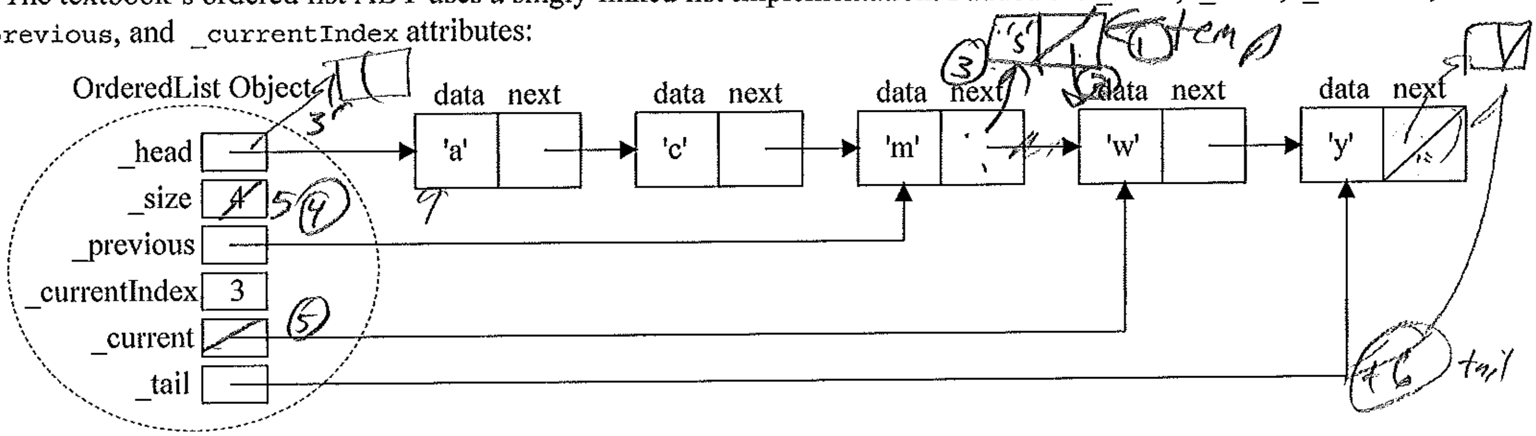
Data Structures (CS 1520) Lecture 9 Name:____________

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) == True:
    raise Exception(" ——— ")

Special cases:
(1) newItem added at head (3')
(2) newItem added at tail (+6)
(3) newItem 1st item (3' & +6 might handle?)

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 param.
    if count == 0:
        print("Blast off!!!")
    else:
        print(count)
        countDown(count-1)
        (***)

main()
```

non-recursive

```
def countDown(count):
    while count > 0:
        print(count)
        count = count - 1
    print("Blast off!!!")
```

Program Output:

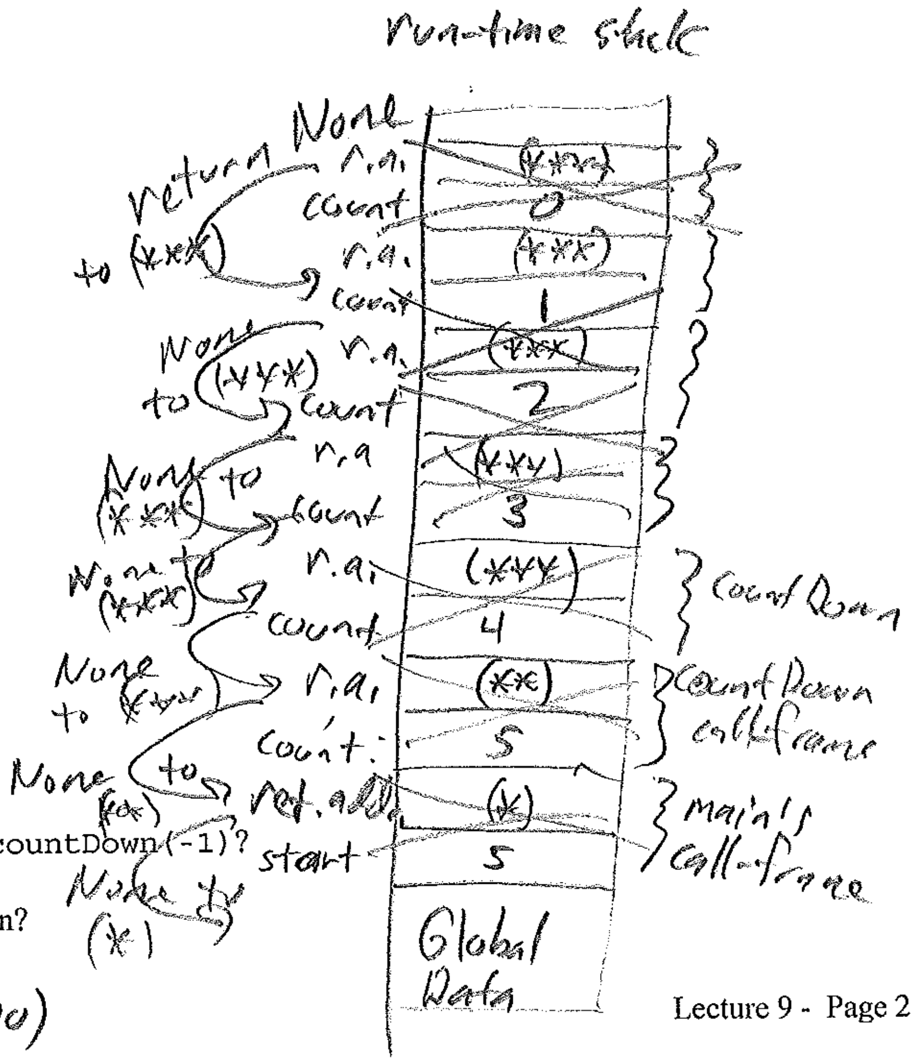
```
Enter count down start: 10

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.

output

5
4
3
2
1
Blast off!!!



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?

import sys
sys.setrecursionlimit(10000)

Call a function :

Push a call-frame on run-time stack in memory containing:

(1) return address - where to return execution when function ends

(2) parameters sent

(3) local variables created in function

When function ends / return, returns its return value or default None to the return address

and

pop 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:                "m"  "c"
            return str(current.getData()) + " " + strHelper(current.getNext())
                              "c"                    ""
                                                     "mu"
    #start __str__  "a c u m"                        "cumu"
    return "(head) " + strHelper(self._head) + "(tail)"
```

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:

$Fib_0 = 0$

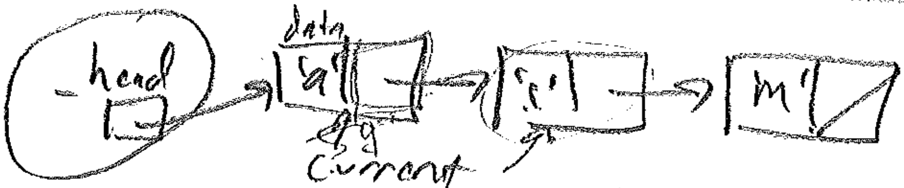
$Fib_1 = 1$

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

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

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

Non-recursive __str__ for OrderedList



"(head)␣a␣c␣m␣(tail)"

a␣ + {rest of string}

```
resultStr = "(head)␣"
current = self._head
while current != None:
    resultStr += str(current.getData()) + "␣"
    current = current.getNext()
resultStr += "(tail)"
```

Trace __str__ recursive