

# SICP

God's Programming Book

Lecture-03 Control



# Control

Slides Adapted from cs61a of UC Berkeley

# Print and None

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(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_return_square(x):  
...     x * x  
...  
>>> does_not_return_square(4)  
>>> sixteen = does_not_return_square(4)  
>>> sixteen + 4
```

**No return**

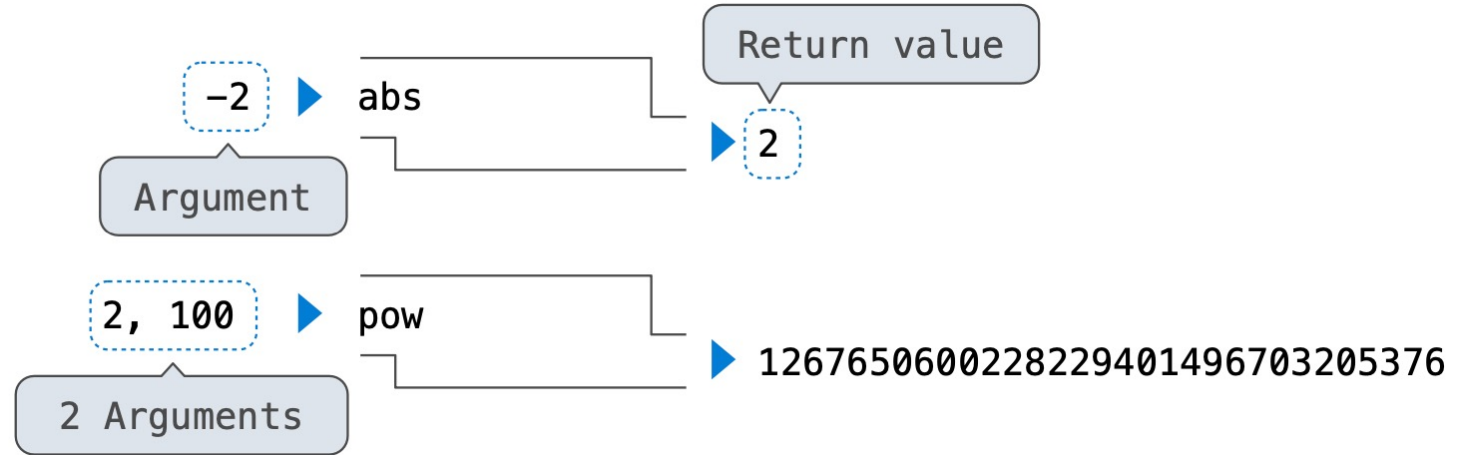
**None value is not displayed**

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

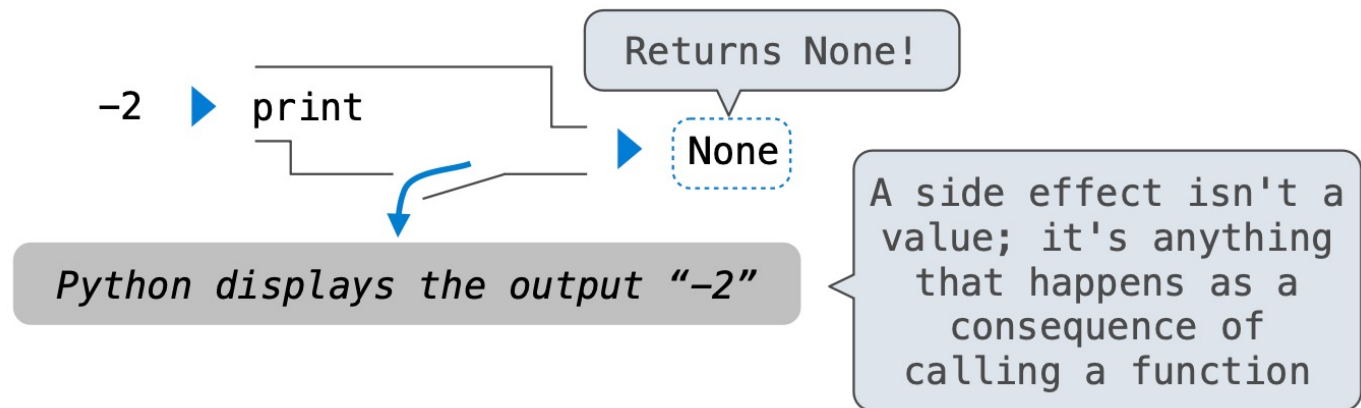
Traceback (most recent call last):  
File "<stdin>", line 1, in <module>  
**TypeError**: unsupported operand type(s) for +: 'NoneType' and 'int'

# Pure Functions & Non-Pure Functions

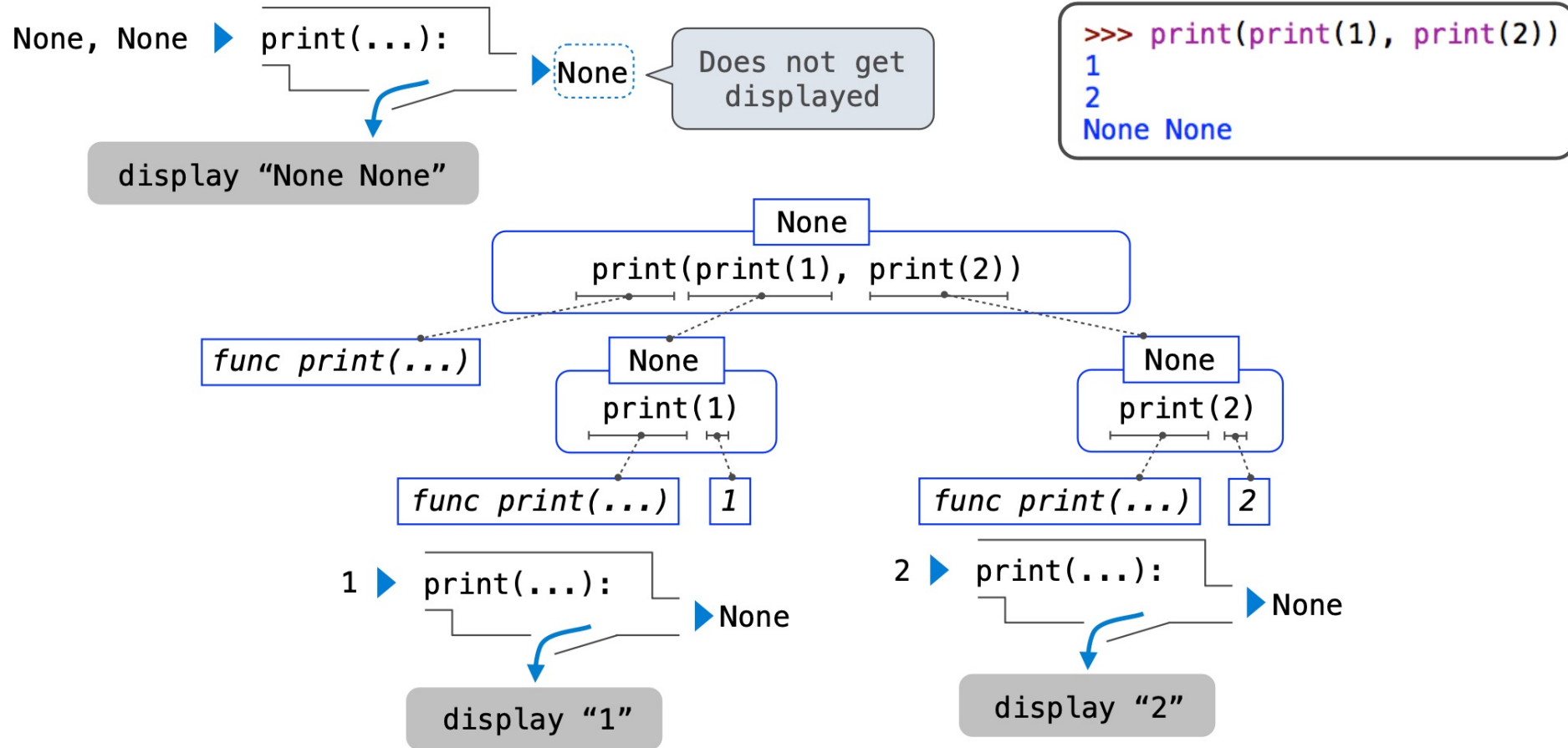
**Pure Functions**  
just return values



**Non-Pure Functions**  
have side effects



# Nested Expressions with Print



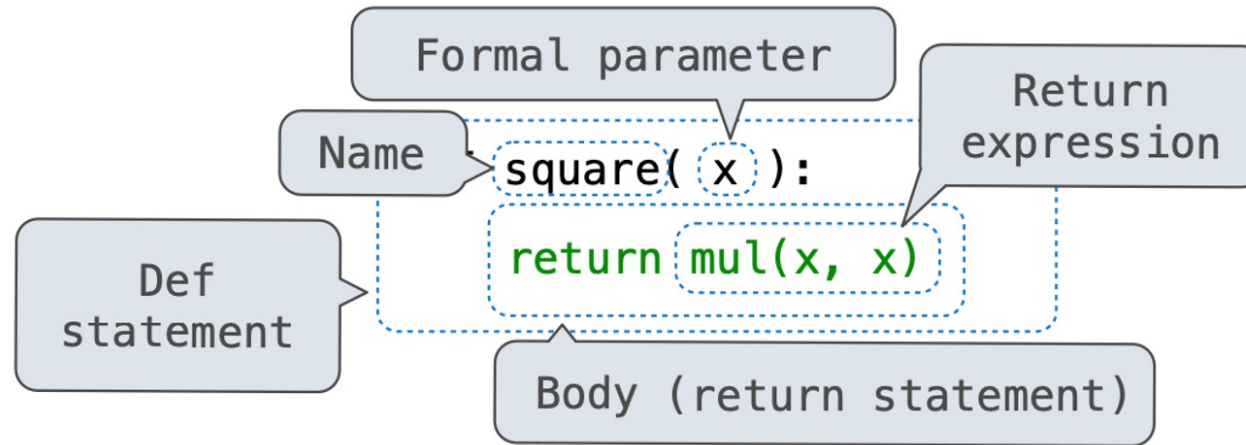
# Multiple Environments

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# Life Cycle of a User-Defined Function

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## Def statement:



## What happens?

A new function is created!

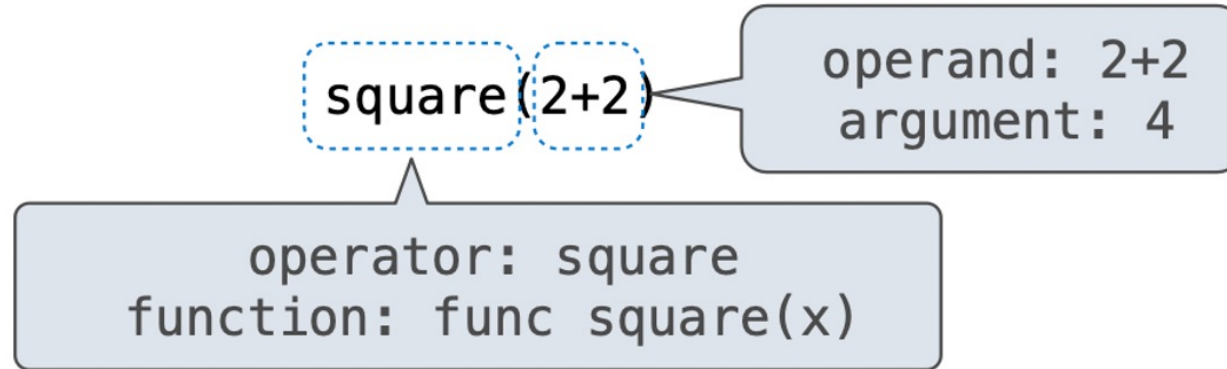
Name bound to that function in the current frame



# Life Cycle of a User-Defined Function

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## Call Expression:



## What happens?

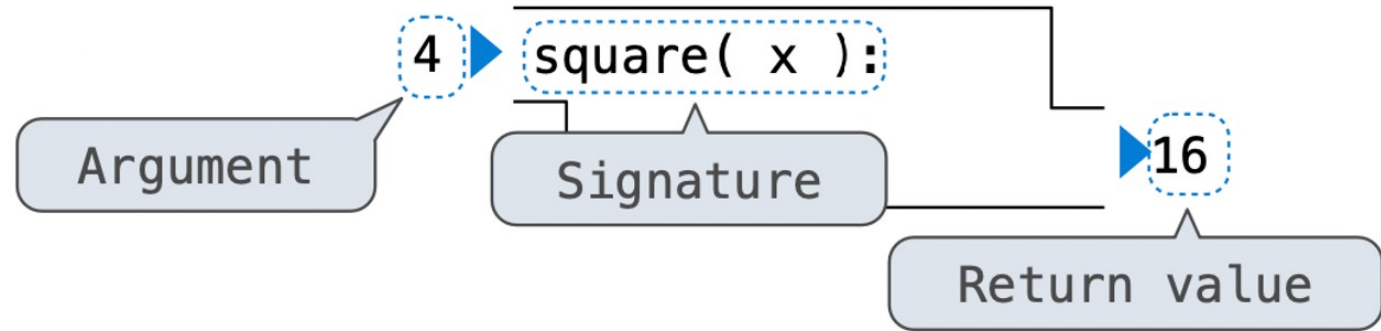
Operator & operands evaluated

Function (value of operator) called on arguments (values of operands)

# Life Cycle of a User-Defined Function

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## Calling/Applying:



## What happens?

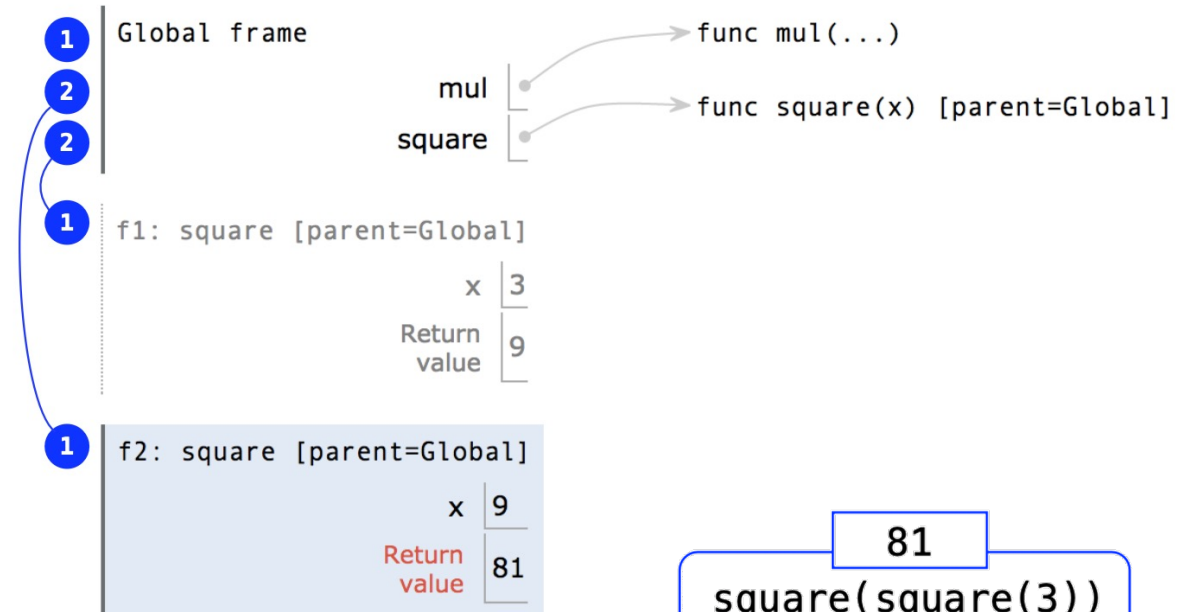
A new frame is created!

Parameters bound to arguments

Body is executed in that new environment

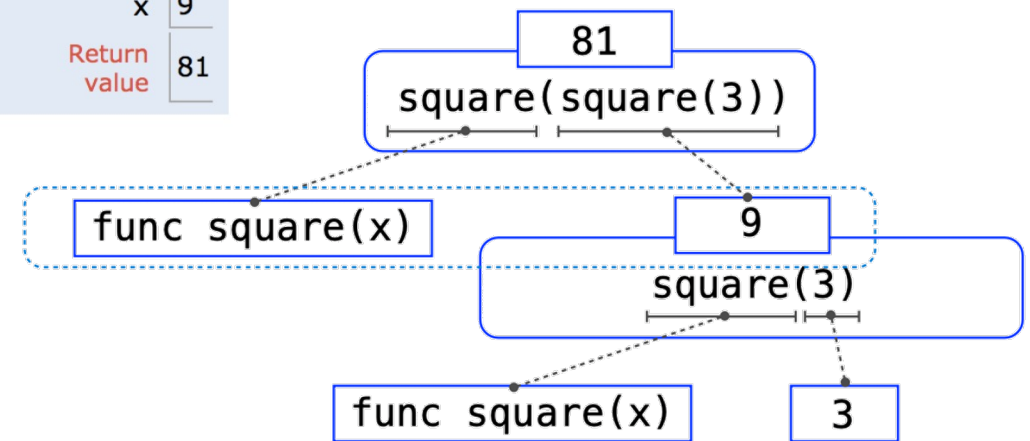
# Multiple Environments in One Diagram!

```
1 from operator import mul
2 def square(x):
3     return mul(x, x)
4 square(square(3))
```

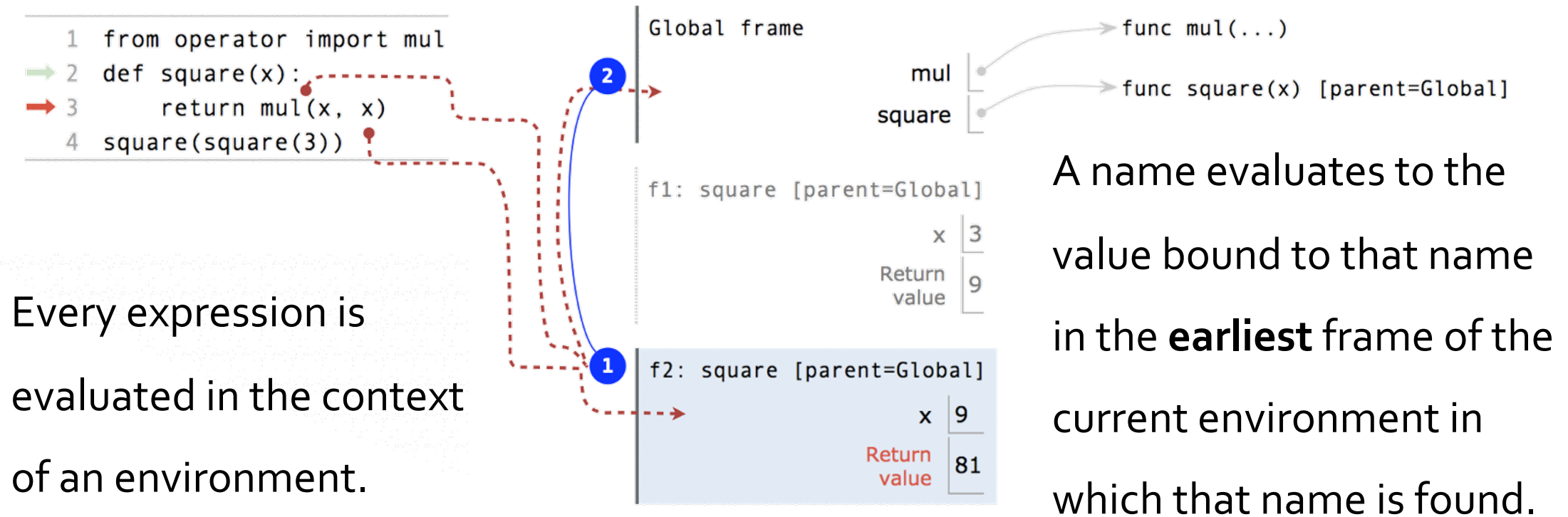


An environment is a sequence of frames.

- The global frame alone
- A local, then the global frame

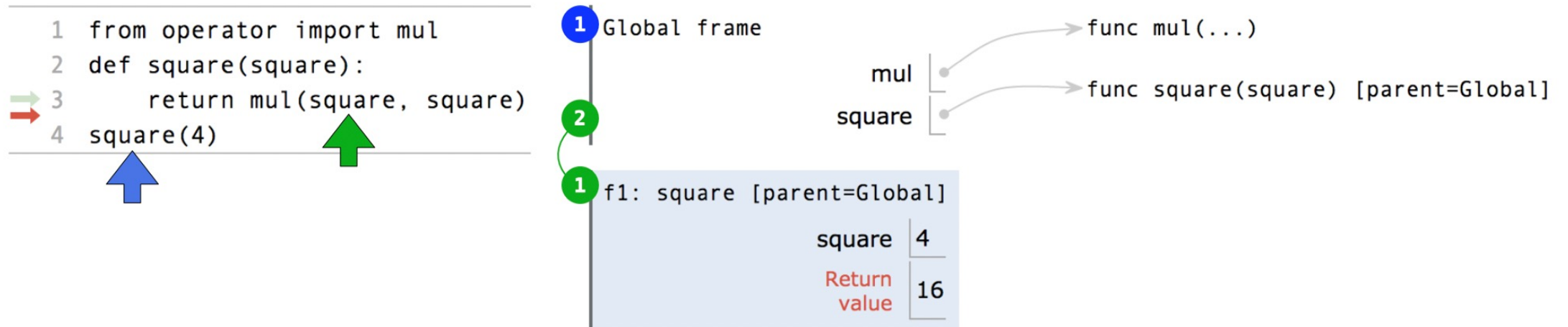


# Names Have No Meaning Without Environments



# Names Have Different Meanings in Different Environments

A call expression and the body of the function being called are evaluated in different environments.



# Miscellaneous Python Features

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# Miscellaneous Python Features

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- Division
- Multiple Return Values
- Source Files
- Doctests
- Default Arguments

# Conditional Statements

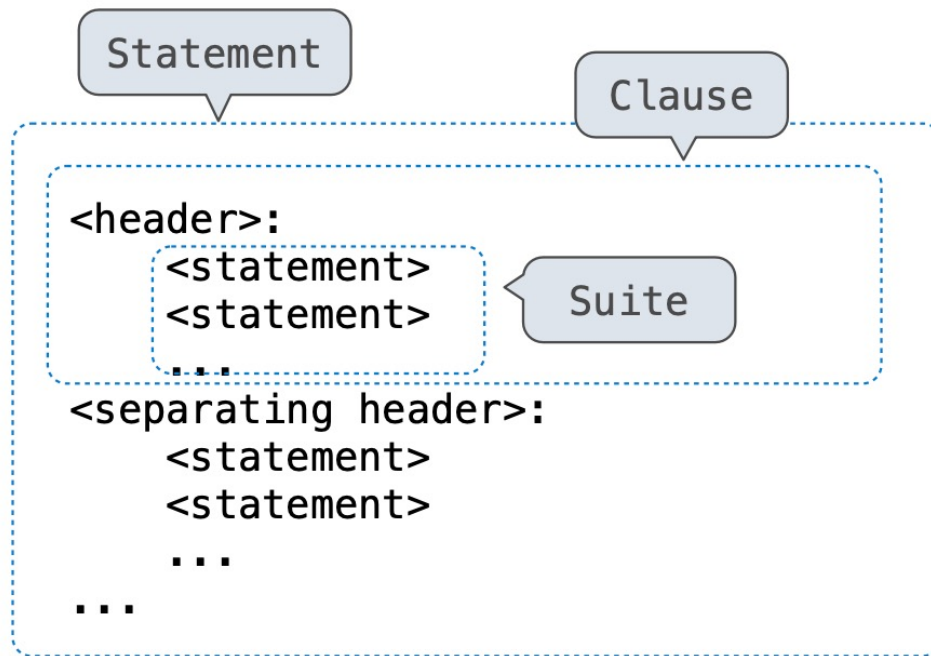
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# Statements

A **statement** is executed by the interpreter to perform an action

## Compound statements:

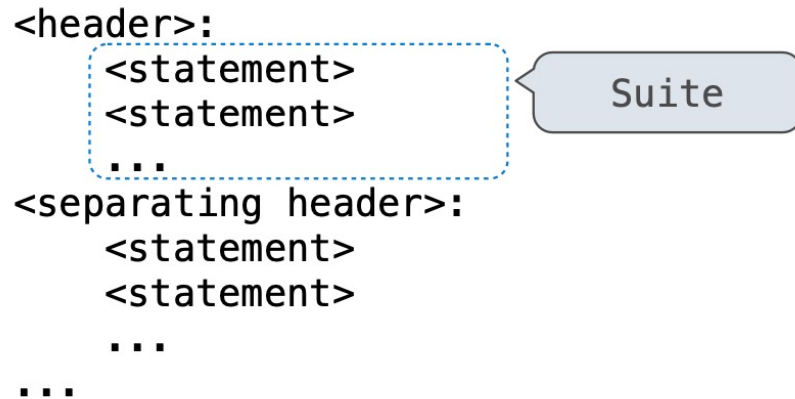


- The first header determines a statement's type
- The header of a clause "controls" the suite that follows
- def statements are compound statements

# Compound Statements

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## Compound statements:



- A suite is a sequence of statements
- To “execute” a suite means to execute its sequence of statements, in order

## Execution Rule for a sequence of statements:

- Execute the first statement
- Unless directed otherwise, execute the rest

# Conditional Statements

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```
def absolute_value(x):  
    """Return the absolute value of x."""  
    if x < 0:  
        return -x  
    elif x == 0:  
        return 0  
    else:  
        return x
```

1 statement,  
3 clauses,  
3 headers,  
3 suites

## Execution Rule for Conditional Statements:

Each clause is considered in order.

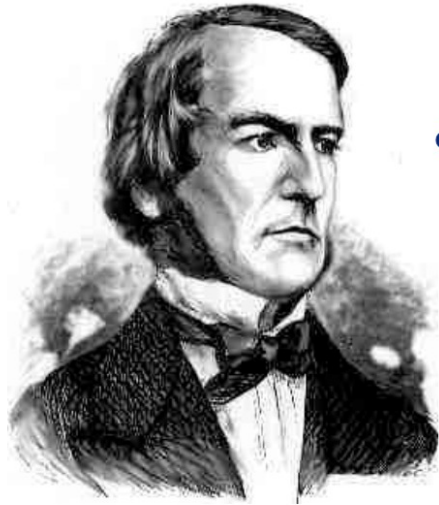
1. Evaluate the header's expression.
2. If it is a true value, execute the suite & skip the remaining clauses.

## Syntax Tips:

1. Always starts with "if" clause.
2. Zero or more "elif" clauses.
3. Zero or one "else" clause, always at the end.

# Boolean Contexts

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George Boole

```
def absolute_value(x):  
    """Return the absolute value of x."""  
    if x < 0:  
        return -x  
    elif x == 0:  
        return 0  
    else:  
        return x
```

Two boolean contexts

- False values in Python: False, 0, "", None (more to come)
- True values in Python: Anything else (True)

# Iteration

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# While Statements



George Boole

```
1 i, total = 0, 0
2 while i < 3:
3     i = i + 1
4     total = total + i
```

Global frame

|       |              |              |              |   |
|-------|--------------|--------------|--------------|---|
| i     | <del>0</del> | <del>1</del> | <del>2</del> | 3 |
| total | <del>0</del> | <del>1</del> | <del>3</del> | 6 |

## Execution Rule for While Statements:

1. Evaluate the header's expression.
2. If it is a true value, execute the (whole) suite, then return to step 1.

# Example: Prime Factorization

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# Prime Factorization

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Each positive integer  $n$  has a set of prime factors: primes whose product is  $n$

...

$$8 = 2 * 2 * 2 \quad 9 = 3 * 3$$

$$10 = 2 * 5$$

$$11 = 11$$

$$12 = 2 * 2 * 3$$

...

One approach: Find the smallest prime factor of  $n$ , then divide by it

$$858 = 2 * 429 = 2 * 3 * 143 = 2 * 3 * 11 * 13$$



# Thanks for Listening

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