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**Program Structures & Algorithms**

**Spring 2022**

**Assignment No. 4**

**Tasks:**

1. A cutoff (defaults to, say, 1000) which you will update according to the first argument in the command line when running. It's your job to experiment and come up with a good value for this cutoff. If there are fewer elements to sort than the cutoff, then you should use the system sort instead.
2. Recursion depth or the number of available threads. Using this determination, you might decide on an ideal number (*t*) of separate threads (stick to powers of 2) and arrange for that number of partitions to be parallelized (by preventing recursion after the depth of *lg t* is reached).
3. An appropriate combination of these.

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1. For Array size = 2,000,000

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cut-Off | Threadcount-4 | Threadcount-8 | Threadcount-16 | Threadcount-32 | Threadcount-64 |
| 20000 | 2101 | 2663 | 2539 | 2472 | 2100 |
| 40000 | 1467 | 1595 | 1457 | 1595 | 1454 |
| 60000 | 1384 | 1478 | 1417 | 1473 | 1434 |
| 80000 | 1413 | 1444 | 1445 | 1590 | 1432 |
| 100000 | 1361 | 1400 | 1371 | 1505 | 1380 |
| 120000 | 1365 | 1538 | 1369 | 1447 | 1376 |
| 140000 | 1319 | 1355 | 1324 | 1479 | 1348 |
| 160000 | 1334 | 1517 | 1349 | 1396 | 1341 |
| 180000 | 1333 | 1767 | 1353 | 1351 | 1334 |
| 200000 | 1332 | 1469 | 1335 | 1295 | 1358 |
| 220000 | 1324 | 1386 | 1356 | 1304 | 1327 |
| 240000 | 1328 | 1484 | 1353 | 1351 | 1345 |
| 260000 | 1296 | 1430 | 1268 | 1349 | 1281 |
| 280000 | 1301 | 1337 | 1286 | 1380 | 1284 |
| 300000 | 1332 | 1353 | 1293 | 1399 | 1278 |
| 320000 | 1314 | 1342 | 1278 | 1508 | 1270 |
| 340000 | 1280 | 1335 | 1282 | 1420 | 1276 |
| 360000 | 1278 | 1351 | 1299 | 1348 | 1332 |
| 380000 | 1285 | 1371 | 1280 | 1321 | 1333 |
| 400000 | 1266 | 1329 | 1283 | 1526 | 1331 |
| 420000 | 1279 | 1363 | 1275 | 1499 | 1331 |
| 440000 | 1306 | 1353 | 1314 | 1482 | 1288 |
| 460000 | 1276 | 1329 | 1284 | 1445 | 1301 |
| 480000 | 1282 | 1320 | 1303 | 1511 | 1297 |
| 500000 | 1269 | 1345 | 1292 | 1460 | 1292 |
| 520000 | 1212 | 1373 | 1259 | 1487 | 1235 |
| 540000 | 1232 | 1355 | 1244 | 1343 | 1226 |
| 560000 | 1237 | 1437 | 1230 | 1284 | 1231 |
| 580000 | 1256 | 1513 | 1246 | 1276 | 1229 |
| 600000 | 1464 | 1678 | 1254 | 1279 | 1237 |
| 620000 | 1345 | 1861 | 1255 | 1253 | 1243 |
| 640000 | 1299 | 1699 | 1252 | 1313 | 1241 |
| 660000 | 1302 | 1615 | 1231 | 1301 | 1277 |
| 680000 | 1398 | 2083 | 1250 | 1399 | 1240 |
| 700000 | 1440 | 1465 | 1294 | 1315 | 1247 |
| 720000 | 1304 | 1412 | 1243 | 1257 | 1258 |
| 740000 | 1247 | 1332 | 1252 | 1243 | 1243 |
| 760000 | 1267 | 1395 | 1249 | 1253 | 1230 |
| 780000 | 1305 | 1335 | 1258 | 1257 | 1240 |
| 800000 | 1264 | 1363 | 1246 | 1198 | 1258 |
| 820000 | 1256 | 1417 | 1230 | 1260 | 1231 |
| 840000 | 1247 | 1563 | 1246 | 1243 | 1219 |
| 860000 | 1240 | 1514 | 1266 | 1245 | 1243 |
| 880000 | 1245 | 1354 | 1253 | 1237 | 1244 |
| 900000 | 1271 | 1341 | 1310 | 1248 | 1242 |
| 920000 | 1443 | 1348 | 1256 | 1222 | 1303 |
| 940000 | 1277 | 1545 | 1274 | 1232 | 1240 |
| 960000 | 1304 | 1505 | 1280 | 1235 | 1237 |
| 980000 | 1293 | 1357 | 1243 | 1246 | 1224 |
| 1000000 | 1304 | 1426 | 1257 | 1278 | 1252 |

Chart, line chart

Description automatically generated

1. For Array size = 4,000,000

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cut-Off | Threadcount-4 | Threadcount-8 | Threadcount-16 | Threadcount-32 | Threadcount-64 |
| 20000 | 4088 | 4652 | 4817 | 4751 | 4444 |
| 40000 | 3355 | 3244 | 3145 | 3294 | 3053 |
| 60000 | 3148 | 3381 | 2972 | 3228 | 2997 |
| 80000 | 2912 | 3104 | 2996 | 3278 | 2934 |
| 100000 | 2924 | 3168 | 3033 | 3144 | 2975 |
| 120000 | 3036 | 3206 | 2958 | 3139 | 3096 |
| 140000 | 2927 | 3069 | 2844 | 3114 | 3487 |
| 160000 | 2998 | 3110 | 2846 | 3130 | 3664 |
| 180000 | 2871 | 3144 | 2873 | 3349 | 3380 |
| 200000 | 2888 | 3062 | 2877 | 2967 | 3383 |
| 220000 | 3125 | 2996 | 2993 | 2948 | 3138 |
| 240000 | 3012 | 3061 | 2988 | 3206 | 3041 |
| 260000 | 3056 | 3002 | 2954 | 2901 | 2925 |
| 280000 | 2964 | 2983 | 2854 | 3060 | 2850 |
| 300000 | 3054 | 2915 | 2833 | 2975 | 2856 |
| 320000 | 2894 | 2875 | 2791 | 3122 | 2838 |
| 340000 | 3055 | 2914 | 2757 | 2970 | 2875 |
| 360000 | 3063 | 2937 | 2760 | 3126 | 2877 |
| 380000 | 3582 | 2943 | 2787 | 2988 | 2877 |
| 400000 | 2922 | 2855 | 2721 | 3021 | 2926 |
| 420000 | 3114 | 2848 | 2694 | 2909 | 2768 |
| 440000 | 2939 | 2933 | 2732 | 3105 | 2827 |
| 460000 | 2946 | 2874 | 2904 | 3188 | 2762 |
| 480000 | 2912 | 2842 | 2776 | 3019 | 2759 |
| 500000 | 2924 | 2836 | 2724 | 3024 | 2882 |
| 520000 | 2748 | 2715 | 2616 | 3086 | 2662 |
| 540000 | 2744 | 2733 | 2896 | 2932 | 2815 |
| 560000 | 2770 | 2853 | 3351 | 3051 | 2842 |
| 580000 | 3037 | 2759 | 3026 | 3282 | 2838 |
| 600000 | 2878 | 2777 | 3052 | 2896 | 2734 |
| 620000 | 2940 | 2812 | 2918 | 2643 | 2637 |
| 640000 | 2757 | 2726 | 3384 | 2648 | 2656 |
| 660000 | 3224 | 2695 | 3504 | 2658 | 2677 |
| 680000 | 2759 | 2660 | 3435 | 2624 | 2818 |
| 700000 | 2731 | 2793 | 3379 | 2622 | 2744 |
| 720000 | 2825 | 2804 | 3698 | 2598 | 2668 |
| 740000 | 2839 | 2802 | 3390 | 2628 | 2647 |
| 760000 | 3062 | 2818 | 2806 | 2601 | 2636 |
| 780000 | 2968 | 2777 | 2848 | 2640 | 2728 |
| 800000 | 2782 | 2713 | 3140 | 2683 | 2617 |
| 820000 | 3132 | 2729 | 2991 | 2665 | 2621 |
| 840000 | 2936 | 2807 | 2654 | 2573 | 2610 |
| 860000 | 2847 | 2843 | 3021 | 2603 | 2601 |
| 880000 | 2673 | 2712 | 2681 | 2637 | 2600 |
| 900000 | 2779 | 2732 | 2622 | 2630 | 2609 |
| 920000 | 2732 | 2813 | 2745 | 2789 | 2594 |
| 940000 | 2753 | 2751 | 2734 | 2871 | 2613 |
| 960000 | 2735 | 2817 | 2847 | 2832 | 2631 |
| 980000 | 2728 | 2782 | 2666 | 2666 | 2618 |
| 1000000 | 2715 | 2767 | 2643 | 2881 | 2615 |

**Chart, line chart

Description automatically generated**

**Conclusion:**

For array sized of length 2,000,000 & 4,000,000, with varying threadCount between 4,8,16,32,64 I have the following observations:

1. Performance is best for threadCount = 2 and worst for threadCount = 64.
2. The performance is the best when the cutoff is below 50% of the array size.