Mock Final Exam. Work alone for the first 30 minutes. (This will be graded for participation only.)
NOTE: These problems were written by the instructor.

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1. (Linked Lists) Use the `LinkedList` and `Node` class definitions below to answer the question. You may directly access the attributes or use typical names for setters/getters.

```
class Node:
    def __init__(self, value):
        self._value = value
        self._next = None

    def get_next(self):
        return self._next
```

```
class LinkedList:
    def __init__(self):
        self._head = None

    def add(self, new):
        new._next = self._head
        self._head = new

    def get_head(self):
        return self._head
```

Write a function `compare(llistA, llistB)` that takes linked lists `llistA` and `llistB` as arguments and returns the following:

-1 if `llistA` is shorter than `llistB`
1 if `llistB` is shorter than `llistA`
0 if the lists are the same length

Your solution **must not** simply count the lengths of the lists and compare them, since the complexity would be proportional to the sum of the lengths of the lists.

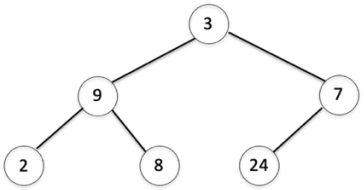
Instead, the complexity of your solution **must** be proportional to the length of the smaller list. ***Use an iterative solution.***

2. (Trees) Consider the following definition of a BinaryTree class:

```
class BinaryTree:
    def __init__(self, value):
        self._value = value
        self._left = None
        self._right = None
```

Use this class to write the solution to the problem below. You may directly access the attributes of the `BinaryTree` class when writing your function, or you may use typical names for getters/setters of the attributes.

Write a function `notate_interior(tree)` that takes a binary tree `tree` and produces an *inorder* traversal of the tree, with `"I"` following any interior node. The output should print the value of each node, one per line. For example, for the following tree



the output would be

```
2
9 I
8
3 I
24
7 I
```

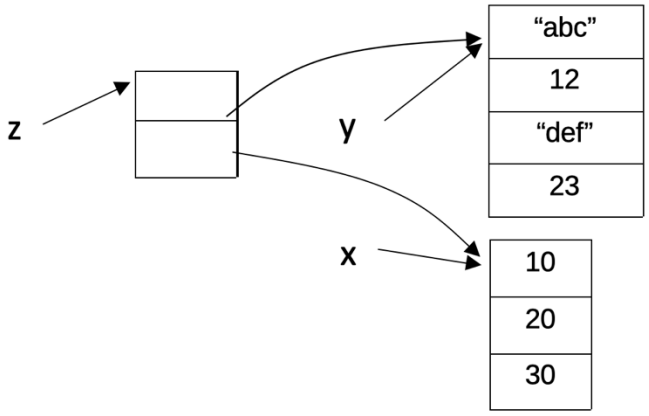
3. (Recursion) Write a ***recursive*** function `every_third(alist)` that returns a list consisting of the elements at every 3rd position of the Python list `alist`. The first element is at position 0; "every 3rd position" means the elements at positions `0, 3, 6, 9,….` For example, the call `every_third([11,22,33,44,55,66,77,88])` should return the list `[11,44,77].` Assume there is at least one element in the list.

4. (Short answer.)
   a) Some data types in Python are *immutable*. Describe in one sentence what that means and give an example of an immutable data type.

   b) What method is defined in a class so that two objects of that class can be compared with the "==" operator?

   c) How is a binary search tree different from a regular binary tree?

5. (References) Write the code that would produce the data objects in the diagram below:



Put your code below:

6. (Complexity) Consider the function defined below:

```
def has_overlaps(list_a, list_b):
    for item in list_b:
        if item in list_a:
            return True
    return False
```

a) Explain why the code below is $O(n^2)$.

b) Give an example of two lists that demonstrate the worst-case complexity.

7. (Complexity) Under what condition is searching for an item in a list O(log(n))?

8. (General programming) Write a function `get_min(invent_dict)` that takes a dictionary of strings that map to integers and returns a list containing a tuple of the key/value pair that has the minimum value. Assume that all values are 0 or greater. **If there are ties, the function returns all of the key/value pairs that have the same minimum.**

   For example, given the dictionary `d` below

   ```
   d = {"spoons": 7, "knives" : 8, "forks": 6, "plates": 10, "cups": 6}
   ```

   The call `get_min(d)` returns `[ ("forks", 6), ("cups", 6) ]`.

   Restrictions: You may not use list comprehensions or the built-in functions `min()` or `sort()`. Your function must have complexity O(n) and must only iterate through the dictionary *one time*.