61A Lecture 2

Wednesday, September 3, 2014

Announcements

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- Videos are a mix of Fall 2013 and new content

Names, Assignment, and User-Defined Functions

(Demo)

Types of Expressions

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Primitive expressions:

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Primitive expressions: 2

Number or Numeral

Types of Expressions

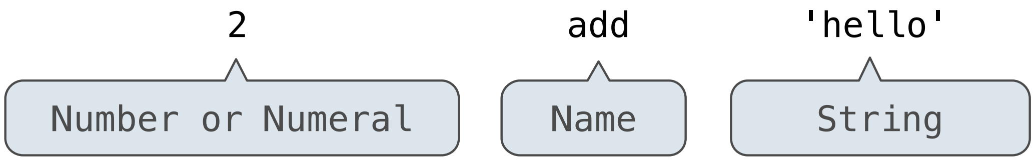
Primitive expressions: `2` `add`

Number or Numeral

Name

Types of Expressions

Primitive expressions:



2 add 'hello'

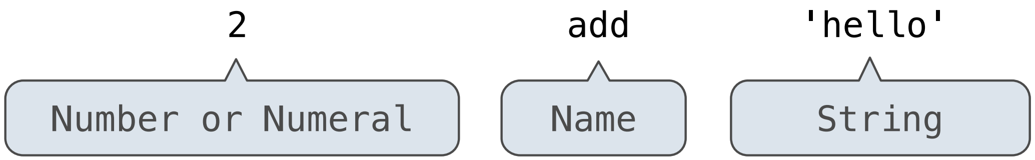
Number or Numeral

Name

String

Types of Expressions

Primitive expressions:



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Call expressions:

Types of Expressions

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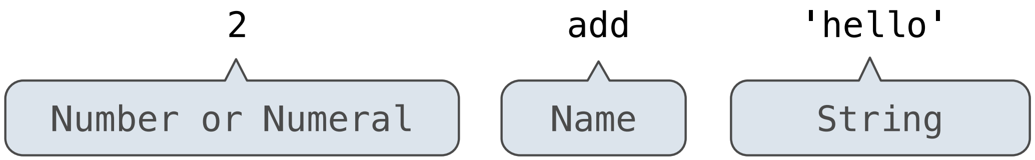

`2` `add` `'hello'`

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Call expressions:

```
max     (     2     ,     3     )
```

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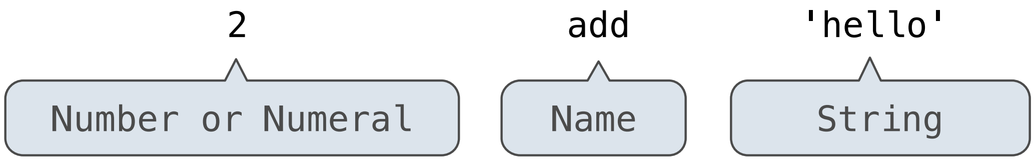

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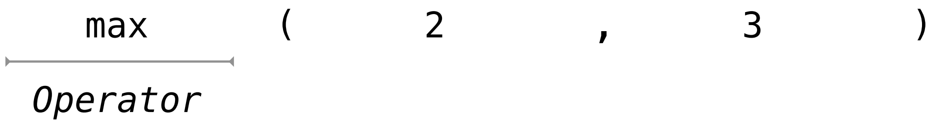

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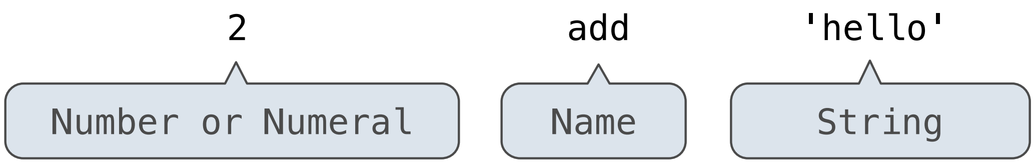

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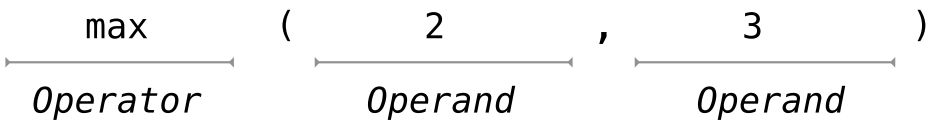

max (2 , 3)

Operator

Operand

Operand

Types of Expressions

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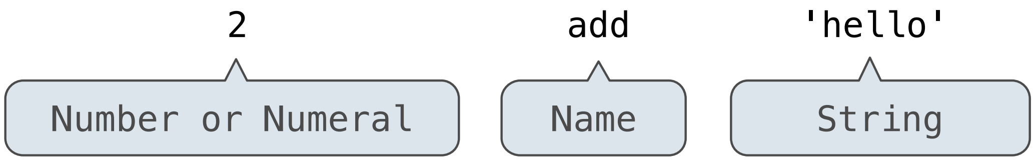

2 add 'hello'

Number or Numeral Name String

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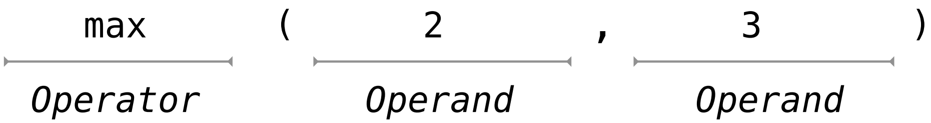

max (2 , 3)

Operator *Operand* *Operand*

```
max(min(pow(3, 5), -4), min(1, -2))
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Types of Expressions

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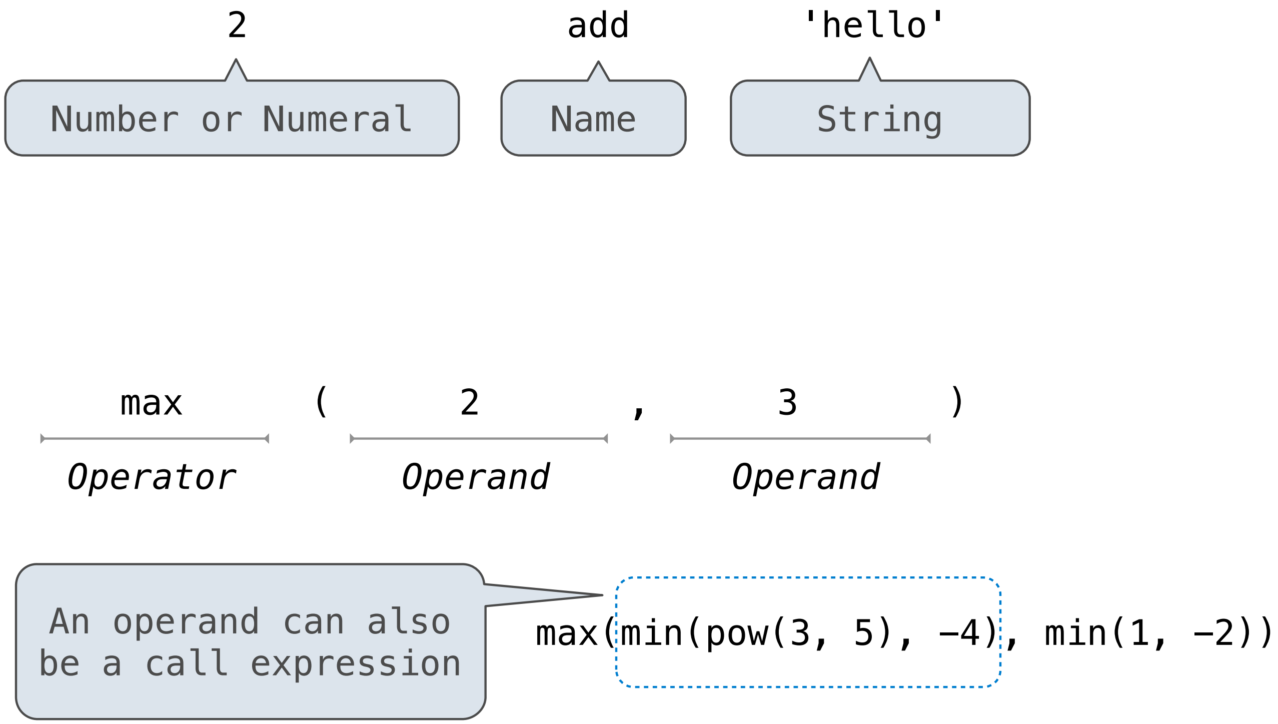

`2` — Number or Numeral

`add` — Name

`'hello'` — String

Call expressions:

`max ( 2 , 3 )`

max — *Operator*

2 — *Operand*

3 — *Operand*

An operand can also be a call expression

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max(min(pow(3, 5), -4), min(1, -2))
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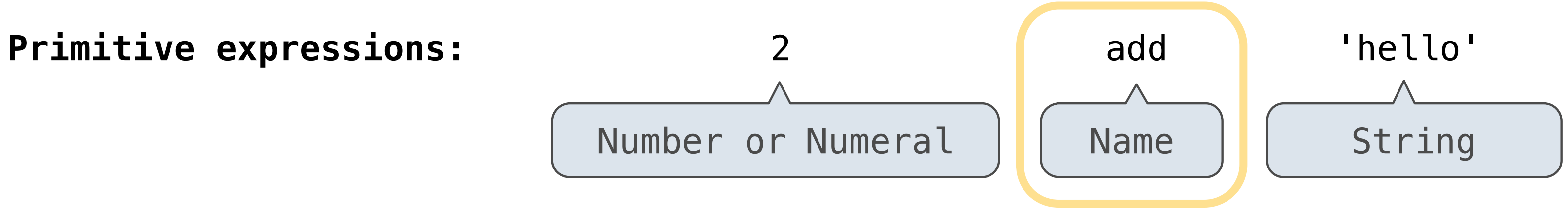
Types of Expressions



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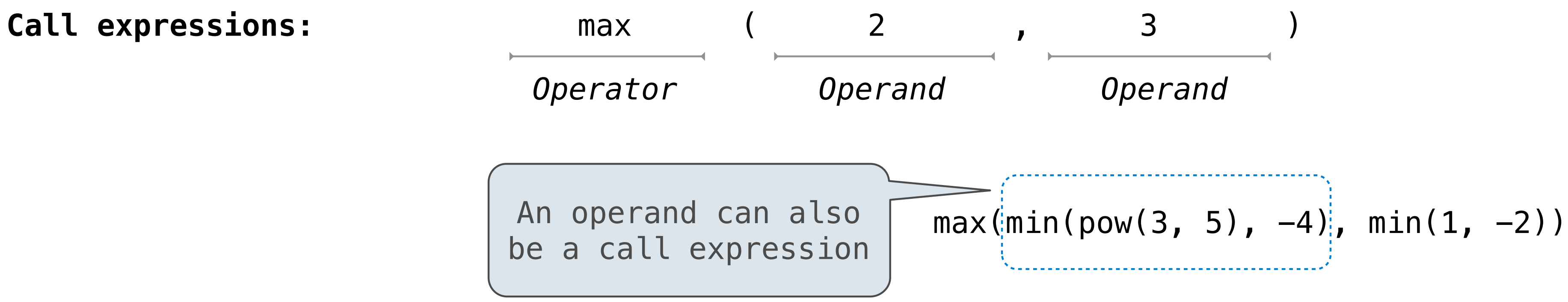

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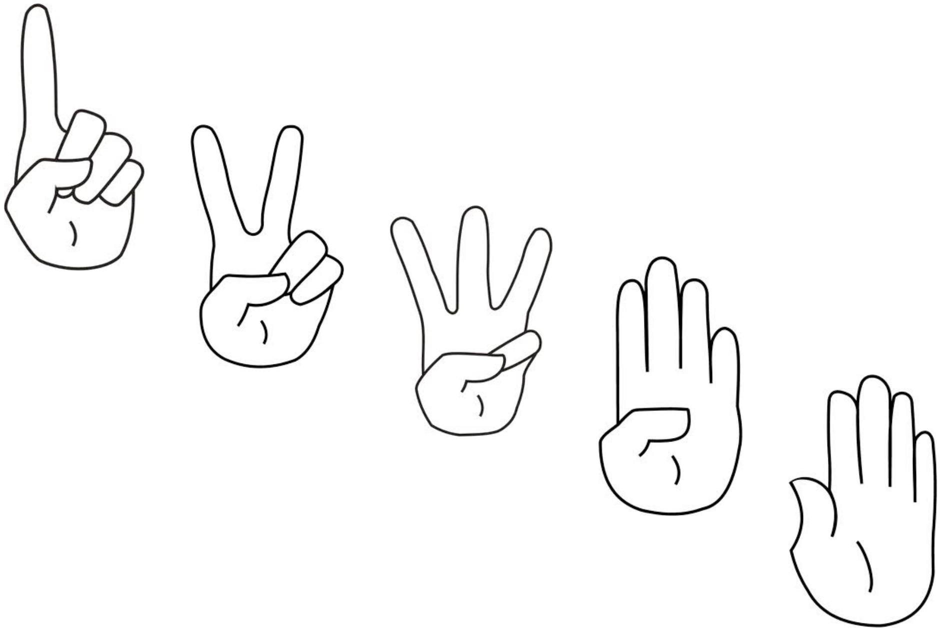

Environment Diagrams

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Environment diagrams visualize the interpreter’s process.

Interactive Diagram

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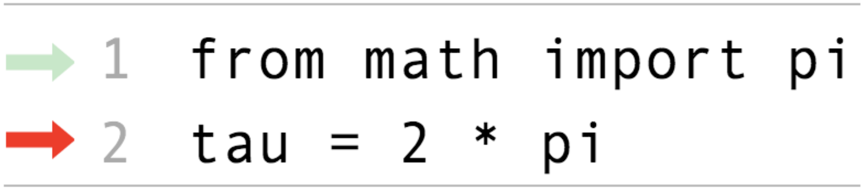

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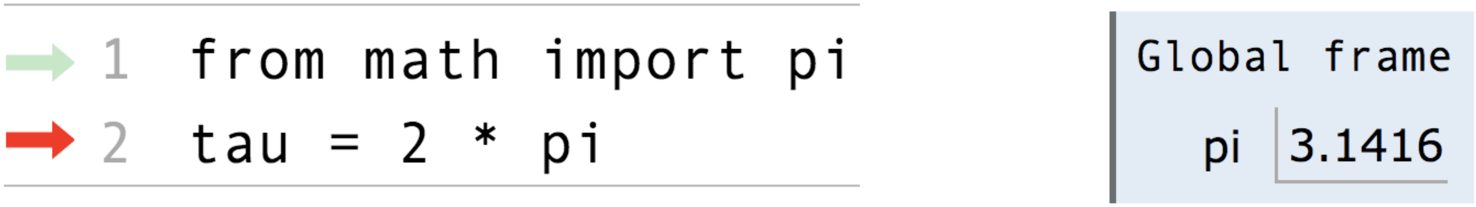

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Global frame

pi 3.1416

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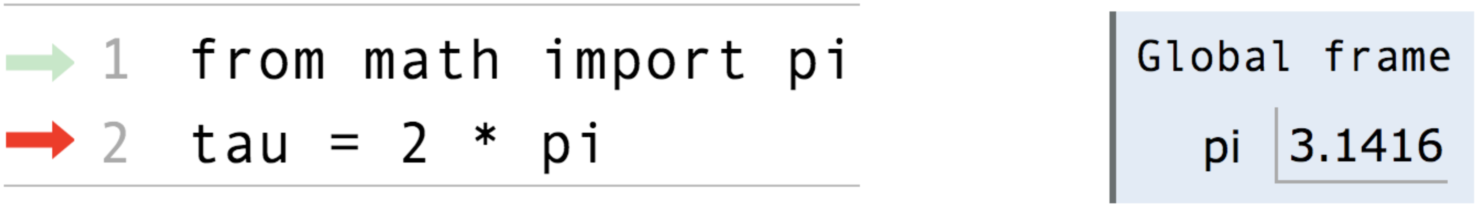

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Code (left):

Frames (right):

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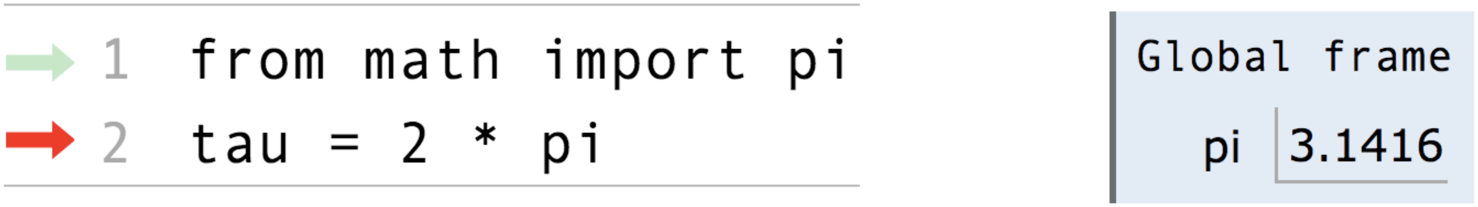

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Code (left):

Statements and expressions

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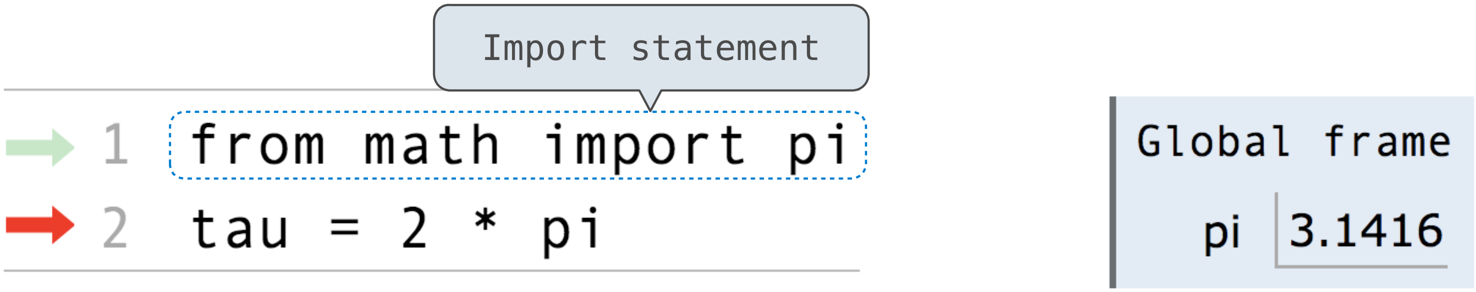

Import statement

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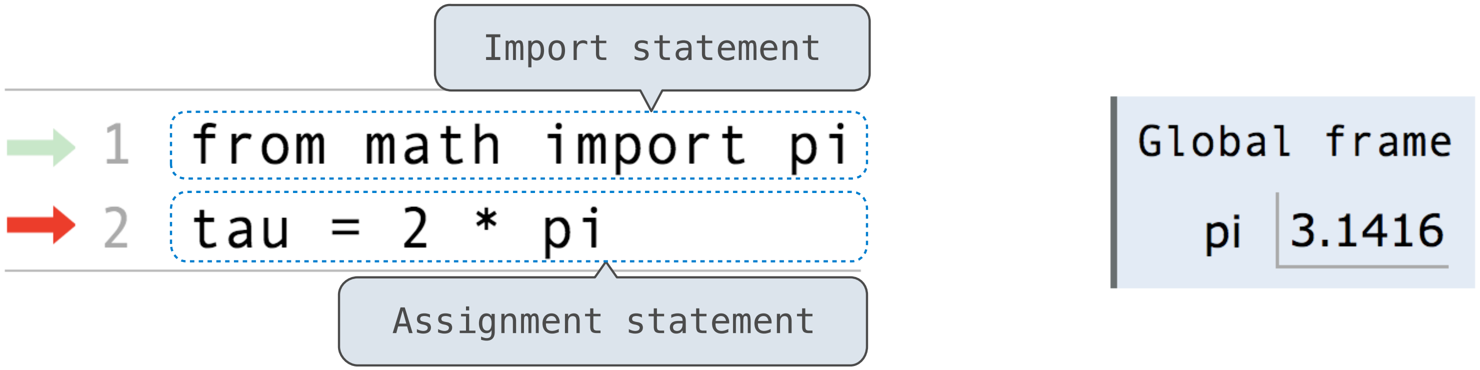

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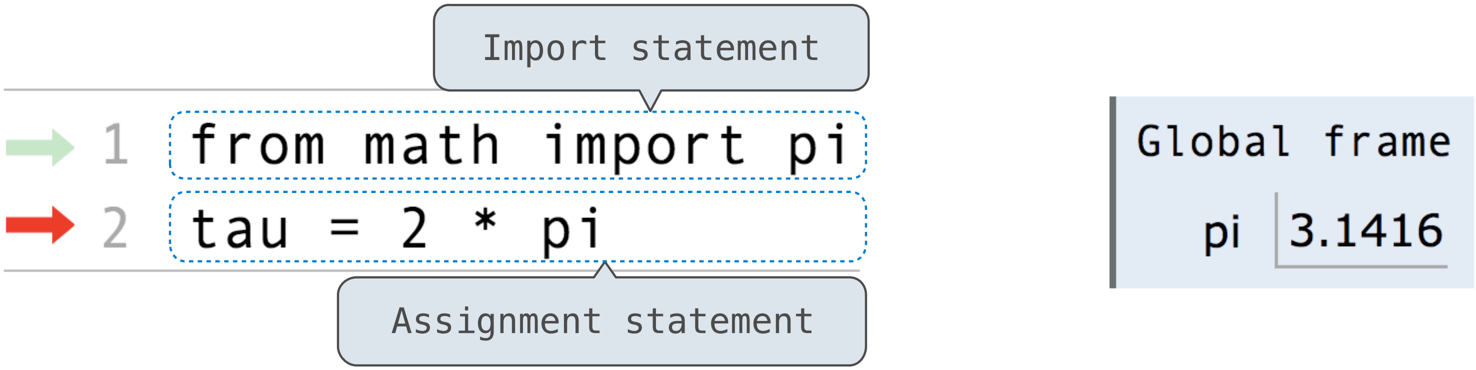

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Code (left):

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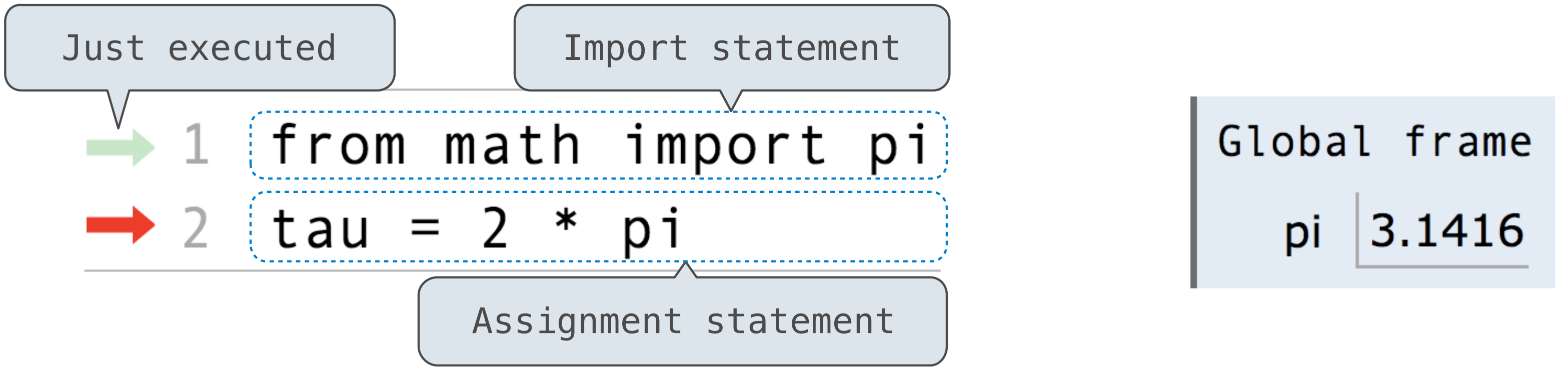

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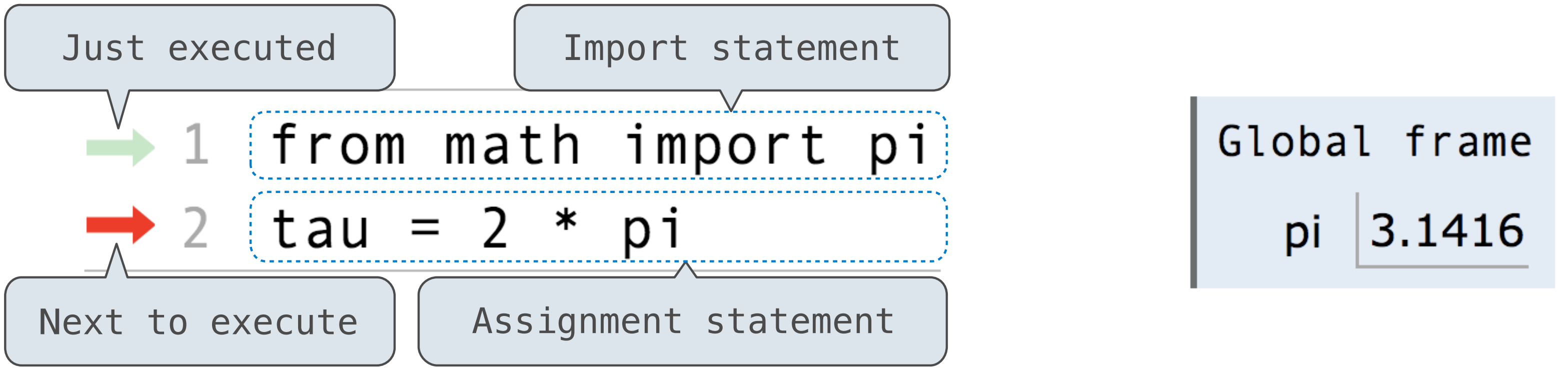

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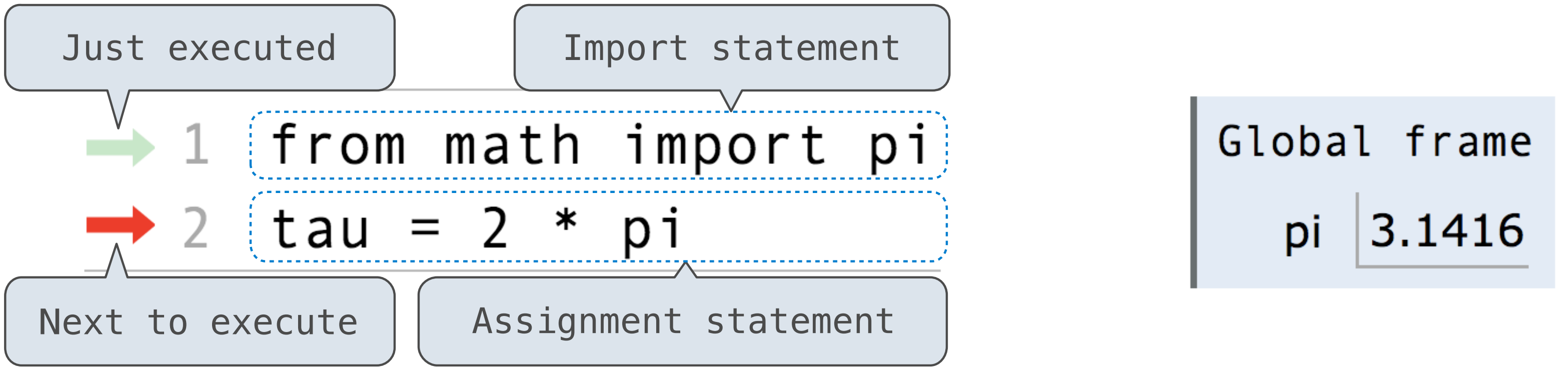

Just executed

Import statement

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Next to execute

Assignment statement

Global frame

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Each name is bound to a value

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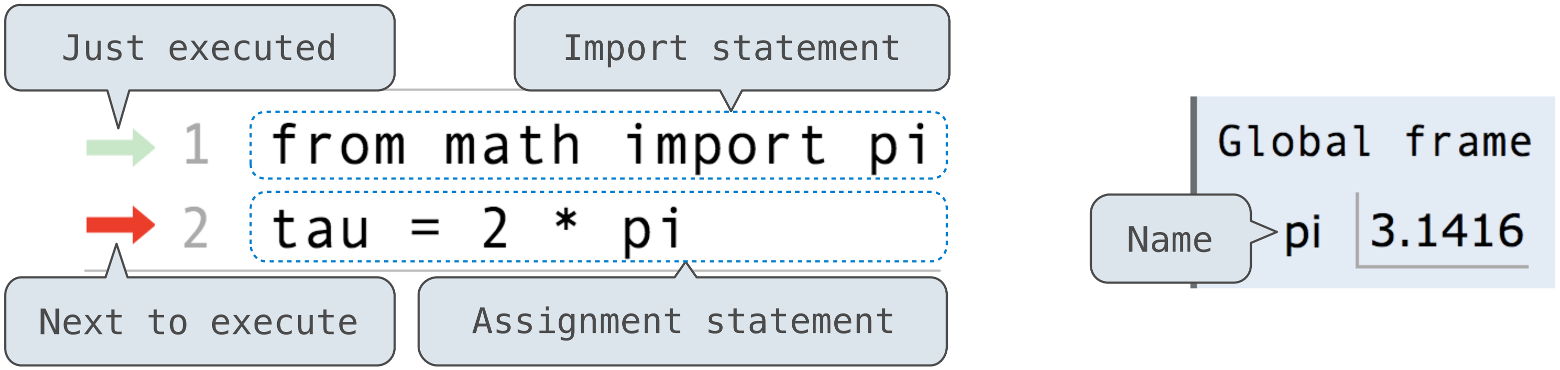

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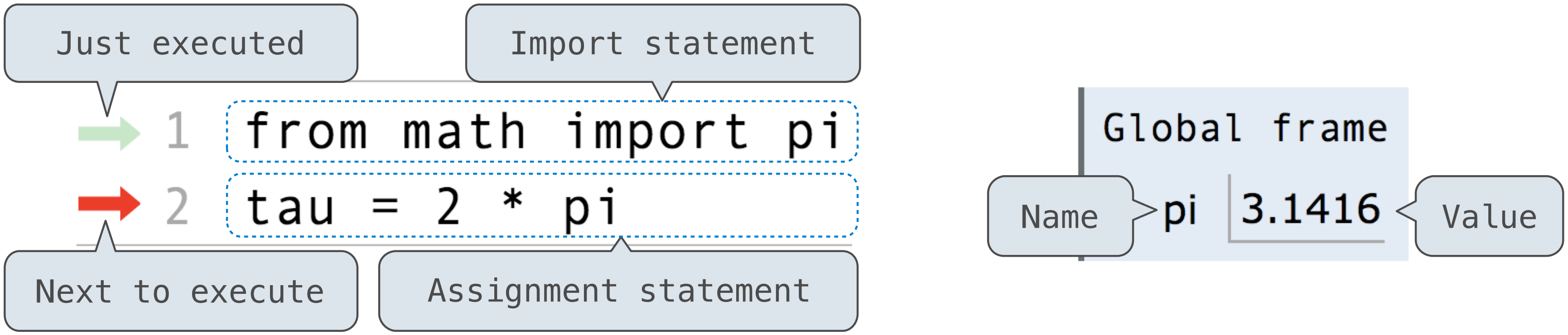

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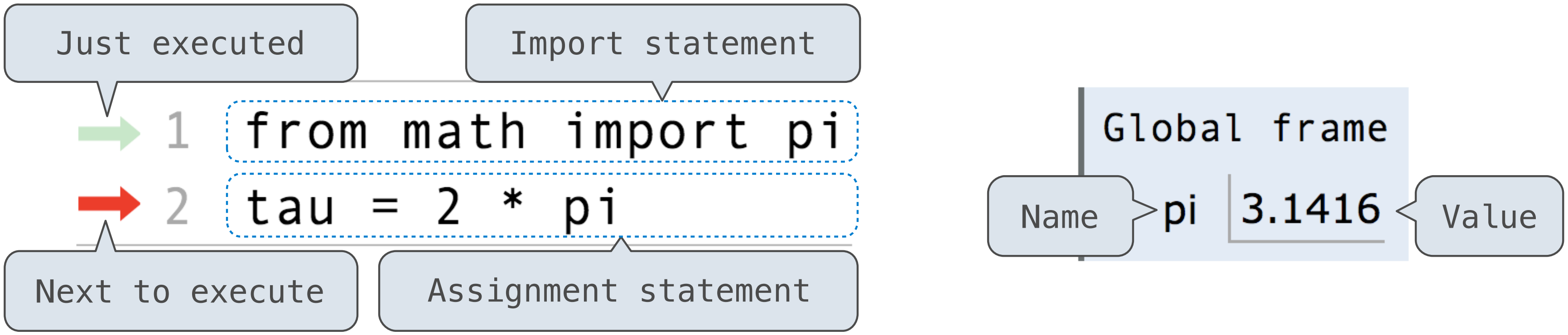

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Within a frame, a name cannot be repeated

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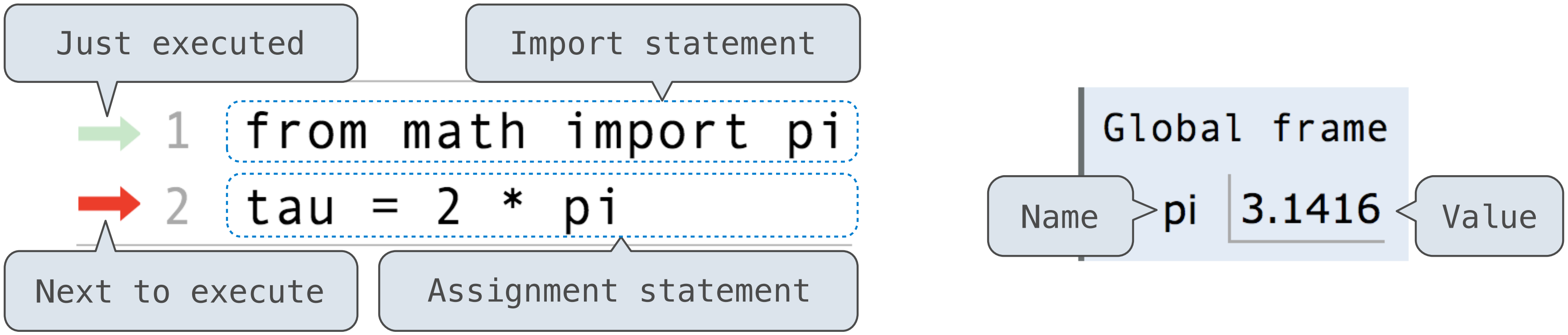

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(Demo)

Interactive Diagram

Assignment Statements

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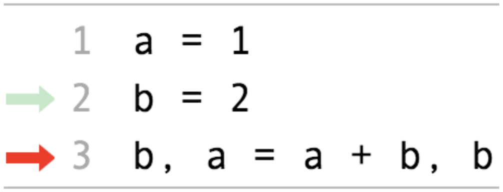
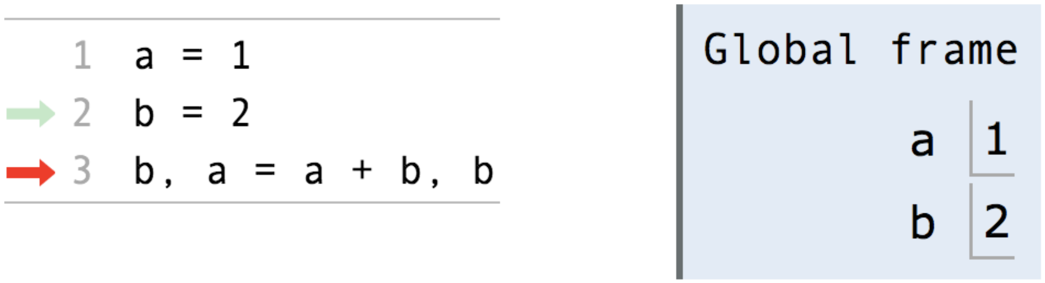


```
a = 1
b = 2
b, a = a + b, b
```

Interactive Diagram

Assignment Statements



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```

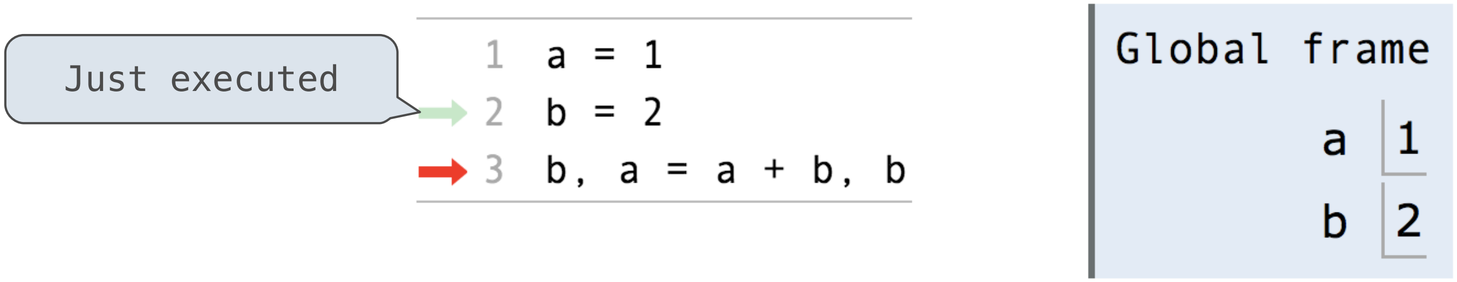
Global frame

a 1

b 2

Interactive Diagram

Assignment Statements



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Interactive Diagram

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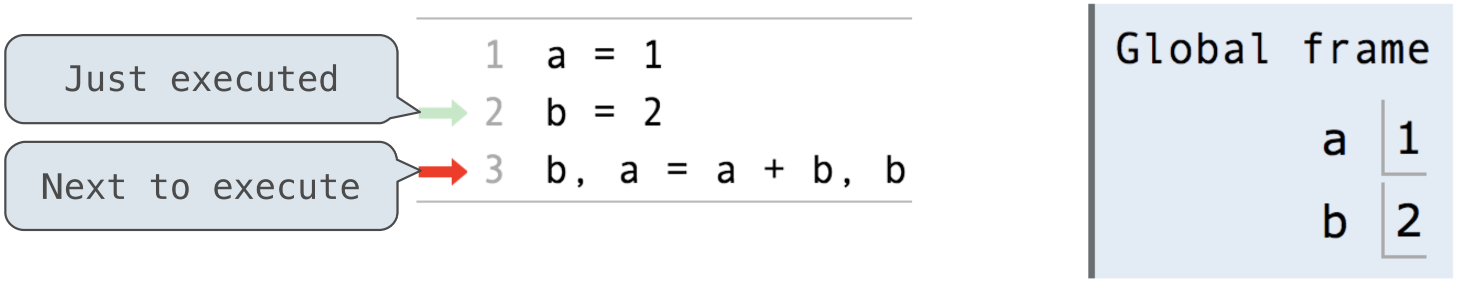

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Interactive Diagram

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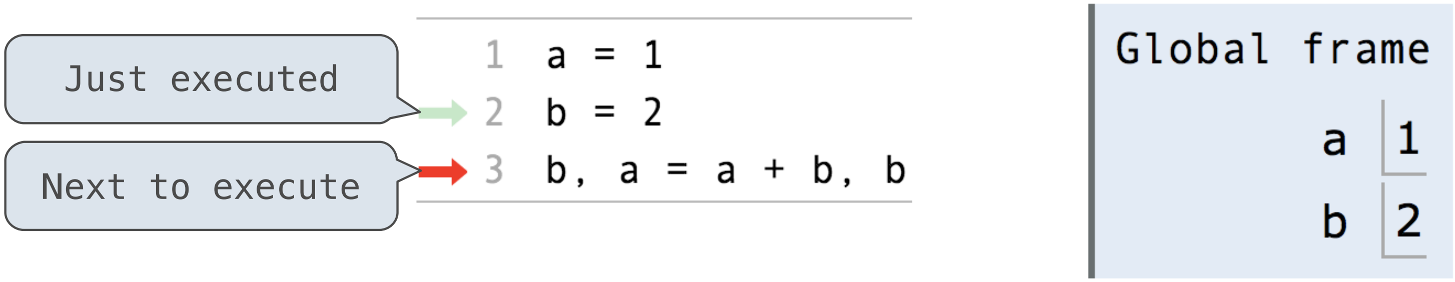

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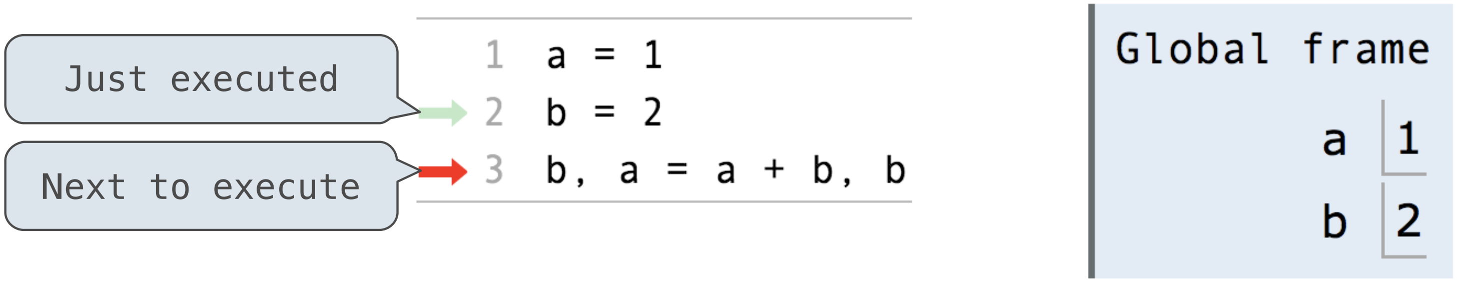
Execution rule for assignment statements:

Interactive Diagram

Assignment Statements



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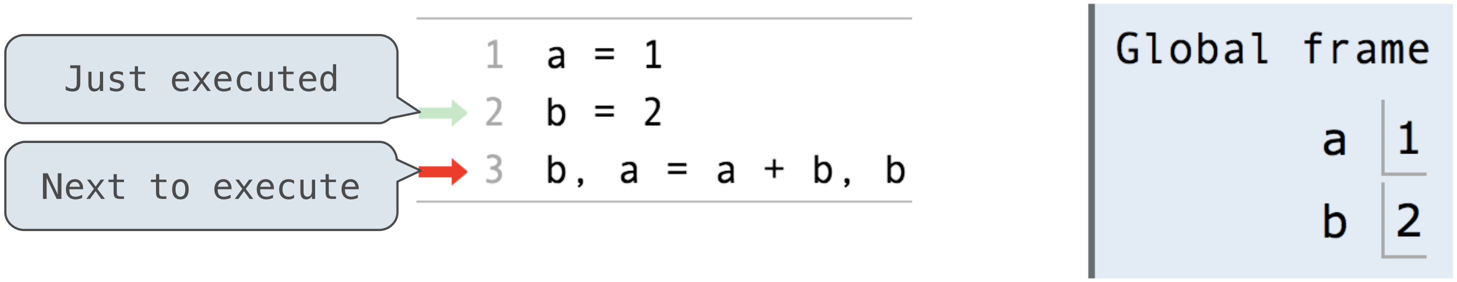
Execution rule for assignment statements:

1. Evaluate all expressions to the right of = from left to right.

Interactive Diagram

Assignment Statements



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Global frame

a	1
b	2

Execution rule for assignment statements:

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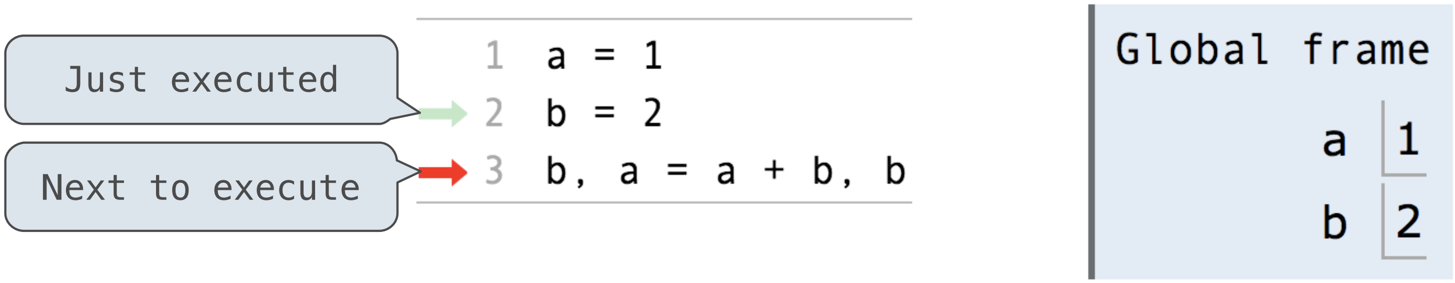
Interactive Diagram

Assignment Statements



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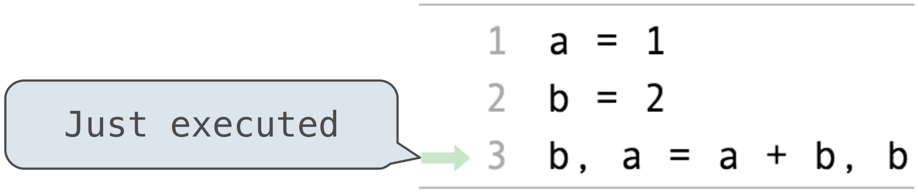

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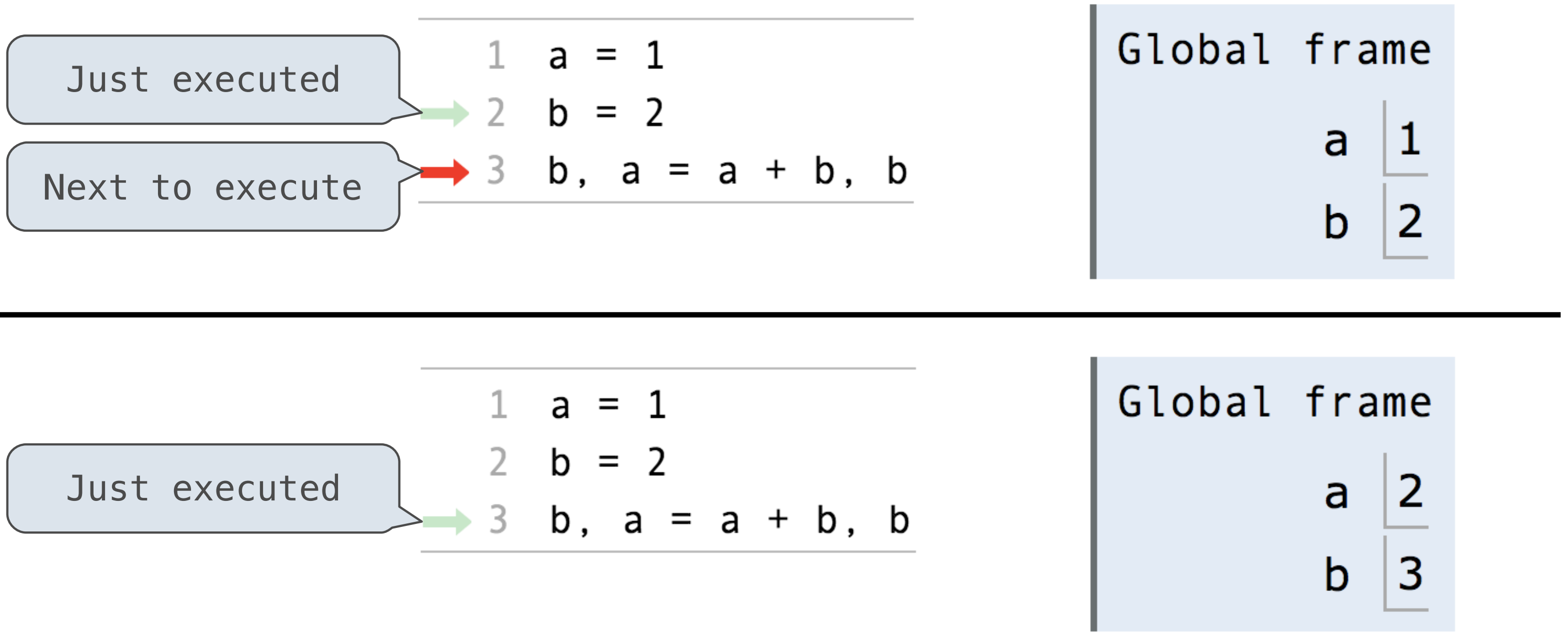

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Discussion Question 1 Solution

(Demo)

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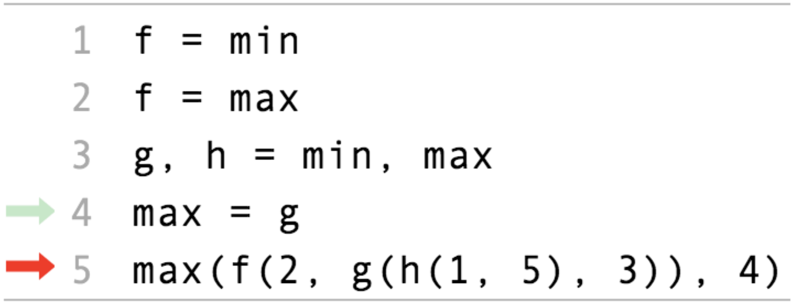

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Interactive Diagram

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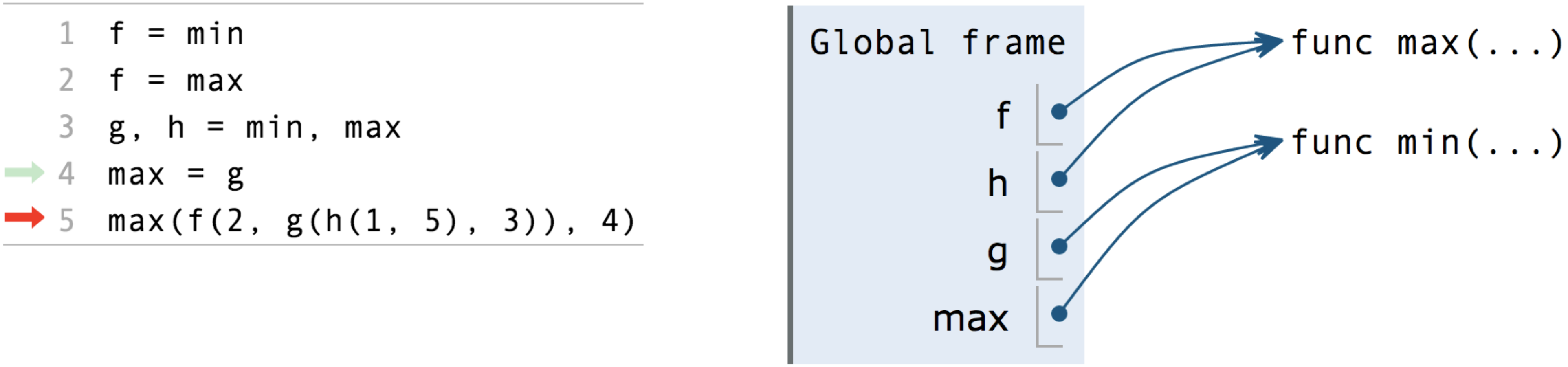

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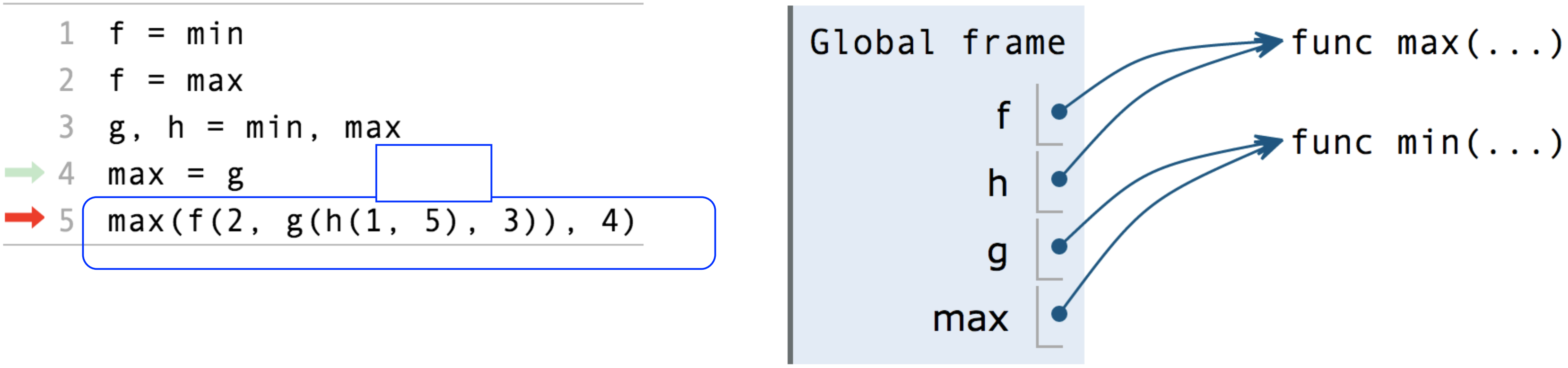

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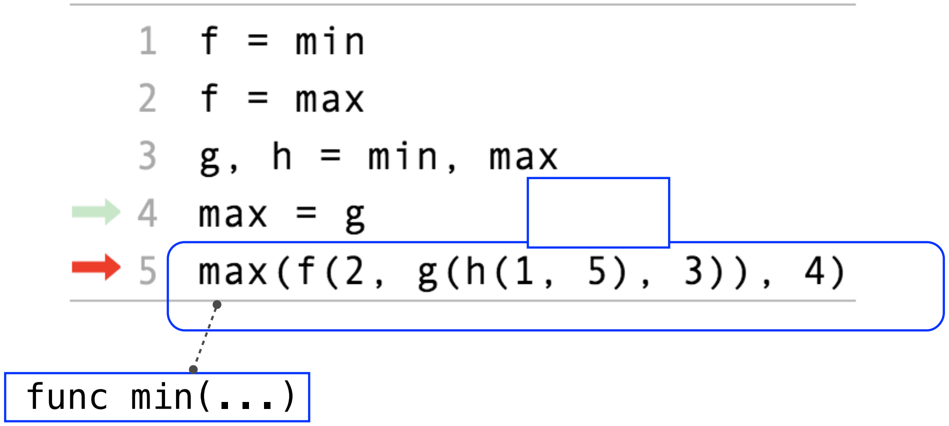

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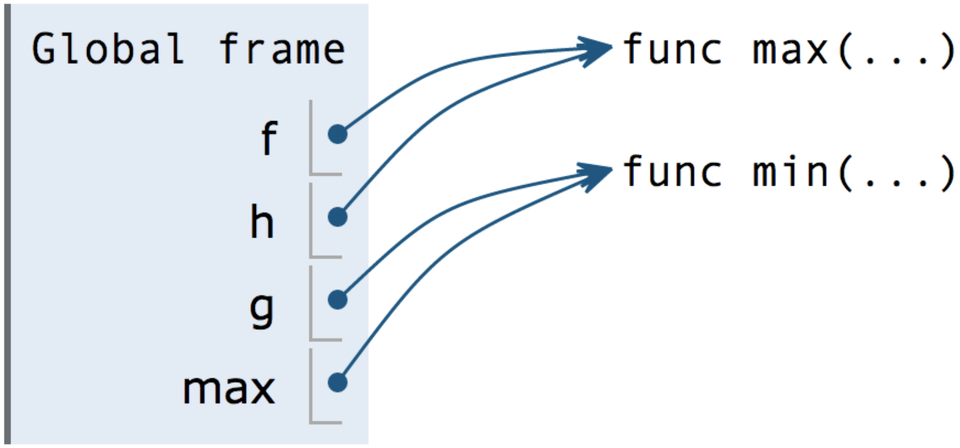

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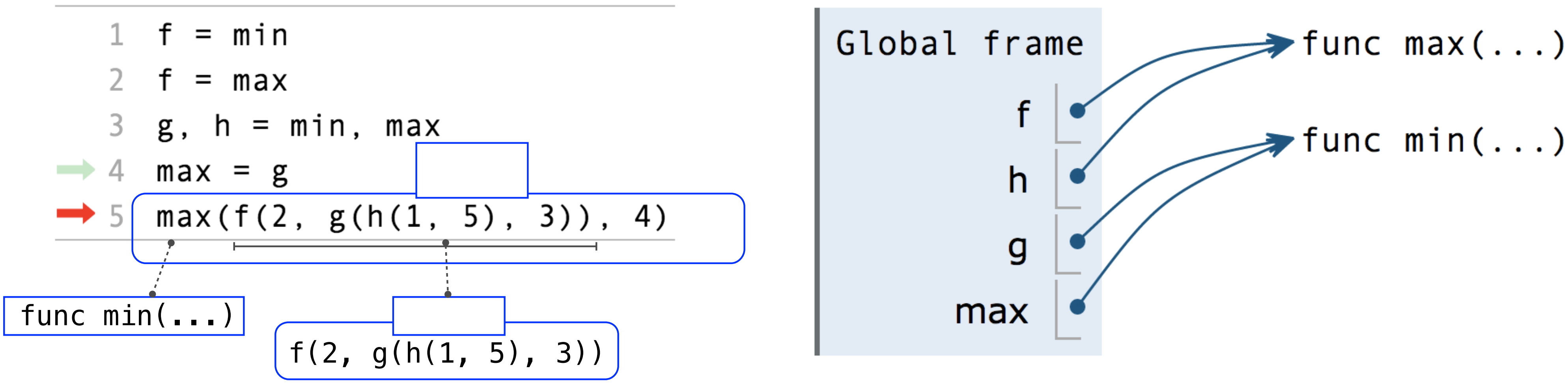

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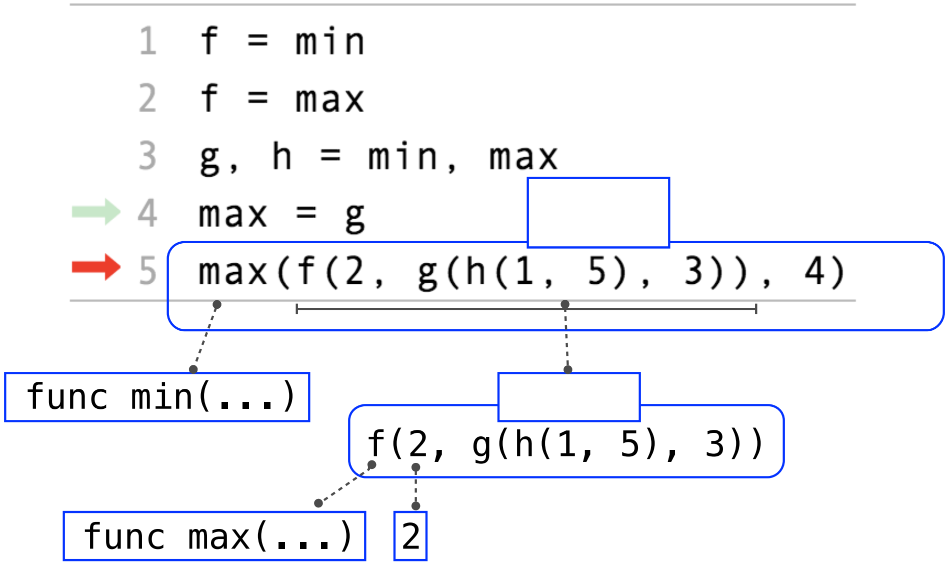

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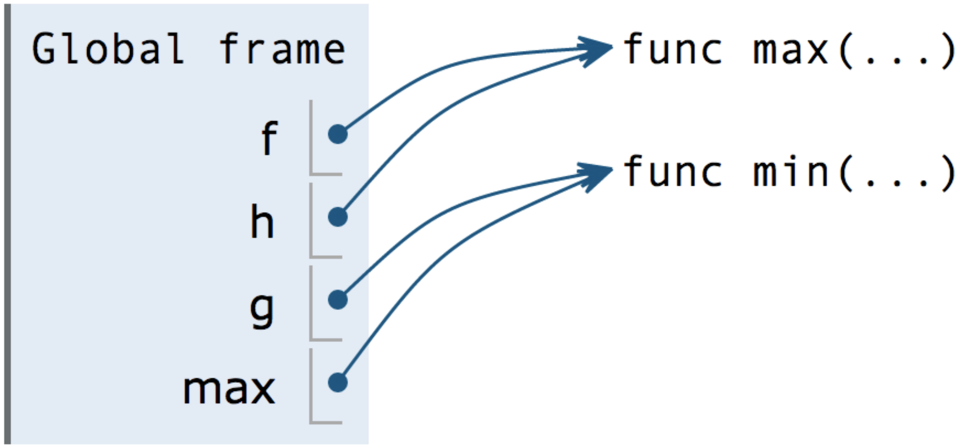
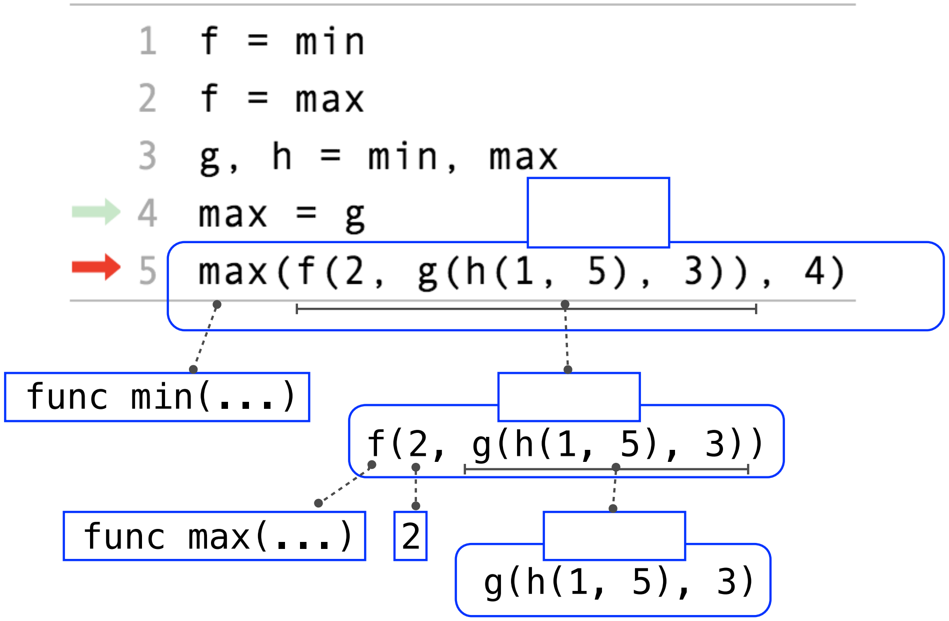


Interactive Diagram

Discussion Question 1 Solution

(Demo)



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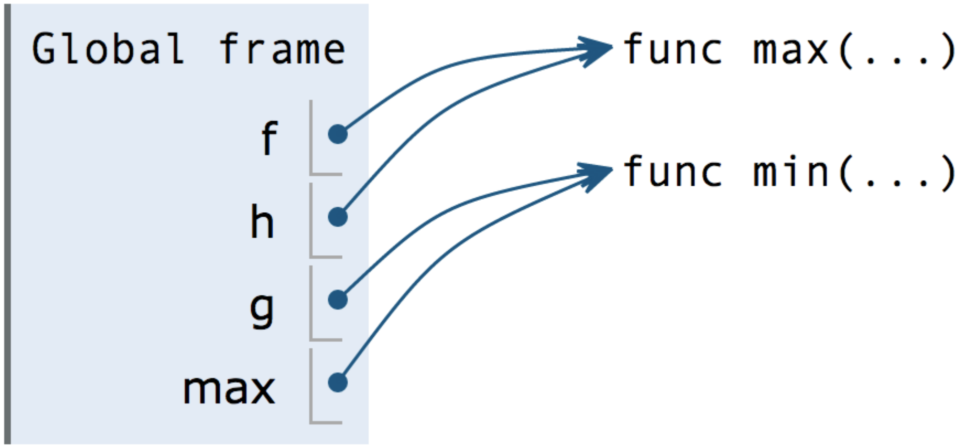

Interactive Diagram

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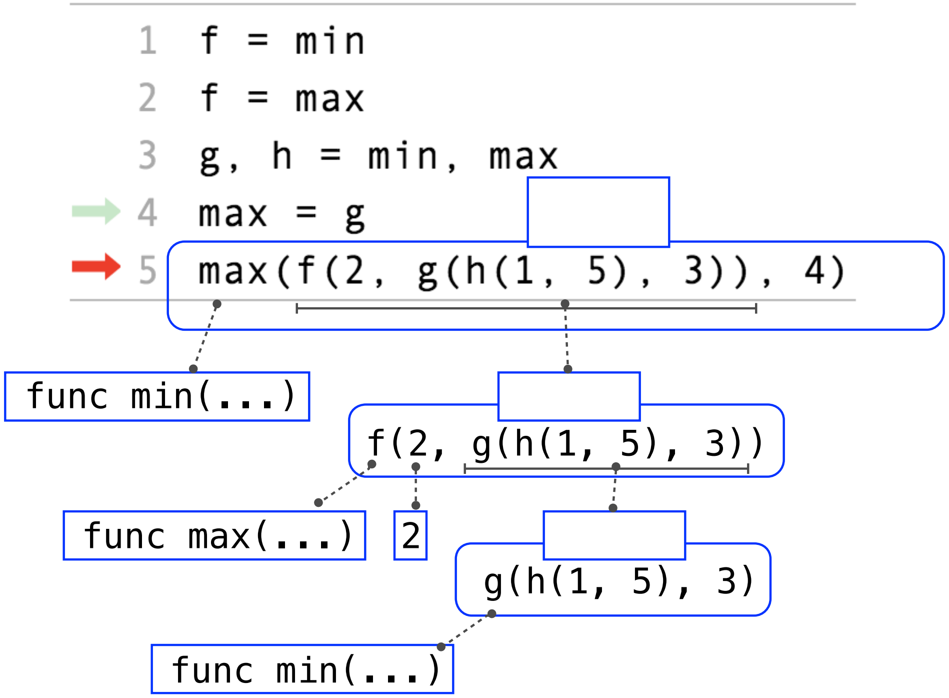

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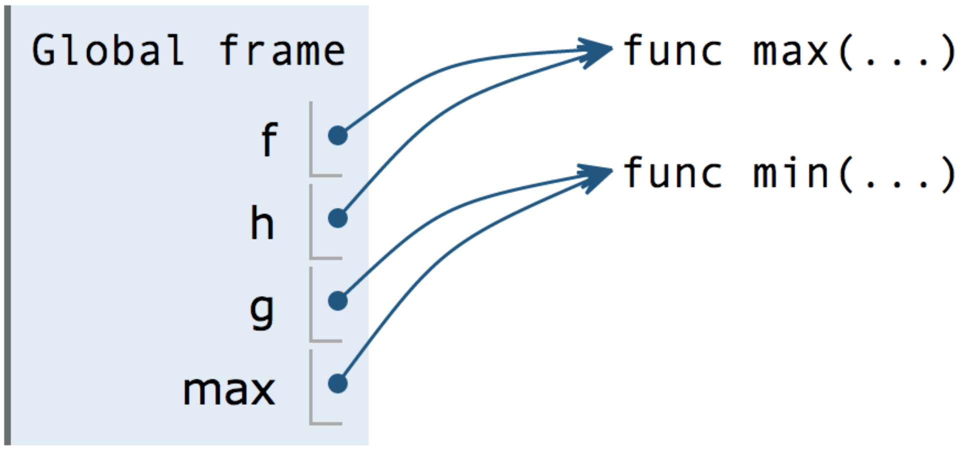

Interactive Diagram

Discussion Question 1 Solution

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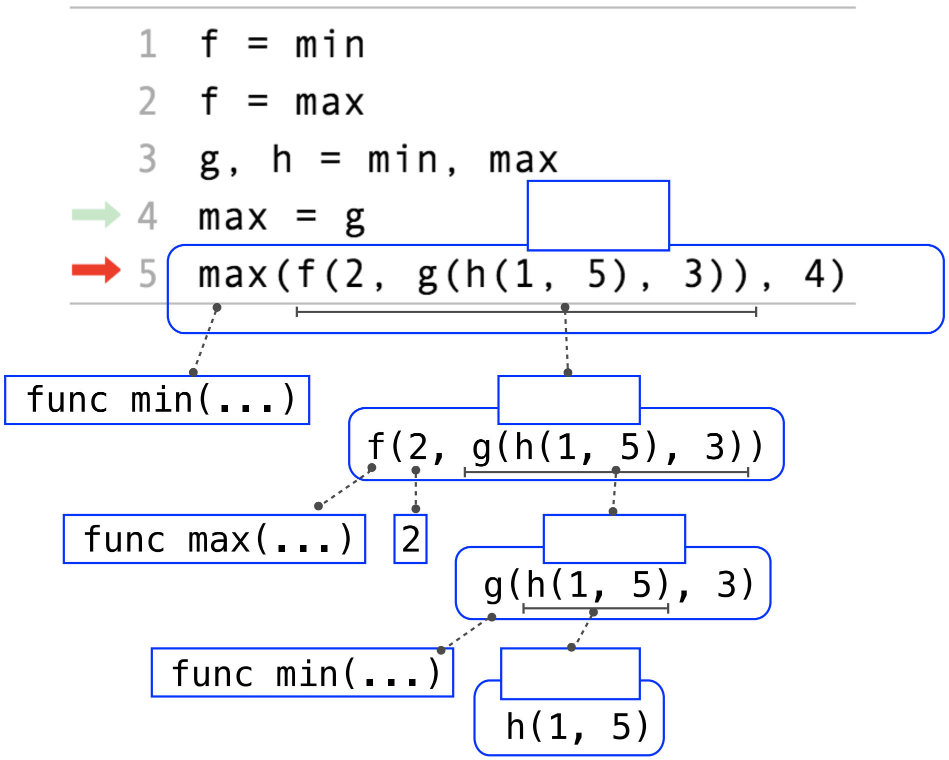

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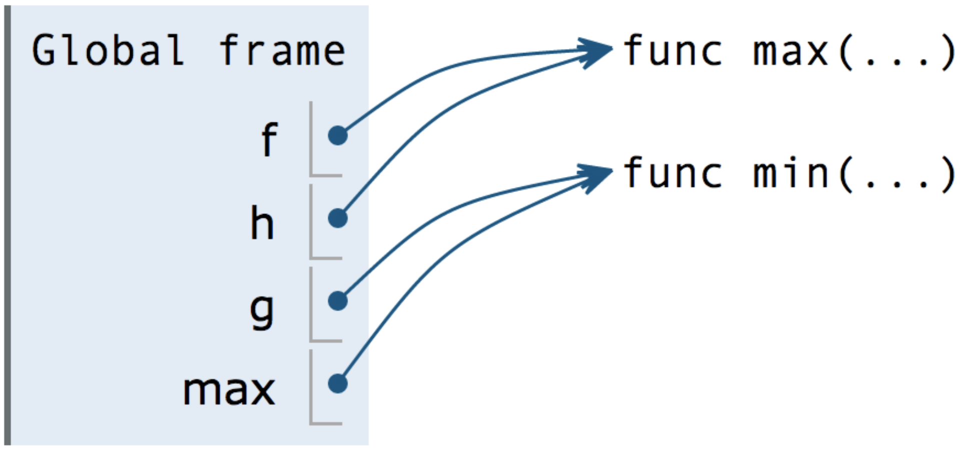

Interactive Diagram

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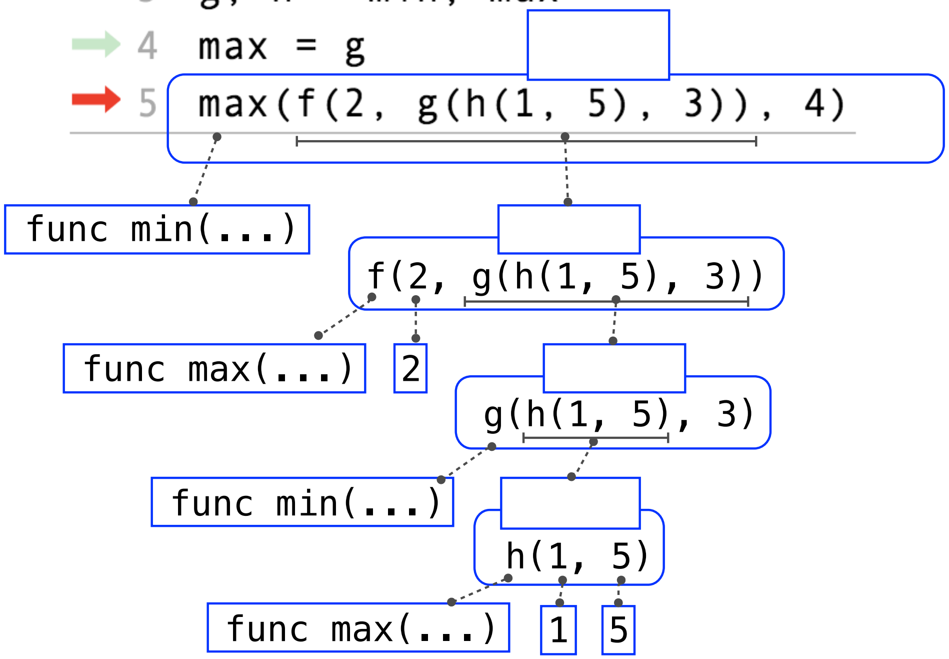

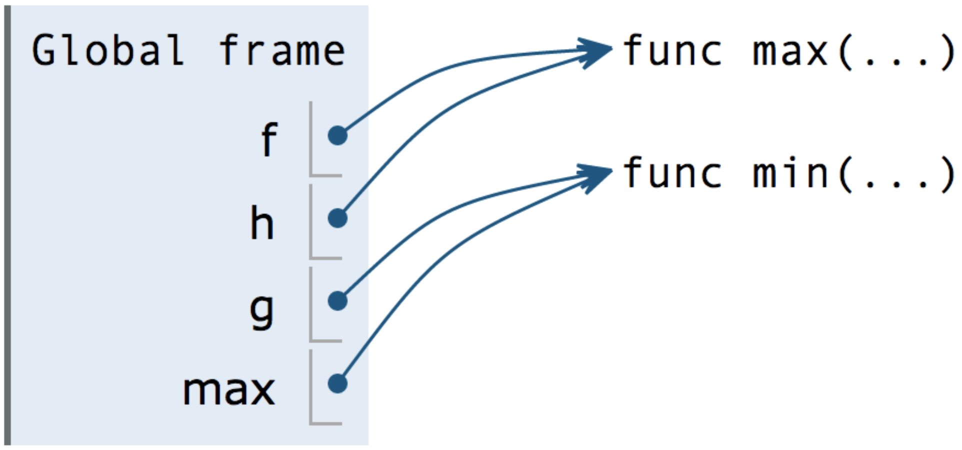

Interactive Diagram

Discussion Question 1 Solution

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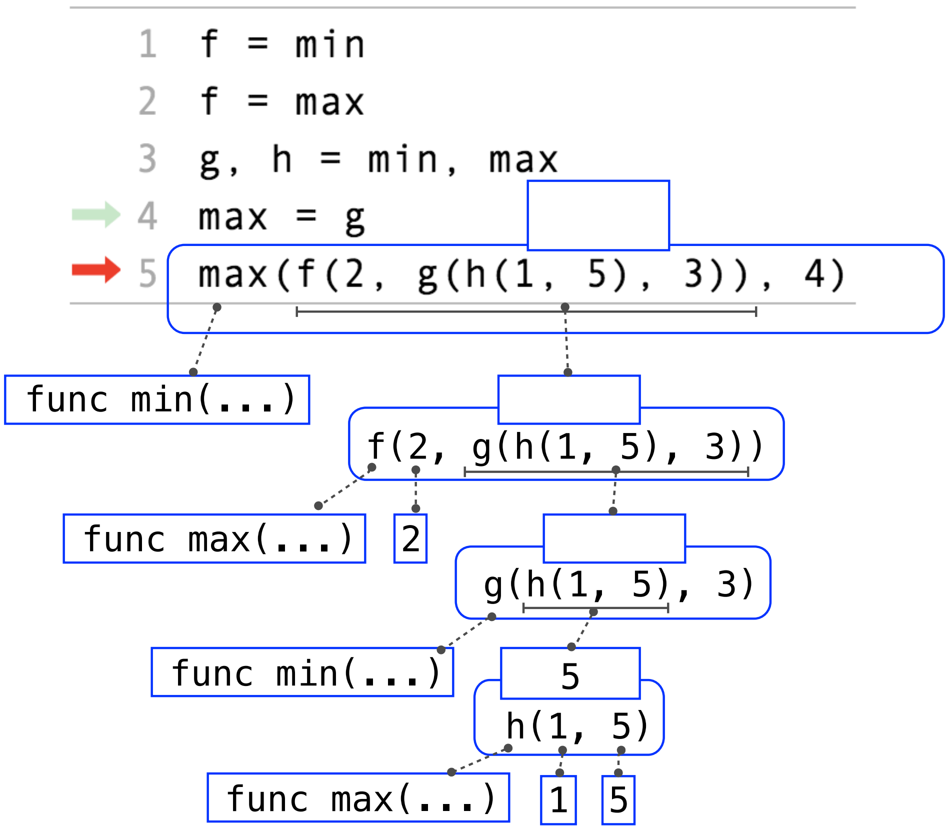

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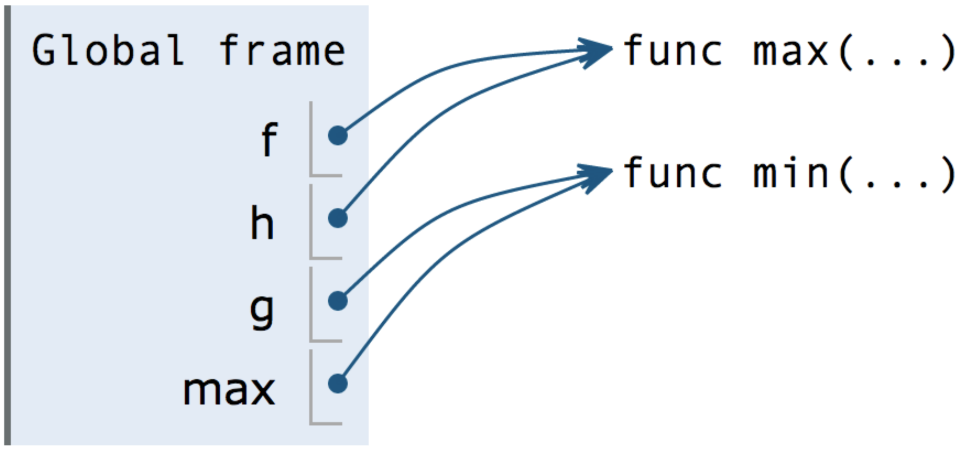

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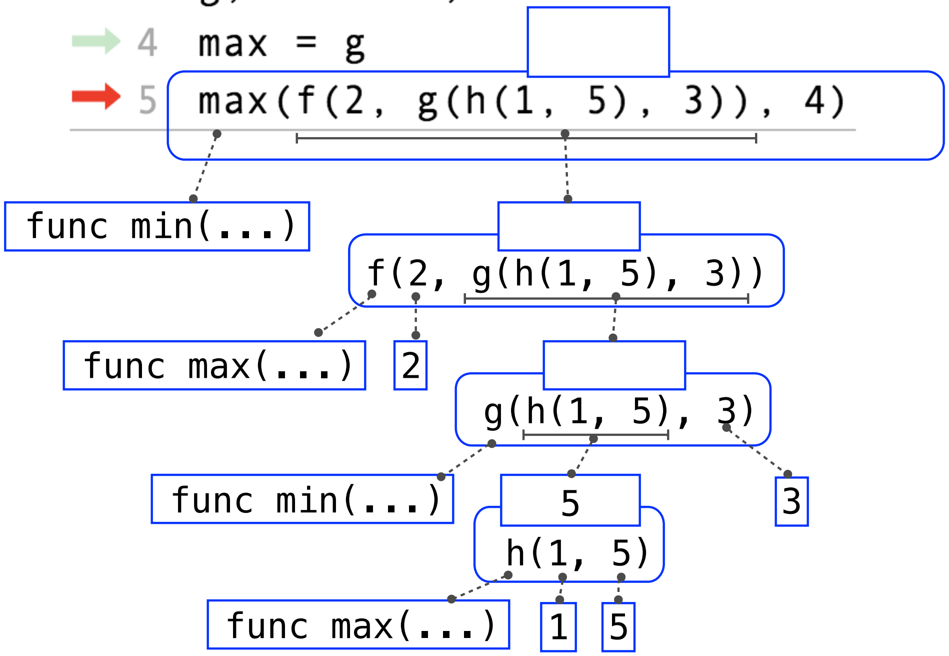

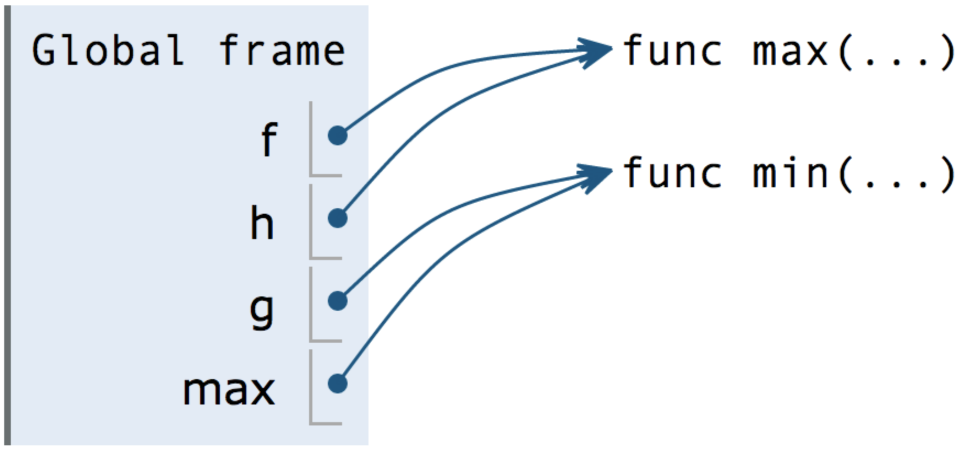

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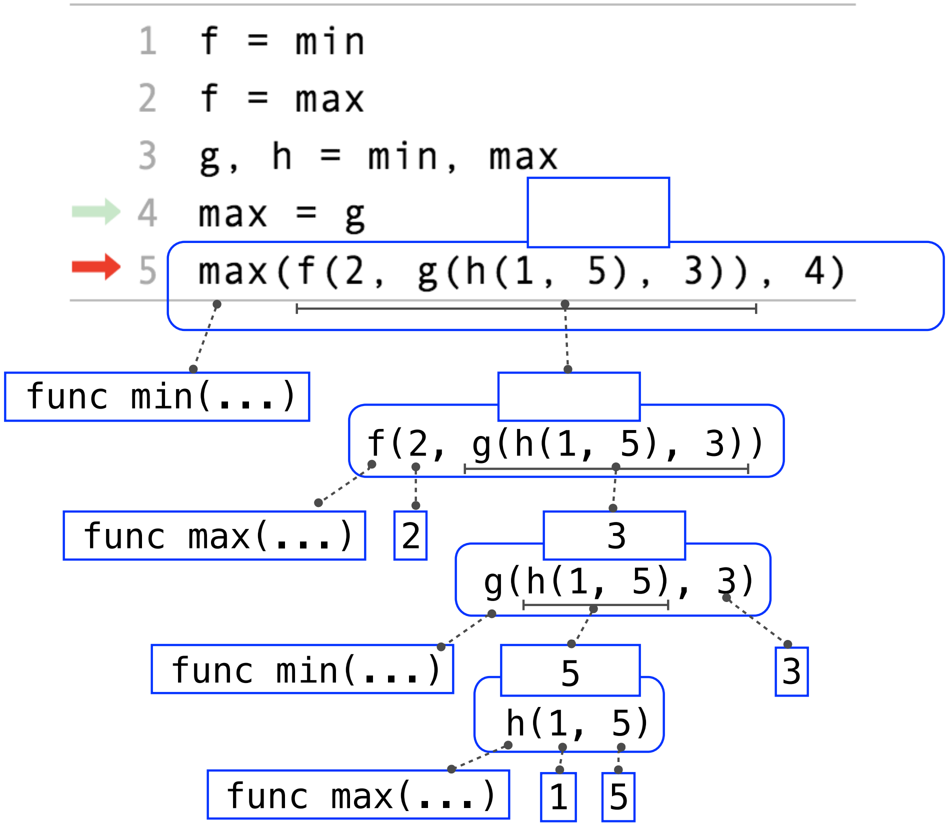

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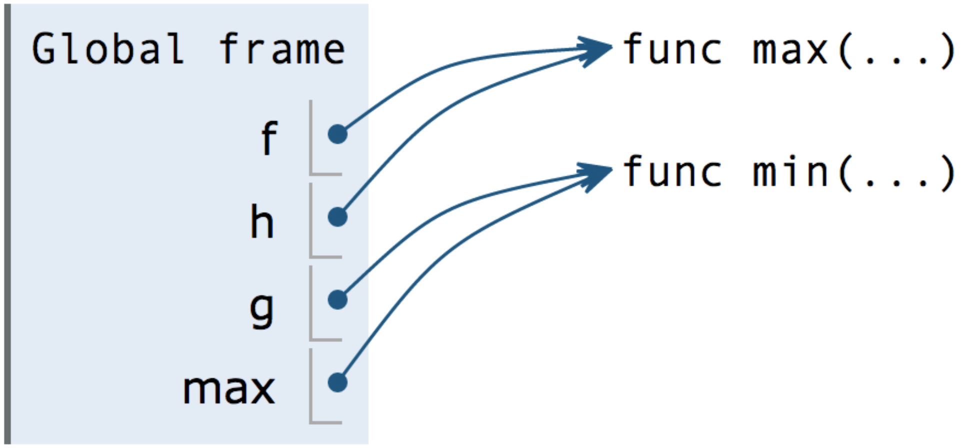

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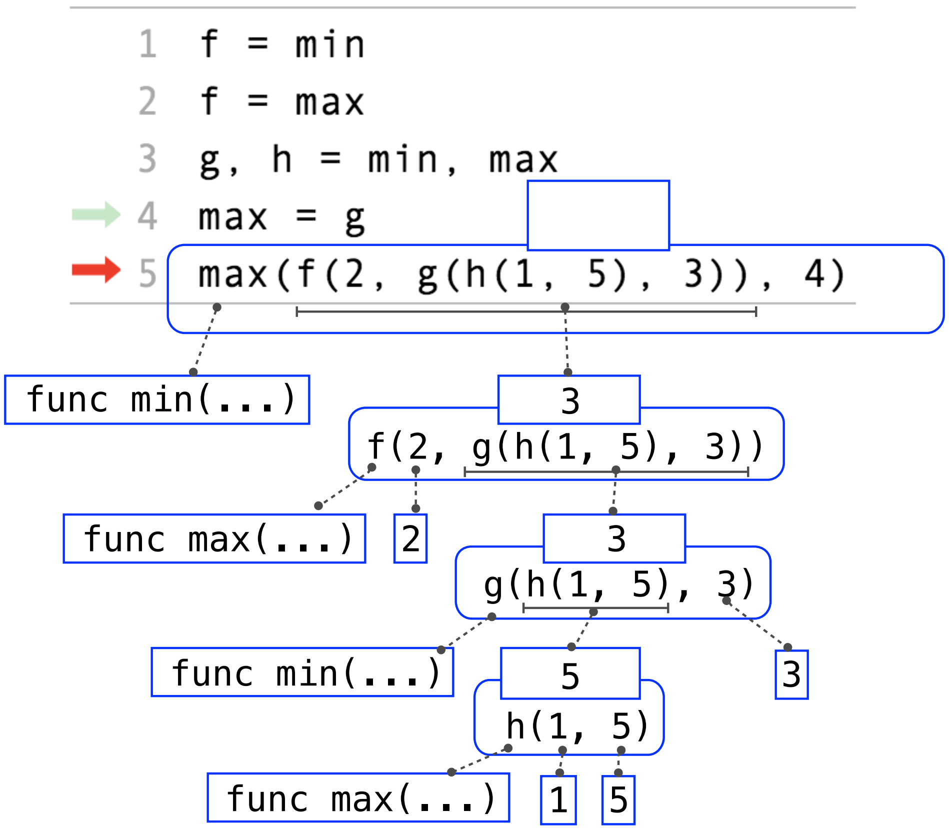

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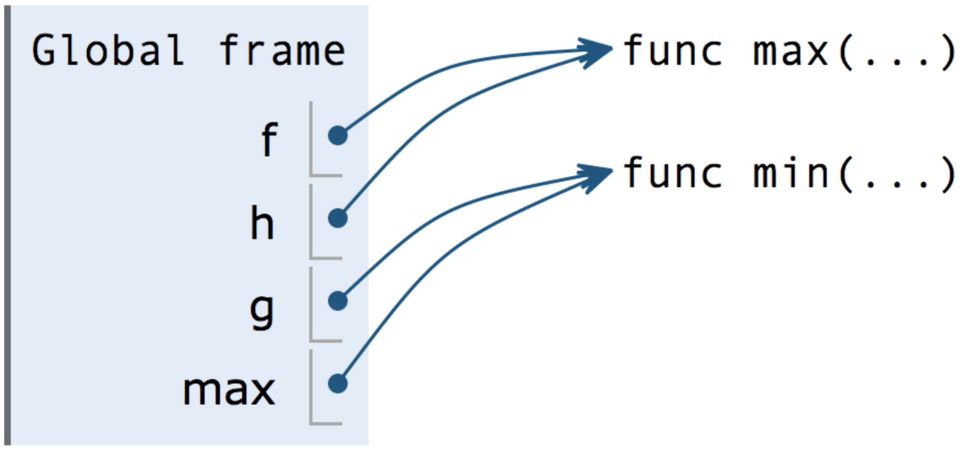

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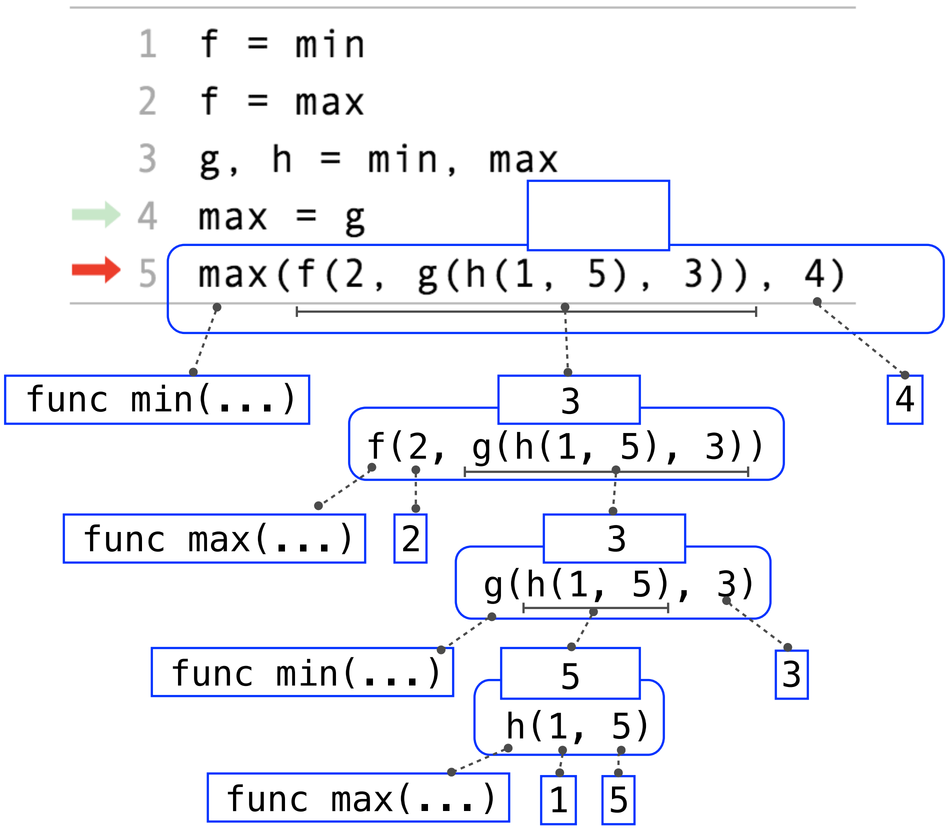

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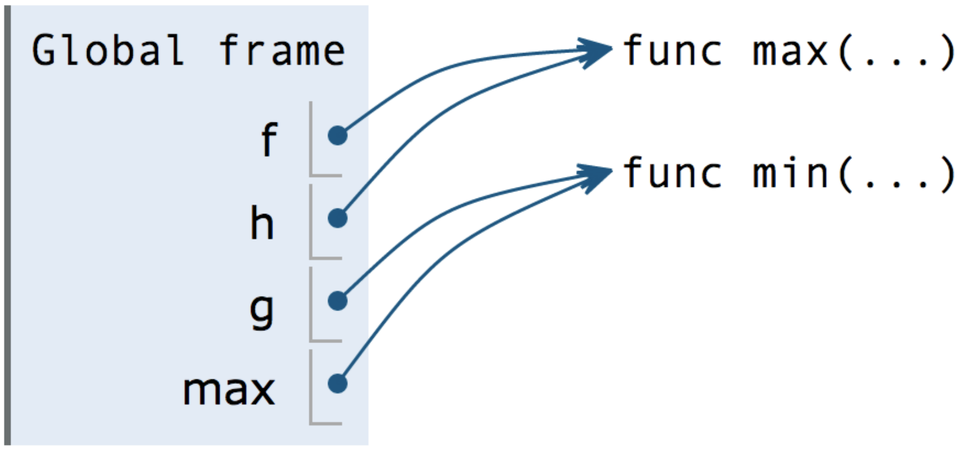

Interactive Diagram

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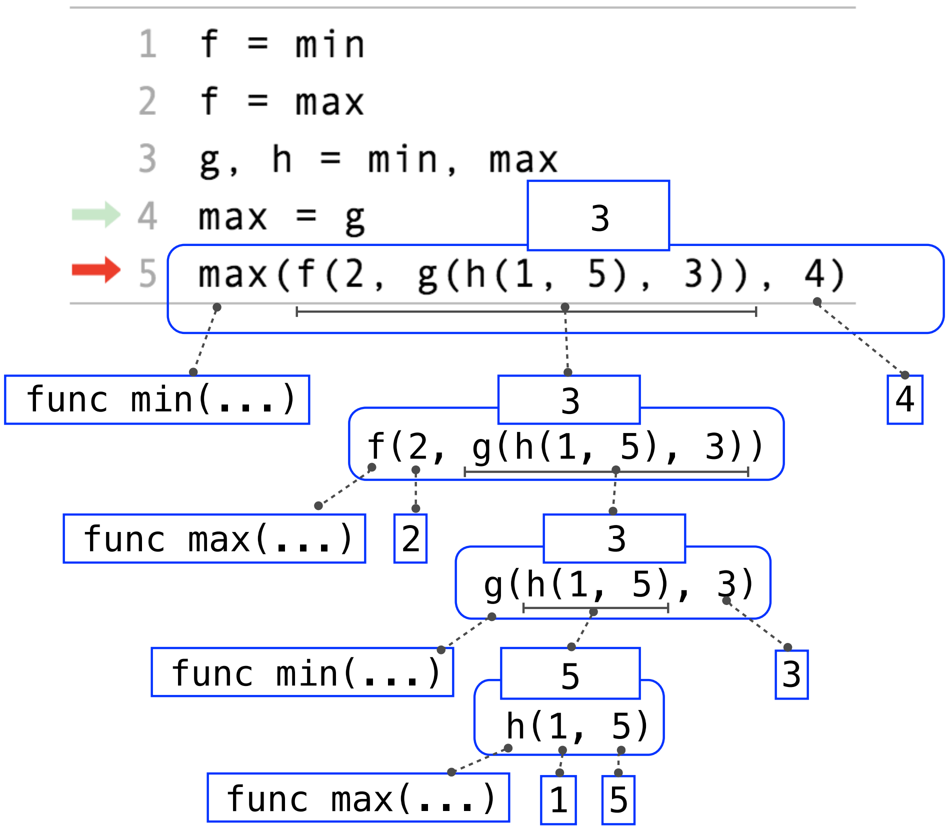

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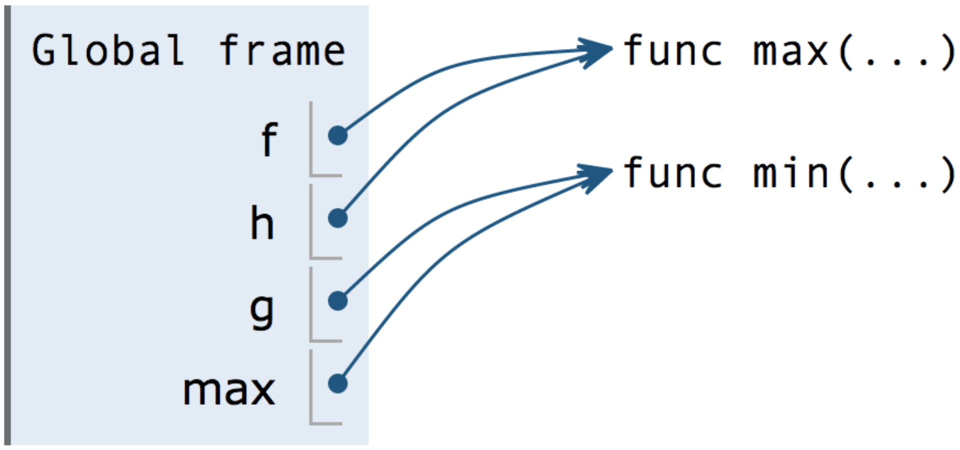

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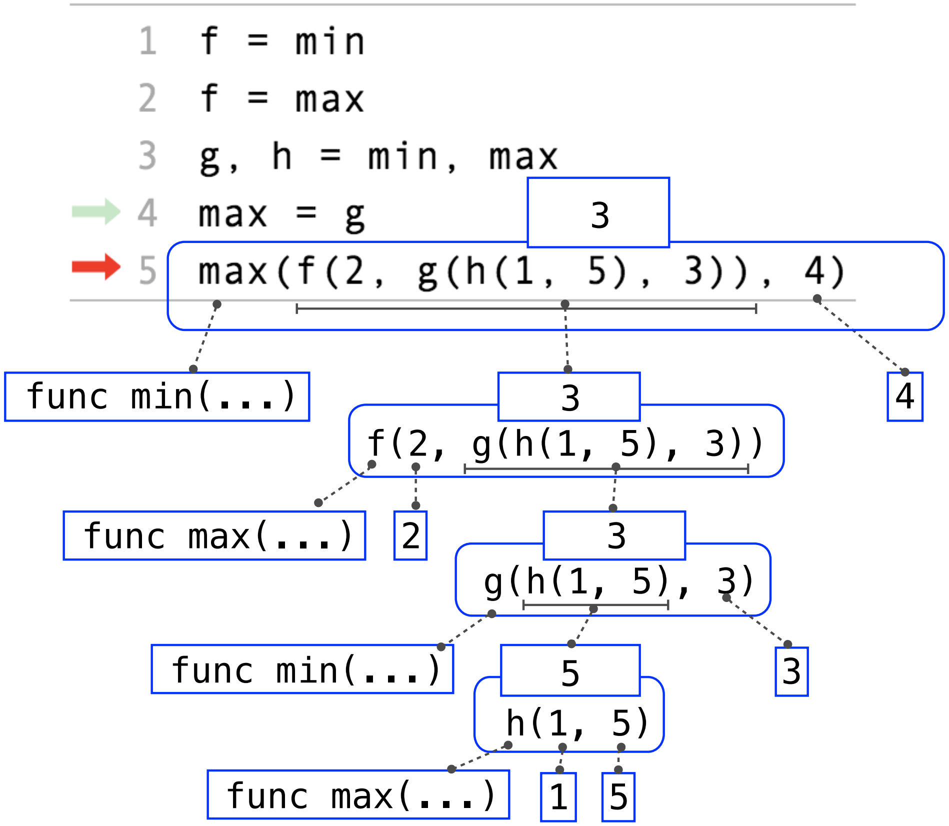

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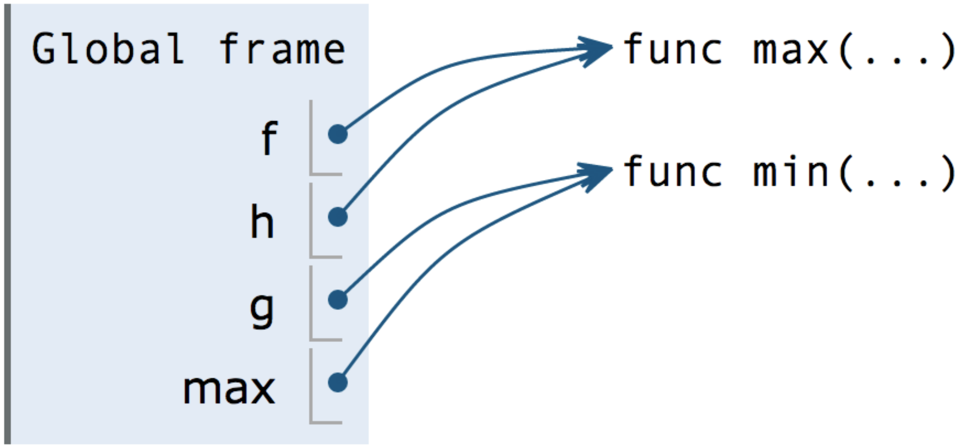

3

Interactive Diagram

Defining Functions

Defining Functions

Assignment is a simple means of abstraction: binds names to values

Function definition is a more powerful means of abstraction: binds names to expressions

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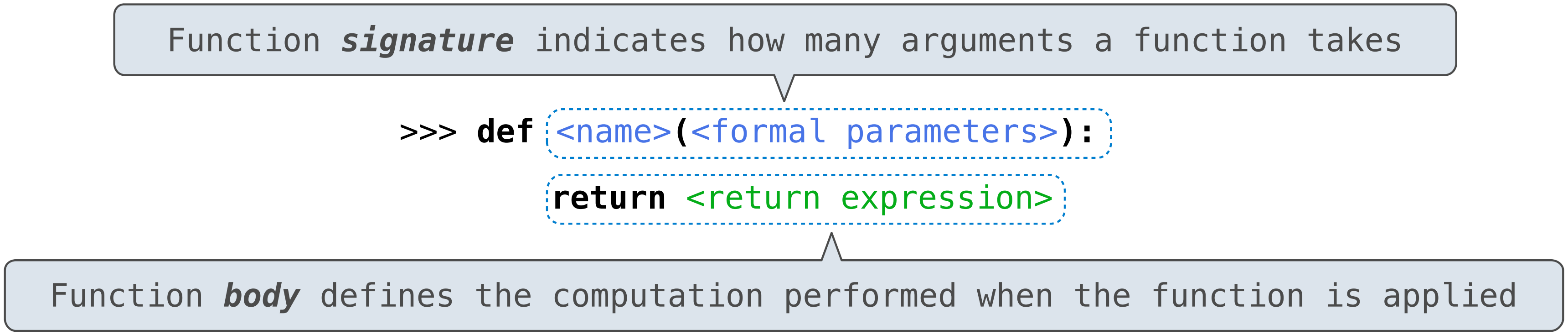

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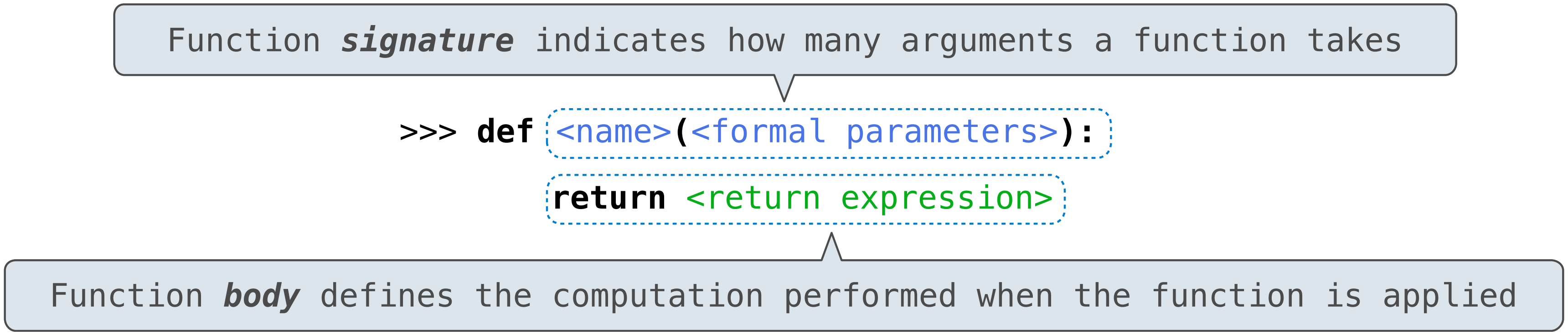

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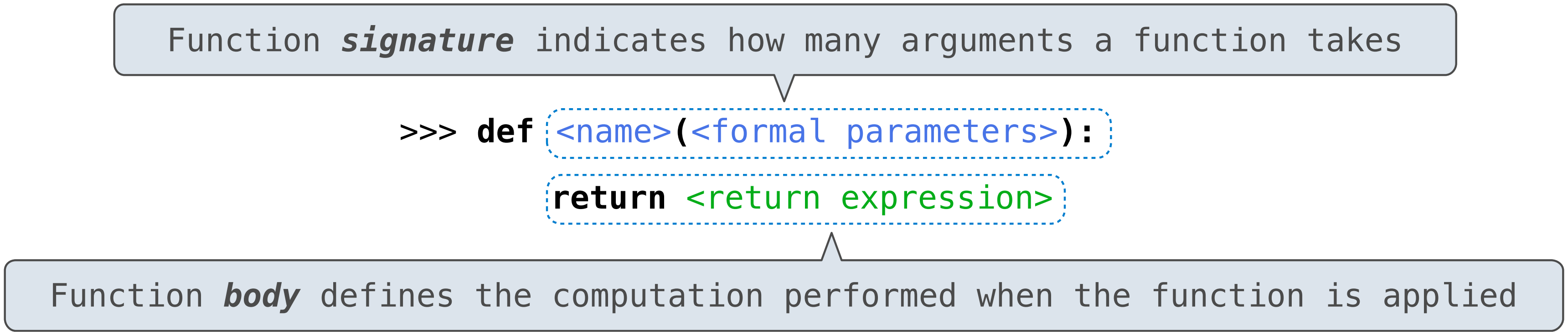

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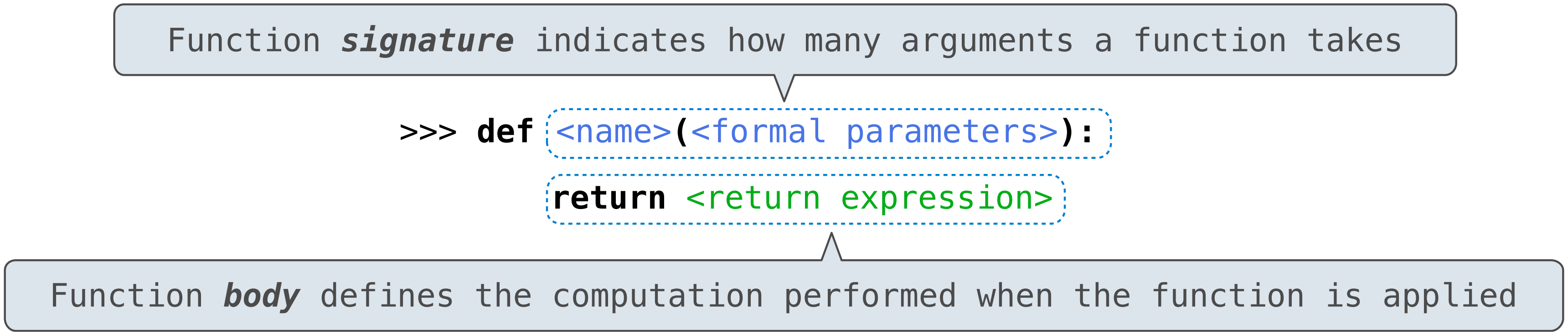

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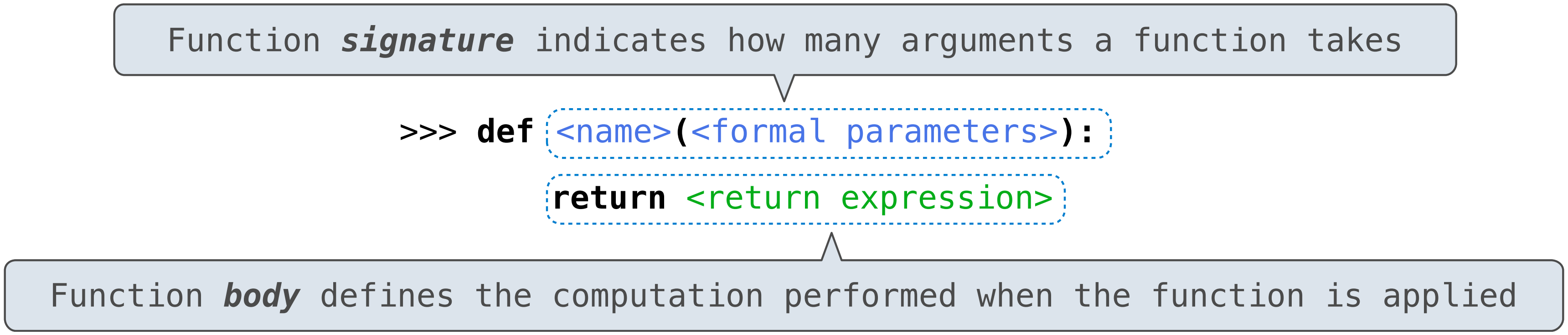

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2. Set the body of that function to be everything indented after the first line
3. Bind <name> to that function in the current frame

Calling User-Defined Functions

Interactive Diagram

Calling User-Defined Functions

Procedure for calling/applying user-defined functions (version 1):

Interactive Diagram

Calling User-Defined Functions

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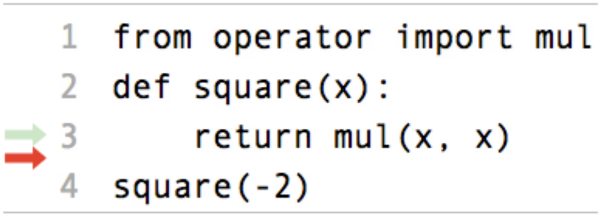

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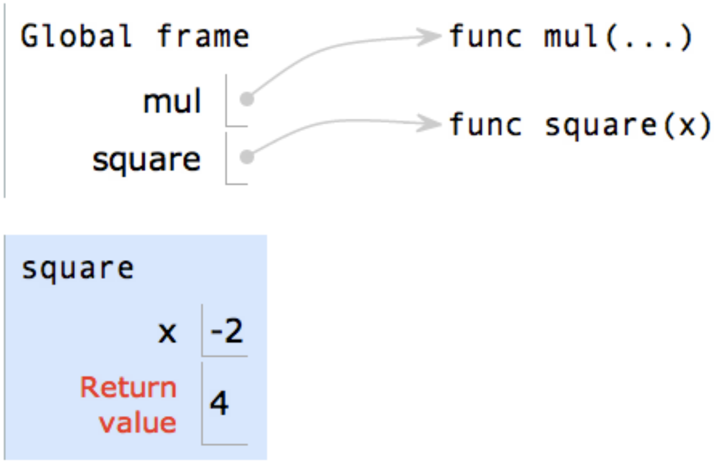

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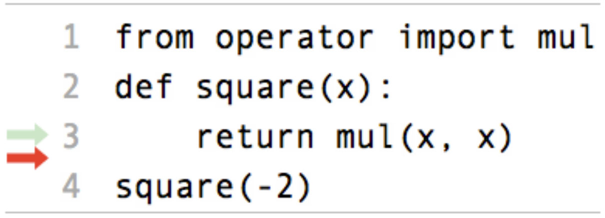

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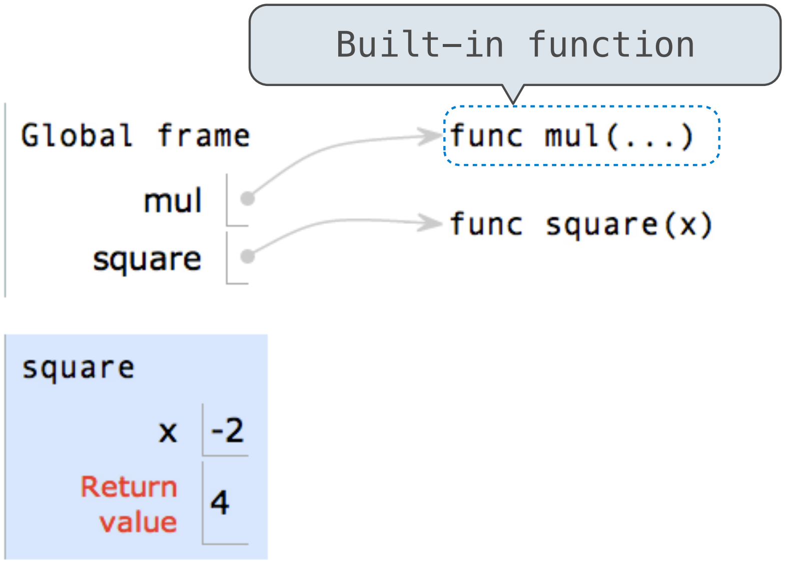

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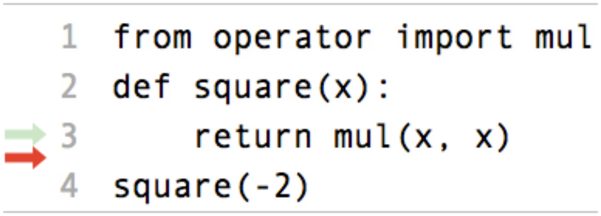

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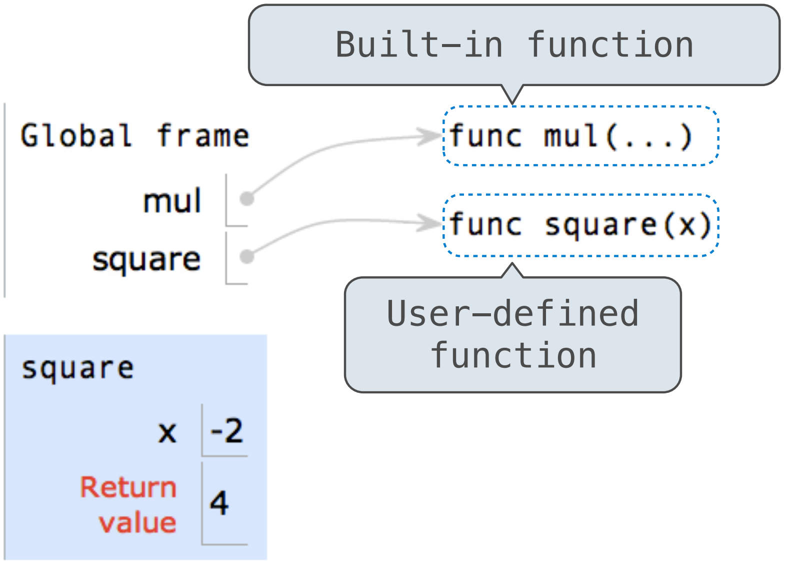

Built-in function

User-defined function

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Calling User-Defined Functions

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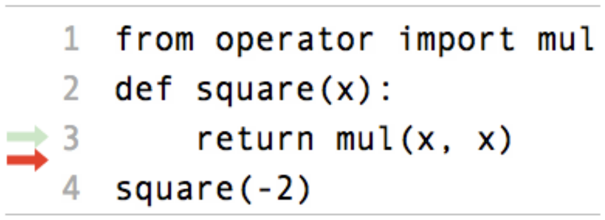

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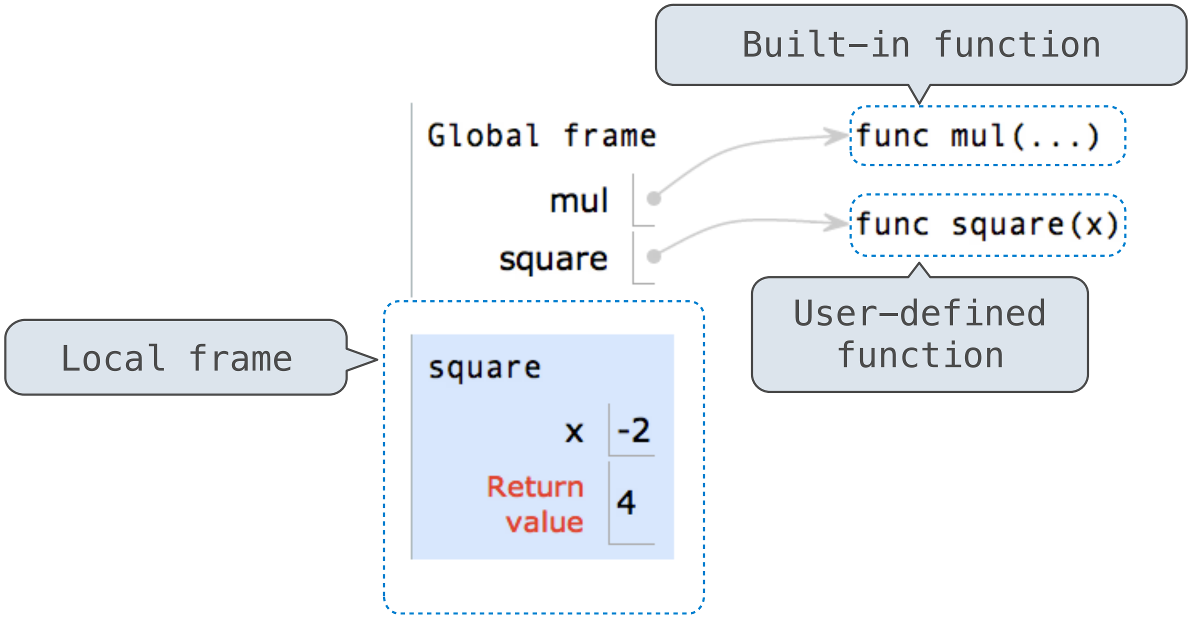

Interactive Diagram

Calling User-Defined Functions

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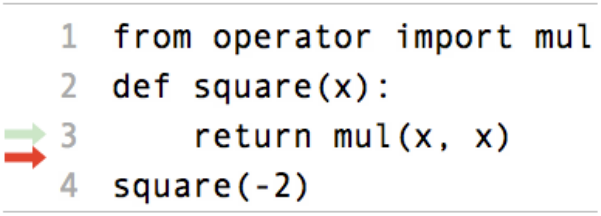

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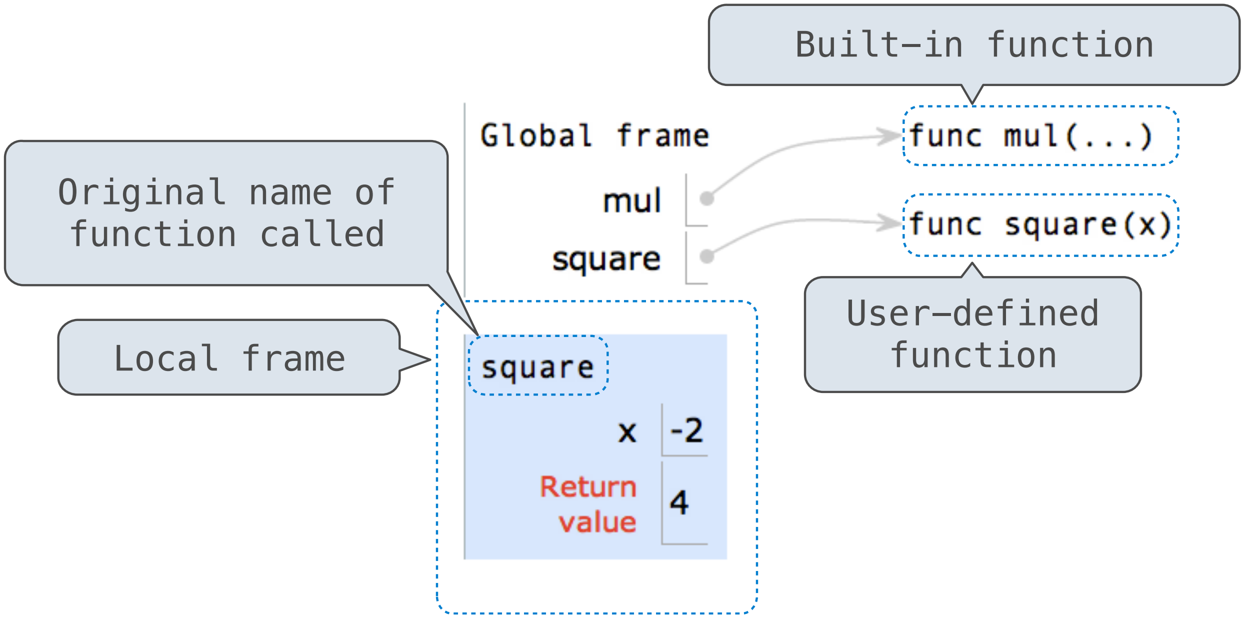

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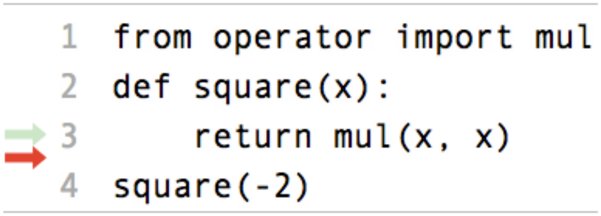

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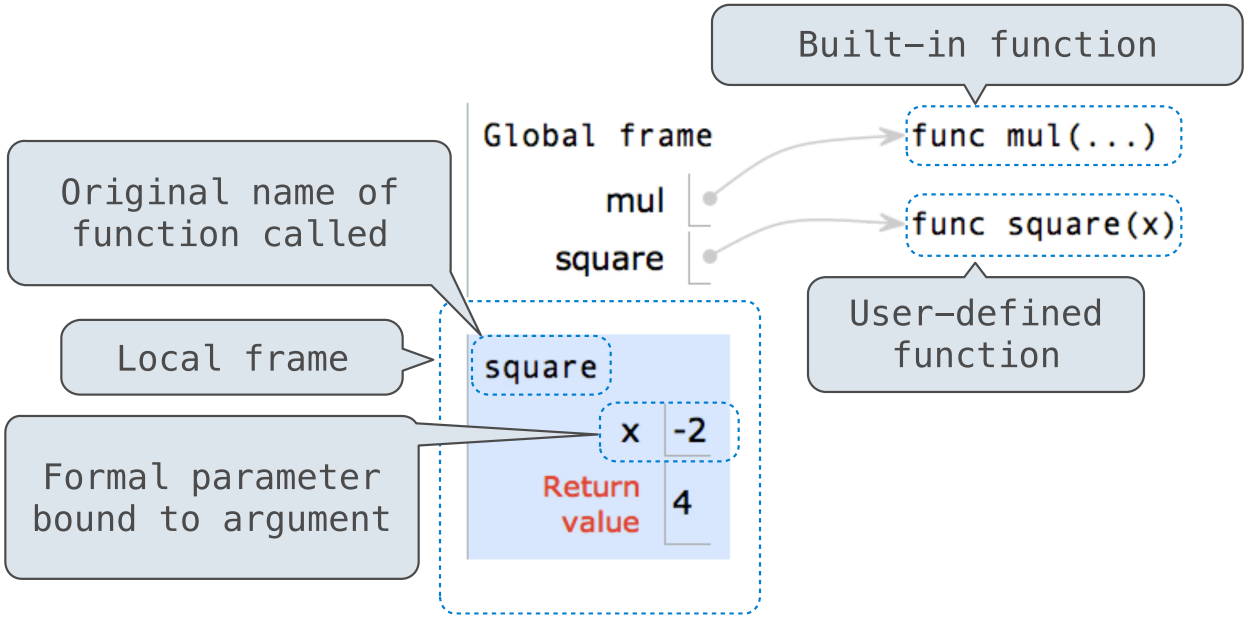

Built-in function

Original name of function called

Local frame

Formal parameter bound to argument

User-defined function

Interactive Diagram

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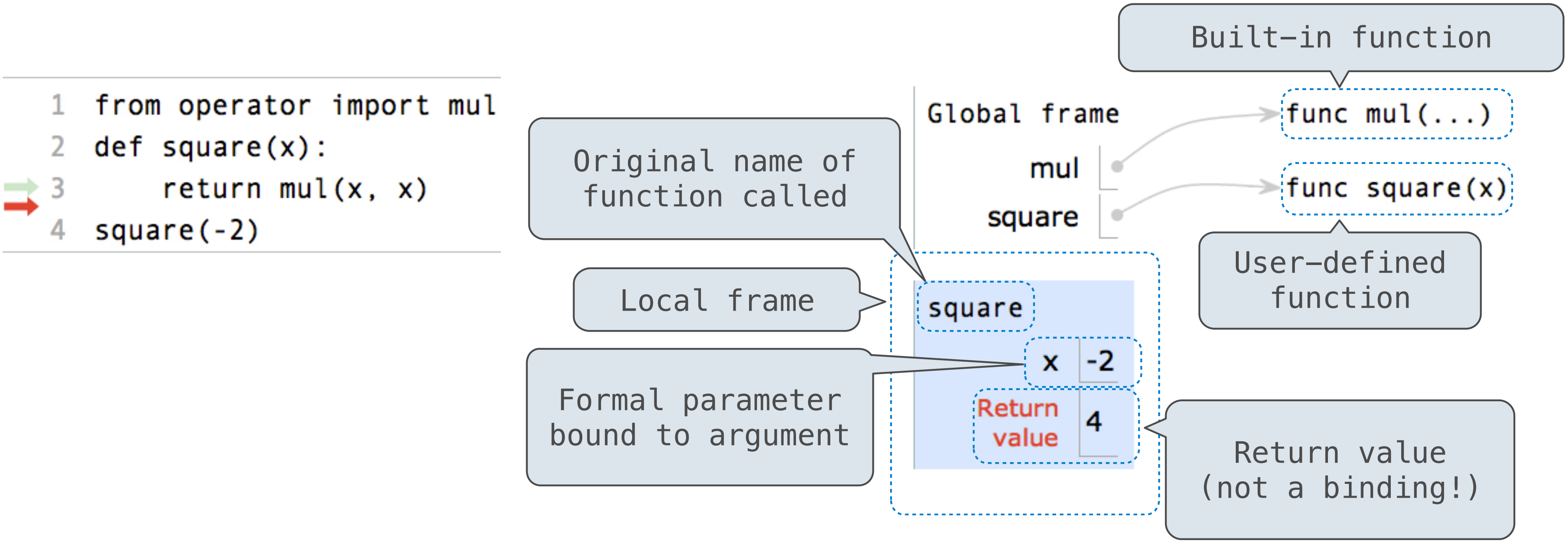

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Built-in function

Original name of function called

User-defined function

Local frame

Formal parameter bound to argument

Return value (not a binding!)

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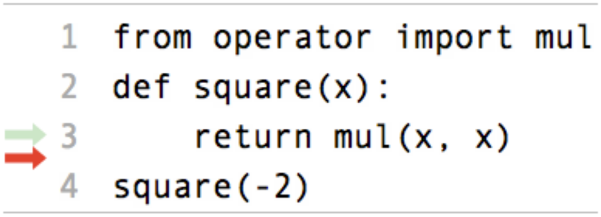

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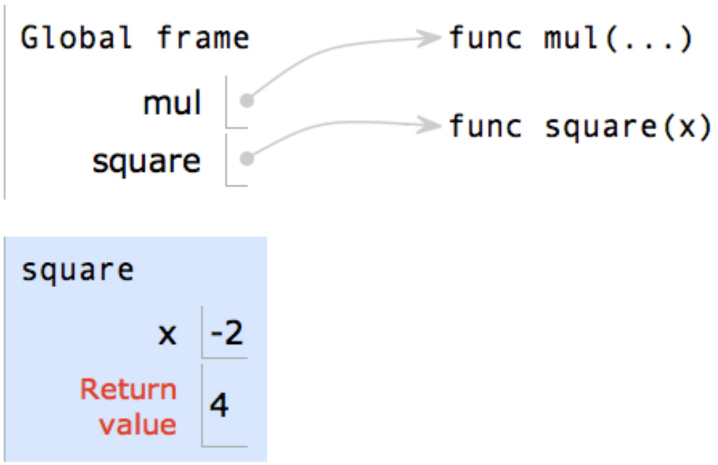

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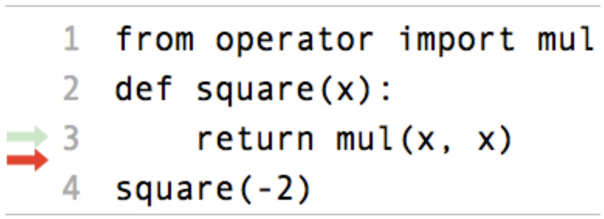

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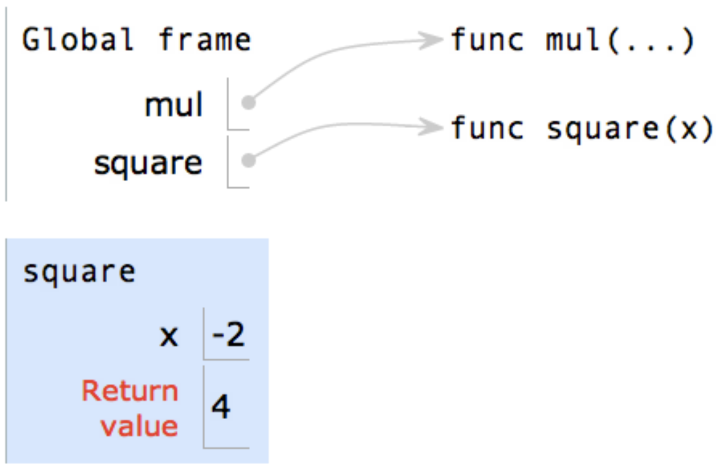

A function's signature has all the information needed to create a local frame

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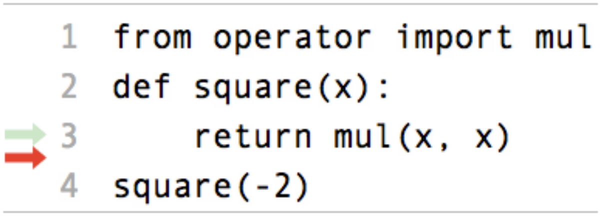

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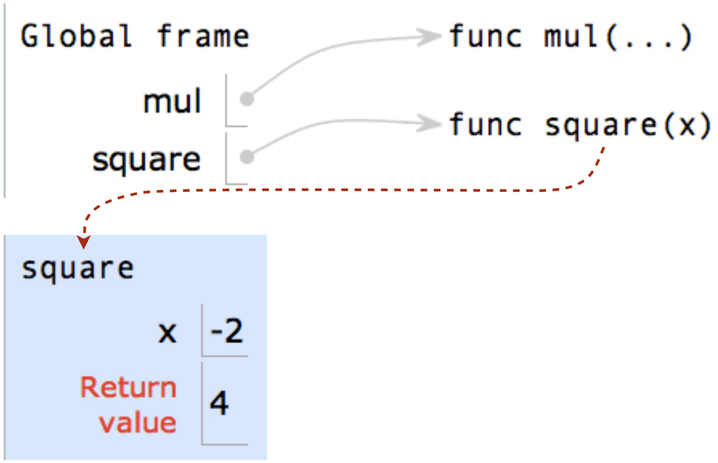

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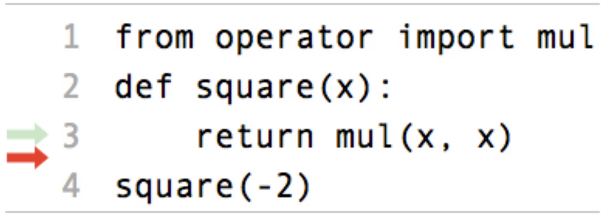

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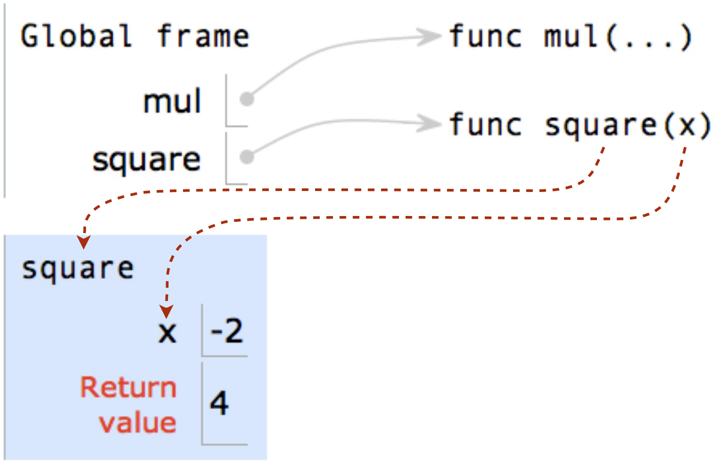

A function's signature has all the information needed to create a local frame

Interactive Diagram

Looking Up Names In Environments

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Every expression is evaluated in the context of an environment.

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- If not found, look for it in the global frame.
  (Built-in names like "max" are in the global frame too,
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(Demo)

Print and None

(Demo)

None Indicates that Nothing is Returned

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>>> def does_not_square(x):
...     x * x
...
```

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```
>>> def does_not_square(x):
...     x * x
...
>>> does_not_square(4)
```

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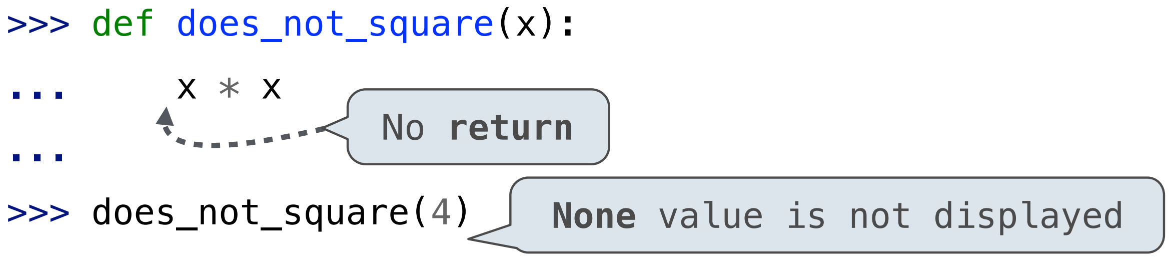

```
>>> def does_not_square(x):
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...
>>> does_not_square(4)
```

No **return**

None value is not displayed

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```
>>> def does_not_square(x):
...     x * x
...
>>> does_not_square(4)
>>> sixteen = does_not_square(4)
```

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```
>>> def does_not_square(x):
...     x * x
...
>>> does_not_square(4)
>>> sixteen = does_not_square(4)
```

No **return**

None value is not displayed

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

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```
>>> def does_not_square(x):
...     x * x
...
>>> does_not_square(4)
>>> sixteen = does_not_square(4)
>>> sixteen + 4
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: unsupported operand type(s) for +: 'NoneType' and 'int'
```

No **return**

None value is not displayed

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

Pure Functions & Non-Pure Functions

Pure Functions
just return values

Non-Pure Functions
have side effects

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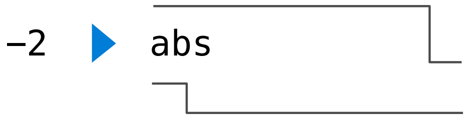

Non-Pure Functions
have side effects

Pure Functions & Non-Pure Functions

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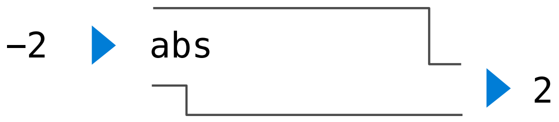

-2

abs

2

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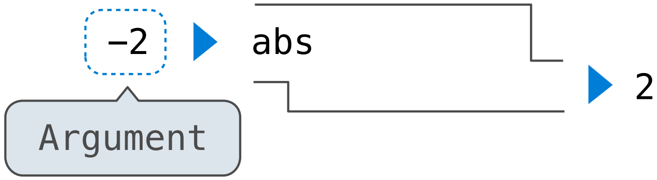

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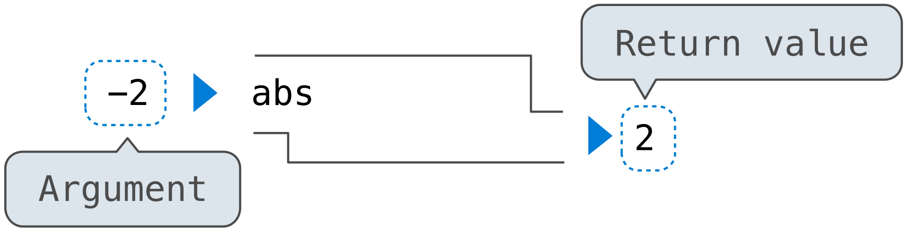

Return value

-2

abs

2

Argument

Non-Pure Functions
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Pure Functions & Non-Pure Functions

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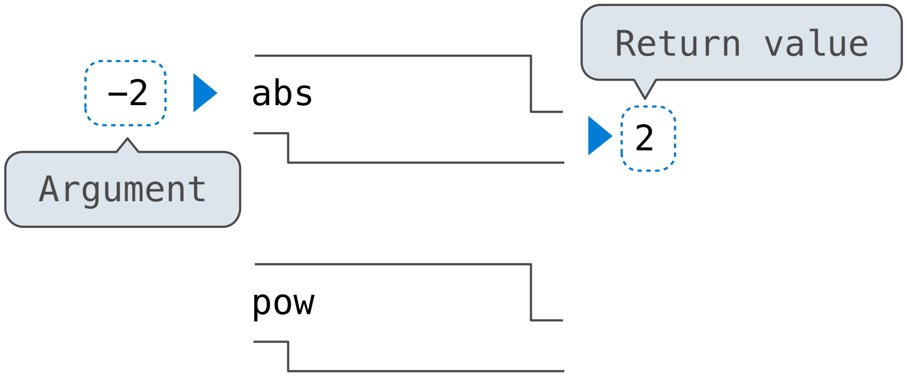

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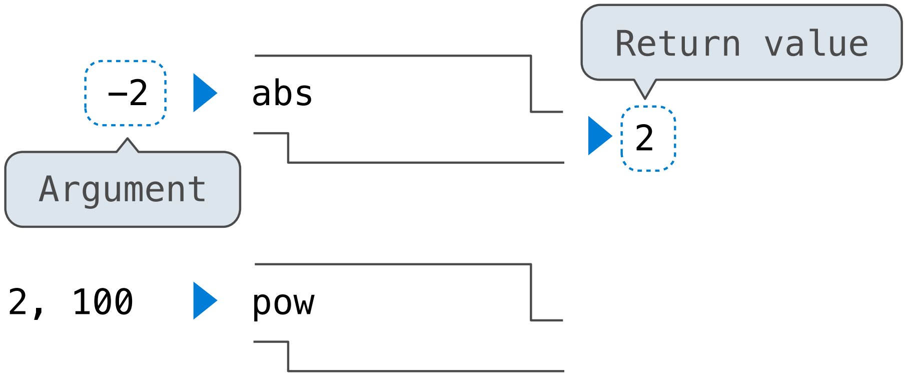

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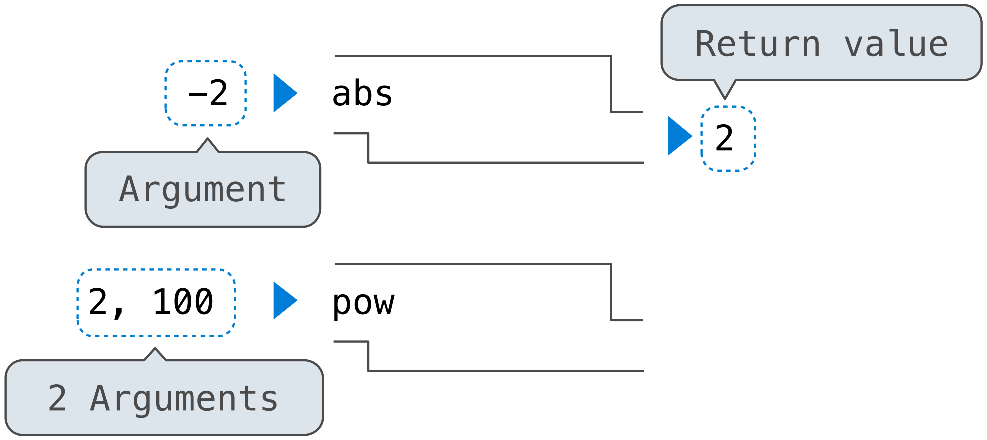

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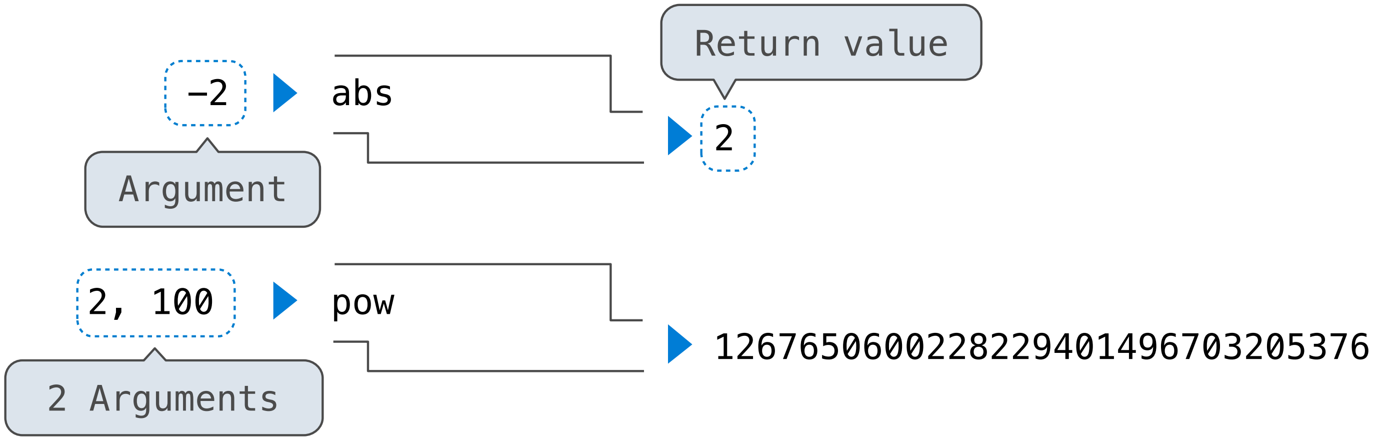

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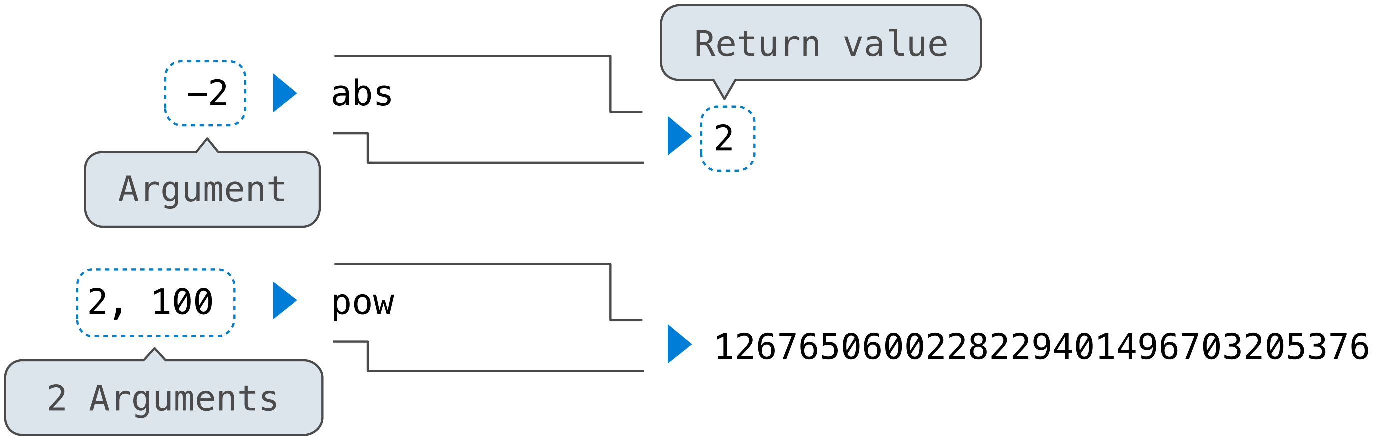

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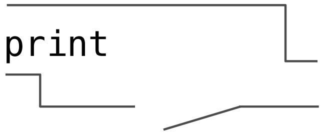

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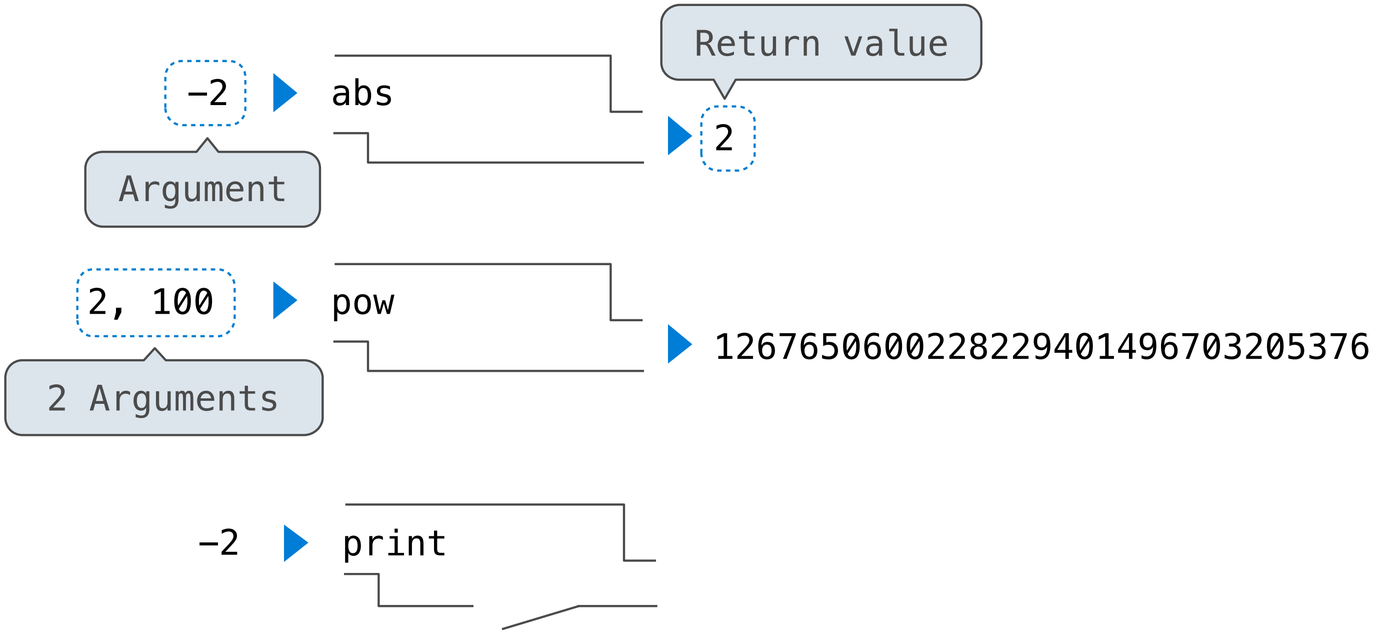

Return value

-2 abs 2

Argument

2, 100 pow 1267650600228229401496703205376

2 Arguments

-2 print

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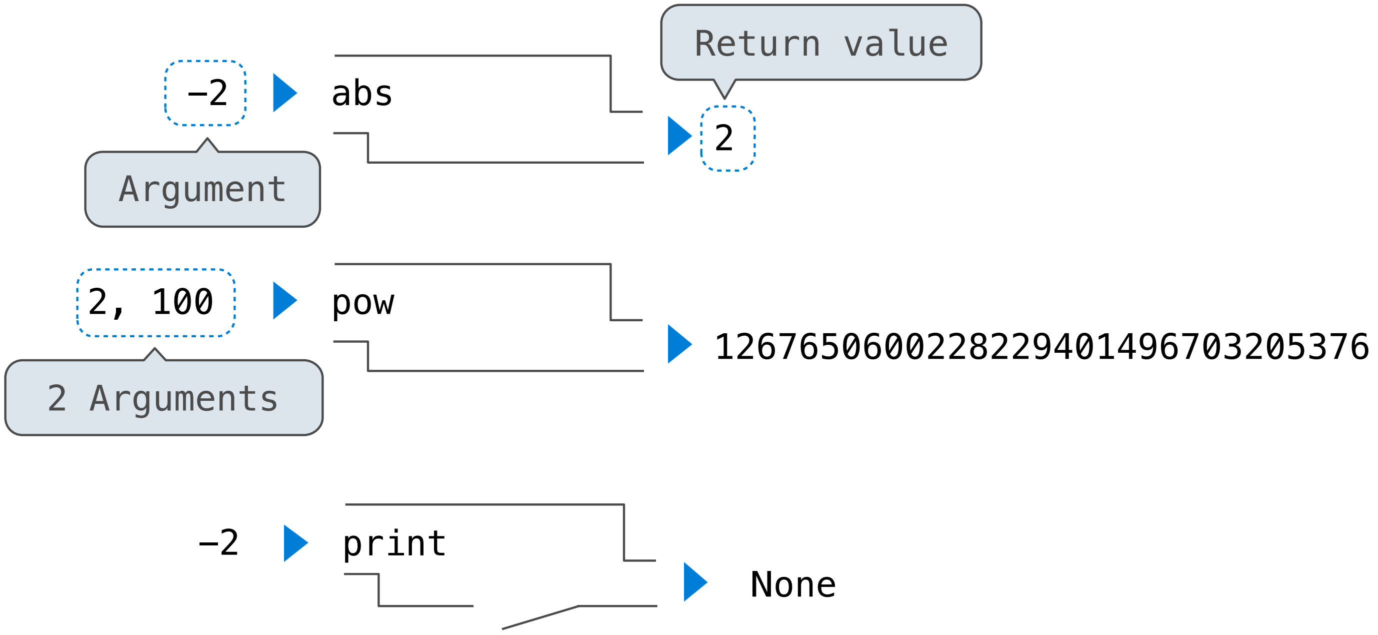

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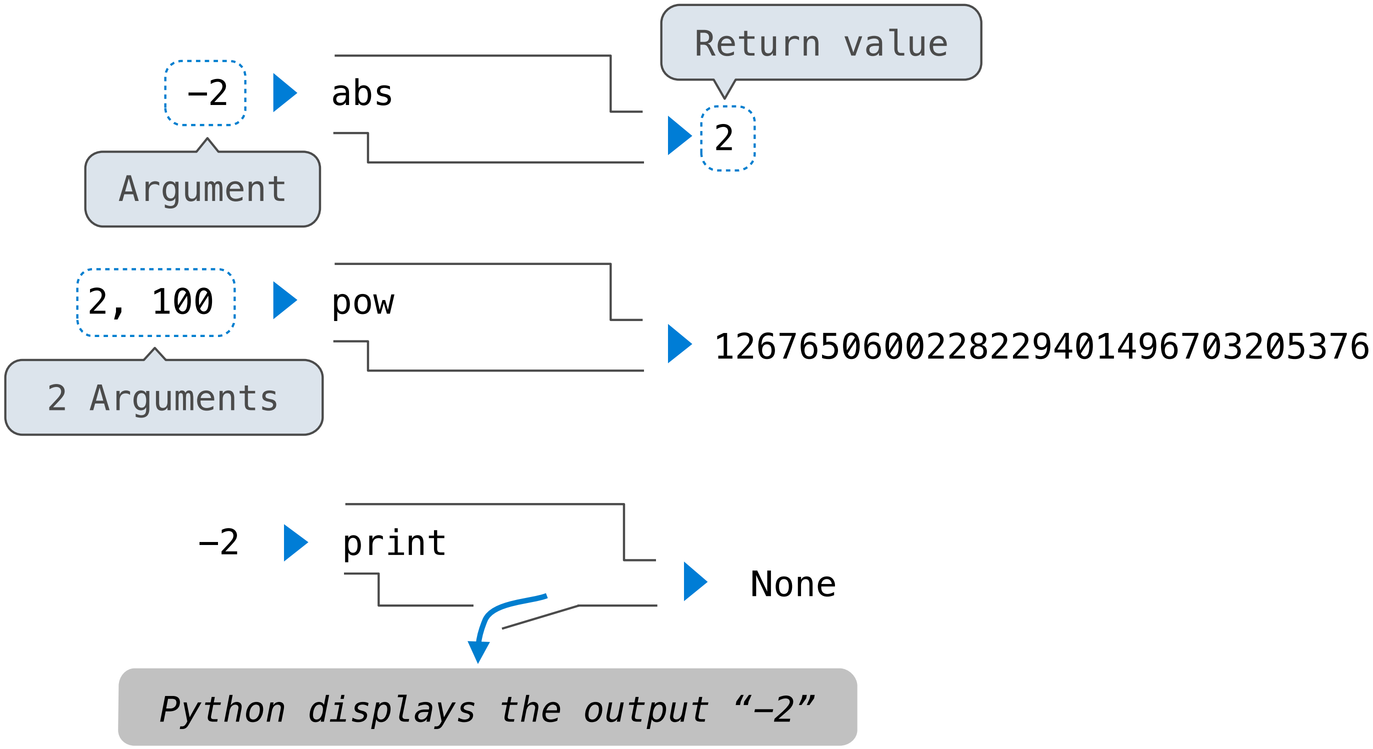
Pure Functions & Non-Pure Functions



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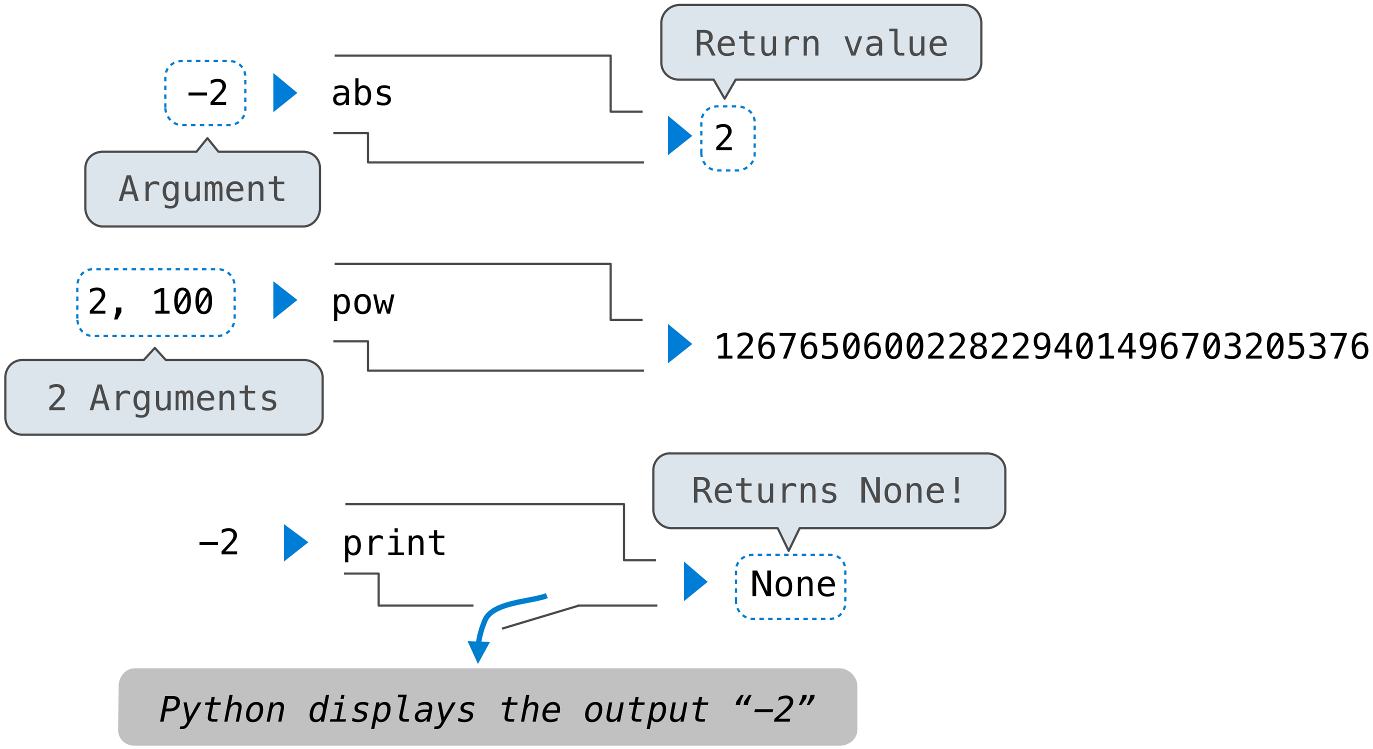

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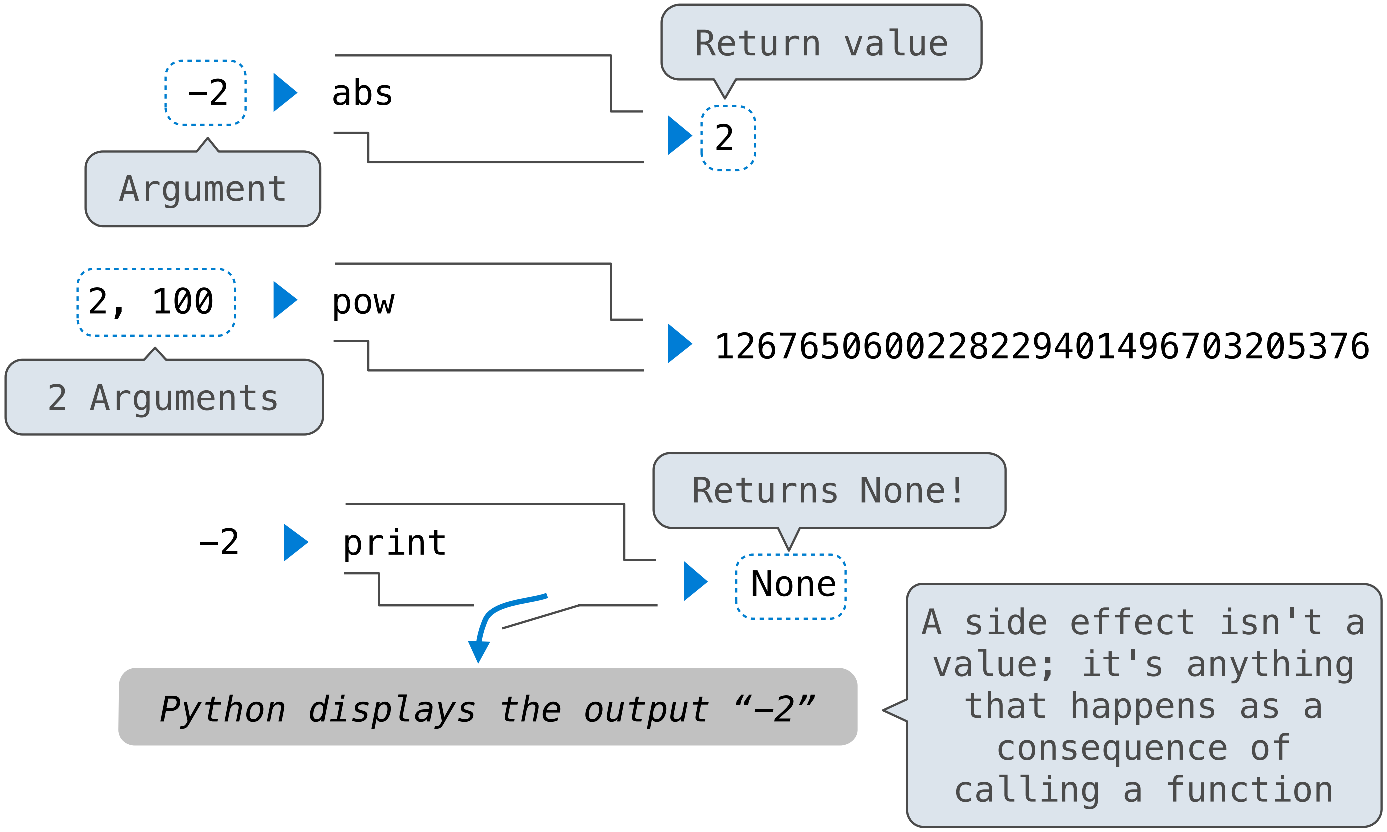


-2 abs 2

Return value

Argument

2, 100 pow 1267650600228229401496703205376

2 Arguments

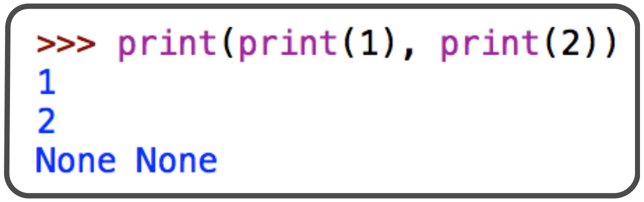
-2 print None

Returns None!

Python displays the output “-2”

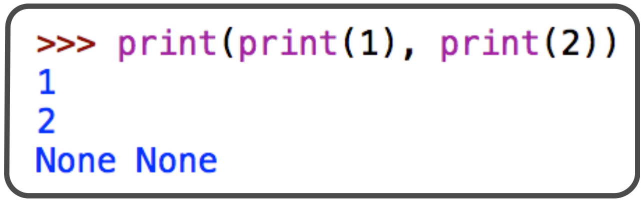
A side effect isn't a value; it's anything that happens as a consequence of calling a function

Nested Expressions with Print



```
>>> print(print(1), print(2))
1
2
None None
```

Nested Expressions with Print



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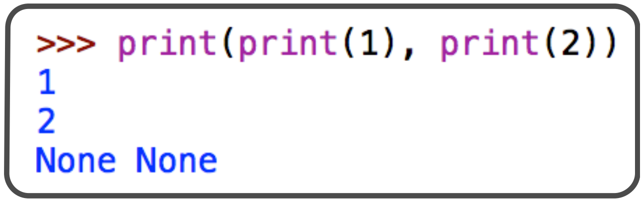

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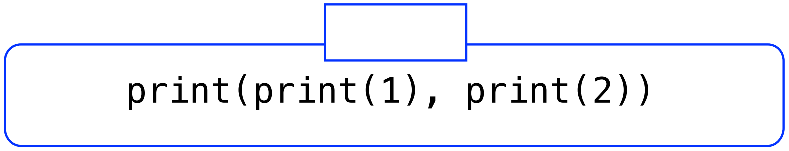

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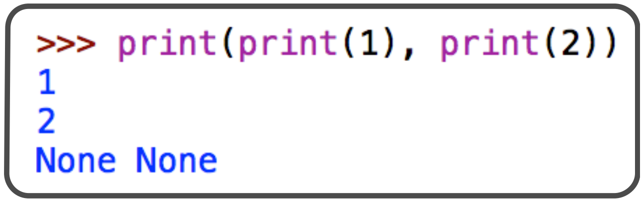

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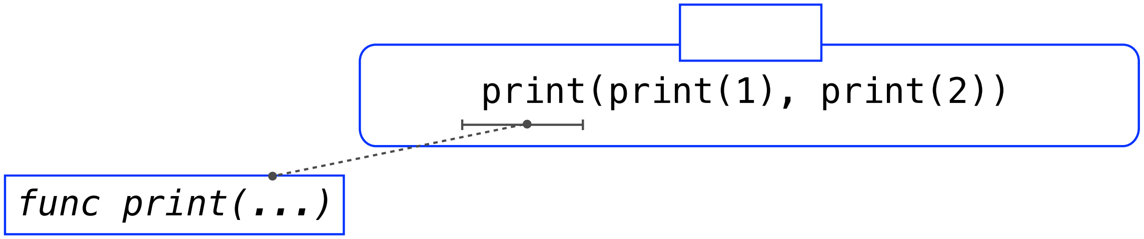

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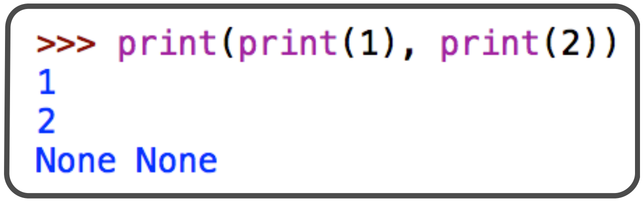

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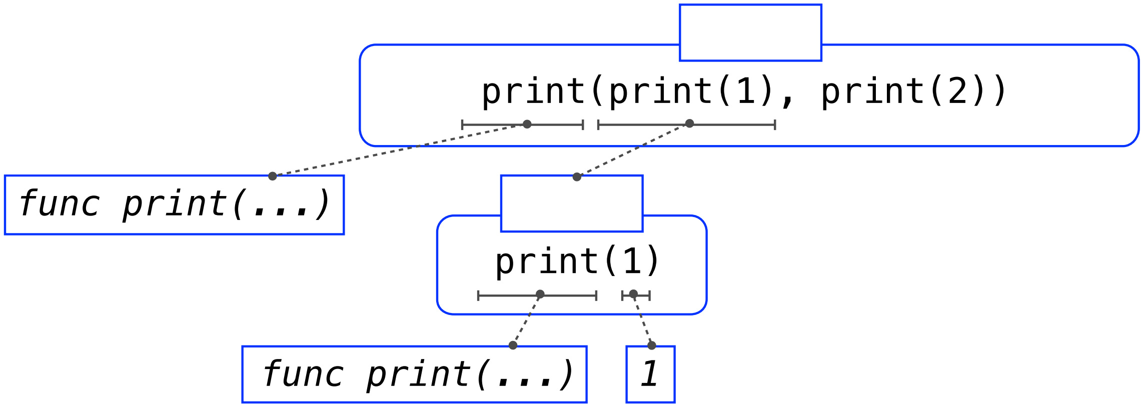
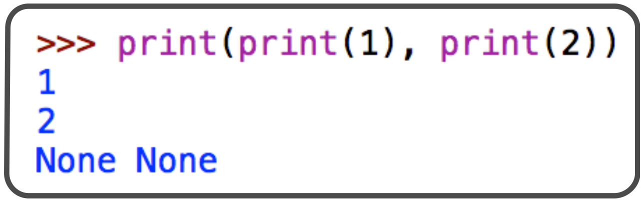


Nested Expressions with Print



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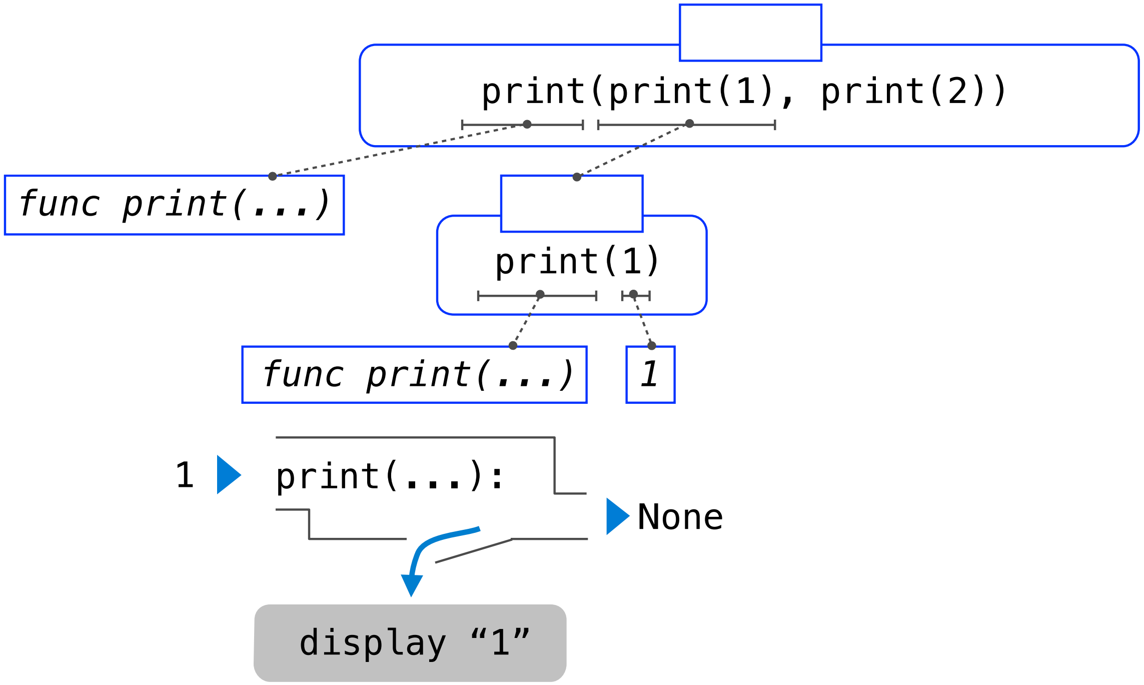

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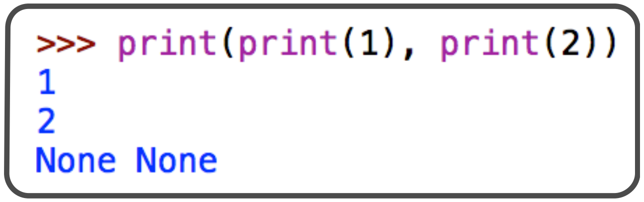

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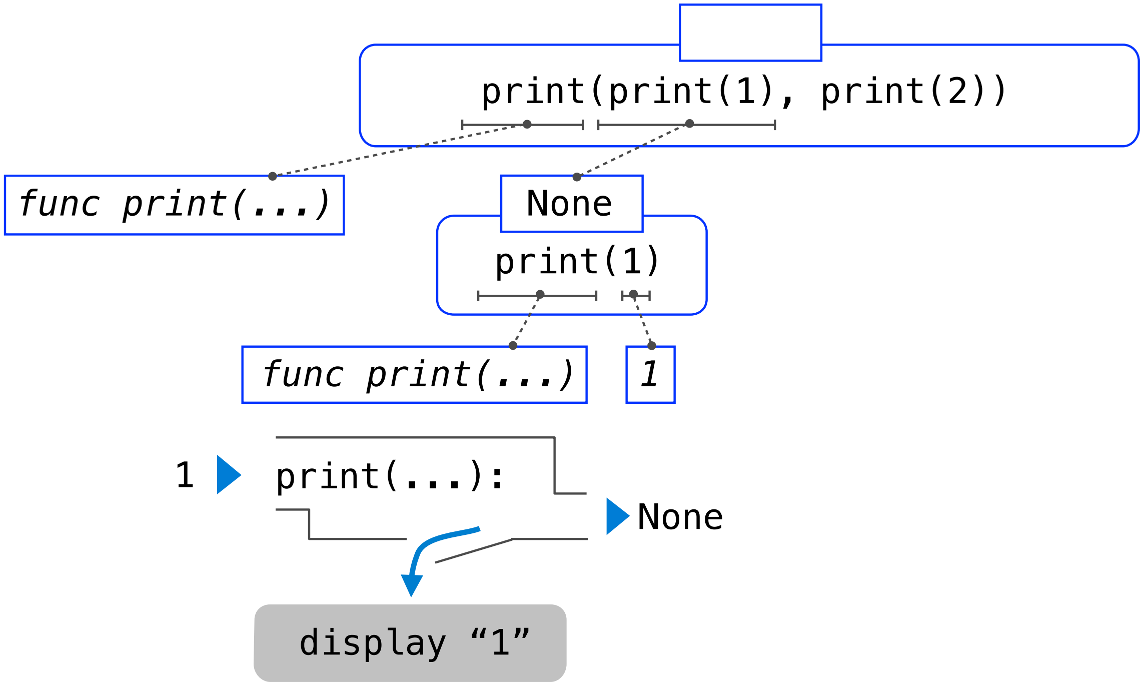

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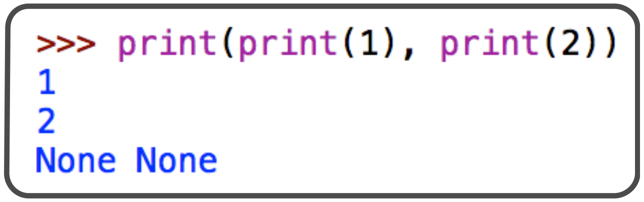

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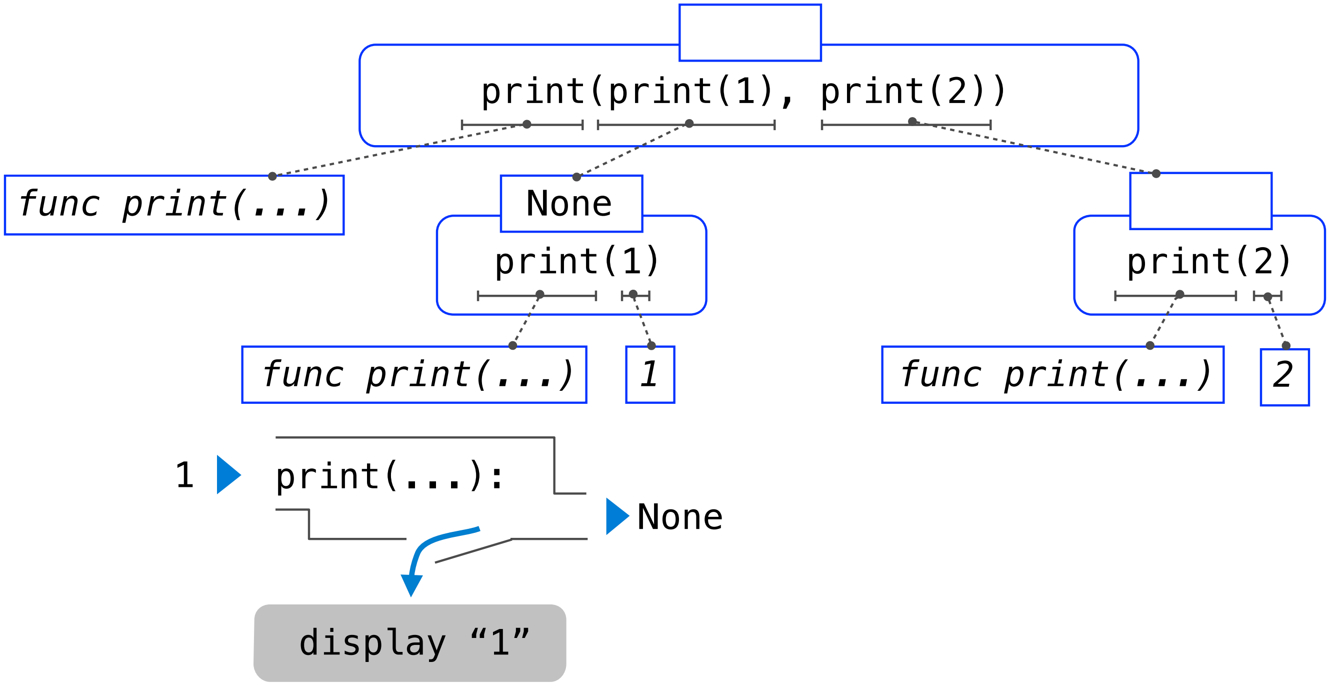

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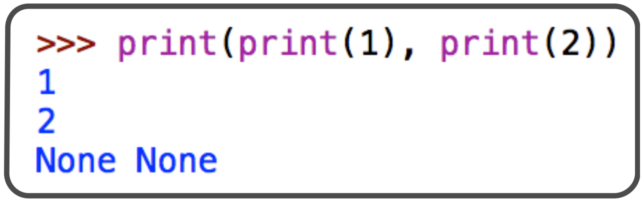

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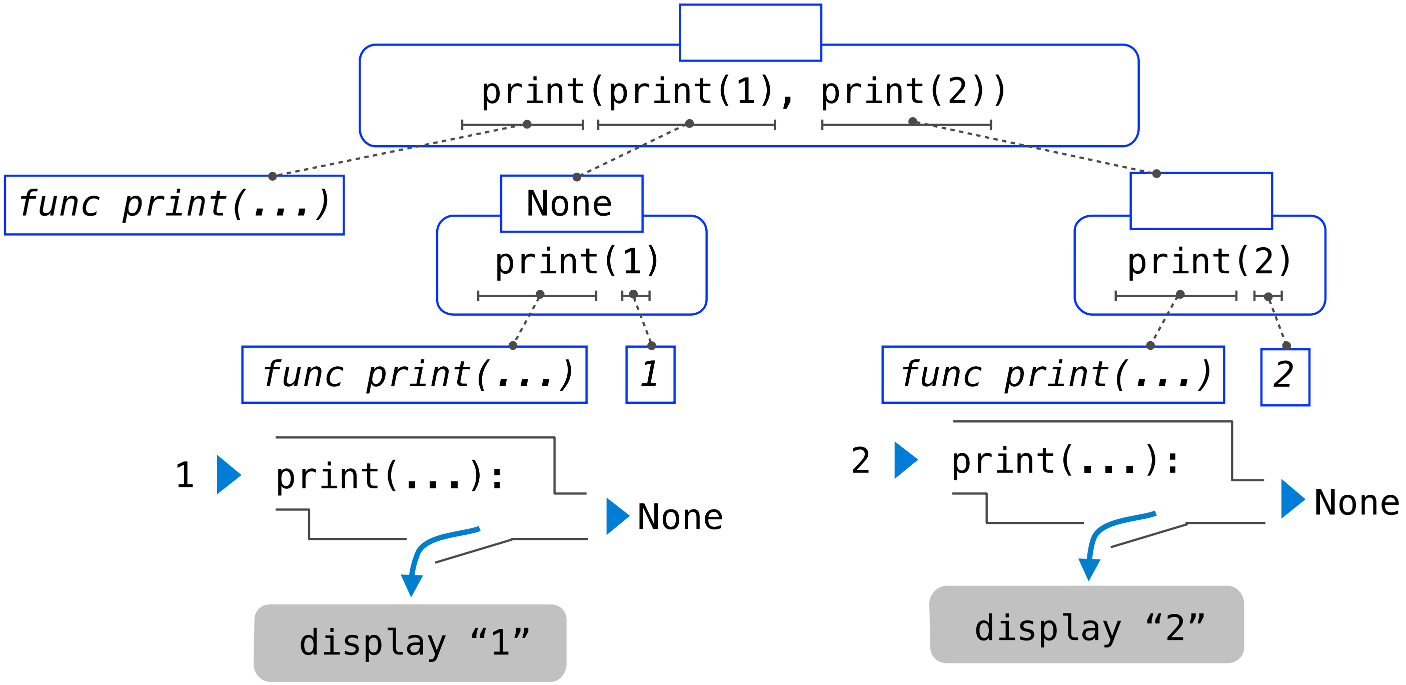
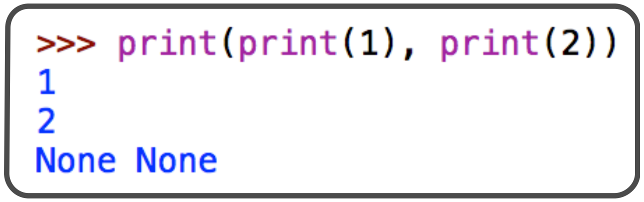


Nested Expressions with Print



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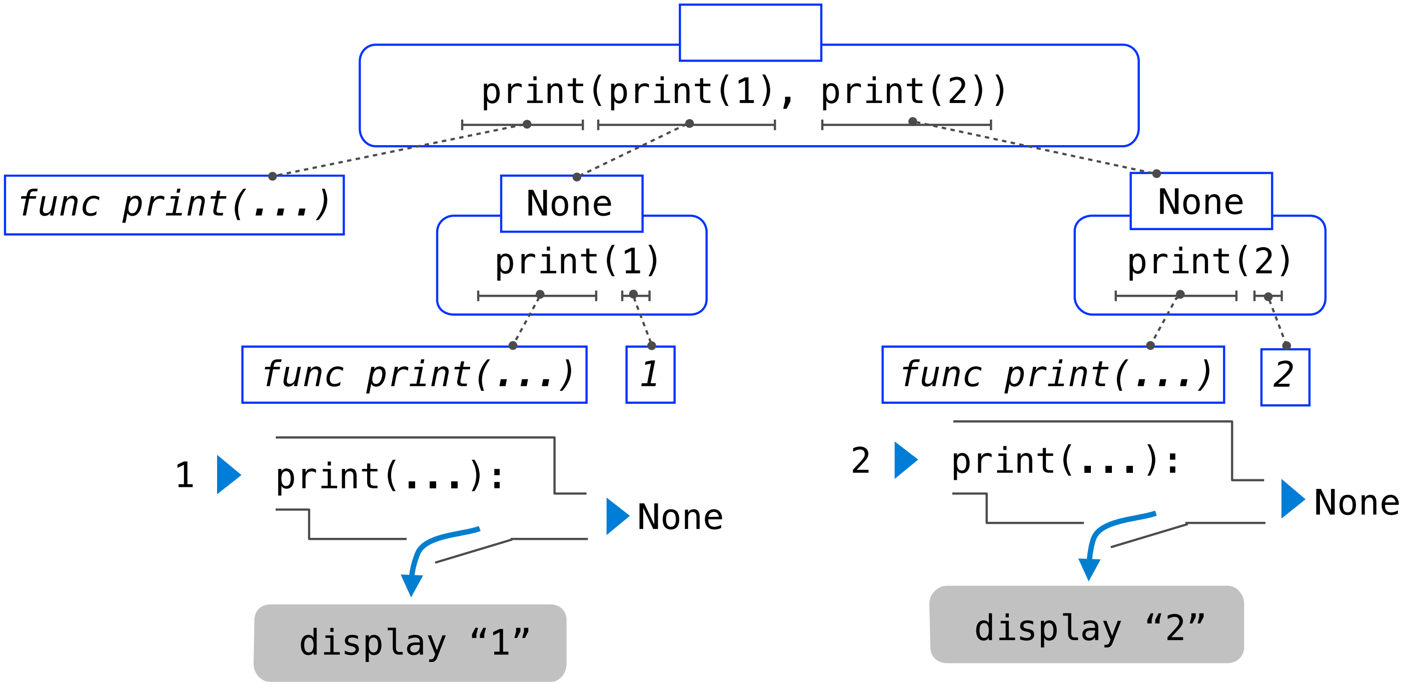
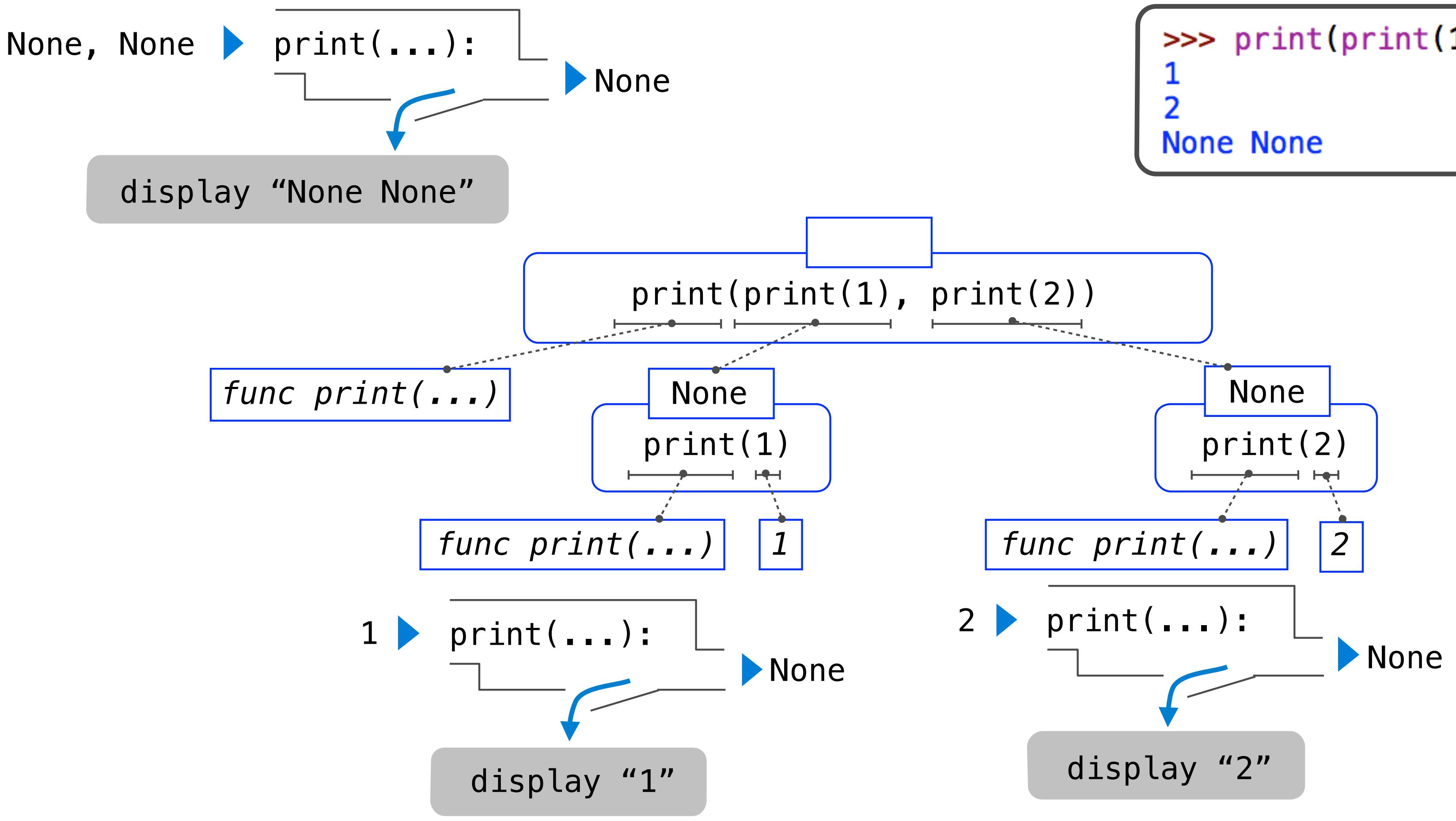


Nested Expressions with Print



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```
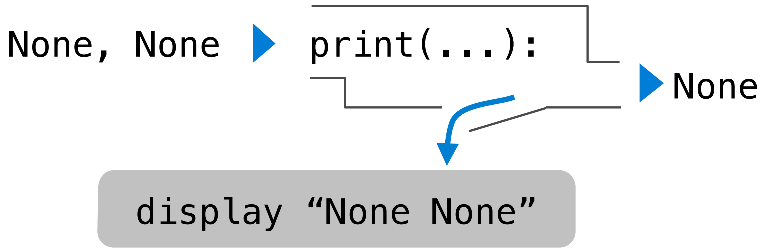
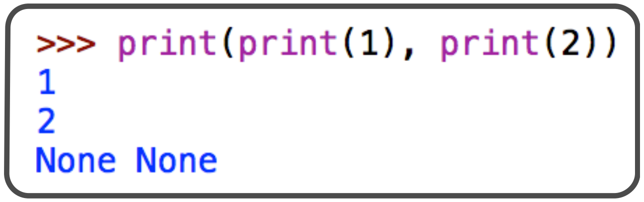

Nested Expressions with Print





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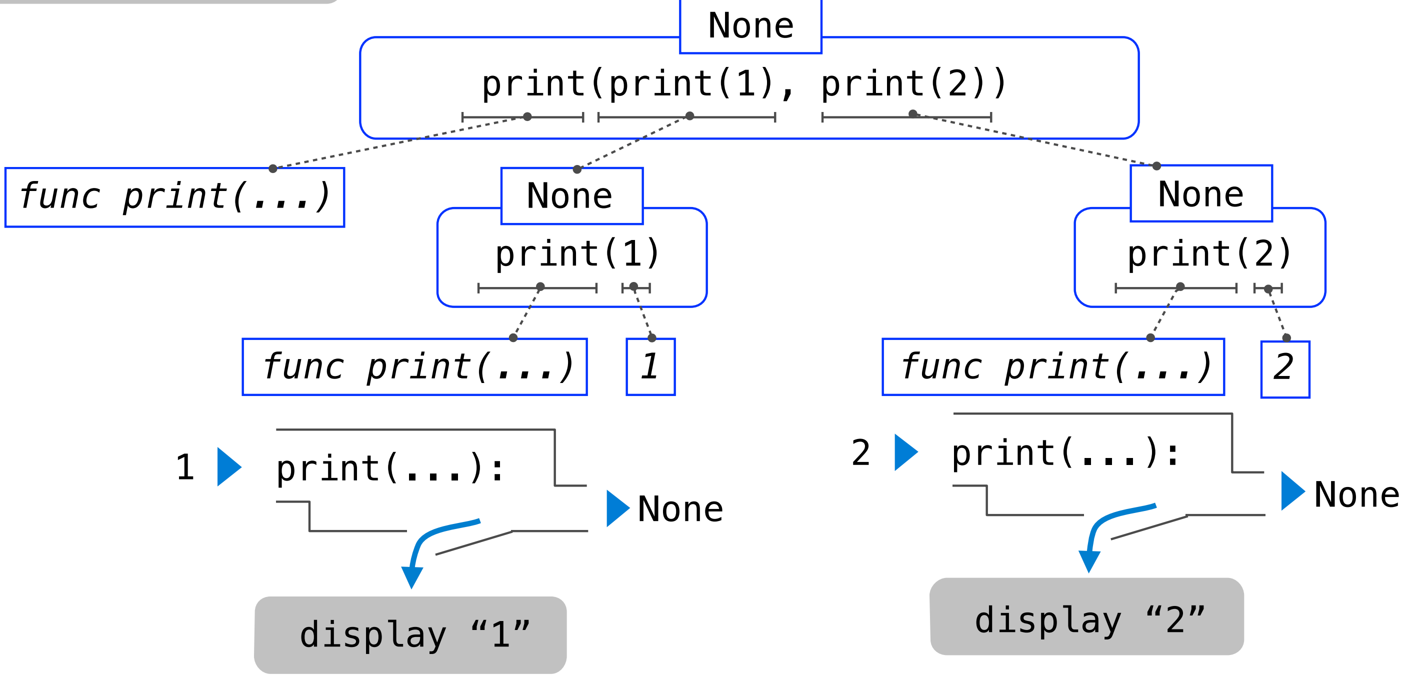
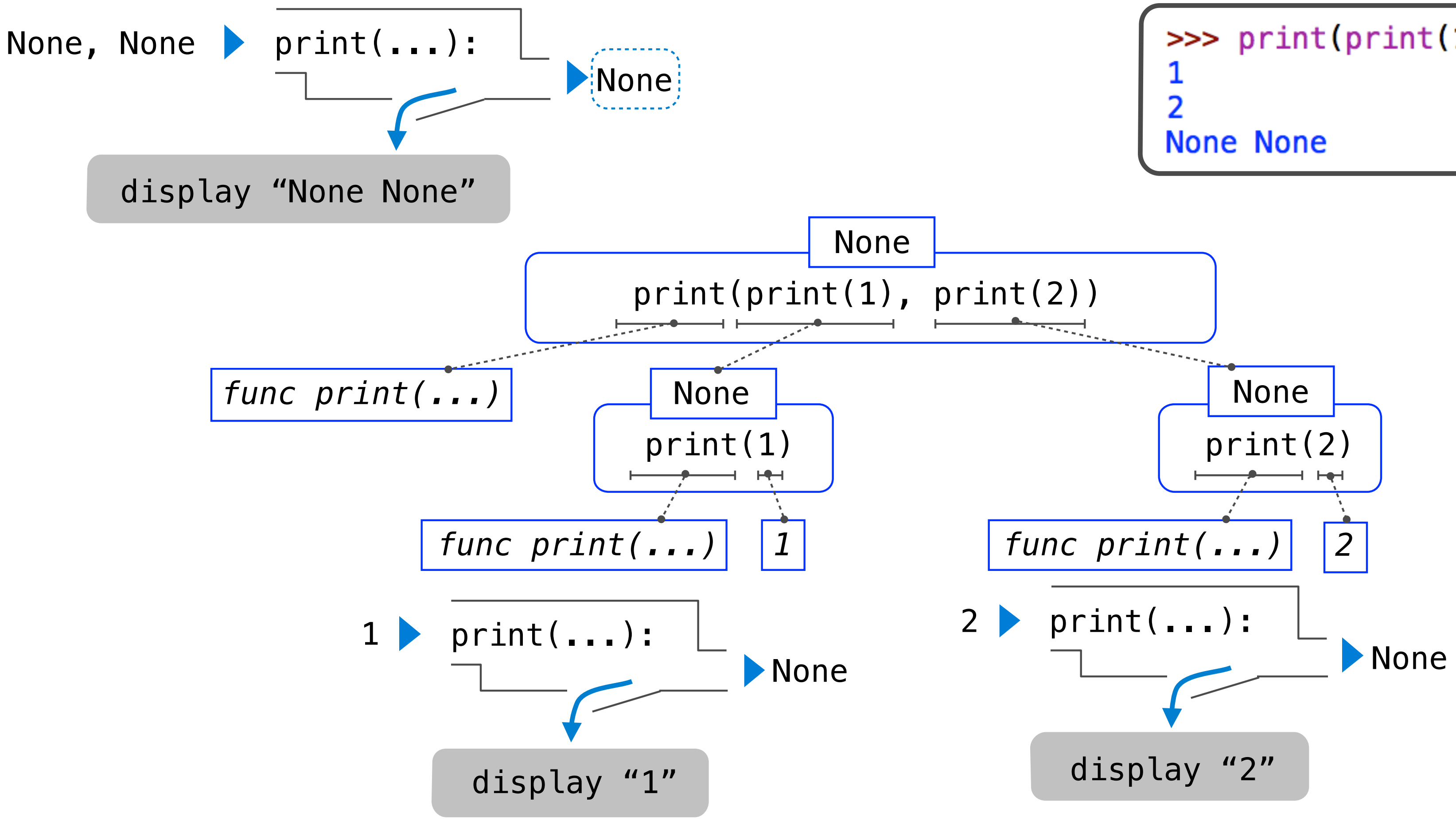


Nested Expressions with Print

```
>>> print(print(1), print(2))
1
2
None None
```



None, None ▶ print(...): ▶ None

display “None None”

None

print(print(1), print(2))

func print(...)

None

print(1)

func print(...)

1

1 ▶ print(...): ▶ None

display “1”

None

print(2)

func print(...)

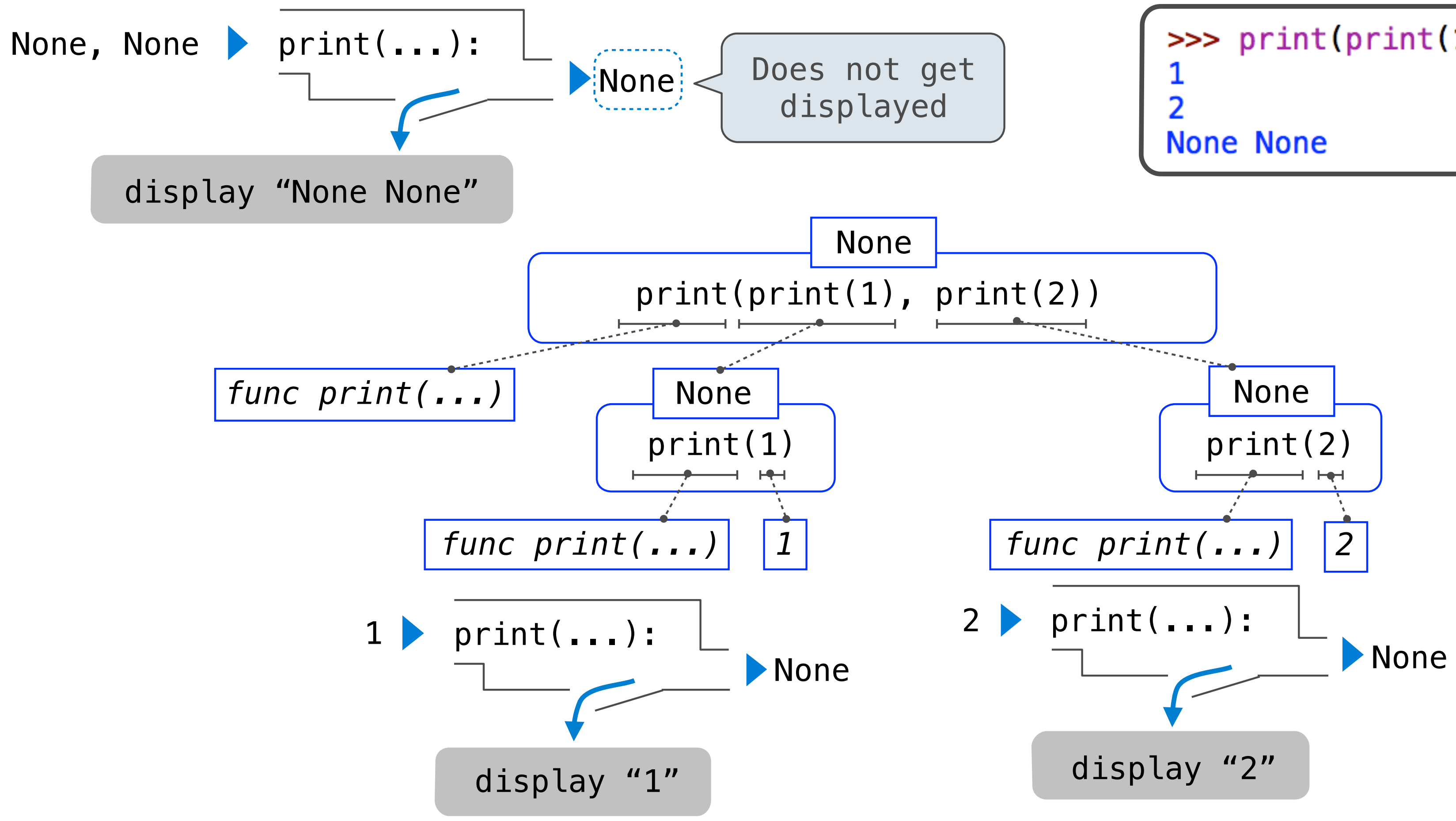
2

2 ▶ print(...): ▶ None

display “2”

Nested Expressions with Print

```
>>> print(print(1), print(2))
1
2
None None
```


None, None
print(...):
None
Does not get displayed
display "None None"
None
print(print(1), print(2))
func print(...)
None
print(1)
None
print(2)
func print(...)
1
func print(...)
2
1
print(...):
None
display "1"
2
print(...):
None
display "2"