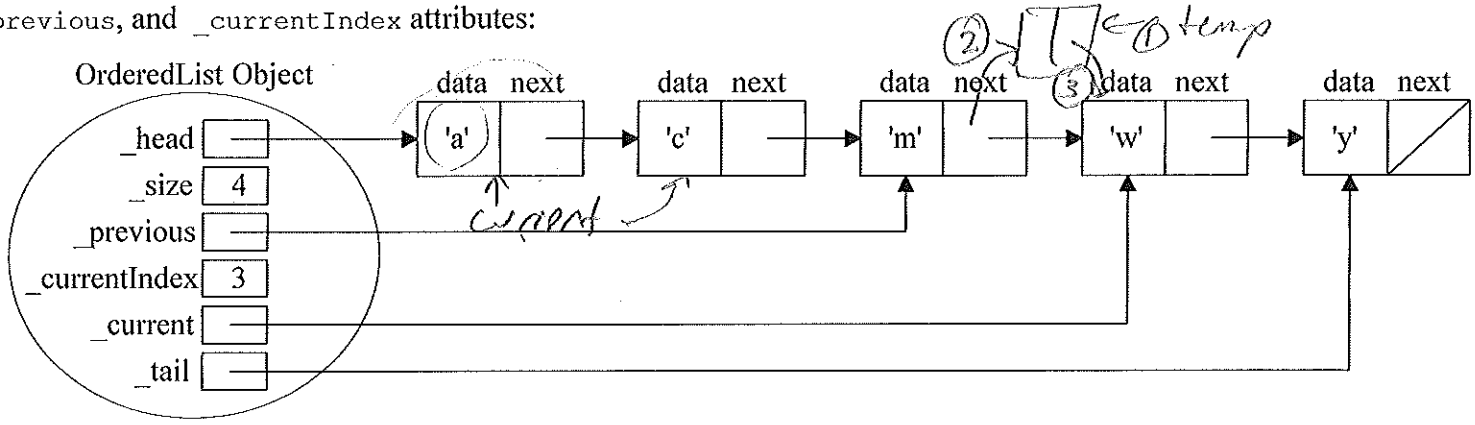
Data Structures (CS 1520) Lecture 9 Name:_____

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):
        raise ValueError("Cannot ...")
    temp = Node(newItem)
    if self._previous == None: # add at head
        self._head = temp
    else:
        self._previous.setNext(temp)
    temp.setNext(self._current)
    if self._current == None: # add at tail
        self._tail = temp
    self._size += 1
    self._current = None
```

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)

def countDown(count):
    if count <=0:
        print('Blast off!!!')
    else:
        print(count)
        countDown(count-1)

main()
```

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.

(See attached)

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

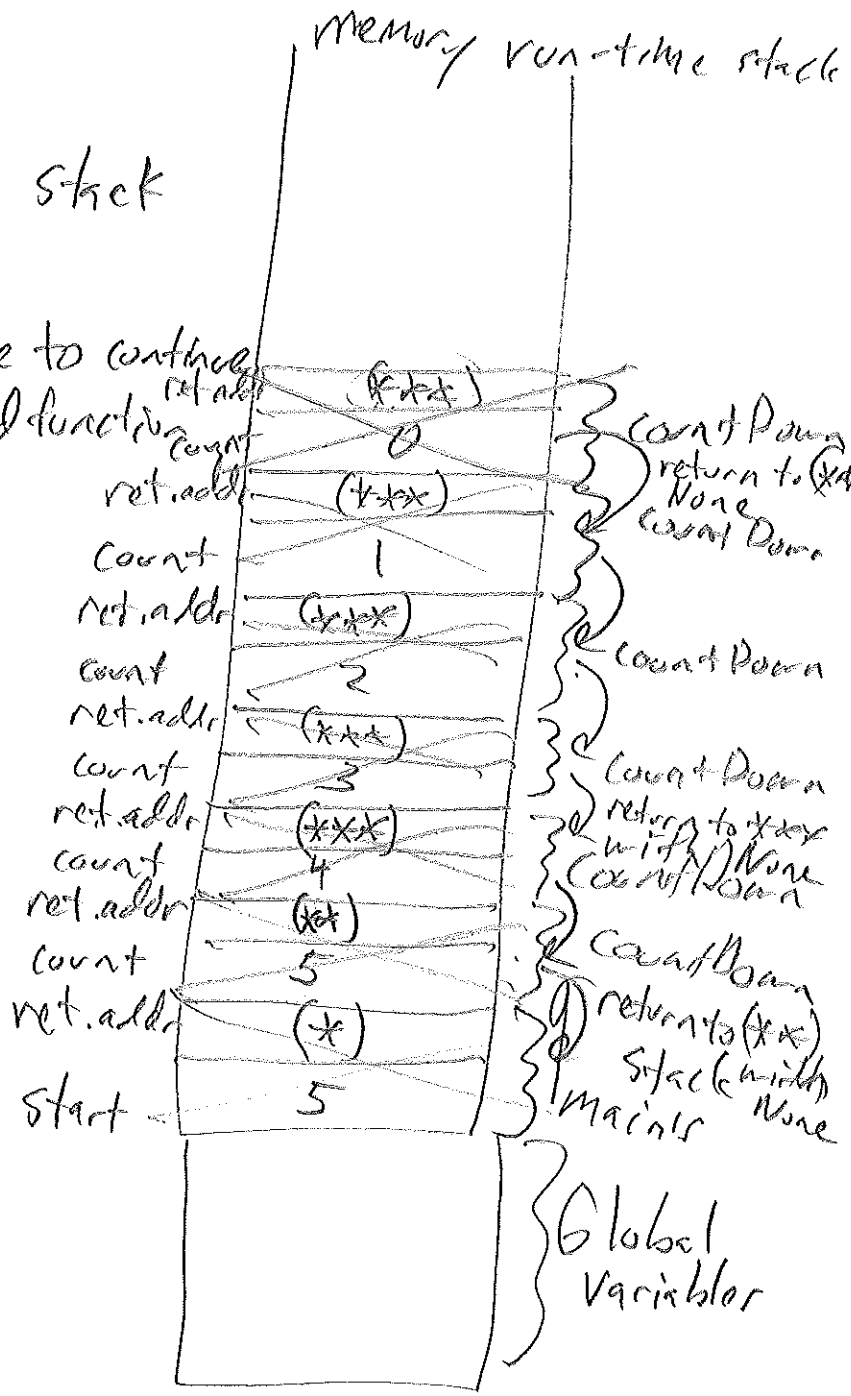
c) Why is there a limit on the depth of recursion? run out of memory

Call function / method

push call-frame on stack

contains:

- return addr. – where to continue after returning / end function
- parameters
- local variables



output

```
Count Down:
5
4
3
2
1
Blast off!!!
```

```
import sys
sys.setrecursionlimit(10000)
```

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)"
```

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, 89

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:

$Fib_0 = 0$

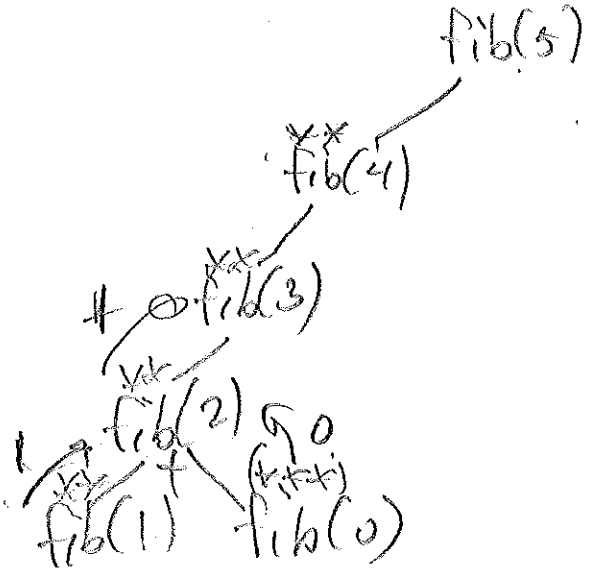
$Fib_1 = 1$

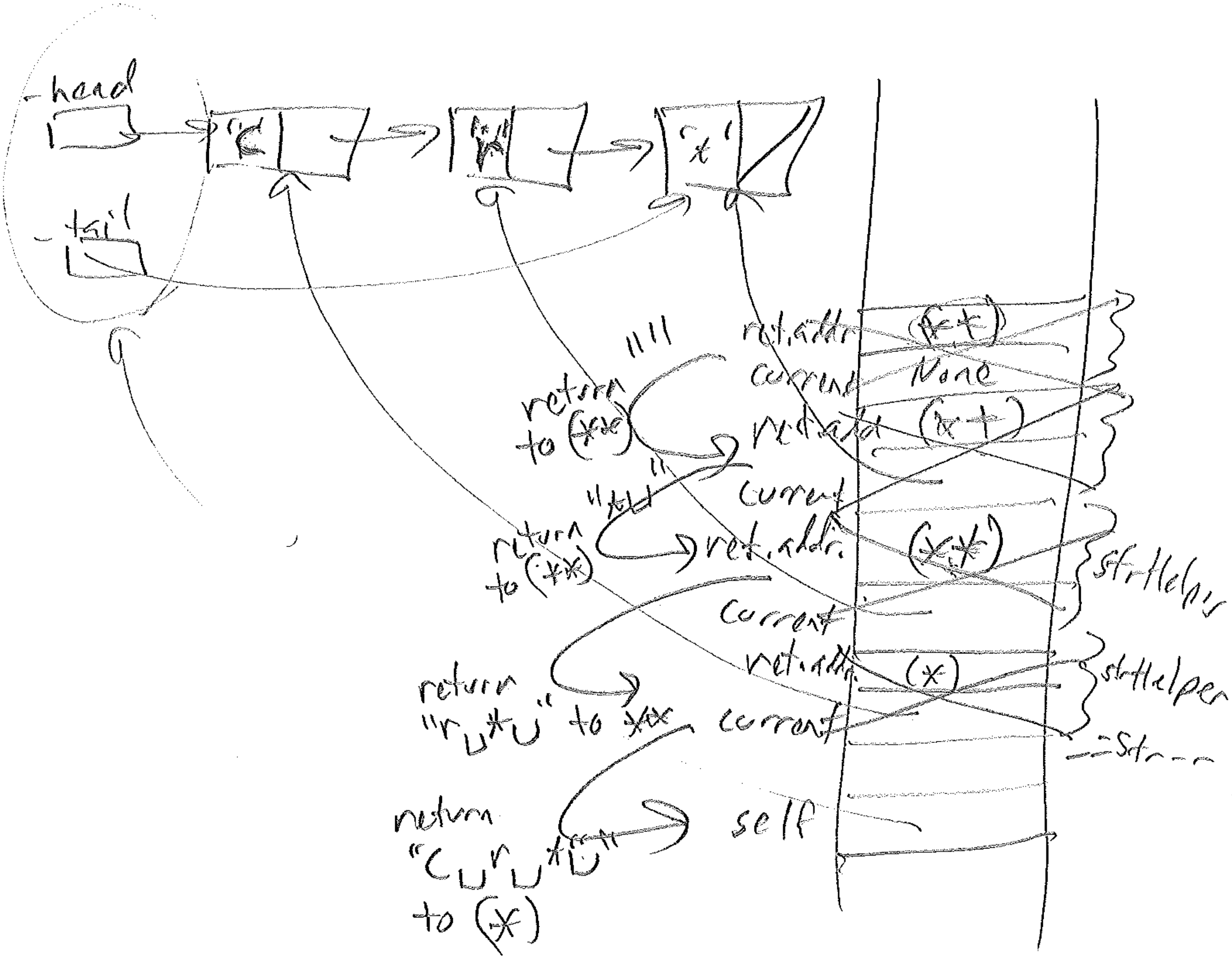
$Fib_N = Fib_{N-1} + Fib_{N-2}$ for $N \geq 2$.

a) Complete the recursive function:

```
def fib(n):
    if n == 0:
        return 0
    elif n == 1:
        return 1
    else:
        return fib(n-1) + fib(n-2)
```

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





_head
_tail
ret.addr
current
None
ret.addr
current
ret.addr
current
ret.addr
current
self
return to (***)
return to (**)
return "r␣*␣" to **
return "c␣r␣*␣" to (*)
strHelper
strHelper
__str__