B- Trees

- B- trees are balanced search trees designed to work well on disks or other direct access secondary storage devices.
- B- Trees are better at minimizing disks I/o operations.
- Database systems use B- Trees and its variants for indexing.

→ A B- tree T is a rooted tree (whose root is T.root) having following properties:

1. Every node x has the following attributes:
   a. x.n, the number of keys currently stored in node x.
   b. The x.n keys themselves, x.key1, x.key2 ---- x.keyn, stored in non-decreasing, so that x.key1 <= x.key2 -- x.keyn
   c. x.leaf, a Boolean value that is true if x is a leaf and false if x is an internal node.

2. Each internal node x also contain x.n+1 pointers x.c1, x.c2 ---- x.n+1 to its children. Leaf nodes have no children, and so their ci attributes are undefined.

3. The key x.keyi seperate the ranges of keys stored in each subtree, if ki is any key stored in the subtree with root x.ci then,

$$k_1 \leq x.key_1 \leq x.key_2 \text{ ---- } x.key_n \leq k_{n+1}$$

4. All leaves have the same deapth, which is the tree's height h.

5. Nodes have lower and upper bounds, on the number of keys, they can contain.

These bounds are fixed integers $t \geq 2$ is called minimum degree of B-tree:

a. Every node other than the root, must have at least $(t-1)$ keys.

Every internal node other than the root thus has at least 't' children. If the tree is non-empty, the root must have at least one key.

b. Every node must contain at most $(2*t-1)$ keys.

Therefore an internal node may have atmost $2*t$ children. A node is full if it has $(2*t-1)$ keys.

B-Trees - Creation

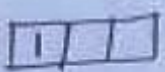
Array = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Degree $t = 2$

Soln: Min Keys $= (t-1) = 1$

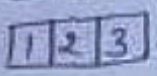
Max Keys $= (2t-1) = 3$

Step-1 Insert-1



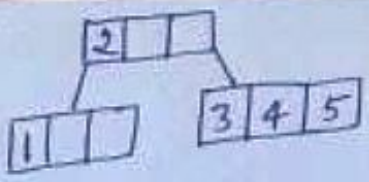
Step-2 Insert-2

Step-3 Insert-3

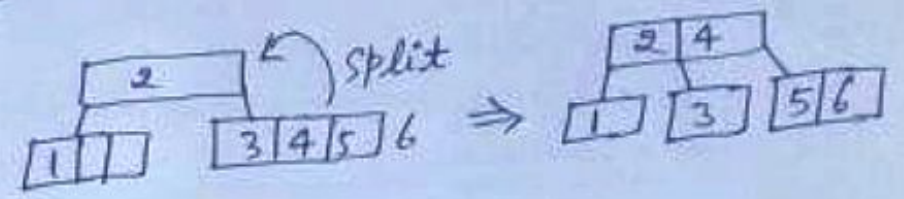


Step-4 Insert-4

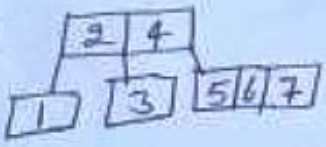
Step-5 Insert-5



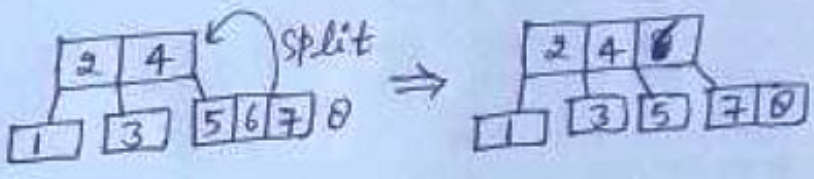
Step-6 Insert-6



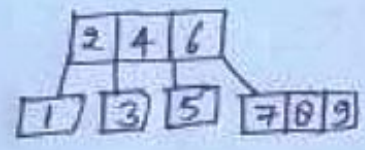
Step-7 Insert-7



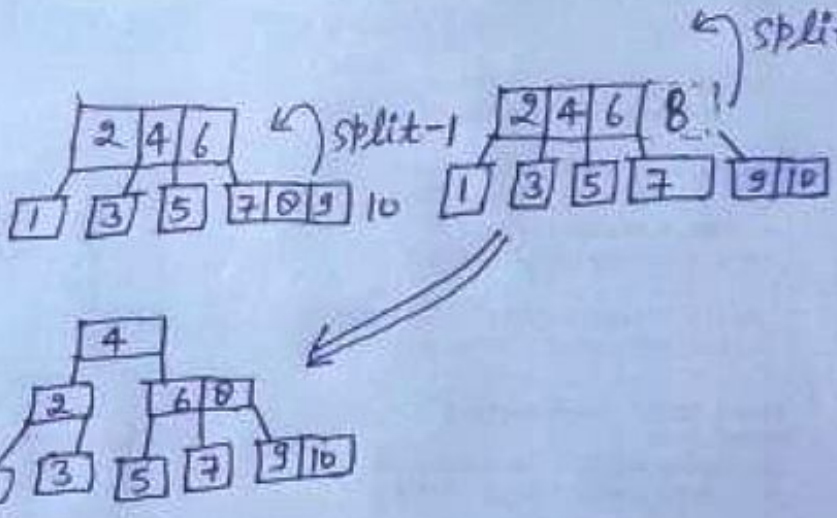
Step-8 Insert-8



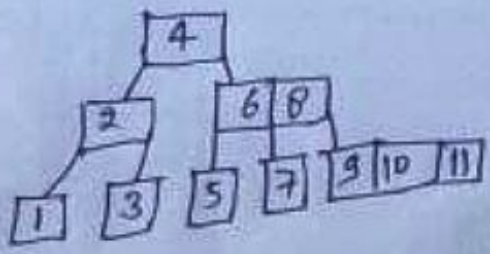
Step-9 Insert-9



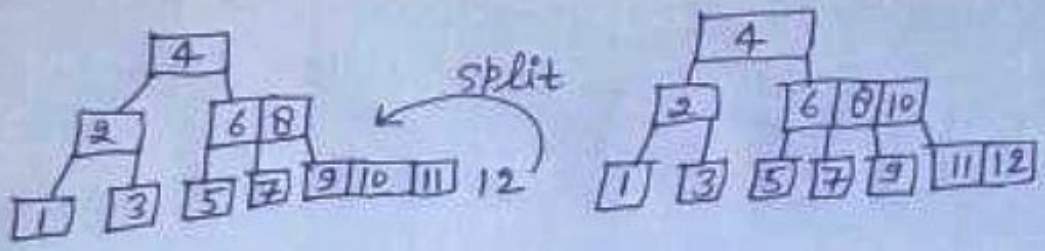
Step-10 Insert-10



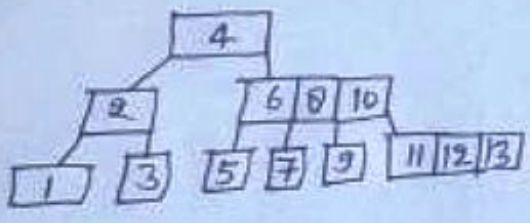
Step-11 Insert-11



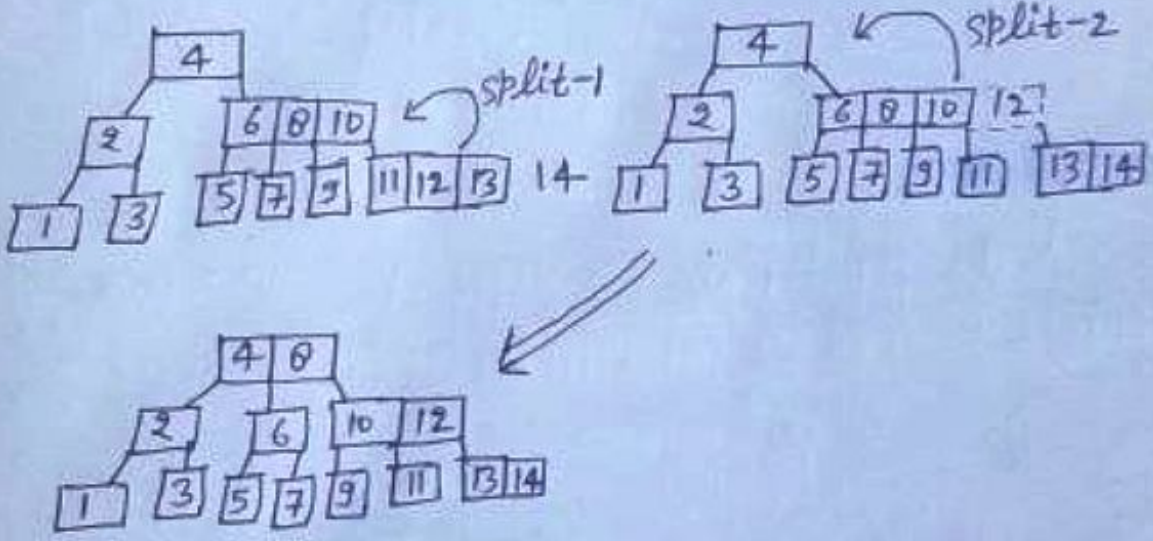
Step-12 Insert -12



Step-13 Insert -13



Step-14 Insert -14



Step-15 Insert -15