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This experiment was to first make a 2-3 tree. These operations included insert, remove, deletemin, and deletemax. After creating the 2-3 tree, testing was needed to compare the binary search tree that was created in lab 4. The tests were done using pseudo random numbers using the srand and rand C++ functions. Random numbers were first inserted into the binary search tree and 2-3 tree. Then a combination of insertions and deletions were performed on both structures based on a probability function that was calculated from the pseudo random numbers.

Data was generated in three main loops. The outer loop generated the number of insertions into the structures, but only 10% of this total number was used for the insertion and deletion inner loop. The number of insertions started at 50,000 and increased by 50,000 until 400,000 items were inserted into the structure. The second inner loop generated a seed to be used for the pseudo random number. This experiment used seed values of 1 to 5. The four inner loops were for the insertion only loop and the combination of insertion and deletion loop (two loops for each structure). It printed out the execution time of each inner loop. These times were put into an Excel spreadsheet to generate the graphs below comparing the execution time vs. number of insertions.

The binary search tree always performed slightly better in the both tests. The execution time for both structures took longer as n increased. The binary search tree demonstrated the average case analysis of O(log n) and performed better than the 2-3 tree, which is always O(log n). The binary search tree can have a worst case scenario of O(n) if it is a skew tree. If this is rare or can be avoided, then the binary search tree would be the better pick for performance. The average execution times are in the table below as well as the graphs comparing the two structures.

n	BST Insert (s)	BST Insert and Delete (s)	2-3 Tree Insert (s)	2-3 Tree Insert and Delete (s)
50000	0.026773	0.0003802	0.062332	0.0005002
100000	0.066497	0.0007354	0.1442286	0.000976
150000	0.1173832	0.0011352	0.2489348	0.0014804
200000	0.1760566	0.001317	0.3321684	0.0017802
250000	0.232789	0.0016444	0.4351008	0.00219
300000	0.2449066	0.0021442	0.5405642	0.0029536
350000	0.2912284	0.0025812	0.65872	0.0033822
400000	0.3883096	0.0027842	0.7694314	0.0035684

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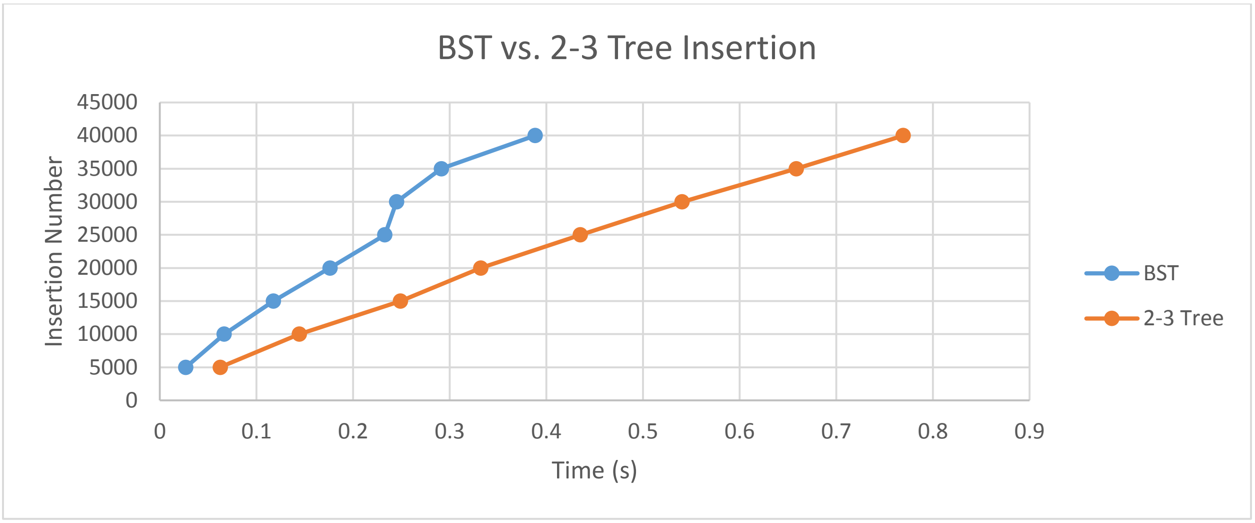
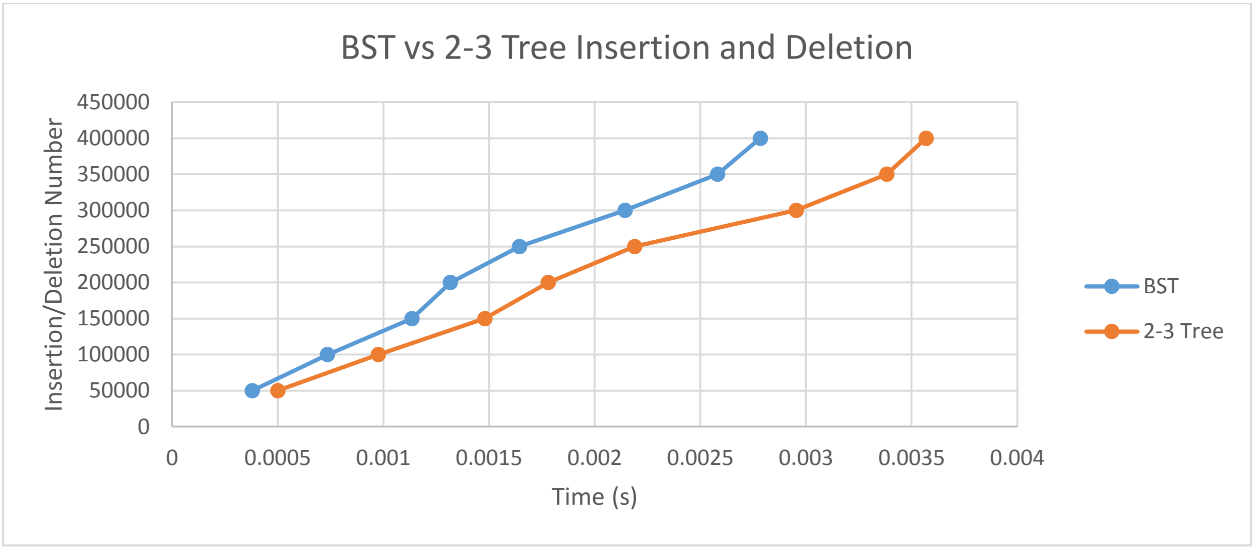

BST vs. 2-3 Tree Insertion
Insertion Number
Time (s)
BST
2-3 Tree


BST vs 2-3 Tree Insertion and Deletion
Insertion/Deletion Number
Time (s)
BST
2-3 Tree