61A Lecture 22

Friday, October 25

- Midterm 2 is on Monday 10/28 7pm–9pm
  - Topics and locations: http://inst.eecs.berkeley.edu/~cs61a/fa13/exams/midterm2.html
  - Bring 1 hand-written, 2-sided sheet of notes. Two study guides will be provided.
  - Emphasis: mutable data, object-oriented programming, recursion, and recursive data
  - Have an unavoidable conflict? Fill out the conflict form by Friday 10/25 @ 11:59pm!
  - Review session on Saturday 10/26 from 1pm to 4pm in 1 Pimentel
  - HKN review session on Sunday 10/27 from 4pm to 7pm to 2050 VLSB
  - Includes content through Wednesday 10/23 (today is review & examples)
- No lab next Monday, Tuesday, & Wednesday
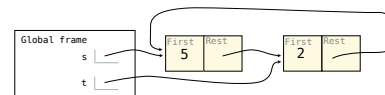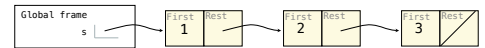- Homework 7 is due Tuesday 11/5 @ 11:59pm (Two weeks)

Mutable Recursive Lists

Recursive Lists Can Change

Attribute assignment statements can change first and rest attributes of an Rlist.

The rest of a recursive list can contain the recursive list as a sub-list.

```
>>> s = Rlist(1, Rlist(2, Rlist(3)))
>>> s.first = 5
>>> t = s.rest
>>> t.rest = s
>>> s.first
5
>>> s.rest.rest.rest.rest.rest.first
2
```


Note: The actual environment diagram is much more complicated.

Recursive Lists as Functions

Mutable Recursive Lists Using Functions

The object system is convenient, but it isn't necessary for designing data types!
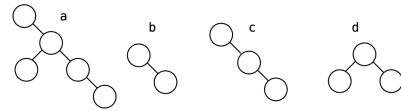
(Demo)

Trees

Pruned Trees

Consider the binary `Tree` class below, which has no entry attribute.
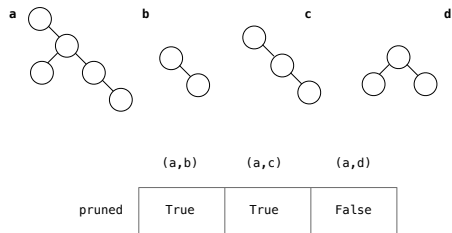
```
class Tree(object):
    """A binary tree with no entries."""
    def __init__(self, left=None, right=None):
        self.left = left
        self.right = right
a = Tree(None, Tree(Tree(), Tree(None, Tree())))
b = Tree(None, Tree())
c = Tree(None, Tree(None, Tree()))
d = Tree(Tree(),  Tree())
```

Write a function **pruned** that takes two **Tree** arguments **t1** and **t2** and returns whether **t2** is a pruned version of **t1**. **t2** is a pruned version of **t1** if all paths from the root of **t2** are also valid paths from the root of **t1**.

	(a,b)	(a,c)	(a,d)
pruned	True	True	False

Pruned Tree Examples

	(a,b)	(a,c)	(a,d)
pruned	True	True	False

Recursive Idea

```
pruned(a, c)

implies

pruned(a.right, c.right)
```


what about c.left?

Recursive Idea

```
pruned(a, d)

would imply

pruned(a.left, d.left)
```


None   Not None
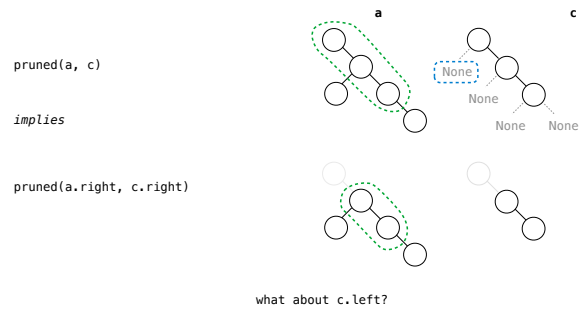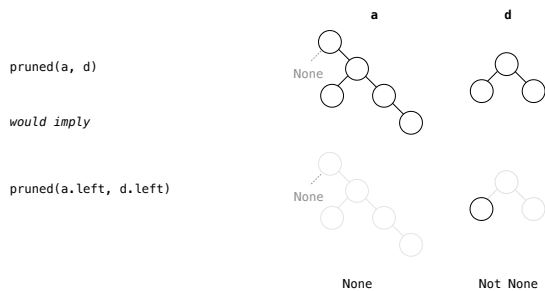
Recursive Implementation

Recursive call: Both the left and right are pruned, respectively

Base cases: one (or more) of the trees is None

```
def pruned(t1, t2):
    if t2 is None:
        return True
    elif t1 is None:
        return False
    else:
        return pruned(t1.left, t2.left) and pruned(t1.right, t2.right)
```

Non-Local Assignment

```
def oski(bear):
    def cal(berk):
        nonlocal bear
        if bear(berk) == 0:
            return (berk+1, berk-1)
        bear = lambda ley: berk-ley
        return (berk, cal(berk))
    return cal(2)
oski(abs)
```
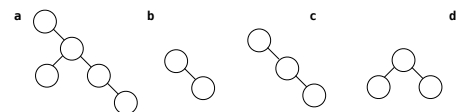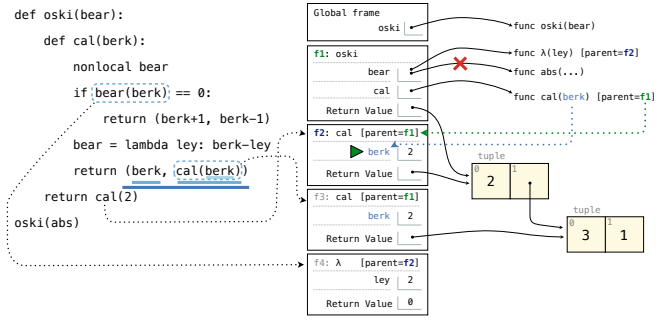
```
Global frame
                    oski
f1: oski
                    bear
                    cal
            Return Value
f2: cal [parent=f1]
               berk    2
            Return Value
f3: cal [parent=f1]
               berk    2
            Return Value
f4: λ    [parent=f2]
                ley    2
            Return Value   0
```

func oski(bear)
func λ(ley) [parent=f2]
func abs(...)
func cal(berk) [parent=f1]

tuple
0 2   1

tuple
0 3   1 1

Non-Local Assignment Variants

```
def oski(bear):
    def cal(berk):
        nonlocal bear
        if bear(berk) == 0:
            return (berk+1, berk-1)
        bear = lambda ley: berk-ley
        return (berk, cal(berk))
    return cal(2)
oski(abs)
```

abs(2)

boar

```
Global frame
                    oski
f1: oski
                    bear
                    cal
            Return Value
f2: cal [parent=f1]
               berk    2
            Return Value
f3: cal [parent=f1]
               berk    2
            Return Value
f4: λ    [parent=f2]
                ley    2
            Return Value   0
```

func oski(bear)
func λ(ley) [parent=f2]
func cal(berk) [parent=f1]

tuple
0 2   1

tuple
0 3   1 1