Fall 2022

Comp2411 Tutorial No. 5:
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1. Compare and contrast the three types of single-level indices, i.e., primary index, clustering index, and secondary index, in terms of their applicable conditions, and the kinds of search/queries as supportable.

Answer:

Applicable conditions:

- Primary index: applicable to a data file which is ordered on the key field (*corresponding to the primary key of the corresponding relation*), upon which the index is built, and it can be either a dense or non-dense index.
- Clustering index: applicable to a data file which is ordered on a non-key field, upon which the index is built; it is normally a non-dense index.
- Secondary index: applicable to a non-ordered data file, and the index is built either on a candidate key or a non-key field; it is always a dense index.

Query types supported by each:

- Primary index: suitable for "one-record-at-a-time" search with a precise condition (such as given an id, find the corresponding employee); it can also be used to support "ordered read" according to the indexed field (eg, primary key).
- Clustering index: suitable for a "batch-at-a-time" search with an exact condition (eg, to list all employees of a given dept).
- Secondary index: suitable for either "ordered read" (if on a candidate key) or "batch-at-a-time" search (if on a non-key field), in both cases the data file is not required to be ordered.

2. Construct a B+ tree for the following set of key values:

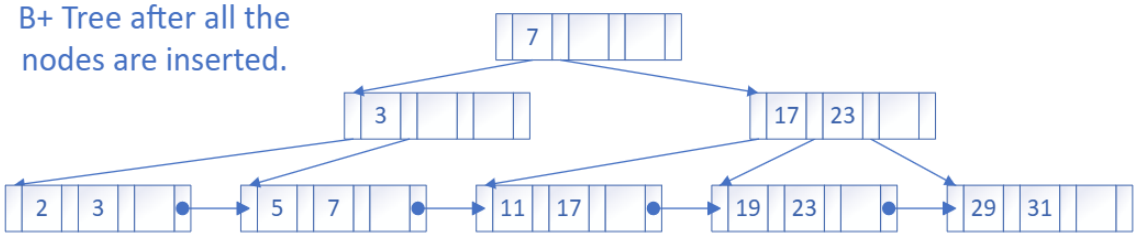
(2, 3, 5, 7, 11, 17, 19, 23, 29, 31)

Assuming that the tree is initially empty, values are added in ascending order, and the order of the tree is 4 and the leaf order is 3.

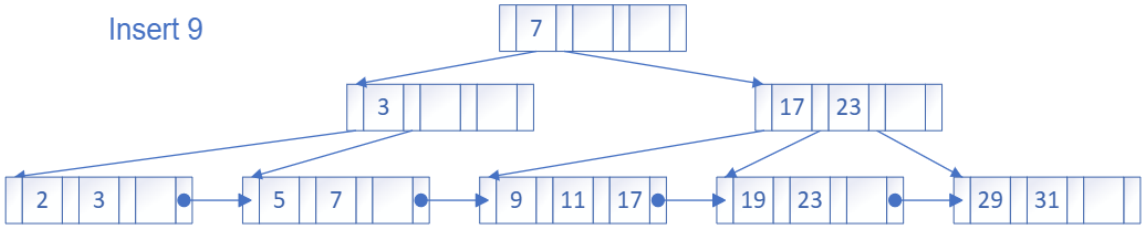
For the tree derived from the above question, show the form of the tree after each of the following series of operations:

a) Insert 9
b) Insert 10
c) Insert 8
d) Delete 7
e) Delete 3
f) Delete 5

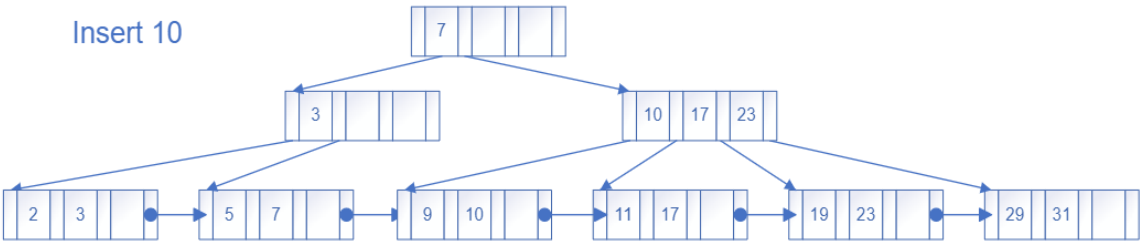
B+ Tree after all the nodes are inserted.

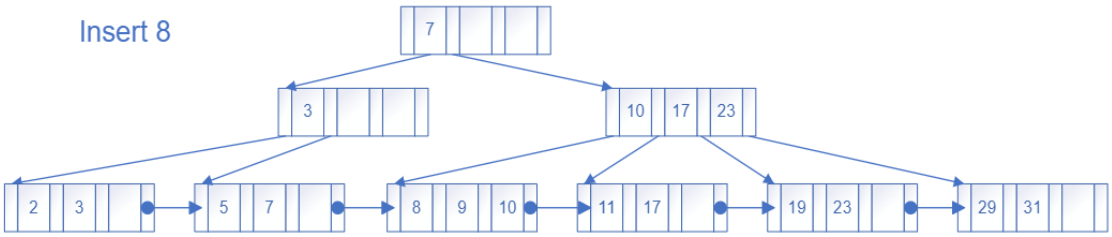


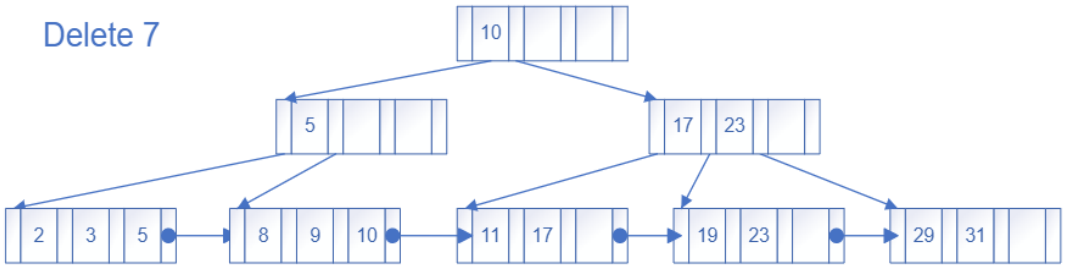
Insert 9

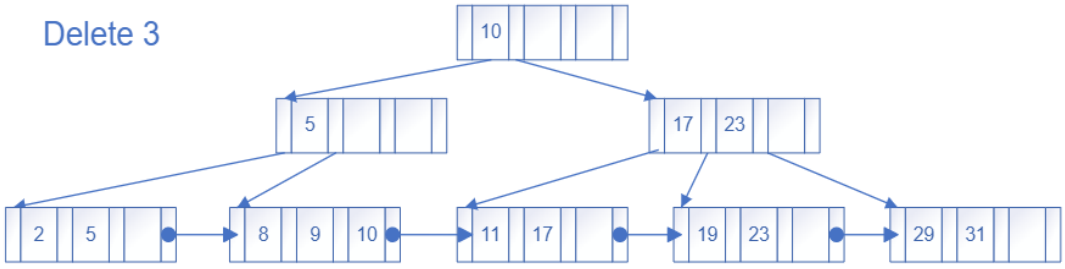


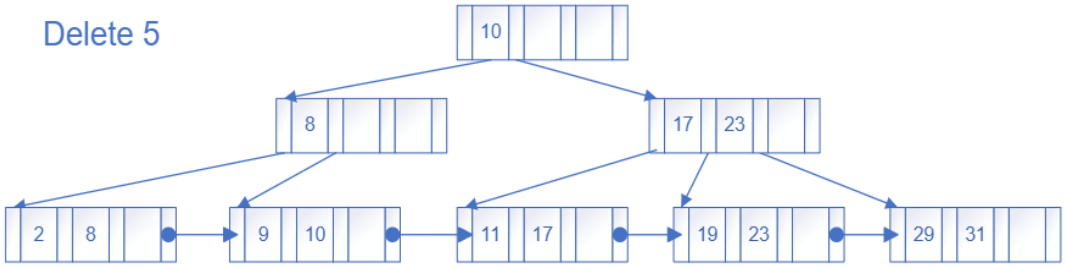
Insert 10











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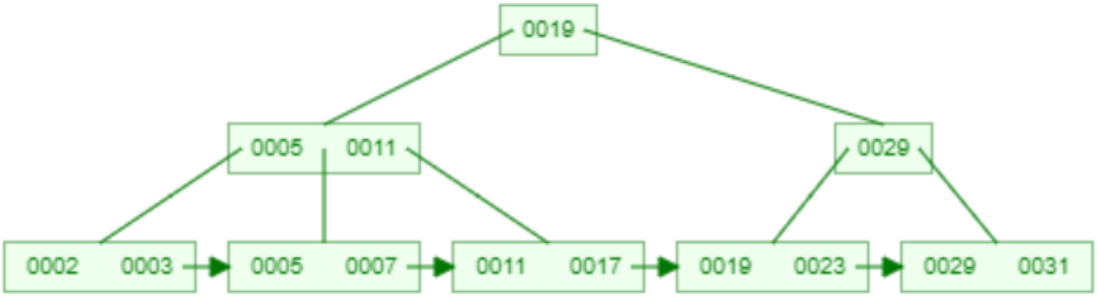
What would happen if the key value [8] is removed?

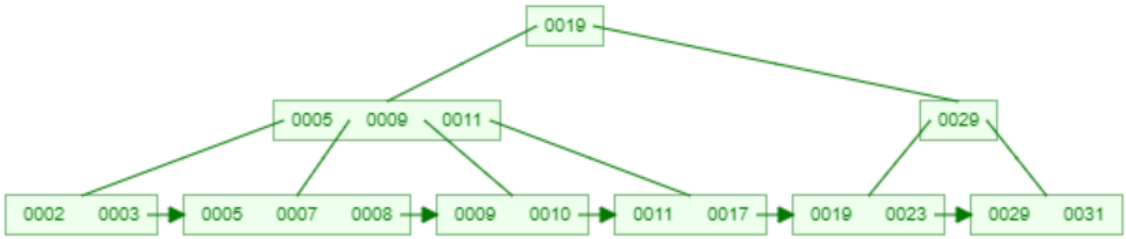
(*Hint: The leaf node contains the value[8] would be merged with the leaf node on the right hand side.*)

Other results could be possible and you may notice that the results are not exactly the same.

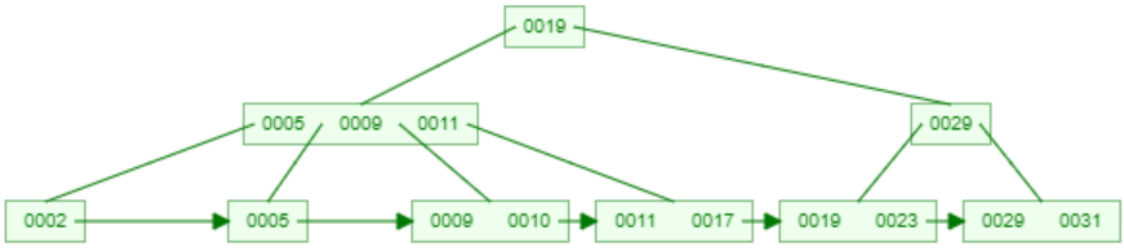
(*from: https://www.cs.usfca.edu/~galles/visualization/BPlusTree.html*)



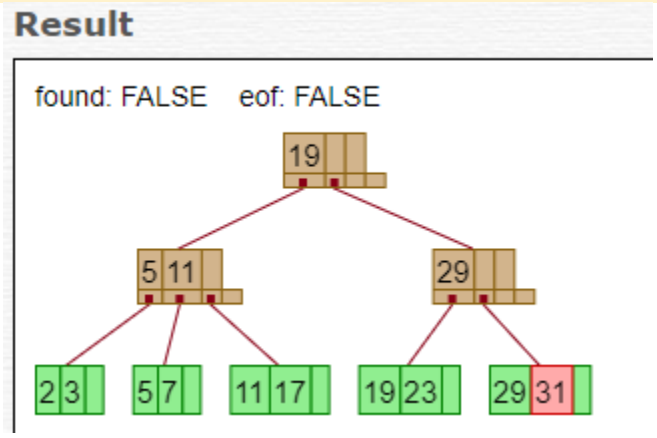
After 9, 10, 8 are inserted.



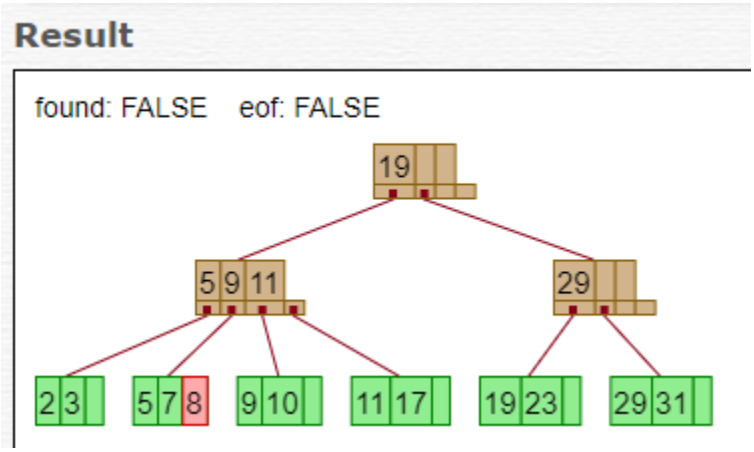
Deletion of values 7, 3, 5



(from: https://goneill.co.nz/btree-demo.php)



After 9, 10, 8 are inserted.



Deletion of values 7, 3, 5