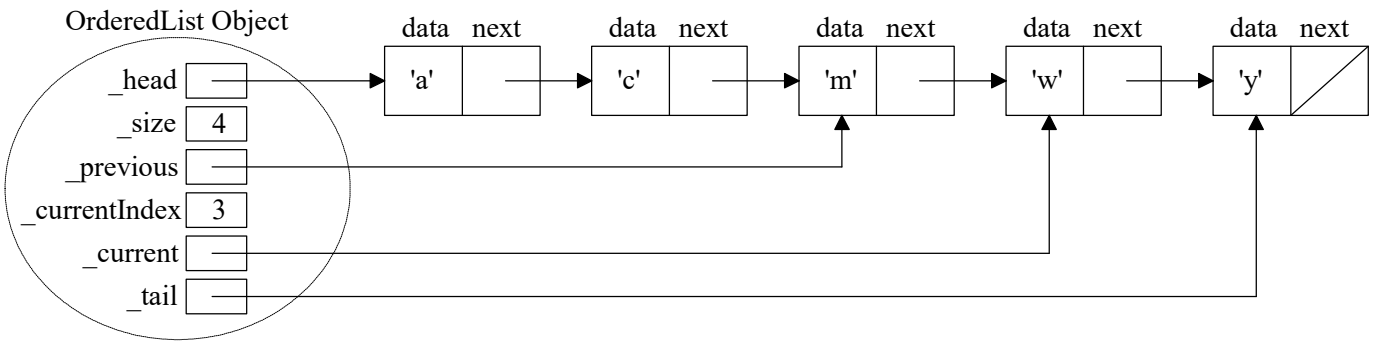
Data Structures (CS 1520) Lab 5 Name:_____

Objective: To understand recursion by writing simple recursive solutions.

To start the lab: Download and unzip the file at: www.cs.uni.edu/~fienup/cs1520s19/labs/lab5.zip

Part A: Recall: We modified the textbook's ordered list ADT that uses a singly-linked list implementation by adding the `_size`, `_tail`, `_current`, `_previous`, and `_currentIndex` attributes:




```
##    NON-RECURSIVE CODE WE ARE REPLACING
 def search(self, targetItem):
    if self._current != None and \
        self._current.getData() == targetItem:
          return True

      self._previous = None
      self._current = self._head
      self._currentIndex = 0
      while self._current != None:
          if self._current.getData() == targetItem:
              return True
          elif self._current.getData() > targetItem:
              return False
          else: #inch-worm down list
              self._previous = self._current
              self._current = self._current.getNext()
              self._currentIndex += 1
      return False
```

```
def search(self, targetItem):
  def searchHelper():
     """ Recursive helper function that moves down the linked list.
         It has no parameters, but uses self._current, self._previous,
         self._currentIndex."""
       # ADD CODE HERE




   # START OF SEARCH - DO NOT MODIFY BELOW CODE
   if self._current != None and \
      self._current.getData() == targetItem:
       return True

   self._previous = None
   self._current = self._head
   self._currentIndex = 0
   return searchHelper()  # Returns the result of searchHelper
```

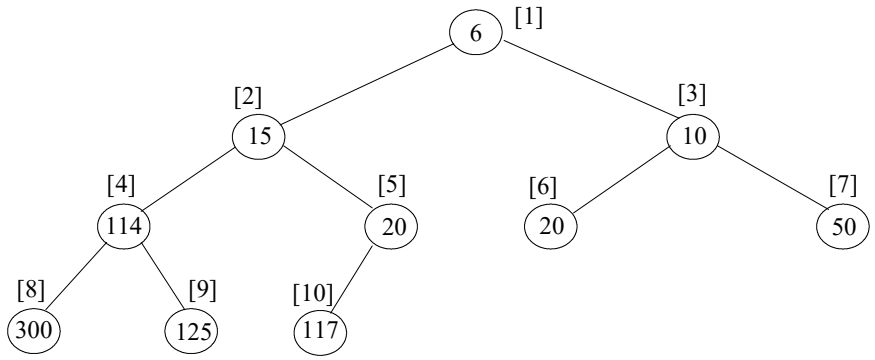
a) What are the base case(s) for the `searchHelper` that **halt** the while-loop of the non-recursive search codc?

b) What are the recursive case(s) for the `searchHelper` that replaces the while-loop of the non-recursive search codc?

c) Complete the recursive `searchHelper` function in the `search` method of our `OrderedList` class in `ordered_linked_list.py`. Test it with the `listTester.py` program.

Raise your hand when done. Demonstrate and explain your code to an instructor.

Part B: Recall that Lecture 7 and Section 6.6 discussed a very "non-intuitive", but powerful list/array-based approach to implement a priority queue, call a binary heap. The list/array is used to store a *complete binary tree* (a full tree with any additional leaves as far left as possible) with the items being arranges by *heap-order property*, i.e., each node is ≤ either of its children. An example of a *min* heap "viewed" an a complete binary tree would be:



Python List actually used to store heap items

0	1	2	3	4	5	6	7	8	9	10
not used	6	15	10	114	20	20	50	300	125	117

Recall the General Idea of `insert(newItem)`:

- append newItem to the end of the list (easy to do, but violates heap-order property)
- restore the heap-order property by repeatedly swapping the newItem with its parent until it *percolates up* to the correct spot

Recall the General Idea of `delMin()`:

- remember the minimum value so it can be returned later (easy to find - at index 1)
- copy the last item in the list to the root, delete it from the right end, decrement size
- restore the heap-order property by repeatedly swapping this item with its smallest child until it *percolates down* to the correct spot
- return the minimum value

Originally, we used iteration (i.e., a loop) to percolate up (see `percUp`) and percolate down (see `percDown`) the tree. (textbook code below)

```
##    NON-RECURSIVE CODE WE ARE REPLACING

def percUp(self,i):
    while i // 2 > 0:
        if self.heapList[i] < self.heapList[i//2]:
           tmp = self.heapList[i // 2]
           self.heapList[i // 2] = self.heapList[i]
           self.heapList[i] = tmp
        i = i // 2
```

```
def percDown(self,i):
    while (i * 2) <= self.currentSize:
        mc = self.minChild(i)
        if self.heapList[i] > self.heapList[mc]:
            tmp = self.heapList[i]
            self.heapList[i] = self.heapList[mc]
            self.heapList[mc] = tmp
        i = mc
```

For part B, I want you to complete the recursive `percUpRec` and recursive `percDownRec` methods in `binHeap.py`. Run the `binHeap.py` file to test your code.

Raise your hand when done. Demonstrate and explain your code to an instructor.

(If you have extra time, work on previous labs or homeworks!)