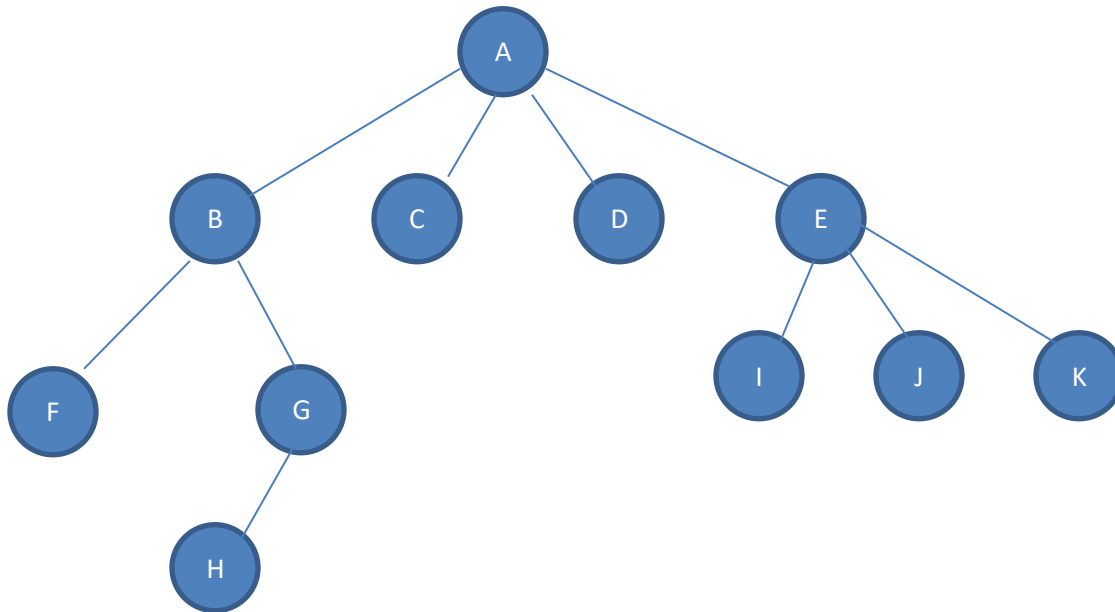


CS220 - Lesson 18 – Tree Worksheet Solution

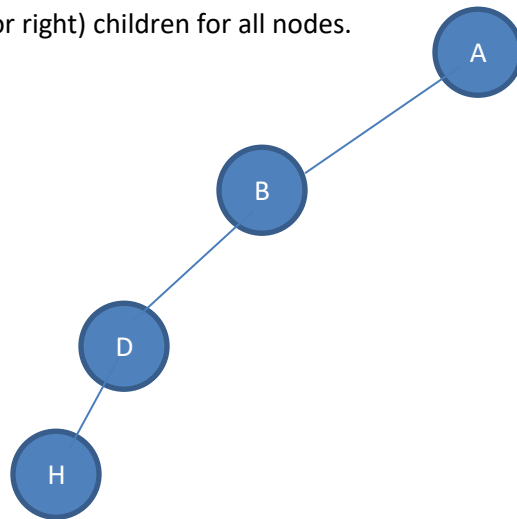


Answer the following questions:

- What is the root node? **A**
- What are the children of node A? **B, C, D, E** Node E? **I, J, K** Node J? **(none)**
- What are the siblings of node C? **B, D, E** Node G? **F** Node K? **I, J**
- What are the ancestors of node J? **E, A** Node D? **A** Node H? **G, B, A**
- What are the descendants of node D? **(none)** Node B? **F, G, H** Node A? **(all, B-K)**
- Which nodes are terminal nodes? **F, H, C, D, I, J, K**
- Which nodes are branch nodes? **A, B, G, E**
- Given node E, list every relationship it has:
child of A, parent of I, J, & K, sibling of B, C, D,
descendant of A,
ancestor of I, ancestor of J, ancestor of K
- What is the degree of node B? **2** node D? **0** node A? **4**
- What is the level of node A? **0** node G? **2** node H? **3**
- What is the height of the tree? **3** Of the sub-tree whose root is E? **1**
- Assuming the tree is a quad-tree:
 - Is the tree full? **No, all nodes do not have 4 children.**
 - Is the tree complete? **No, every level is not full.**
 - Is the tree height-balanced? **No, the height of sub-tree B is 2, while the height of sub-tree C is 0.**
- Define what it means that a tree has no cycles? **There is only one possible path between any two nodes.**

Describe a tree and draw a diagram of a tree that is equivalent to a list. We call this a *degenerate tree*.

A tree with only left (or right) children for all nodes.







Describe the advantages of a *complete* and a *height-balanced* tree.

A minimal number of edges (links) are wasted (unused).

You can get to any node in the tree with a minimal number of link traversals.

Trees can hold a lot of data. Determine the amount of data in a binary tree at each level of the tree and for the entire tree to each level.

		Nodes in Level:	Total nodes in tree
Level 0:		1	1
Level 1:		2	3
Level 2:		4	7
Level 3:		8	15
Level n:		2^n	$2^{n+1}-1$

If you stored the name of every person on the earth, approximately 7 billion names, what would be the height of the binary tree?

What is the maximum level in the tree? That is, for what value of n will $2^{n+1}-1 \geq 7$ billion?

$$2^{n+1} \geq 7 \text{ billion} + 1$$

$$\log_2(2^{n+1}) \geq \log_2(7 \text{ billion} + 1) = 32.7$$

$$n+1 \geq \log_2(7 \text{ billion} + 1) = 32.7 \quad \rightarrow n \geq 31.7 \quad \rightarrow \text{maxLevel is } 32$$

height is 33 (because height = maxLevel + 1)