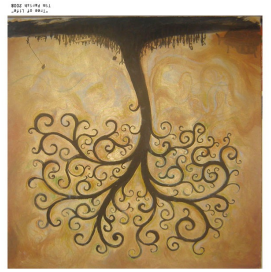


Announcements

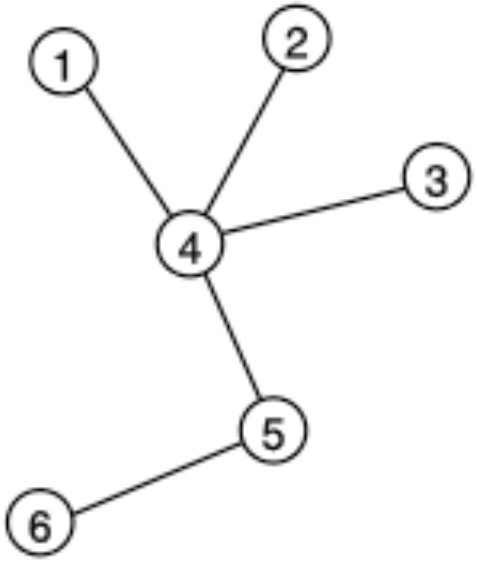
MP4 available, due 3/10/17, 11:59p. EC due 3/3/17, 11:59p.

Trees:

"… most important nonlinear structure in computer science."

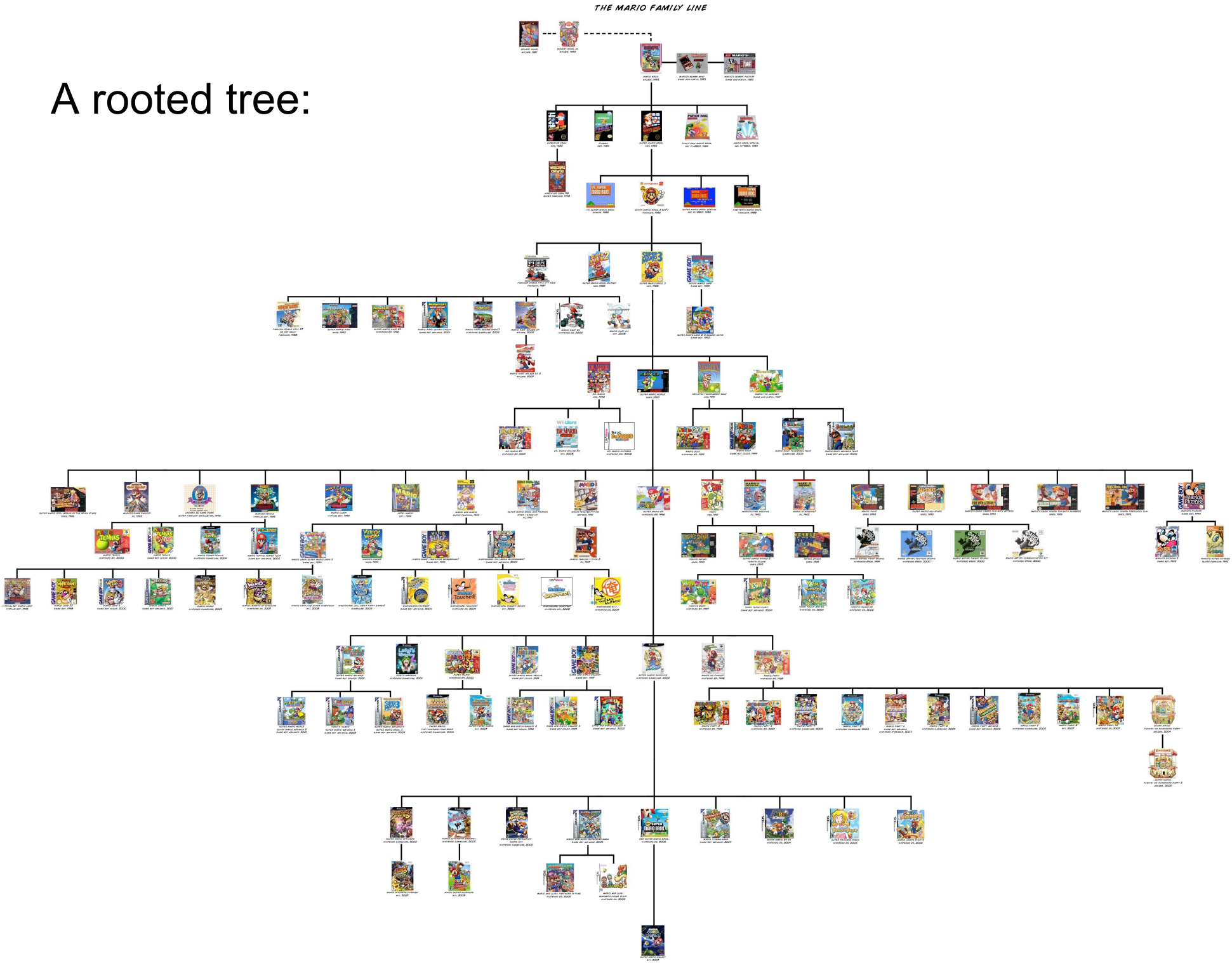
-- Donald Knuth, *Art of Computer Programming Vol 1*

A tree: _____



We'll study more specific trees:

A rooted tree:



Tree terminology:

For general trees:

•What's the longest English word you can make using the vertex labels in the tree (repeats allowed)?

•Find an edge that is not on the longest path in the tree. Give that edge a reasonable name.

For the rest of the exercises, assume the tree is rooted.

•One of the vertices is called the "root" of the tree. Guess which one it is.

•Make an English word containing the names of the vertices that have a parent but no sibling.

•How many parents does each vertex have?

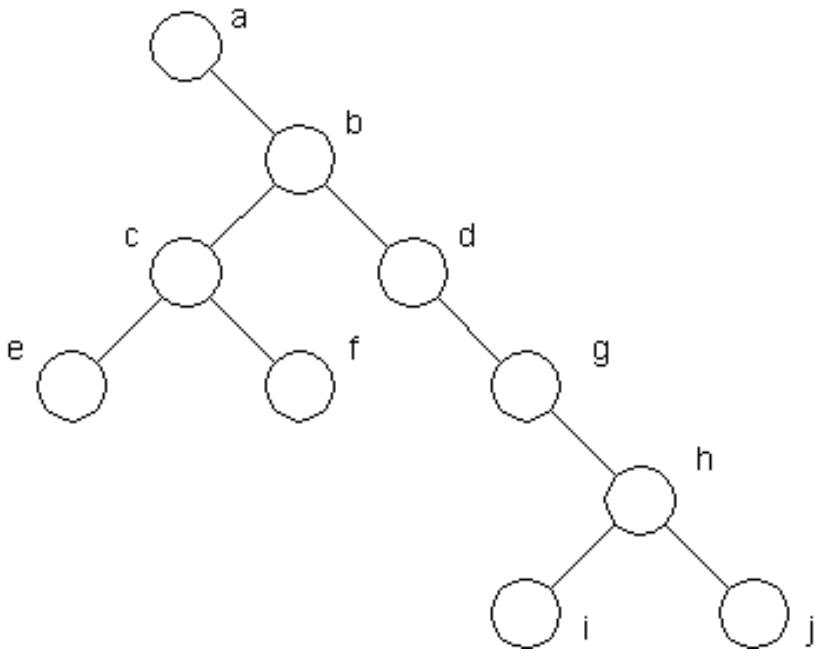
•Which vertex has the fewest children?

•Which vertex has the most ancestors?

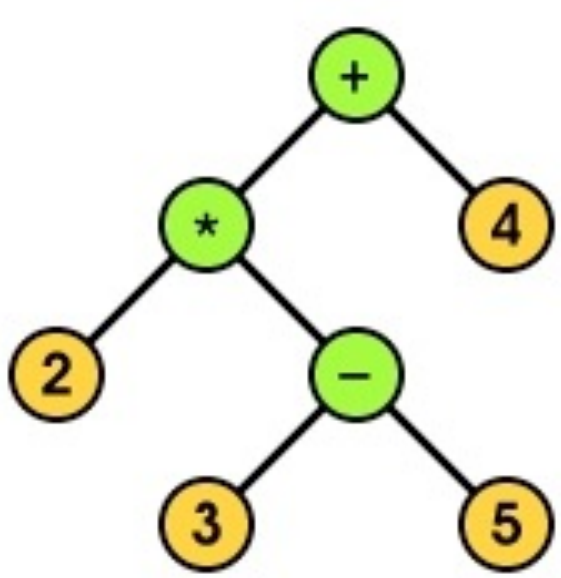
•Which vertex has the most descendants?

•List all the vertices is b's left subtree.

•List all the leaves in the tree.



Binary tree, recursive definition:



A *binary tree* T is either

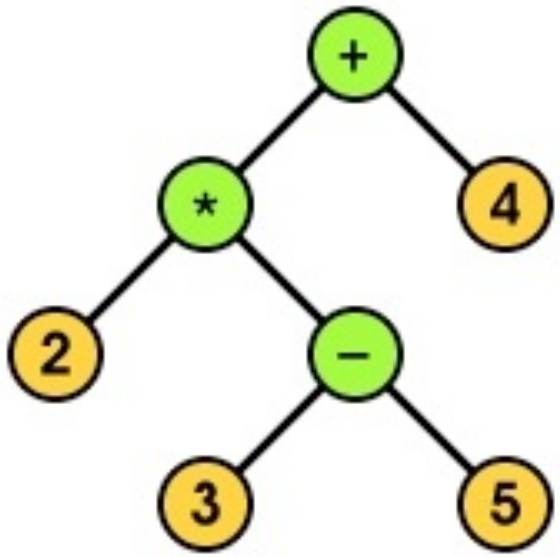
-

OR

-

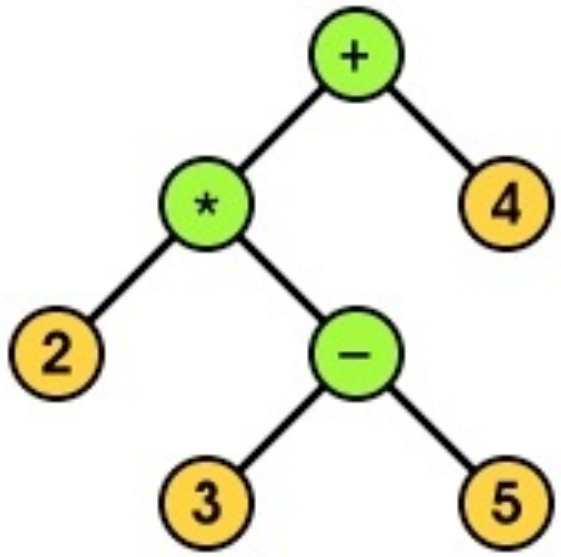
An (important) example of a function on a binary tree:

height(t) -- length of longest path from root to a leaf



Given a tree T, write a recursive defn of the height of T, height(T):

Full Binary tree: a tree in which every node has 2 or 0 children



F is a full binary tree if and only if:

- F={} OR,
- F={r, T_L, T_R}, and

Perfect Binary tree:

Perfect tree of height h, P_h:

- P_{-1} is an empty tree
- if h > -1, then P_h is {r, T_L, T_R}, where T_L and T_R are P_{h-1}.

P_0:

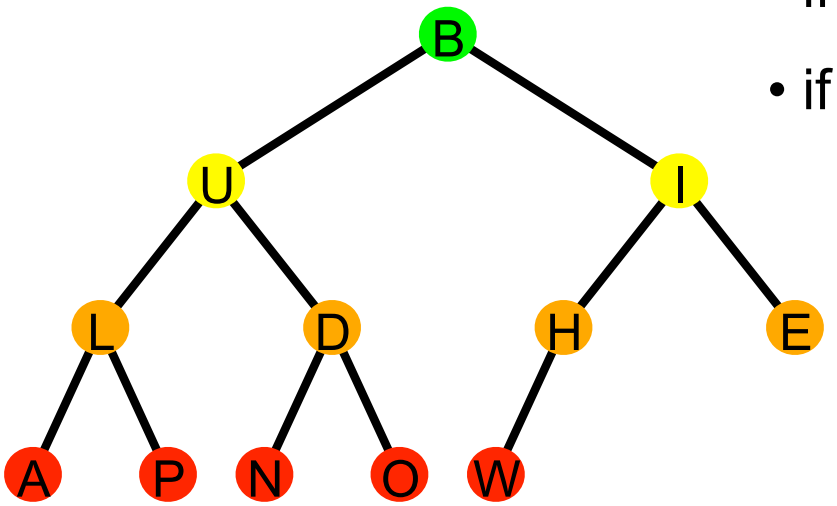
P_2:

P_1:

Check for understanding:

How many nodes in a perfect tree of height h?

Complete Binary tree: for any level k in [0,h-1], level k has 2^k nodes, and on level h, all nodes are "pushed to the left."



Complete tree of height h, C_h:

- if h= -1, then C_h is {}
- if h > -1, then C_h is {r, T_L, T_R}, and either:

T_L is _____ and T_R is _____

OR

T_L is _____ and T_R is _____

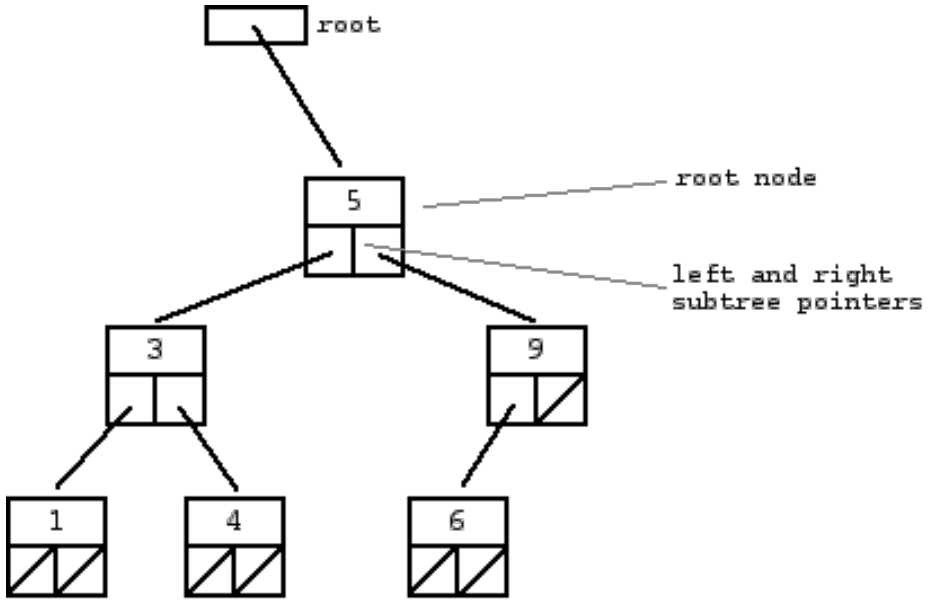
http://xlinux.nist.gov/dads//HTML/completeBinaryTree.html

Check for understanding:

Is every full tree complete?

Is every complete tree full?

Rooted, directed, ordered, binary trees



Tree ADT:

- insert
- remove
- traverse

```
template <class T>
class tree{
public:
…
private:
   struct treeNode{
      T data;
      treeNode * left;
      treeNode * right;
   };
   treeNode * root
…
};
```

Theorem: if there are n data items in a binary tree, then there are _____ null pointers.