

ECE 2574

Introduction to Data Structures and Algorithms

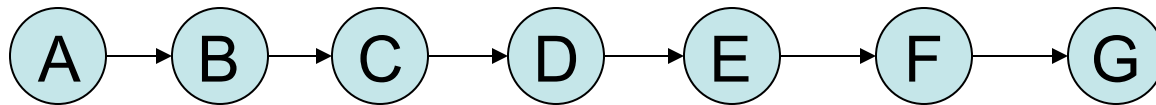
30: General and Binary Trees

Chris Wyatt

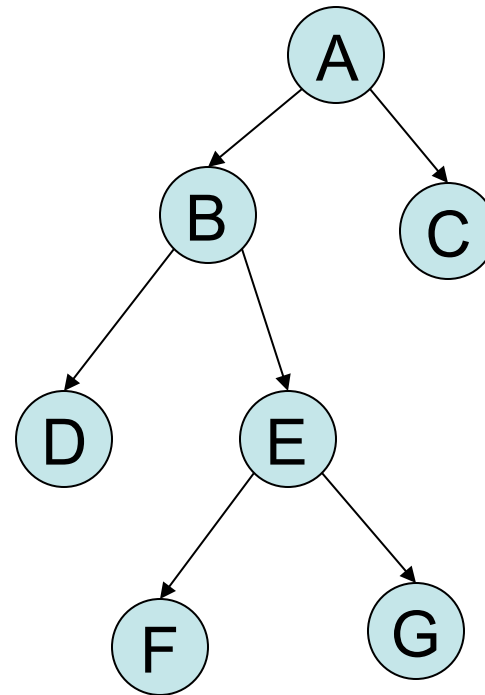
Electrical and Computer Engineering

Trees are non-linear, value oriented structures

List Holding 7 Items



Example of a Tree Holding 7 Items, a ***Hierarchy***



Tree Terminology

Tree

Node (vertex)

Links (edges)

Parent

Child

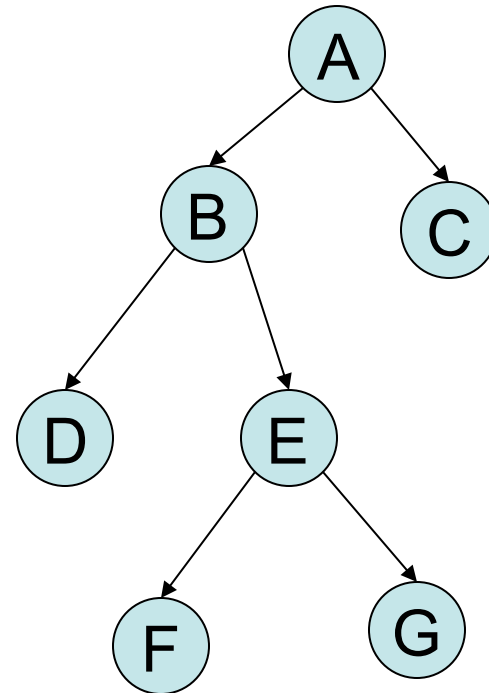
Sibling

Root

Leaf

Ancestor

Descendent



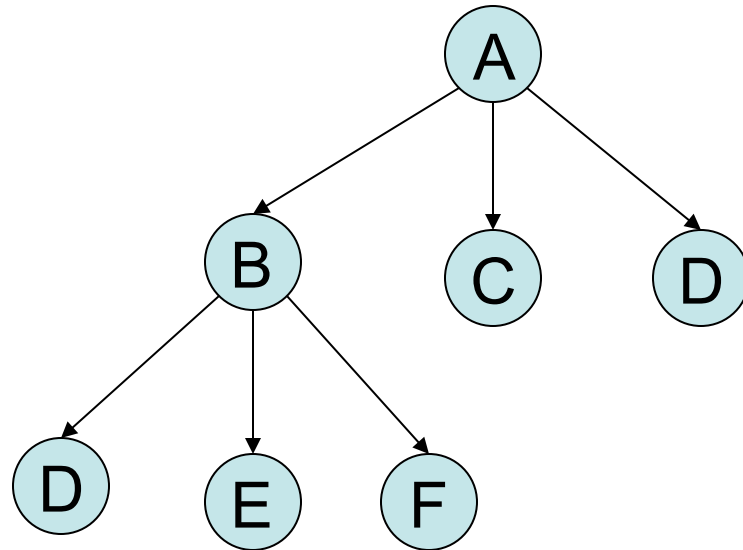
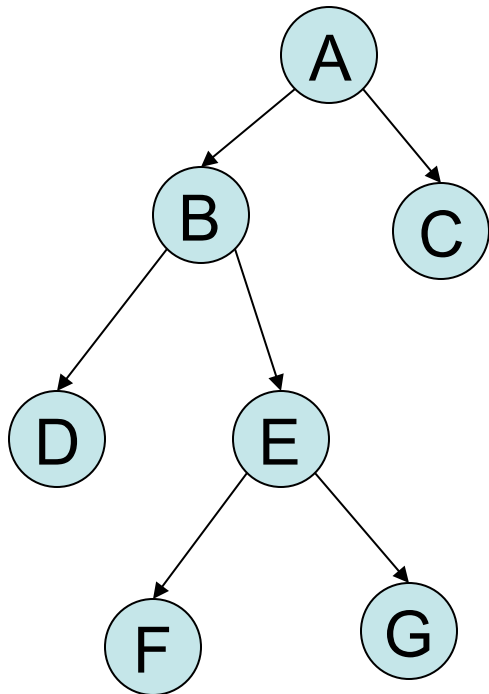
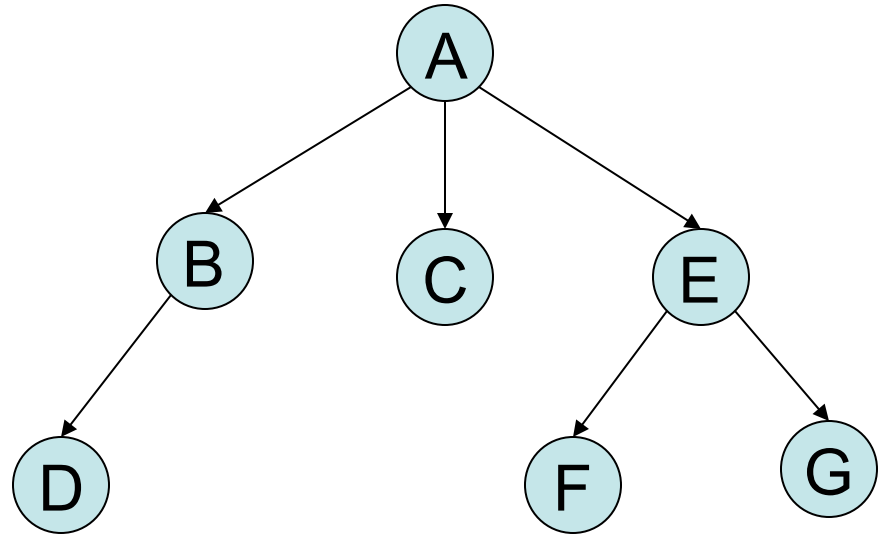
Tree Terminology

Subtree

Binary Tree

M-ary Tree

General Tree



Formal Definition of a Binary Tree

A Binary Tree T is a set of nodes such that

T is empty

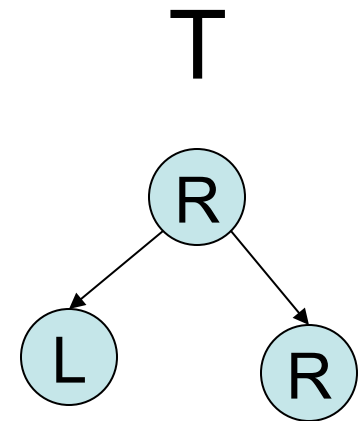
T is partitioned into three subsets:

1. A single node R , the root

- Two, possible empty sets forming binary trees

2. the left subtree

3. the right subtree

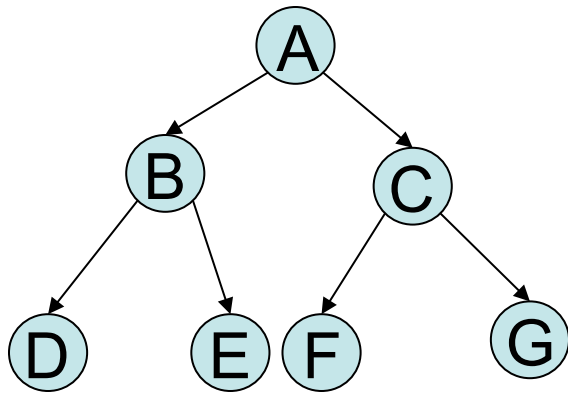


Binary Tree Terminology

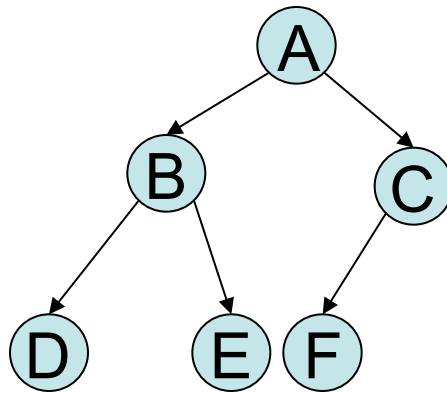
Path

Height

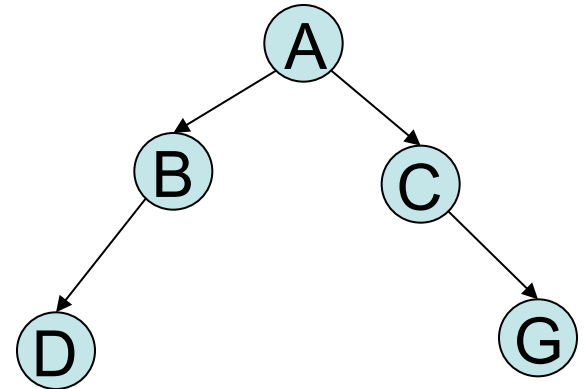
Full Tree



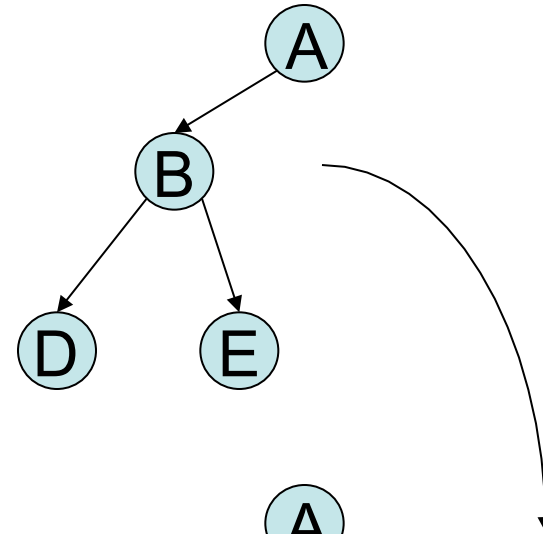
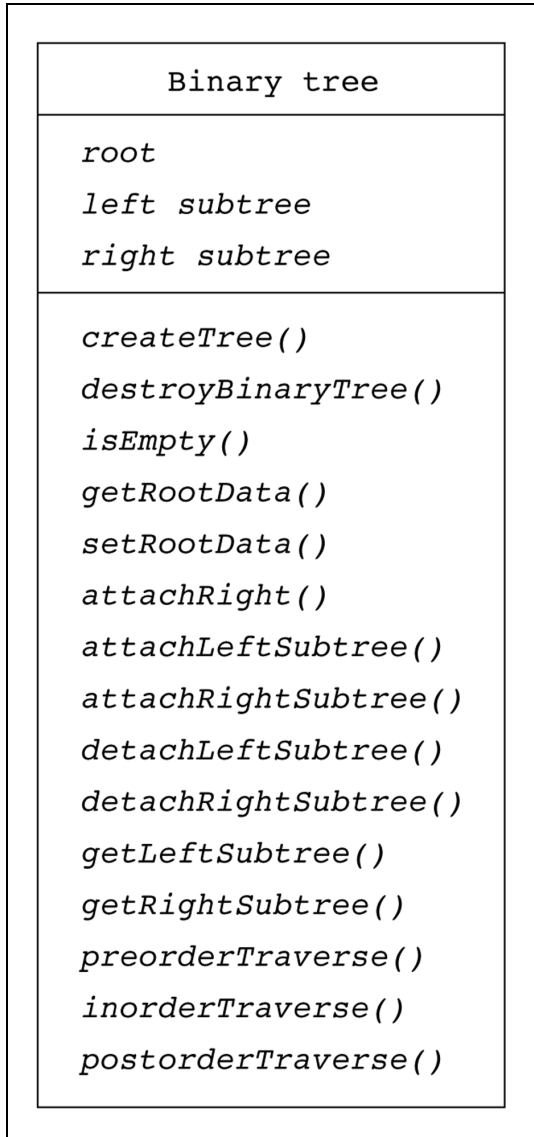
Complete Tree



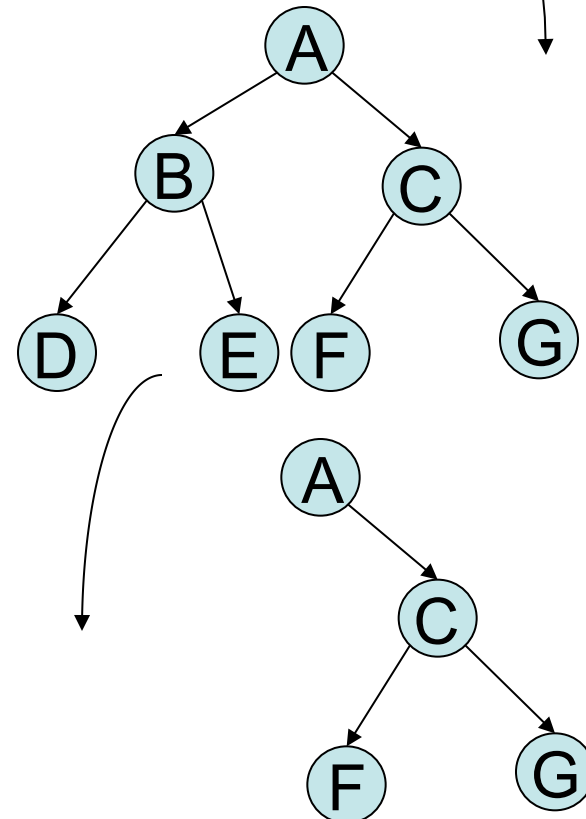
Balanced Tree



The Binary Tree ADT



attach right subtree



detach left subtree

Traversals of Binary Trees

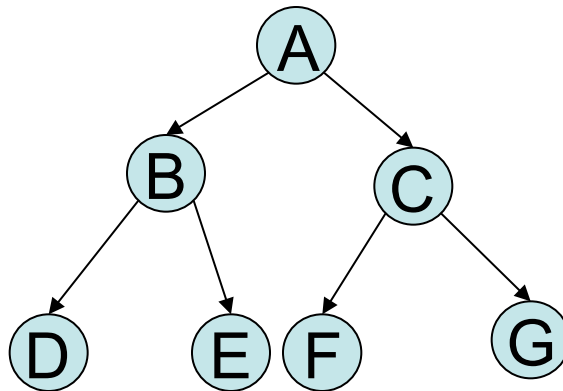
Preorder traversal

if T is not empty

visit the root of T

preorder traverse left subtree of T

preorder traverse right subtree of T



Traversals of Binary Trees

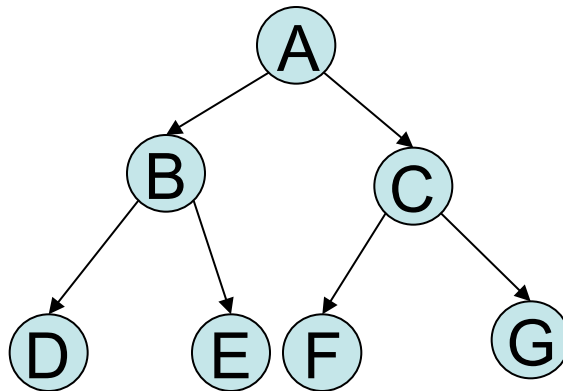
Inorder traversal

if T is not empty

inorder traverse left subtree of T

visit the root of T

inorder traverse right subtree of T



Traversals of Binary Trees

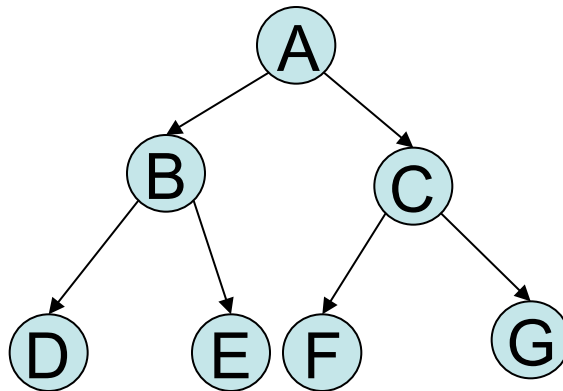
Postorder traversal

if T is not empty

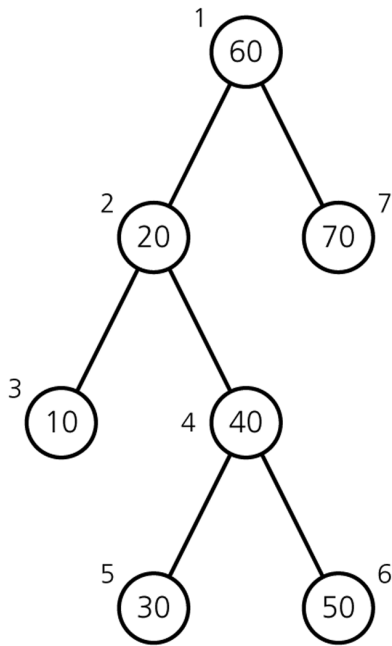
postorder traverse left subtree of T

postorder traverse right subtree of T

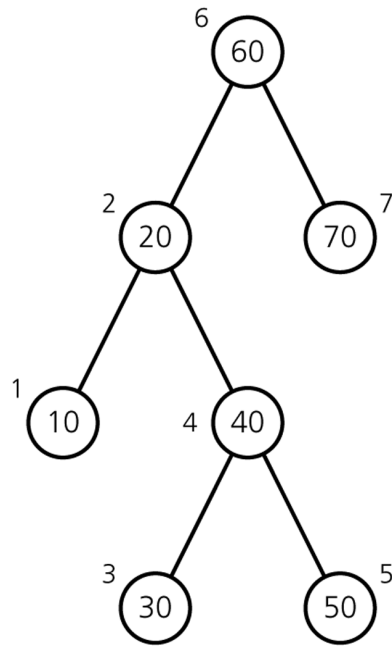
visit the root of T



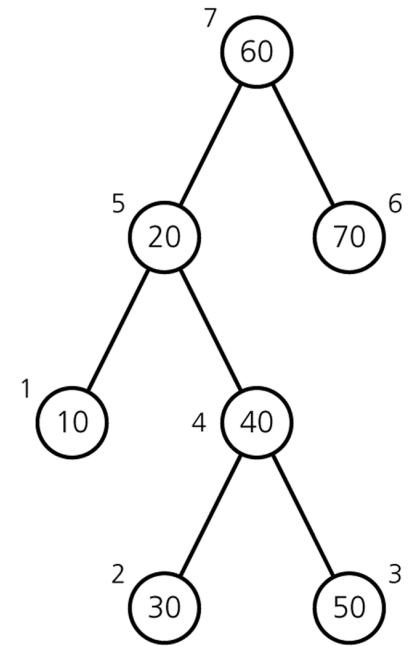
Examples



(a) Preorder: 60, 20, 10, 40, 30, 50, 70



(b) Inorder: 10, 20, 30, 40, 50, 60, 70

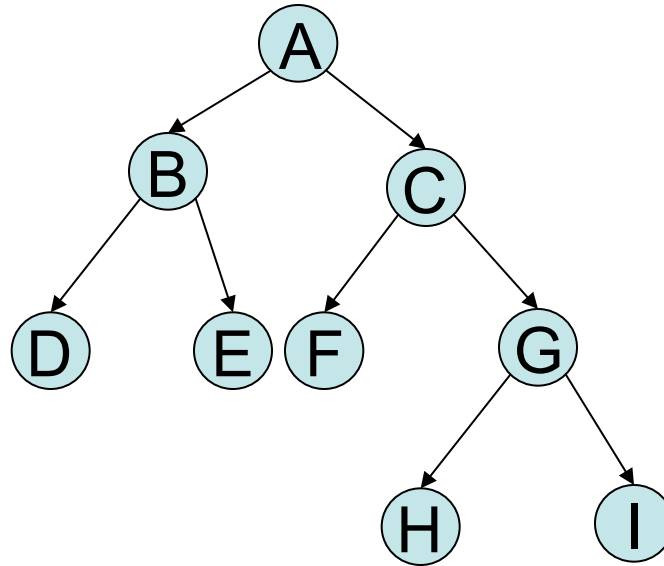


(c) Postorder: 10, 30, 50, 40, 20, 70, 60

(Numbers beside nodes indicate traversal order.)

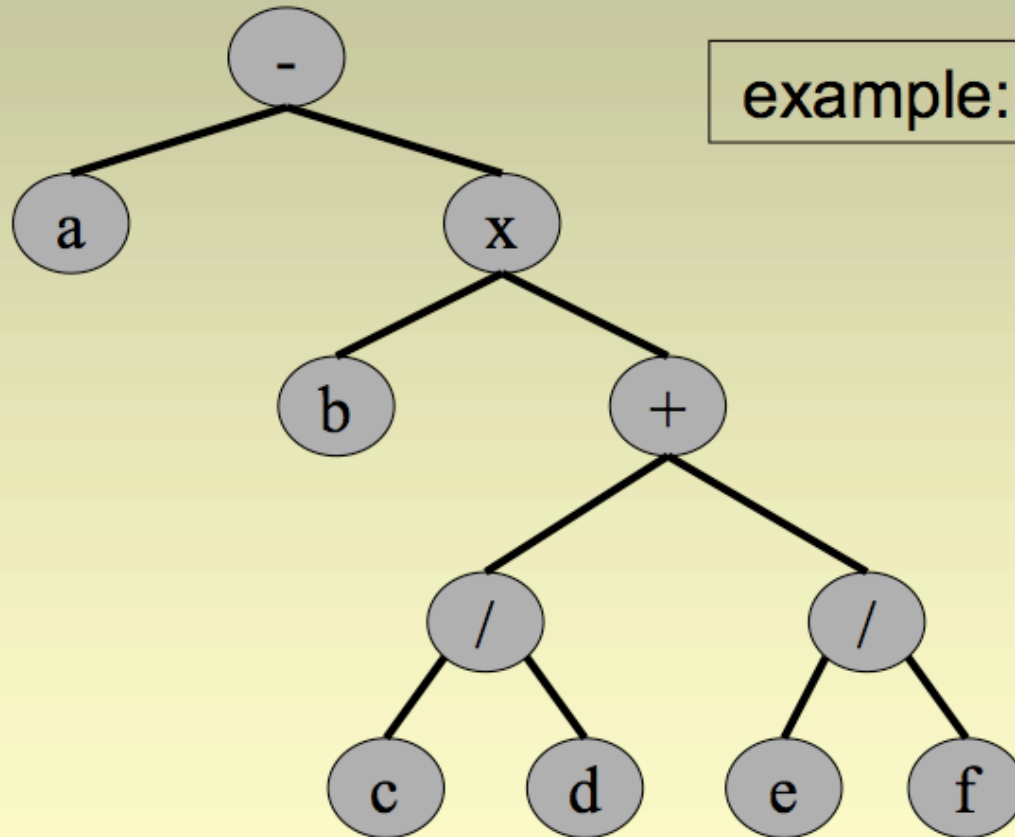
In class exercise

What is the preorder, inorder, and postorder traversals of the following Binary Tree



What are trees good for?

Parsing and representing relationships



What are trees good for?

Representing Hierarchies

Organization.

Document

Chapter 1

Section 1

Section 2

Section 3

Subsection 1

Chapter 2

Section 1

Subsection 1

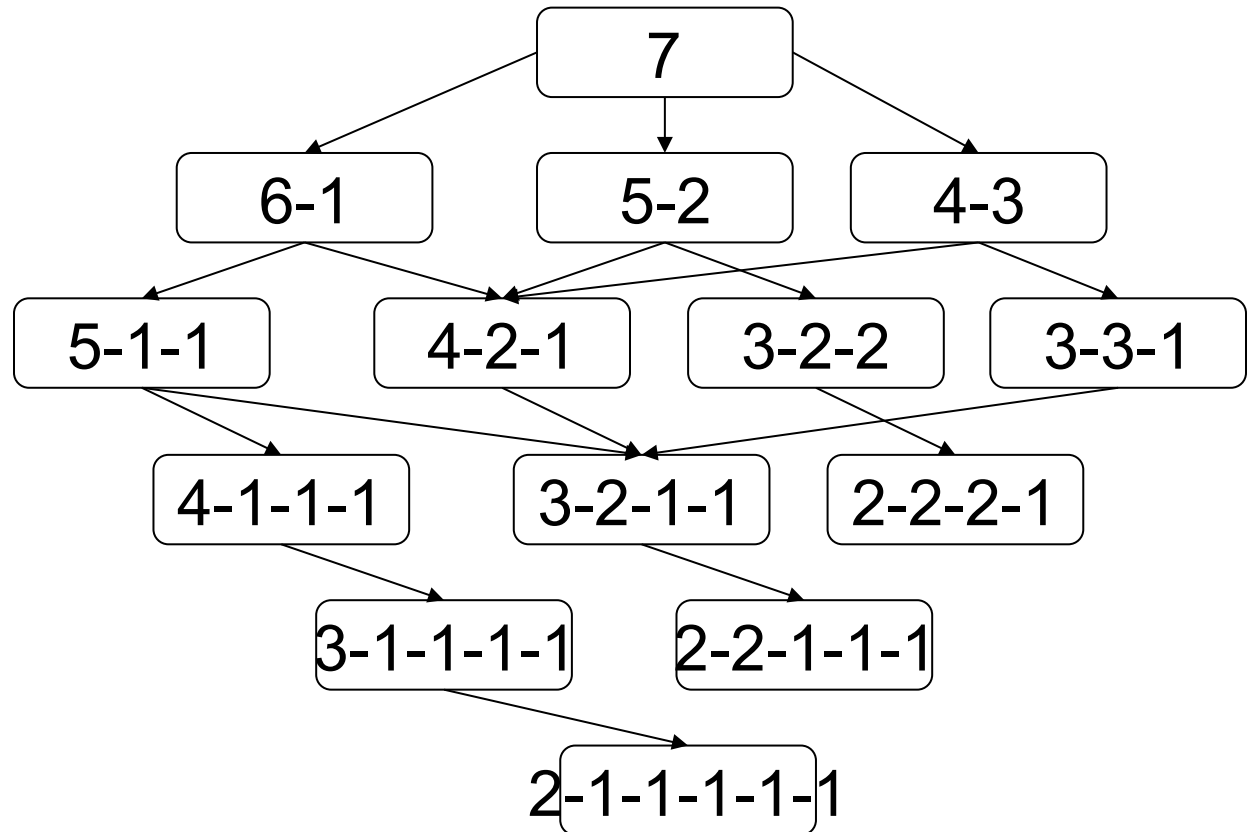
Section 2

example: table of contents

What are trees good for?

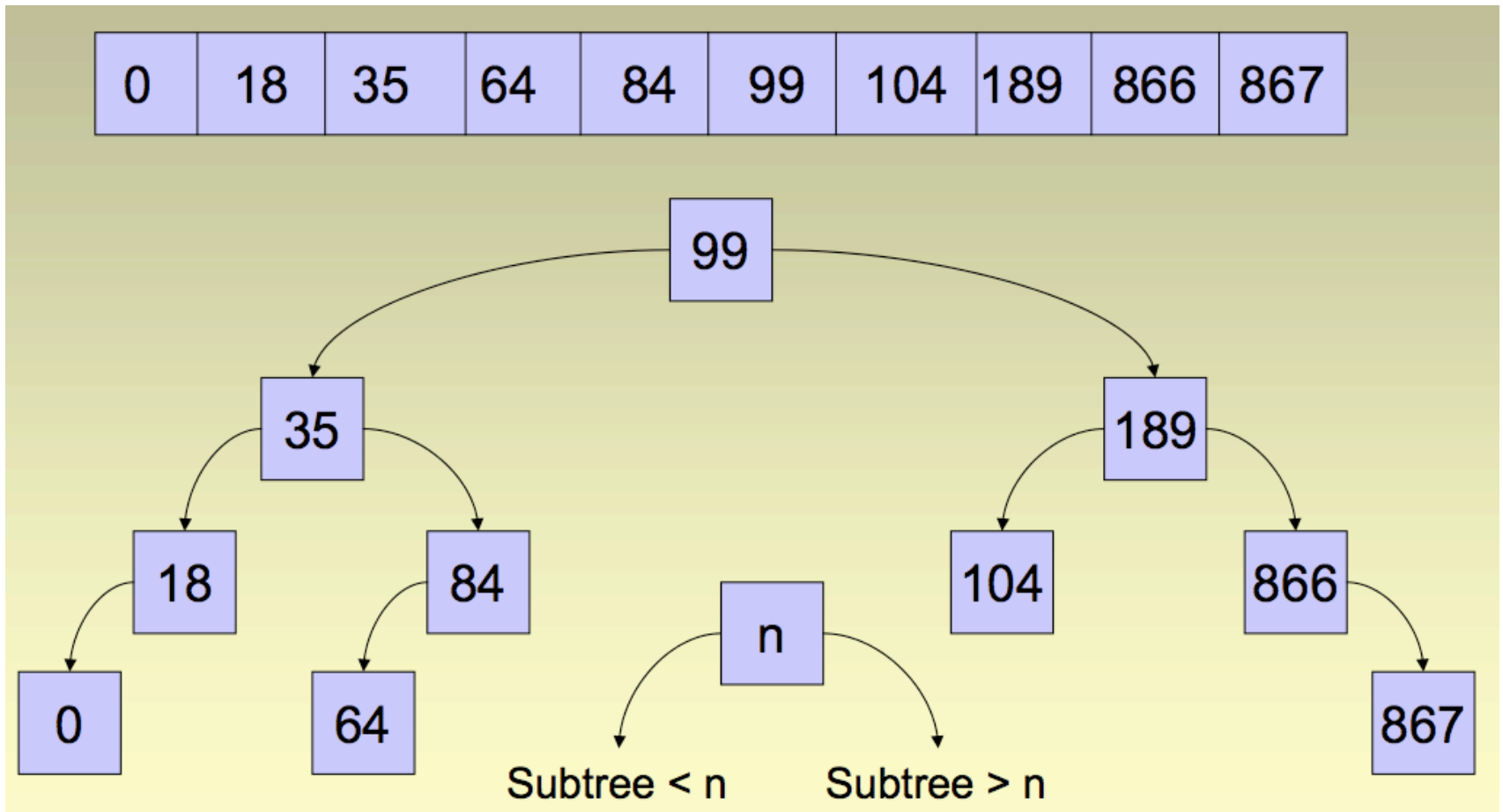
Modeling decisions

State space for NIM game, 7 tokens



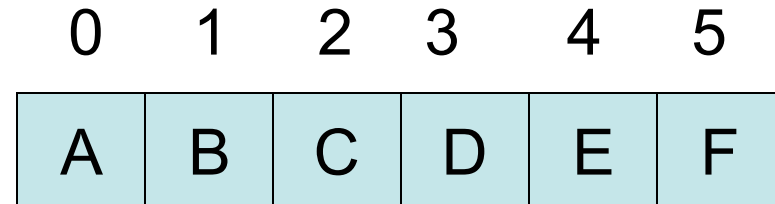
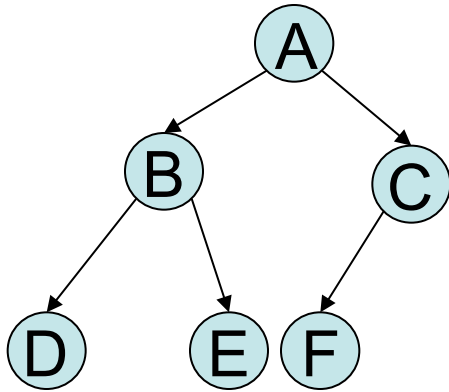
What are trees good for?

Organization and searching



Representing Binary Trees

Array based implementation for complete trees



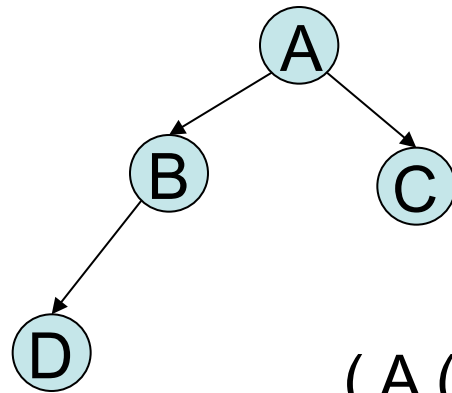
Why does this not work for non-complete trees?

Representing Binary Trees

List based representation (not in your text)

Consider a list with contents given by a pair (tuple) of
and item (atom) followed by a list.

```
struct list
{
  item a;
  list l;
}
```

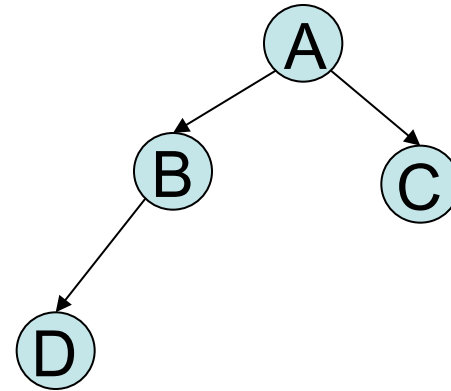


(A((B(D())))(C()))

Representing Binary Trees

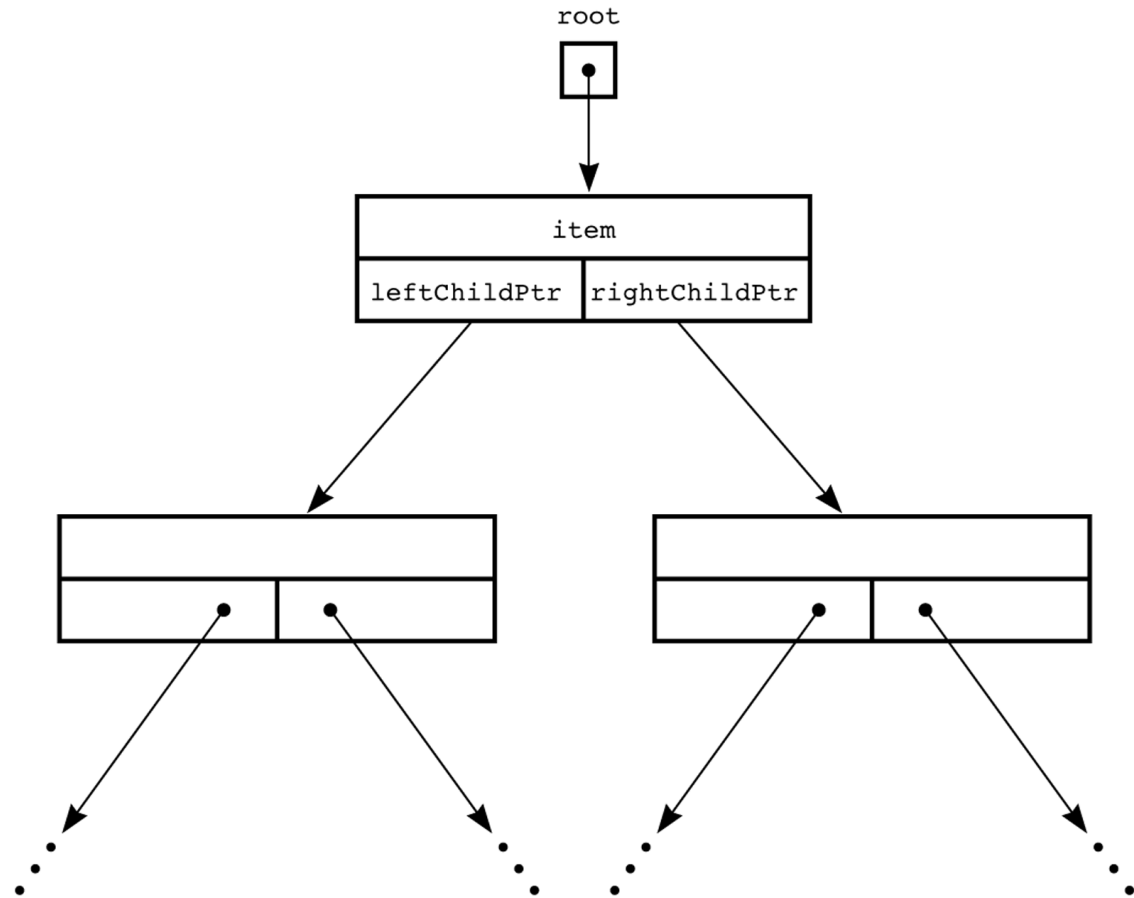
Pointer based implementation, an extension of a linked list

```
struct node
{
    item a;
    node * left;
    node * right;
}
```



Representing Binary Trees

```
struct node
{
    item a;
    node * left;
    node * right;
}
```



Next Actions and Reminders

Read CH pp. 442-449

Program 4 is due 11/17