DISCUSSION 02

Environment Diagrams, Higher-Order Functions

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LOGISTICS 

- Homework 02 due today 02/02 @ 11:59pm
- Hog 
  - You can choose to work alone or in group of 2
    - If you work with a partner, only one of you need to submit and add the other on Gradescope!
  - Checkpoint 1 due next Tue 02/07
  - The whole project due next Fri 02/10
  - Submit the whole project by next Thu 02/09 for one extra point!
- Sign up for tutoring sections or CSM sections
  - Not required, but a good place to go if you want more practice!

ABOUT MIDTERM 1 

Yes, it's coming ...

- **Default: Next Monday (02/06) 7-9pm, in-person, right-handed desk**
- If you need any type of accommodations (left-handed desk, remote exam, alternate time, extended time, etc.), please fill out this form by today!!
- Check out Ed post #376 for more details!
- Pro Tips
  - Make sure you are (somewhat) comfortable with all the topics in scope
  - Familiarize yourself with the study guide beforehand
    - This was from last semester; the updated version will be linked in the midterm logistics post once it's ready
  - Do past exams
    - For each question, make sure you understand it before moving on to the next exam
    - Consult walkthrough videos! They are super helpful
    - Post on Ed thread / come to OH for help

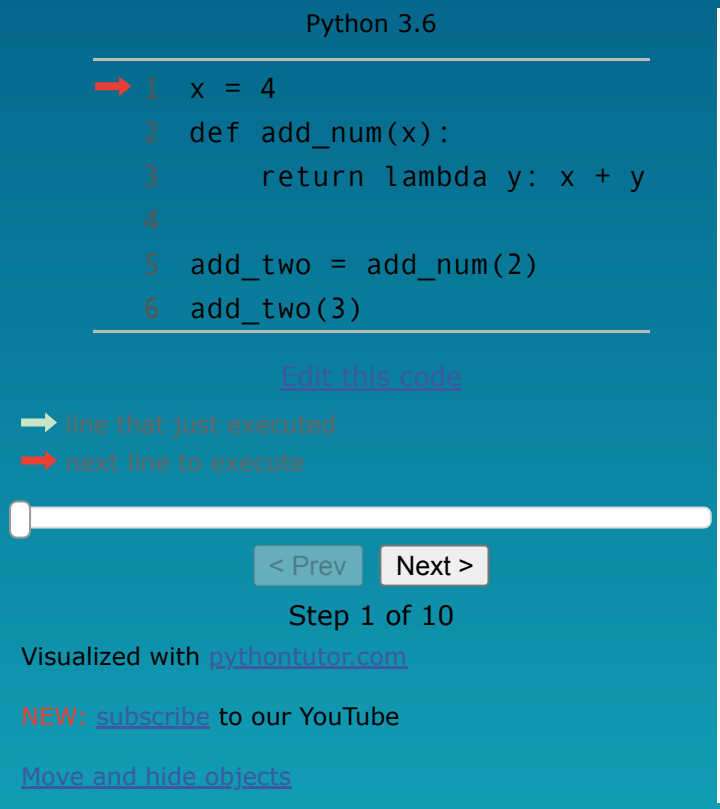
HIGHER ORDER FUNCTIONS 

HIGHER ORDER FUNCTIONS

- A higher order function (HOF) is a function that manipulates other functions by taking in functions as arguments, returning a function, or both.
- HOFs are powerful abstraction tools that allow us to express certain general patterns as named concepts in our programs.

```
1  def composer(func1, func2):
2      """Return a function f, such that f(x) = func1(func2(x))."""
3      def f(x):
4          return func1(func2(x))
5      return f
```

HIGHER ORDER FUNCTIONS



WORKSHEET Q4

CURRYING 

CURRYING

- Currying - converting a function that takes multiple arguments into a chain of functions that each take a single argument

```
1  def curried_pow (x):
2      def h (y):
3          return pow(x, y)
4      return h
5  curried_pow(2)(3) # same as pow(2, 3)
```

CURRYING

- Why is it useful?

```
>>> pow(2, 3)
8
>>> pow(2, 4)
16
>>> pow(2, 10)
1024
```

```
>>> pow_2 = curried_pow(2)
>>> pow_2(3)
8
>>> pow_2(4)
16
>>> pow_2(10)
1024
```

- In **contexts where only one-argument functions are allowed**, such as with the `map` function, which applies a one-argument function to every term in a sequence, we can curry a multiple-argument function into a one-argument function

WORKSHEET Q6, 8, 7

CALL EXPRESSIONS

FUNCTION VALUES

- Values that represent functions, also known as function objects
- In general, there are 2 parts to a function:
  - The code (function body), represented by the intrinsic name
  - The parent frame - where the function is ***defined***
- The function body is not evaluated until we call the function!
- To call a function, write the name of the variable that corresponds to the function value, write a parenthesis, and put all parameters for the function, if any - this is just a call expression

FUNCTION VALUES

- Intrinsic name
  - For a function defined using the `def` statement, for example:

```
1  def some_func (x, y):
2      return x * 2 + y * 5
```

    Here `some_func` is the intrinsic name
  - For a lambda function, its intrinsic name is just `λ`.
    - To differentiate between lambda functions, we often add the line number where the lambda is defined.
      For example:

```
1  # global frame
2  other_func = lambda x, y: x * 2 + y * 5
```

      Here `other_func` will be represented as `λ(x, y) <line 2>` in the environment diagram

FUNCTION VALUES

```
def go (bears):
        print( print(bears))
        print('GO BEARS!')
        return  'gob ears'
```

```
>>> go
Function
>>> go('bruh')
bruh
None
GO BEARS!
'gob ears'
```

EVALUATING A CALL EXPRESSION

1. Evaluate the operator, which should evaluate to a function value.
2. Evaluate the operands from left to right.
3. Draw a new frame, labelling it with the following:
    - A unique index (`f1`, `f2`, `f3`, ...)
    - The intrinsic name of the function, which is also the name of the function object itself
    - The parent frame (`[parent = ...]`)
4. Bind the formal parameters to the argument values obtained in step #2
5. Evaluate the body of the function in this new frame until a return value is obtained. Write down the return value in the frame.

* If a function does not have a return value, it implicitly returns `None`

* For built-in or imported functions like `abs` and `add`, we do not need to draw a new frame when calling them

WORKSHEET Q1-2

LAMBDA EXPRESSIONS 

LAMBDA EXPRESSIONS

- A lambda expression evaluates to function values but does not bind it to a name, unless we bind it to some names using assignment statements
- Anatomy:

```
f = lambda <p1>, <p2>, ...: <returned expr>
```

  This is equivalent to (though not the same as)

```
def f(<p1>, <p2>, ...):
    return <returned expr>
```

- Similarly, the return expression of a lambda function is not evaluated until the lambda is called
- Unlike `def` statements, lambda expressions can be used as an operator or an operand to a call expression. This is because they are simply one-line expressions that evaluate to functions

LAMBDA EXPRESSIONS

	`lambda`	`def`
Type	Expression that evaluates to a value	Statement that alters the environment
Results of execution	Creates an anonymous `lambda` function with no intrinsic name.	Creates a function with an intrinsic name and binds it to that name in the current environment.
Effect on the environment	Does not create or modify any variables.	Both creates a new function object and binds it to a name in the current environment.
Usage	A lambda expression can be used anywhere that expects an expression, such as in an assignment statement or as the operator or operand to a call expression.	After executing a def statement, the created function is bound to a name. You should use this name to refer to the function anywhere that expects an expression.

LAMBDA EXPRESSIONS

```
>>> what = lambda x : x + 5
>>> what
<function <lambda> at ...>
>>> what(4)
9
>>> (lambda y: y + 5)(4)
9
>>> (lambda f, x: -f(x))(lambda y: y + 1, 10)
-11
```

WORKSHEET Q3

ATTENDANCE! 

go.cs61a.org/mingxiao-att

- The attendance form and slides are both linked on our section website!
  - go.cs61a.org/mingxiao-index
- Please do remember to fill out the form by midnight today!!