

B/B+ Trees

1. Figure 7 shows a B-tree where key values are indicated in the records. Each block can hold upto three records. A record with a key value 34 is inserted into the B-tree. Obtain the modified B-tree after insertion.

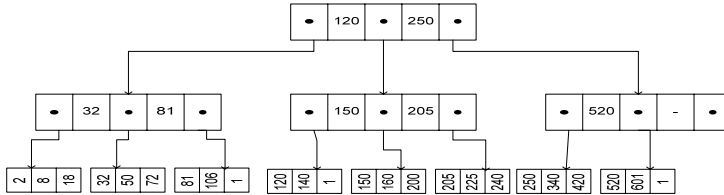


Fig. 7

2. The following key values are inserted into a B+ -tree in which order of the internal nodes is 3, and that of the leaf nodes is 2, in the sequence given below. The order of internal nodes is the maximum number of tree pointers in each node, and the order of leaf nodes is the maximum number of data items that can be stored in it. The B+ -tree is initially empty.

10, 3, 6, 8, 4, 2, 1

The maximum number of times leaf nodes would get split up as a result of these insertions is

- (A) 2 (B) 3 (C) 4 (D) 5
3. Which of the following statement(s) is/are correct regarding Bellman-Ford shortest path algorithm?
- P. Always finds a negative weighted cycle, if one exists.
 - Q. Finds whether any negative weighted cycle is reachable from the source.
- (A) P only
 (B) Q only
 (C) Both P and Q
 (D) Neither P nor Q
4. A B-tree of order 4 is built from scratch by 10 successive insertions. What is the maximum number of node splitting operations that may take place?
- (A) 3
 (B) 4
 (C) 5
 (D) 6
5. The order of an internal node in a B⁺ tree index is the maximum number of children it can have. Suppose that a child pointer takes 6 bytes, the search field takes 14 bytes, and the block size is 512 bytes. What is the order of the internal node?
- (A) 24
 (B) 25
 (C) 26
 (D) 27
6. Consider the B⁺ tree of order d shown in Fig. 7. (A B⁺ tree of order d contains between d and 2d keys in each node).

- (a) Draw the resulting B⁺-tree after 100 is inserted in the tree shown in Fig. 7.

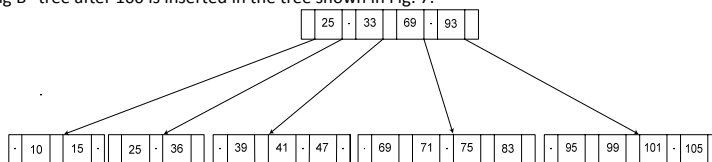


Fig. 7

For a B⁺-tree of order d with n leaf nodes, the number of nodes accessed during a search is O (-----).

7. Which of the following is correct?

- (A) B-trees are for storing data on disk and B⁺ trees are for main memory.
- (B) Range queries are faster on B⁺ trees
- (C) B trees are for primary indexes and B⁺ trees are for secondary indexes.
- (D) The height of a B⁺ tree is independent of the number of records.

8. (a) Suppose you are given an empty B⁺ - tree where each node (leaf and internal) can stored up to 5 key values. Suppose values 1, 2, ..., 10 are inserted, in order into the tree. Show the tree pictorially

- i After 6 insertions, and
 - ii After all 10 insertions
- Do not show the intermediate stages.

- (a) Suppose instead of splitting a node when it is full, we try to move a value to the left sibling. If there is no left sibling, or the left sibling is full, we split the node. Show the tree after values 1, 2, ..., 9 have been inserted. Assume, as in (a), that each node can hold up to 5 keys.
- (b) In general, suppose a B⁺ - tree node can hold a maximum of m keys, and you insert a long sequence of keys in increasing order. Then what approximately is the average number of keys in each leaf level node
 - i In the normal case, and
 - ii With insertion as in (b).

9. We wish to construct a B⁺ tree with fan-out (the number of pointers per node) equal to 3 for the following set of key values:

80, 50, 10, 70, 30, 100, 90

Assume that the tree is initially empty and the values are added in the order given

- (a) Show the tree after insertion of 10, after insertion of 30, and after insertion of 90. Intermediate trees need not be shown.
- (b) The key values 30 and 10 are now deleted from the tree in that order. Show the tree after each deletion.

10. A B⁺ -tree index is to be built on the Name attribute of the relation STUDENT. Assuming that all student names are of length 8 bytes, disk blocks are of size 512 bytes, and index pointers are of size 4 bytes. Given this scenario, what would be the best choice of the degree (i.e. the number of pointers per node) of the B⁺ -tree?

- A. 16
- B. 42
- C. 43
- D. 44

11. A B⁺ -tree of order d is a tree in which each internal node has between d and 2d key values. An internal node with M key values has M+1 children. The root (if it is an internal node) has between 1 and 2d key values. The distance of a node from the root is the length of the path from the root to the node. All leaves are at the same distance from the root. The height of the tree is the distance of a leaf from the root.

- (a) What is the total number of key values in the internal nodes of a B⁺ -tree with l leaves (l ≥ 2)?
- (b) What is the maximum number of internal nodes in a B⁺ -tree of order 4 with 52 leaves?
- (c) What is the minimum number of leaves in a B⁺ -tree of order d and height h (h ≥ 1)?

12. The following table refers to search times for a key in B-trees and B⁺ -trees.

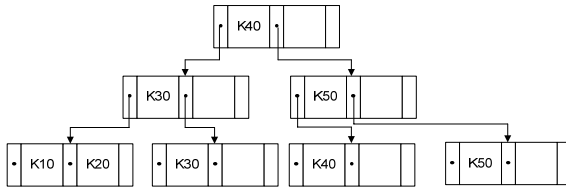
B -tree		B+ -tree	
Successful Search	Unsuccessful Search	Successful Search	Unsuccessful Search
X1	X2	X3	X4

A successful search means that the key exists in the database and unsuccessful means that it is not present in the database. Each of the entries X₁, X₂, X₃, and X₄ can have a value of either *constant* or *variable*: *Constant* means that the search time is the same, independent of the specific key value, whereas *variable* means that it is depend on the specific key value chosen for the search

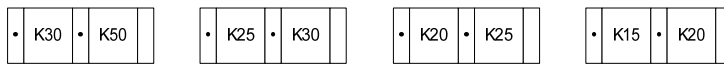
Give the correct values for the entries X₁, X₂, X₃, and X₄ (for example, X₁ = Constant, X₂ = Constant, X₃ = Constant, X₄ = Constant).

13. **Statements for linked Answer Questions 84 & 85**

Consider the B⁺ tree in the adjoining figure, where each node has at most two keys and three links.

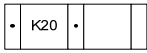


Keys K15 and then K25 are inserted into this tree in that order. Exactly how many of the following nodes (disregarding the links) will be present in the tree after the two insertions?



- (A) 1 (B) 2 (C) 3 (D) 4

Now the keys K50 is deleted from the B⁺ tree resulting after the two insertions made earlier. Consider the following statements about the B⁺ tree resulting after this deletion.

- (i) The height of the tree remains the same.
- (ii) The node  (disregarding the links) is present in the tree.
- (iii) The root node remains unchanged (disregarding the links).

Which of the following option is true?

- (A) Statements (i) and (ii) are true
- (B) Statements (ii) and (iii) are true
- (C) Statements (iii) and (i) are true
- (D) All the statements are false