

# FINAL REVIEW

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## COMPUTER SCIENCE MENTORS 61A

April 25 to April 29, 2016

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### 1 What Would Python Print? Iterators

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```
1. class SkipIterator:
    def __init__(self, rng, n):
        self.obj = rng
        self.skip = n

    def __iter__(self):
        return self

    def __next__(self):
        result = self.obj.curr
        self.obj.curr += self.skip
        return result

class SkippedNaturals:
    def __init__(self):
        self.curr = 0
        self.skip = 1

    def __iter__(self):
        return SkipIterator(self, self.skip)
```

Expression	Interactive Output
<pre>p = SkippedNaturals() twos = <b>iter</b>(p) p.skip = p.skip + 1 threes = <b>iter</b>(p) <b>next</b>(twos)</pre>	
<b>next</b> (twos)	
<b>next</b> (threes)	
<b>next</b> (threes)	

Solution:

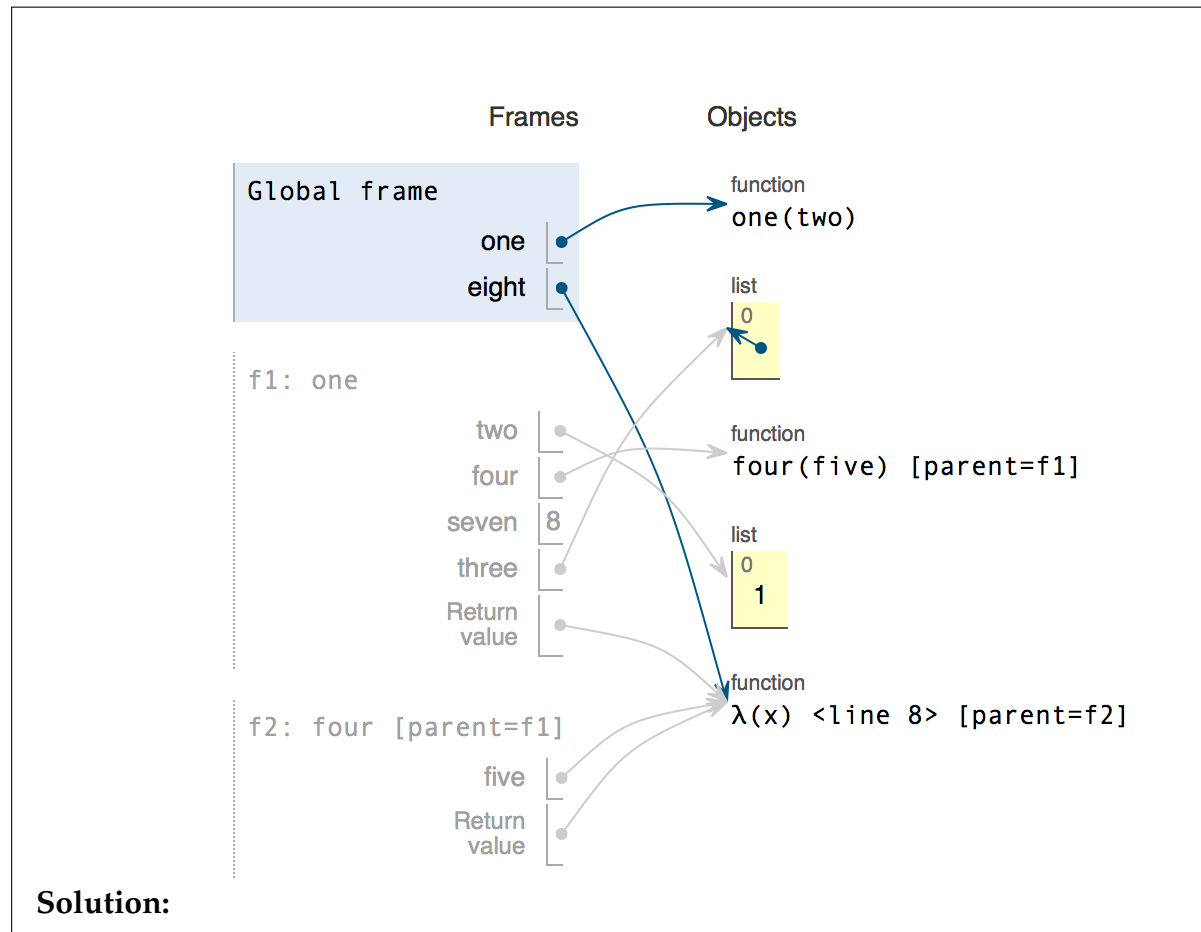
0
1
2
4

## 2 Environment Diagrams

2. Draw the environment diagram for the following code snippet:

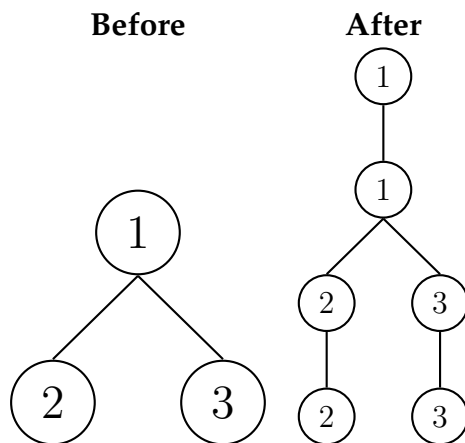
```
def one(two):
    three = two
    def four(five):
        nonlocal three
        if len(three) < 1:
            three.append(five)
            five = lambda x: four(x)
        else:
            five = seven + 7
        return five
    two = two + [1]
    seven = 8
    return four(three)

eight = one([])
print(eight(9))
```



### 3 Recursive Data Structures

3. DoubleTree hired you to architect one of their hotel expansions! As you might expect, their floor plan can be modeled as a tree and the expansion plan requires doubling each node (the patented double tree floor plan). Here's what some sample expansions look like:



Fill in the implementation for `double_tree`.

```

def double_tree(t):
    """
    Given a tree, return a new tree where entries appear
    twice.
    >>> double_tree(Tree(1))
    Tree(1, [Tree(1)])
    >>> double_tree(Tree(1, [Tree(2), Tree(3)]))
    Tree(1, [Tree(1, [Tree(2, [Tree(2)]),
                        Tree(3, [Tree(3)])
                    ])]
    """
  
```

#### Solution:

```

def double_tree(t):
    if t.is_leaf():
        return Tree(t.label, [Tree(t.label)])
    else:
        dbl_children = [double_tree(c) for c in t.children]
        return Tree(t.label,
                    [Tree(t.label, dbl_children)])
  
```

4. Fill in the implementation of `double_link`.

```
def double_link(lst):
    """
    Using mutation, replaces the second in each pair of items
    with the first. The first of each pair stays as is.
    >>> double_link(Link(1, Link(2, Link(3, Link(4)))))
    Link(1, Link(1, Link(3, Link(3))))
    >>> double_link(
        Link('c', Link('s', Link(6, Link(1, Link('a')))))
    )
    Link('c', Link('c', Link(6, Link(6, Link('a')))))
    """
    if _____:
        return _____
    _____
    _____
    return _____
```

**Solution:**

```
if lst is Link.empty or lst.rest is Link.empty:
    return lst
lst.rest.first = lst.first
double_link(lst.rest.rest)
return lst
```

## 5. Fill in the implementation of shuffle.

```

def shuffle(lst):
    """
    Swaps each pair of items in a linked list.
    >>> shuffle(Link(1, Link(2, Link(3, Link(4)))))
    Link(2, Link(1, Link(4, Link(3))))
    >>> shuffle(
        Link('s', Link('c', Link(1, Link(6, Link('a')))))
    )
    Link('c', Link('s', Link(6, Link(1, Link('a')))))
    """
    if _____
        return _____
    new_head = lst.rest
    lst.rest = _____
    _____
    return _____

```

**Solution:**

```

if lst == Link.empty or lst.rest == Link.empty:
    return lst
new_head = lst.rest
lst.rest = shuffle(new_head.rest)
new_head.rest = lst
return new_head

```

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## 4 Scheme

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6. Write a Scheme function `insert` that creates a new list that would result from inserting an item into an existing list at the given index. Assume that the given index is between 0 and the length of the original list, inclusive.

```
(define (insert lst item index)
```

```
)
```

**Solution:**

```
(define (insert lst item index)
  (if (= index 0)
      (cons item lst)
      (cons (car lst) (insert (cdr lst) item (- index 1)))))
)
```

**Extra:** Write this as a tail recursive function. Assume `append` is tail recursive.

**Solution:**

```
(define (insert lst item index)
  (define (helper lst index so-far)
    (if (or (null? lst) (= index 0))
        (append so-far (cons item lst))
        (helper (cdr lst) (- index 1)
                  (append so-far (list (car lst)))))
  )
  (helper lst index nil)
)
```

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## 5 Interpreters

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7. Circle the number of calls to `scheme_eval` and `scheme_apply` for the code below.

```
(define (square x) (* x x))  
(+ (square 3) (- 3 2))
```

Calls to <code>scheme_eval</code> (circle one)	2	5	14	24
Calls to <code>scheme_apply</code> (circle one)	1	2	3	4

**Solution:** 14 for eval, 4 for apply.



## 6 Recursive Select in SQL

8. Create a `mod_seven` table that has two columns, a number from 0 to 100 and then its value mod 7.

**Hint:** You can create a table first with all of the initial data you will build from, and then build the `mod_seven` table.

**Solution:**

```
with
  base(n) as (
    select 0 union
    select n+1 from base where n+1<7
  ),
  mod_seven (n, value) as (
    select n, n from base union
    select n+7, value from mod_seven where n+7<=100
  )
select * from mod_seven;
```

ALTERNATIVE SOLUTION WITH MODULO OPERATOR

```
with
  mod_seven (n, value) as (
    select 0, 0 union
    select n+1, (n+1)%7 from mod_seven where n<100
  )
select * from mod_seven;
```

ALTERNATIVE SOLUTION WITH ONE **TABLE**

(This could be a pre-step to approaching the original solution.)

```
with
  mod_seven (n, value) as (
    select 0, 0 union
    select 1, 1 union
    select 2, 2 union
    select 3, 3 union
    select 4, 4 union
    select 5, 5 union
    select 6, 6 union
    select n+7, value from mod_seven where n+7 <= 100
  )
select * from mod_seven;
```

## 7 Iterators, Generators, and Streams

9. Write a generator that will take in two iterators and will compare the first element of each iterator and yield the smaller of the two values.

```
def interleave(iter1, iter2):  
    """  
    >>> gen = interleave(iter([1, 3, 5, 7, 9]),  
                           iter([2, 4, 6, 8, 10]))  
  
    >>> for elem in gen:  
    ...     print(elem)  
    ...  
    1  
    2  
    3  
    4  
    5  
    6  
    7  
    8  
    9  
    """
```

**Solution:**

```
t1, t2 = next(iter1), next(iter2)  
while True:  
    if t1 > t2:  
        yield t2  
        t2 = next(iter2)  
    else:  
        yield t1  
        t1 = next(iter1)
```

## 10. Food Planning Scheme

- (a) You and your 61A friends are cons. You cdr'd just studied for the final, but instead you scheme to drive away across a stream in a car during dead week. Of course, you would like a variety of food to eat on your roadtrip.

Write a stream that takes in a list of foods and outputs each food, looping back to the first food in the list when the list is exhausted.

Write an infinite stream that takes in a list of foods and loops back to the first food in the list when the list is exhausted. **Bonus:** Count all the puns in this question! (**define** (food-stream foods)

)

### Solution:

```
(define (food-stream foods)
  (cons-stream (car foods)
               (food-stream (append (cdr foods)
                                     (list (car foods))))))
)
```

- (b) We discover that some of our food is stale! Every other food that we go through is stale, so put it into a new stale food stream. Assume is-stale starts off at 0. (**define** (stale-stream foods is-stale)

)

### Solution:

```
(define (stale-stream foods is-stale)
  (cond ((null? foods) nil)
        ((= is-stale 1)
         (cons-stream (car foods)
                       (stale-stream (cdr foods) 0)))
        (else (stale-stream (cdr foods) 1)))
)
```