**Optional Project-4**

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**Question1:**

QuickSort is implemented in QuickSortPartition.java. quickSortOrdinary() is implemented using single Pivot partition. quickSortDual is implemented using Dual pivot partition.

When duplicates are allowed the time taken by both of them varies as follows. For input size of 1048576.

normal partition Time: 1791 msec.

Memory: 40 MB / 123 MB.

dual partition Time: 1470 msec.

Memory: 45 MB / 123 MB.

normal partition Time: 1715 msec.

Memory: 40 MB / 123 MB.

dual partition Time: 1807 msec.

Memory: 46 MB / 123 MB.

**Question 2:**

Selecting Kth largest element is implemented using partition method with select() method. And priority Queue with selectPriority method.

selecting 102 largest result 1048483

first time Time: 159 msec.

Memory: 25 MB / 123 MB.

result2 1048483

second time Time: 61 msec.

Memory: 27 MB / 123 MB.\*/

searching 102220th largest element result 946951

first time Time: 177 msec.

Memory: 25 MB / 123 MB.

result2 946951

second time Time: 468 msec.

Memory: 30 MB / 123 MB.

Selecting kth element with k values smaller is fast with normal priority Queue method. Whereas for large k this method is comparatively slower because of heap operations and comparitions.

**Question 3:**

Alternating remove method for two children is implemented using BST.java. removeTwoMaxLeft() and removeTwoMinRight () are used to alternatively select replace the deleted node with maximum of left child and minimum of right child alternatively. flagRemove Boolean flag is used to achieve this.