INFS2200/7903 – Relational Database Systems

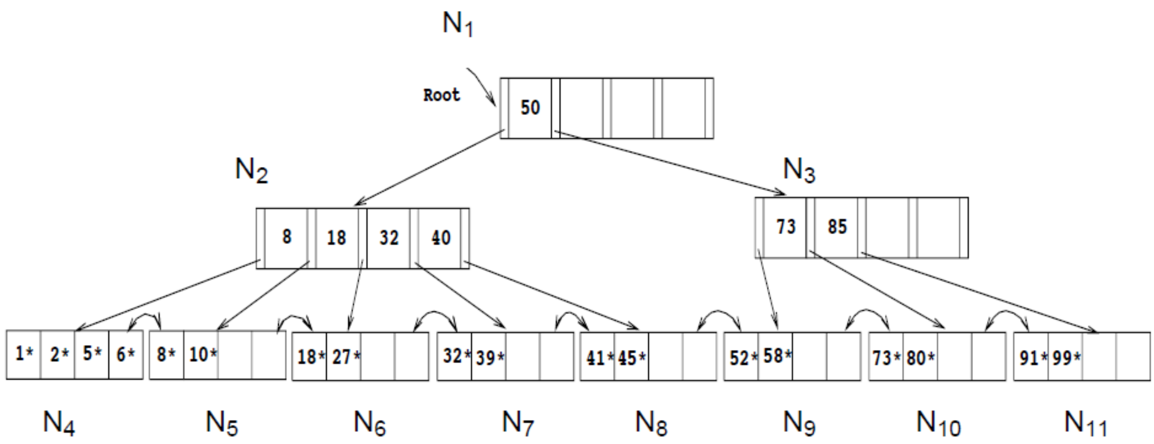
School of Information Technology and Electrical Engineering (ITEE), UQ

Tutorial 6

Question 1 Consider the B+ tree index of order p = 5 shown in the figure below. Answer each of the following questions:

A. List all the tree nodes that must be visited to answer the following query: "Get all records with search key equal to 10".

B. What is the minimum number of tree nodes that must be visited to answer the following query: "Get all records with search key greater than 30"? List all the visited tree nodes.



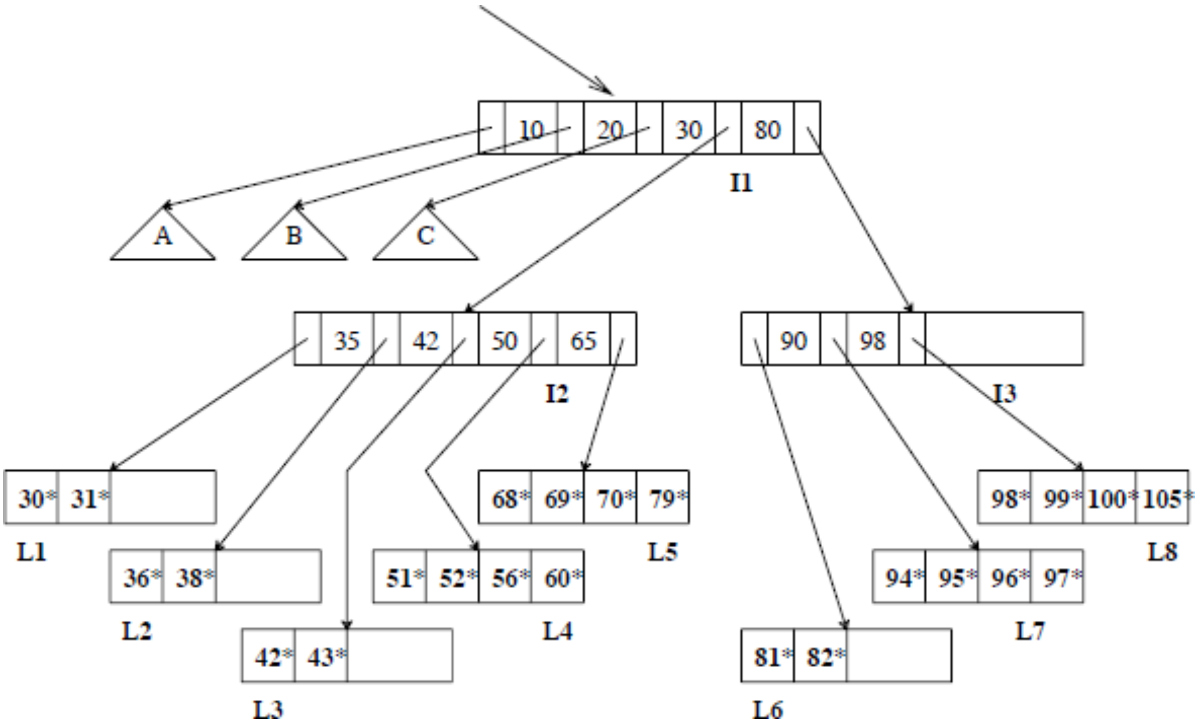
Question 2 Consider the B+ tree index of order p = 5 shown in the figure below. Note that subtrees A, B, and C are not fully specified and their content is not needed for answering this question. Assume that in the case of a leaf node split, the keys are redistributed according to the following rule: 2 keys stay in the old node and the remaining keys are moved to a new node.

Answer each of the following questions:

A. Name all the tree nodes that must be fetched to answer the following query: "Get all records with search key greater than 38."

B. Show the B+ tree that would result from inserting a record with search key 109 into the tree.

C. Name a search key value such that inserting it into the (original) tree would cause an increase in the height of the tree.


10
20
30
80
I1
A
B
C
35
42
50
65
I2
90
98
I3
30* 31*
L1
36* 38*
L2
42* 43*
L3
51* 52* 56* 60*
L4
68* 69* 70* 79*
L5
81* 82*
L6
94* 95* 96* 97*
L7
98* 99* 100* 105*
L8

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Answers for Question 1 are given below:

A. We use top-down search in a B+ tree. Nodes N_1, N_2, N_5 need to be visited to answer the query "Get all records with search key equal to 10".

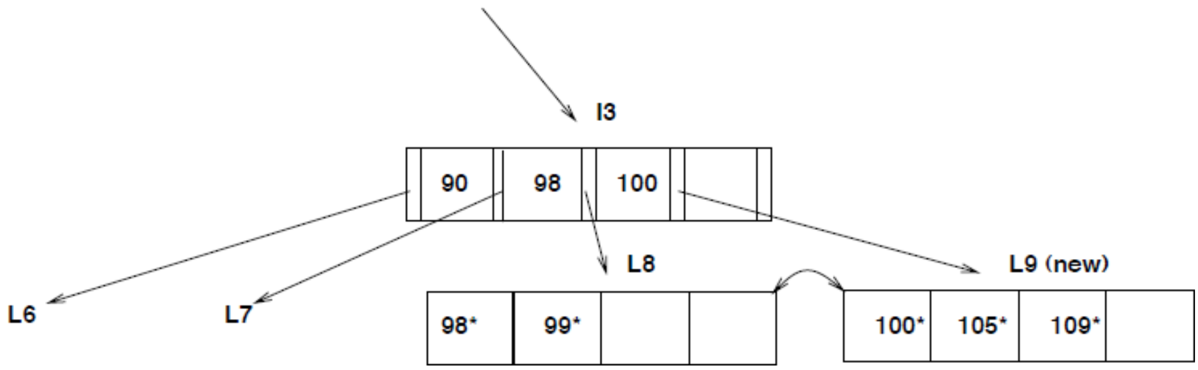
B. The p_{next} pointers in leaf nodes can be utilized to support range search in the B+ tree. To answer the query "Get all records with search key greater than 30", we first use "30" to search in the B+ tree, and then follow the p_{next} pointers to fetch all the remaining matching blocks.

In total, there are 8 tree nodes visited: N_1, N_2, N_6, N_7, N_8, N_9, N_{10}, N_{11}.

Answers for Question 2 are given below:

A. Nodes I1, I2, and everything in the range [L2…L8] must be fetched to answer the query "Get all records with search key greater than 38."

B. The resulting subtree nodes are shown below:



Note: *Node L8 is split into two nodes – L8 and L9 (new).*

C. There are many search keys X such that inserting X would increase the height of the tree. For example, any search key in the range [65…79] would suffice. A key in this range would go into L5 if there were room for it. But since L5 is full already, it must split. This in turn causes I2 to split, which causes I1 to split. Since I1 is the root node, a new root is created and the tree becomes taller.