# **Binary Tree Definition**

**T is a binary tree if either**

* T has no nodes, or
* T is of the form

*r*

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*TL*  *TR*

where ***r***is a node and ***TL***and ***TR***are both binary trees

If ***r***is the root of ***T***, then

* the binary tree ***TL***is the **left** **subtree** of node ***r***

and

* the binary tree ***TR***is the **right** **subtree** of node ***r***

If *TL* is not empty, its **root** is the **left child** of ***r***

If *TR* is not empty, its **root** is the **right child** of ***r***

Each node in a binary tree can have no more than **two children**.

Notice that if **both subtrees of a node are empty**, that node is a **leaf**.

# **Binary Search Tree Definition**

The nodes of a tree typically contain values.

A **binary search tree** is a **binary tree** that is sorted according to the values in its nodes.

As its name suggests, a binary search tree organizes data in a way that facilitates **searching** it for a particular data item.

**Binary Search Tree Definition**

For each **node n**, a binary search tree satisfies the following three properties:

1. **n’s value is** **greater than** **all values in its** **left subtree TL**.
2. **n’s value is less than all values in its right subtree TR**.
3. **Both TL and TR are binary search trees.**

This organization of data enables you to search a binary search tree for a particular data item, given its value instead of its position.

**Example**

Let’s consider a binary search tree whose nodes contain people’s names.

Suppose that these objects are Alan, Bob, Elisa, Jane, Nancy, Tom, and Wendy.

Figure 15-13 illustrates one binary search tree that we can form with these names.

A picture containing text, clipart

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Different binary search trees can contain the same data. However, the **time of insertion** matters when it comes to the **order** of the nodes in the tree.

Diagram

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All of these are valid binary search trees yet have different shapes.

# **Binary Search Tree Operations**