Environments

Announcements

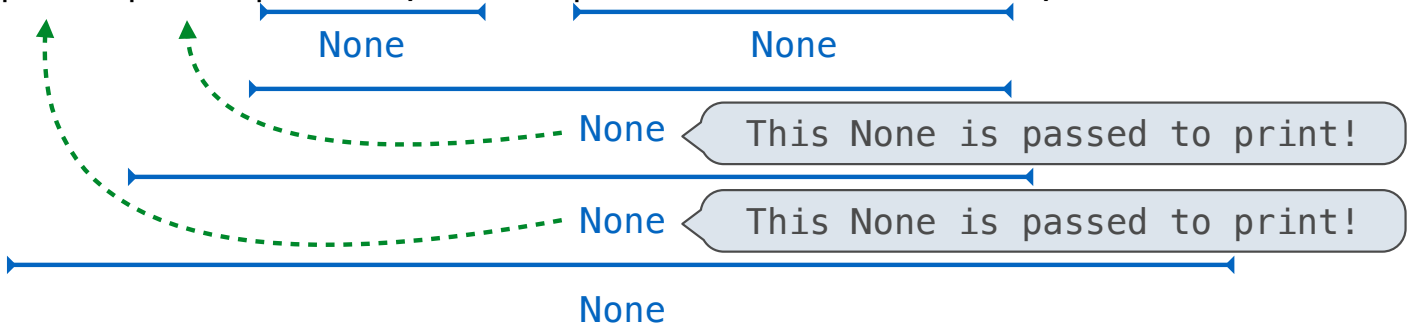
Print and None Review

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?")
```




```
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

See "Lecture Example: Repeating" on Pensieve

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 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
```

616161

6161

61

0

An iterative appraoch: 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.

See "Lecture Example: Repeating" on Pensieve

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.

See "Lecture Example: Repeating" on Pensieve

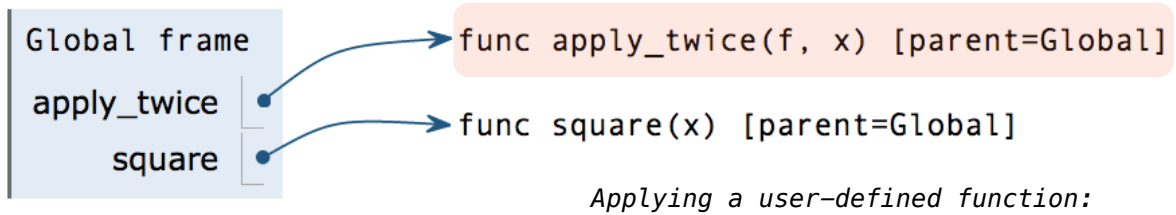
Environments for Higher-Order Functions

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

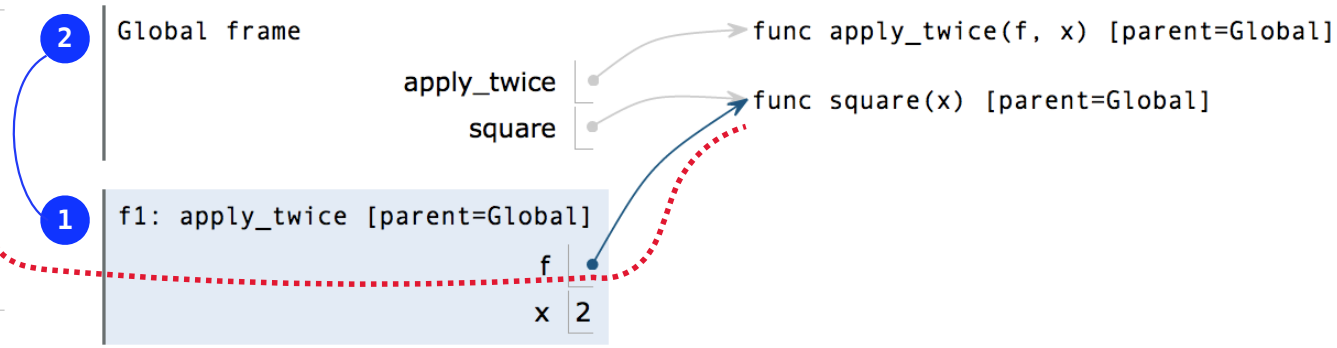
```
1  def apply_twice(f, x):
2      return f(f(x))
3
4  def square(x):
5      return x * x
6
7  result = apply_twice(square, 2)
```



Applying a user-defined function:

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

```
1  def apply_twice(f, x):
2      return f(f(x))
3
4  def square(x):
5      return x * x
6
7  result = apply_twice(square, 2)
```

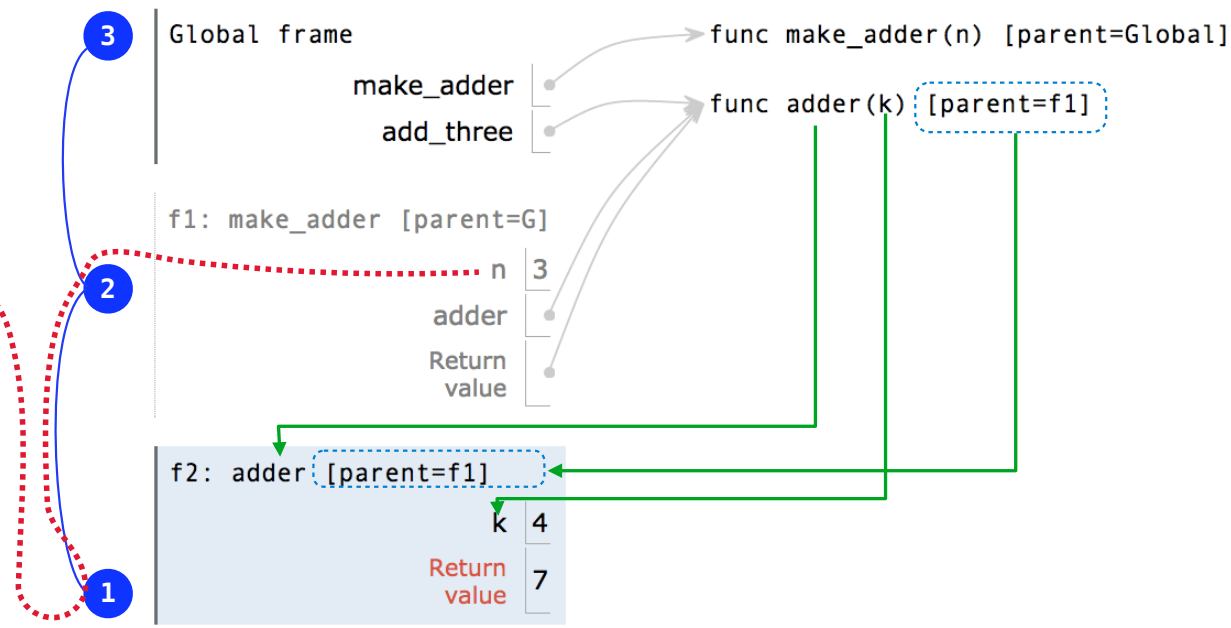


pythontutor.com/composingprograms.html#code=def%20apply_twice%28f,%20x%29%3A%0A%20%20%20%20return%20f%28f%28x%29%29%0A%20%20%20%20%0Adef%20square%28x%29%3A%0A%20%20%20%20return%20x%20*%20x%0A%20%20%20%20%0Aresult%20%3D%20apply_twice%28square,%202%29&mode=display&origin=composingprograms.js&cumulative=true&py=3&rawInputLstJSON=[]&curInstr=0

Environment Diagrams for Nested Def Statements

Nested def

```
1 def make_adder(n):
2     def adder(k):
3         return k + n
4     return adder
5
6 add_three = make_adder(3)
7 add_three(4)
```



- 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