FINAL REVIEW 13

COMPUTER SCIENCE 61A

August 4, 2016

1 Mutable Sequences

1. Write a function that takes in two values `x` and `el`, and a list, and adds as many `el`'s to the end of the list as there are `x`'s.

```
def add_this_many(x, el, lst):
    """ Adds el to the end of lst the number of times x occurs
    in lst.
    >>> lst = [1, 2, 4, 2, 1]
    >>> add_this_many(1, 5, lst)
    >>> lst
    [1, 2, 4, 2, 1, 5, 5]
    >>> add_this_many(2, 2, lst)
    >>> lst
    [1, 2, 4, 2, 1, 5, 5, 2, 2]
    """
```

2. Given a deep dictionary `d`, replace all occurences of `x` *as a value (not a key)* with `y`. Hint: You will need to combine iteration and recursion.

```
def replace_all_deep(d, x, y):
    """
    >>> d = {1: {2: 3, 3: 4}, 2: {4: 4, 5: 3}}
    >>> replace_all_deep(d, 3, 1)
    >>> d
    {1: {2: 1, 3: 4}, 2: {4: 4, 5: 1}}
    """
```

2 Object-Oriented Programming

1. Assume these commands are entered in order. What would Python output?

```
>>> class Foo:
...     def __init__(self, a):
...         self.a = a
...     def garply(self):
...         return self.baz(self.a)
>>> class Bar(Foo):
...     a = 1
...     def baz(self, val):
...         return val
>>> f = Foo(4)
>>> b = Bar(3)
>>> f.a


>>> b.a


>>> f.garply()
```

```
>>> b.garply()

>>> b.a = 9
>>> b.garply()

>>> f.baz = lambda val: val * val
>>> f.garply()
```

3 Mutable Linked Lists and Trees

3.1 Linked Lists

Here is the implementation of the linked list class:

```
class Link:
    empty = ()
    def __init__(self, first, rest=empty):
        assert rest is Link.empty or isinstance(rest, Link)
        self.first = first
        self.rest = rest
    def __getitem__(self, i):
        if i == 0:
            return self.first
        return self.rest[i-1]
    def __len__(self):
        return 1 + len(self.rest)
    def __repr__(self):
        if self.rest is Link.empty:
            return 'Link({})'.format(self.first)
        else:
            return 'Link({}, {})'.format(self.first,
                                         repr(self.rest))
```

1. Write a recursive function `flip_two` that takes as input a linked list `lnk` and mutates `lnk` so that every pair is flipped.

```
def flip_two(lnk):
    """
    >>> one_lnk = Link(1)
    >>> flip_two(one_lnk)
    >>> one_lnk
    Link(1)
    >>> lnk = Link(1, Link(2, Link(3, Link(4, Link(5)))))
    >>> flip_two(lnk)
    >>> lnk
    Link(2, Link(1, Link(4, Link(3, Link(5)))))
    """
```

3.2 Trees

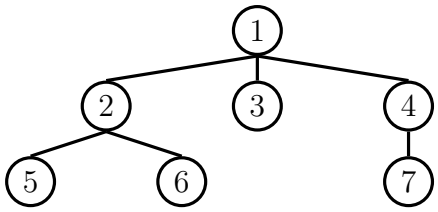
```
class Tree:
    def __init__(self, entry, children=[]):
        for c in children:
            assert isinstance(c, Tree)
        self.entry = entry
        self.children = children

    def is_leaf(self):
        return not self.children
```

1. Assuming that every entry in `t` is a number, let's define `average(t)`, which returns the average of all the entries in `t`.

```
def average(t):
    """
    Returns the average value of all the entries in t.
    >>> t0 = Tree(0, [Tree(1), Tree(2, [Tree(3)])])
    >>> average(t0)
    1.5
    >>> t1 = Tree(8, [t0, Tree(4)])
    >>> average(t1)
    3.0
    """
```

2. Write a program `flatten` that given a Tree `t`, will return a linked list of the elements of `t`, ordered by level. Entries on the same level should be ordered from left to right. For example, the following tree will return the linked list `<1 2 3 4 5 6 7>`.




```
def flatten(t):
```

4 Scheme

1. Write a Scheme function that, when given an element, a list, and an index, inserts the element into the list at that index.

```
(define (insert element lst index)




                                                    )
```

2. Define `deep-apply`, which takes a nested list and applies a given procedure to every element. `deep-apply` should return a nested list with the same structure as the input list, but with each element replaced by the result of applying the given procedure to that element. Use the built-in `list?` procedure to detect whether a value is a list. The procedure `map` has been defined for you.

```
(define (map fn lst)
  (if (null? lst)
    nil
    (cons (fn (car lst)) (map fn (cdr lst)))))
(define (deep-apply fn nested-list)




                                                    )
```

```
scm> (deep-apply (lambda (x) (* x x)) '(1 2 3))
(1 4 9)
scm> (deep-apply (lambda (x) (* x x)) '(1 ((4) 5) 9))
(1 ((16) 25) 81)
scm> (deep-apply (lambda (x) (* x x)) 2)
4
```

4.1 Streams

1. What would Scheme display?

```
scm> (define (has-even? s)
       (cond ((null? s) False)
             ((even? (car s)) True)
             (else (has-even? (cdr-stream s)))))
has-even?
scm> (define ones (cons-stream 1 ones))

scm> (define twos (cons-stream 2 twos))

scm> ones

scm> (cdr ones)

scm> (cdr-stream ones)

scm> (has-even? ones)

scm> (has-even? twos)
```

5 Logic

1. Write facts for `match`, a relation between two lists if and only if the two lists are identical.

```
> (query (match (i am so cool) (i am . ?you)))
Success!
you: (so cool)
```

6 Generators

1. Write a generator function that returns all subsets of the positive integers from 1 to `n`. Each call to this generator's `__next__` method will return a list of subsets of the set `[1, 2, ..., n]`, where `n` is the number of times `__next__` was previously called.

```
def generate_subsets():
    """
    >>> subsets = generate_subsets()
    >>> for _ in range(3):
    ...     print(next(subsets))
    ...
    [[]]
    [[], [1]]
    [[], [1], [2], [1, 2]]
    """
```