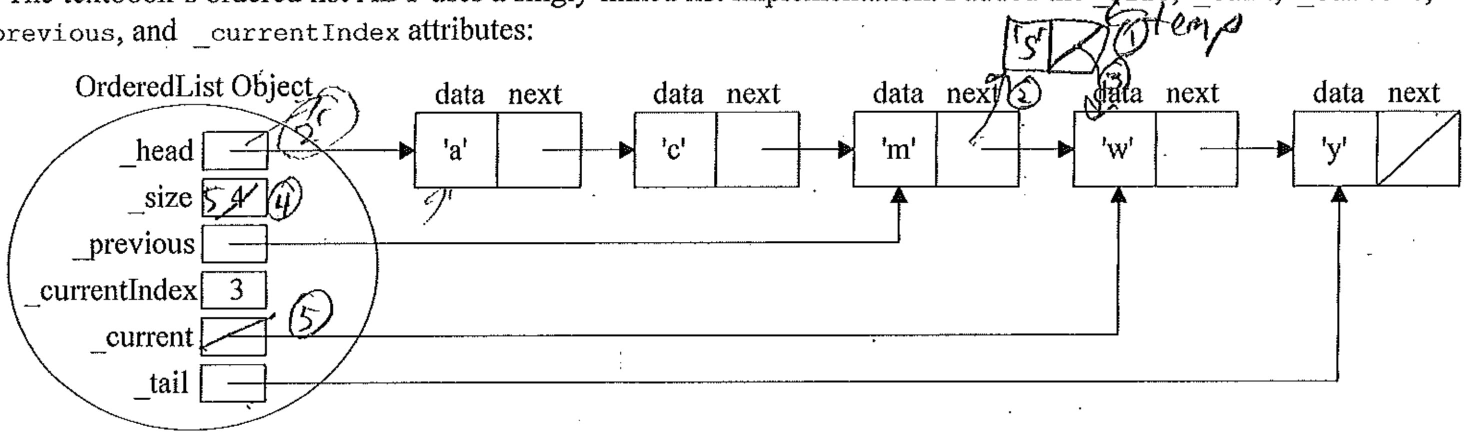
1. The textbook's ordered list ADT uses a singly-linked list implementation. I added the `_size`, `_tail`, `_current`, `_previous`, and `_currentIndex` attributes:



The `search(targetItem)` method searches for `targetItem` in the list. It returns `True` if `targetItem` is in the list; otherwise it returns `False`. Additionally, it has the side-effects of setting `_current`, `_previous`, and `_currentIndex`. The complete `search(targetItem)` method code for the `OrderedList` is:

```
class OrderedList:

   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
```

a) What's the purpose of the "`elif self._current.getData() > targetItem:`" check?

b) Complete the `add(item)` method including a check of it's precondition: `newItem` is not in the list.

```
   def add(self, newItem):
       if self.search(newItem):
           raise ValueError("Cannot add duplicates to list.")
       temp = Node(newItem)
       if self._previous == None:
           self._head = temp
       else:
           self._previous.setNext(temp)
       temp.setNext(self._current)
       if self._current == None:
           self._tail = temp
       self._current = None
       self._size += 1
```

2. A *recursive function* is one that calls itself. Complete the recursive code for the `countDown` function that is passed a starting value and proceeds to count down to zero and prints "Blast Off!!!".

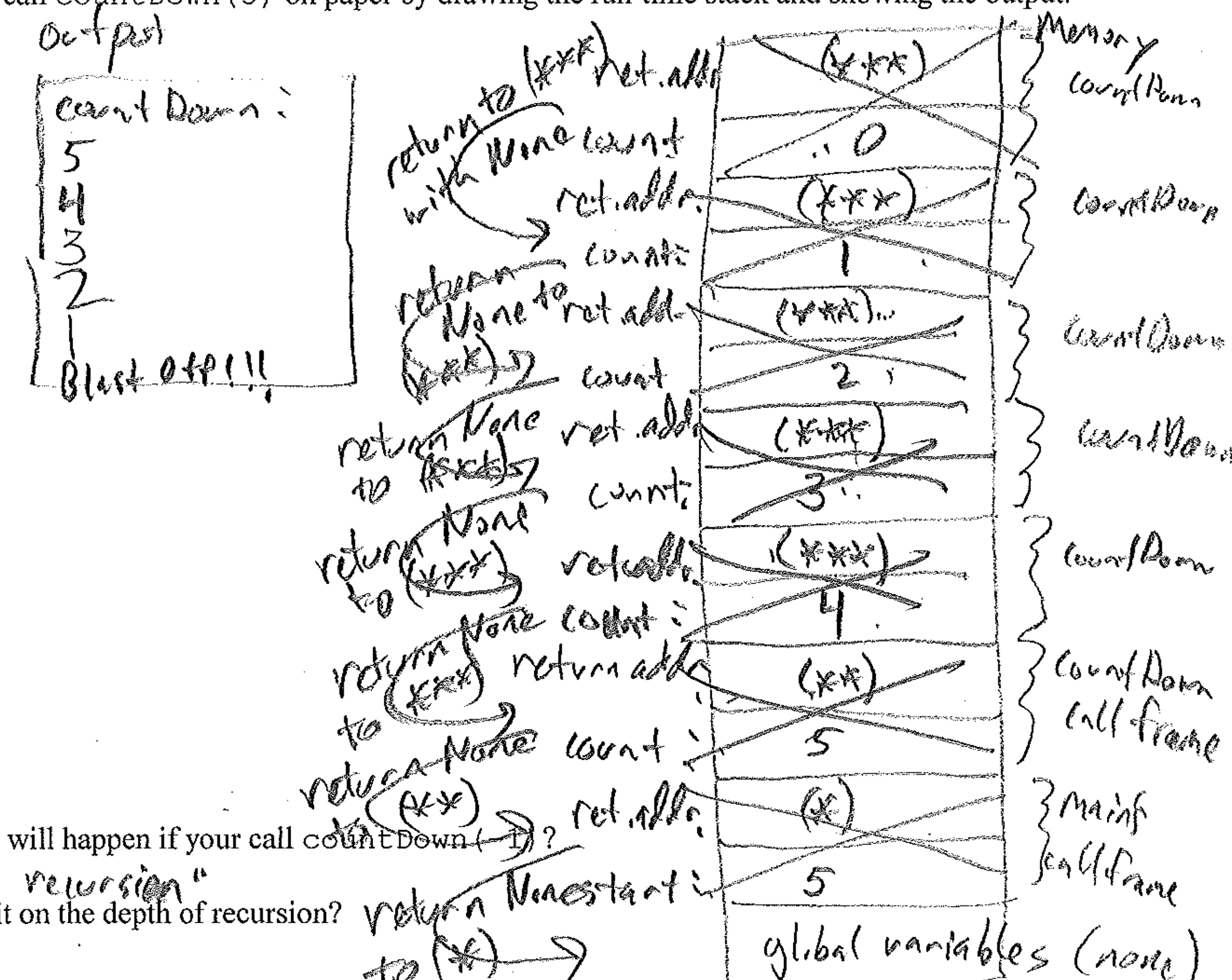
Hint: The `countDown` function, like most recursive functions, solves a problem by splitting the problem into one or more simpler problems of the same type. For example, `countDown(10)` prints the first value (i.e, 10) and then solves the simpler problem of counting down from 9. To prevent "infinite recursion", if-statement(s) are used to check for trivial *base case*(s) of the problem that can be solved without recursion. Here, when we reach a `countDown(0)` problem we can just print "Blast Off!!!".

```
""" File:  countDown.py """

def main():
    start = eval(input("Enter count down start: "))
    print("\nCount Down:")
    countDown(start)      "actual parameter"
    (**)
def countDown(count):     "formal parameter"
    if count <= 0:
        print("Blast off!!!")
    else:
        print(count)
        countDown(count-1)
        (***)

main()
(*)
```

Program Output:

```
Enter count down start: 10 5

Count Down:
10
9
8
7
6
5
4
3
2
1
Blast Off!!!
```

a) Trace the function call `countDown(5)` on paper by drawing the run-time stack and showing the output.



b) What do you think will happen if your call `countDown(-1)`?

"infinite recursion"

c) Why is there a limit on the depth of recursion?

Non-recursive code:

```
def CountDown(count):      # 10
    while count > 0:
        print(count)
        count -= 1
    print("Blast Off!!!")
```

Recursive:

base case(s):
  count == 0: print("Blast off!!!")

recursive case(s)
  count > 0: print(count)
  CountDown(count - 1)

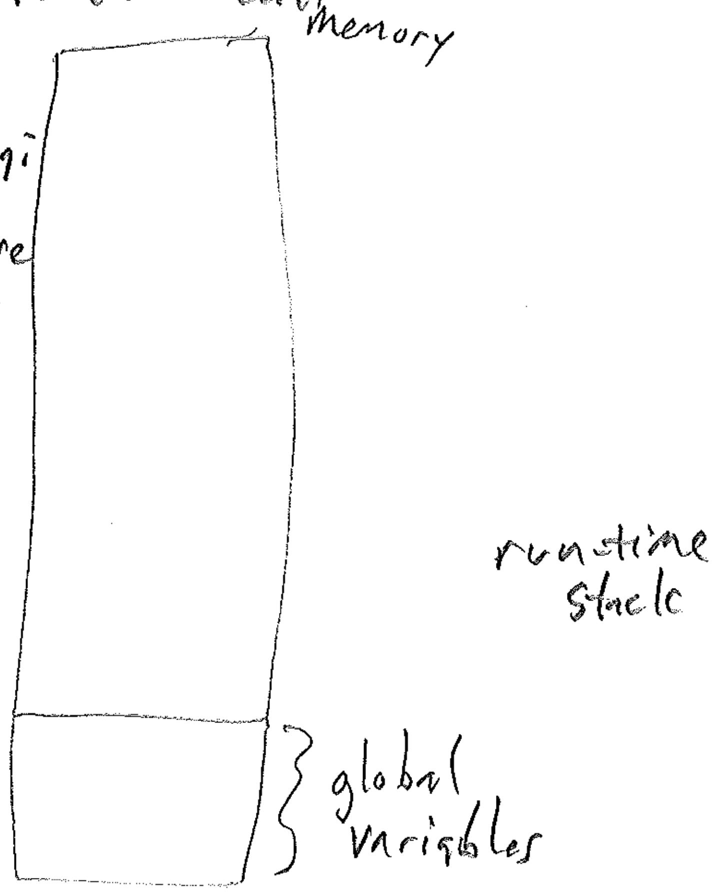
What happens on a function call?

Push call-frame on run-time stack including:

(1) "return address" - where to return to in caller

(2) parameters

(3) local variables



What happens on a return?

- continue execution at ret. addr. with the returned value or default None by popping call-frame

3. Complete the recursive strHelper function in the __str__ method for our OrderedList class.

```
def __str__(self):
    """ Returns a string representation of the list with a space between each item. """

    def strHelper(current):
        if current == None:
            return ""
        else:
            return str(current.getData()) + " " + strHelper(current.getNext())

    return "(head) " + strHelper(self._head) + "(tail)"
```

"(head) a c m w (tail)"

base case: current == None
return ""

(see next page too)

4. Some mathematical concepts are defining by recursive definitions. One example is the Fibonacci series:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, ...

After the second number, each number in the series is the sum of the two previous numbers. The Fibonacci series can be defined recursively as:

$Fib_0 = 0$

$Fib_1 = 1$

$Fib_N = Fib_{N-1} + Fib_{N-2}$ for $N \geq 2$.

a) Complete the recursive function: `def fib (n):`

b) Draw the *call tree* for fib(5).

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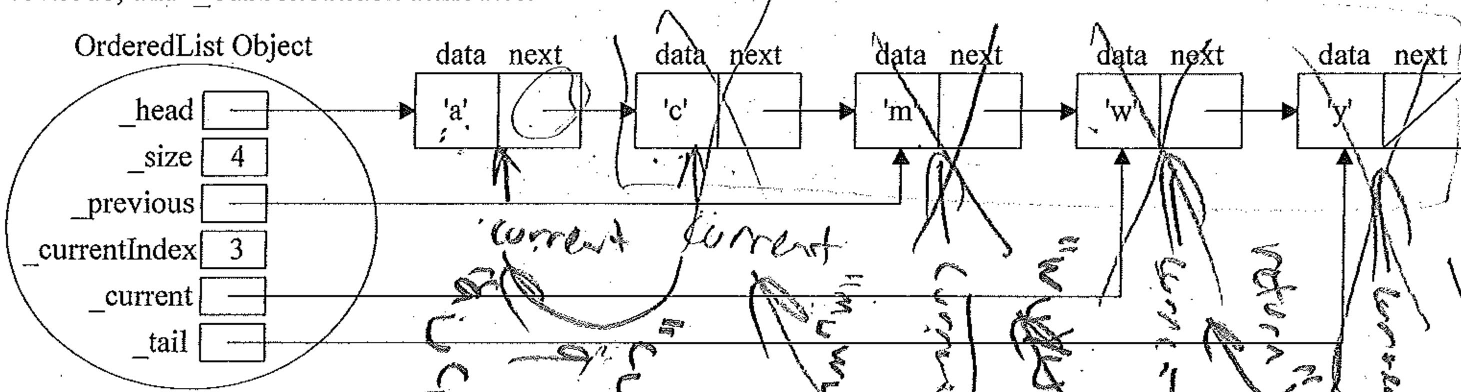

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