LAB 05

Trees, Data Abstraction, Python Lists

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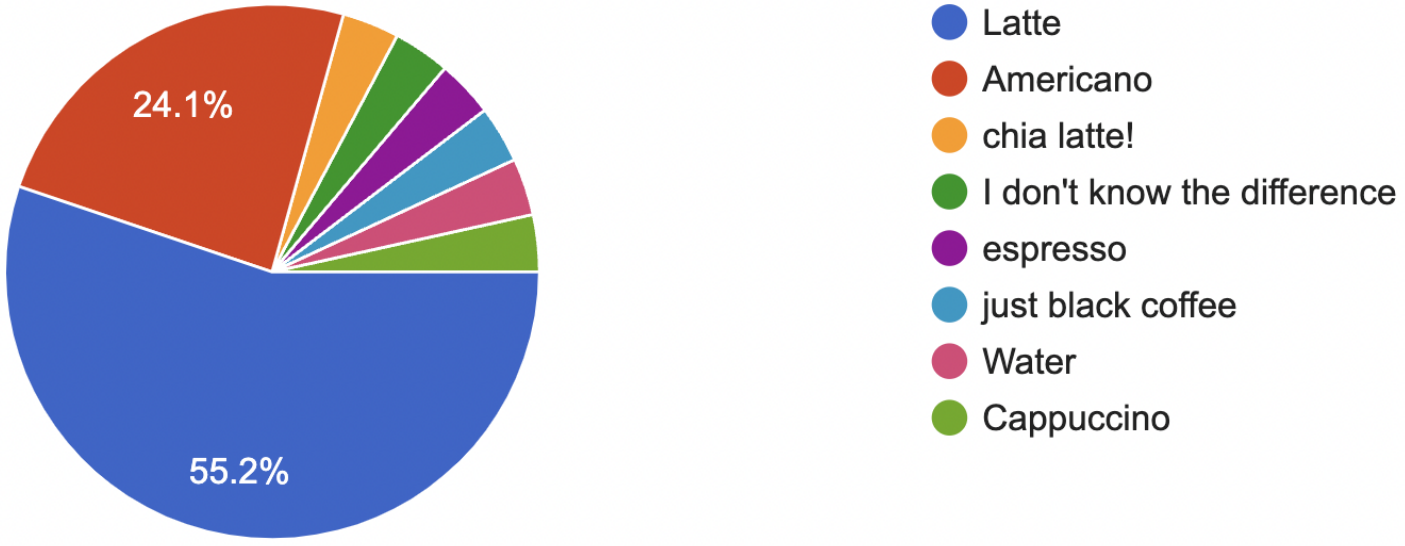
LOGISTICS 🏡

- Lab 05 due Wed 09/28
- CATS 🐅
  - Try out the game here: cats.cs61a.org
  - Checkpoint 1 due tomorrow Tue 09/27
  - The whole project due Fri 09/30
  - Submit everything by Thu 09/29 for one extra credit
- NO homework due this week - homework 04 due next Thu 10/06

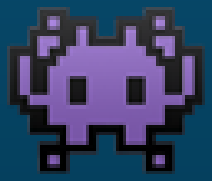
HIGHLIGHT FROM LAST TIME 👀

Latte or Americano or ...?

29 responses



DATA ABSTRACTION



DATA ABSTRACTION - INTRO

- Data abstraction allows us to treat code as "objects", so that we don't have to worry about the actual implementation (e.g., how information is stored and calculated) - we just need to know what it does.
- The nature of abstraction allows whoever uses them to assume that the functions have been written correctly and work as described.
- A data abstraction consists of two types of functions:
  - Constructors: functions that build and return the abstract data type
  - Selectors: functions that retrieve information from the data type.

RATIONAL NUMBERS REVISIT

- Constructor: `rational(n, d)` returns a rational number $x = \frac{n}{d}$ using some underlying representation, which we, as users, do not need to know anything of
- Selectors:
  - `numer(x)` returns the numerator of x
  - `denom(x)` returns the denominator of x
- Arithmetic Operations:

```
def mul_rational(x, y):
    return rational(numer(x) * numer(y), \
                    denom(x) * denom(y))
```

  - Note how we can manipulate rational numbers using their constructor/selectors without knowing their implementation
  - Side note: the `\` is used to indicate that the expression continues on the next line

RATIONAL NUMBERS REVISIT

There are many ways to implement the rational number data abstraction. Below are two examples:

```
def rational(n, d):
    return [n, d]
def numer(x):
    return x[0]
def denom(x):
    return x[1]
```

```
def rational(n, d):
    return {'n': n, 'd': d}
def numer(x):
    return x['n']
def denom(x):
    return x['d']
```

No matter which one we use, the rational number data abstraction has the same, correct behavior from the users' end.

In other words, as programmers, we can design the underlying implementation for the data abstraction however we want as long as it behaves correctly according to its documentation.

DON'T BREAK THE ABSTRACTION BARRIER!

Parts of the program that...	Treat rationals as...	Using...
Use rational numbers to perform computation	whole data values	`add_rational`, `mul_rational` `rationals_are_equal`, `print_rational`
Create rationals or implement rational operations	numerators and denominators	`rational`, `numer`, `denom`
Implement selectors and constructor for rationals	two-element lists	list literals and element selection
Implementation of lists		

Source: lecture 13 slides

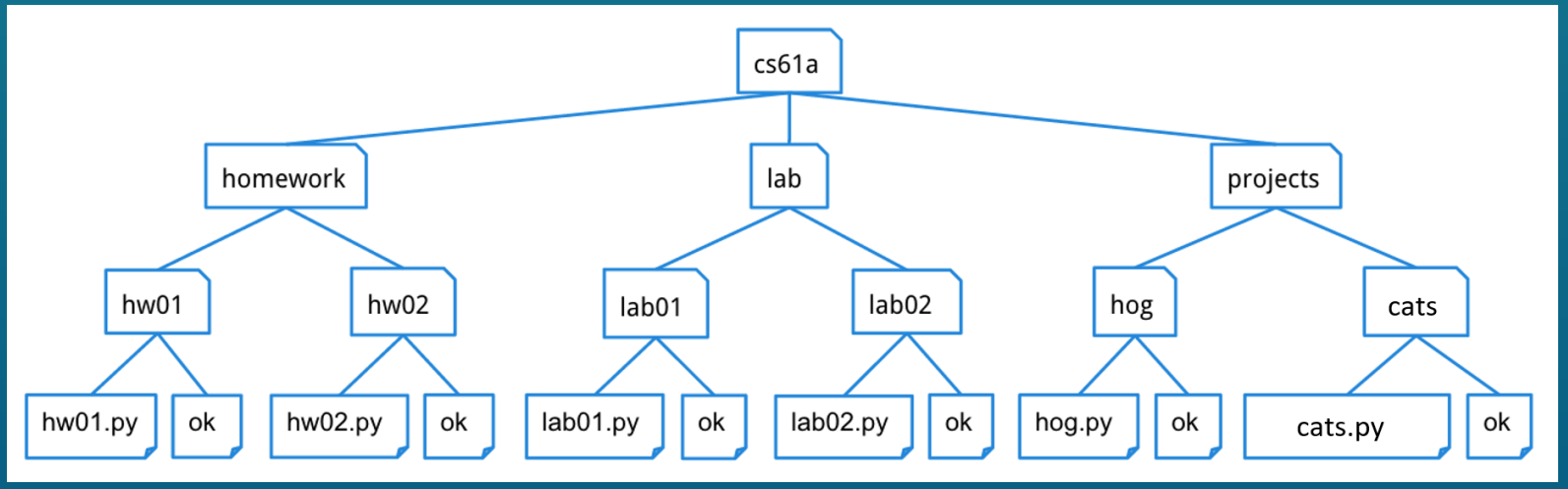
DON'T BREAK THE ABSTRACTION BARRIER!

- Why?
  - Breaking the abstraction barrier is essentially repeating some function's job
  - Once the underlying implementation changes, the code may not work anymore
- Examples of violating the abstraction barriers:
  - `mul_rational([1, 2], [3, 4])` - should be `mul_rational(rational(1, 2), rational(1, 2))`
  - ```
    def divide_rational(x, y):
        return [ x[0] * y[1], x[1] * y[0] ]
    # should be:
    def divide_rational(x, y):
        return rational(denom(x) * numer(y), \
                        numer(x) * denom(y))
    ```
- Takeaway: do not repeat any work that an existing function could do!
    ```

TREES 

TREES - INTRO

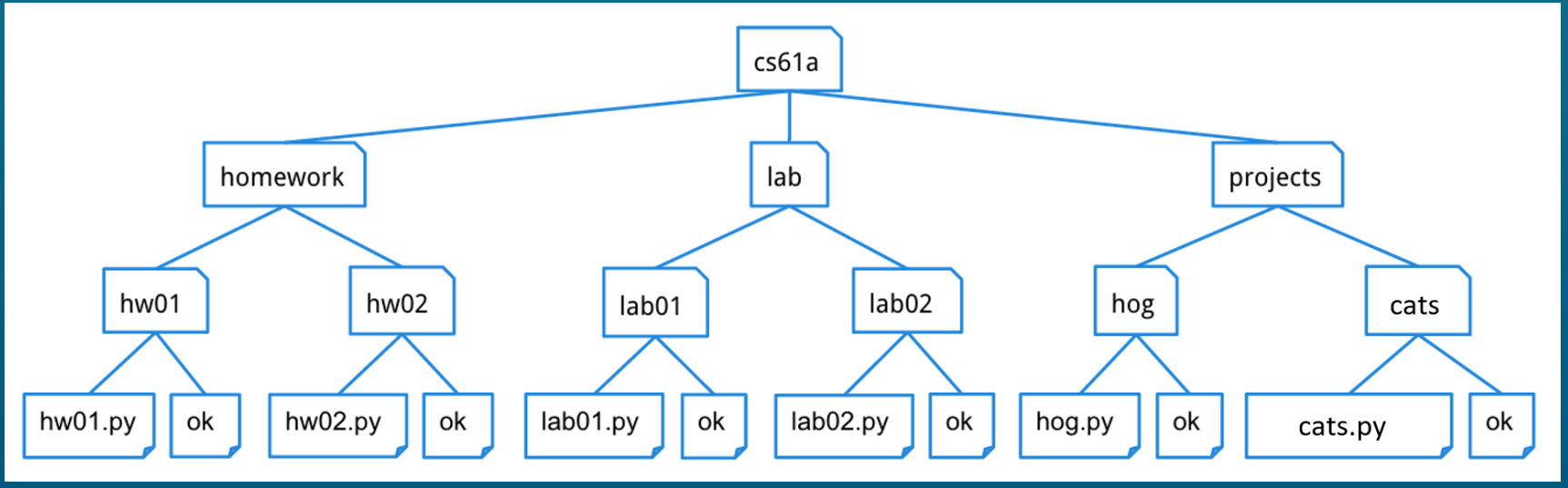
- A tree is a data structure that represents a hierarchy of information.
  - For example, a file system:



As you can see, unlike trees in nature, the tree abstract data type is drawn with the root at the top and the leaves at the bottom.

TREES - TERMINOLOGY

- node: any location within the tree (e.g., root node, leaf nodes, etc.)
- root: the node at the top of the tree
- label: the value in a node
- branches: **a list of trees** directly under the tree's root
- leaf: a tree with zero branches



TREES - DATA ABSTRACTION

- Constructor:
  - `tree(label, branches=[])`: creates and returns a tree object with the given `label` value at its root node and list of `branches`. Notice that the second argument to this constructor, `branches`, is optional - if you want to make a tree with no branches, leave this argument empty
- Selector:
  - `label(tree)`: returns the value in the root node of `tree`.
  - `branches(tree)`: returns the list of branches of `tree`.
- Convenience function:
  - `is_leaf(tree)`: returns `True` if `tree`'s list of branches is empty, and `False` otherwise.

TREES - EXAMPLES

```
sample_tree = tree(1, [tree(2), \
                       tree(3, [tree(4), tree(5)]), \
                       tree(6, [tree(7), tree(8)])])
```

Bonus: on code.cs61a.org, call `draw(tree)` on a tree to visualize it!

- To extract the number `5` from this tree, which is the label of the root of its second branch's second branch, we would do this:

```
label(branches(branches(sample_tree)[1])[1])
```

- The `print_tree` function prints out a tree in a human-readable form, where the root is unindented, and each of its branches is indented one level further.
    - Don't worry too much about its implementation - just make sure that you are able to interpret the structure of the tree from the output

ATTENDANCE! 

go.cs61a.org/mingxiao-att

- The attendance form and slides are both linked on our section website!
- If you finish early, let me or any of the AI's know and we'll check you off
- Once again, please do remember to fill out the form by midnight today!!