CSE 373: Trees

Chapter 4

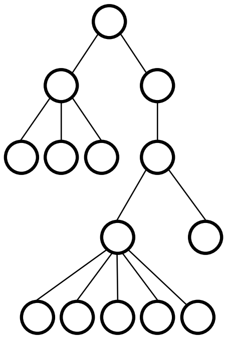
Summary of Chapter 3

Lists, Stacks, and Queues…

- are composed of elements in a *sequential* order
  - Lists – arbitrary order
  - Stacks – LIFO
  - Queues – FIFO
- implementations are usually array- or link-based
- operations add, remove, find, iterate over elements
- usually, searching for a specific element is O(n)
  - counterexample?

Trees

Trees allow the expression of non-sequential relationships



Real-life Instances of Trees

- Family trees
- Organization Charts
- Classification trees
  - what kind of flower is this?
  - what's wrong with my car?
- File directory structure
  - folders, subfolders in Windows
  - directories, subdirectories in UNIX
- Non-recursive procedure call chains

Tree Terminology

root:

leaf:

child:

parent:

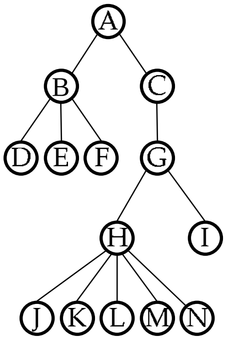
sibling:

grandparent

grandchild:

ancestor:

descendent:



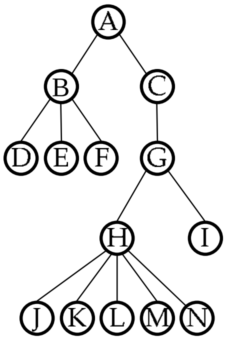
More Tree Terminology

path:

depth:

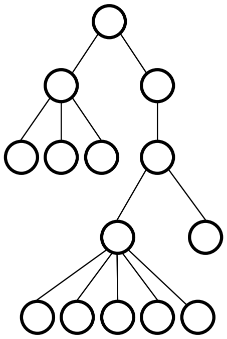
height:

degree:



Implementation of Trees

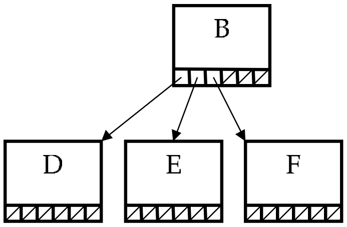
- Trees can't be implemented with lists (easily)
- Why not?



Naive Tree Implementation

If we can bound the degree of a tree's nodes, it has a simple implementation:

```
struct TreeNode {
  Object data;
  TreeNode *child[MAX_DEGREE];
};
```

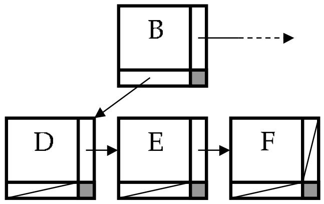


General Tree Implementation

Since a tree can have any number of children…

- Parent links to first child
- Siblings link to one another

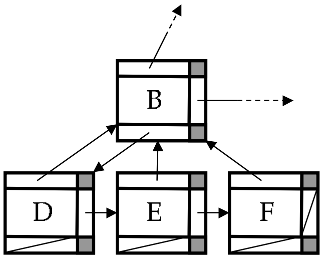
```
struct TreeNode {
  Object data;
  TreeNode *firstchild;
  TreeNode *sibling;
};
```



Design Decision: Parent Pointer

- For most operations, only pointers to children are needed
- Some implementations may also store a pointer to a node's parent:

```
struct TreeNode {
  Object data;
  TreeNode *parent;
  TreeNode *firstchild;
  TreeNode *sibling;
};
```



Tree Operations

- Like List, not a well-defined ADT…
- Possible Operations
  - Tree operations:
    ```
    TreeNode *root();
    TreeNode *find(Object);
    ```
  - Node operations:
    ```
    void addChild(Object);
    int numChildren();
    TreeNode *getKthChild(int);
    void deleteKthChild(int);
    ```
  - Also traversal operations…

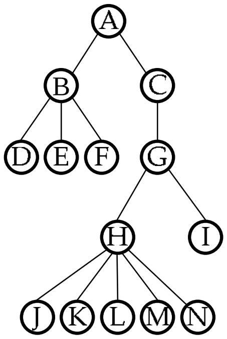
Well-defined Traversals

pre-order:

1) process node
2) process children

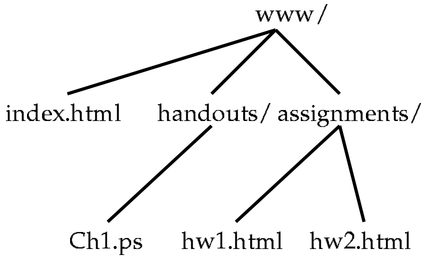
post-order:

1) process children
2) process node



Traversal Applications

- Print Directory Listing



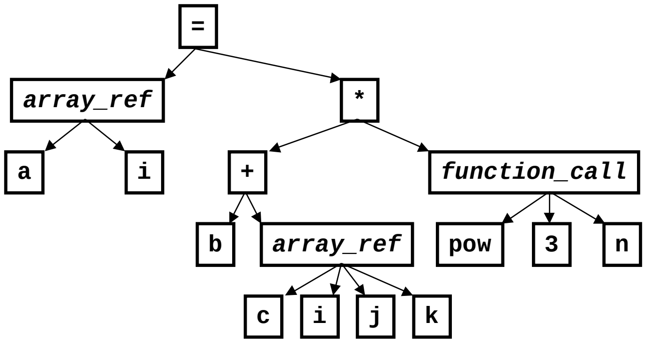
- Print Disk Usage

Tree Applications

- Storing data for the “real life instances of trees”
- **CAD/drawing:** Storing hierarchies of objects
  (a wheel is made of a tire and spokes; a car is made…)
- **graphics:** Storing a scene’s geometry/structure
- **languages:** Storing a class hierarchy (*e.g.*, C++)

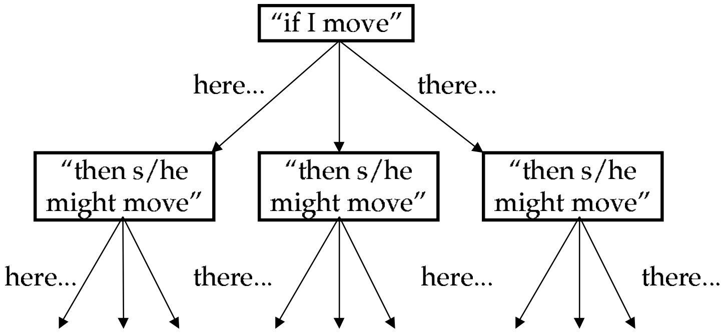
Application: Storing Expressions

```
a[i] = (b + c[i,j,k]) * pow(3,n);
```



Application: AI programs

Decision Trees:



"if I move"
here...
there...
"then s/he might move"
"then s/he might move"
"then s/he might move"
here...
there...
here...
there...