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Long Project 3 Writeup

In this project, three different data structures were tested for runtime and memory used: skip list, red black tree, and Java TreeSet. These were each compared by running one million contains, removes, and between 4 and 32 million add operations.

The skip list structure was the slowest structure across the board, and almost half as fast as the red black tree. The skip list also seemed to scale approximately linearly, doubling in runtime when the number of elements doubled. Memory use for the skip list was also generally between 45% and 65% over the tests.

The red black tree was faster than the skip list but slower than the TreeSet across the board. While the red black tree appeared to be increasing in runtime linearly with the elements, at 32 million elements, the runtime was significantly less than that trend would assume. This could be due to the logarithmic worst case runtime given by a balanced tree structure. The memory for the red black tree also fluctuated between 45% and 78% memory use, with two values being close at 73% and 78%.

The TreeSet structure was the fastest of the 3 data structures across the board. The TreeSet performed close to the red black tree on the 8 million elements, but the time was 20-25% faster than the red black tree on sets of 16 and 32 million. The memory usage of TreeSet showed a higher utilization of 85% and 65% for 4 and 8 million, while the utilization for 16 and 32 million was only 31% and 39%.

In conclusion, the skip list was clearly the slowest, while the red black tree and the TreeSet were more competitive. However, the TreeSet structure was still the fastest of the three. Looking at memory usage, the values seen seemed unstable, however the TreeSet data structure consistently used less amounts of memory than the other structures at higher numbers of elements.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Skip list | RBT | TreeSet |
| 4 M | 14.478 | 8.905 | 7.193 |
| 8 M | 31.094 | 19.390 | 15.539 |
| 16 M | 78.5 | 43.181 | 31.581 |
| 32 M | 171.523 | 51.669 | 39.907 |

**Table 1.** Seconds per Test

|  |  |  |  |
| --- | --- | --- | --- |
|  | Skip list | RBT | TreeSet |
| 4 M | 2400/3170 | 2333/3178 | 2441/2857 |
| 8 M | 579/2191 | 1173/2199 | 1420/2186 |
| 16 M | 1110/2463 | 1970/2507 | 699/2288 |
| 32 M | 2162/3379 | 1538/3430 | 1369/3492 |

**Table 2.** Memory used per test in MB