DATABASE MANAGEMENT SYSTEMS
B Plus Tree : Bulk Loading (Top Down Vs Bottom Up)

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Objective :

- To use External Merge Sort for sorting the data
- To implement Bulk Loading for building the B+ Tree in two ways:
    - Top-down Approach
    - Bottom-Up Approach
- To compare the performance of both approaches and compare them with insertion without sorting.
- Analyze the quality of indices created from each of the algorithms (height, number of nodes)

- **What is done?**
    - Generated 1000 random numbers to form the input of the B+ Tree.
    - Ran External Merge Sort on the file containing the random numbers.
    - Insert into the B+ Tree using Bulk Loading (both top-down and bottom-up) approach.

- **Comparison of the two approaches :**
    - **Normal Insert approach :**
        - Total number of nodes : 1060
        - Height of the tree : 8
        - Time taken in Bottom-Up insertions 26460587e-09 nanoseconds.
    - See the bplustreeNormal.out file to check the final output (the B+ Tree formed).

- ○ **Top-Down approach :**
  - ■ Total number of nodes : 751
  - ■ Height of the tree : 7
  - ■ Time taken in Bottom-Up insertions 23991027e-09 nanoseconds.
- ○ See the bplustreetopdown.out file to check the final output (the B+ Tree formed).
- ○ **Bottom-Up approach :**
  - ■ Total number of nodes : 504
  - ■ Height of the tree : 7
  - ■ Time taken in Bottom-Up insertions 20706230e-09 nanoseconds.
- ○ See the bplustreeBottomUp.out file to check the final output (the B+ Tree formed).

It's evident from the above mentioned results that, the Bottom-Up approach is more efficient than Top-Down approach. And bulk-loading is more efficient than normal insertions.

Also, bulk-loading is the more space efficient as compared to normal insertions.
Thus, bottom-up is the best, then comes top-down, and the least desired is normal insertion.

- ● **References :**
  - ○ External_Merge_Sort-
    http://www.ashishsharma.me/2011/08/external-merge-sort.html
  - ○ B + Tree structure - https://gist.github.com/mikelikesbikes/4742901