CS1332 Fall 2018 - Week 03

Labor Day - 9/3/18

9/5/18

Topics

I. Stacks review
    A. Stack ADT - abstract data type with the expected “Last In, First Out” (LIFO) behavior; can be implemented with an Array, SLL, or DLL

II. Queues
    A. An ADT like the stack, but with the expected “First In, First Out” (FIFO) behavior.
    B. Queues are very linear structures
        1. Applications: a water pipe, waitlists, print queues, online orders
    C. Operations:
        1. enqueue(x) - adds to one end
        2. x dequeue() - removes from the opposite end
        3. x peek() - returns the item at the front of the queue without removing it
        4. isEmpty()
        5. size()

III. SLL-backed queue
    A. Must have a head and a tail - which end do we perform each operation at?
        1. If we add to the head, we have to remove from the tail, but removing from the tail of a SLL is O(n)
        2. Instead, add to the tail and remove from the head
            a) Adding to the tail - O(1)
            b) Removing from the head - O(1)

IV. Array-backed queue
    A. Values we will keep track of:
        1. capacity - length of the backing array
        2. front index - of first element
        3. back index - of last element (can also be the spot after the last el.)
        4. size - number of elements actually present in the array
    B. Example 1:
        1. enqueue “ramblin” (ignoring resizing for now)

0	1	2	3	4	5	6
r	a	m	b	l	i	n
Front						Back

character	size	front	back
	0	0	0
r	1	0	0
a	2	0	1
m	3	0	2
b	4	0	3
l	5	0	4
i	6	0	5
n	7	0	6

2. dequeue 4 times

character	size	front	back
r	6	1	6
a	5	2	6
m	4	3	6
b	3	4	6

3. enqueue “wr”

character	size	front	back
w	4	4	0 (7 % 7)
r	5	4	1

    a) Mod the back by capacity when adding to the back
    b) Mod the front by capacity when removing

V. Deques
  A. Deque - “Double Ended Queue,” does not have a LIFO or FIFO behavior
    1. Defined by ability to perform add/remove operations from both ends of the structure
  B. Operations:
    1. addFirst(x)

        2. addLast(x)
        3. x removeFirst()
        4. x removeLast()

VI. DLL-backed deque
   A. addFirst() - add at the head
   B. addLast() - add at the tail
   C. removeFirst() - remove from the head
   D. removeLast() - remove from the tail
   E. We can add and remove from the front and back in O(1) time

VII. Array-backed deque
   A. Uses the same “circular” array we used when creating an Array-backed queue
   B. addFirst() - add at the front index
      1. front should be set to capacity - 1 if decremented to -1
   C. addLast() - add at the back index
      1. back should be mod by capacity when incrementing
   D. removeFirst() - remove from the front index
      1. front should be mod by capacity when incrementing
   E. removeLast() - remove from the back index, make sure
      1. back should be set to capacity - 1 if decremented to -1

<u>Activities</u>

I. Stack reality check

9/7/18

<u>Topics</u>

I. Overview of worst case runtimes

	Access - known index	Search - unknown index
Array	O(1)	O(n)
SLL	O(n)	O(n)
DLL	O(n)	O(n)
Stack	O(n)	O(n)
Queue	O(n)	O(n)
Deque	O(n)	O(n)

   A. The data structures that access and search in O(n) are not bad data structures because they are simply not built for this purpose

II. Trees Intro

A. Characteristics:

1. No cycles - you cannot reach a node from itself (eg. circular SLLs have a cycle, non-circular SLLs do not have any cycles)
2. Highly recursive
3. ADT - can be implemented with Arrays (messy in most cases) and Linked List-like structures with nodes and pointers (preferred)

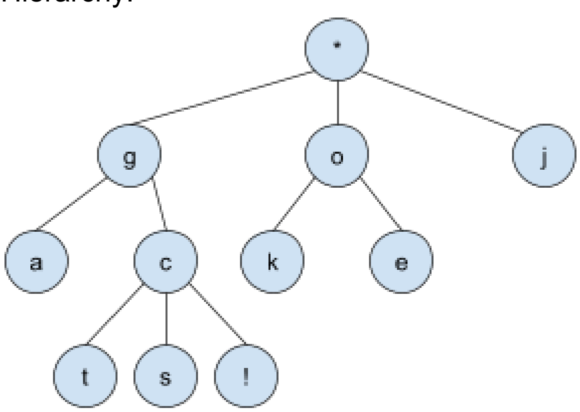
B. Properties:

1. Shape - structure of the tree
2. Order - arrangement of data in the structure
3. Types of trees are defined by their shape and order properties

C. Terminology:

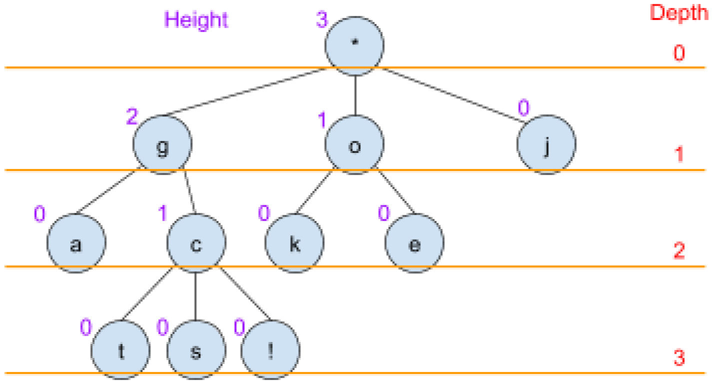
1. Root - like the head of a linked list; the entry point for the tree
2. Children - like the linked node's next node, but tree nodes can have more than one child
3. External/Leaf nodes - nodes without children
4. Internal nodes - nodes with children

D. Hierarchy:



1. g is the *parent* of a and c and *grandparent* of t and s
2. a and c are *siblings*
3. a and c are *cousins* of k and e
4. c,t,s,! is a *subtree* of g

E. Depth & Height



1. Depth - distance of a node from the root
    a) Depth of the root is always 0
2. Height - distance of a node from the furthest leaf node
    a) Height of a leaf node is always 0
    b) The height of a node can be calculated by adding 1 to the maximum height of its children
        (1) Eg. height(g) = 1 + max(height(a), height(c)) = 1 + 1

F. Tree ADT operations
1. Information methods:
    a) size()
    b) isEmpty()
    c) iterator()
    d) position() - returns a list of all node positions
2. Accessor methods:
    a) root() - returns root of the tree
    b) parent(x) - returns the parent of node x
    c) children(x) - returns the children of node x
    d) numChild(x) - returns the number of children node x has
3. Query methods:
    a) isInternal() - called on a node
    b) isExternal() - called on a node
    c) isRoot() - called on a node

III. Binary Trees

A. Shape - each node can have at most 2 children
1. Node stores at minimum child references and data but can also contain:
    a) root - reference to the root
    b) parent - reference to its parent
    c) internal - is it an internal node
    d) external - is it an external node

B. Iterating through a binary tree
1. Use recursion to iterate while the current node is not null, this allows you to access parent nodes when you begin returning from the recursive calls