Welcome to Data C88C!

Lecture 05: Environments

Monday, June 30th, 2025

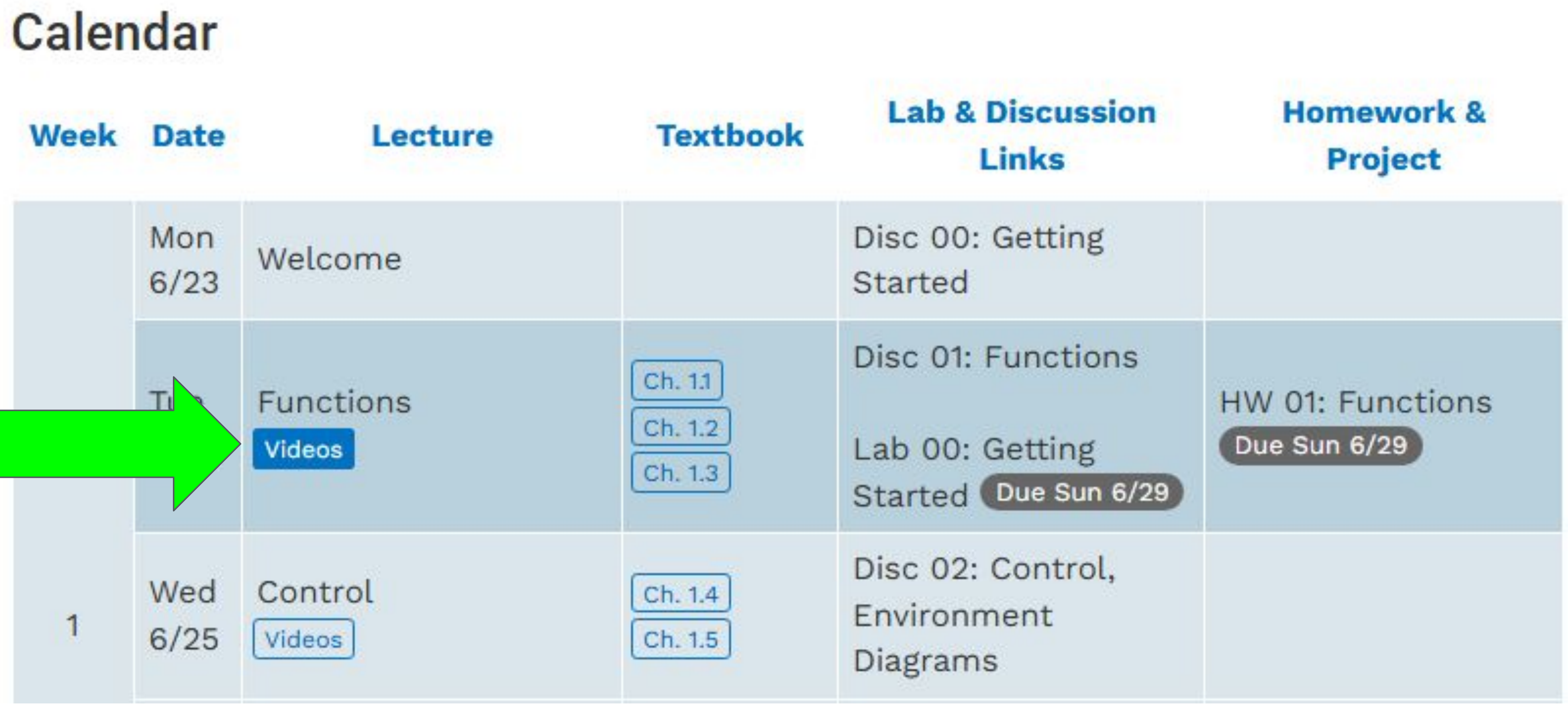
Week 2

Summer 2025

Instructor: Eric Kim (ekim555@berkeley.edu)

Announcements

- Assignment Extension Policy: [link]
  - **tldr:** everyone gets an automatic 1-day extension for: Labs, HWs, Projects
  - Already applied on Gradescope, no need to contact course staff to request it
- **Reminder**: Midterm coming up (Tues July 15th, 3pm-5pm)
  - Don't fall behind in the class! Class moves very quickly, starting this week
- Due dates
  - Lab00, HW01 were due: Sun June 29th
  - Lab01, Lab02, HW01 due: Tues July 1st, 11:59 PM PST
- **Reminder**: watch YouTube video BEFORE lecture!
  - See course website for video link



Calendar

Week	Date	Lecture	Textbook	Lab & Discussion Links	Homework & Project
1	Mon 6/23	Welcome		Disc 00: Getting Started	
	Tu	Functions Videos	Ch. 1.1 Ch. 1.2 Ch. 1.3	Disc 01: Functions Lab 00: Getting Started Due Sun 6/29	HW 01: Functions Due Sun 6/29
	Wed 6/25	Control Videos	Ch. 1.4 Ch. 1.5	Disc 02: Control, Environment Diagrams	

Important: watch these videos before lecture to maximize learning!

Lecture Overview

- Environment Diagrams ("V2")

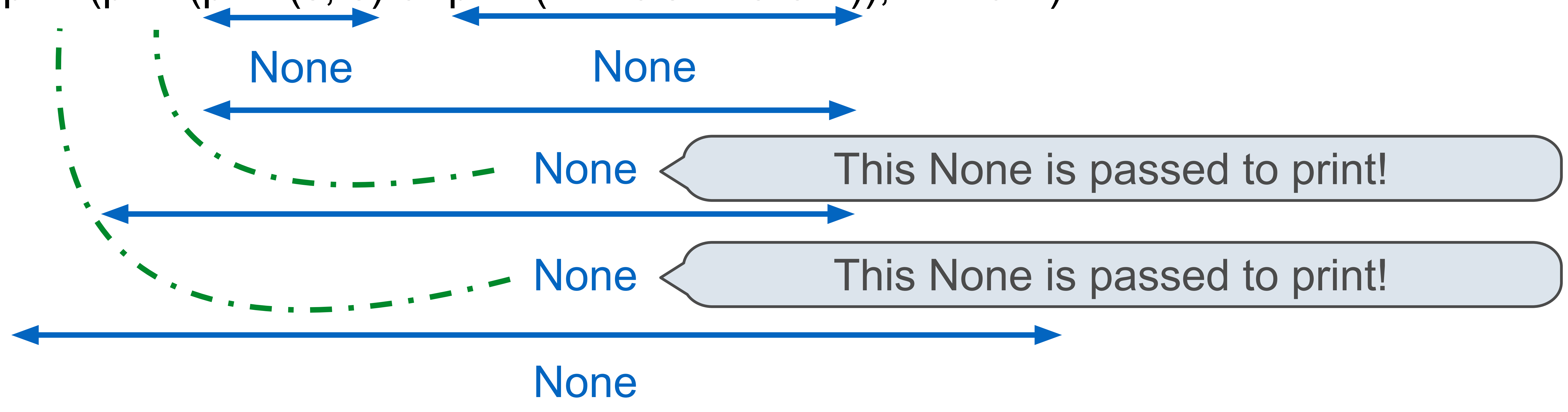
Print and None Review

Fall 2022 CS 61A Midterm 1, Question 1

What does the long expression print?

s = "Knock"

print(print(print(s, s) or print("Who's There?")), "Who?")



None

None

None

This None is passed to print!

None

This None is passed to print!

None

```
Knock Knock

Who's There?

None

None Who?
```

False values in Python: `False, 0, '', None` *(more to come)*

To evaluate the expression **<left> or <right>**:

1. Evaluate the subexpression **<left>**.
2. If the result is a true value **v**, then the expression evaluates to **v**.
3. Otherwise, the expression evaluates to the value of the subexpression **<right>**.

Iteration Review

Spring 2023 Midterm 1, Question 3(a)

Definition: A positive integer n is a *repeating sequence* of positive integer m if n is written by repeating the digits of m one or more times. For example, 616161 is a repeating sequence of 61, but 61616 is not.

Hint: pow(10, 3) is 1000, and 654321 % pow(10, 3) is 321 (the last 3 digits).

Implement `` `repeating(t, n)` `` which takes positive integers t and n. It returns whether n is a repeating sequence of some t-digit integer.

```
def repeating(t, n):
    """Return whether t digits repeat to form positive integer n.

    >>> repeating(1, 616161)
    False
    >>> repeating(2, 616161)  # repeats 61 (2 digits)
    True
```

6161**61**

6161

61

0

An iterative approach: Repeatedly remove t digits from the end, and make sure that the last t digits never change.

Code structure: A while loop that checks the last t digits and returns **False** if they change.

Repeating (Spring 2023 Midterm 1 Q3a)

```
def repeating(t, n):
    """Return whether t digits repeat to form positive integer n.

    >>> repeating(1, 6161)
    False
    >>> repeating(2, 6161)  # repeats 61 (2 digits)
    True
    >>> repeating(3, 6161)
    False
    >>> repeating(4, 6161)  # repeats 6161 (4 digits)
    True
    >>> repeating(5, 6161)  # there are only 4 digits
    False
    """
    if pow(10, t-1) > n:  # make sure n has at least t digits
        return False
    rest = n
    while rest:
        if rest % pow(10, t) != n % pow(10, t):
            return False
        rest = rest // pow(10, t)
    return True
```

Go through digits, looking for something

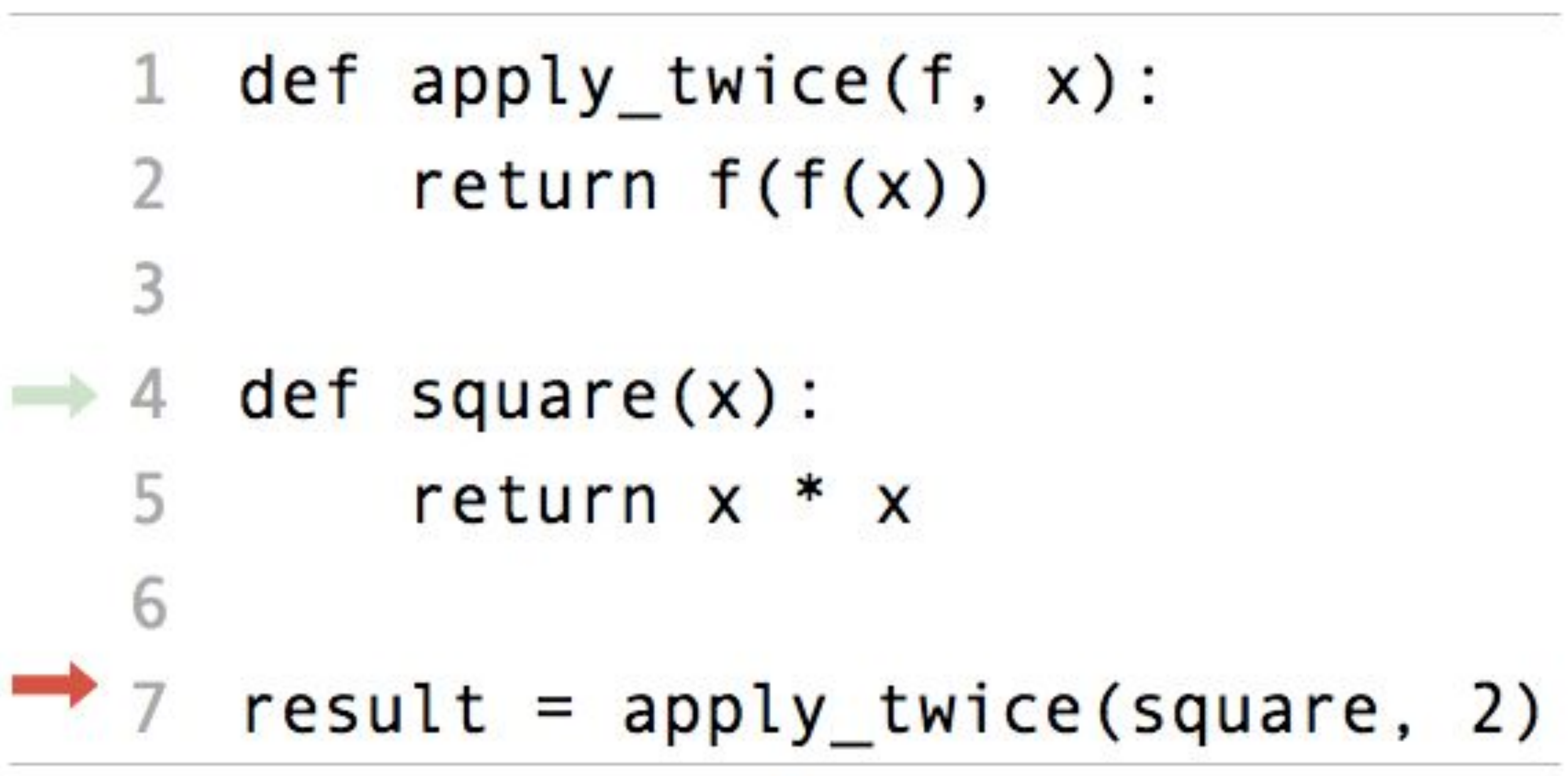
The iterative process to implement "whether" functions is often to look for something that determines the function's output, and return when it's found.

Environments for Higher-Order Functions

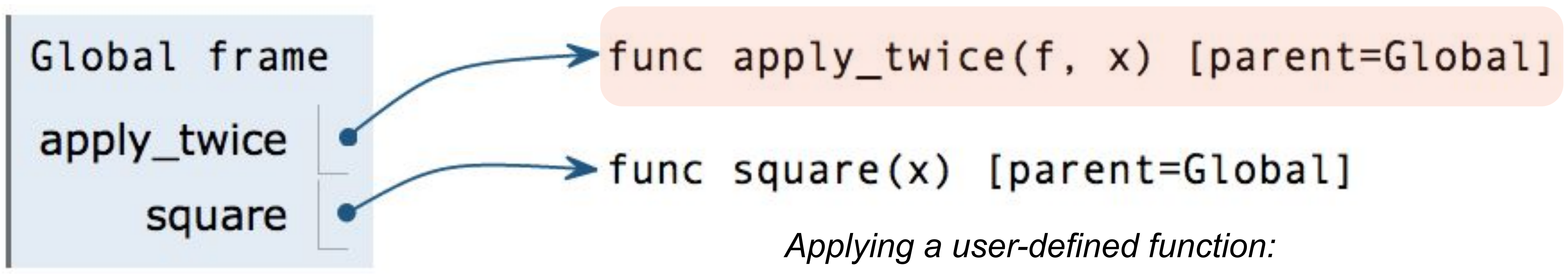
Student advice from the Fall 2024 final survey:

"ENVIRONMENT DIAGRAMS ARE EXTREMELY IMPORTANT! Taking this class with no prior Python experience and minimal overall programming experience, taking time to understand environment diagrams helped me fully understand step-by-step how my code is interpreted, and any areas where my code may be going wrong. This made coding more intuitive for me, as it helped me gain a understanding of the connections being made between my code and carried out functions."

Names can be Bound to Functional Arguments

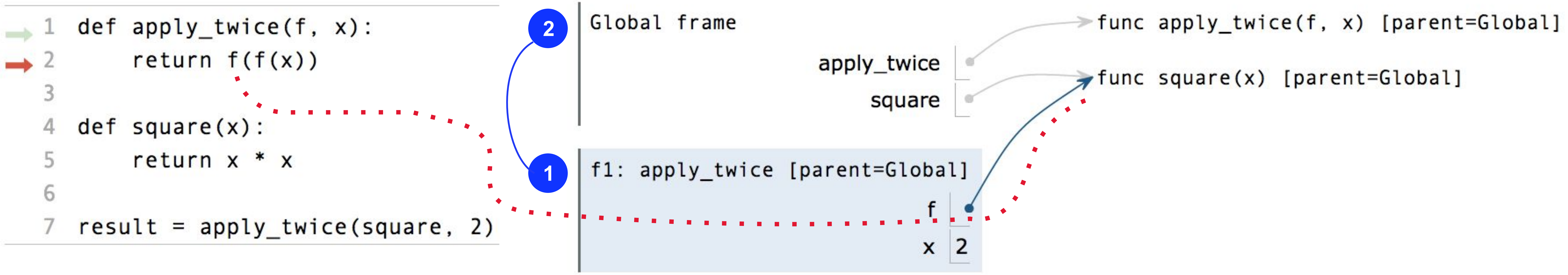


```python
def apply_twice(f, x):
    return f(f(x))

def square(x):
    return x * x

result = apply_twice(square, 2)
```


Global frame
apply_twice
square
func apply_twice(f, x) [parent=Global]
func square(x) [parent=Global]

Applying a user-defined function:

- Create a new frame
- Bind formal parameters (f & x) to arguments
- Execute the body: return f(f(x))



```python
def apply_twice(f, x):
    return f(f(x))

def square(x):
    return x * x

result = apply_twice(square, 2)
```

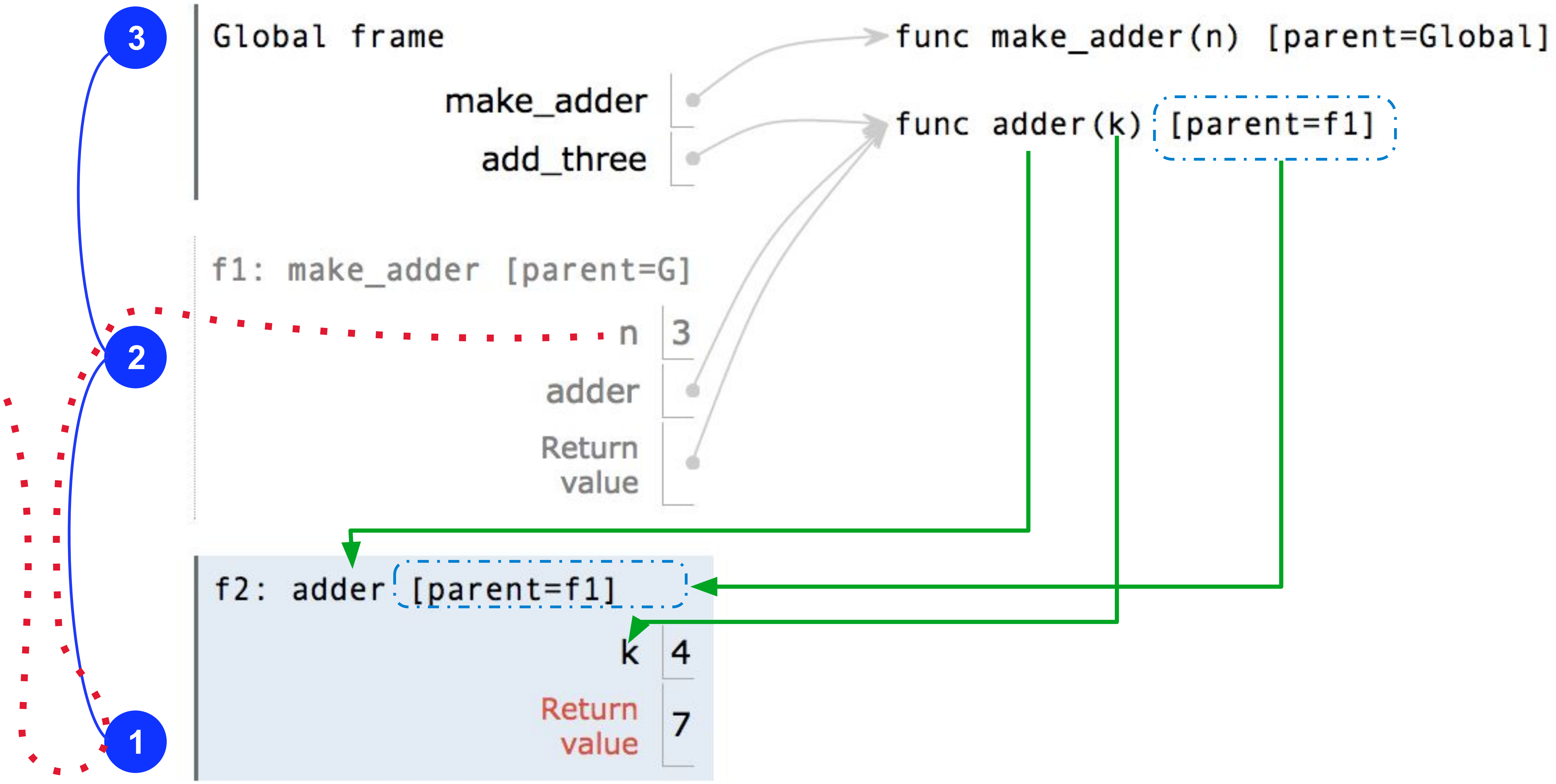
2
1
Global frame
apply_twice
square
func apply_twice(f, x) [parent=Global]
func square(x) [parent=Global]
f1: apply_twice [parent=Global]
f
x 2

pythontutor.com/composingprograms.html#code=def%20apply_twice%28f,%20x%29%3A%0A%20%20%20%20return%20f%28f%28x%29%29%0A%20%20%20%20%0Adef%20square%28x%29%3A%0A%20%20%20%20return%20x%20*%20x%0A%20%20%20%20%0Aresult%20%3D%20apply_twice%28square,%202%29&mode=display&origin=composingprograms.js&cumulative=true&py=3&rawInputLstJSON=[]&curInstr=0

Environment Diagrams for Nested Def Statements

Nested def

```python
def make_adder(n):
    def adder(k):
        return k + n
    return adder

add_three = make_adder(3)
add_three(4)
```



```
Global frame                      func make_adder(n) [parent=Global]
          make_adder  •           func adder(k) [parent=f1]
           add_three  •

f1: make_adder [parent=G]
                   n  3
               adder  •
        Return value  •

f2: adder [parent=f1]
                   k  4
        Return value  7
```

- Every user-defined function has a parent frame (often global)
- The parent of a function is the frame in which it was defined
- Every local frame has a parent frame (often global)
- The parent of a frame is the parent of the function called

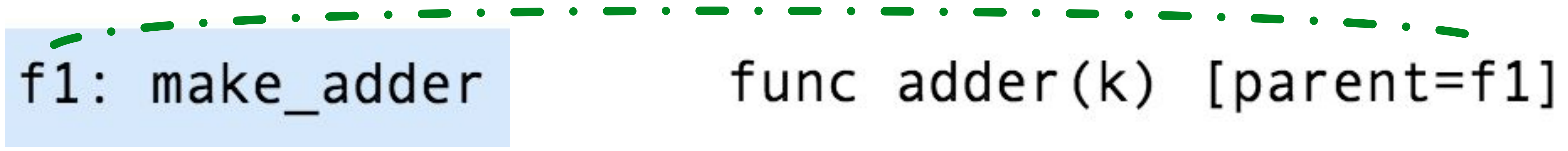
http://pythontutor.com/composingprograms.html#code=def%20make_adder%28n%29%3A%0A%20%20%20%20def%20adder%28k%29%3A%0A%20%20%20%20%20%20%20%20return%20k%20%2B%20n%0A%20%20%20%20return%20adder%0A%20%20%20%20%0Athree_more_than%20%3D%20make_adder%283%29%0Aresult%20%3D%20three_more_than%284%29&cumulative=false&curInstr=0&mode=display&origin=composingprograms.js&py=3&rawInputLstJSON=%5B%5D

How to Draw an Environment Diagram

When a function is defined:

Create a function value: func <name>(<formal parameters>) [parent=<label>]

Its parent is the current frame.



```
f1: make_adder        func adder(k) [parent=f1]
```

Bind <name> to the function value in the current frame

When a function is called:

1. Add a local frame, titled with the <name> of the function being called.
2. Copy the parent of the function to the local frame: [parent=<label>]
3. Bind the <formal parameters> to the arguments in the local frame.
4. Execute the body of the function in the environment that starts with the local frame.

Lambda Expressions

(Demo)

https://pythontutor.com/cp/composingprograms.html#code=def%20apply_twice%28f,%20x%29%3A%0A%20%20%20%20return%20f%28f%28x%29%29%0A%20%20%20%20%0Ax%20%3D%203%0Aresult%20%3D%20apply_twice%28lambda%20y%3A%20x%20*%20y,%202%29&cumulative=true&curInstr=0&mode=display&origin=composingprograms.js&py=3&rawInputLstJSON=%5B%5D

https://pythontutor.com/cp/composingprograms.html#code=bear%20%3D%20-1%0Aoski%20%3D%20lambda%20print%3A%20print%28bear%29%0Abear%20%3D%20-2%0Aprint%28oski%28abs%29%29&cumulative=true&curInstr=0&mode=display&origin=composingprograms.js&py=3&rawInputLstJSON=%5B%5D