61A Lecture 20

Friday, October 17

Announcements

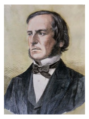
- Guerrilla Section 4 on Sunday 10/19: Object-oriented programming and recursive data
  - Meet in 271 Soda: Vanguard section from 12-2pm; Main section from 2:30-4:30pm
- Homework 6 is due Monday 10/20 @ 11:59pm
  - Homework party on Monday 10/20 6pm-8pm in 2050 VLSB
- Project 3 is due Thursday 10/23 @ 11:59pm
- Midterm 2 is on Monday 10/27 7pm-9pm
  - Class Conflict? Fill out the conflict form at the top of http://cs61a.org
  - Review session on Saturday 10/25 3pm-6pm in 2050 VLSB
- CSUA and Hackers@Berkeley are holding a hack-a-thon on Saturday for 61A students
  - 10am - 11pm in Wozniak Lounge

Introducing Cohorts

Each of you has been randomly placed in the cohort of a patron computer scientist

00: Ada Lovelace

Wrote first program



10: George Boole

Invented boolean logic

01: Haskell Curry

Math for functional programming

11: Grace Hopper

Wrote first compiler

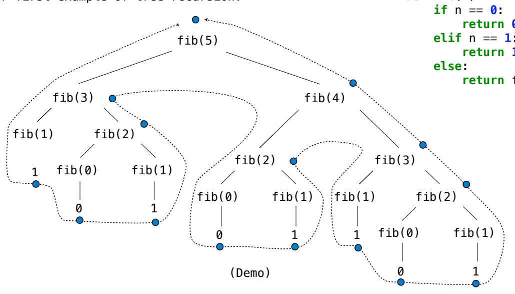
cs61a.org/cohorts.html

Measuring Efficiency

Recursive Computation of the Fibonacci Sequence

Our first example of tree recursion:

```
def fib(n):
    if n == 0:
        return 0
    elif n == 1:
        return 1
    else:
        return fib(n-2) + fib(n-1)
```



(Demo)

http://en.wikipedia.org/wiki/File:Fibonacci.jpg

Memoization

Memoization

Idea: Remember the results that have been computed before

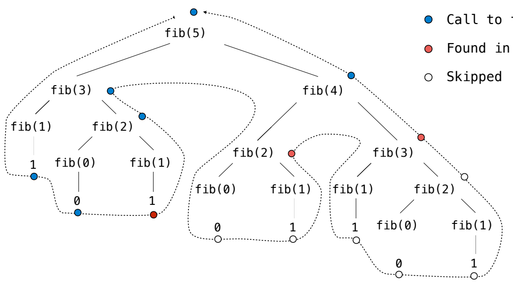
```
def memo(f):
    cache = {}
    def memoized(n):
        if n not in cache:
            cache[n] = f(n)
        return cache[n]
    return memoized
```

Keys are arguments that map to return values

Same behavior as f, if f is a pure function

(Demo)

Memoized Tree Recursion



● Call to fib

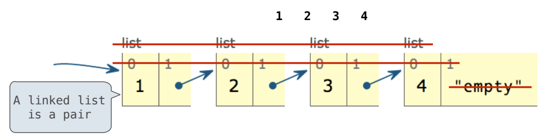
🔴 Found in cache

○ Skipped

Linked List Class

Linked Lists as Objects

Linked list idea: Pairs are sufficient to represent sequences of arbitrary length



Data abstraction (old way):

```
>>> s = link(1, link(2, link(3, link(4, empty))))
>>> len_link(s)
4
>>> getitem_link(s, 2)
3
>>> s
[1, [2, [3, [4, 'empty']]]]
```

Link class (new way):

```
>>> s = Link(1, Link(2, Link(3, Link(4))))
>>> len(s)
4
>>> s[2]
3
>>> s
Link(1, Link(2, Link(3, Link(4))))
```

Linked List Class

Linked list class: pairs are two-attribute objects

```
class Link:

    empty = ()

    def __init__(self, first, rest=empty):
        self.first = first
        self.rest = rest

    def __getitem__(self, i):
        if i == 0:
            return self.first
        else:
            return self.rest[i-1]

    def __len__(self):
        return 1 + len(self.rest)
```

Some zero length sequence

Calls this method

This element selection syntax

Yes, this call is recursive too

More special method names:

`__getitem__`	Element selection []
`__len__`	Built-in len function

Methods can be recursive too!

(Demo)

Tree Class

Tree Class

A Tree has an entry (any value) at its root and a list of branches

```
class Tree:
    def __init__(self, entry, branches=()):
        self.entry = entry
        for branch in branches:
            assert isinstance(branch, Tree)
        self.branches = list(branches)


def fib_tree(n):
    if n == 0 or n == 1:
        return Tree(n)
    else:
        left = fib_tree(n-2)
        right = fib_tree(n-1)
        return Tree(left.entry + right.entry, (left, right))
```

Built-in isinstance function: returns True if branch has a class that *is* **or** *inherits from* Tree

(Demo)

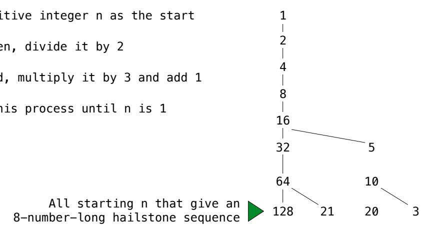
Example: Hailstone Trees

Pick a positive integer n as the start

If n is even, divide it by 2

If n is odd, multiply it by 3 and add 1

Continue this process until n is 1


1
2
4
8
16
32
5
64
10
128
21
20
3
All starting n that give an 8-number-long hailstone sequence

(Demo)