CSE 326: Data Structures
Lecture #1
Lists, MultiLists & Trees

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Today's Outline

- Things Bart Forgot (handouts)
- How Homework Works
- Project Guidelines & Forming Teams
- Lists (from Monday)
- Multi-lists
- Priority Queues

Homework

- Quiz on Friday
  - lasts about 10 minutes in class
  - what you get right counts toward homework
  - what you get wrong becomes short answer for homework
  - quiz returned on Monday
- Homework due Thursday
  - turn in at the start of section

Project Guidelines & Teams

List ADT (review)

- List operations
  - Create/Destroy
  - Length
  - Find
  - Insert/Remove
  - Next/Previous

$$(A_1\ A_2\ \ldots\ A_{n-1}\ A_n)$$
$$\texttt{length = n}$$

- List properties
  - A_i precedes A_{i+1} for $1 \leq i < n$
  - A_i succeeds A_{i-1} for $1 < i \leq n$
  - Size 0 list is defined to be the **empty list ( )**

Applications

- Everything!
  - Class list
  - compilers: list of functions in a program, statements in a function
  - graphics: list of triangles to be drawn to the screen
  - operating systems: list of programs running
  - music: compose crazy hard transcendental études
  - other data structures: queues, stacks!

Iterators

- General method of examining collections

```
List<Object> *list;
Object x;
...
ListItr<Object> *i = list->first();
while ( i->hasNext() ) {
  x = i->next();
}
```

List Operations

- Iteration operations:
  - **`ListItr<Object> first()`**
  - **`ListItr<Object> kth(int)`**
  - **`ListItr<Object> last()`**
- Main operations:
  - **`ListItr<Object> find(Object)`**
  - **`void insert(Object, listItr<Object>)`**
  - **`void remove(ListItr<Object>)`**
  - **`bool isEmpty()`**

Application: Polynomial ADT

A_i is the coefficient of the x^{n-i} term:

$3x^2 + 2x + 5$	**(3 2 5)**
$8x + 7$	**(8 7)**
$x^2 + 3$	**(1 0 3)**

Problem?

$x^{2001} + 1$

```
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```
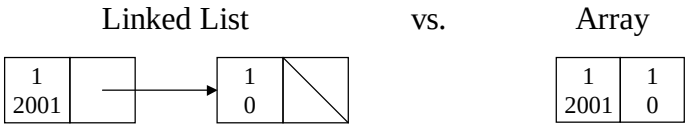

Sparse List Data Structure (?): $x^{2001} + 1$

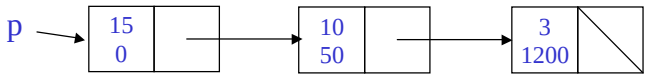
(<1 2001> <1 0>)



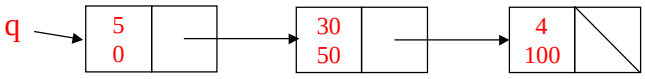
Addition of Two Polynomials

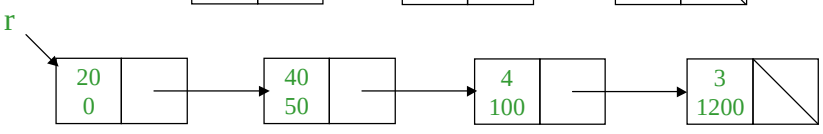
- Similar to merging two sorted lists

$15+10x^{50}+3x^{1200}$



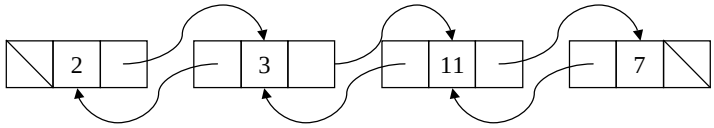
$5+30x^{50}+4x^{100}$



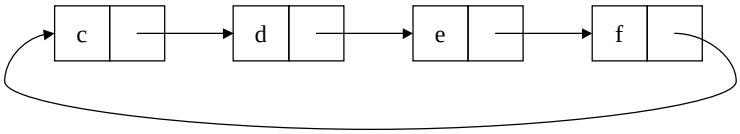


Other Data Structures for Lists

- Doubly Linked List



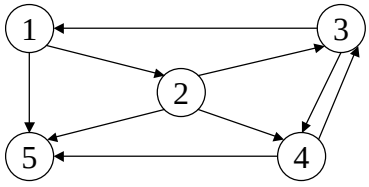
- Circular List

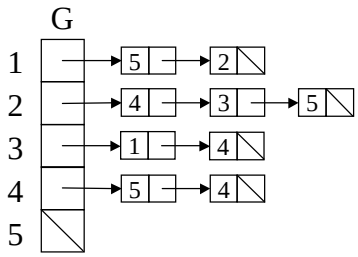


Multiple Linked Lists

- Many ADTS such as graphs, relations, sparse matrices, multivariate polynomials use multiple linked lists
- Several options
  - array of lists
  - lists of lists
  - multi lists
- *General principle throughout the course: use one ADT to implement a more complicated one.*

Array of Linked Lists: Adjacency List for Graphs





•Array G of unordered linked lists
•Each list entry corresponds to an edge in the graph

Reachability by Marking

- Suppose we want to mark all the nodes in the graph which are reachable from a given node **k**.
  - Let **G[1..n]** be the adjacency list rep. of the graph
  - Let **M[1..n]** be the mark array, initially all **false**s.

```
mark(int i){
  M[i] = true;
  x = G[i]
  while (x != NULL) {
    if (M[x->node] == false)
      mark(G[x->node])
    x = x->next
  }
}
```

Thoughts on Reachability

- The marking algorithm visits each node and each edge at most once. Why?
- This marking algorithm uses Depth First Search. DFS uses a stack to track nodes. Where?
- Graph reachability is closely related to garbage collection
  - the nodes are blocks of memory
  - marking starts at all global and active local variables
  - the marked blocks are reachable from a variable
  - unmarked blocks are garbage

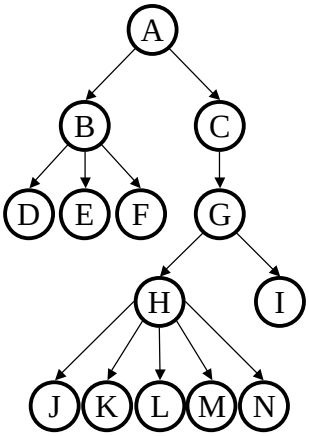
MultiLists

Trees

- Family Trees
- Organization Charts
- Classification trees
  - what kind of flower is this?
  - is this mushroom poisonous?
- File directory structure
  - folders, subfolders in Windows
  - directories, subdirectories in UNIX
- Non-recursive procedure call chains

Tree Terminology

root:
leaf:
child:
parent:
sibling:
ancestor:
descendent:
subtree:



More Tree Terminology

depth:

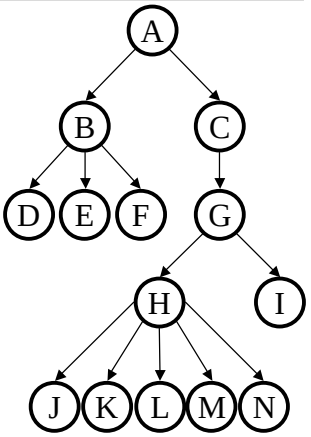
height:

degree:

branching factor:

preorder traversal:

postorder traversal:

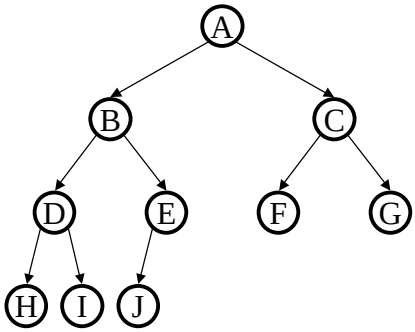


One More Tree Terminology Slide

binary:

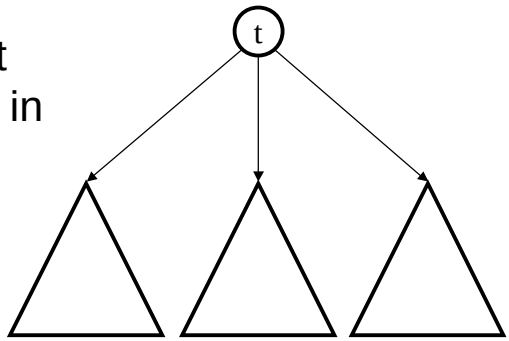
n-ary:

complete:

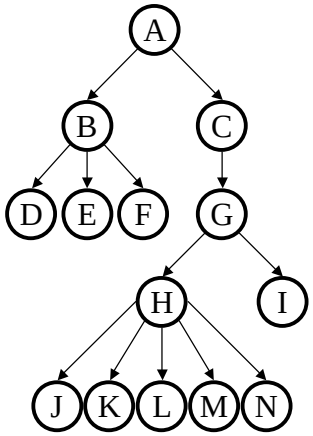


Tree Calculations

- Find the longest undirected path in a tree
- Might be:
  –
  –



Tree Calculations Example



To Do

- Subscribe to Mailing List
- Form teams
- Start Project I
- Read chapter 6 in the book
- Think about whether you like this homework format

Coming Up

- Templates Tutorial tomorrow
  - during section – 10:50 in GUG 410
- More Priority Queue Operations
- Mergeable Priority Queues
- First Quiz (Friday June 22nd)
- First project due (Wednesday June 27th)