Function Examples

Announcements

Hog Contest Rules

cs61a.org/proj/hog_contest

Hog Contest Rules

- Up to two people submit one entry;
  Max of one entry per person

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- Your score is the number of entries against which you win more than 50.00001% of the time

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Fall 2011 Winners

Kaylee Mann
Yan Duan & Ziming Li
Brian Prike & Zhenghao Qian
Parker Schuh & Robert Chatham

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Adam Robert Villaflor & Joany Gao
Zhen Qin & Dian Chen
Zizheng Tai & Yihe Li

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Your name could be here FOREVER!

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Describing Functions

Boolean Favorites

```
def likes(n):
    """Returns whether George Boole likes the non-negative integer n."""
    ...

def mystery1(n):
    k = 1
    while k < n:
        if likes(n):
            print(k)
        k = k + 2
```

mystery1 prints ______ less than n ______ .

Boolean Favorites

```
def likes(n):
    """Returns whether George Boole likes the non-negative integer n."""
    ...

def mystery1(n):
    k = 1
    while k < n:
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```

One approach:

mystery1 prints ______ less than n ______ .

Boolean Favorites

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def likes(n):
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    ...

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```

One approach:

1. Read the code

mystery1 prints ______ less than n ______ .

Boolean Favorites

```
def likes(n):
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    ...

def mystery1(n):
    k = 1
    while k < n:
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            print(k)
        k = k + 2
```

One approach:

1. Read the code
2. Read the description options

mystery1 prints ______ less than n ______ .

Boolean Favorites

```
def likes(n):
    """Returns whether George Boole likes the non-negative integer n."""
    ...

def mystery1(n):
    k = 1
    while k < n:
        if likes(n):
            print(k)
        k = k + 2
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

mystery1 prints ______ less than n ______ .

Boolean Favorites

```
def likes(n):
    """Returns whether George Boole likes the non-negative integer n."""
    ...

def mystery1(n):
    k = 1
    while k < n:
        if likes(n):
            print(k)
        k = k + 2
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

mystery1 prints ______ less than n ______ .

mystery1 prints all odd numbers less than n that George likes.

Boolean Favorites

```
def likes(n):
    """Returns whether George Boole likes the non-negative integer n."""
    ...

def mystery1(n):
    k = 1
    while k < n:
        if likes(n):
            print(k)
        k = k + 2
```

```
likes = is_prime
n = 8
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

mystery1 prints ______ less than n ______ .

mystery1 prints all odd numbers less than n that George likes.

Boolean Favorites

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def likes(n):
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```

```
likes = is_prime
n = 8
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

mystery1 prints ______ less than n ______ .

~~**mystery1** prints all odd numbers less than n that George likes.~~

Boolean Favorites

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def likes(n):
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    ...

def mystery1(n):
    k = 1
    while k < n:
        if likes(n):
            print(k)
        k = k + 2
```

```
likes = is_prime
n = 8
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

all odd numbers

mystery1 prints ______ less than n ______ .

~~**mystery1** prints all odd numbers less than n that George likes.~~

Boolean Favorites

```
def likes(n):
    """Returns whether George Boole likes the non-negative integer n."""
    ...

def mystery1(n):
    k = 1
    while k < n:
        if likes(n):
            print(k)
        k = k + 2
```

```
likes = is_prime
n = 8
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

all odd numbers ▼ but only if George likes n ▼

mystery1 prints ______ less than n ______ .

~~**mystery1** prints all odd numbers less than n that George likes.~~

Boolean Favorites

```
def likes(n):
    """Returns whether George Boole likes the non-negative integer n."""
    ...

def mystery2(n):
    i, j, k = 0, None, None
    while i < n:
        if likes(i):
            if j != None and (k == None or i - j < k):
                k = i - j
            j = i
        i = i + 1
    return k
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

mystery 2 returns ______ or returns None if ______ .

Boolean Favorites

```
def likes(n):
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    ...

def mystery2(n):
    i, j, k = 0, None, None
    while i < n:
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            if j != None and (k == None or i - j < k):
                k = i - j
            j = i
        i = i + 1
    return k
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

the smallest difference between
two positive integers below n
that George likes

mystery 2 returns ______ or returns None if ______ .

Boolean Favorites

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def likes(n):
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            j = i
        i = i + 1
    return k
```

One approach:

1. Read the code
2. Read the description options
3. Consider an example

the smallest difference between two positive integers below n that George likes

There are no two such integers

mystery 2 returns ______ or returns None if ______ .

Generating Environment Diagram

A Day at the Beach

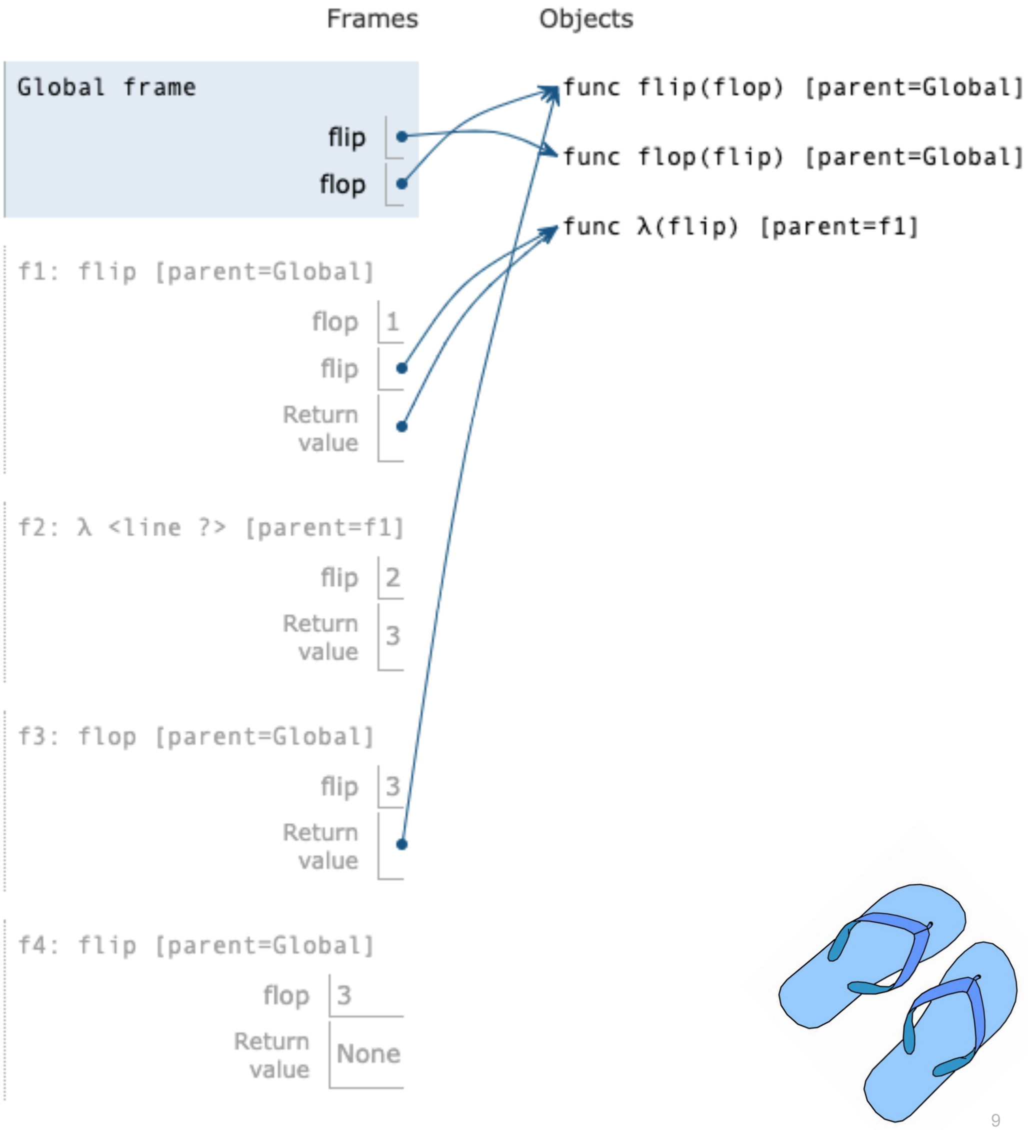
```
def flip(flop):
    if ______:

        ______
    flip = ______
    return flip

def flop(flip):
    return flop


______


flip(____)(3)
```



Frames

Objects

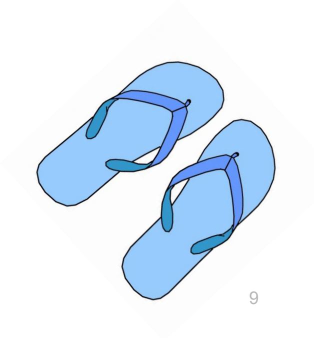
Global frame
flip: func flip(flop) [parent=Global]
flop: func flop(flip) [parent=Global]

f1: flip [parent=Global]
flop: 1
flip: func λ(flip) [parent=f1]
Return value: func λ(flip) [parent=f1]

f2: λ <line ?> [parent=f1]
flip: 2
Return value: 3

f3: flop [parent=Global]
flip: 3
Return value: func flip(flop) [parent=Global]

f4: flip [parent=Global]
flop: 3
Return value: None



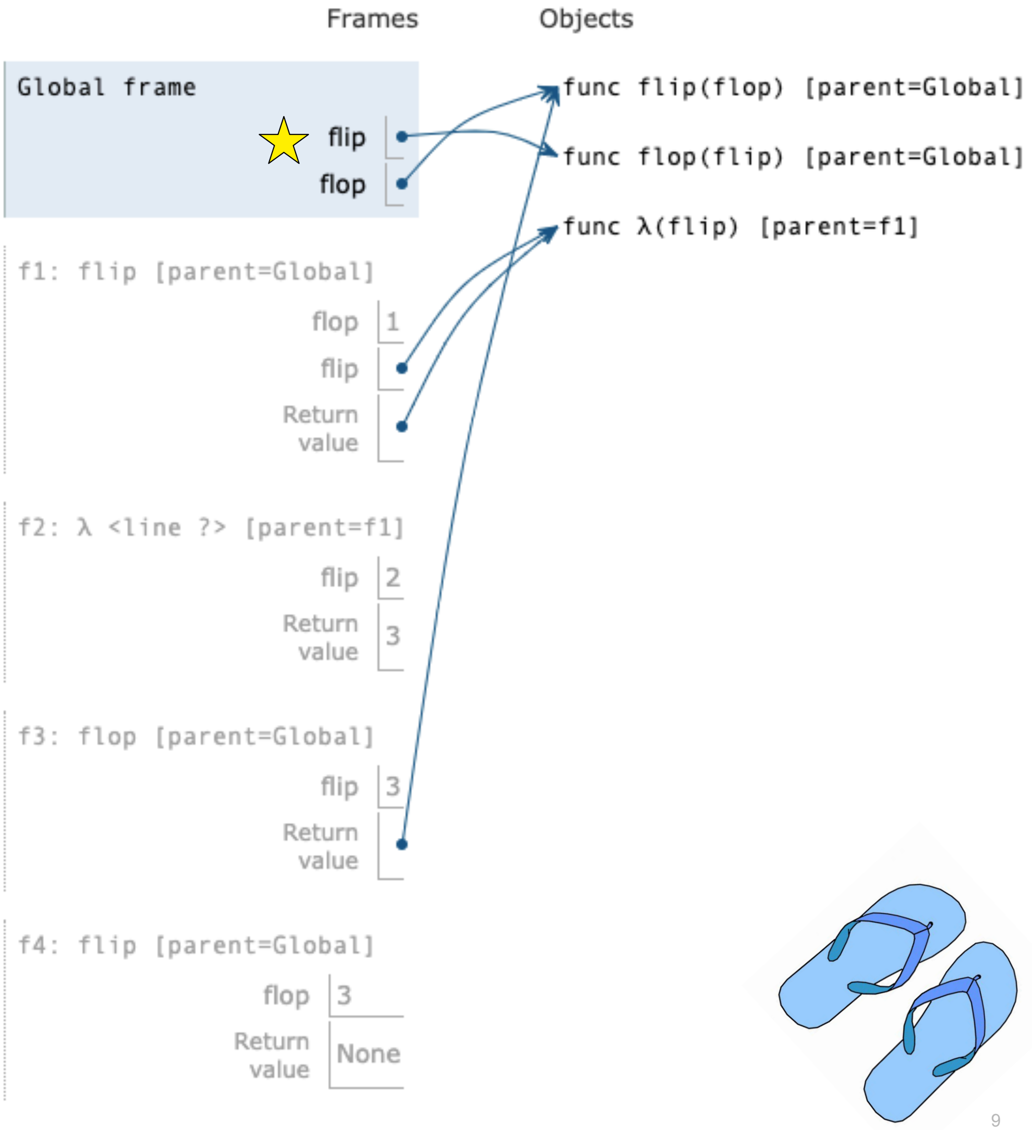
A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

______

flip(____)(3)
```



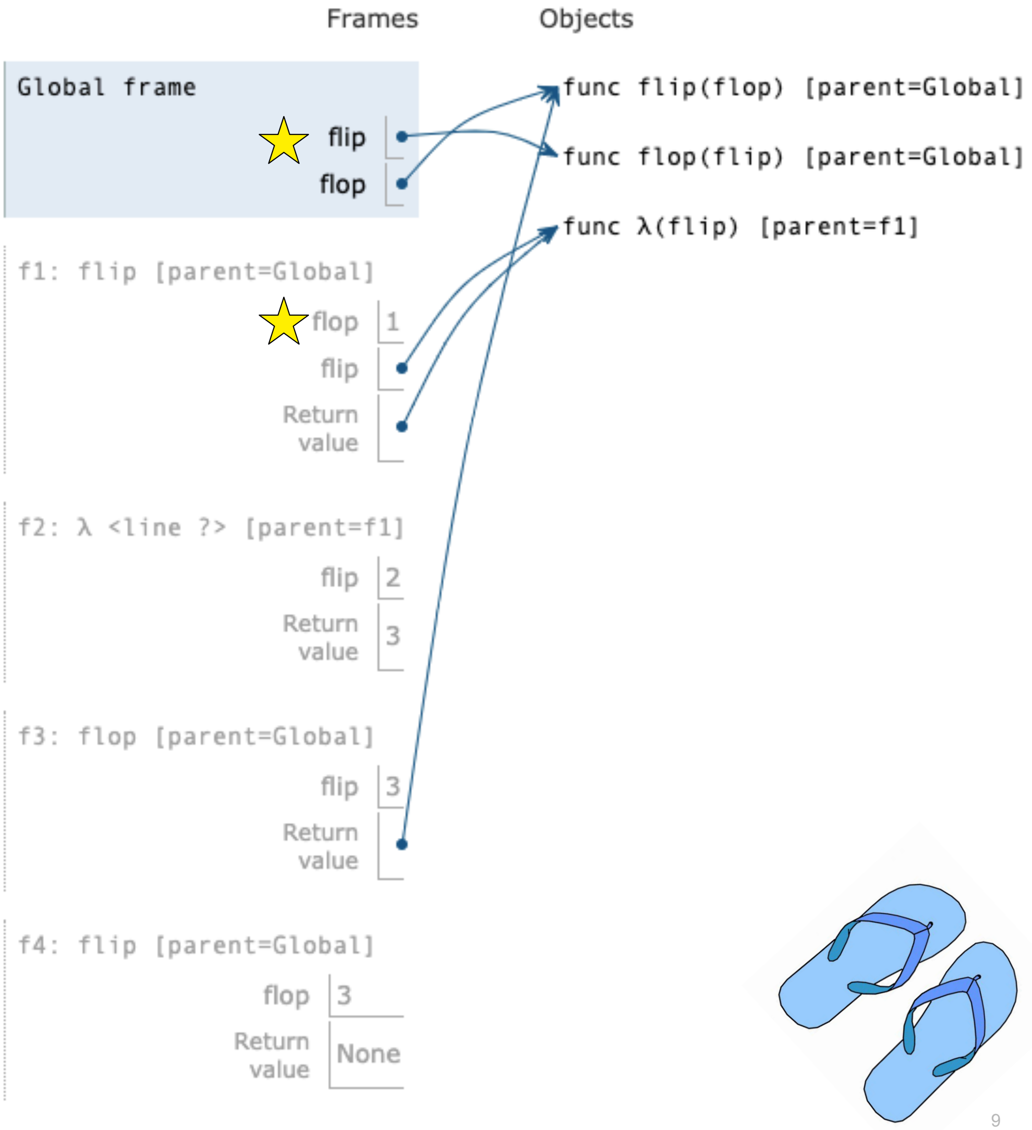
A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

______

flip(____)(3)
```



Frames

Objects

Global frame

☆ flip

flop

func flip(flop) [parent=Global]

func flop(flip) [parent=Global]

func λ(flip) [parent=f1]

f1: flip [parent=Global]

☆ flop 1

flip

Return value

f2: λ <line ?> [parent=f1]

flip 2

Return value 3

f3: flop [parent=Global]

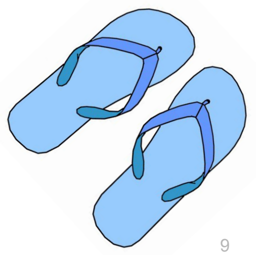
flip 3

Return value

f4: flip [parent=Global]

flop 3

Return value None



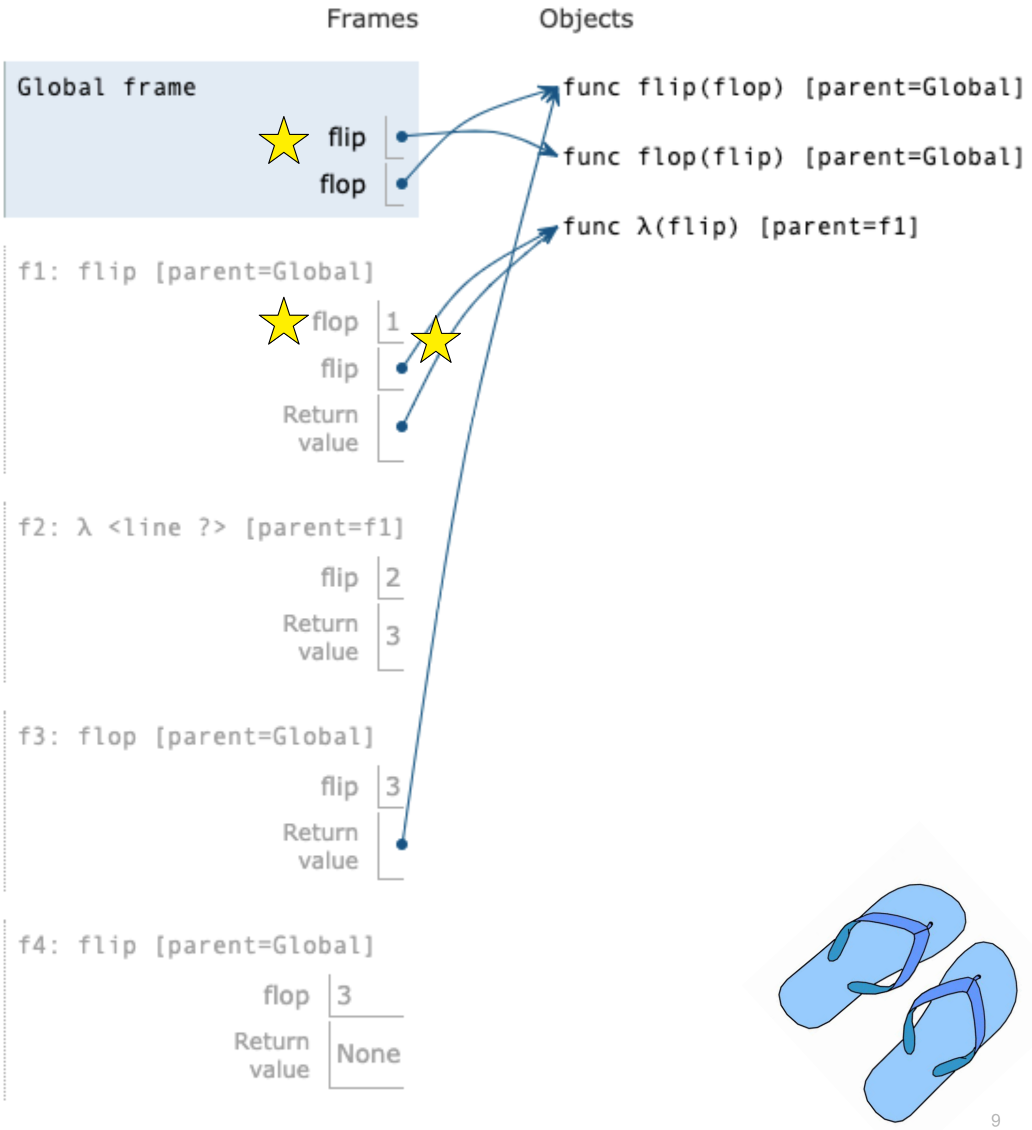
A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

______

flip(____)(3)
```



Frames

Objects

Global frame

☆ flip

flop

func flip(flop) [parent=Global]

func flop(flip) [parent=Global]

func λ(flip) [parent=f1]

f1: flip [parent=Global]

☆ flop 1

flip ☆

Return value

f2: λ <line ?> [parent=f1]

flip 2

Return value 3

f3: flop [parent=Global]

flip 3

Return value

f4: flip [parent=Global]

flop 3

Return value None

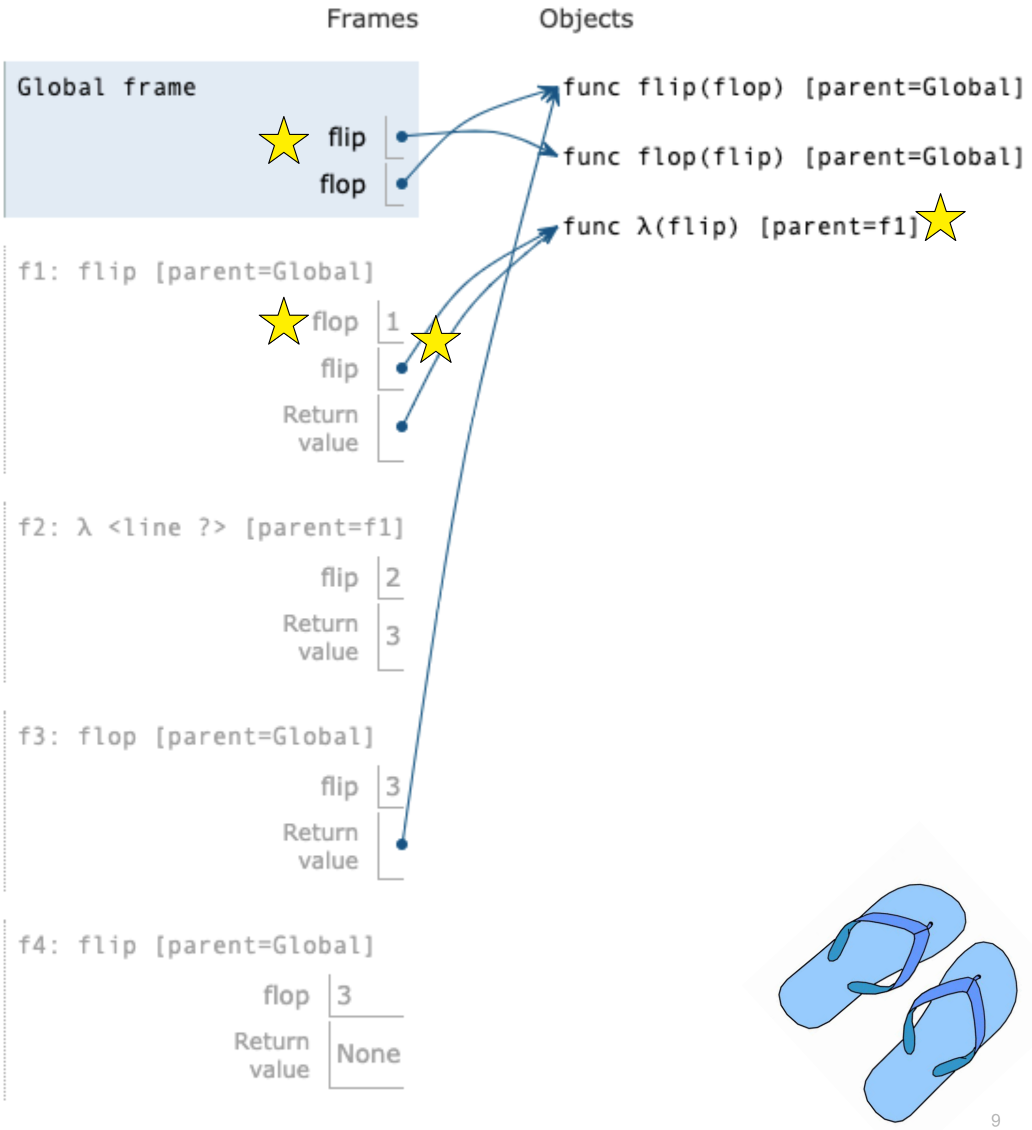
A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

______

flip(____)(3)
```



Frames

Objects

Global frame

flip

flop

func flip(flop) [parent=Global]

func flop(flip) [parent=Global]

func λ(flip) [parent=f1]

f1: flip [parent=Global]

flop 1

flip

Return value

f2: λ <line ?> [parent=f1]

flip 2

Return value 3

f3: flop [parent=Global]

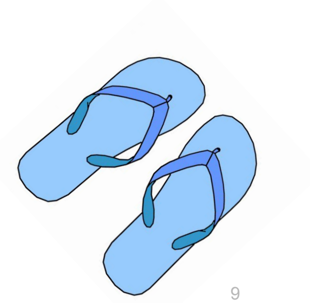
flip 3

Return value

f4: flip [parent=Global]

flop 3

Return value None



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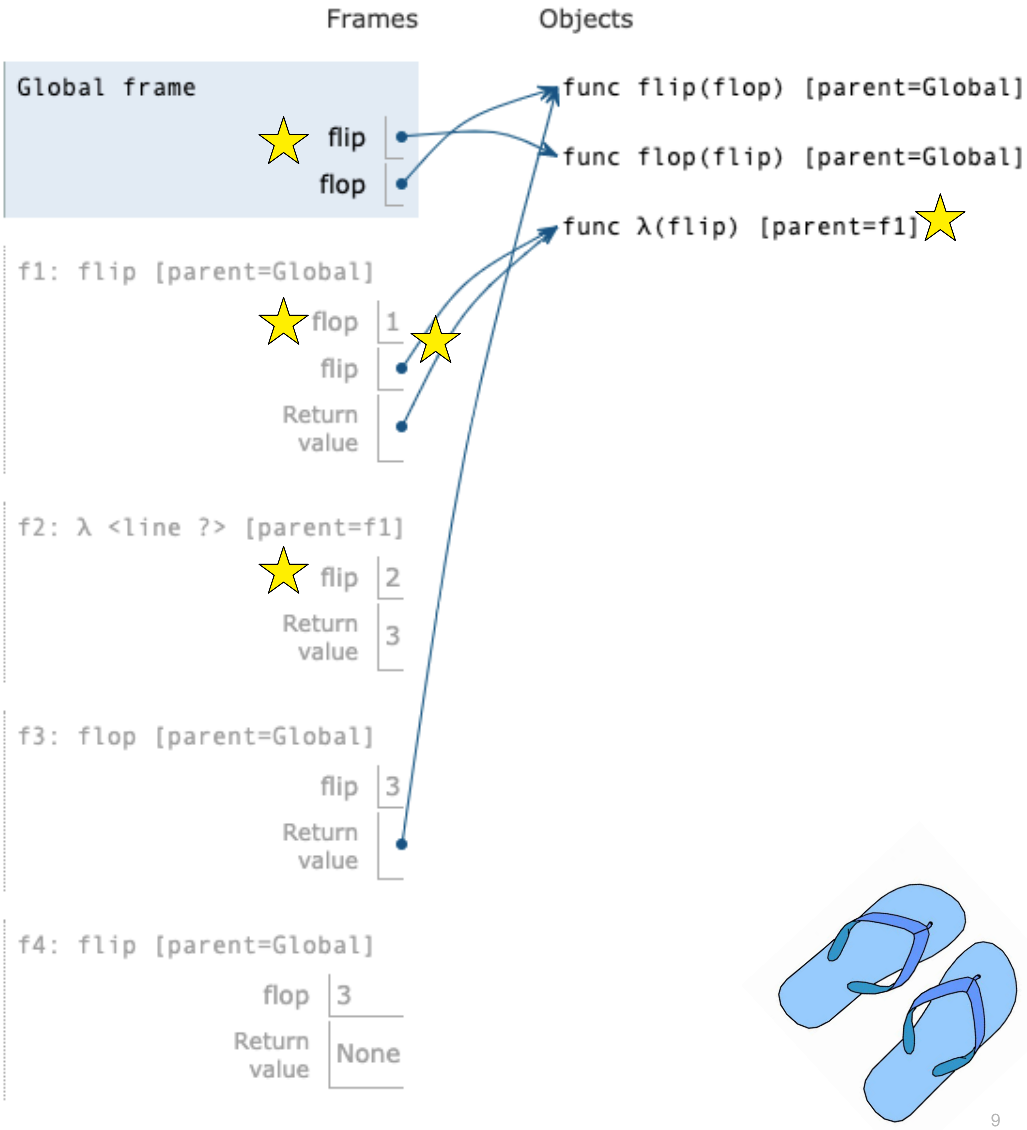
```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

______

flip(____)(3)
```

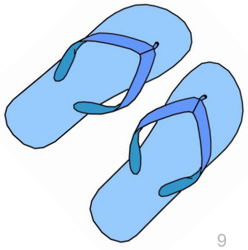


Frames

Objects

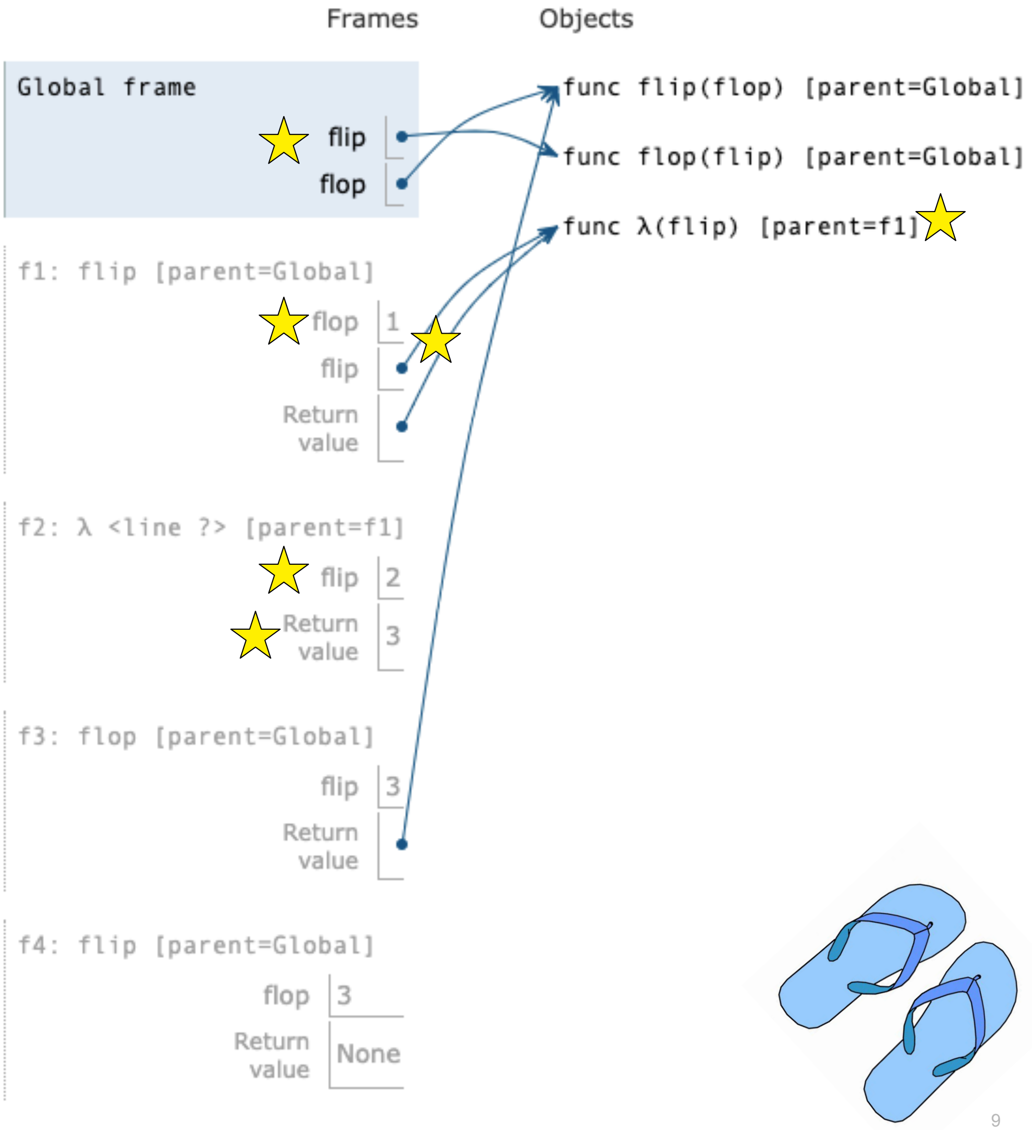
```
Global frame
        flip  •
        flop  •

f1: flip [parent=Global]
        flop  1
        flip  •
      Return
       value  •

f2: λ <line ?> [parent=f1]
        flip  2
      Return
       value  3

f3: flop [parent=Global]
        flip  3
      Return
       value  •

f4: flip [parent=Global]
        flop  3
      Return
       value  None
```

```
func flip(flop) [parent=Global]
func flop(flip) [parent=Global]
func λ(flip) [parent=f1]
```



A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

______

flip(____)(3)
```



Frames

Objects

Global frame

flip

flop

func flip(flop) [parent=Global]

func flop(flip) [parent=Global]

func λ(flip) [parent=f1]

f1: flip [parent=Global]

flop 1

flip

Return value

f2: λ <line ?> [parent=f1]

flip 2

Return value 3

f3: flop [parent=Global]

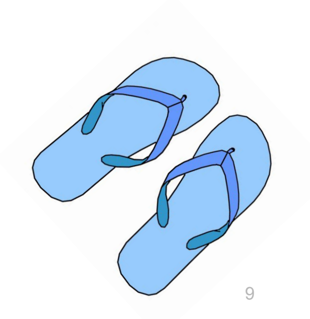
flip 3

Return value

f4: flip [parent=Global]

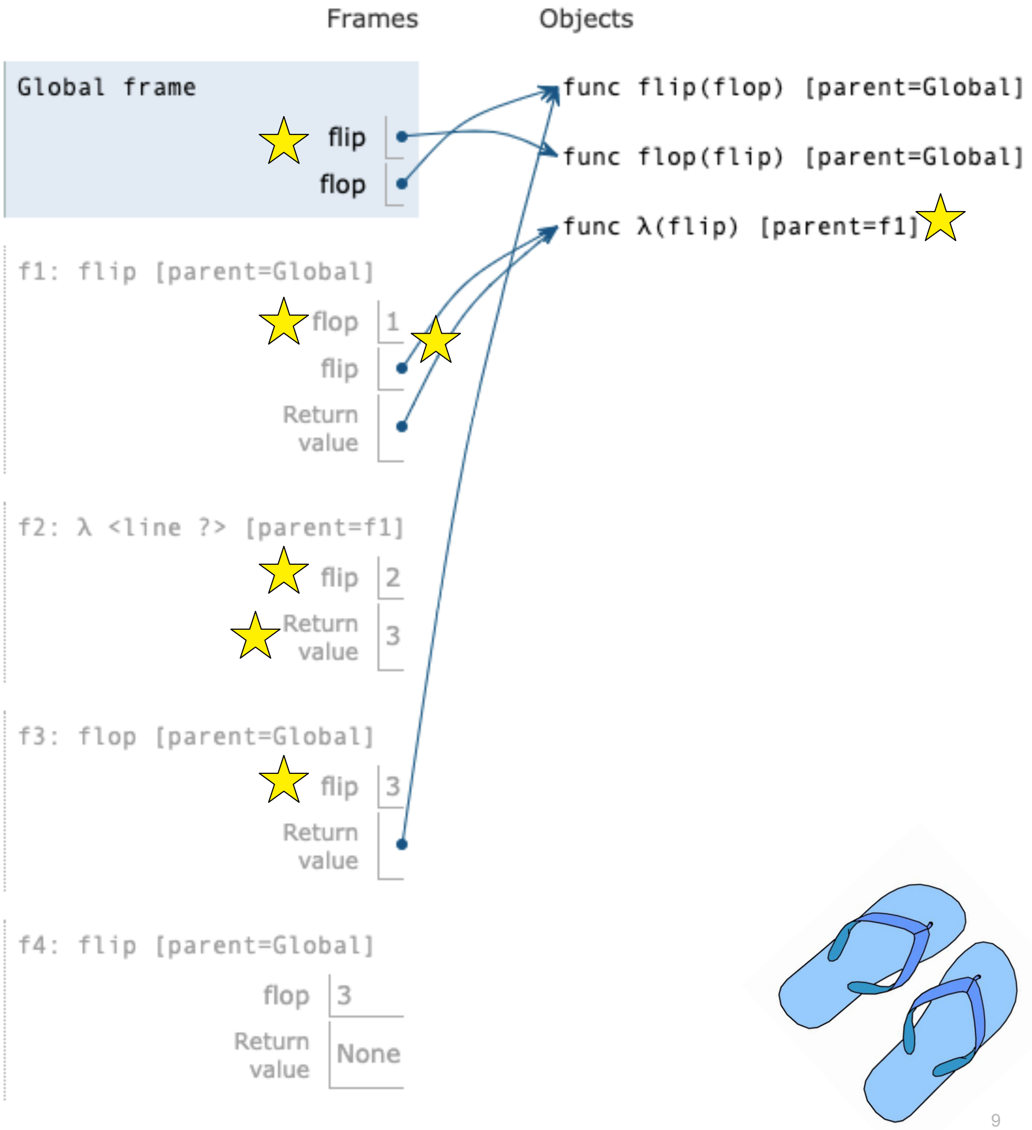
flop 3

Return value None



A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

______

flip(____)(3)
```



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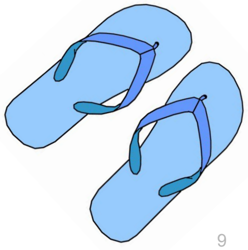
flop 3

Return value None



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    flip = ______
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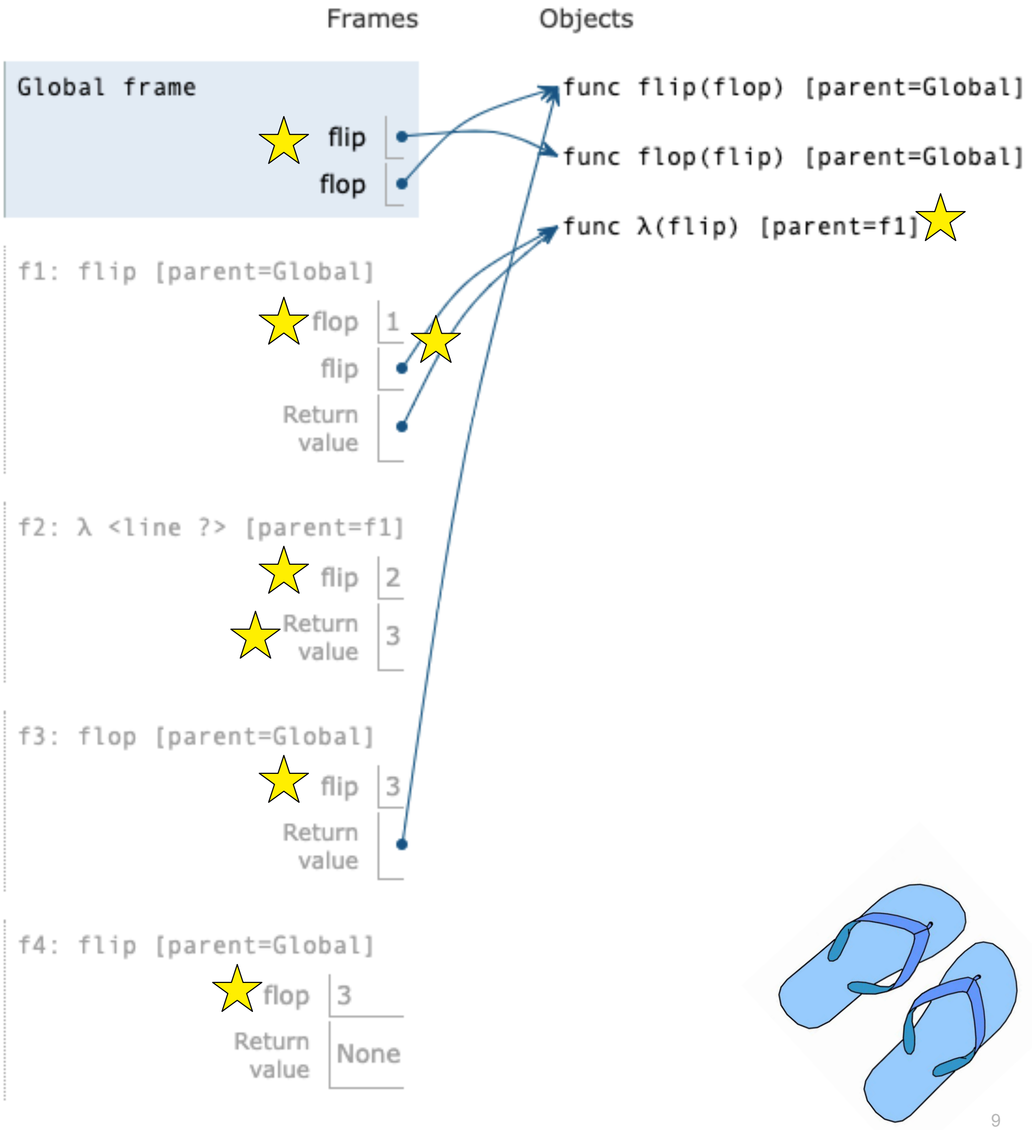
______

flip(____)(3)
```



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Return value

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flip 2

Return value 3

f3: flop [parent=Global]

flip 3

Return value

f4: flip [parent=Global]

flop 3

Return value None

A Day at the Beach

```
def flip(flop):
    if ______:
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def flop(flip):
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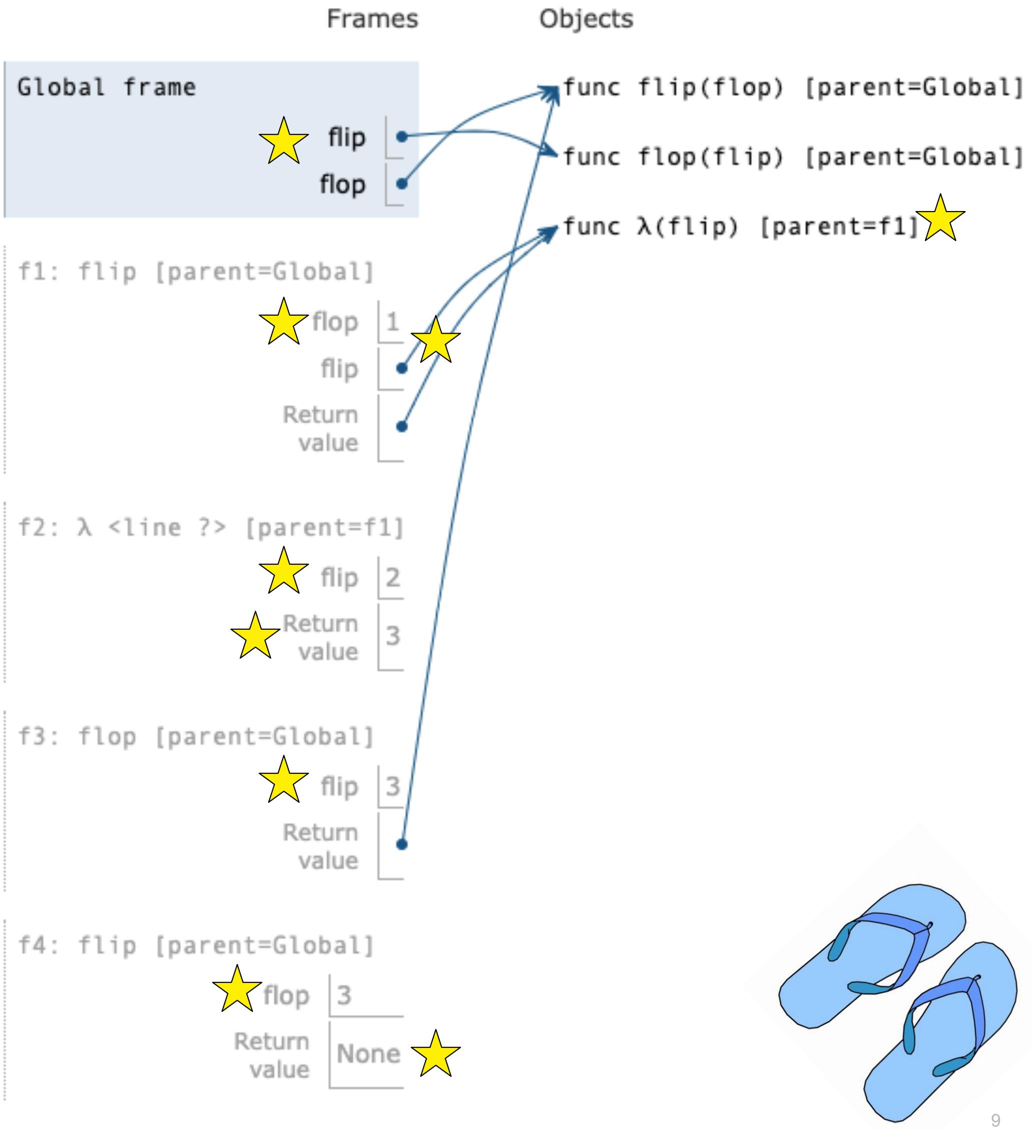
______


flip(____)(3)
```



Frames

Objects

Global frame

☆ flip

flop

func flip(flop) [parent=Global]

func flop(flip) [parent=Global]

func λ(flip) [parent=f1] ☆

f1: flip [parent=Global]

☆ flop 1

flip

Return value ☆

f2: λ <line ?> [parent=f1]

☆ flip 2

☆ Return value 3

f3: flop [parent=Global]

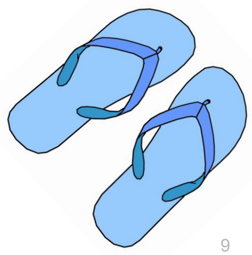
☆ flip 3

Return value

f4: flip [parent=Global]

☆ flop 3

Return value None ☆



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def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

flip, flop = flop, flip
______

flip(____)(3)
```

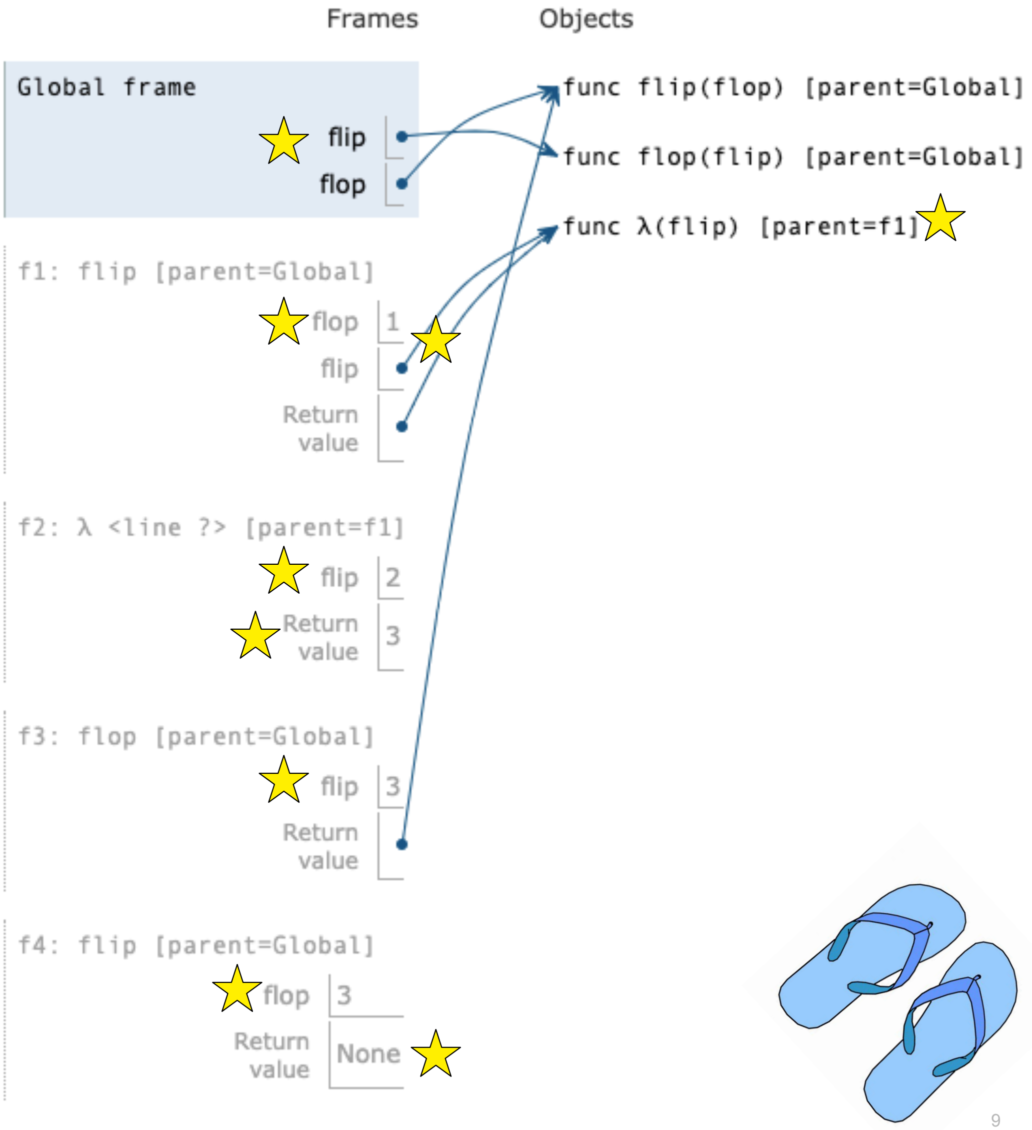

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Return value

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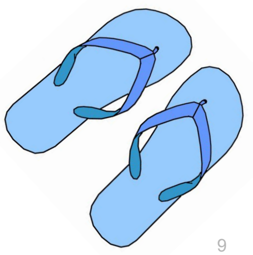
Return value None



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    flip = ______
    return flip

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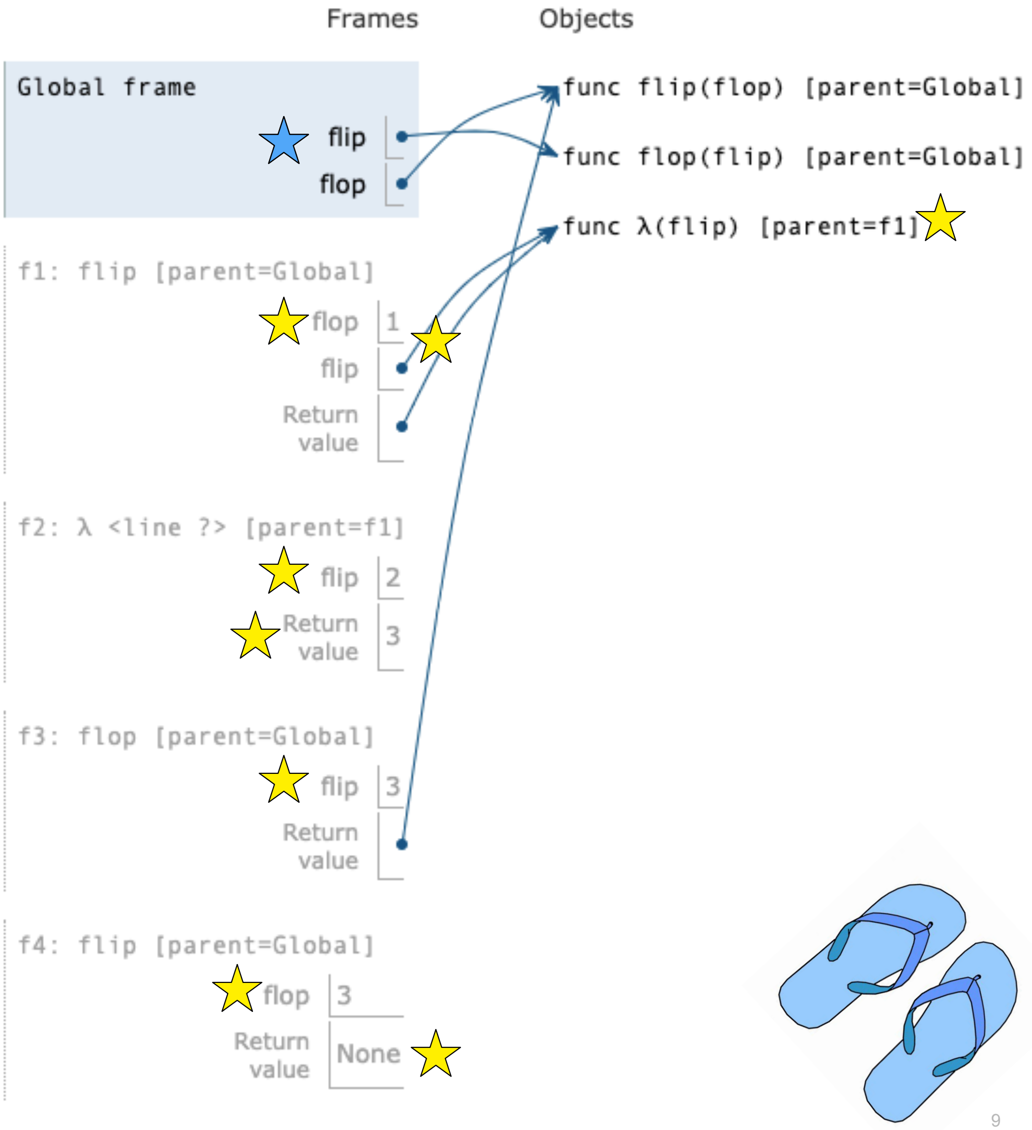
    return flop

flip, flop = flop, flip
______

flip(____)(3)
```



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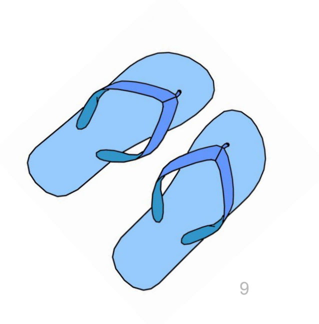
flop 3

Return value None



A Day at the Beach

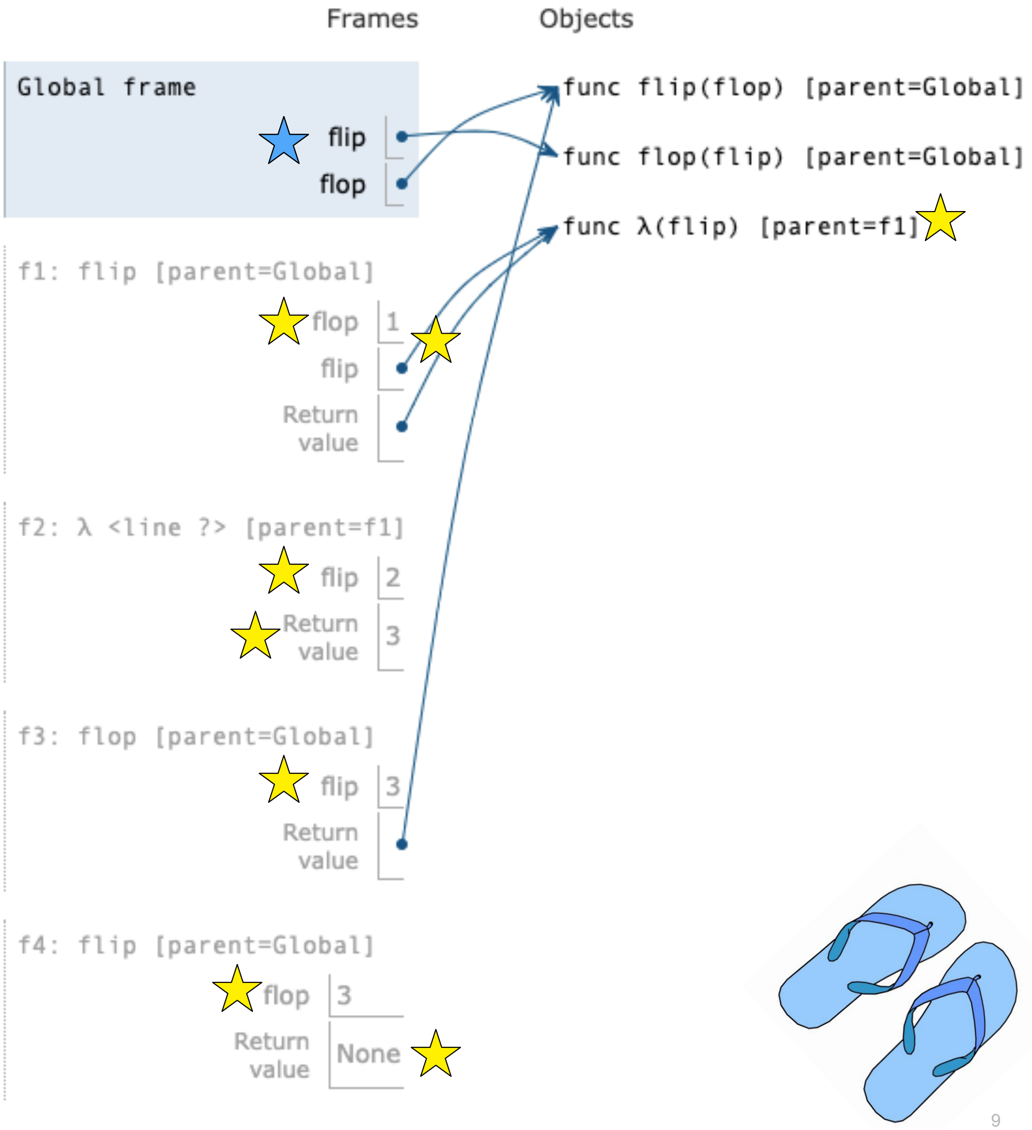
```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

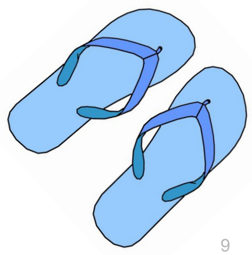
def flop(flip):
    return flop

flip, flop = flop, flip
______

flip(____)(3)
```

flop(1)





A Day at the Beach

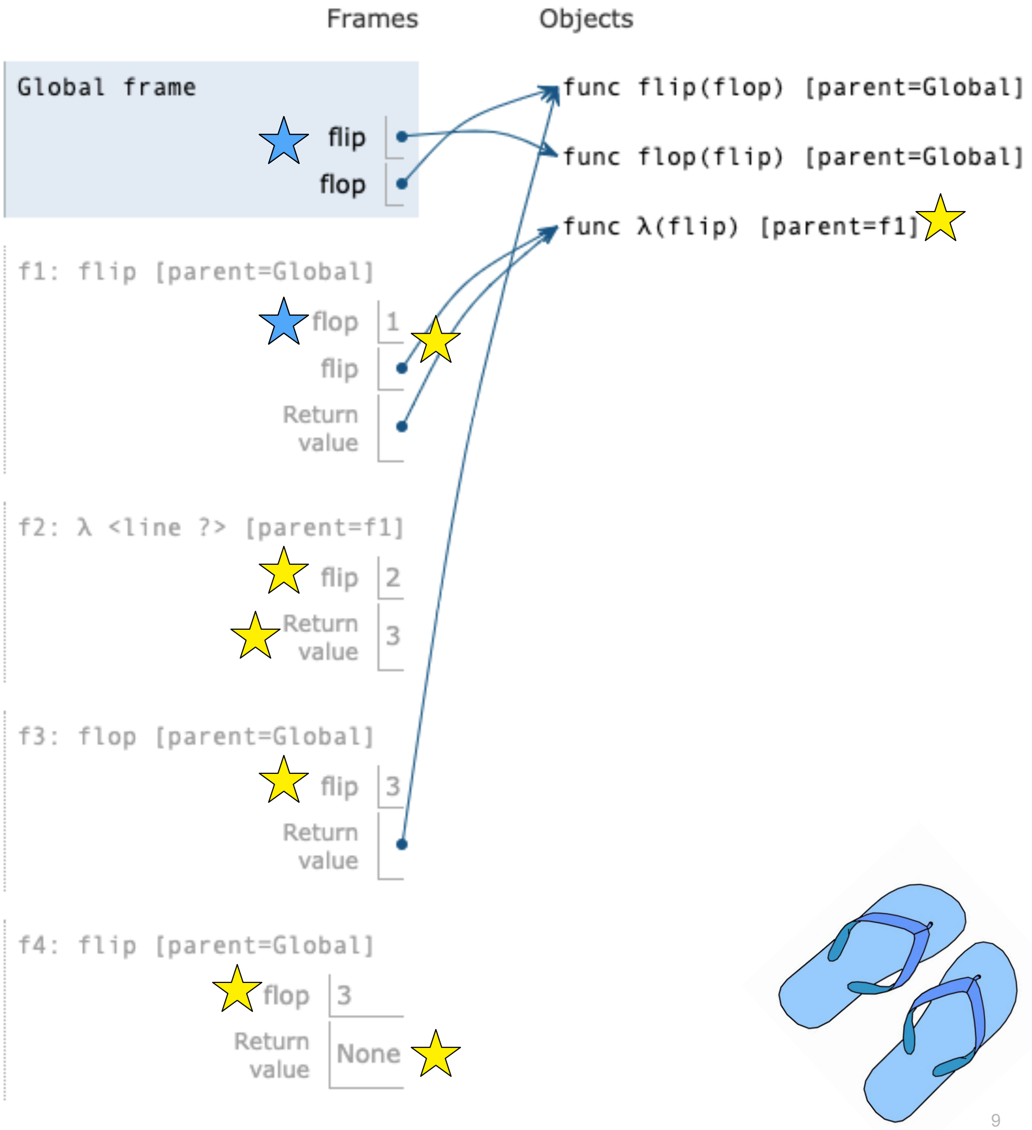
```
def flip(flop):
    if ______:
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

flip, flop = flop, flip
______

flip(____)(3)
```

flop(1)



Frames

Objects

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Return value

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flip 2

Return value 3

f3: flop [parent=Global]

flip 3

Return value

f4: flip [parent=Global]

flop 3

Return value None

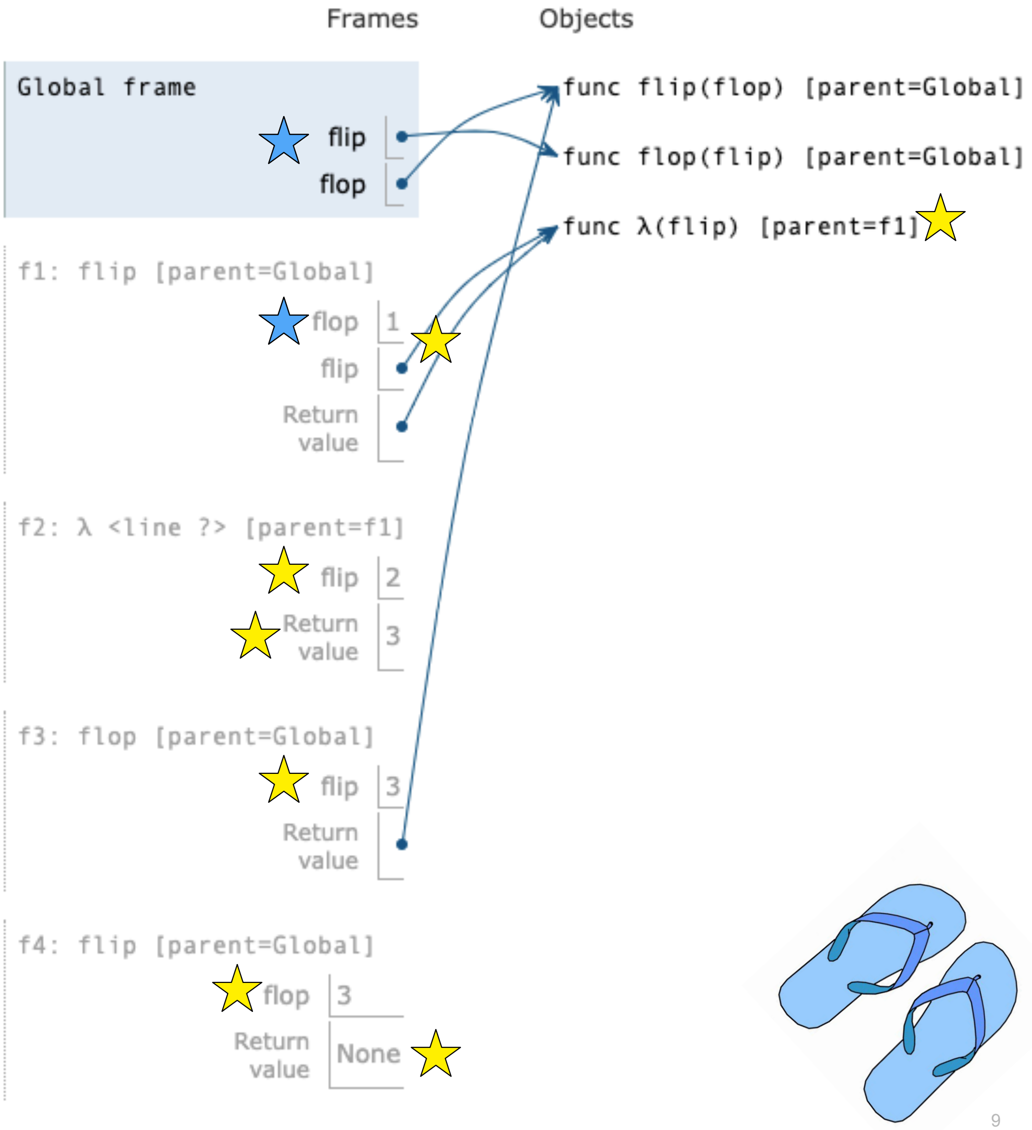
A Day at the Beach

```
def flip(flop):
    if ______:          not true for flop == 1
        ______
    flip = ______
    return flip

def flop(flip):
    return flop

flip, flop = flop, flip
______

flip(____)(3)
     flop(1)
```



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flip 2

Return value 3

f3: flop [parent=Global]

flip 3

Return value

f4: flip [parent=Global]

flop 3

Return value None

A Day at the Beach

```
def flip(flop):
    if ______:         not true for flop == 1
        ______
    flip = lambda flip: 3
    return flip

def flop(flip):
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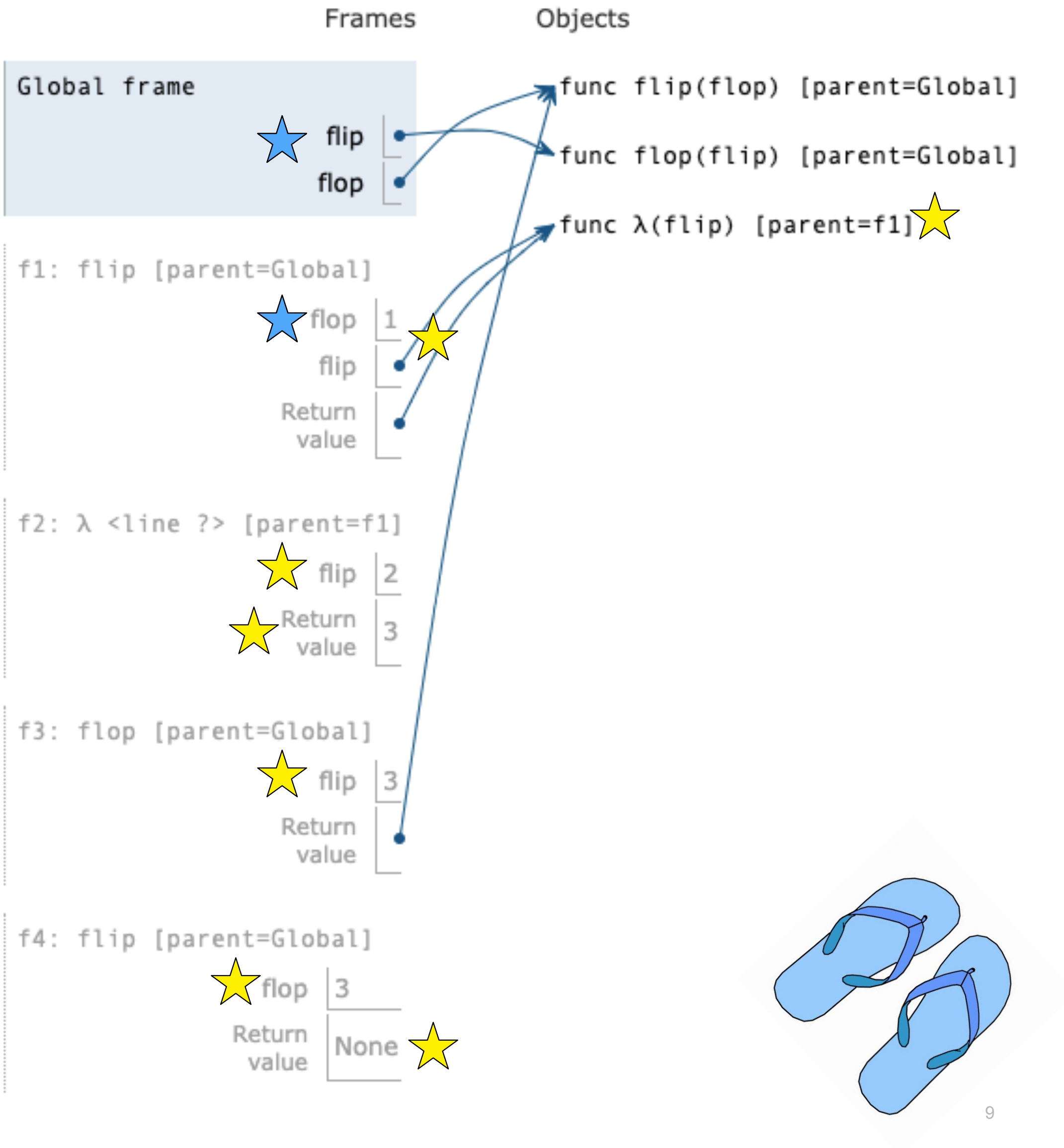
flip, flop = flop, flip

flip(____)(3)
      flop(1)
```



Frames

Objects

```
Global frame
        flip  •   func flip(flop) [parent=Global]
        flop  •   func flop(flip) [parent=Global]
                  func λ(flip) [parent=f1]

f1: flip [parent=Global]
        flop  1
        flip  •
      Return  •
       value

f2: λ <line ?> [parent=f1]
        flip  2
      Return  3
       value

f3: flop [parent=Global]
        flip  3
      Return  •
       value

f4: flip [parent=Global]
        flop  3
      Return  None
       value
```

A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = lambda flip: 3
    return flip

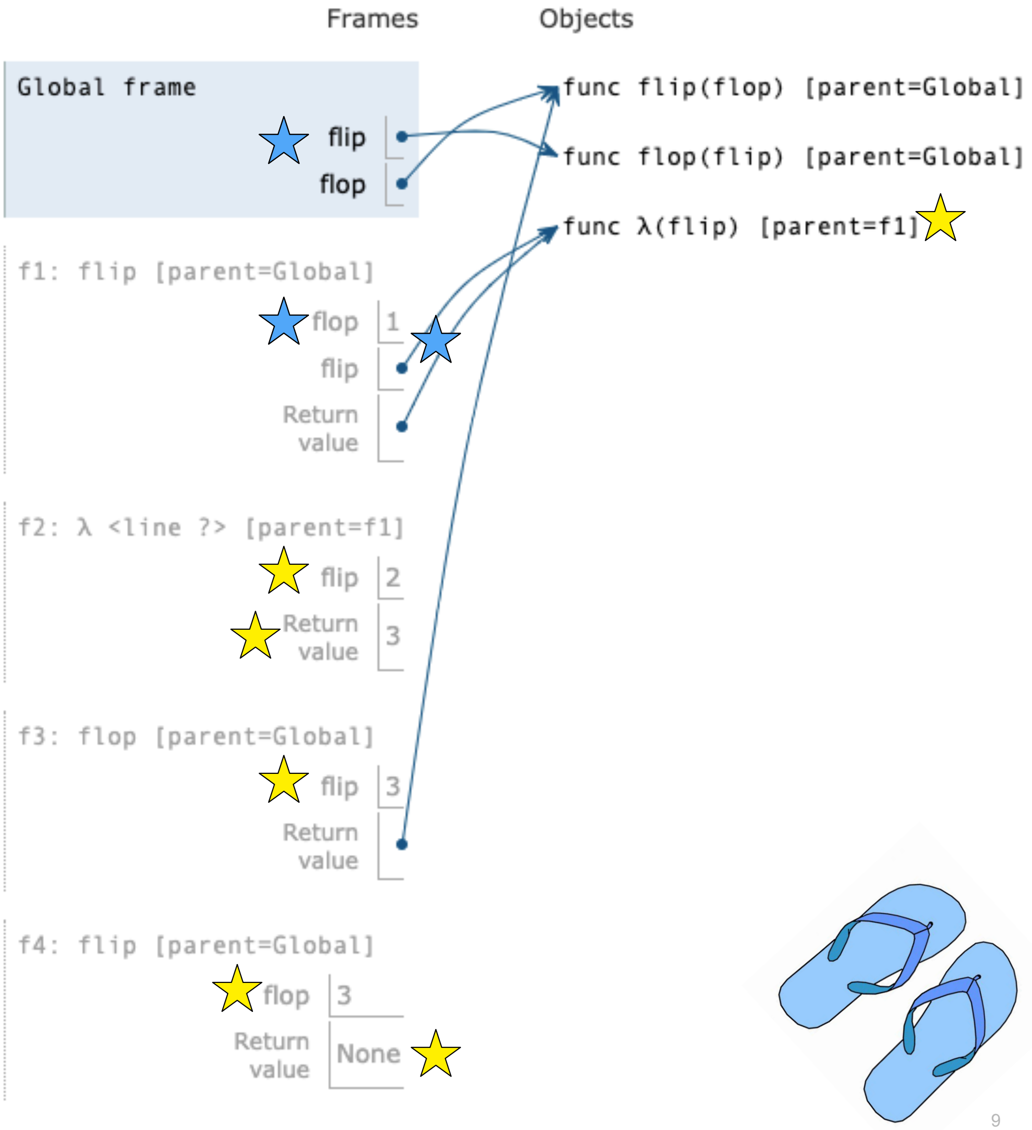
def flop(flip):
    return flop

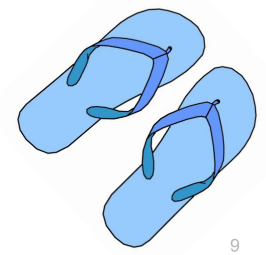
flip, flop = flop, flip

flip(____)(3)
```

not true for flop == 1

flop(1)





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```
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    if ______:          not true for flop == 1
        ______
    flip = lambda flip: 3
    return flip

def flop(flip):
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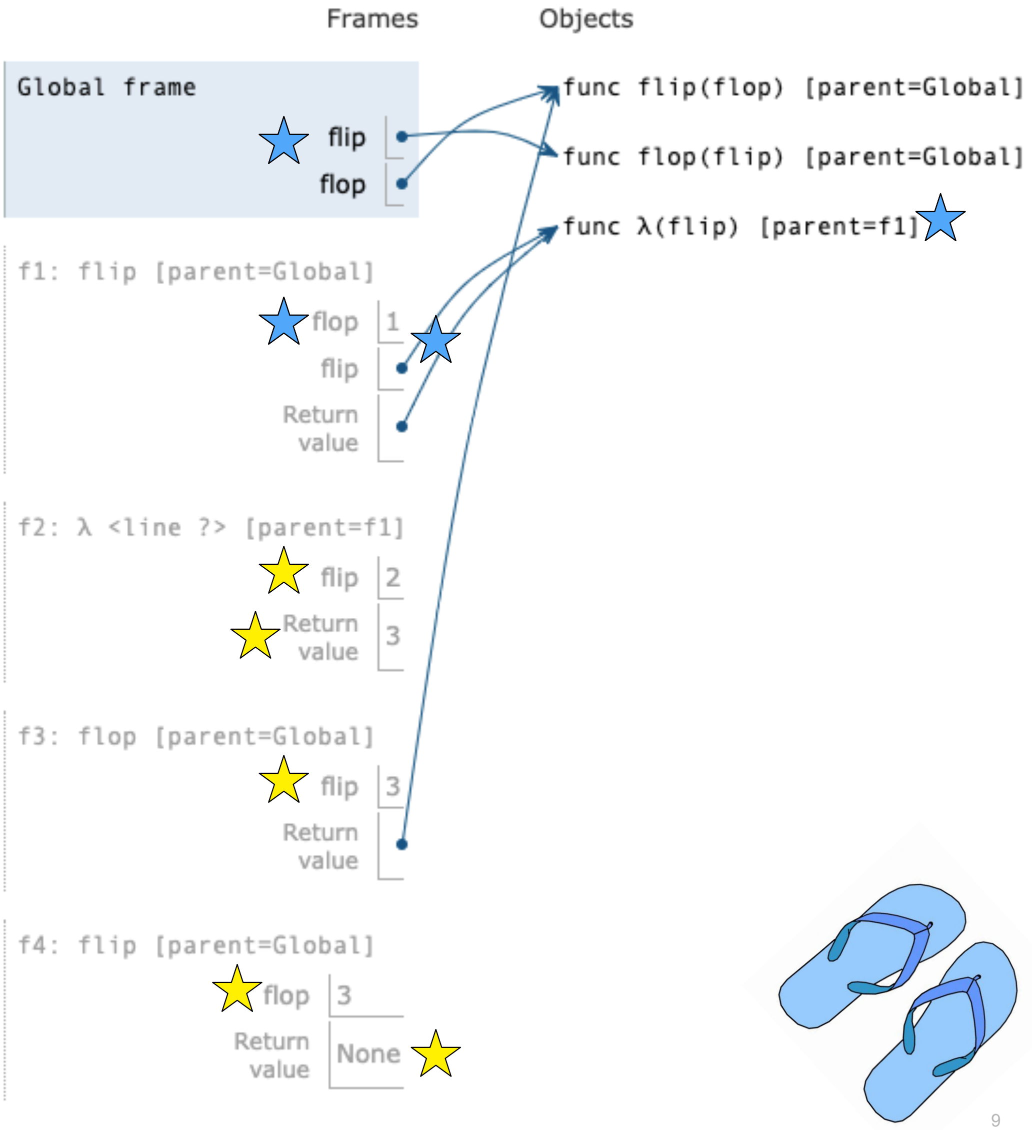
flip, flop = flop, flip

flip(____)(3)
      flop(1)
```



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```
def flip(flop):
    if ______:             not true for flop == 1
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    flip = lambda flip: 3
    return flip

def flop(flip):
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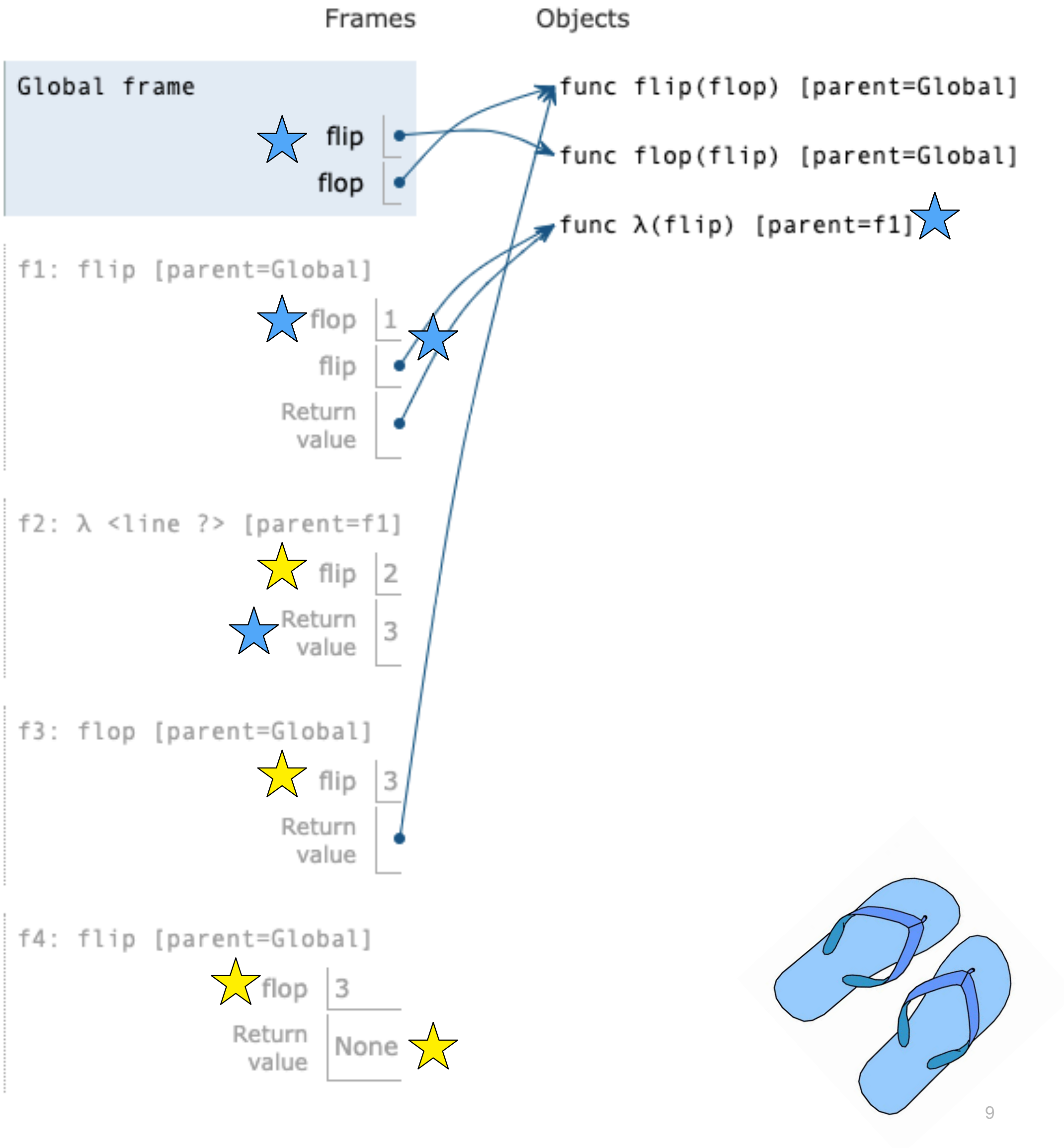
flip, flop = flop, flip

flip(____)(3)
       flop(1)
```



A Day at the Beach

```
def flip(flop):
    if ______:
        ______
    flip = lambda flip: 3
    return flip

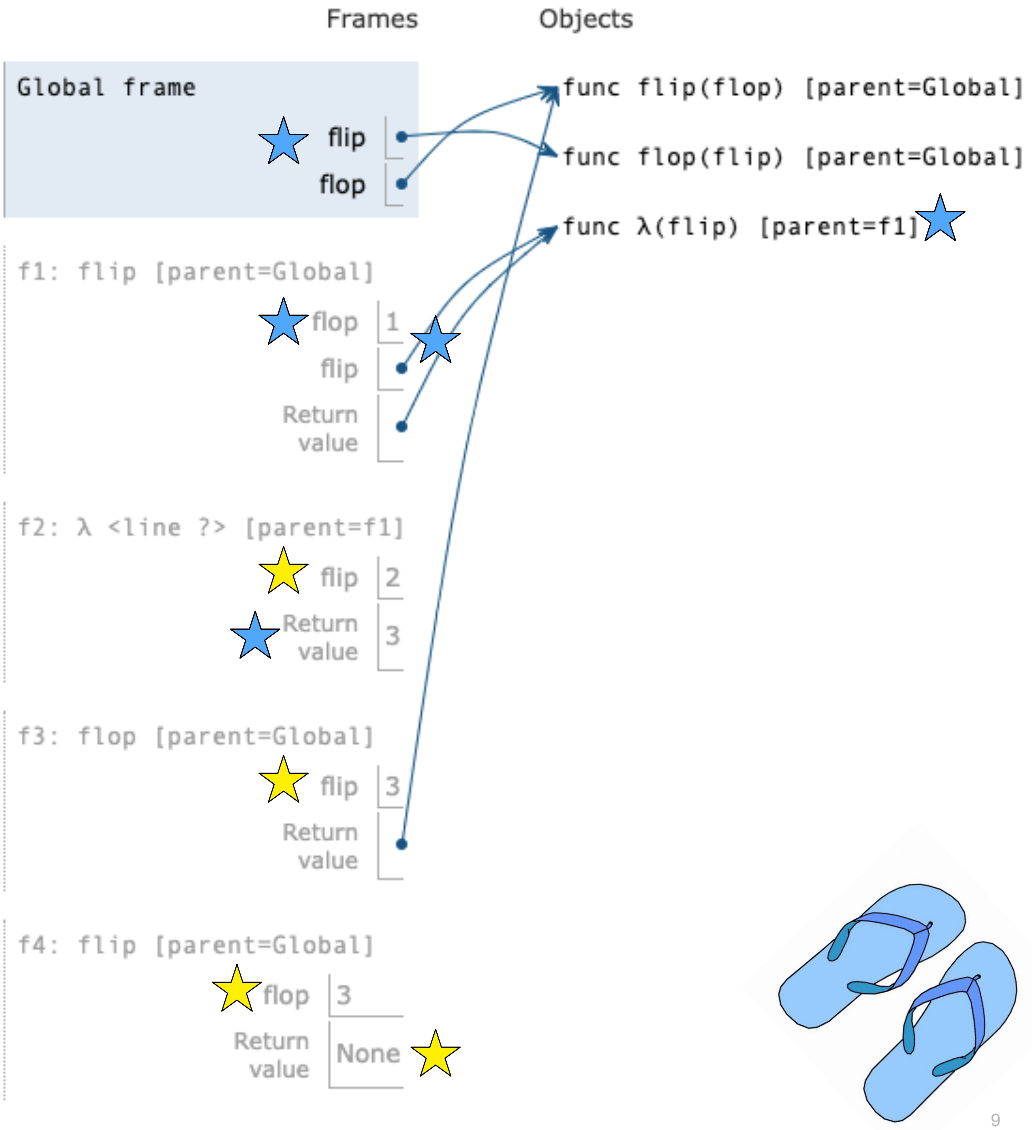
def flop(flip):
    return flop

flip, flop = flop, flip

flip(____)(3)
```

not true for flop == 1

flop(1)(2)



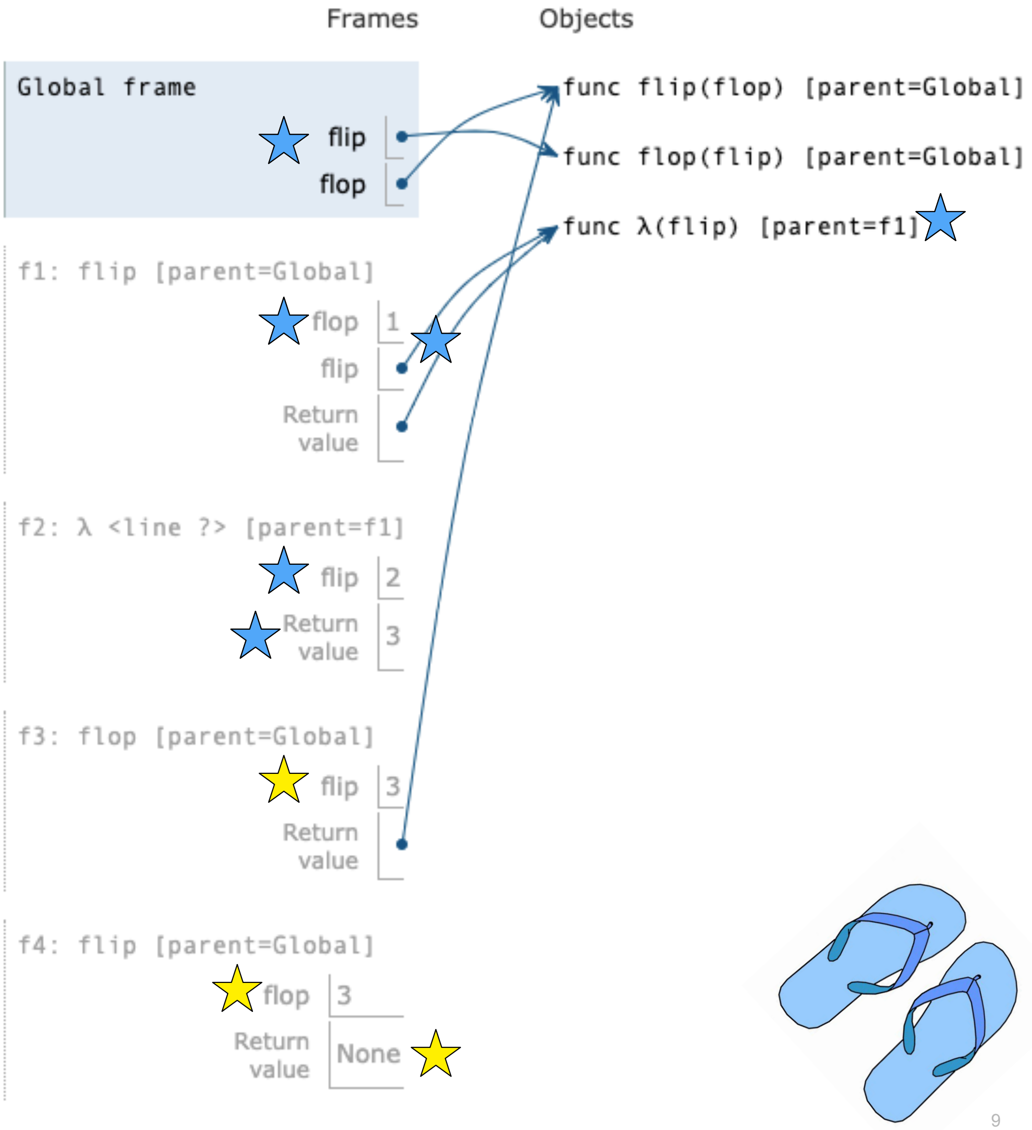
A Day at the Beach

```
def flip(flop):
    if ______:          not true for flop == 1
        ______
    flip = lambda flip: 3
    return flip

def flop(flip):
    return flop

flip, flop = flop, flip

flip(____)(3)
     flop(1)(2)
```



A Day at the Beach

```
def flip(flop):
    if ______:        not true for flop == 1
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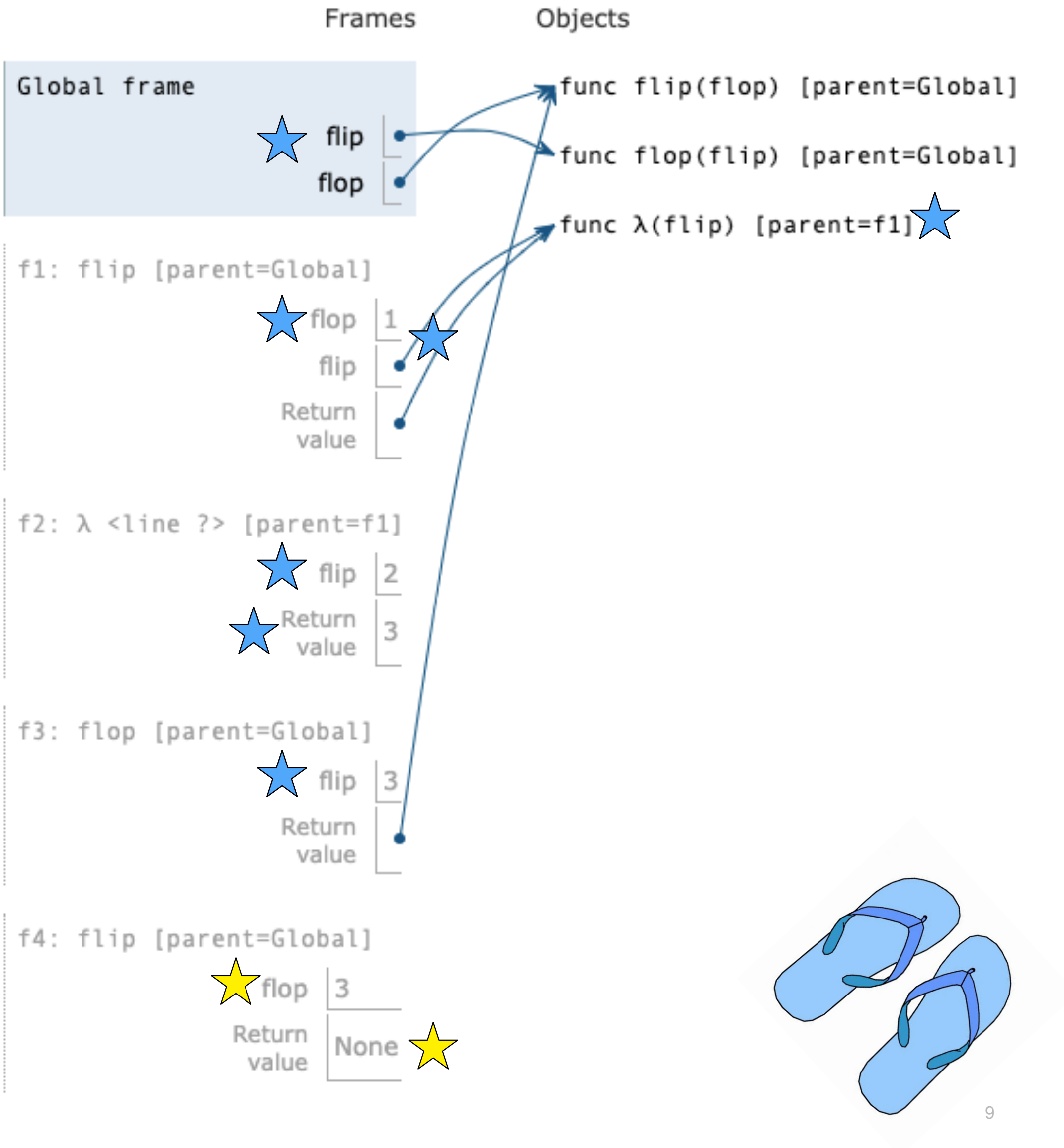

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        ______
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def flop(flip):
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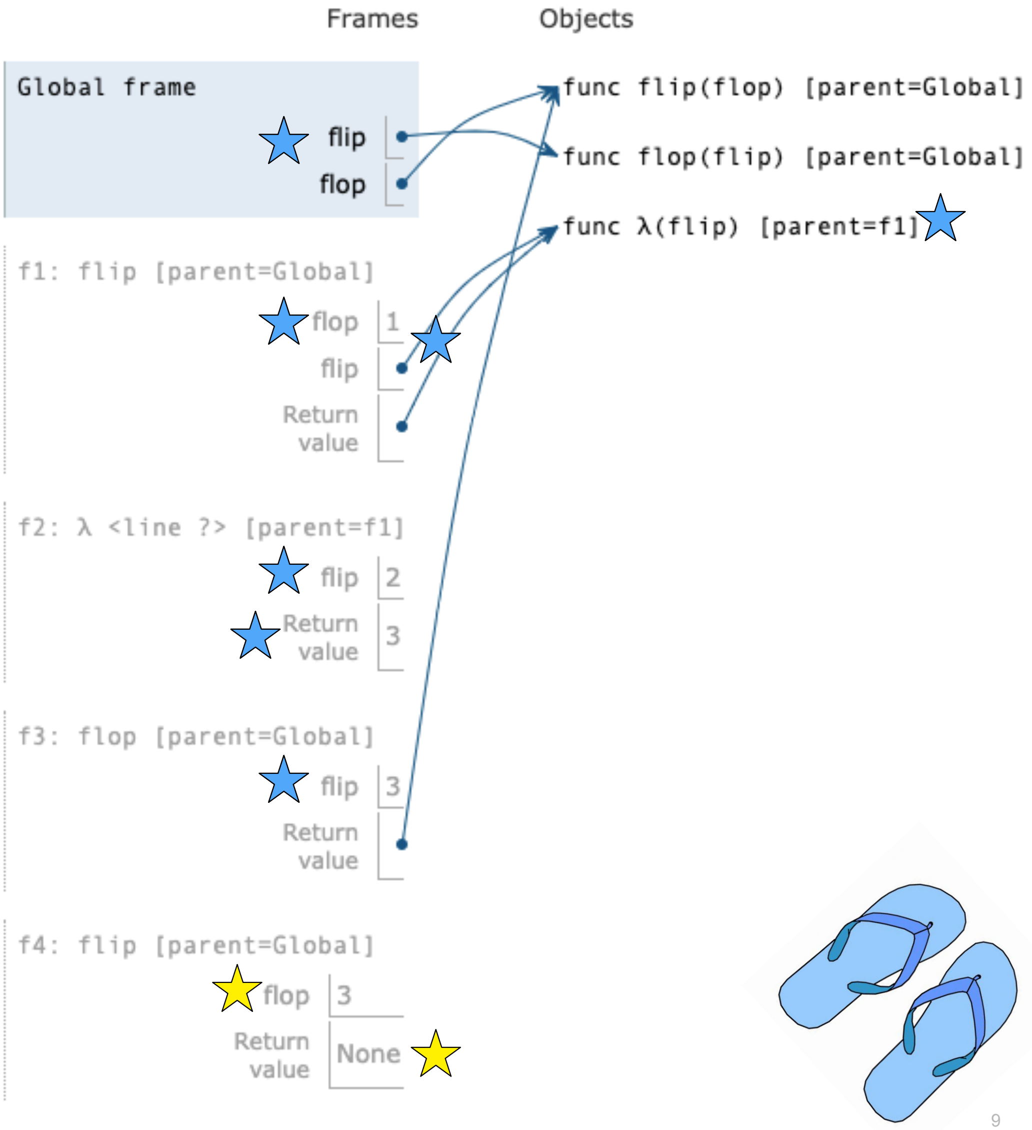
flip, flop = flop, flip

flip(____)(3)

        flop(1)(2)
```



Frames

Objects

Global frame
flip
flop

func flip(flop) [parent=Global]
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f1: flip [parent=Global]
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flip
Return value

f2: λ <line ?> [parent=f1]
flip 2
Return value 3

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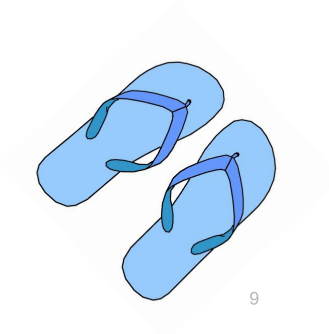
flip 3
Return value

f4: flip [parent=Global]
flop 3
Return value None



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def flip(flop):
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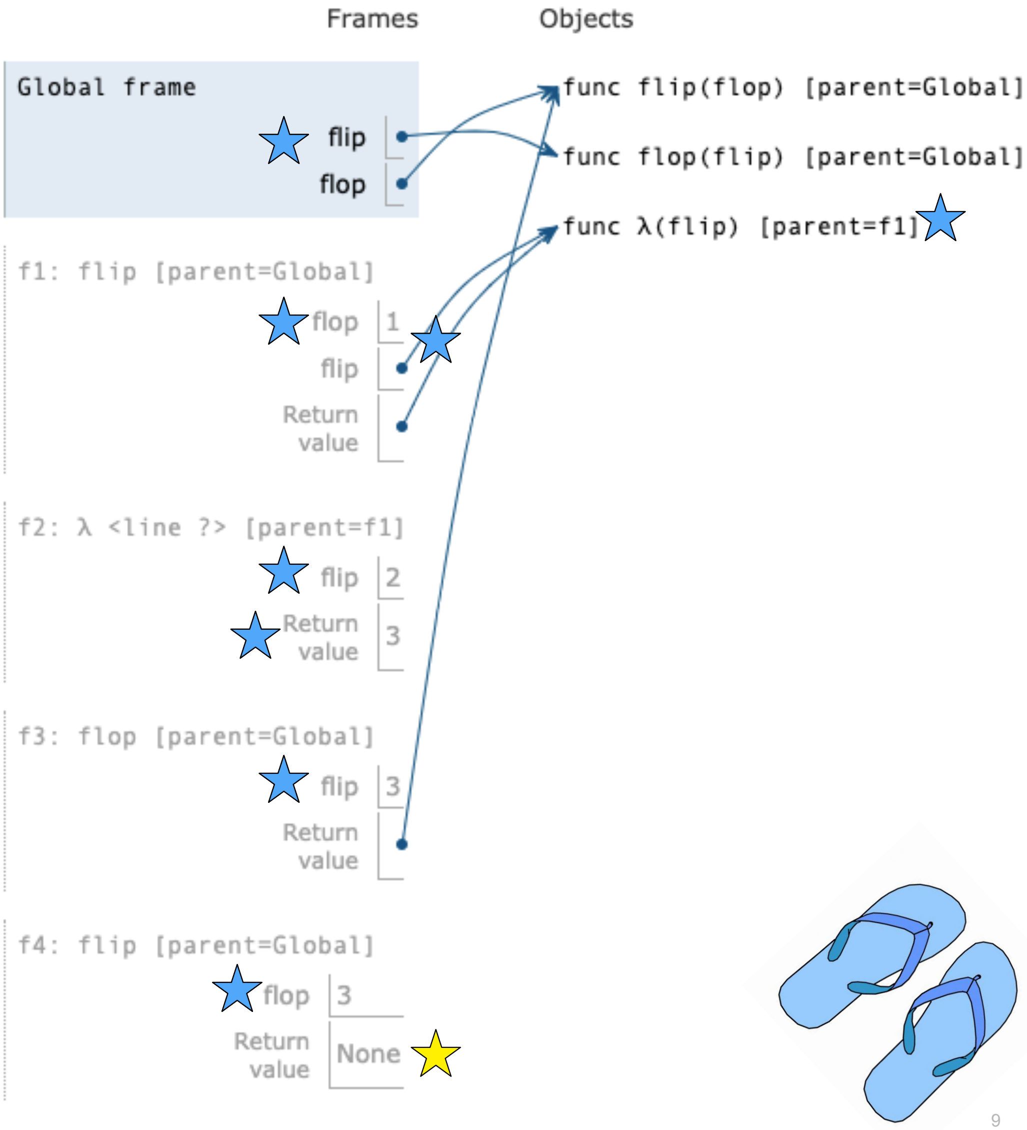
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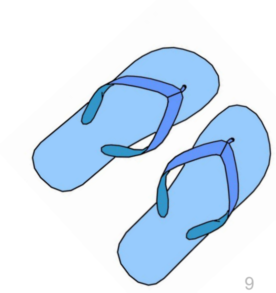

A Day at the Beach

```
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    if ______:        not true for flop == 1
                          true for flop == 3
       ______
    flip = lambda flip: 3
    return flip

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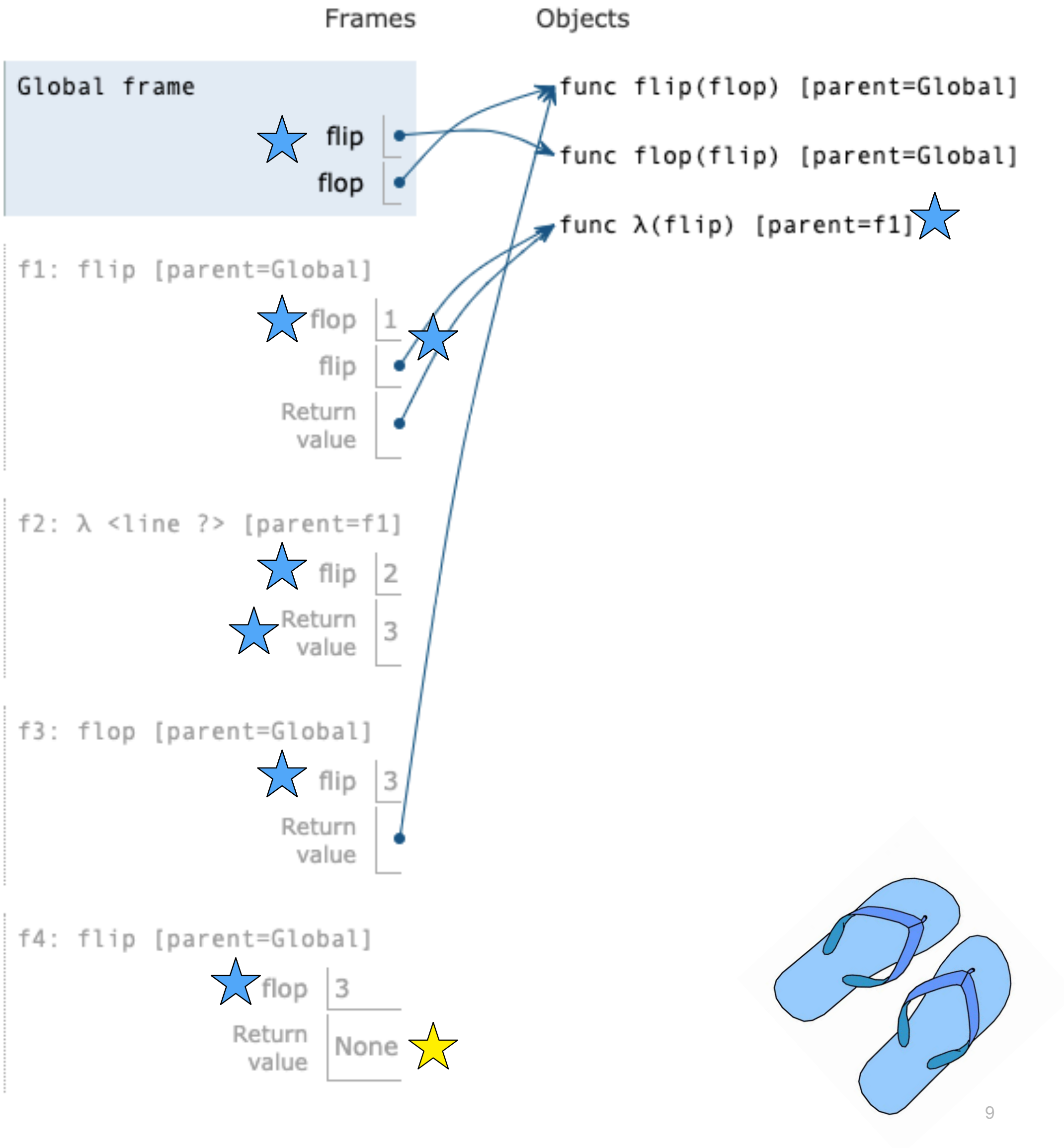
flip, flop = flop, flip

flip(____)(3)
     flop(1)(2)
```



A Day at the Beach

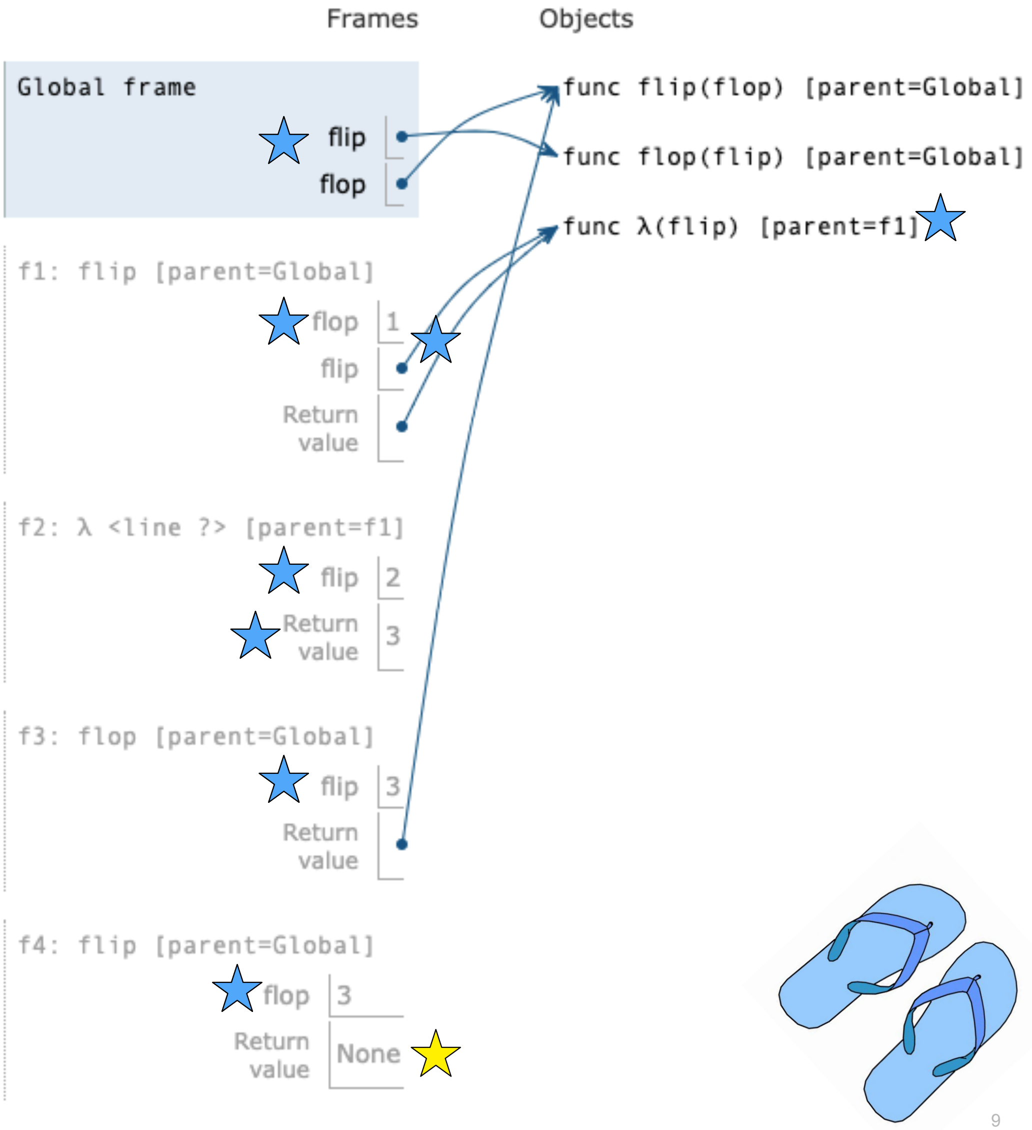
```
def flip(flop):
    if flop>2:        not true for flop == 1
                          true for flop == 3
        ______
    flip = lambda flip: 3
    return flip

def flop(flip):
    return flop

flip, flop = flop, flip

flip(____)(3)
```

flop(1)(2)



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flip 2

Return value 3

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flip 3

Return value

f4: flip [parent=Global]

flop 3

Return value None

A Day at the Beach

```
def flip(flop):
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                           true for flop == 3
        return None
    flip = lambda flip: 3
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flip, flop = flop, flip

flip(____)(3)
      ^
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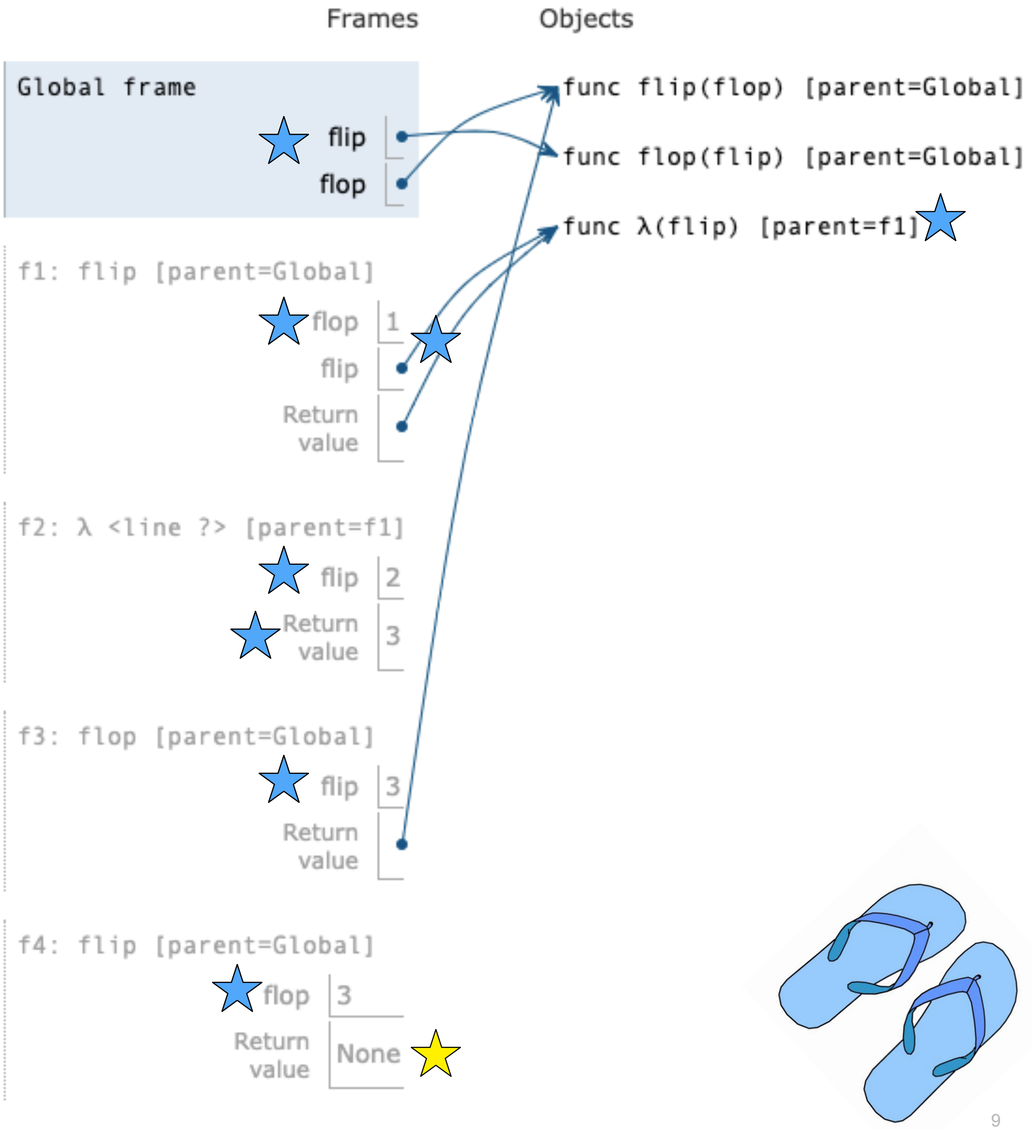
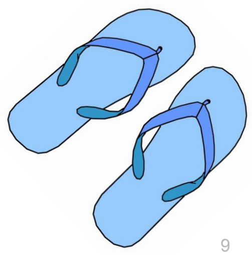
```





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```
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    if flop>2:
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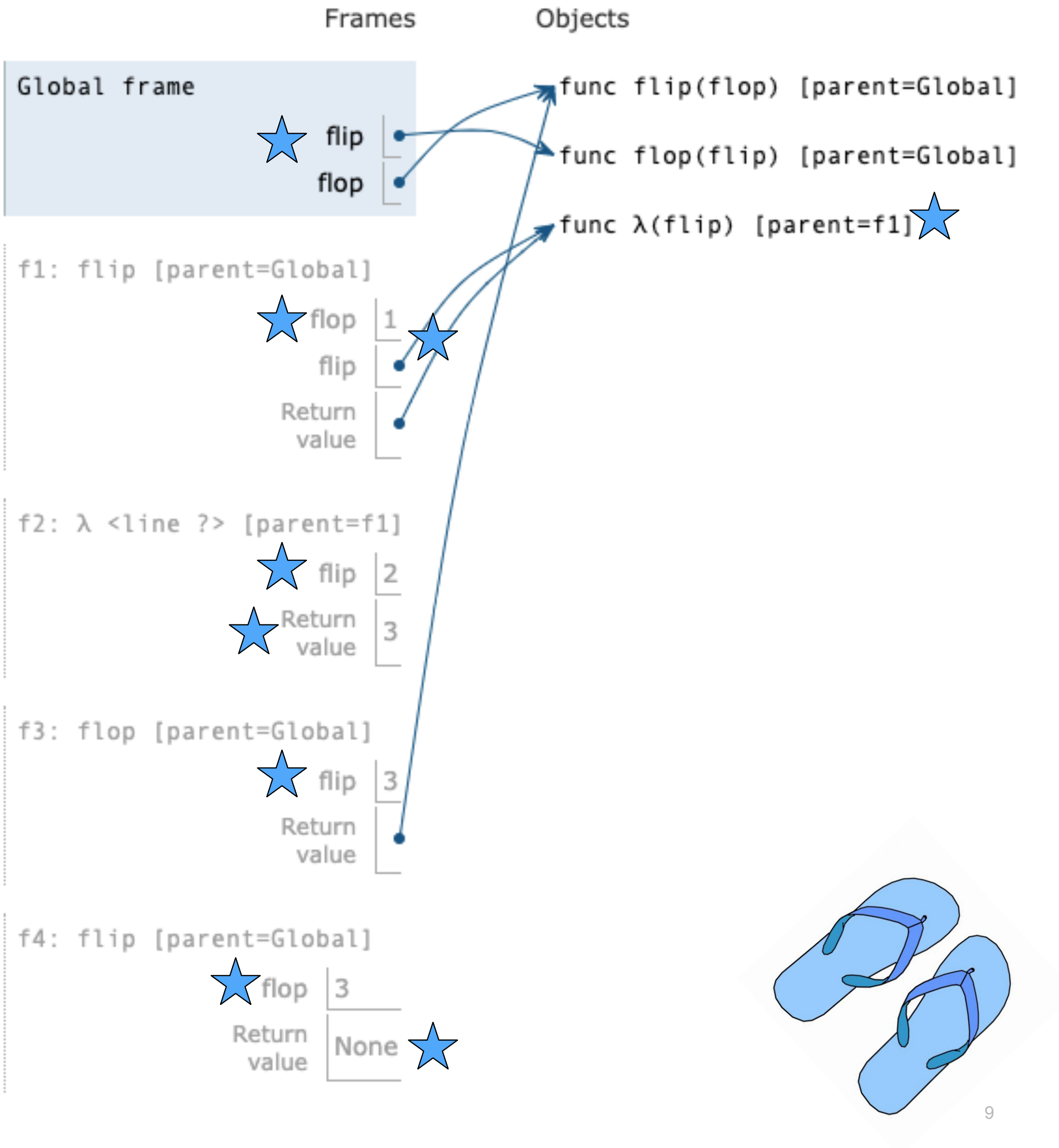
flip(____)(3)
```

not true for flop == 1

true for flop == 3

flop(1)(2)



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Return value 3

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flip 3

Return value

f4: flip [parent=Global]

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Return value None

Implementing Functions

Implementing a Function

```
def remove(n, digit):
    """Return all digits of non-negative N
       that are not DIGIT, for some
       non-negative DIGIT less than 10.

    >>> remove(231, 3)
    21
    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0

    while ________________________________:

        n, last = n // 10, n % 10

        if _______________________________:

            kept = _______________________

            digits = _____________________

    return _______________________________
```

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Read the description

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Read the description

Verify the examples & pick a simple one

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            digits = _____________________

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Read the description

Verify the examples & pick a simple one

Read the template

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       that are not DIGIT, for some
       non-negative DIGIT less than 10.

    >>> remove(231, 3)
    21
    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0

    while ________________________________:

        n, last = n // 10, n % 10

        if _______________________________:

            kept = _______________________

            digits = _____________________

    return _______________________________
```

Read the description

Verify the examples & pick a simple one

Read the template

Implement without the template, then change your implementation to match the template.
OR
If the template is helpful, use it.

Implementing a Function

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Write code to compute the result

Implementing a Function

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Did you really return the right thing?

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```

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Did you really return the right thing?

Check your solution with the other examples

Implementing a Function

231

3

```
def remove(n, digit):
    """Return all digits of non-negative N
          are        IT, for some
       non-negative DIGIT less than 10.

    >>> remove(231, 3)
    21
    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0

    while ________________________________:

        n, last = n // 10, n % 10

        if _______________________________:

            kept = _______________________

            digits = _____________________

    return _______________________________
```

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Implementing a Function

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def remove(n, digit):
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            kept = _______________________

            digits = _____________________

    return ______________________________
```

231

3

21

Read the description

Verify the examples & pick a simple one

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        n, last = n // 10, n % 10

        if _______________________________:

            kept = _______________________

            digits = _____________________

    return _______________________________
```

231

3

21

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    >>> remove(243132, 2)
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    kept, digits = 0, 0

    while __________n > 0__________:

        n, last = n // 10, n % 10

        if ______last != digit______:

            kept = ____________________

            digits = __________________

    return ____________________________
```

231

3

21

Read the description

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Write code to compute the result

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def remove(n, digit):
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    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0

    while __________n > 0__________:

        n, last = n // 10, n % 10

        if _____last != digit_____:

            kept = ____________________

            digits = __________________

    return ___________kept___________
```

231

3

21

Read the description

Verify the examples & pick a simple one

Read the template

Implement without the template, then change your implementation to match the template.
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Annotate names with values from your chosen example

Write code to compute the result

Did you really return the right thing?

Check your solution with the other examples

Implementing a Function

```
def remove(n, digit):
    """Retu n al  digits of non-negative N
       are    IT, for some
         ga     IT less than 10.

    >>> remove(231, 3)
    21
    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0

    while n > 0:

        n, last = n // 10, n % 10

        if last != digit:

            kept = kept + last

            digits = ____________________

    return kept
```

231

3

21

Read the description

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    >>> remove(231, 3)
    21
    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0

    while ____________n > 0____________:

        n, last = n // 10, n % 10

        if _______last != digit________:

            kept = __10*kept + last____

            digits = __________________

    return _____________kept_____________
```

231

3

21

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    kept, digits = 0, 0

    while ________n > 0_________:

        n, last = n // 10, n % 10

        if ____last != digit_____:

            kept = ~~10*~~kept + last

    21      digits = ____________

    return _______kept_______
```

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        if ____last != digit____:

            kept = ~~10*~~kept + last*10

            digits = ______________

    return ______kept______
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    kept, digits = 0, 0

    while ____________n > 0____________:

        n, last = n // 10, n % 10

        if ________last != digit________:

            kept = ~~10*~~kept + last*10

            digits = ____________________

    return ____________kept____________
```

231

3

21

1

+ 20

21

Read the description

Verify the examples & pick a simple one

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    kept, digits = 0, 0

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        if ______last != digit______:

            kept = ~~10*~~kept + last*10

            digits = ______digits + 1______

    return ______kept______
```

231

3

21

$$\begin{array}{r} 1 \\ +\ 20 \\ \hline 21 \end{array}$$

Read the description

Verify the examples & pick a simple one

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        if last != digit:

            kept = ~~10*~~kept + last*10**digits

            digits = digits + 1

    return kept
```

231

3

21

1

+ 20

21

Read the description

Verify the examples & pick a simple one

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        if last != digit:

            kept = ~~10*~~kept + last*10**digits

            digits = digits + 1

    return kept
```

231

4

21

```
   1
+ 20
----
  21
```

Read the description

Verify the examples & pick a simple one

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        if ______last != digit______:

            kept = ~~10*~~kept + last*10**digits

            digits = ______digits + 1______

    return ______kept______
```

231

4

231

  1
+ 20
―――
 21

Read the description

Verify the examples & pick a simple one

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        if ________last != digit________:

            kept = ~~10*~~kept + last*10**digits

            digits = ____digits + 1____

    return ________kept________
```

231

4

231

```
   1         1
+ 20      + 30
         + 200
----      -----
  21       231
```

Read the description

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    >>> remove(243132, 2)
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    """
    kept, digits = 0, 0
    while n > 0:
        n, last = n // 10, n % 10
        if last != digit:
            kept = kept + last
            digits = ____________________
    return kept
```

231

3

21

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    >>> remove(231, 3)
    21
    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0

    while ___________n > 0___________:

        n, last = n // 10, n % 10

        if _______last != digit_______:

            kept = ____kept/10 +    last____

            digits = ___________________

    return __________kept______________
```

231

3

21

Read the description

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    kept, digits = 0, 0

    while __________n > 0__________:

        n, last = n // 10, n % 10

        if _____last != digit__________:

            kept = ____kept/10 +   last____

            digits = ____________________

    return ________kept * 10___________
```

231

3

21

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        n, last = n // 10, n % 10

        if     last != digit      :

            kept = kept/10 +  last

            digits = digits + 1

    return      kept * 10
```

231

3

21

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    kept, digits = 0, 0

    while ____________n > 0____________:

        n, last = n // 10, n % 10

        if ________last != digit________:

            kept = ___kept/10 +    last___

            digits = ___digits + 1___

    return ______kept * 10 ** (digits-1)
```

231

3

21

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    >>> remove(231, 3)
    21
    >>> remove(243132, 2)
    4313
    """
    kept, digits = 0, 0
    while n > 0:
        n, last = n // 10, n % 10
        if last != digit:
            kept = kept/10 + last
            digits = digits + 1
    return round(kept * 10 ** (digits-1))
```

231

3

21

Read the description

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Write code to compute the result

Did you really return the right thing?

Check your solution with the other examples

Decorators

Function Decorators

(Demo)

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(Demo)

```
@trace1
def triple(x):
    return 3 * x
```

Function Decorators

(Demo)

Function decorator

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@trace1
def triple(x):
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```
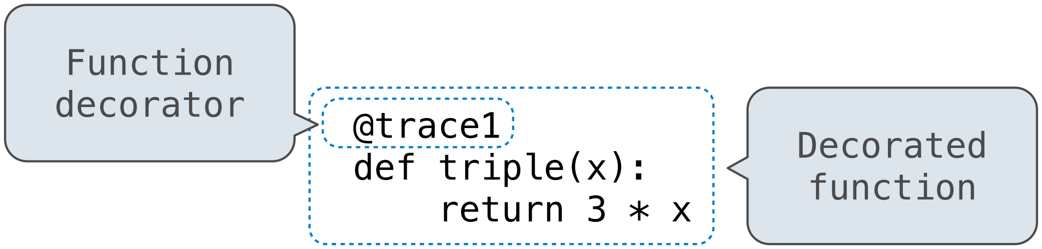

Function Decorators

(Demo)



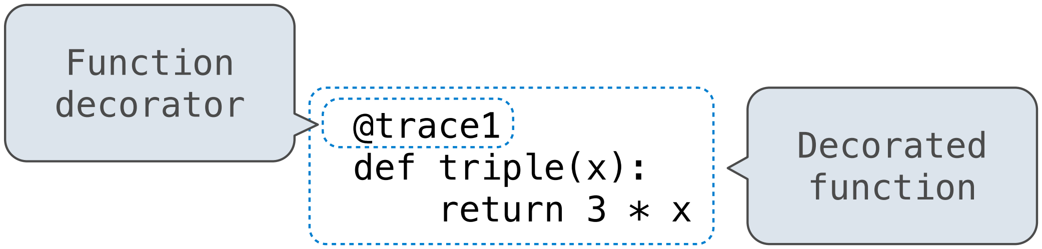
Function decorator

```
@trace1
def triple(x):
    return 3 * x
```

Decorated function

Function Decorators

(Demo)



Function decorator

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@trace1
def triple(x):
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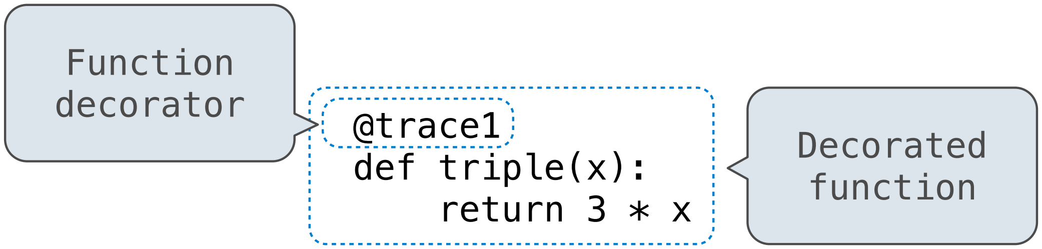
Decorated function

is identical to

Function Decorators

(Demo)



Function decorator

```
@trace1
def triple(x):
    return 3 * x
```

Decorated function

is identical to

```
def triple(x):
    return 3 * x
triple = trace1(triple)
```

Function Decorators

(Demo)

Function decorator

```
@trace1
def triple(x):
    return 3 * x
```

Decorated function

is identical to

Why not just use this?

```
def triple(x):
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triple = trace1(triple)
```