[301] Function Scope

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Learning Objectives Today

Understand local variables

- When are they created?
- When do they die?
- When are they shared?
- Where are they stored? (frames)

Please continue reading Chapter 3 of Think Python

Understand global variables

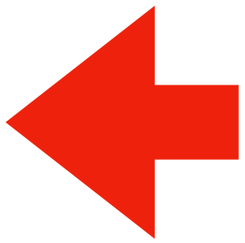
- How are they accessed? (global keyword)
- Where are they stored? (global frame)

Understand argument passing

- Meaning of “pass by value”
- The insignificance of parameter and argument naming

Today's Outline

Context
- Examples



Frames

Demos: Local Variables

Demos: Global Variables

Demos: Argument Passing

Context

Often (in life and programming), the same name can mean different things in different contexts

- Examples?

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- Human name: Matthew (who is in the room?)
- Street address: 534 State Street (what city are we in?)
- Functions: speak (cat module or dog module?)
- Files: main.py (which directory are we in?)

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- How do we keep variable names organized?

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- How do we keep variable names organized? **with groups called “frames”**
- How do we know what a variable name is referring to?

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Python programs will often have different variables with the same name

- How do we keep variable names organized? **with groups called “frames”**
- How do we know what a variable name is referring to? **we’ll learn some rules for this**

Today's Outline

Context

Frames 

Demos: Local Variables

Demos: Global Variables

Demos: Argument Passing

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Every time a function is invoked (i.e., called), the invocation gets a new “frame” for holding variables

- The parameters also exist in a frame
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Global frame

- There is always one global frame that all functions can access
- When a variable name is used, Python looks two places:
  1. the function invocation's frame (first)
  2. the global frame (only if not found before)

Example from Think Python

```
1  def print_twice(bruce):
2      print(bruce)
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4
5  def cat_twice(part1, part2):
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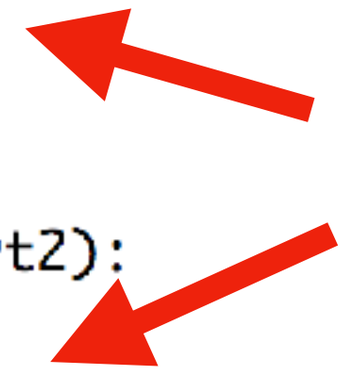

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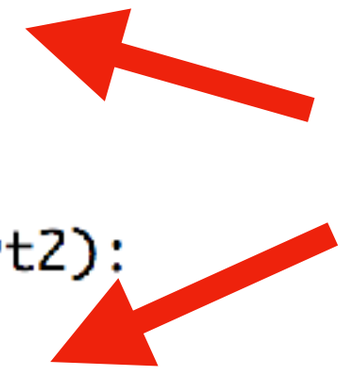

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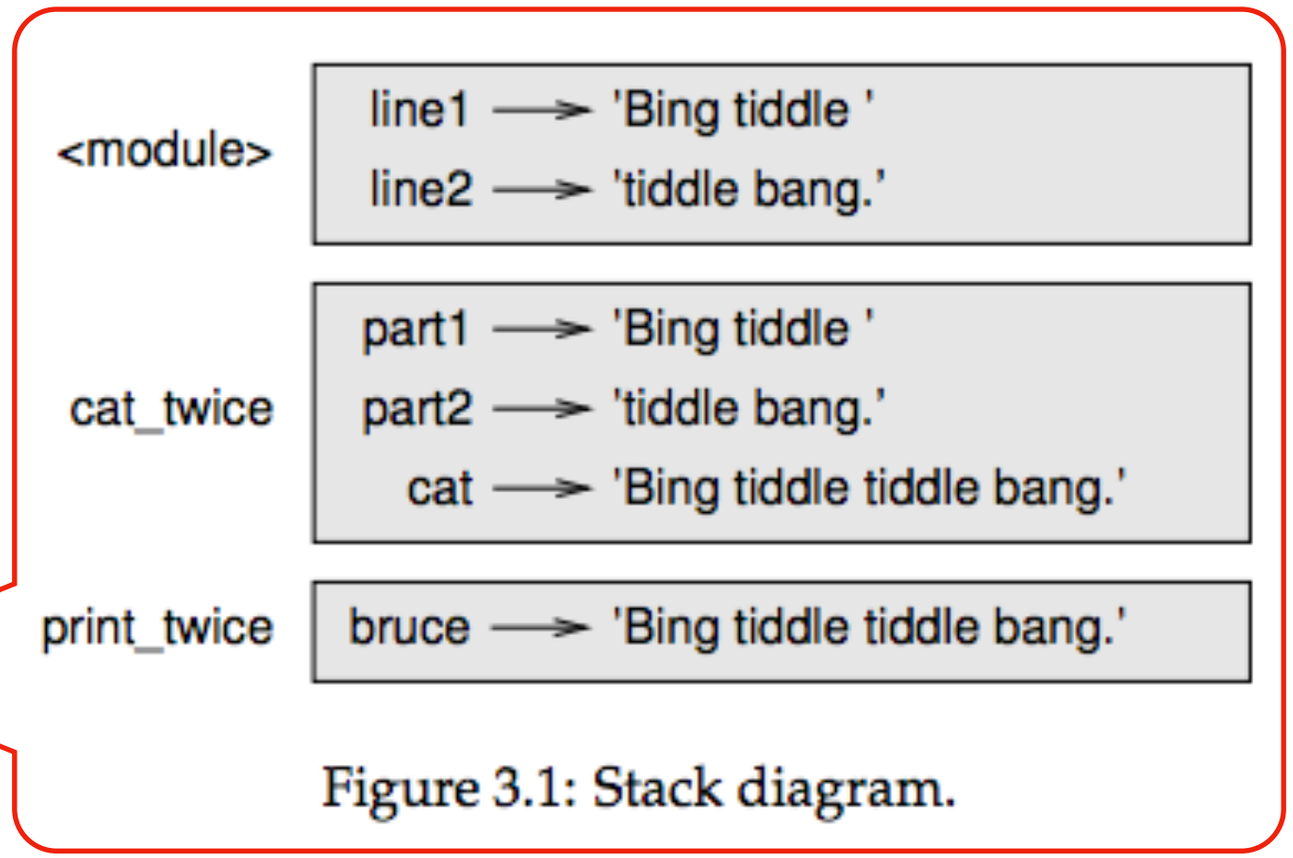
Downey illustrates like this (this is called a stack diagram)



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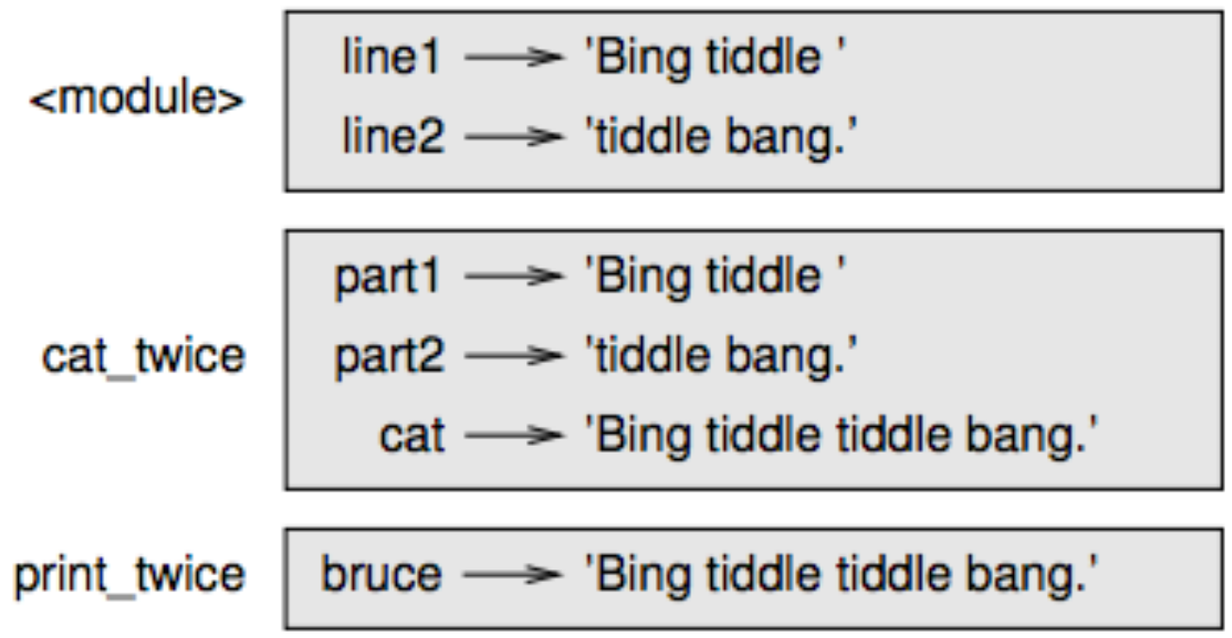
this code can access: `line1, line2`

global frame



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can access: `line1, line2, part1, part2, cat`

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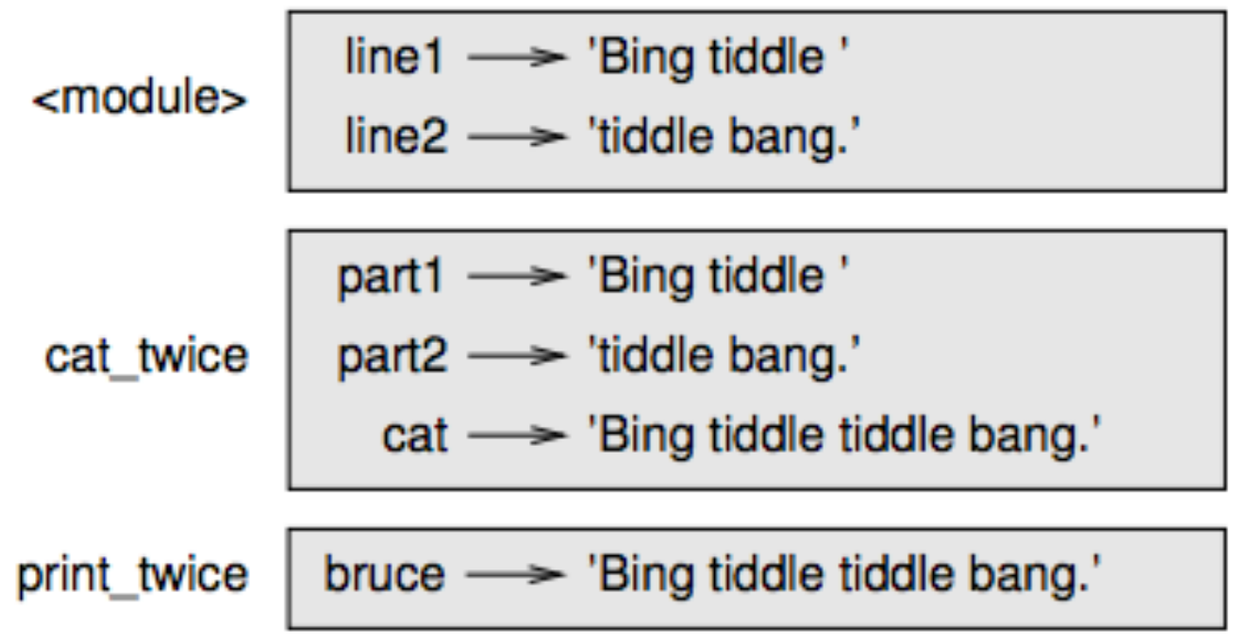

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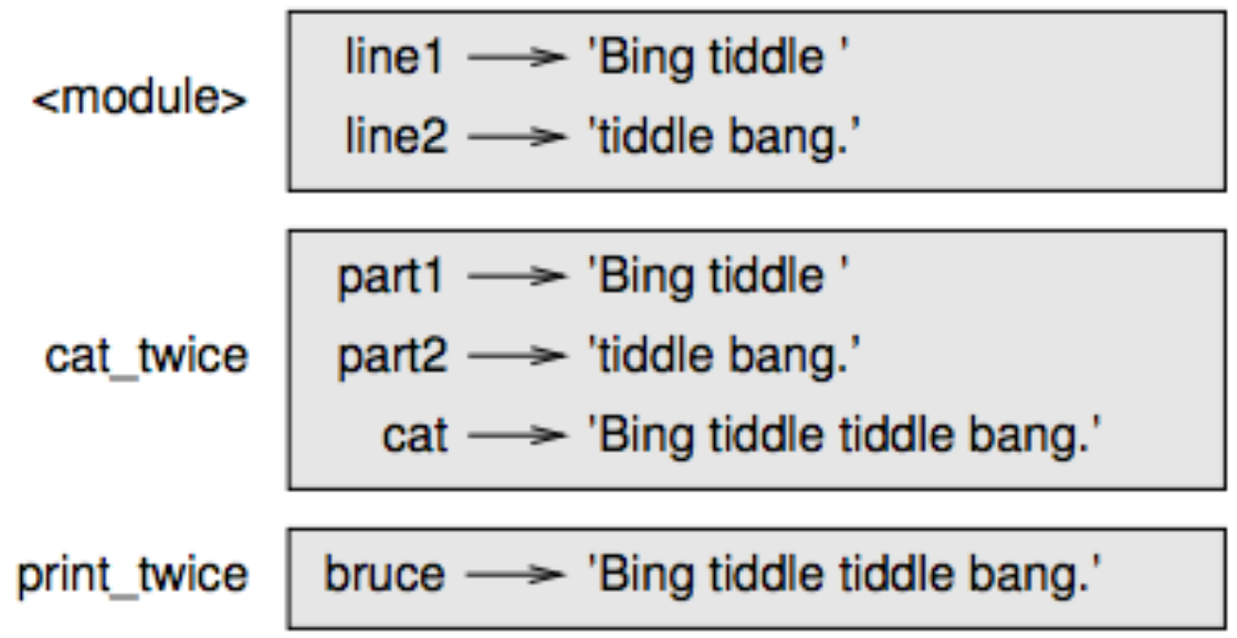

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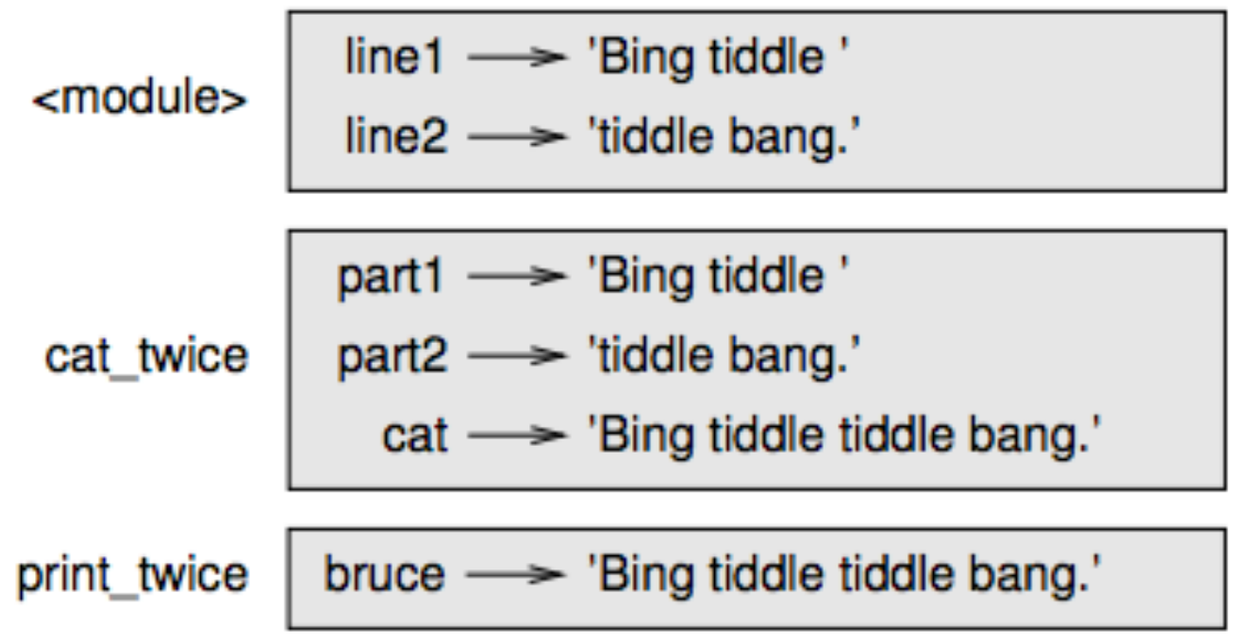
we call the variables that can currently be accessed "in scope" and variables that cannot be "out of scope"

global frame



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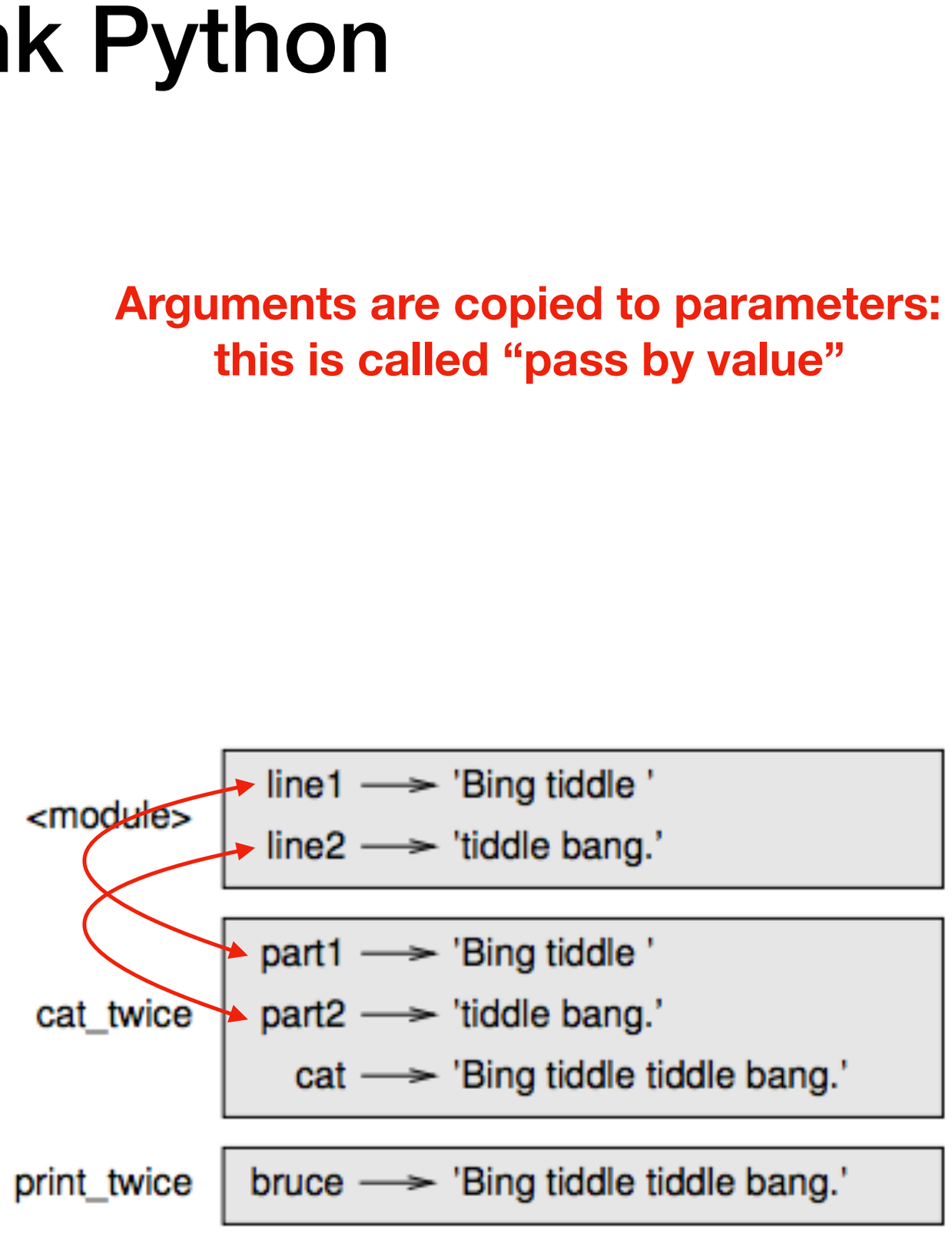
Arguments are copied to parameters: this is called “pass by value”



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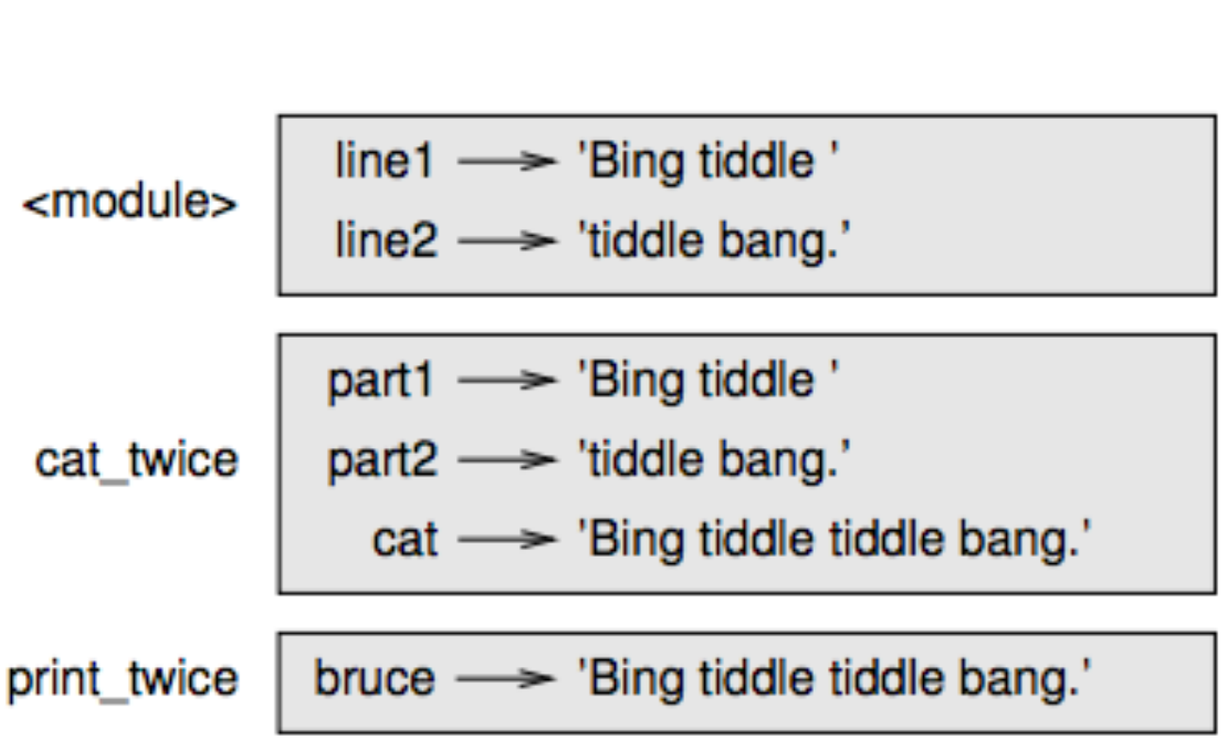
Think Python vs PythonTutor



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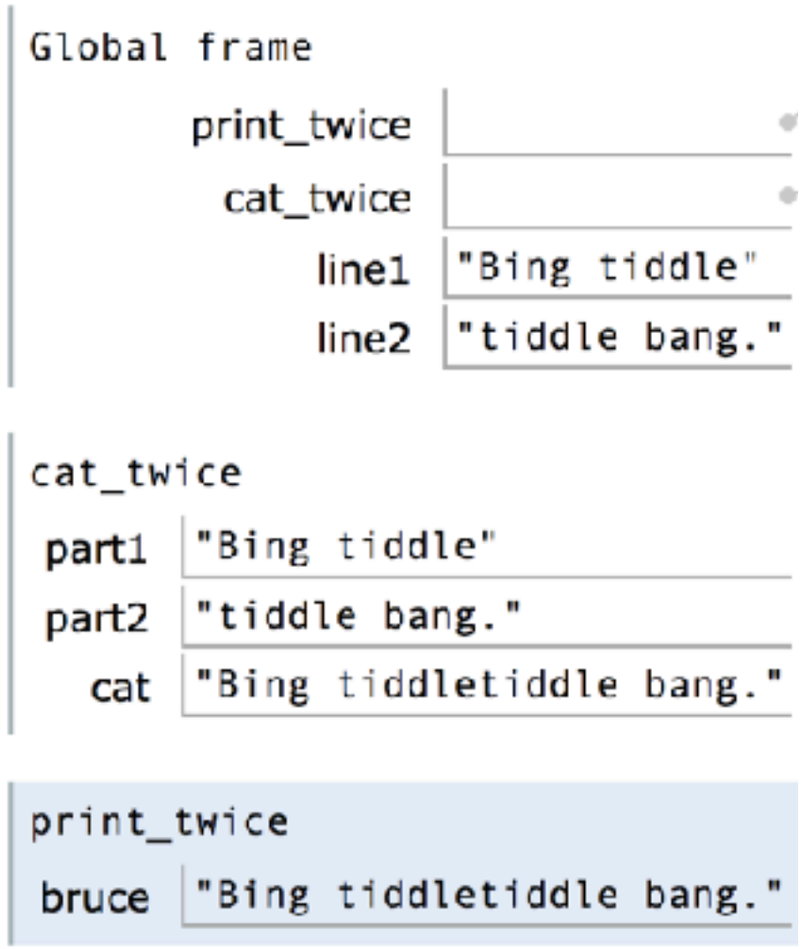

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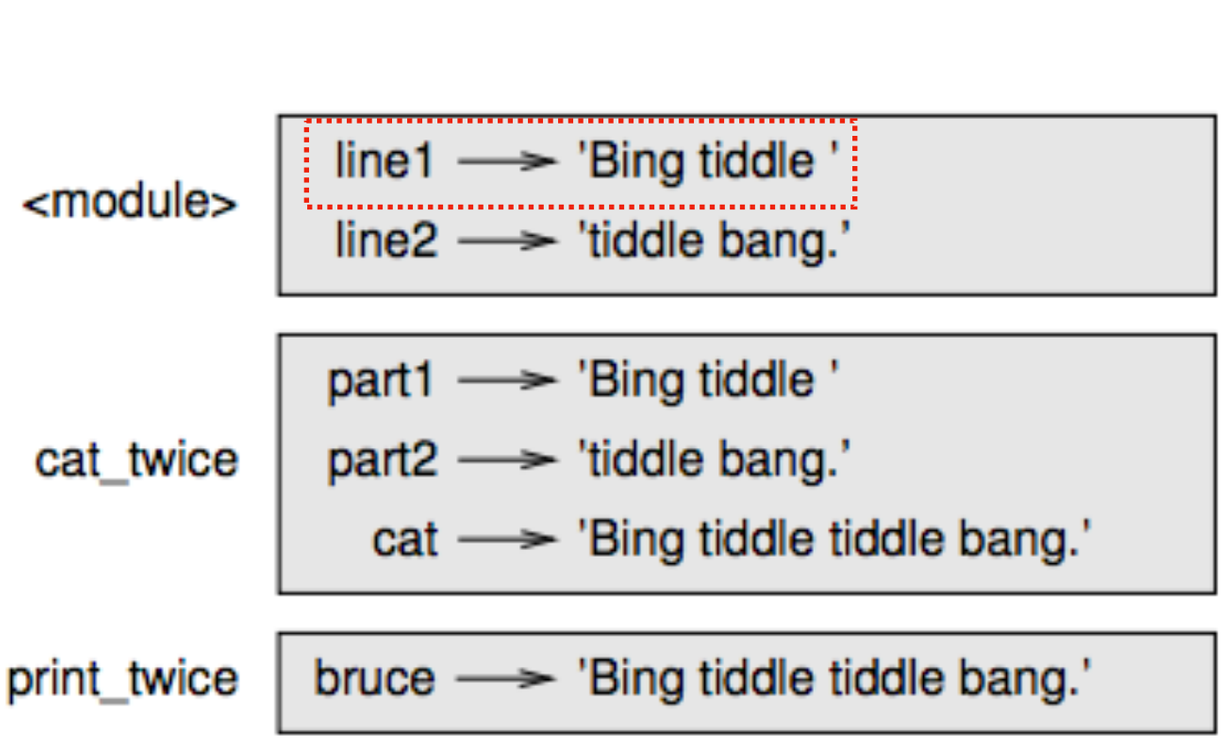

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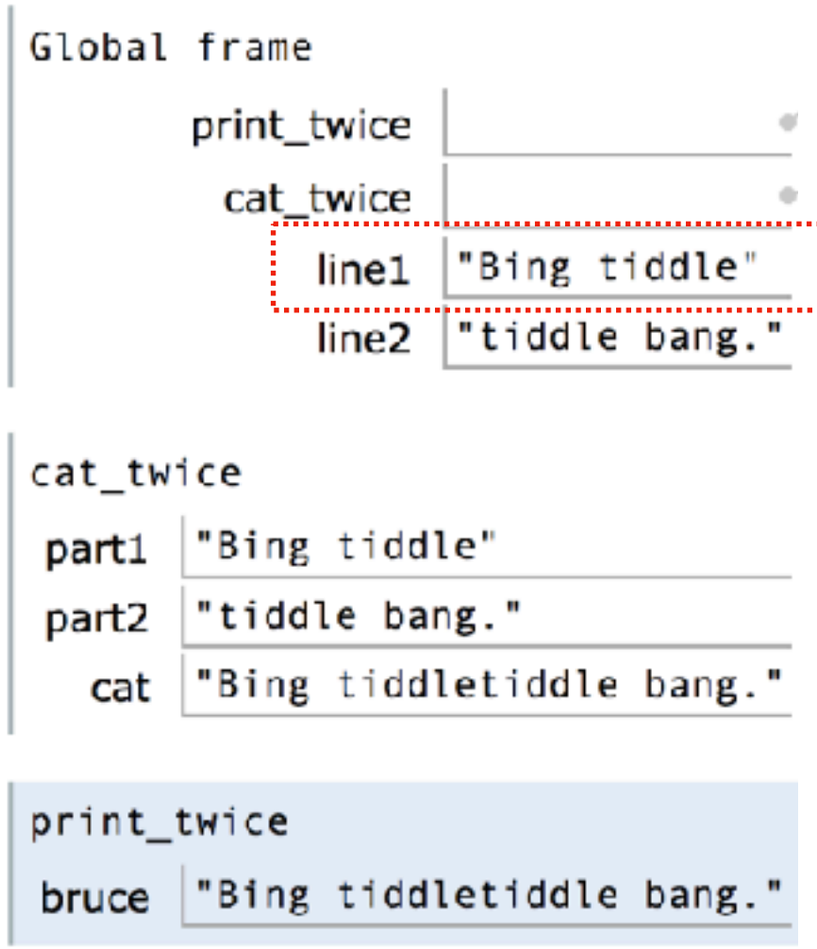

Difference 1: PythonTutor uses boxes instead of arrows

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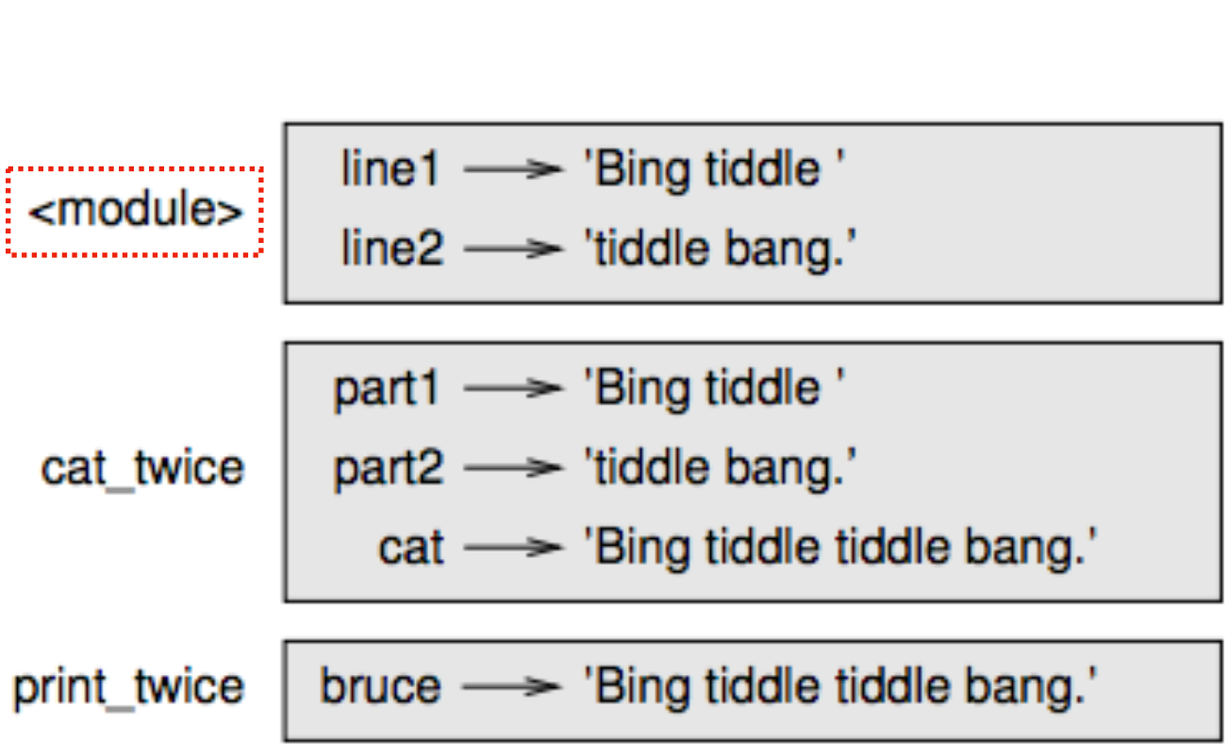

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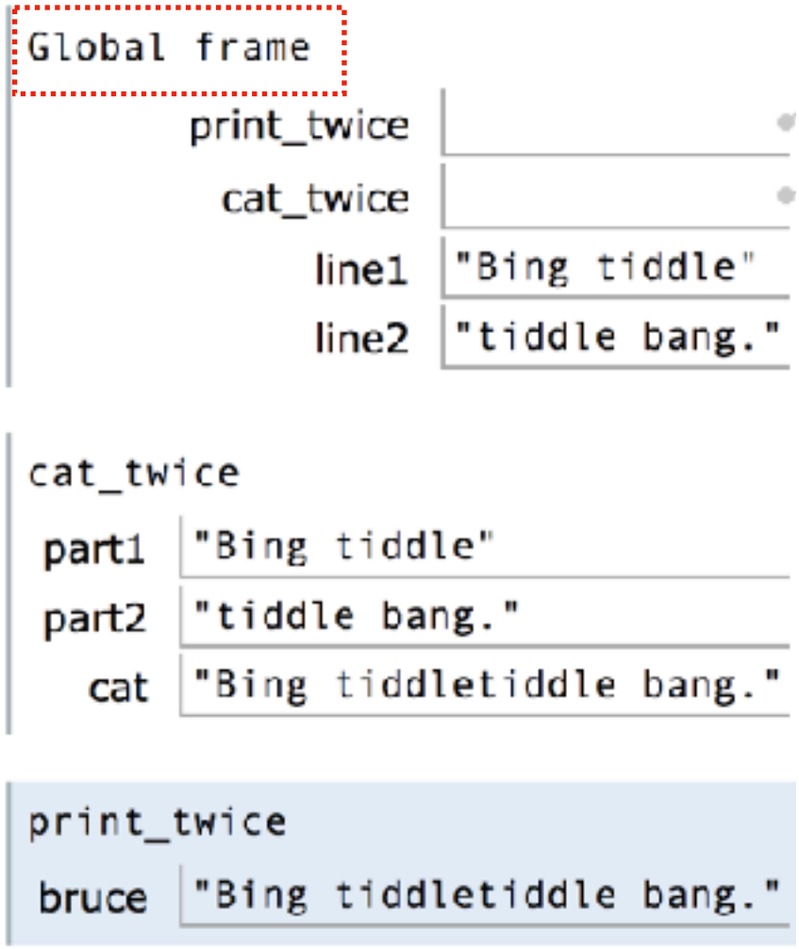

Difference 2: PythonTutor more clearly indicates the global frame

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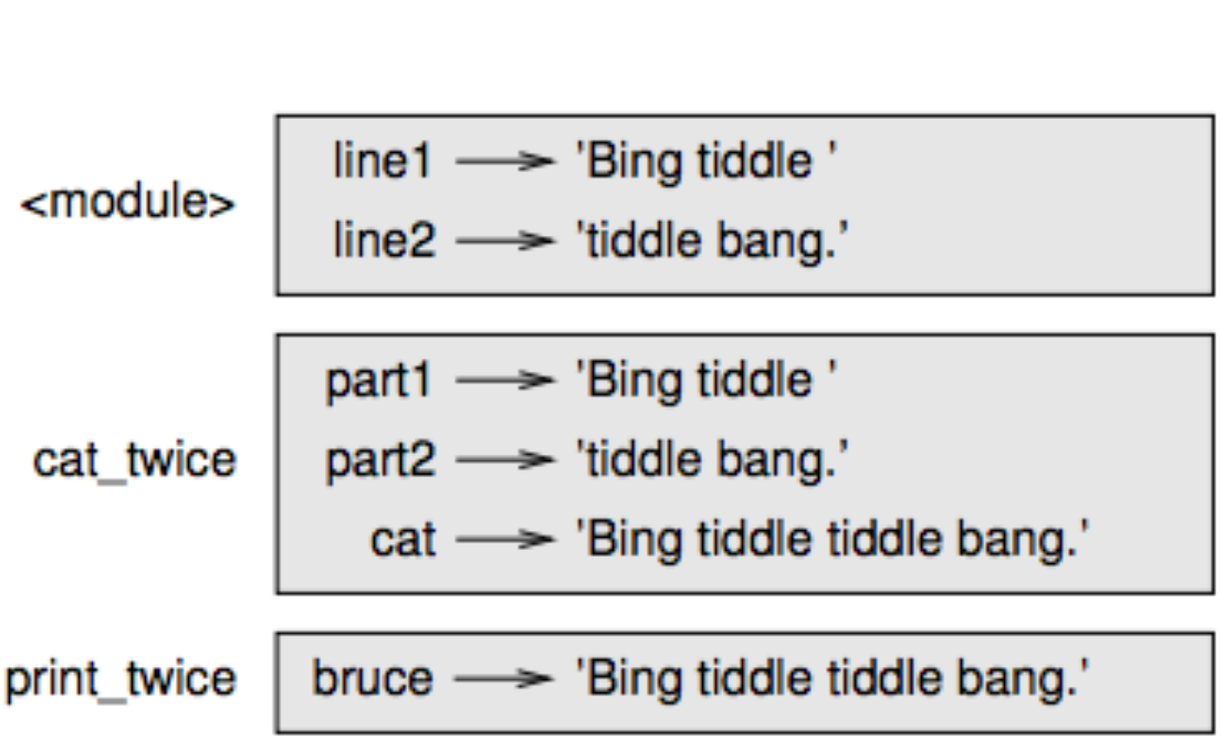

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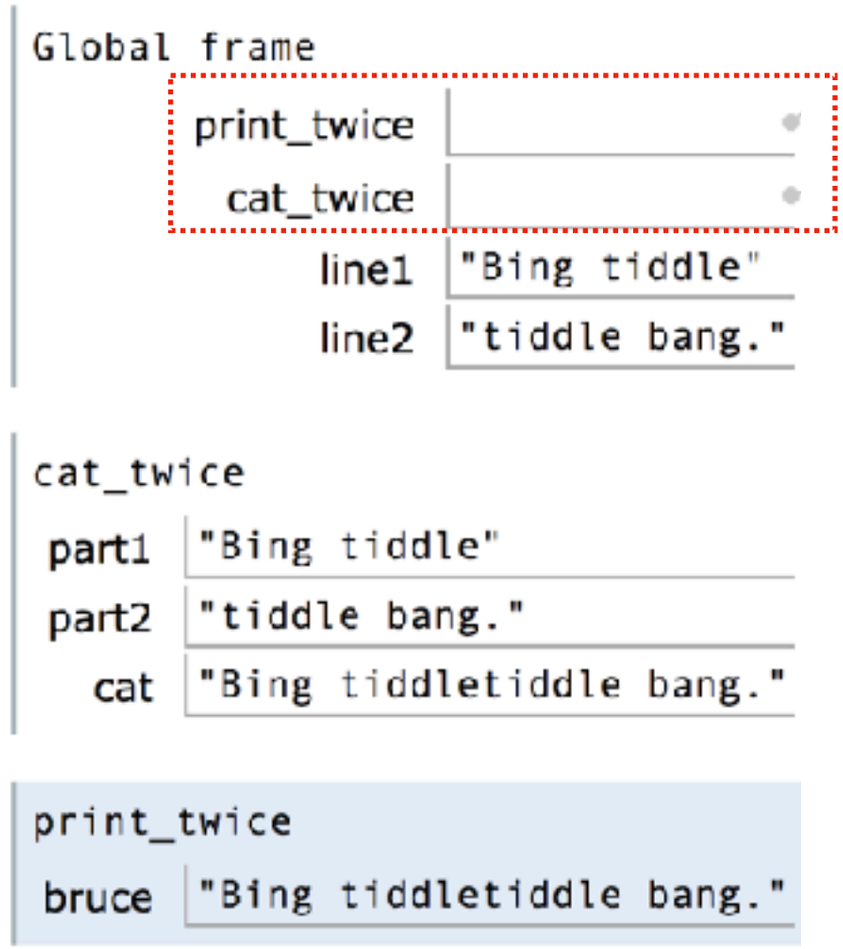

Difference 3: PythonTutor also shows function definitions in the global frame

Today's Outline

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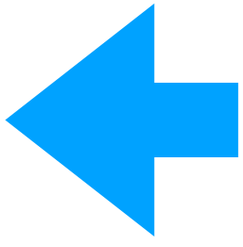
Frames

Demos: Local Variables



Demos: Global Variables

Demos: Argument Passing

Lessons about Local Variables

```
def set_x():
    x = 100

print(x)
```

Lesson 1: functions don't execute unless they're called

Lessons about Local Variables

```
def set_x():
    x = 100

set_x()
print(x)
```

Lesson 2: variables created in a function die after function returns

Lessons about Local Variables

```
def count():
    x = 1
    x += 1
    print(x)

count()
count()
count()
```

Lesson 3: variables start fresh every time a function is called again

Lessons about Local Variables

```
def display_x():
    print(x)

def main():
    x = 100
    display_x()
```

Lesson 4: you can't see the variables of other function invocations, even those that call you

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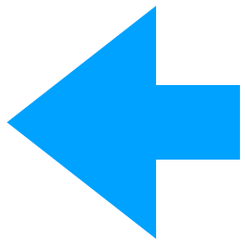
Demos: Global Variables



Demos: Argument Passing

Lessons about Global Variables

```
msg = 'hello' # global, because outside any
function

def greeting():
    print(msg)

print('before: ' + msg)
greeting()
print('after: ' + msg)
```

Lesson 5: you can generally just use global variables inside a function

Lessons about Global Variables

```
msg = 'hello'

def greeting():
    msg = 'welcome!'
    print('greeting: ' + msg)

print('before: ' + msg)
greeting()
print('after: ' + msg)
```

Lesson 6: if you do an assignment to a variable in a function,
Python assumes you want it local

Lessons about Global Variables

```
msg = 'hello'

def greeting():
    print('greeting: ' + msg)
    msg = 'welcome!'

print('before: ' + msg)
greeting()
print('after: ' + msg)
```

Lesson 7: assignment to a variable should be before its use in a function, even if there's a a global variable with the same name

Lessons about Global Variables

```
msg = 'hello'

def greeting():
    global msg
    print('greeting: ' + msg)
    msg = 'welcome!'

print('before: ' + msg)
greeting()
print('after: ' + msg)
```

Lesson 8: use a global declaration to prevent Python from creating a local variable when you want a global variable

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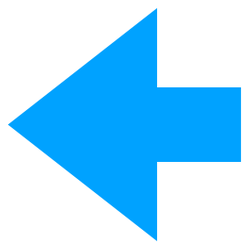

Lessons about Argument Passing

```
def f(x):
    x = 'B'
    print('inside: ' + x)

val = 'A'
print('before: ' + val)
f(val)
print('after: ' + val)
```

Lesson 9: in Python, arguments are "passed by value", meaning changes to a parameter inside the function don't change the argument outside

Lessons about Argument Passing

```
x = 'A'

def f(x):
    x = 'B'
    print('inside: ' + x)

print('before: ' + x)
f(x)
print('after: ' + x)
```

Lesson 10: it's irrelevant whether the argument (outside) and parameter (inside) have the same variable name