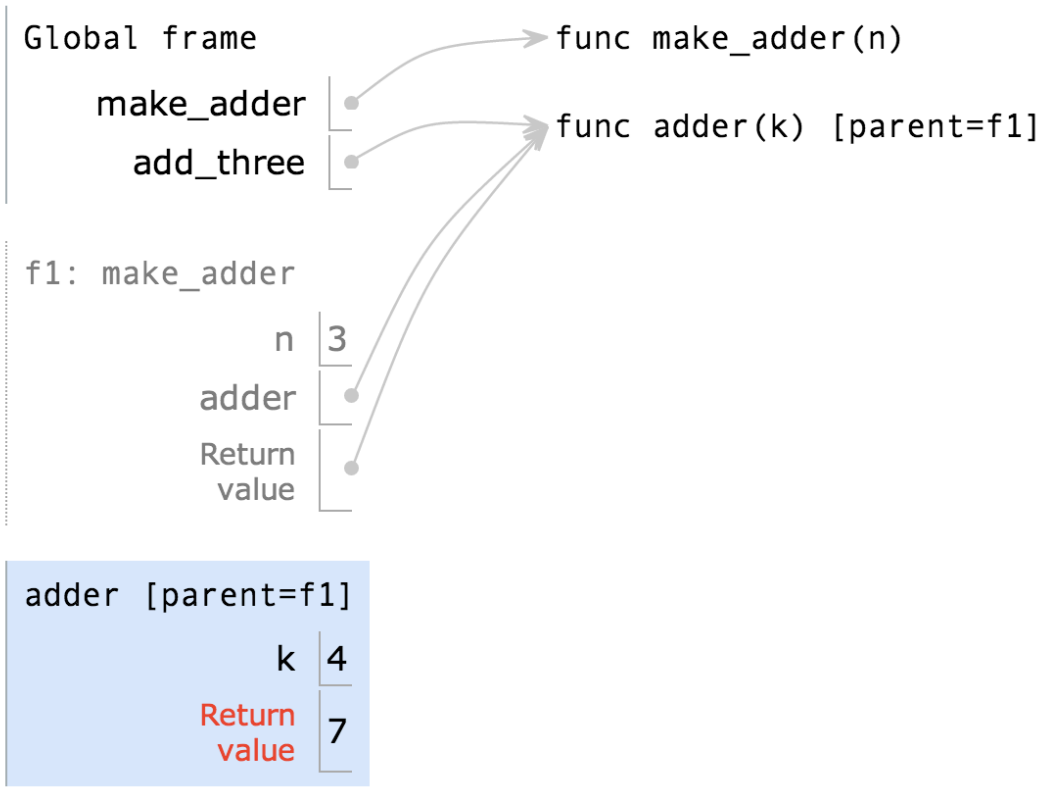

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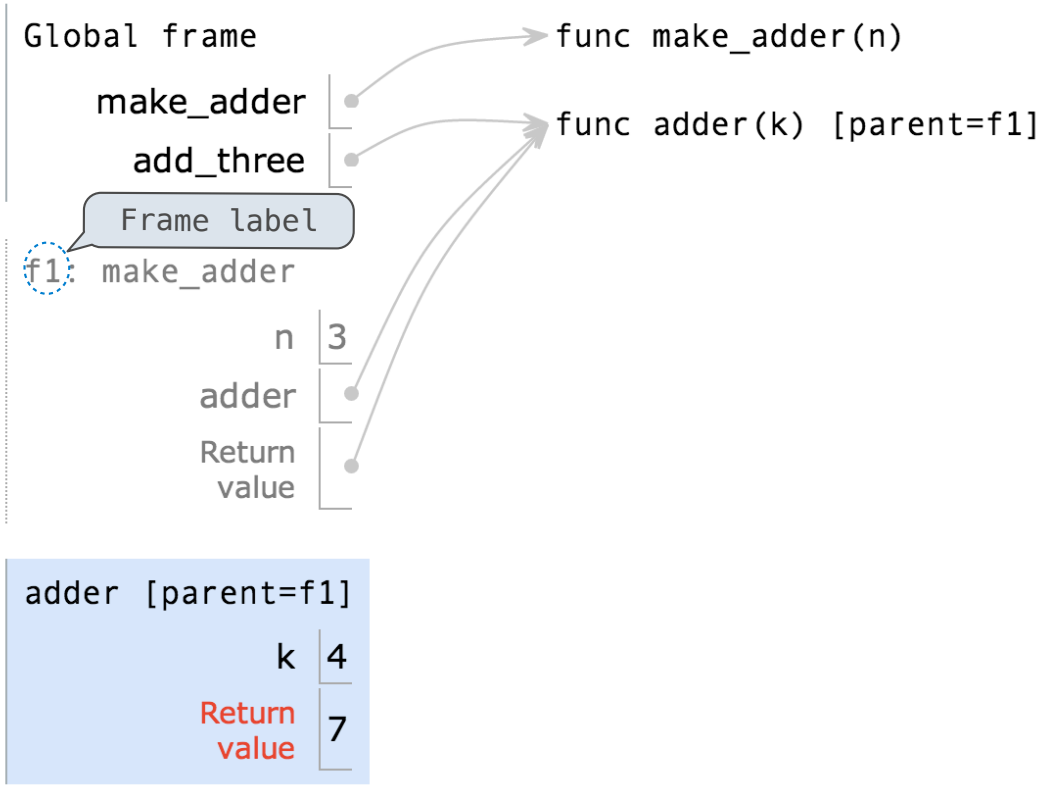

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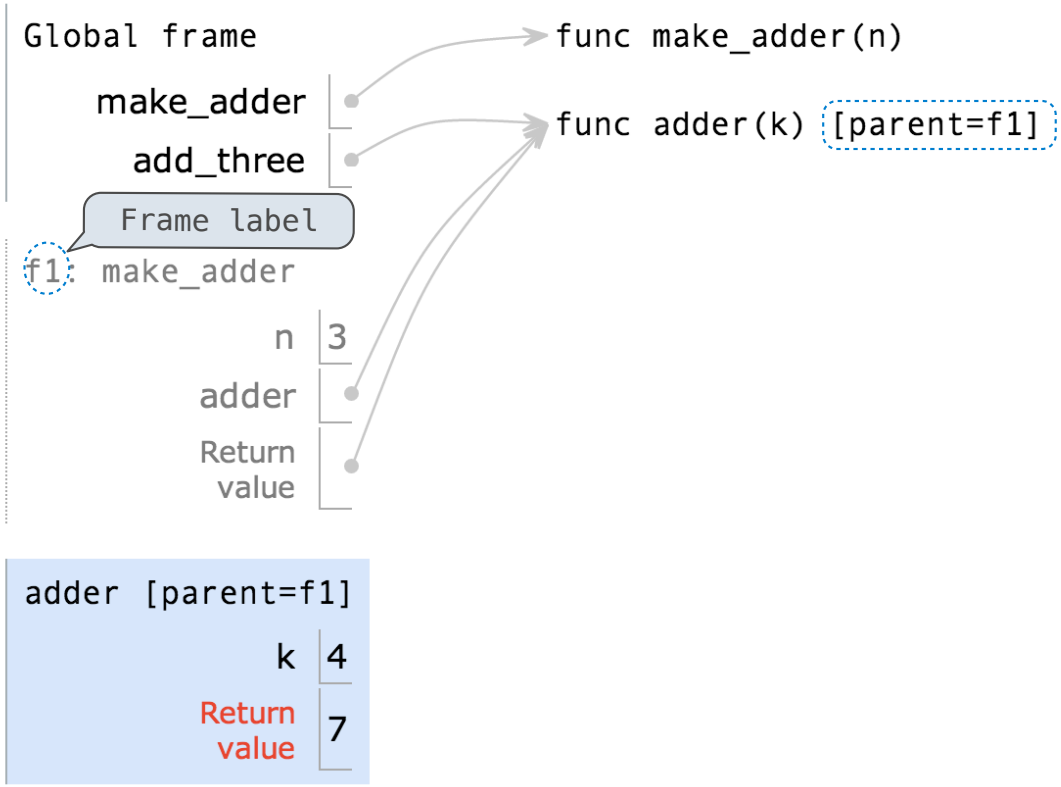

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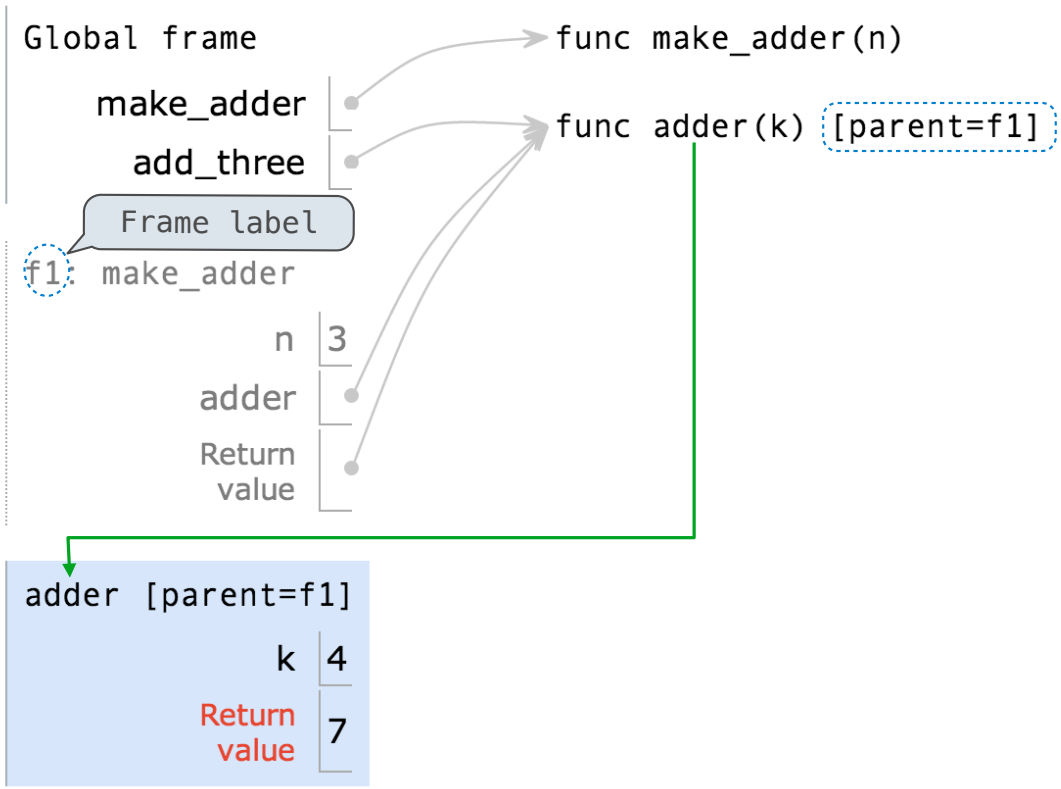

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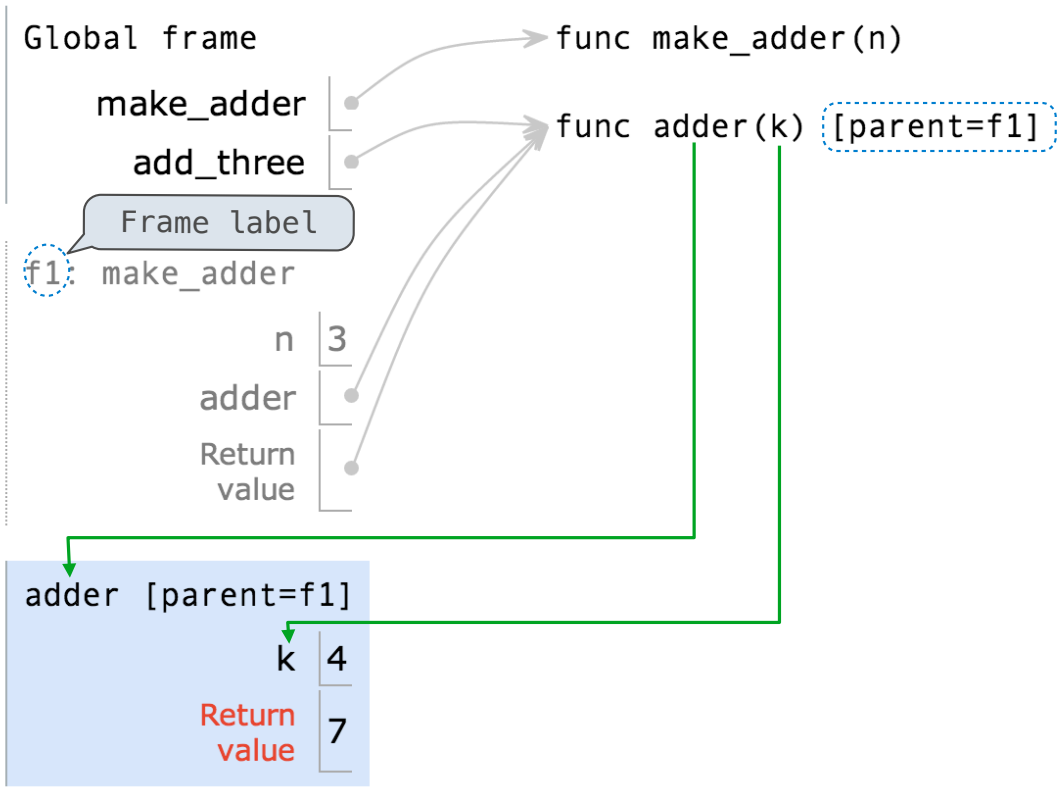

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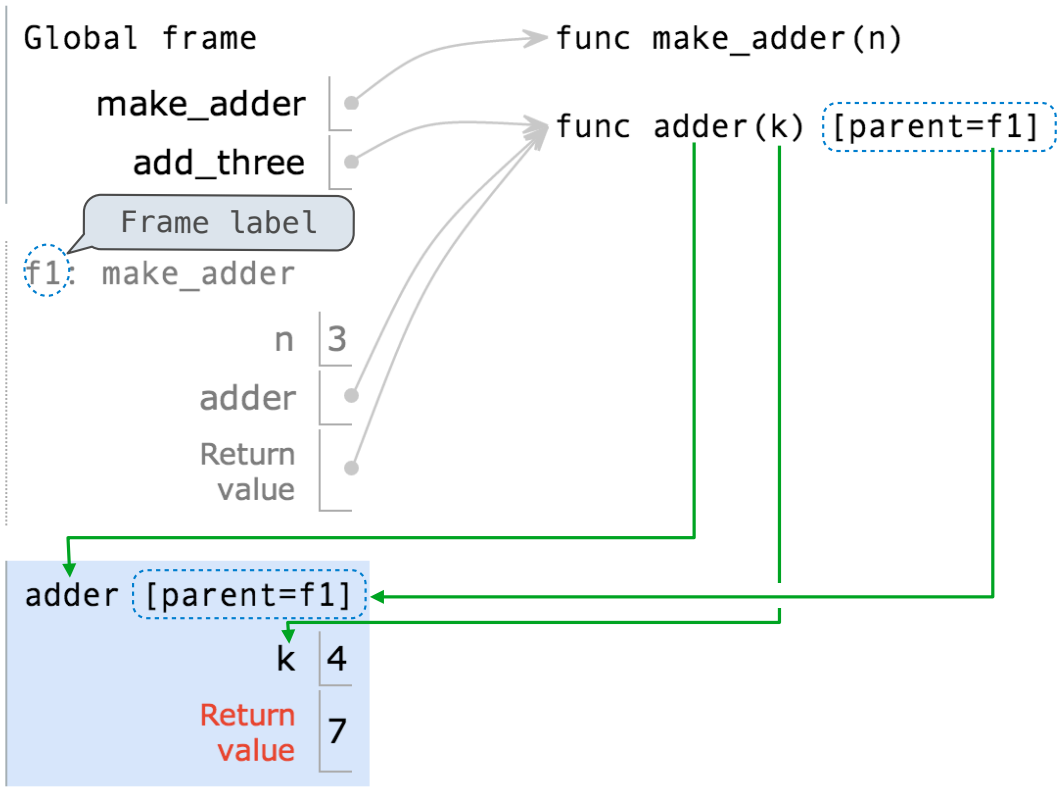

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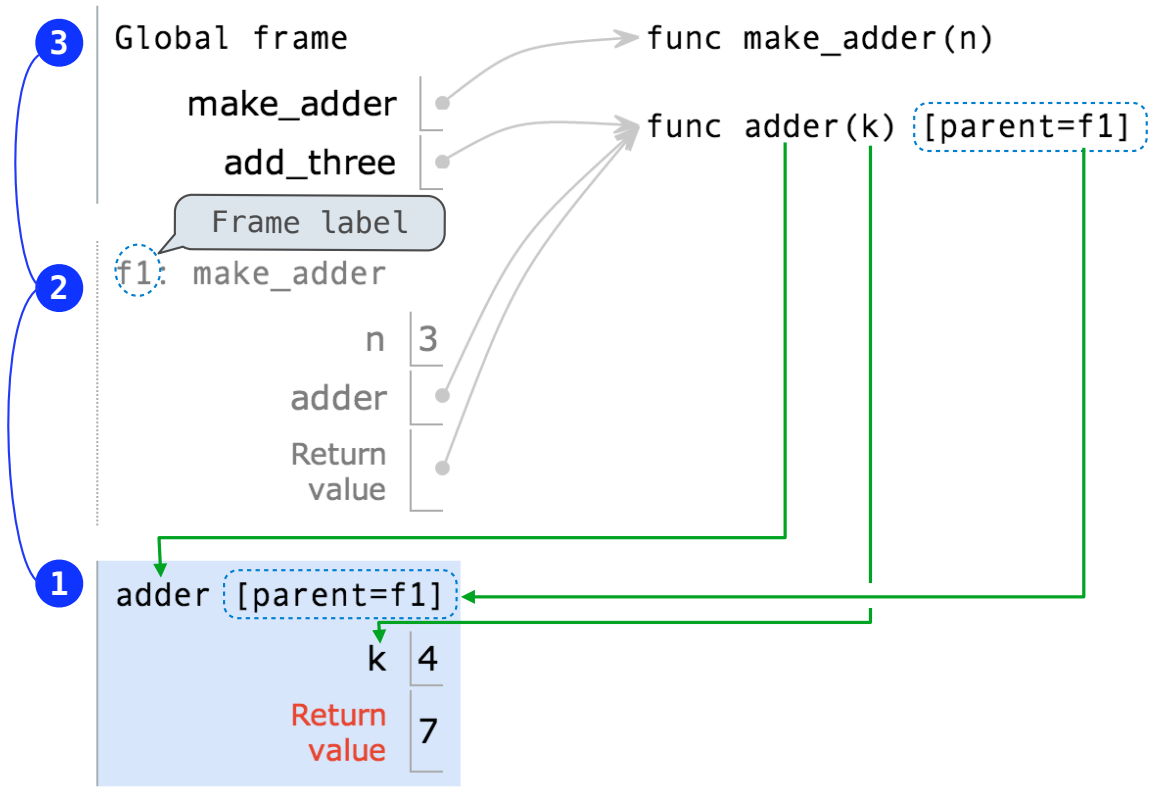

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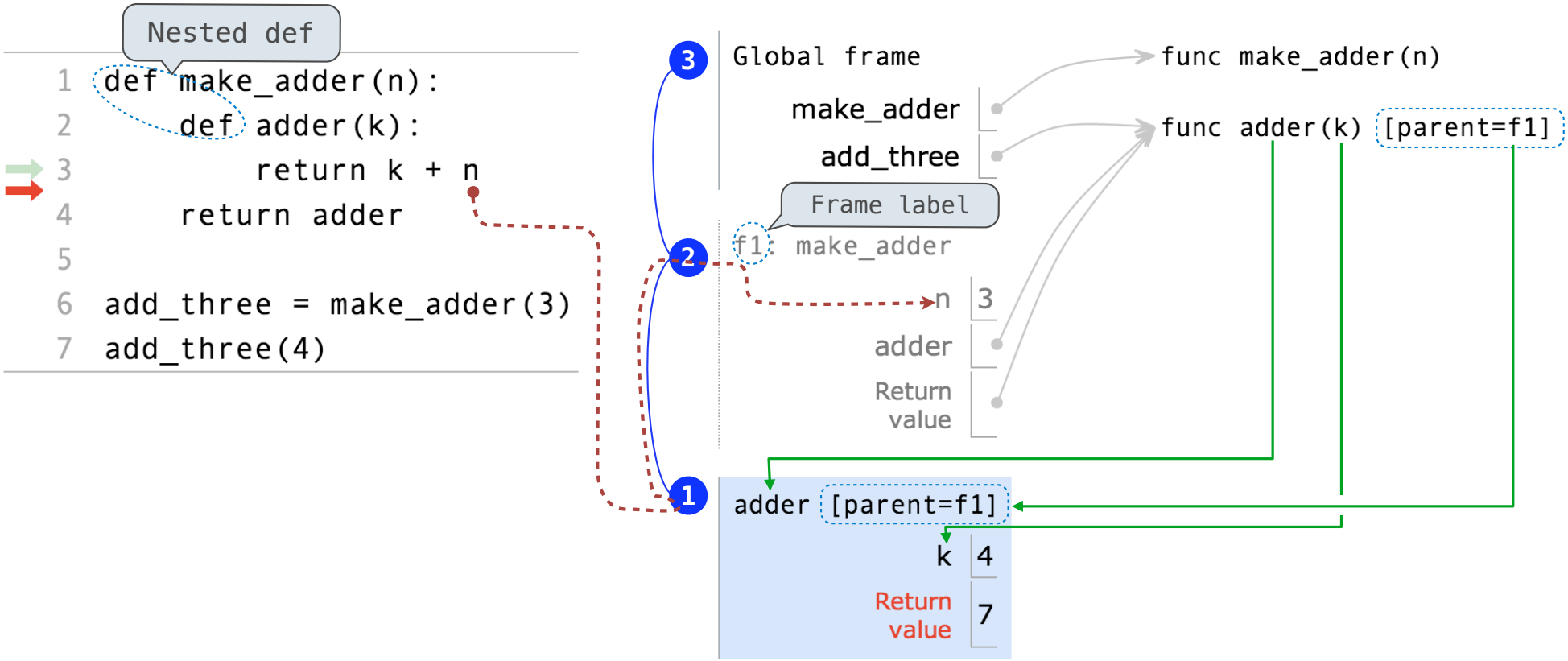

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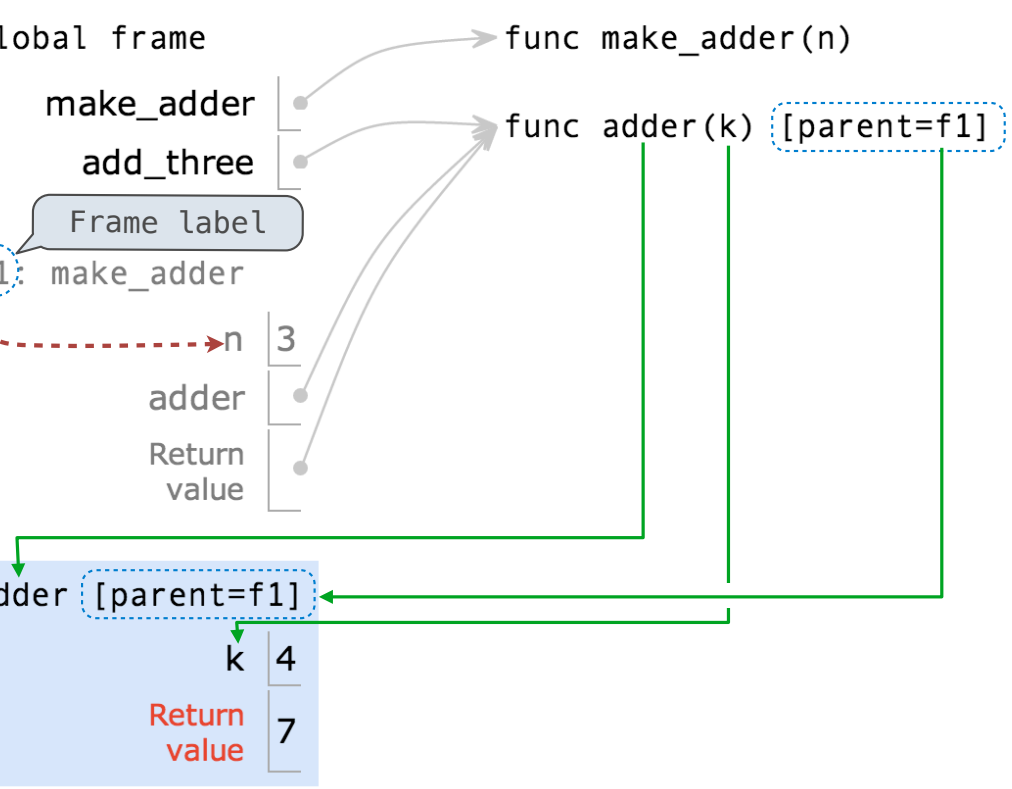

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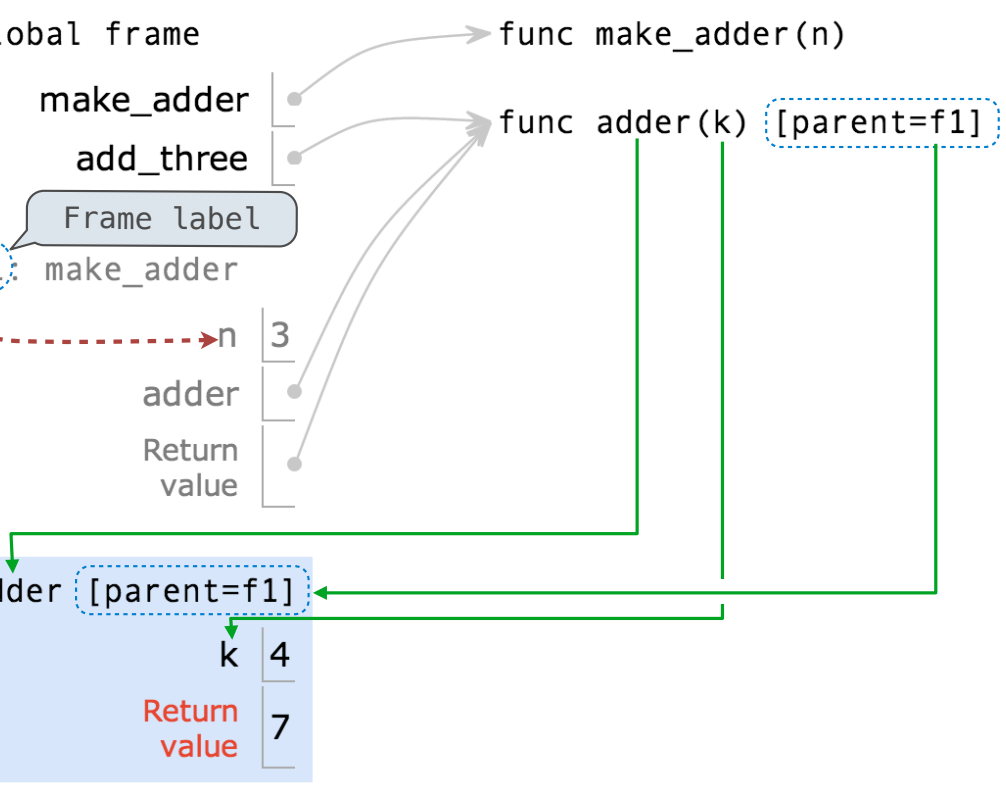

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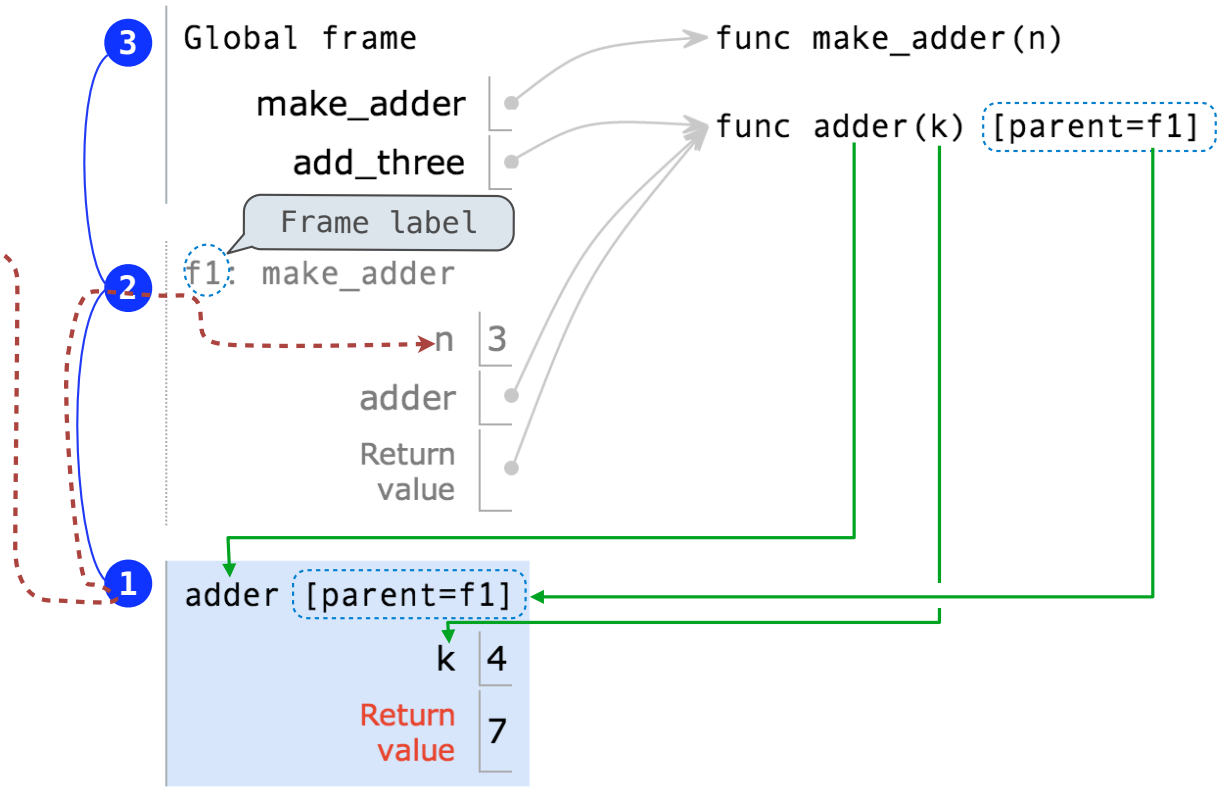

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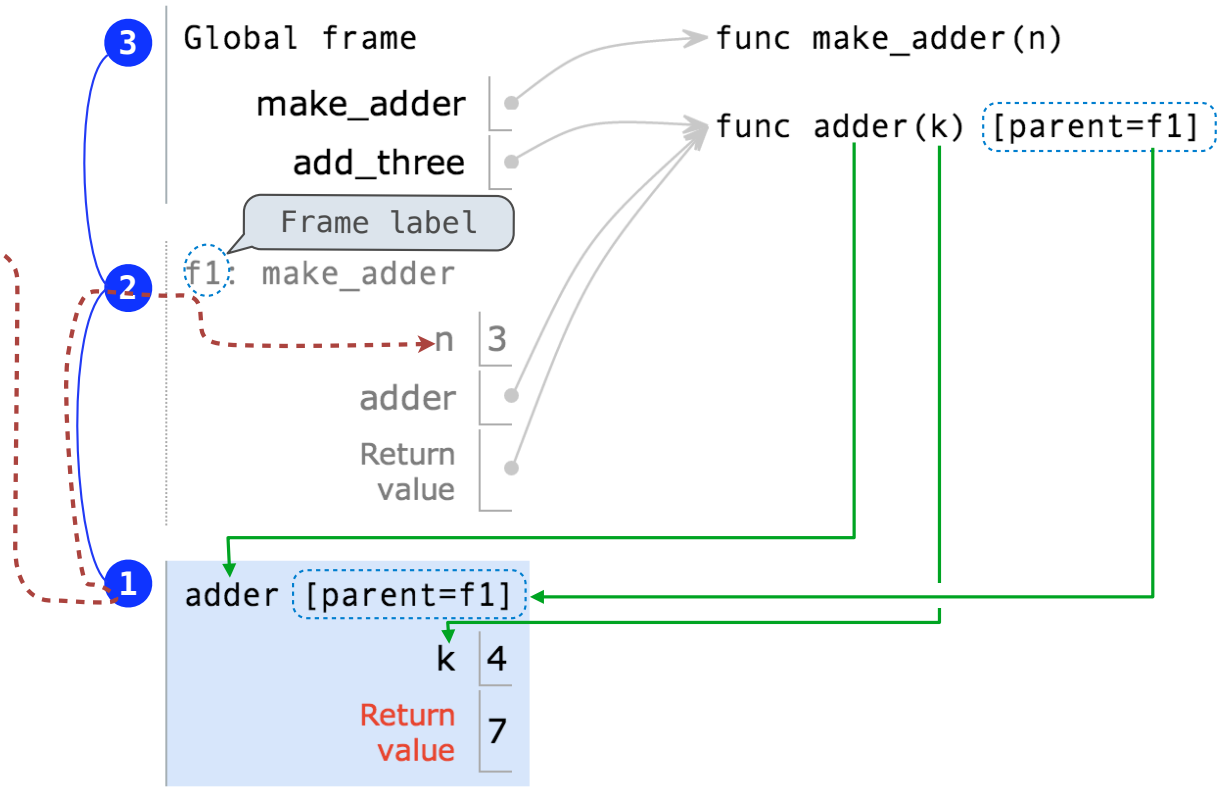

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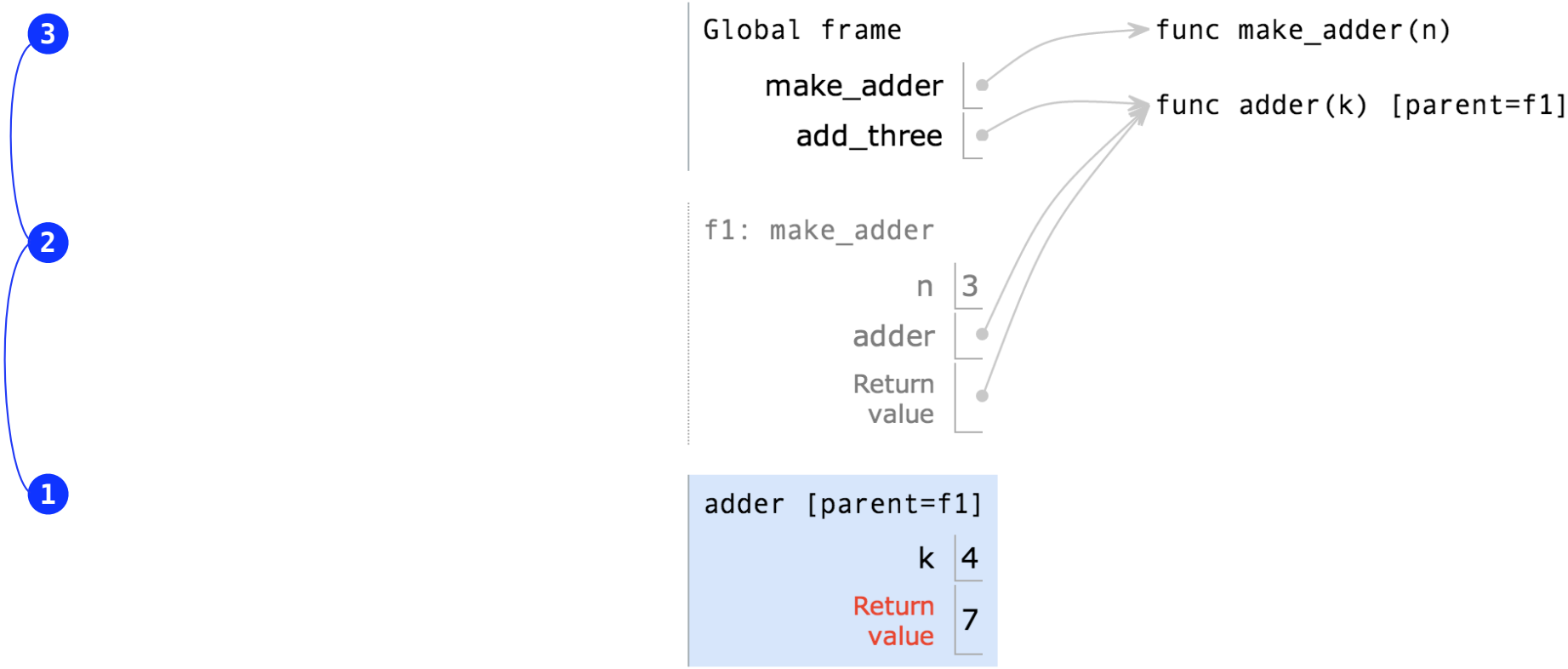
An Environment is a Sequence of Frames



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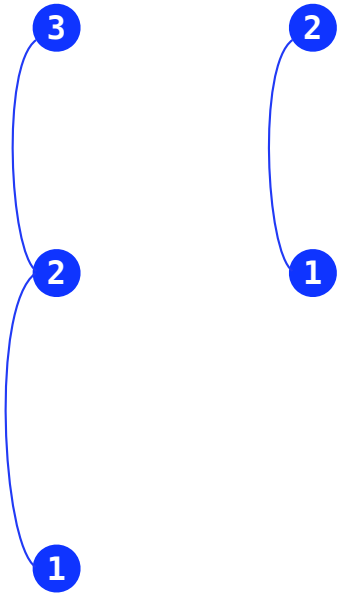

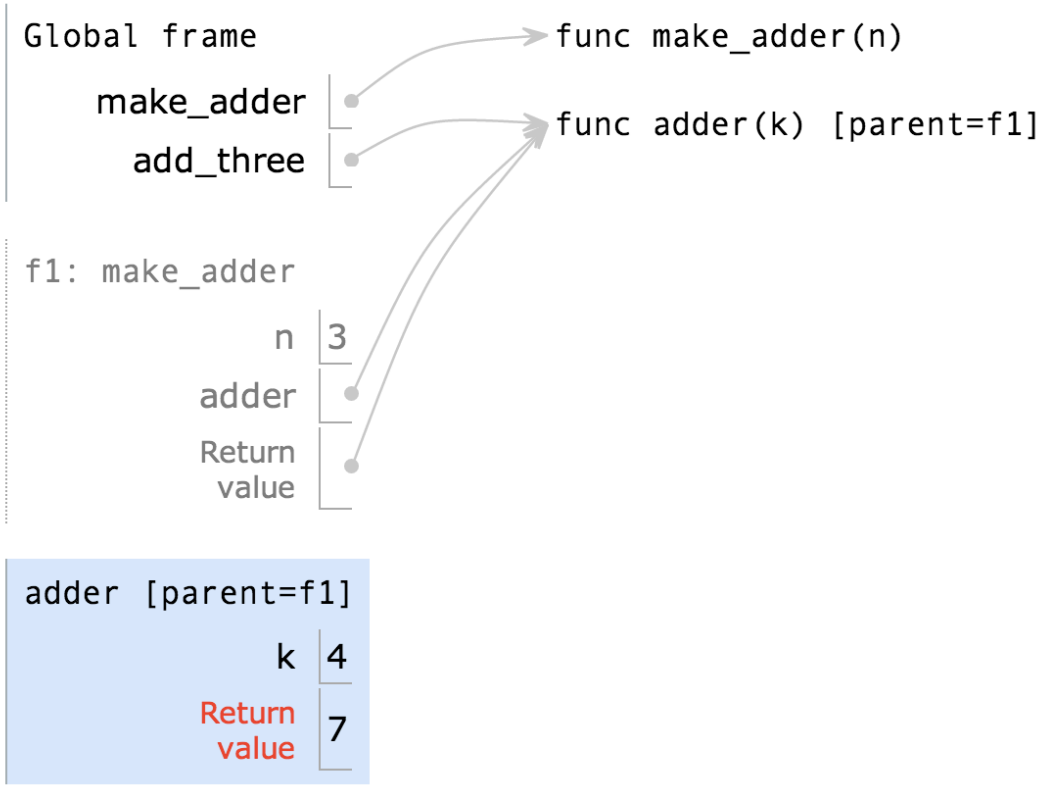

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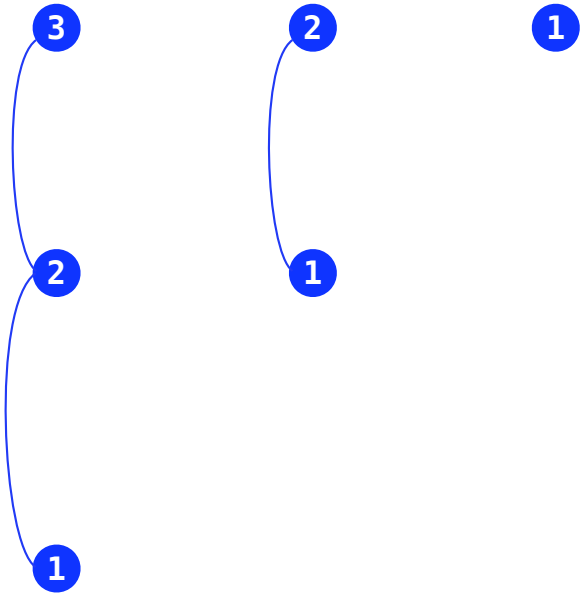

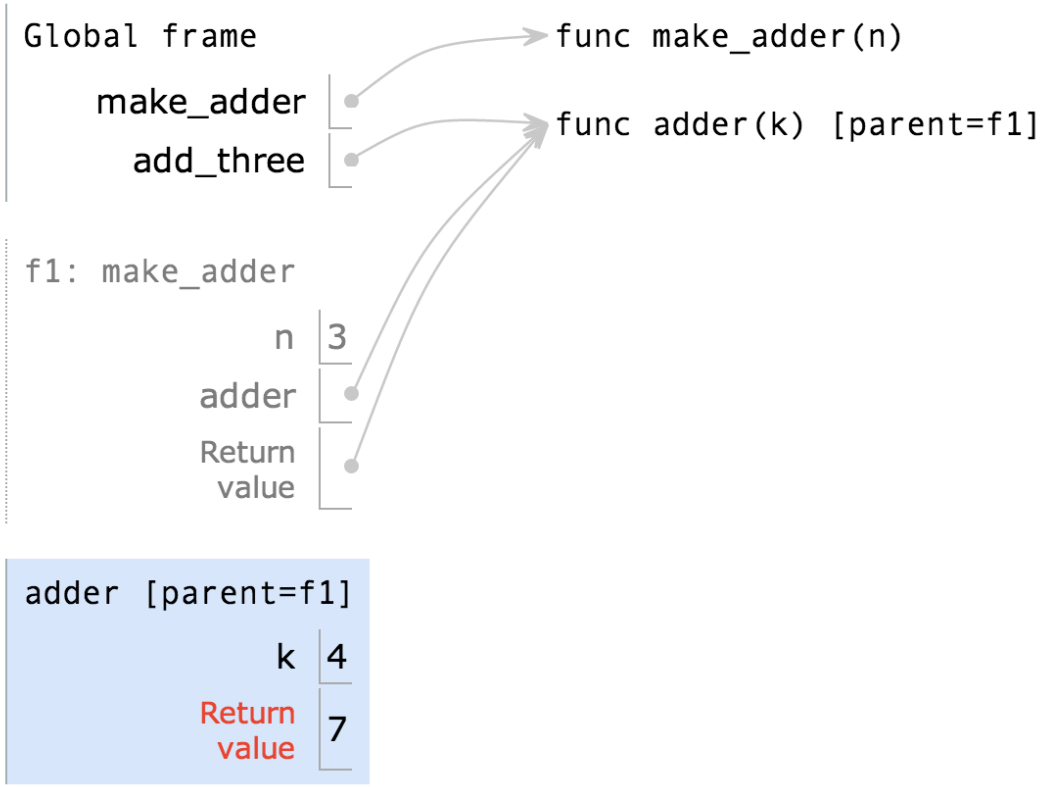

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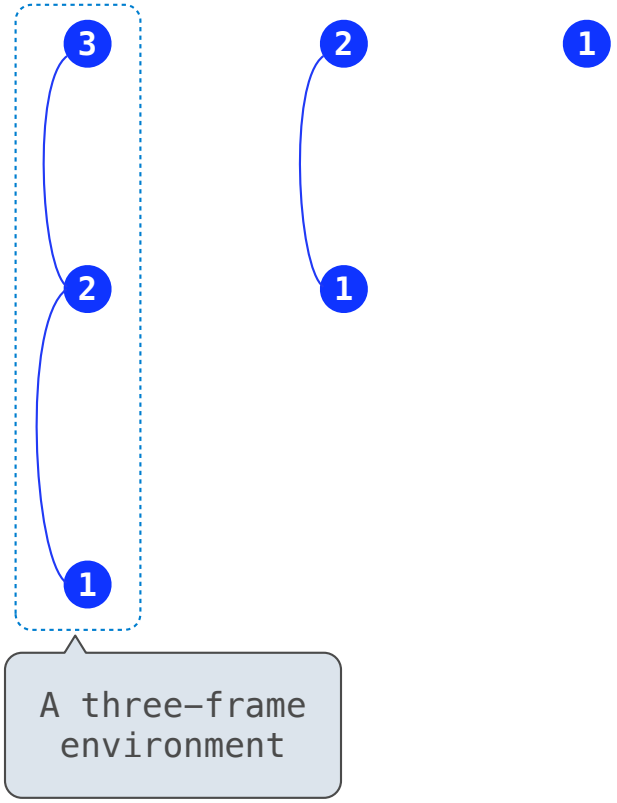

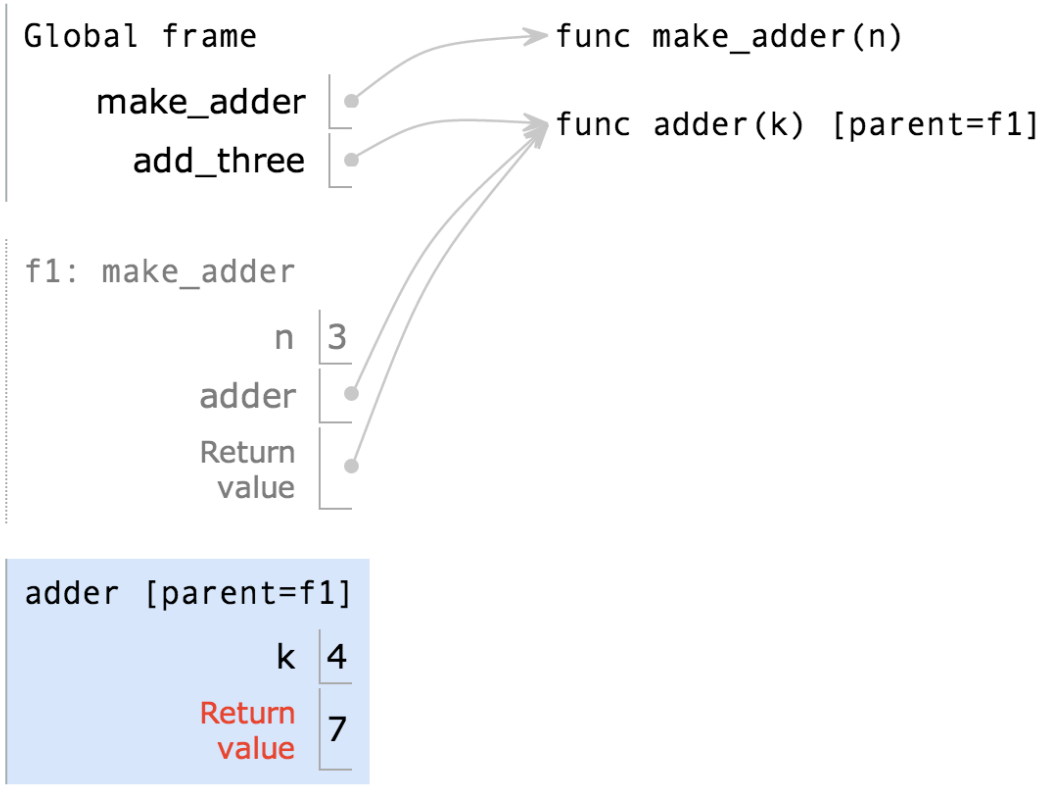

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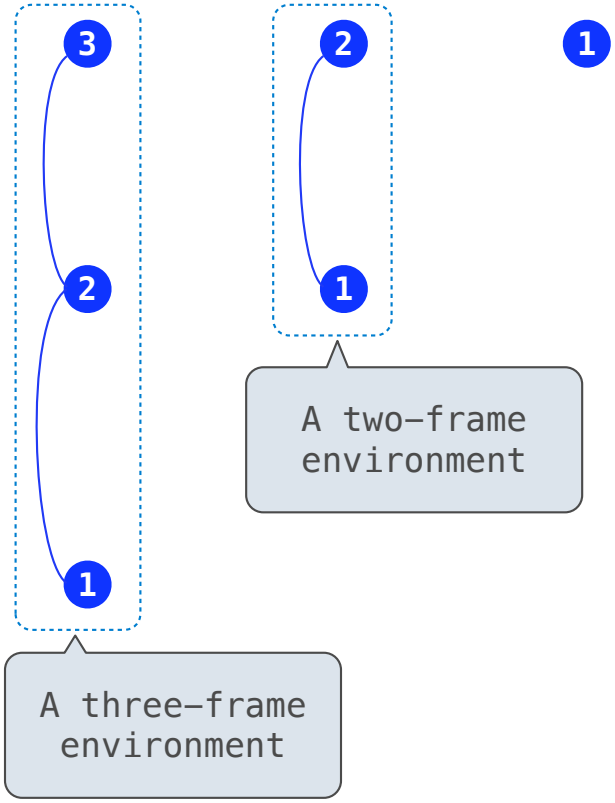

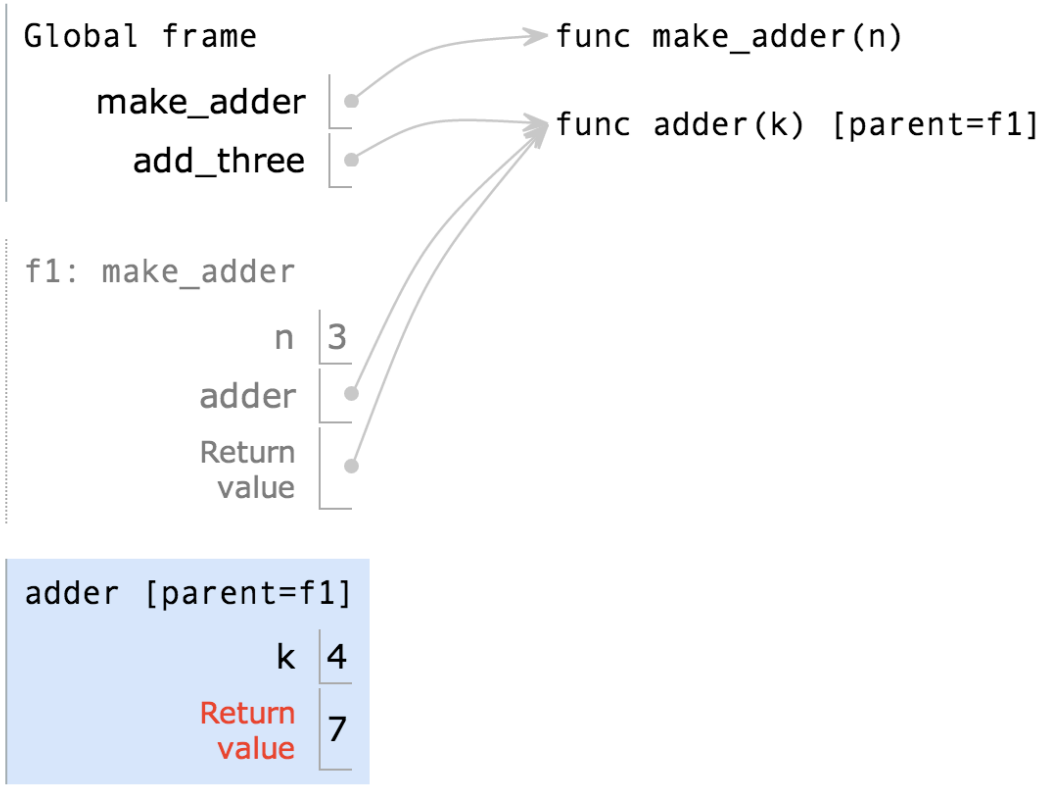

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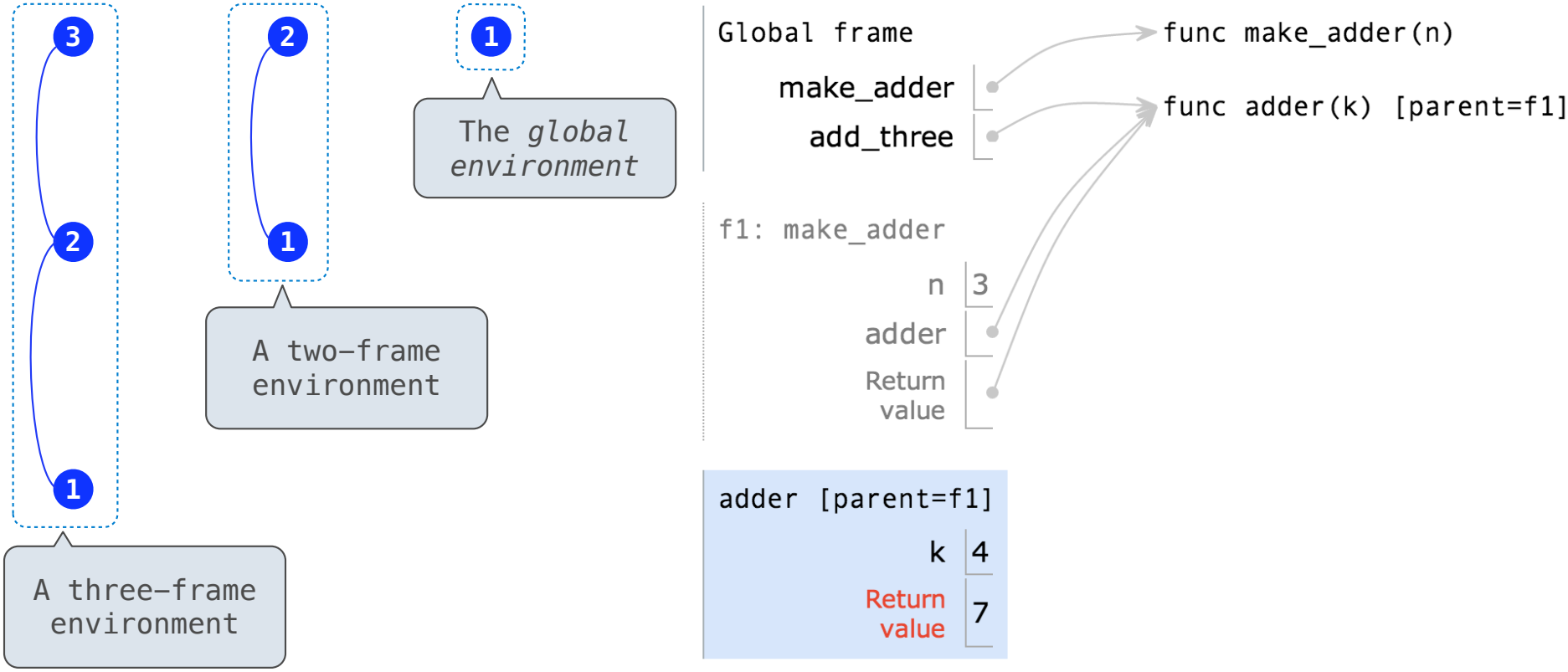

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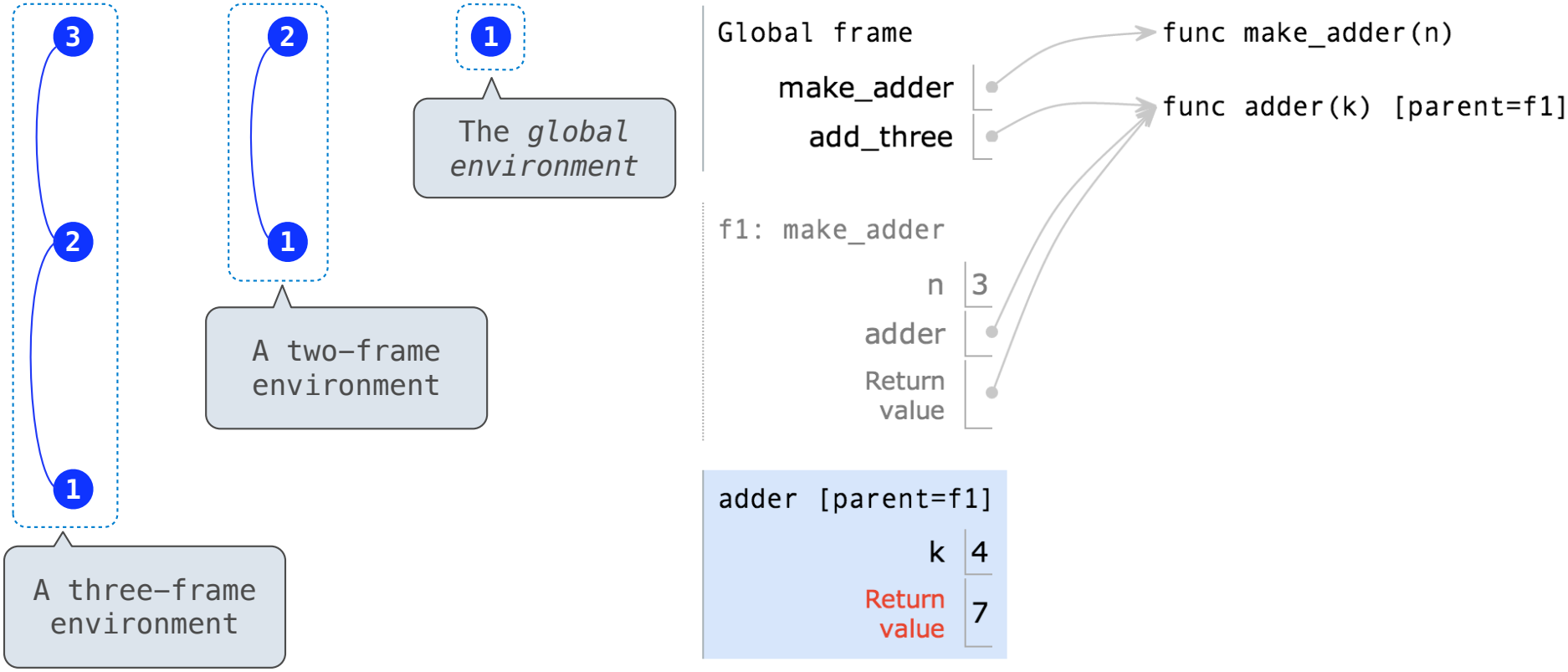

A local frame extends the environment that begins with its parent.

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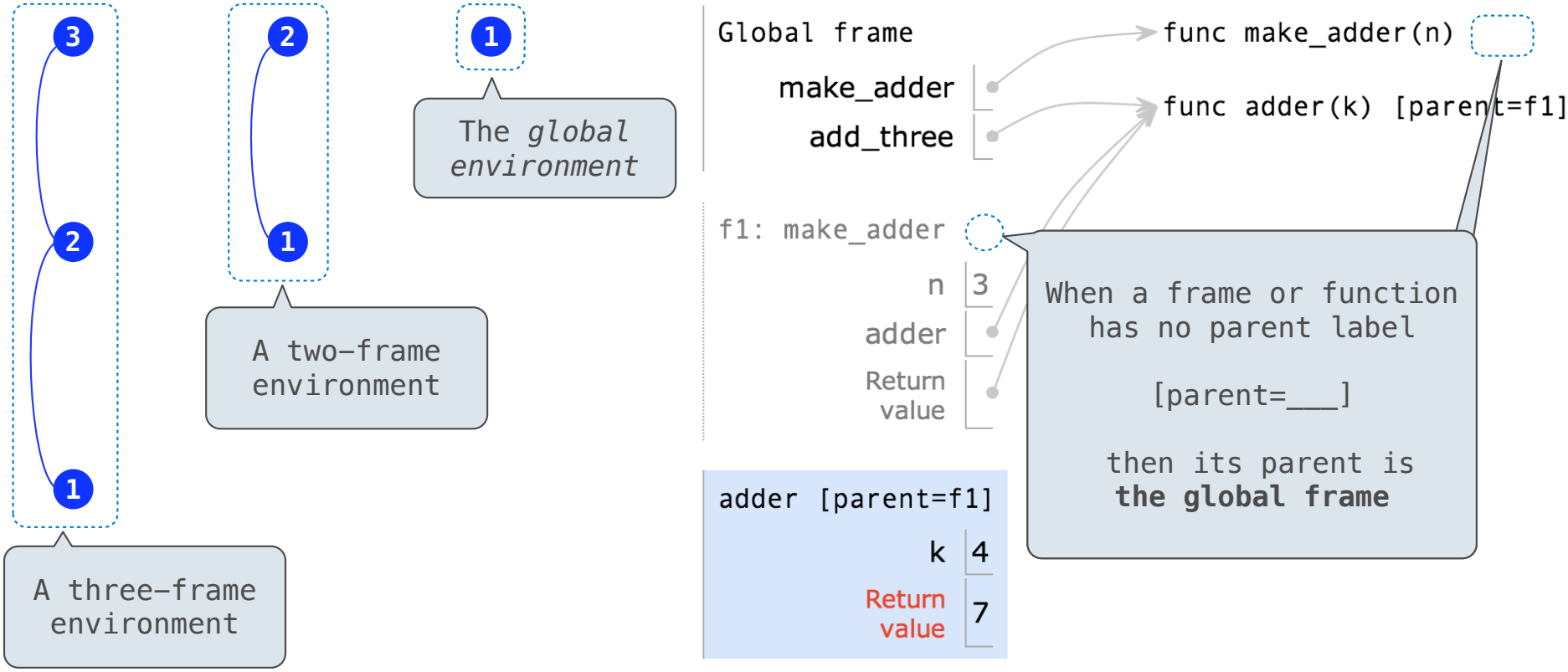

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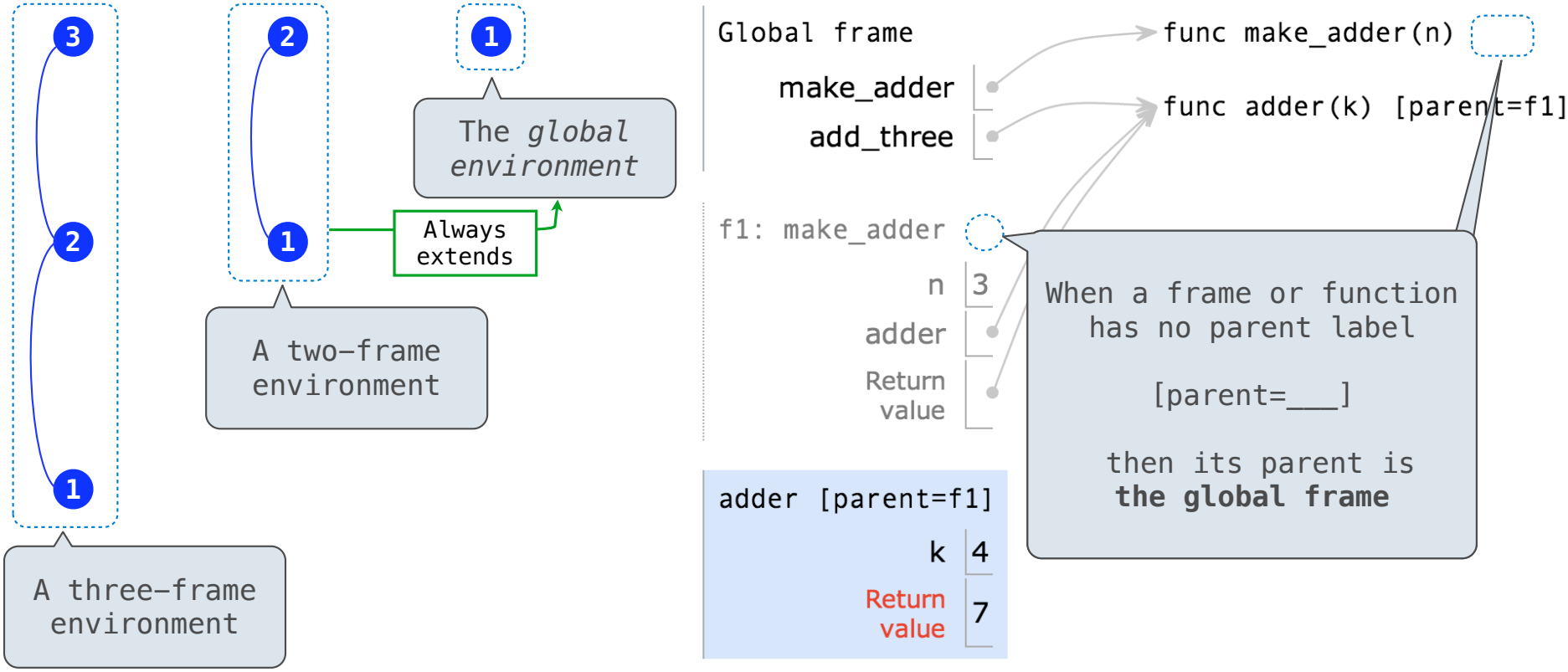

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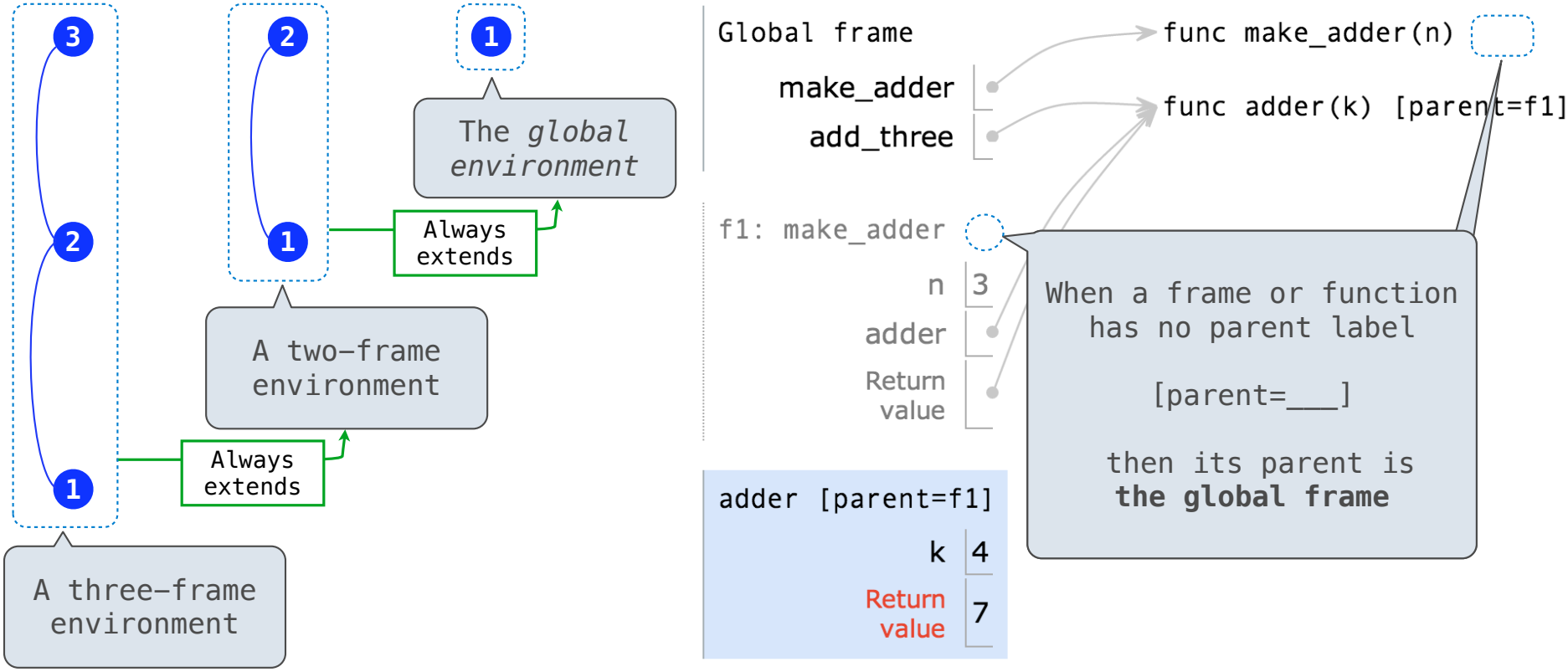

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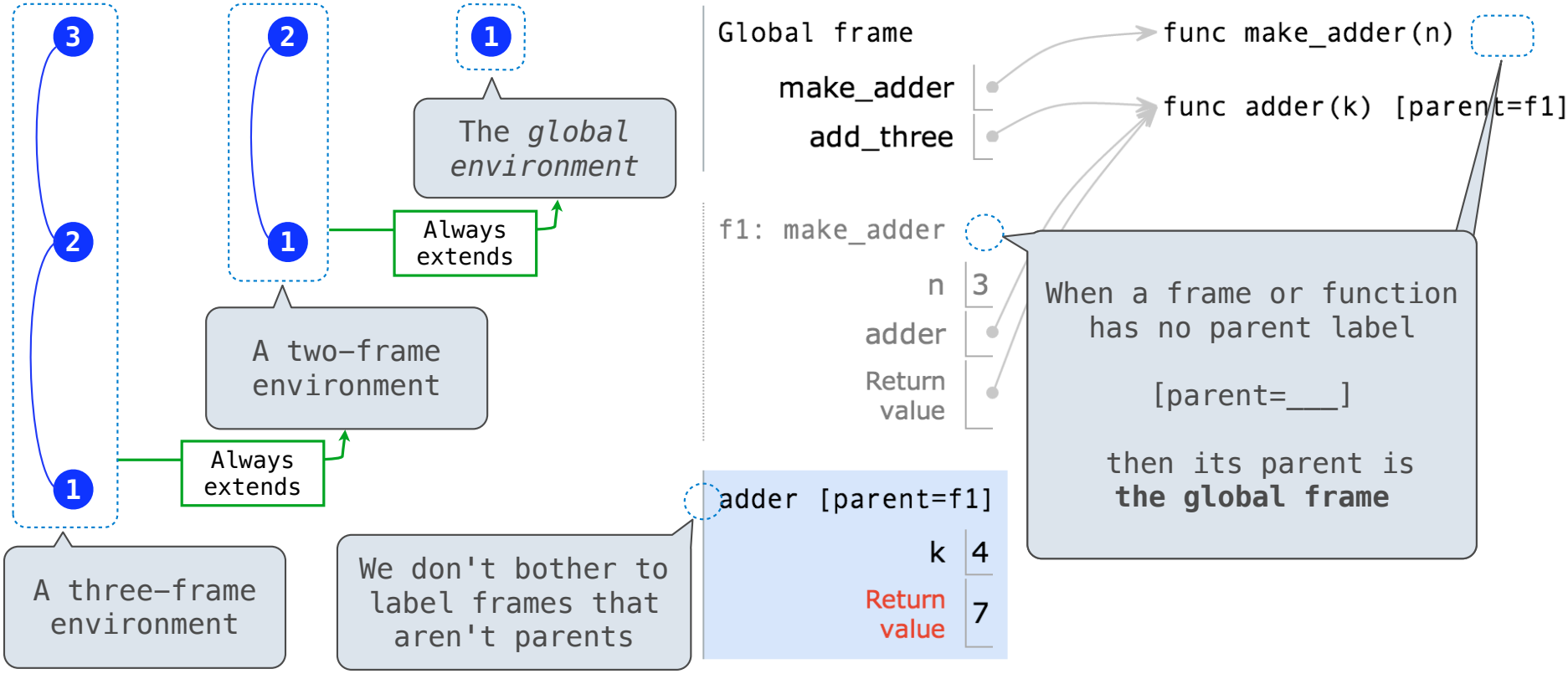

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How to Draw an Environment Diagram

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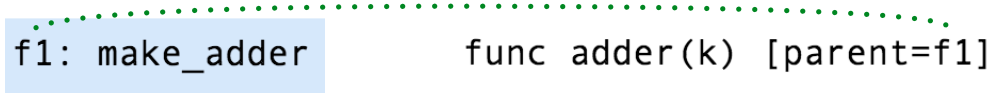

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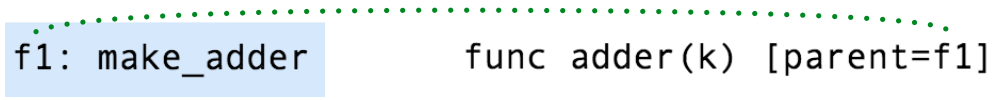

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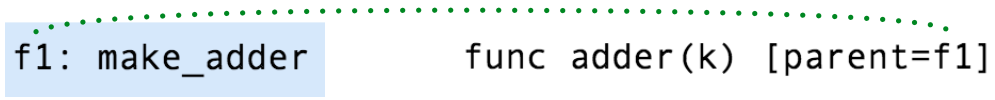

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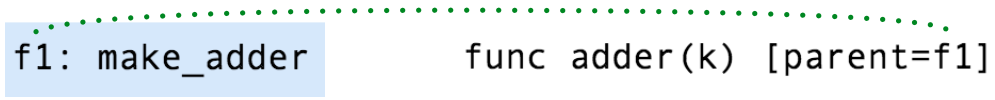

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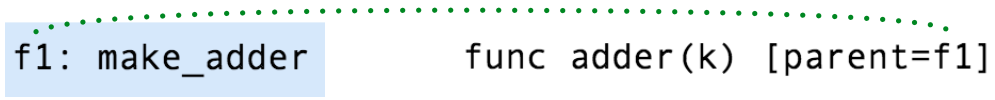

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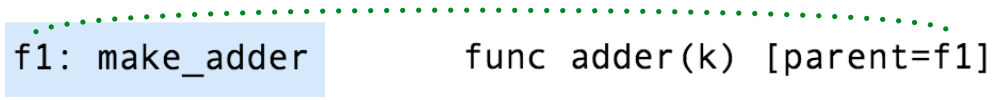

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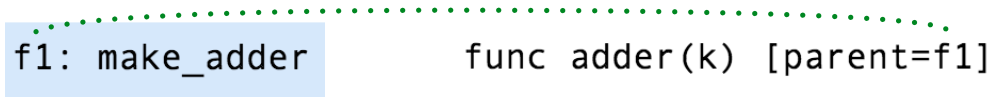

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4. Execute the body of the function in the environment that starts with the **local frame**.

Local Names

(Demo)

Local Names are *not* Visible to Other (Non-Nested) Functions

```
1  def f(x, y):
2      return g(x)
3
4  def g(a):
5      return a + y
6
7  result = f(1, 2)
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Example: http://goo.gl/b6WvUc

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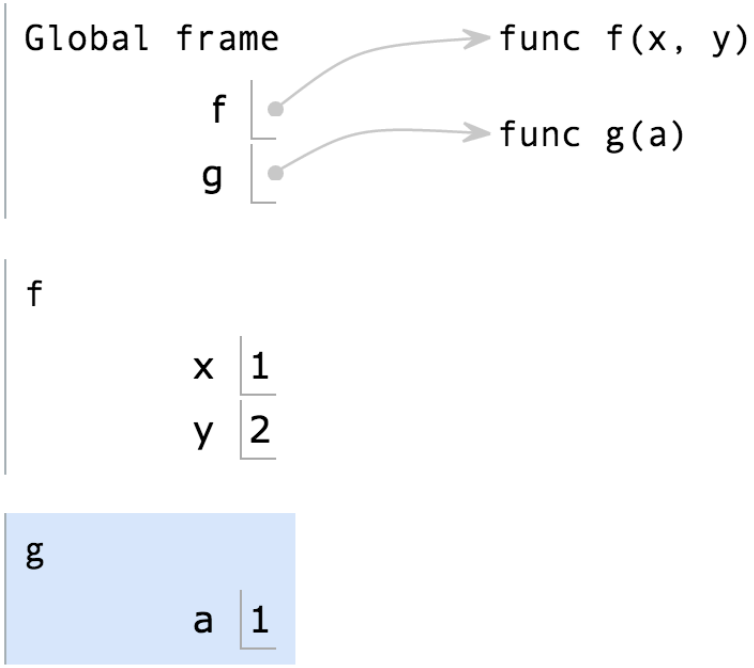

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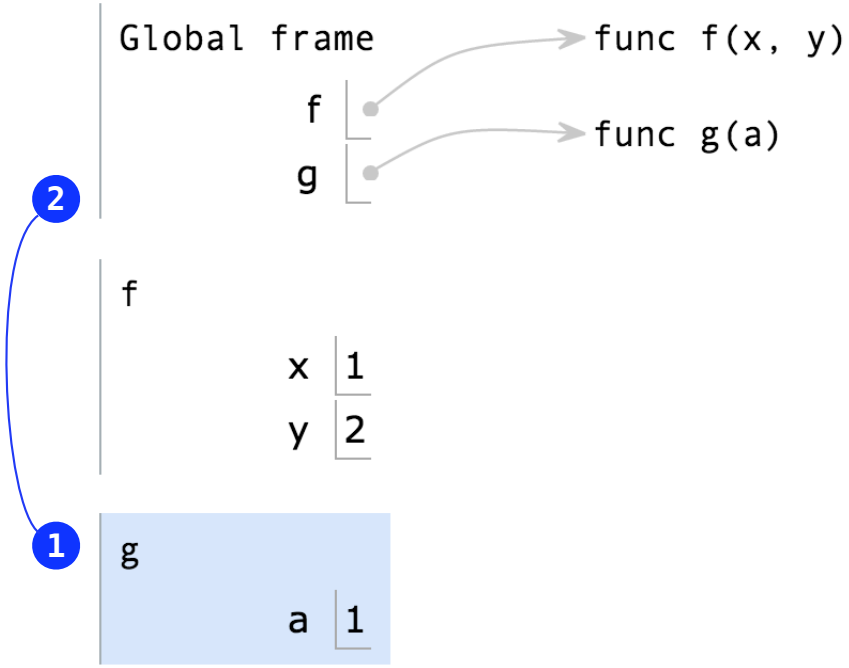

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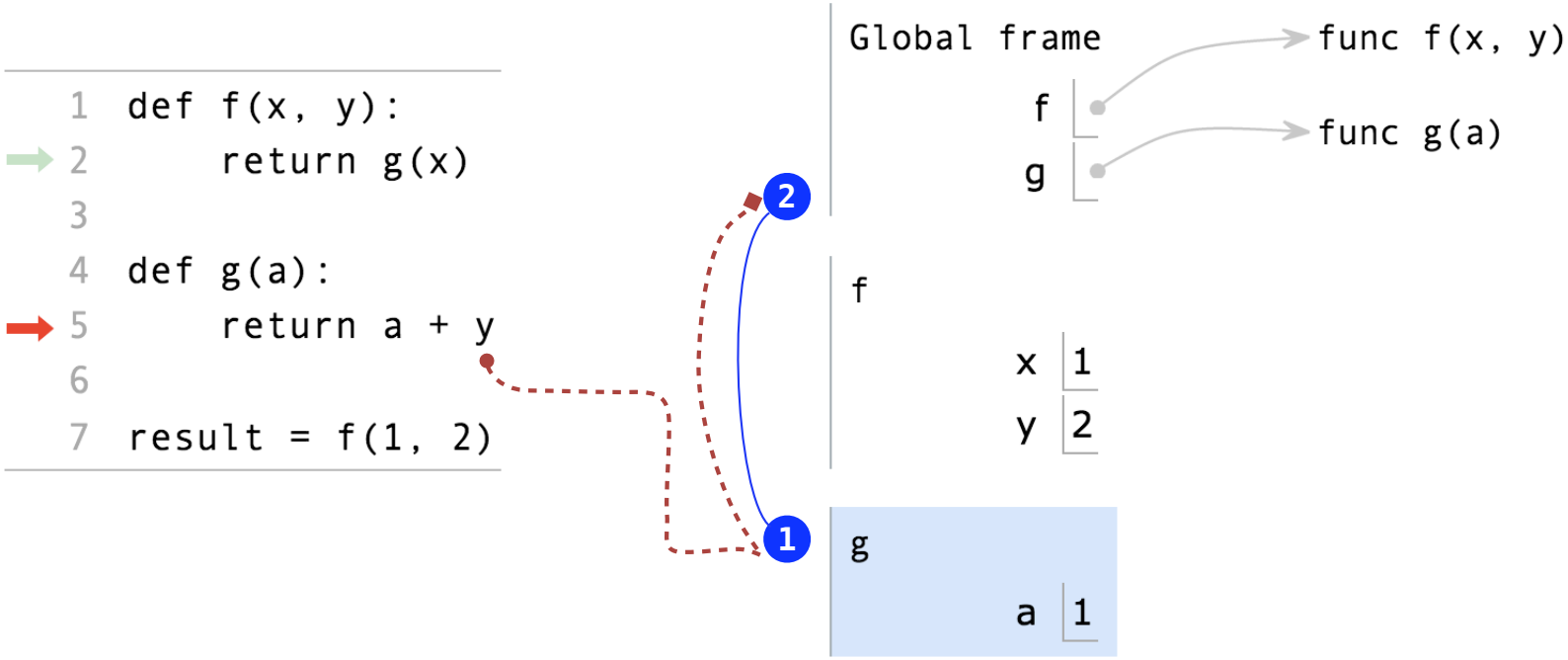

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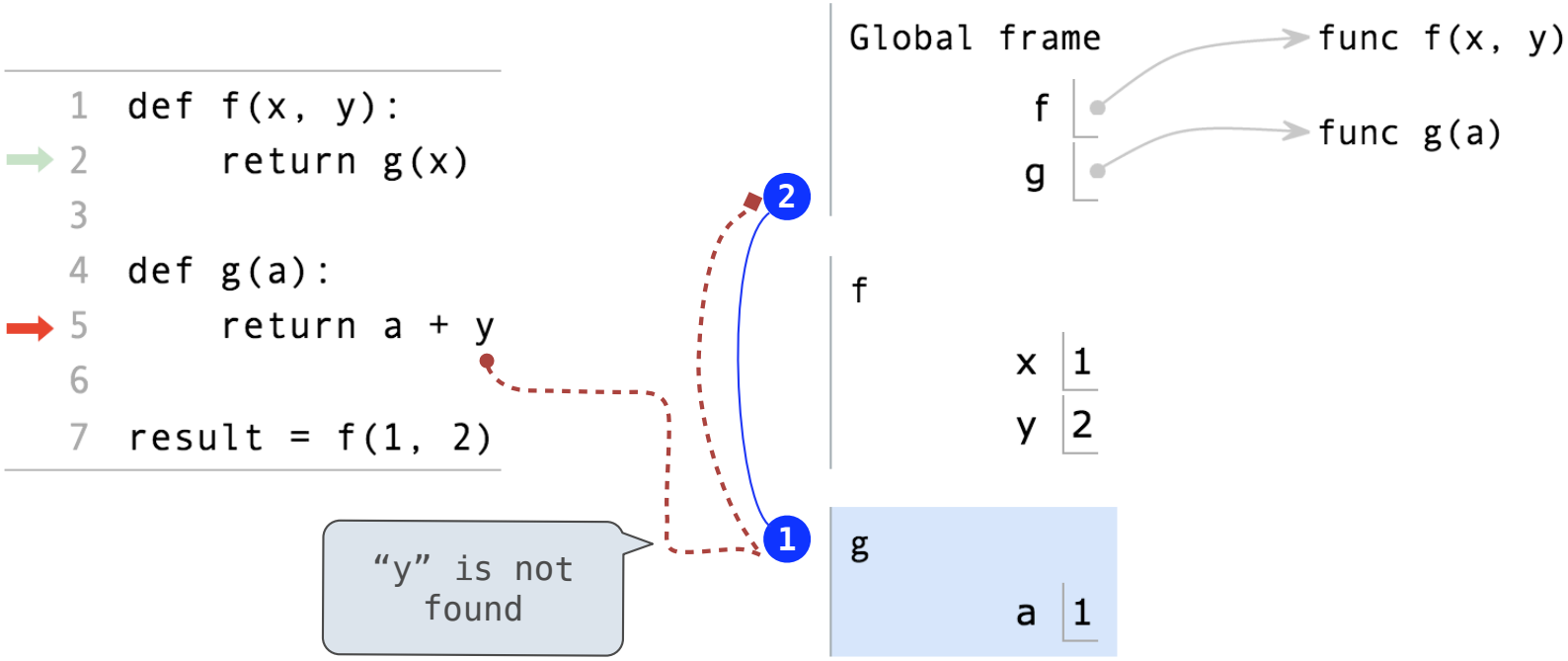

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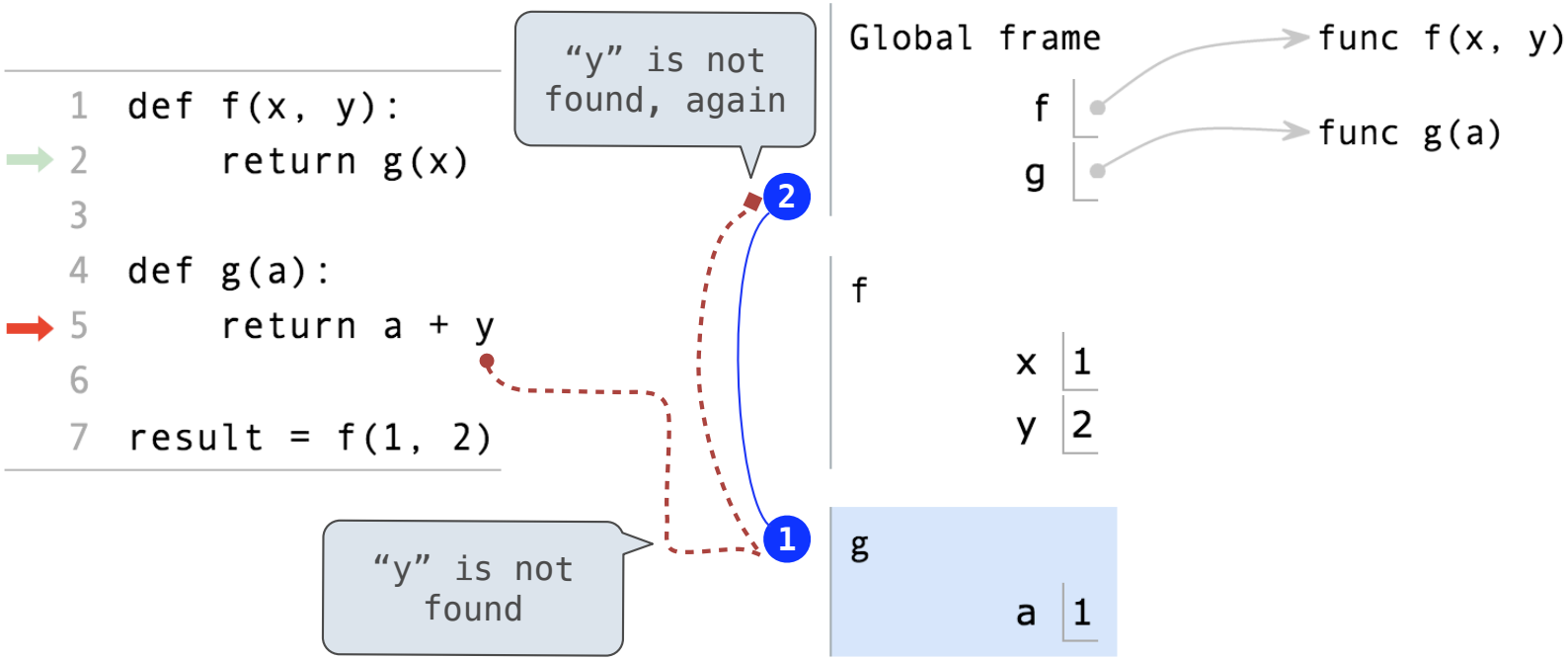

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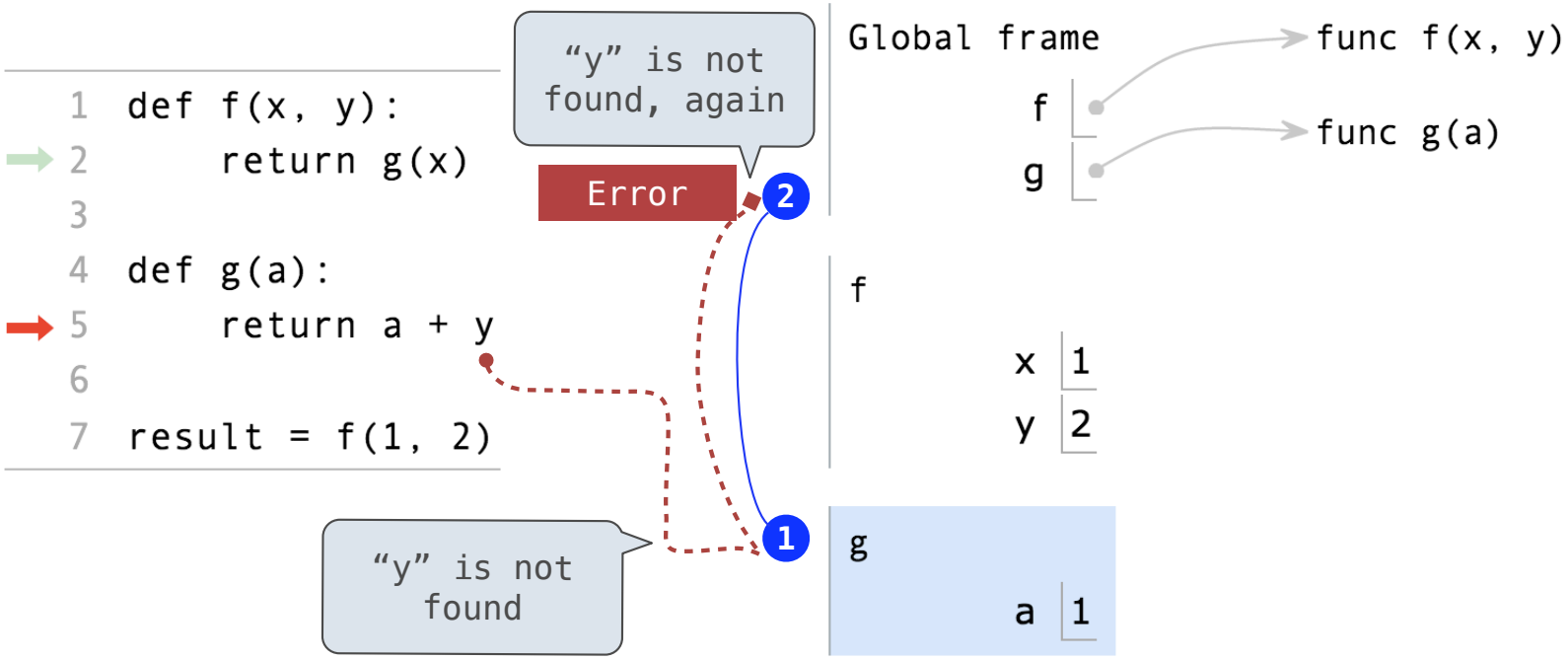

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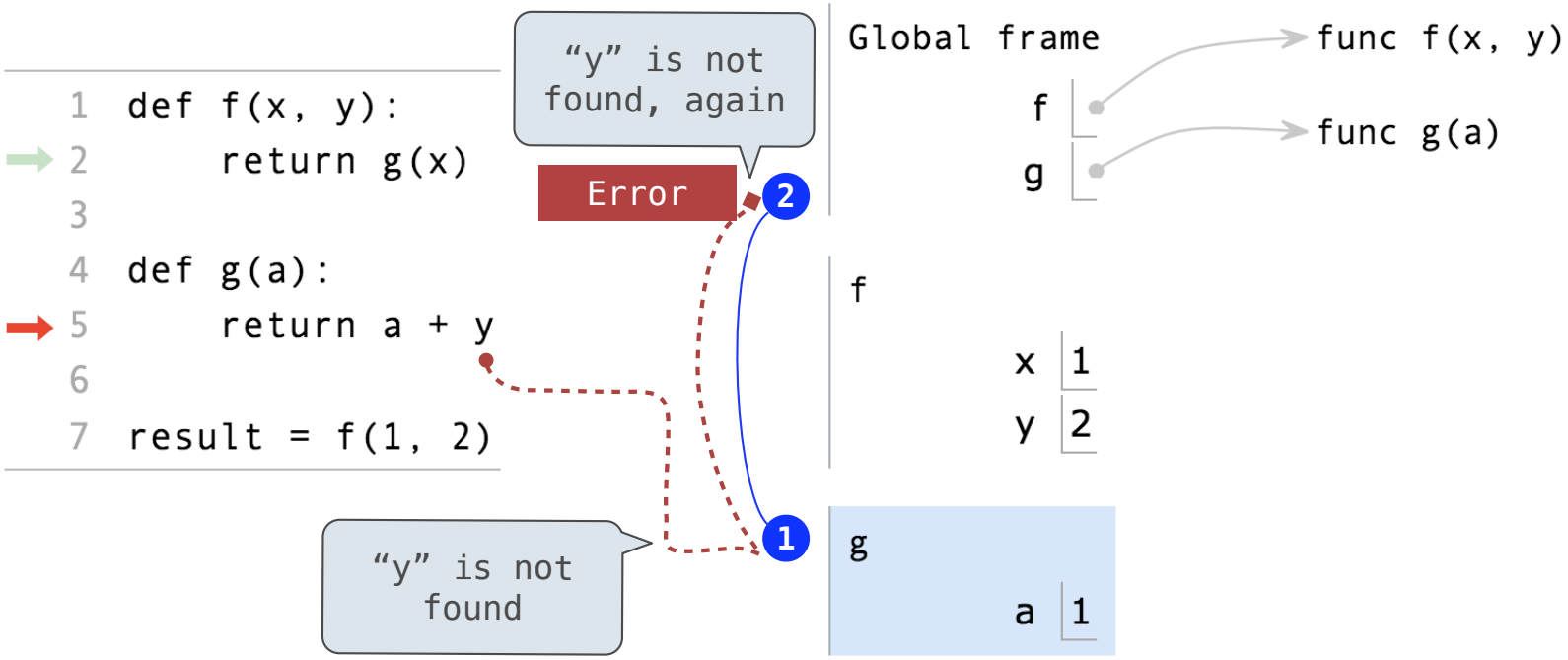

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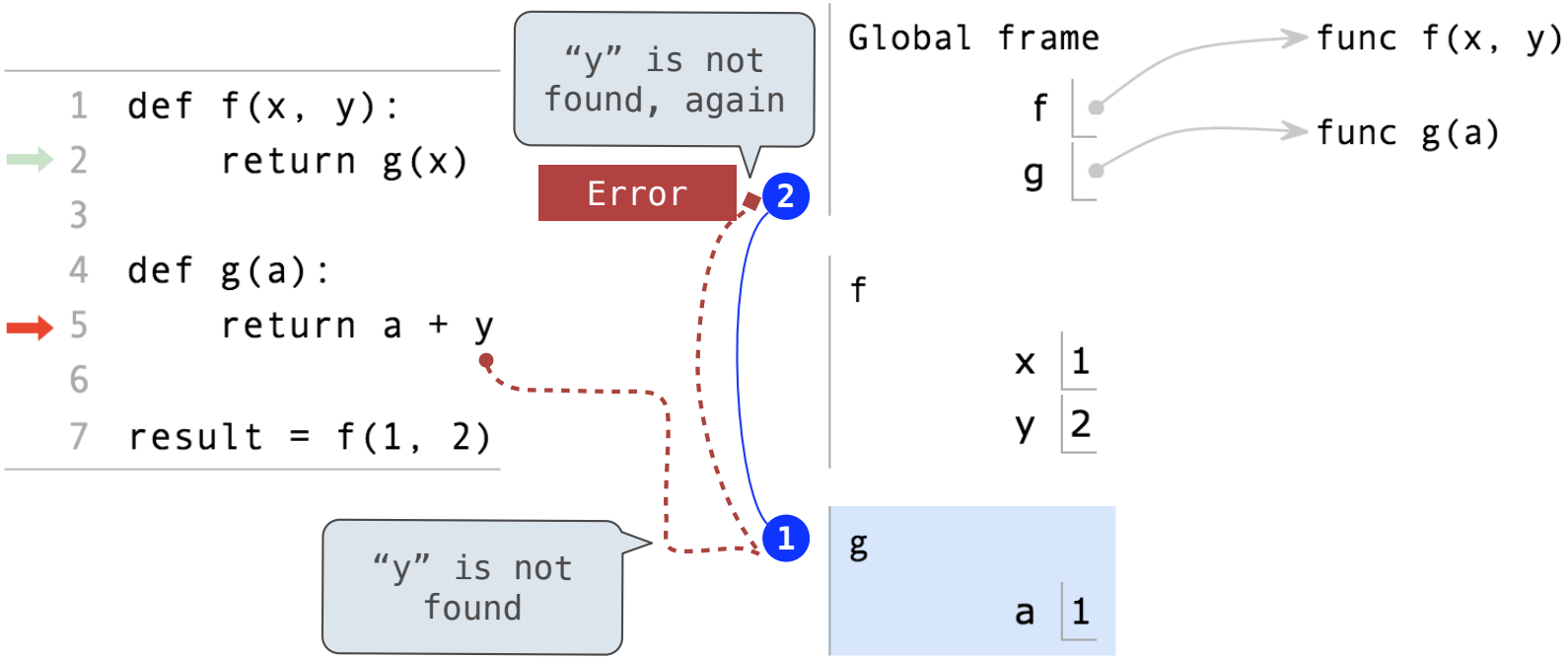


- An environment is a sequence of frames.
- The environment created by calling a top-level function (no def within def) consists of one local frame, followed by the global frame.

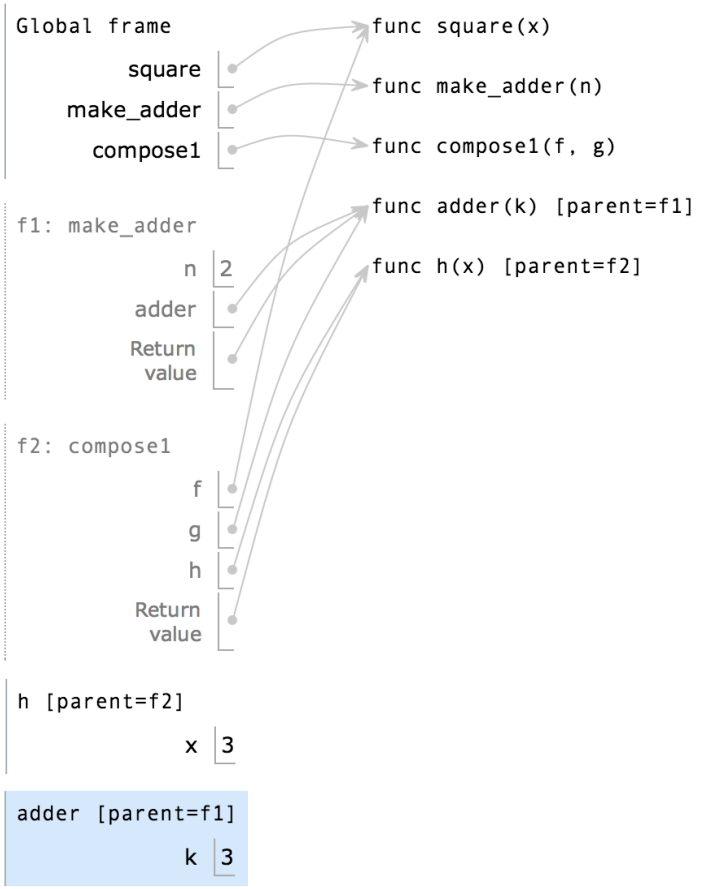
Example: http://goo.gl/b6WvUc

Function Composition

(Demo)

The Environment Diagram for Function Composition

```
1  def square(x):
2      return x * x
3
4  def make_adder(n):
5      def adder(k):
6          return k + n
7      return adder
8
9  def compose1(f, g):
10     def h(x):
11         return f(g(x))
12     return h
13
14 compose1(square, make_adder(2))(3)
```



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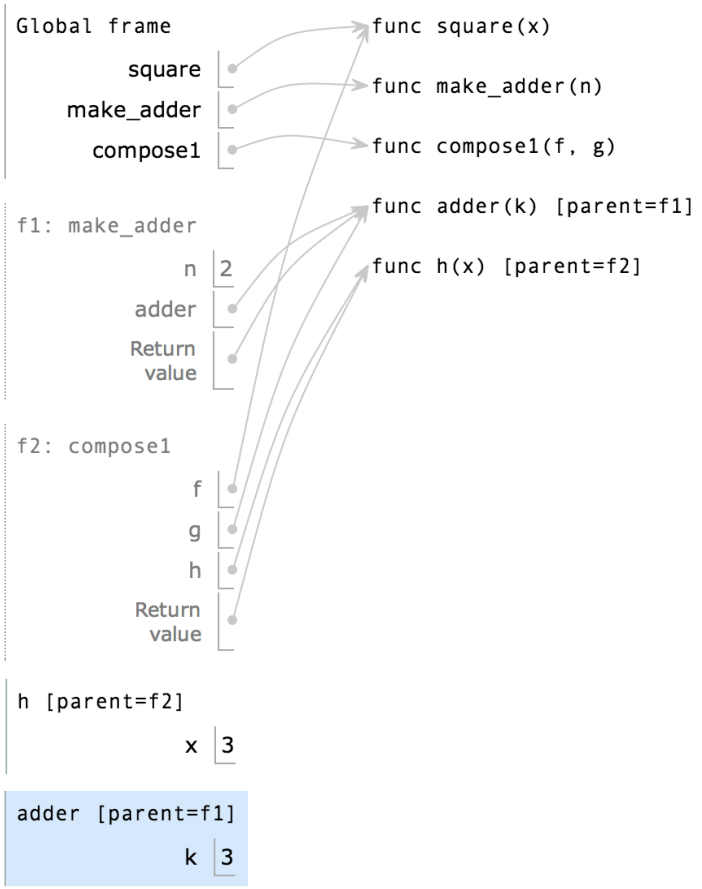

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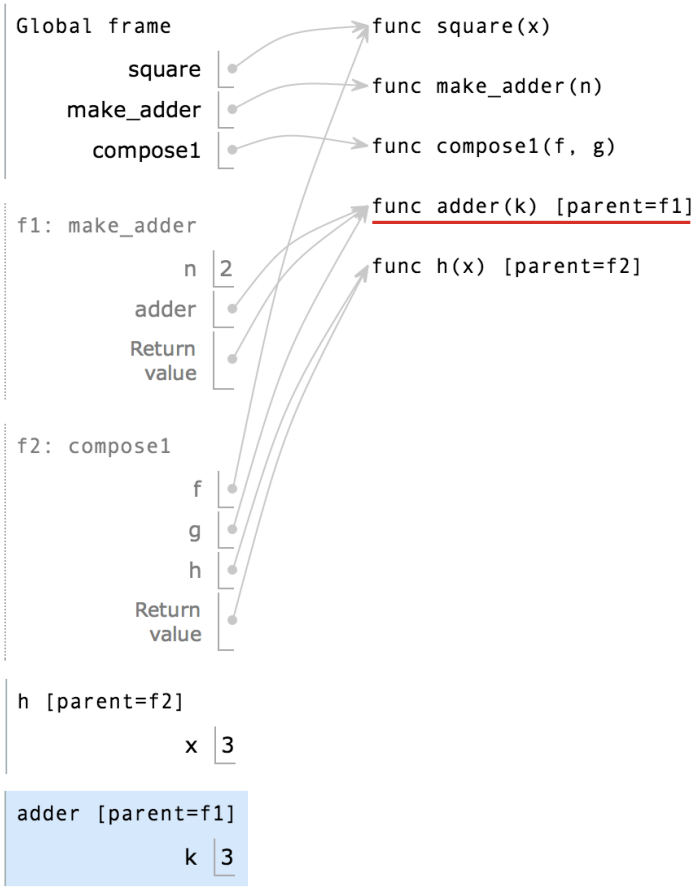

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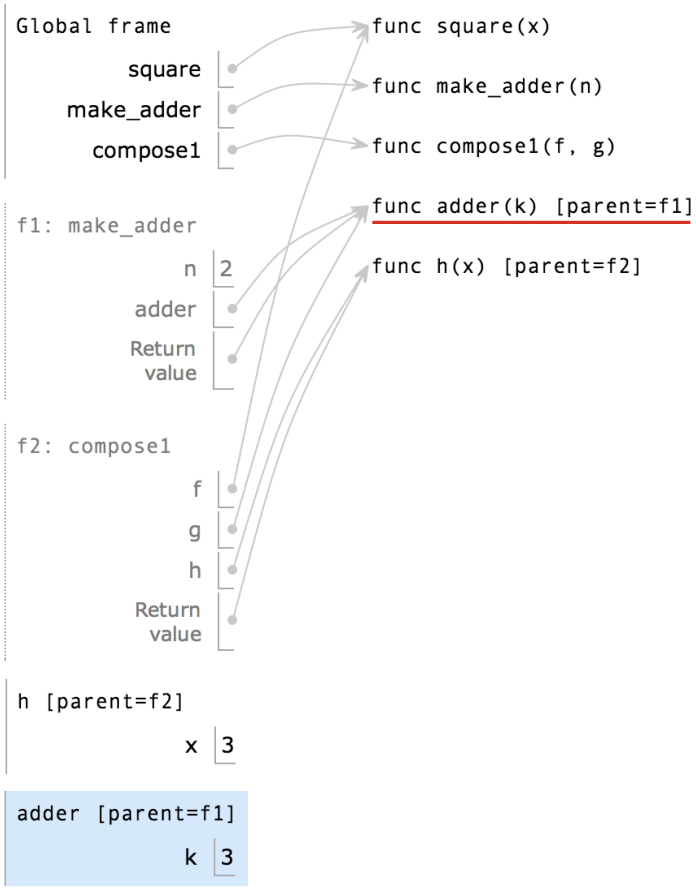

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9  def compose1(f, g):
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11         return f(g(x))
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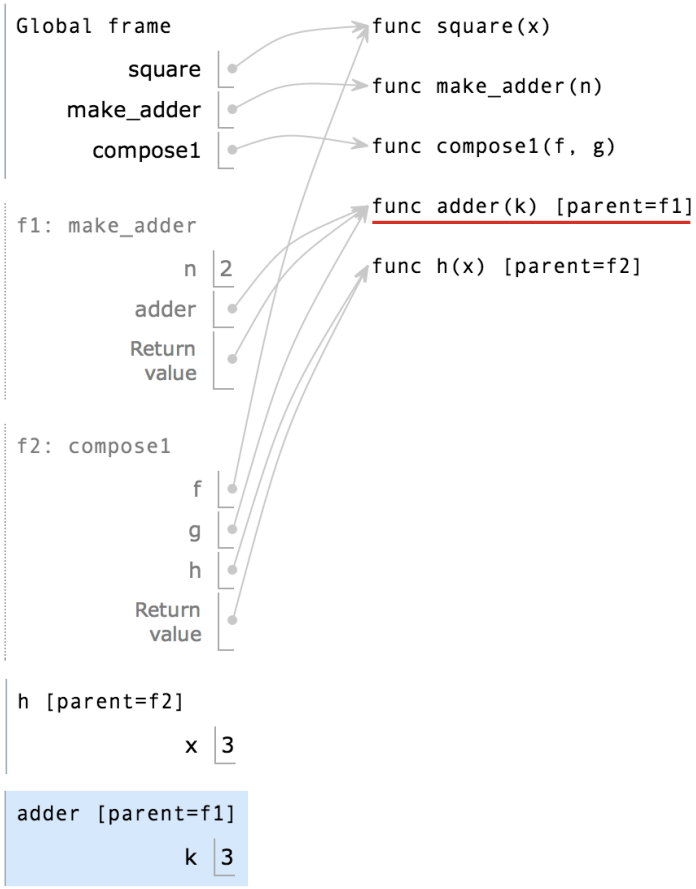
14 compose1(square, make_adder(2))(3)
```

Return value of make_adder is an argument to compose1



Example:

The Environment Diagram for Function Composition

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1  def square(x):
2      return x * x
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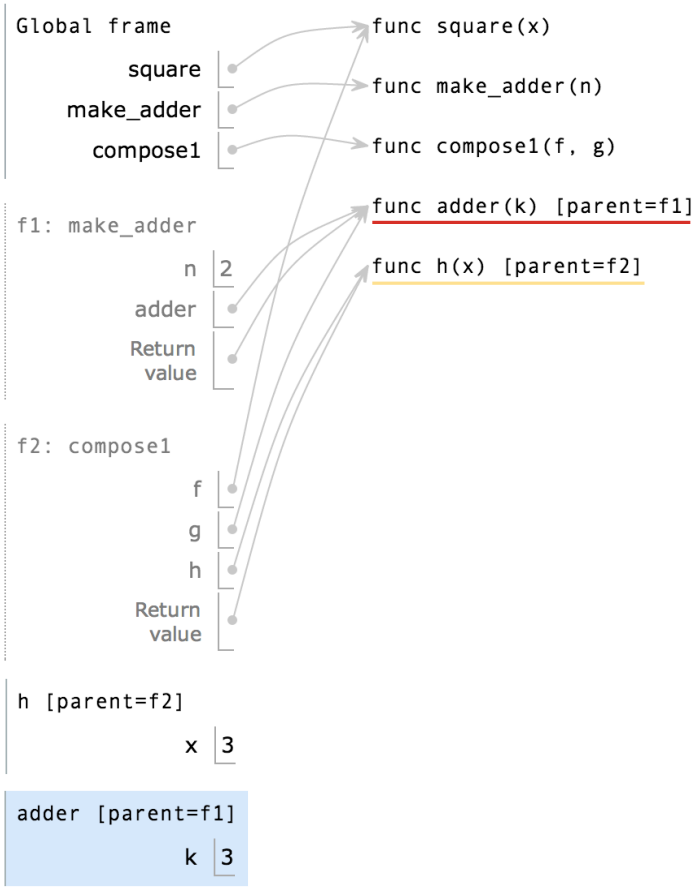

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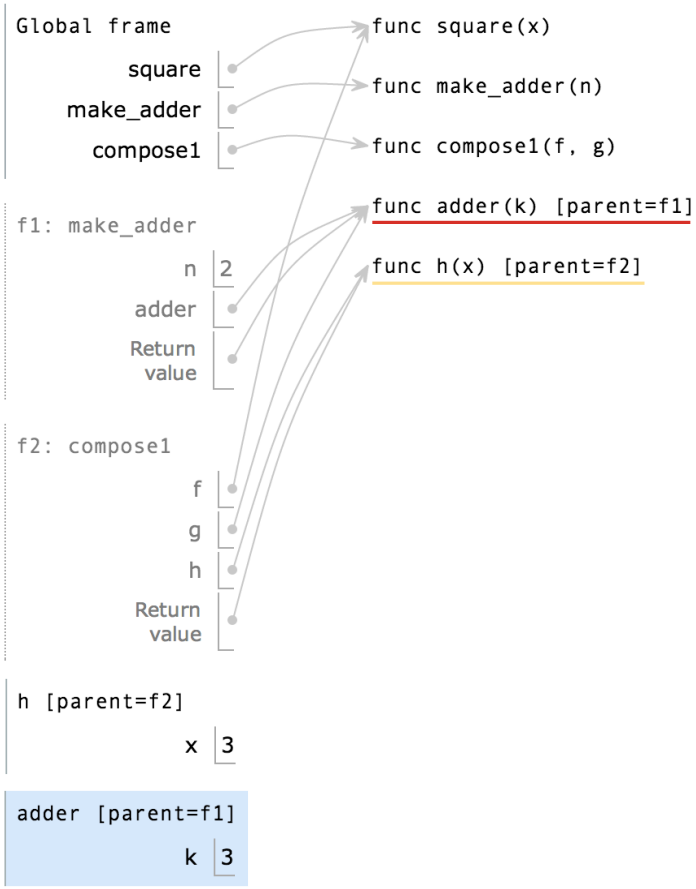

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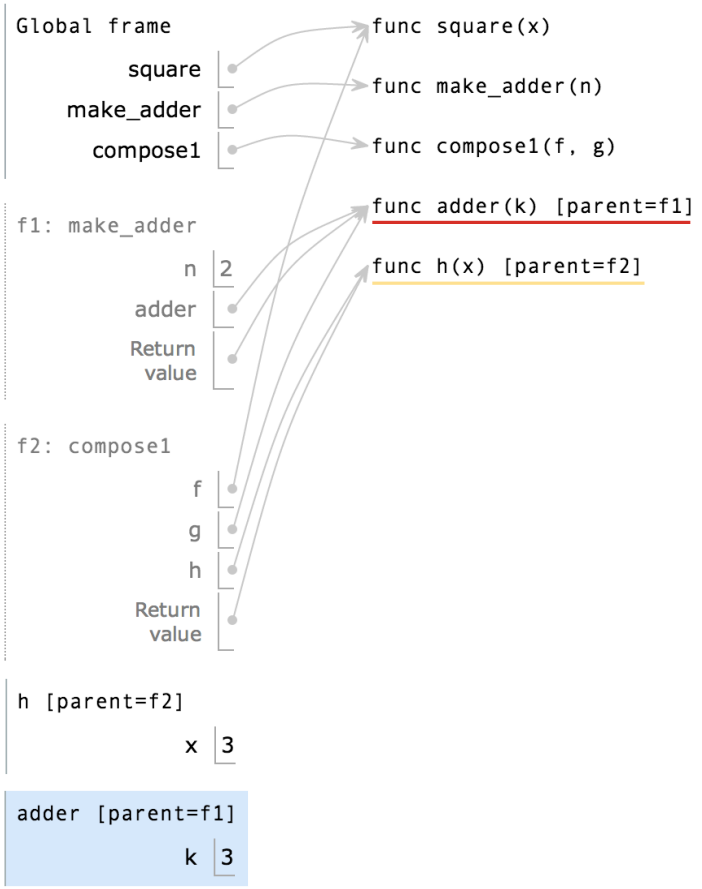

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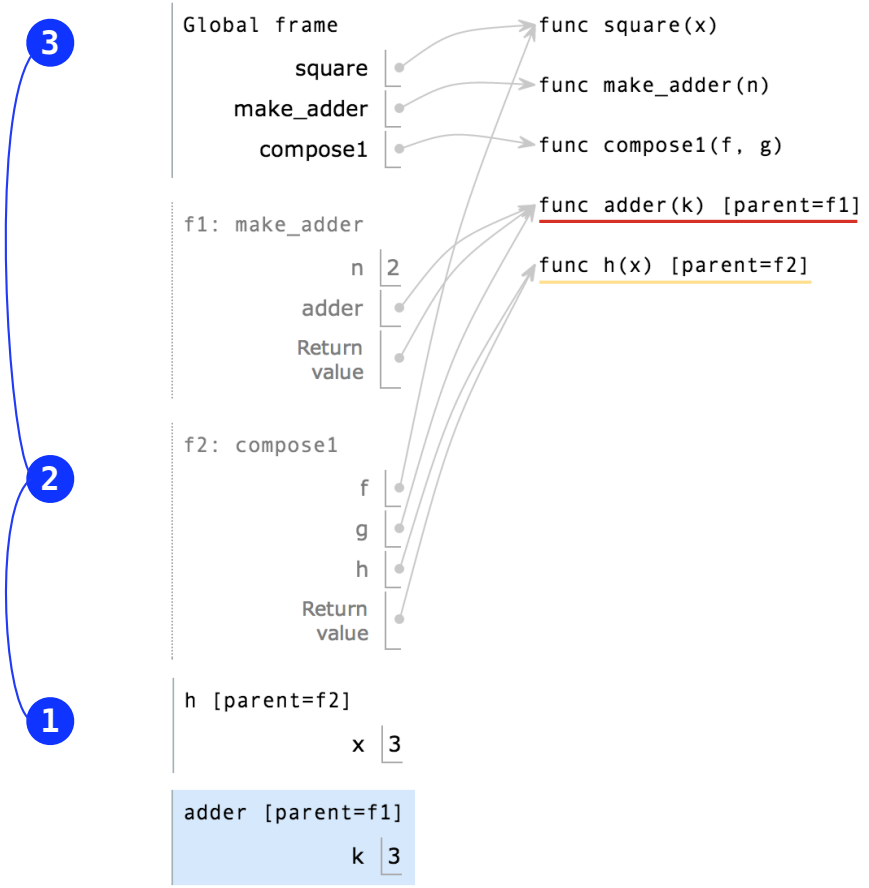

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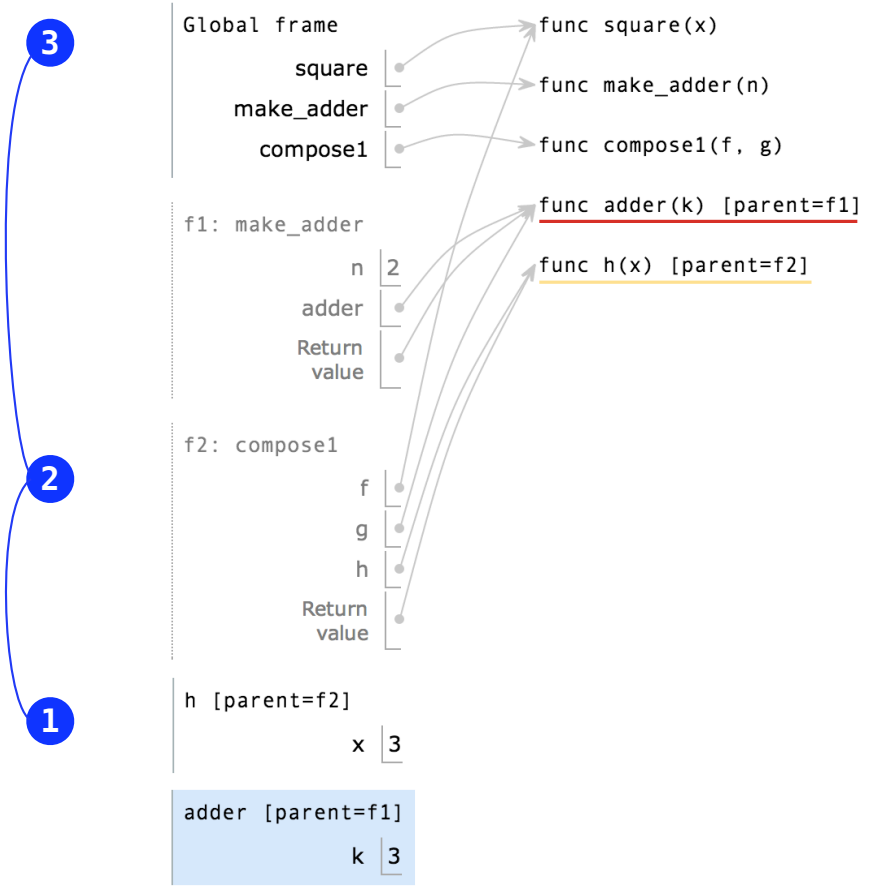

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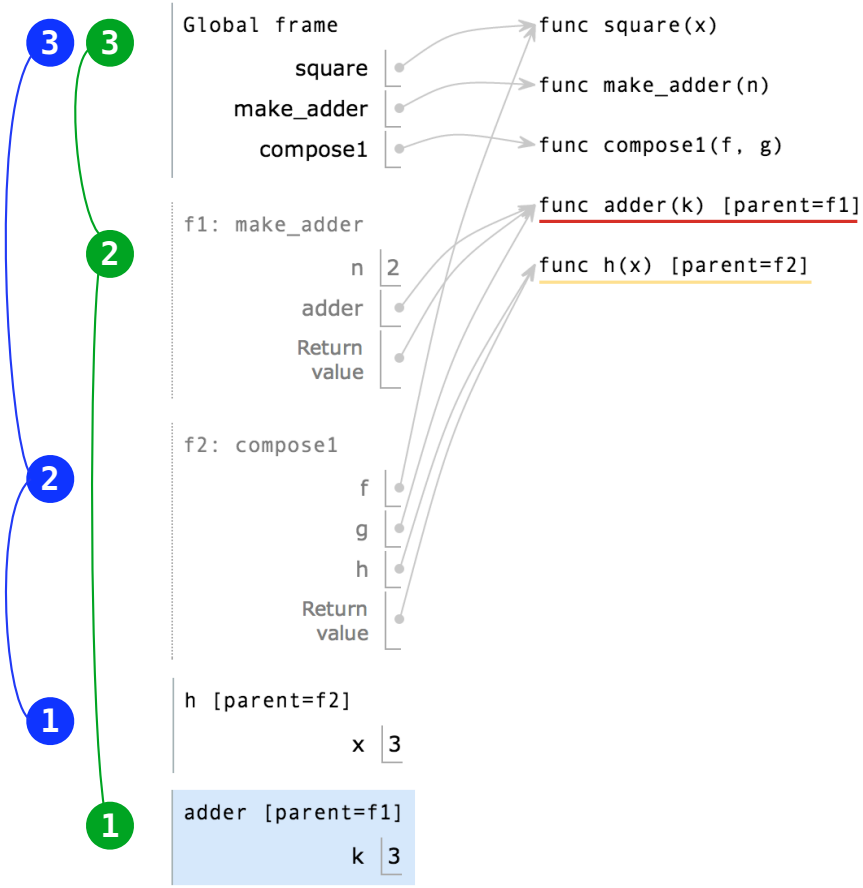

Example:

The Game of Hog

(Demo)