

Instructions

Form a small group. Start on the first problem. Check off with a helper or discuss your *solution process* with another group once everyone understands *how to solve* the first problem and then repeat for the second problem ...

You may not move to the next problem until you check off or discuss with another group and *everyone understands why the solution is what it is*. You may use any course resources at your disposal: the purpose of this review session is to have everyone learning together as a group.

0.1 What would Python display?

```
>>> pikachu, charmander = 'electric', 'fire'
>>> ash = [[pikachu], [charmander], [[pikachu]]]
>>> pikachu, charmander = 2, 0
>>> ash[pikachu] = [ash, ash[pikachu][charmander]]
>>> ash
```

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1 Lists & Tree Recursion

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Mutative (*destructive*) operations change the state of a list by adding, removing, or otherwise modifying the list itself.

- `lst.append(element)`
- `lst.extend(lst)`
- `lst.pop(index)`
- `lst += lst` (**not** `lst = lst + lst`)
- `lst[i] = x`
- `lst[i:j] = lst`

Non-mutative (*non-destructive*) operations include the following.

- `lst + lst`
- `lst * n`
- `lst[i:j]`
- `list(lst)`

Recall: To execute assignment statements,

- Evaluate all expressions to the right of the = sign
- Bind all names to the left of the = to those resulting values

The **Golden Rule of Equals** describes how this rule behaves with composite values. *Composite values*, such as functions and lists, are connected by a pointer. When an expression evaluates to a composite value, we are returned the pointer to that value, rather than the value itself.

In an environment diagram, we can summarize this rule with,

Copy *exactly* what is in the box!

1.1 Write a list comprehension that accomplishes each of the following tasks.

- (a) Square all the elements of a given list, `lst`.
- (b) Compute the dot product of two lists `lst1` and `lst2`. *Hint:* The dot product is defined as $lst1[0] \cdot lst2[0] + lst1[1] \cdot lst2[1] + \dots + lst1[n] \cdot lst2[n]$. The Python `zip` function may be useful here.

- (c) `[[0], [0, 1], [0, 1, 2], [0, 1, 2, 3], [0, 1, 2, 3, 4]]`

- (d) Return the same list as above, except now excluding every instance of the number 2: `[[0], [0, 1], [0, 1, 3], [0, 1, 3, 4]]`

1.2 Draw the environment diagram that results from running the following code.

```
pom = [16, 15, 13]
pompom = pom * 2
pompom.append(pom[:])
pom.extend(pompom)
```

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- 1.3 Draw the environment diagram that results from running the following code.

```

bless, up = 3, 5
another = [1, 2, 3, 4]
one = another[1:]

another[bless] = up
another.append(one.remove(2))
another[another[0]] = one
one[another[0]] = another[1]
one = one + [another.pop(3)]
another[1] = one[1][1][0]
one.append([one.pop(1)])

```

1.4 **def** jerry(jerry):
 def jerome(alex):
 alex.append(jerry[1:])
 return alex
 return jerome

```

ben = ['nice', ['ice']]
jerome = jerry(ben)
alex = jerome(['cream'])
ben[1].append(alex)
ben[1][1][1] = ben
print(ben)

```

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- 1.5 Implement `subset_sum`, which takes in a list of integers and a number k and returns whether there is a subset of the list that adds up to k ? *Hint*: The `in` operator can determine if an element belongs to a list.

```
def subset_sum(seq, k):
    """
    >>> subset_sum([2, 4, 7, 3], 5)      # 2 + 3 = 5
    True
    >>> subset_sum([1, 9, 5, 7, 3], 2)
    False
    """
```

2 Trees Assignment Project Exam Help

```
def tree(label, branches=[]):
```

```
    return [label] + list(branches)
```

```
def label(tree):
```

```
    return tree[0]
```

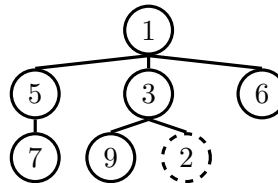
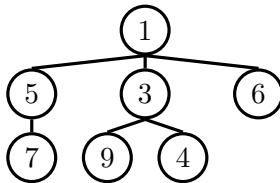
```
def branches(tree):
```

```
    return tree[1:]
```

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- 2.1 A **min-heap** is a tree with the special property that every node's value is less than or equal to the values of all of its branches.



Implement `is_min_heap` which takes in a tree data abstraction and returns whether the tree satisfies the min-heap property or not.

3 Growth

3.1 Give a tight asymptotic runtime bound for the following functions in $\Theta(\cdot)$ notation, or “Infinite” if the program does not terminate.

(a) **def** one(n):

```
    while n > 0:
        n = n // 2
```

(b) **def** two(n):

```
    for i in range(n):
        for j in range(i):
            print(str(i), str(j))
```

(c) **def** three(n):

```
    i = 1
    while i <= n:
        for j in range(i):
            print(j)
        i *= 2
```

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4 Nonlocals & OOP

4.1 Draw the environment diagram that results from running the code.

```
def campa(nile):
    def ding(ding):
        nonlocal nile
        def nile(ring):
            return ding
        return nile(ding(1914)) + nile(1917)
```

```
ring = campa(lambda nile: 103)
```

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4.2 Implement the classes so that the code to the right runs.

```
class Plant:
```

```
    def __init__(self):
```

```
    def absorb(self):
```

```
    def grow(self):
```

```
class Leaf:
```

```
    def __init__(self, plant):
```

```
    def absorb(self):
```

```
    def __repr__(self):
        return 'Leaf'
```

```
class Sugar:
```

```
    def __init__(self, leaf, plant):
```

```
    def activate(self):
```

```
    def __repr__(self):
        return 'Sugar'
```

```
>>> p = Plant()
>>> p.height
1
>>> p.materials
[]
>>> p.absorb()
>>> p.materials
[Sugar]
>>> Sugar.sugars_created
1
>>> p.leaf.sugars_used
0
>>> p.grow()
>>> p.materials
[]
>>> p.height
2
>>> p.leaf.sugars_used
1
```

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5 Exam Preparation *Extra Practice*

- 5.1 Implement `slice_reverse` which takes a linked list `s` and mutatively reverses the elements on the interval, $[i, j)$ (including i but excluding j). Assume `s` is zero-indexed, $i > 0$, $i < j$, and that `s` has at least j elements.

```
def slice_reverse(s, i, j):
```

```
    """
```

```
    >>> s = Link(1, Link(2, Link(3)))
```

```
    >>> slice_reverse(s, 1, 2)
```

```
    >>> s
```

```
    Link(1, Link(2, Link(3)))
```

```
    >>> s = Link(1, Link(2, Link(3, Link(4, Link(5)))))
```

```
    >>> slice_reverse(s, 2, 4)
```

```
    >>> s
```

```
    Link(1, Link(2, Link(4, Link(3, Link(5)))))
```

```
    """
```

```
    start =
```

```
    for
```

```
        start =
```

```
    reverse = Link.empty
```

```
    current =
```

```
    for
```

```
        
```

```
        current.rest =
```

```
        reverse =
```

```
        current =
```

```
    
```

```
    
```

```
    
```

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- 5.2 A **Binary Search Tree** is a tree where each node contains either 0, 1, or 2 nodes and where the left branch (if present) contains values *strictly less than* ($<$) the root value, and the right branch (if present) contains values *strictly greater than* ($>$) the root value. The definition is recursive: both the left and right branches must also be BSTs for the entire tree to be a BST.

Implement `is_binary` which takes in a Tree `t`, and returns `True` if `t` is a Binary Search Tree and `False` otherwise. Trees can contain any number of branches, but if a tree contains only one branch, interpret it as a left branch.

```
def is_binary(t):
    def binary(t, lo, hi):

        if _____:

            if t.is_leaf():
                return True

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            elif _____:

                return https://powcoder.com

            elif _____:

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                return _____

            return False
    return binary(t, float('-inf'), float('inf'))
```

- 5.3 Give a tight asymptotic runtime bound for the following scenarios in $\Theta(\cdot)$ notation, or “Infinite” if the program does not terminate. Assume the implementation of `is_binary` is optimal.

- (a) `is_binary` on a well-formed binary search tree with n nodes.
- (b) `is_binary` on a tree where each node contains 3 branches and the overall height of the tree is n .