Wednesday, February 22

Linked lists

- Advantages
  - No fixed mem allocation
  - Insert and delete: just updates the next pointer
  - Easily implement structures like stacks and queues
- Disadvantages
  - Mem usage: next node req more mem, not friendly to processor caches, slightly less mem efficient than arrays
  - Traversal: can't randomly access must traverse all of them, reverse traversing is difficult in singly linked lists - easy in double but the prev pointer takes more mem
- Circular singly linked
  - Tail linked back to head
- Doubly linked list
  - Prev and next pointers
  - Sentinel nodes
- Sentinel nodes
  - Dummy nodes at head and tail
  - They mark the beginning and end of the list

Singly linked lists

- Constructor
  - Allocate for a single node, duplicate
- Destructor
  - Free node
- LL delete
  - Walk the list and delete nodes
- Lookup
  - Start at head and traverse until value found
  - Worst case: not there
  - O(n)
- Insertion
  - O(n)
  - Check if already there, create node, this becomes the new head
- Printing
  - Traverse and print node
- Removing
  - Track current and previous nodes
- Move to front
  - Track curr and prev
  - Find the node, move to head

Linked list stacks

Linked list queues

Doubly linked lists

- Prepending

        - Insert at head
        - Connect to tail correctly
    - Appending
        - Insert at tail
        - Connect to head correctly
    - Inserting
    - Popping
        - Disconnect and return head
    - Dropping
        - Disconnect and return tail

Communication

- Information source
    - Produce message to be communicated to receiving terminal
    - Various forms of messages
- Transmitter
    - Operates on message to produce signal suitable for transmission over the channel
    - Compression and or encryption
- Channel
    - Medium that signal is transmitted through
- Receiver
    - Performs inverse of transmitter
    - Decompression or decryption
- Destination

Entropy

- Measure of uncertainty of the occurrence of an event
- Formula
- Least and most entropy
- Ex:
    - AAAA: guessing right has no entropy (no randomness)
    - AABC: A has the least entropy
    - AAAD: D has the most entropy
- Like asking the avg number of questions needed to correctly guess
- ABCD: 2 Qs asked

Run-length coding

- Repeated data
- Runs of repeated data
- Aabb is a2b2

Huffman coding

- David A. Huffman
- Assing each symbol a unique bit-string code

Friday, February 24

Trees

Node

- Smallest entity in tree

Root

- If null the tree is empty

Leaf

- Has no children (both children null)

Four traversals

- Preorder
    - Root, all the way down left, right
- Inorder
    - Left, root, right
    - Sorted tree if children are xxxx
- Postorder
    - Left right root
    - Stack order
- Level order
    - Across levels left to right

Successor: next node in some order

Predecessor: previous node in some order

Well defined for preorder, inroderm and postorder

Binary search tree

- Ordered tree
- Want a balanced tree
- Less than node goes left, greater than node goes right

Bad tree n nodes down, depth is n

Balanced tree has log n depth

Find stuff

- Binary search tree: leftmost node
- Max: rightmost node

Time complexity

- Balanced tree
    - O logn
- Imbalanced
    - O n

Height funct

Check if balanced funct: if height of both sides doesn't differ by more than 1

Find key

- Current node greater than key
    - Recursively find the key in left subtree
- Current node less than key
    - Find in right subtree recursively
- Current matches

        - Found the key

Inserting

- Current node null
    - Create new node as root
- Current node greater than key
    - Insert key in left recursively
- Current node less than key
    - Insert right recursively

Removing

- Follow DFS (depth first search) to find the node
- Node to removing is missing left child
- Node to remove is missing right child
- Node to remove has two children

Delta tree

- Postorder traversal
- Delete left right recursively
- Then root

Data compression

Communication

Information source

- Produce a message to be communicated with the receiving terminal
- Digital data to waves
- Message forms
    - Symbols
    - Time and variables

Transmitter

Channel

- Medium through which a signal is transmitted
- Ex
    - Radio freq, light, cables, wires

Receiver

- Wave to digital

Destination

Entropy

- Measure about uncertainty of an event
- Probabilities
- Run length encoding
    - Split message into seq of identical symbols
    - Seq called a run
    - AAB → A2B1
- Huffman
    - Histogram of symbols and freq

- Priority queue
    - Lower freq higher priority
    - Least popular at the top
- Huffman tree
- Increase entropy