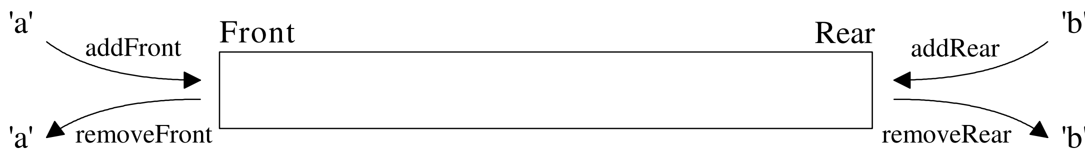
Fall 2010 Name: ________________________

Data Structures - Test 2

Question 1. A Deque (pronounced “Deck”) ADT is like a queue, but it allows adding or removing items from either the front or the rear of the Deque. Abstractly, the Deque behaves as:



Consider the following Deque implementation which uses a Python list representation.

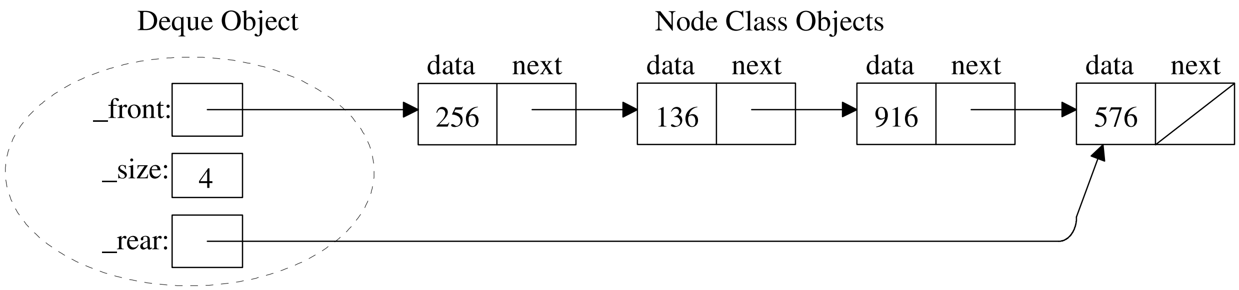
```
class Deque:
    def __init__(self):
        self.items = []

    def isEmpty(self):
        return self.items == []

    def addRear(self, item):
        self.items.append(item)

    def addFront(self, item):
        self.items.insert(0,item)

    def removeRear(self):
        return self.items.pop()

    def removeFront(self):
        return self.items.pop(0)

    def __len__(self):
        return len(self.items)
```

a) (10 points) Complete the worst-case big-oh notation for each Deque operation assuming the above implementation. Let n be the number of items in the Deque.

isEmpty	addFront	addRear	removeFront	removeRear	len

b) (8 points) Instead of the above list representation of a Deque, explain how an Array (the textbook Array class) can be used to improve performance of the Deque.

Question 2. An alternative implementation of a Deque would be a linked implementation as in:



a) (6 points) Complete the worst-case big-oh notation for each Deque operation assuming the above implementation. Let n be the number of items in the Deque.

isEmpty	addFront	addRear	removeFront	removeRear	len

b) (9 points) Provide a sentence or two of justification for your answers in part (a) for each of the following operations:

removeFront:

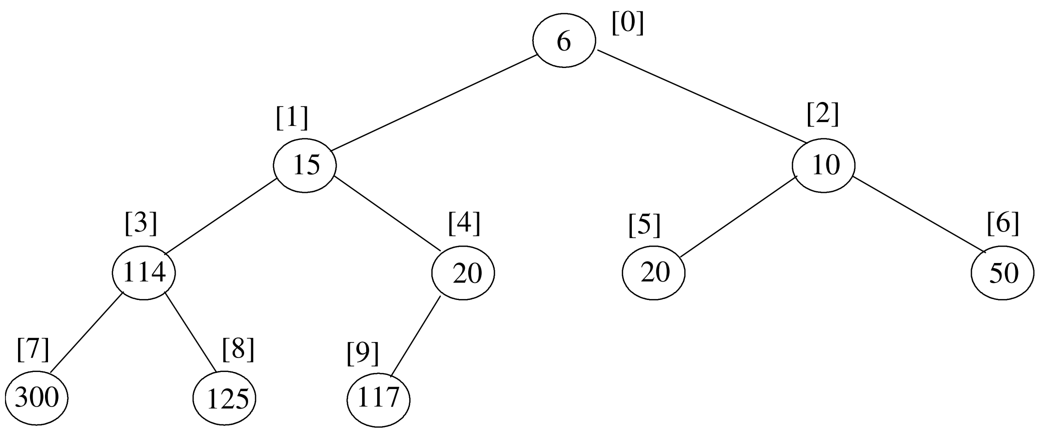
removeRear

c) (20 points) Complete the addFront and removeFront methods of the linked Deque implementation:

```
from node import Node    # Has constructor method: Node(myData, myNext)
                         # Has public data attributes: data and next

class Deque:
    def __init__(self):
        self._front = None
        self._rear = None
        self._size = 0

    def addFront(self, item):




    def removeRear(self):
```

d) (7 points) Suggest a recommendation for improving the linked implementation of the Deque.

Question 3. Consider the following heap with array indexes indicated in [ ]'s.



a) (4 points) For a node at index i, what is the index of:

- its left child if it exists:
- its parent if it exists:

b) (10 points) What would the above heap look like after adding 18, **and then** popping (dequeuing) an item?

c) (6 points) Explain why adding a new item to a heap has a worst-case big-oh of $O(\log_2 n)$, where n is the number of items in the heap

Question 4. Consider implementing a **sorted** list ADT that includes the following operations:

- indexed-based operations: [ ] as an accessor and `remove` (e.g., print myList[i] and myList.remove(i))
- content-based operations: `insert` and `index` (e.g., myList.insert(item) and i = myList.index(item))

a) (5 points) If the underlying representation is an Array sorted by item values, then complete the worst-case big-oh notation for each sorted list operation. Assume that a binary search is used to find an item. Let n be the number of items in the sorted list.

myList[i]	myList.remove(i)	myList.insert(item)	i = myList.index(item)

b) (5 points) If the underlying representation is a doubly-linked list sorted by item values, then complete the worst-case big-oh notation for each sorted list operation. Let n be the number of items in the sorted list.

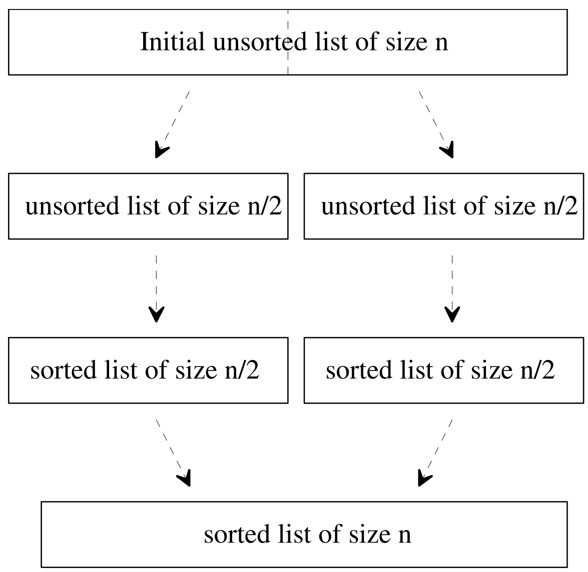
myList[i]	myList.remove(i)	myList.insert(item)	i = myList.index(item)

Question 5. Recall that merge sort is a recursive divide-and-conquer algorithm such that:

Divide - splits list/array into two equal parts

Conquer - recursively merge sort each half

Combine - merge the sorted halves back together



a) (5 points) When merging two sorted lists of size n/2 each, what is the worst-case number of comparisons that must be performed? (justify your answer for partial credit)

b) (5 points) What maximum depth of recursion does the merge sort algorithm require when sorting a list of size n? (justify your answer for partial credit)