61A Lecture 9

Friday, September 19

Announcements

- Midterm 1 is on Monday 9/22 from 7pm to 9pm
  - 2 review sessions on Saturday 9/20 3pm-4:30pm and 4:30pm-6pm in 1 Pimentel
  - HKN review session on Sunday 9/21 from 12pm to 3pm in 2060 Valley LSB
- No lecture on Monday
- No lab or office hours next week: Tuesday 9/23, or Wednesday 9/24
- Optional Hog strategy contest ends Wednesday 10/1 @ 11:59pm

Abstraction

Functional Abstractions

```
def square(x):
    return mul(x, x)
```

```
def sum_squares(x, y):
    return square(x) + square(y)
```

What does sum_squares need to know about square?

• Square takes one argument.	**Yes**
• Square has the intrinsic name square.	**No**
• Square computes the square of a number.	**Yes**
• Square computes the square by calling mul.	**No**

```
def square(x):
    return pow(x, 2)
```

```
def square(x):
    return mul(x, x-1) + x
```

If the name "square" were bound to a built-in function, sum_squares would still work identically.

Choosing Names

Names typically don’t matter for correctness

but

they matter a lot for composition

From:	**To:**
true_false	rolled_a_one
d	dice
play_helper	take_turn
my_int	num_rolls
l, I, O	k, i, m

Names should convey the meaning or purpose of the values to which they are bound.

The type of value bound to the name is best documented in a function's docstring.

Function names typically convey their effect (print), their behavior (triple), or the value returned (abs).

Which Values Deserve a Name

Reasons to add a new name

Repeated compound expressions:

```
if sqrt(square(a) + square(b)) > 1:
    x = x + sqrt(square(a) + square(b))
```

▽

```
hypotenuse = sqrt(square(a) + square(b))
if hypotenuse > 1:
    x = x + hypotenuse
```

PRACTICAL GUIDELINES

Meaningful parts of complex expressions:

```
x = (-b + sqrt(square(b) - 4 * a * c)) / (2 * a)
```

▽

```
discriminant = sqrt(square(b) - 4 * a * c)
x = (-b + discriminant) / (2 * a)
```

More Naming Tips

- Names can be long if they help document your code:

  ```
  average_age = average(age, students)
  ```

  is preferable to

  ```
  # Compute average age of students
  aa = avg(a, st)
  ```

- Names can be short if they represent generic quantities: counts, arbitrary functions, arguments to mathematical operations, etc.

  ```
  n, k, i - Usually integers
  x, y, z - Usually real numbers
  f, g, h - Usually functions
  ```

Testing

Test-Driven Development

Write the test of a function before you write the function.

A test will clarify the domain, range, & behavior of a function.

Tests can help identify tricky edge cases.

Develop incrementally and test each piece before moving on.

You can't depend upon code that hasn't been tested.

Run your old tests again after you make new changes.

Bonus idea: Run your code interactively.

Don't be afraid to experiment with a function after you write it.

Interactive sessions can become doctests. Just copy and paste.

(Demo)

Decorators

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

Review

What Would Python Print?

The print function returns None. It also displays its arguments (separated by spaces) when it is called.

```
from operator import add, mul
def square(x):
    return mul(x, x)
```

A function that takes any argument and returns a function that returns that arg

```
def delay(arg):
    print('delayed')
    def g():
        return arg
    return g
```

Names in nested def statements can refer to their enclosing scope

This expression	Evaluates to	Interactive Output
5	5	5
print(5)	None	5
print($\underbrace{\texttt{print(5)}}_{\texttt{None}}$)	None	5 None
delay(delay)()(6)()	6	delayed delayed 6
print(delay(print)()(4))	None	delayed 4 None

What Would Python Print?

The print function returns None. It also displays its arguments (separated by spaces) when it is called.

```
from operator import add, mul
def square(x):
    return mul(x, x)
```

A function that always returns the identity function

```
def pirate(arggg):
    print('matey')
    def plunder(arggg):
        return arggg
    return plunder
```

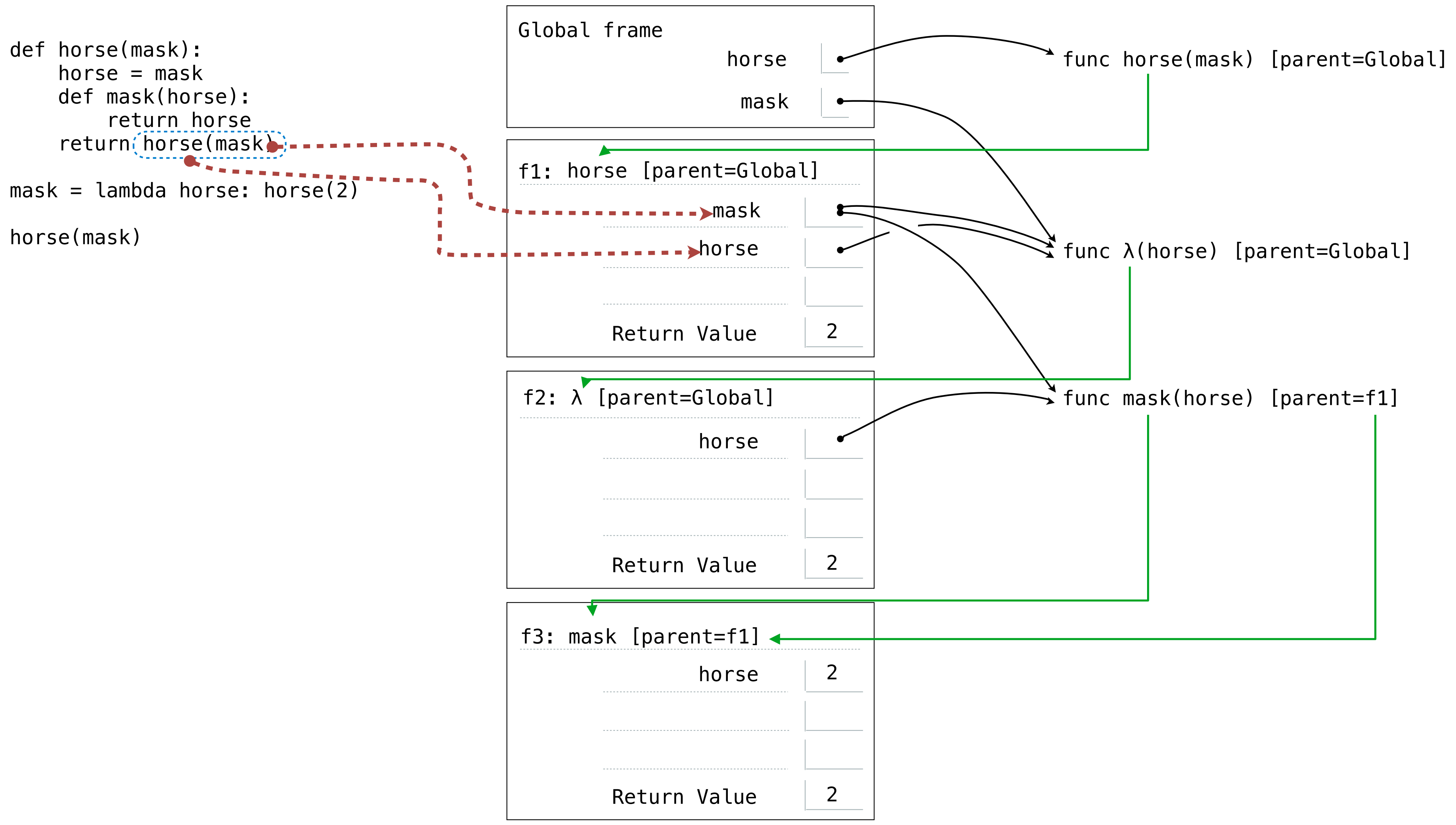
This expression	**Evaluates to**	**Interactive Output**
$\texttt{add(}\underbrace{\underbrace{\underbrace{\texttt{pirate(3)}}\texttt{(square)}}_{\textit{func square(x)}}\texttt{(4)}}_{\textit{16}}\texttt{, 1)}$	17	Matey 17
$\underbrace{\underbrace{\texttt{pirate(pirate(pirate))}}_{\textit{Identity function}}\texttt{(5)}}_{\textit{5}}\texttt{(7)}$	Error	Matey Matey Error

A name evaluates to the value bound to that name in the earliest frame of the current environment in which that name is found.

```
def horse(mask):
    horse = mask
    def mask(horse):
        return horse
    return horse(mask)

mask = lambda horse: horse(2)

horse(mask)
```



Global frame
horse
mask
func horse(mask) [parent=Global]
f1: horse [parent=Global]
mask
horse
Return Value 2
func λ(horse) [parent=Global]
f2: λ [parent=Global]
horse
Return Value 2
func mask(horse) [parent=f1]
f3: mask [parent=f1]
horse 2
Return Value 2