**Analysis Data Collected for HashMap**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| n | T(n) —Try 1 | T(n) —Try 2 | T(n) — Try 3 | T(n) — Try 4 | T(n) — Try 5 | T(n) — average | T(n)/n |
| 16000 | 811 | 763 | 759 | 723 | 737 | 758.6 | 4.74x10-2 |
| 26000 | 1185 | 1176 | 1177 | 1177 | 1177 | 1178.4 | 4.53x10-2 |
| 52000 | 2268 | 2241 | 2203 | 2197 | 2198 | 2221.4 | 4.27x10-2 |
| 104000 | 4418 | 4267 | 4384 | 4274 | 4373 | 4343.2 | 4.17x10-2 |
| 208000 | 8833 | 8833 | 8772 | 8794 | 8718 | 8790 | 4.22x10-2 |
| 416000 | 17563 | 17673 | 17640 | 17478 | 17297 | 17530.2 | 4.21x10-2 |
| 832000 | 35225 | 36666 | 34888 | 35135 | 34966 | 35376 | 4.25x10-2 |
| 1664000 | 73598 | 72021 | 71669 | 72529 | 72191 | 72401.6 | 4.35x10-2 |
| 3,328,000 | 148983 | 149790 | 151841 | 149777 | 151347 | 150347.6 | 4.51x10-2 |

Converging to 4.21x10-2 as it fluctuates between high and low

T(416000) = 17530.2 = a\*(416000) a = 4.21x10-2

**Analysis Data Collected for TreeMap (Red-Black Tree)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| n | T(n) —Try 1 | T(n) —Try 2 | T(n) — Try 3 | T(n) — Try 4 | T(n) — Try 5 | T(n) — average | T(n)/lgn |
| 16000 | 706 | 731 | 720 | 722 | 735 | 722.8 | 1.71x102 |
| 26000 | 1155 | 1130 | 1154 | 1149 | 1131 | 1143.8 | 2.59x102 |
| 52000 | 2270 | 2254 | 2261 | 2259 | 2333 | 2275.4 | 4.82x102 |
| 104000 | 4586 | 4456 | 4549 | 4499 | 4531 | 4524.2 | 9.01x102 |
| 208000 | 9155 | 9263 | 9307 | 9044 | 9242 | 9202.2 | 1.73x103 |
| 416000 | 18403 | 18082 | 18607 | 18613 | 18486 | 18438.2 | 3.28x103 |
| 832000 | 37989 | 39236 | 37804 | 38340 | 37752 | 38224.2 | 6.45x103 |
| 1664000 | 78199 | 82727 | 77172 | 81738 | 80744 | 80116 | 1.28x104 |
| 3,328,000 | 168088 | 171728 | 169235 | 169026 | 164140 | 168443.4 | 2.58x104 |

Converging to 1.28x104 as it fluctuates between high and low

T(1664000) = 80116 = a\*lg(1664000) a = 1.28x104

Conclusion:

Overall, my analysis shows that the TreeMap is more efficient than the HashMap as the TreeMap converges at 1.28x104 and HashMap converges at 4.21x10-2. This could mean that the values for n I chose were too small, since the HashMap empirical runtimes were much slower than the TreeMap. The HashMap runtime was much quicker than the TreeMap when the input for n was large. In my theoretical analysis, I had the HashMap to be more efficient due to the time complexity being O(n) and the TreeMap to be slower as it has a time complexity of O(lgn). So, HashMap data structure is useful for large sets of data that are not in order and TreeMap data structure is useful for small sets of data that are to be sorted in order.