DISCUSSION 02

Environment Diagrams, Higher-Order Functions

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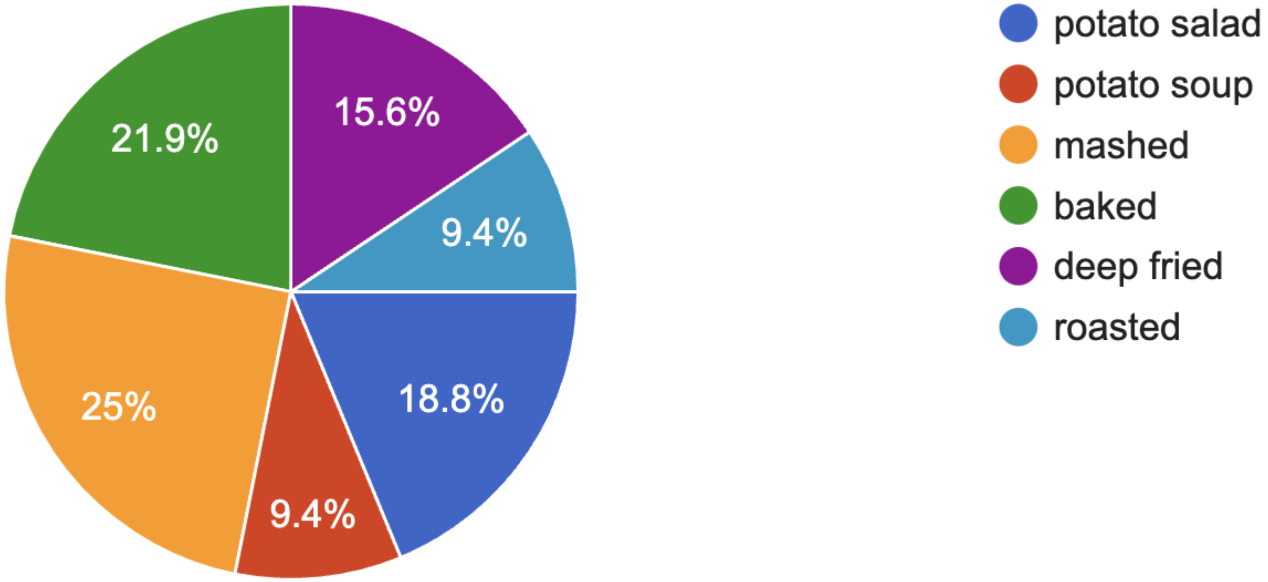
FROM LAST TIME... 👀

If you were a potato, how would you like to be cooked?

32 responses



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.

```python
def composer(func1, func2):
    """Return a function f, such that f(x) = func1(func2(x))."""
    def f(x):
        return func1(func2(x))
    return f
```

RULES OF VARIABLE LOOKUP

1. Look it up in the current frame
2. If not found, go look in the parent frame, and up and up until global. If it's not there, throw an error.

   * Built-in functions like `max` and `min` are usually not displayed on the environment diagram.

HIGHER ORDER FUNCTIONS

Python 3.6

```
x = 4
def add_num(x):
    return lambda y: x + y

add_two = add_num(2)
add_two(3)
```

Edit this code

line that just executed

next line to execute

< Prev   Next >

Step 1 of 10

Visualized with pythontutor.com

NEW: subscribe to our YouTube

Move and hide objects

Frames   Objects

WORKSHEET Q4

CURRYING 🍛

CURRYING

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

```python
def curried_pow(x):
    def h(y):
        return pow(x, y)
    return h
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 <u>contexts where only one-argument functions are allowed</u>, 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:

    ```python
    def some_func(x, y):
        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:

      ```python
      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!!