**Experiment 1: Windows 10 VM 1 Processor**

**Random Data Set**

**No threads**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 16 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 3.2 | 6.4 |
| 4000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 64000 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.5 | 4.5 |
| 128000 | 0 | 0 | 0 | 15 | 16 | 0 | 0 | 0 | 0 | 16 | 4.7 | 7.184010022 |
| 256000 | 16 | 0 | 16 | 0 | 0 | 16 | 16 | 15 | 16 | 0 | 9.5 | 7.762087348 |
| 512000 | 15 | 16 | 15 | 32 | 30 | 15 | 15 | 15 | 15 | 31 | 19.9 | 7.286288493 |
| 1024000 | 47 | 47 | 47 | 46 | 47 | 32 | 47 | 47 | 47 | 32 | 43.9 | 5.957348403 |
| 2048000 | 93 | 78 | 78 | 78 | 95 | 95 | 79 | 79 | 63 | 79 | 81.7 | 9.45568612 |
| 4096000 | 172 | 156 | 156 | 218 | 172 | 172 | 171 | 156 | 157 | 158 | 168.8 | 17.8986033 |
| 8192000 | 312 | 375 | 360 | 406 | 344 | 359 | 328 | 328 | 376 | 329 | 351.7 | 27.3461149 |
| 16384000 | 625 | 718 | 703 | 703 | 688 | 718 | 671 | 672 | 734 | 703 | 693.5 | 29.6690074 |
| 32768000 | 1234 | 1468 | 1391 | 1468 | 1438 | 1421 | 1328 | 1312 | 1312 | 1296 | 1366.8 | 76.96466722 |
| 65536000 | 2532 | 2703 | 2704 | 2937 | 2749 | 2610 | 2719 | 2624 | 2531 | 2624 | 2673.3 | 113.2537417 |
| 1 thread |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 31 | 0 | 16 | 16 | 15 | 0 | 16 | 16 | 16 | 15 | 14.1 | 8.383913167 |
| 2000 | 16 | 16 | 16 | 16 | 16 | 16 | 15 | 0 | 15 | 16 | 14.2 | 4.749736835 |
| 4000 | 31 | 15 | 15 | 15 | 16 | 16 | 18 | 15 | 16 | 16 | 17.3 | 4.64865572 |
| 8000 | 16 | 16 | 0 | 0 | 15 | 15 | 13 | 16 | 0 | 15 | 10.6 | 6.988562084 |
| 16000 | 15 | 16 | 0 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 14.3 | 4.775981575 |
| 32000 | 16 | 16 | 15 | 16 | 15 | 16 | 16 | 16 | 15 | 0 | 14.1 | 4.721228654 |
| 64000 | 16 | 15 | 16 | 15 | 16 | 15 | 15 | 15 | 16 | 16 | 15.5 | 0.5 |
| 128000 | 15 | 15 | 16 | 16 | 15 | 31 | 16 | 16 | 15 | 30 | 18.5 | 6.020797289 |
| 256000 | 31 | 32 | 14 | 31 | 32 | 16 | 15 | 15 | 32 | 16 | 23.4 | 8.224354078 |
| 512000 | 32 | 32 | 47 | 34 | 31 | 47 | 32 | 32 | 32 | 31 | 35 | 6.049793385 |
| 1024000 | 47 | 63 | 62 | 47 | 63 | 62 | 62 | 47 | 61 | 47 | 56.1 | 7.449161027 |
| 2048000 | 95 | 109 | 94 | 110 | 93 | 94 | 94 | 93 | 94 | 109 | 98.5 | 7.116881339 |
| 4096000 | 187 | 203 | 188 | 203 | 188 | 188 | 187 | 171 | 172 | 172 | 185.9 | 10.99499886 |
| 8192000 | 329 | 360 | 375 | 421 | 359 | 359 | 327 | 360 | 328 | 359 | 357.7 | 26.40094695 |
| 16384000 | 640 | 671 | 703 | 797 | 703 | 813 | 657 | 688 | 640 | 656 | 696.8 | 58.36403002 |
| 32768000 | 1250 | 1345 | 1329 | 1672 | 1485 | 1453 | 1312 | 1359 | 1328 | 1358 | 1389.1 | 113.9161534 |
| 65536000 | 4531 | 2782 | 2625 | 2766 | 2781 | 2780 | 2750 | 2671 | 2688 | 2640 | 2901.4 | 546.2318555 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 30 | 31 | 15 | 31 | 31 | 32 | 16 | 32 | 16 | 31 | 26.5 | 7.116881339 |
| 2000 | 31 | 16 | 31 | 16 | 16 | 31 | 31 | 16 | 31 | 16 | 23.5 | 7.5 |
| 4000 | 31 | 31 | 32 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31.1 | 0.3 |
| 8000 | 16 | 31 | 15 | 32 | 31 | 32 | 19 | 31 | 16 | 16 | 23.9 | 7.569015788 |
| 16000 | 32 | 16 | 31 | 31 | 31 | 15 | 16 | 16 | 31 | 32 | 25.1 | 7.647875522 |
| 32000 | 30 | 31 | 16 | 31 | 16 | 31 | 31 | 16 | 31 | 30 | 26.3 | 6.753517602 |
| 64000 | 47 | 31 | 31 | 47 | 32 | 32 | 32 | 31 | 32 | 32 | 34.7 | 6.165225057 |
| 128000 | 32 | 32 | 47 | 31 | 47 | 47 | 31 | 31 | 31 | 31 | 36 | 7.211102551 |
| 256000 | 46 | 47 | 31 | 47 | 31 | 46 | 46 | 48 | 32 | 32 | 40.6 | 7.45922248 |
| 512000 | 48 | 46 | 47 | 62 | 47 | 48 | 48 | 46 | 46 | 62 | 50 | 6.049793385 |
| 1024000 | 77 | 78 | 62 | 79 | 78 | 62 | 62 | 78 | 63 | 62 | 70.1 | 7.917701687 |
| 2048000 | 110 | 125 | 109 | 188 | 126 | 125 | 110 | 108 | 125 | 109 | 123.5 | 22.8002193 |
| 4096000 | 187 | 202 | 188 | 234 | 203 | 219 | 203 | 187 | 203 | 187 | 201.3 | 14.77193285 |
| 8192000 | 438 | 360 | 376 | 421 | 406 | 406 | 374 | 406 | 375 | 376 | 393.8 | 23.79411692 |
| 16384000 | 751 | 719 | 719 | 812 | 813 | 750 | 688 | 703 | 703 | 704 | 736.2 | 42.67270791 |
| 32768000 | 1392 | 1375 | 1390 | 1562 | 1422 | 1406 | 1375 | 1329 | 1375 | 1358 | 1398.4 | 59.6509849 |
| 65536000 | 2859 | 2827 | 2796 | 3000 | 2844 | 2766 | 2720 | 2750 | 2625 | 2671 | 2785.8 | 100.7311273 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 threads |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 63 | 48 | 62 | 47 | 47 | 47 | 47 | 47 | 46 | 47 | 50.1 | 6.220128616 |
| 2000 | 77 | 47 | 47 | 63 | 62 | 63 | 48 | 48 | 48 | 47 | 55 | 10 |
| 4000 | 48 | 62 | 47 | 46 | 47 | 46 | 63 | 46 | 62 | 62 | 52.9 | 7.66093989 |
| 8000 | 62 | 47 | 46 | 63 | 63 | 63 | 46 | 63 | 47 | 48 | 54.8 | 8.022468448 |
| 16000 | 62 | 47 | 48 | 48 | 46 | 62 | 62 | 47 | 47 | 62 | 53.1 | 7.286288493 |
| 32000 | 47 | 47 | 62 | 62 | 63 | 79 | 48 | 62 | 62 | 47 | 57.9 | 9.964436763 |
| 64000 | 63 | 62 | 47 | 46 | 47 | 47 | 64 | 47 | 48 | 62 | 53.3 | 7.746612163 |
| 128000 | 46 | 63 | 62 | 62 | 62 | 62 | 60 | 78 | 62 | 63 | 62 | 7.197221686 |
| 256000 | 79 | 63 | 63 | 94 | 63 | 63 | 63 | 109 | 63 | 63 | 72.3 | 15.71018778 |
| 512000 | 62 | 77 | 78 | 109 | 77 | 96 | 77 | 94 | 77 | 77 | 82.4 | 12.68227109 |
| 1024000 | 93 | 94 | 93 | 125 | 110 | 107 | 95 | 125 | 94 | 94 | 103 | 12.40967365 |
| 2048000 | 156 | 140 | 140 | 171 | 140 | 156 | 140 | 172 | 140 | 141 | 149.6 | 12.55547689 |
| 4096000 | 219 | 235 | 216 | 297 | 235 | 250 | 235 | 234 | 219 | 235 | 237.5 | 22.0918537 |
| 8192000 | 516 | 406 | 406 | 437 | 453 | 421 | 406 | 406 | 391 | 437 | 427.9 | 34.47448332 |
| 16384000 | 734 | 781 | 765 | 906 | 781 | 749 | 734 | 719 | 734 | 750 | 765.3 | 50.86462425 |
| 32768000 | 1703 | 1438 | 1454 | 1579 | 1501 | 1406 | 1406 | 1359 | 1390 | 1422 | 1465.8 | 98.71757696 |
| 65536000 | 2953 | 2719 | 2781 | 2890 | 2859 | 2795 | 2703 | 2703 | 2641 | 2734 | 2777.8 | 92.44652508 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 94 | 109 | 109 | 109 | 109 | 109 | 110 | 94 | 94 | 109 | 104.6 | 6.945502142 |
| 2000 | 94 | 94 | 94 | 110 | 109 | 109 | 94 | 93 | 94 | 95 | 98.6 | 7.045565982 |
| 4000 | 125 | 110 | 109 | 140 | 111 | 110 | 109 | 110 | 109 | 93 | 112.6 | 11.62067124 |
| 8000 | 110 | 94 | 94 | 140 | 93 | 110 | 109 | 94 | 94 | 109 | 104.7 | 13.90719238 |
| 16000 | 94 | 109 | 109 | 125 | 109 | 109 | 93 | 109 | 94 | 95 | 104.6 | 9.820386958 |
| 32000 | 109 | 110 | 110 | 141 | 110 | 93 | 110 | 110 | 109 | 124 | 112.6 | 11.74904251 |
| 64000 | 109 | 109 | 172 | 125 | 109 | 109 | 109 | 93 | 94 | 109 | 113.8 | 21.15561391 |
| 128000 | 109 | 93 | 109 | 126 | 125 | 110 | 110 | 109 | 93 | 95 | 107.9 | 11.14854251 |
| 256000 | 125 | 109 | 128 | 124 | 109 | 125 | 109 | 126 | 125 | 109 | 118.9 | 8.141867108 |
| 512000 | 126 | 126 | 138 | 157 | 188 | 127 | 125 | 124 | 141 | 110 | 136.2 | 20.96568625 |
| 1024000 | 202 | 138 | 140 | 219 | 156 | 141 | 141 | 141 | 141 | 140 | 155.9 | 27.96587206 |
| 2048000 | 188 | 187 | 234 | 266 | 203 | 187 | 186 | 188 | 188 | 187 | 201.4 | 25.76121115 |
| 4096000 | 282 | 328 | 281 | 329 | 297 | 296 | 265 | 263 | 266 | 265 | 287.2 | 23.81512125 |
| 8192000 | 453 | 500 | 469 | 578 | 484 | 469 | 437 | 469 | 453 | 454 | 476.6 | 37.74970199 |
| 16384000 | 828 | 828 | 813 | 859 | 860 | 798 | 812 | 781 | 797 | 781 | 815.7 | 26.89256403 |
| 32768000 | 1562 | 1469 | 1688 | 1781 | 1531 | 1531 | 1453 | 1421 | 1453 | 1423 | 1531.2 | 113.0865156 |
| 65536000 | 4094 | 3078 | 3031 | 3063 | 3031 | 2812 | 2828 | 2719 | 2796 | 2702 | 3015.4 | 384.8049376 |
| 16 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 204 | 235 | 189 | 251 | 203 | 266 | 203 | 204 | 203 | 187 | 214.5 | 25.35448678 |
| 2000 | 203 | 202 | 218 | 234 | 219 | 218 | 203 | 234 | 203 | 204 | 213.8 | 12.09793371 |
| 4000 | 203 | 221 | 203 | 219 | 250 | 328 | 187 | 204 | 188 | 187 | 219 | 40.73327878 |
| 8000 | 218 | 201 | 219 | 266 | 219 | 235 | 204 | 203 | 218 | 203 | 218.6 | 18.77871135 |
| 16000 | 250 | 203 | 234 | 265 | 219 | 281 | 187 | 203 | 187 | 188 | 221.7 | 32.54857908 |
| 32000 | 251 | 188 | 203 | 234 | 203 | 282 | 203 | 203 | 203 | 203 | 217.3 | 27.72381648 |
| 64000 | 218 | 203 | 203 | 204 | 218 | 281 | 203 | 188 | 204 | 187 | 210.9 | 25.28418478 |
| 128000 | 219 | 203 | 219 | 249 | 219 | 266 | 203 | 234 | 218 | 219 | 224.9 | 18.70534683 |
| 256000 | 203 | 219 | 219 | 204 | 281 | 391 | 203 | 203 | 204 | 203 | 233 | 57.39512174 |
| 512000 | 219 | 219 | 234 | 218 | 235 | 266 | 234 | 234 | 234 | 219 | 231.2 | 13.70255451 |
| 1024000 | 296 | 281 | 250 | 250 | 266 | 281 | 251 | 249 | 268 | 250 | 264.2 | 16.13567476 |
| 2048000 | 297 | 297 | 313 | 281 | 297 | 311 | 282 | 298 | 294 | 281 | 295.1 | 10.78378412 |
| 4096000 | 374 | 391 | 403 | 390 | 593 | 516 | 375 | 438 | 376 | 375 | 423.1 | 70.35971859 |
| 8192000 | 578 | 563 | 641 | 577 | 751 | 765 | 578 | 578 | 547 | 562 | 614 | 75.72978278 |
| 16384000 | 968 | 938 | 1329 | 1032 | 953 | 1203 | 891 | 891 | 875 | 922 | 1000.2 | 142.4856484 |
| 32768000 | 1640 | 1688 | 1640 | 1859 | 1673 | 1859 | 1546 | 1547 | 1579 | 1578 | 1660.9 | 109.5430965 |
| 65536000 | 2922 | 3001 | 2953 | 3532 | 2969 | 3625 | 2860 | 2922 | 2907 | 3016 | 3070.7 | 258.3617812 |

**Experiment 2: Random Data Set: Ubuntu VM 1 Processor**

**No threads**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.4 | 0.663324958 |
| 2000 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2.1 | 5.647123161 |
| 4000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8000 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0.2 | 0.4 |
| 16000 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0.5 | 0.5 |
| 32000 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1.2 | 0.4 |
| 64000 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 7 | 2 | 2.6 | 1.496662955 |
| 128000 | 32 | 4 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 4 | 7.1 | 8.312039461 |
| 256000 | 27 | 9 | 9 | 9 | 9 | 9 | 8 | 12 | 9 | 9 | 11 | 5.422176685 |
| 512000 | 164 | 19 | 18 | 18 | 18 | 18 | 17 | 20 | 19 | 19 | 33 | 43.67379077 |
| 1024000 | 410 | 38 | 40 | 42 | 39 | 39 | 37 | 46 | 40 | 38 | 76.9 | 111.0598487 |
| 2048000 | 1085 | 79 | 76 | 126 | 79 | 78 | 85 | 109 | 81 | 79 | 187.7 | 299.5059432 |
| 4096000 | 1935 | 199 | 192 | 162 | 195 | 241 | 206 | 312 | 187 | 187 | 381.6 | 519.2853166 |
| 8192000 | 2641 | 711 | 689 | 673 | 703 | 690 | 695 | 791 | 760 | 670 | 902.3 | 580.6990701 |
| 16384000 | 2438 | 1241 | 1446 | 1258 | 1268 | 1296 | 1427 | 1427 | 1401 | 1326 | 1453 | 336.4968945 |
| 32768000 | 4706 | 2488 | 2889 | 2751 | 2533 | 2619 | 2740 | 3175 | 3129 | 2870 | 2990 | 611.630444 |
| 65536000 | 7418 | 4820 | 5265 | 5127 | 4978 | 5113 | 5180 | 5169 | 5224 | 5169 | 5346 | 701.3695246 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 thread |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 53 | 5 | 4 | 4 | 6 | 5 | 5 | 4 | 5 | 5 | 9.6 | 14.47895024 |
| 2000 | 54 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 5 | 5 | 9.6 | 14.80675522 |
| 4000 | 39 | 4 | 5 | 5 | 5 | 5 | 4 | 8 | 4 | 5 | 8.4 | 10.25865488 |
| 8000 | 31 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 5 | 5 | 7.7 | 7.772387021 |
| 16000 | 50 | 5 | 5 | 5 | 5 | 5 | 6 | 5 | 5 | 5 | 9.6 | 13.46996659 |
| 32000 | 40 | 6 | 6 | 6 | 6 | 5 | 6 | 9 | 5 | 6 | 9.5 | 10.22007828 |
| 64000 | 43 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 13 | 11.1 | 10.79305332 |
| 128000 | 38 | 9 | 9 | 9 | 8 | 9 | 8 | 13 | 9 | 9 | 12.1 | 8.734414691 |
| 256000 | 143 | 13 | 14 | 14 | 19 | 14 | 13 | 17 | 14 | 14 | 27.5 | 38.54153604 |
| 512000 | 82 | 22 | 23 | 24 | 30 | 24 | 22 | 31 | 22 | 23 | 30.3 | 17.51028269 |
| 1024000 | 302 | 42 | 43 | 84 | 48 | 47 | 43 | 57 | 42 | 45 | 75.3 | 76.53241143 |
| 2048000 | 445 | 110 | 83 | 114 | 107 | 124 | 108 | 117 | 116 | 102 | 142.6 | 101.3412058 |
| 4096000 | 600 | 230 | 181 | 191 | 278 | 187 | 156 | 467 | 329 | 284 | 290.3 | 135.2686586 |
| 8192000 | 1359 | 707 | 885 | 757 | 792 | 735 | 851 | 932 | 821 | 857 | 869.6 | 176.0018182 |
| 16384000 | 2355 | 1452 | 1829 | 1366 | 1497 | 1295 | 1472 | 1604 | 1566 | 1492 | 1593 | 288.3507586 |
| 32768000 | 4794 | 2186 | 2963 | 2633 | 2978 | 2435 | 2670 | 3401 | 2884 | 2984 | 2993 | 679.6832792 |
| 65536000 | 6809 | 5058 | 5323 | 4994 | 5221 | 4851 | 5063 | 5610 | 5376 | 5106 | 5341 | 530.7015074 |
| 2 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 15 | 8 | 8 | 8 | 8 | 12 | 7 | 8 | 8 | 7 | 8.9 | 2.42693222 |
| 2000 | 16 | 9 | 8 | 8 | 7 | 7 | 7 | 8 | 7 | 8 | 8.5 | 2.578759392 |
| 4000 | 16 | 8 | 8 | 20 | 8 | 9 | 8 | 16 | 8 | 7 | 10.8 | 4.422668877 |
| 8000 | 12 | 9 | 8 | 8 | 8 | 10 | 8 | 17 | 7 | 7 | 9.4 | 2.905167809 |
| 16000 | 10 | 10 | 9 | 9 | 11 | 11 | 8 | 18 | 8 | 8 | 10.2 | 2.821347196 |
| 32000 | 8 | 9 | 8 | 9 | 9 | 10 | 9 | 9 | 14 | 8 | 9.3 | 1.676305461 |
| 64000 | 10 | 11 | 10 | 11 | 10 | 11 | 10 | 11 | 10 | 9 | 10.3 | 0.640312424 |
| 128000 | 22 | 13 | 13 | 13 | 12 | 13 | 12 | 14 | 12 | 12 | 13.6 | 2.870540019 |
| 256000 | 37 | 24 | 17 | 17 | 17 | 17 | 16 | 19 | 17 | 16 | 19.7 | 6.181423784 |
| 512000 | 98 | 27 | 28 | 27 | 27 | 27 | 49 | 28 | 26 | 26 | 36.3 | 21.5965275 |
| 1024000 | 130 | 49 | 46 | 93 | 48 | 60 | 48 | 54 | 47 | 47 | 62.2 | 26.30513258 |
| 2048000 | 370 | 110 | 117 | 92 | 114 | 108 | 104 | 124 | 620 | 117 | **187.6** | 163.7548167 |
| 4096000 | 691 | 431 | 282 | 326 | 381 | 304 | 226 | 400 | 1041 | 223 | 430.5 | 240.3752275 |
| 8192000 | 1619 | 787 | 696 | 705 | 840 | 792 | 785 | 961 | 1554 | 728 | 946.7 | 328.1877664 |
| 16384000 | 2461 | 1343 | 1313 | 1306 | 1497 | 1276 | 1348 | 1932 | 2151 | 1378 | 1601 | 402.2897588 |
| 32768000 | 4642 | 2443 | 3102 | 2506 | 2598 | 2620 | 2796 | 3566 | 3010 | 2740 | 3002 | 632.1768819 |
| 65536000 | 6305 | 4866 | 5483 | 4911 | 5012 | 4926 | 5051 | 5762 | 5576 | 5063 | 5296 | 448.7313784 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 23 | 26 | 20 | 14 | 16 | 14 | 15 | 17 | 14 | 15 | 17.4 | 4.004996879 |
| 2000 | 13 | 27 | 20 | 15 | 17 | 14 | 30 | 17 | 15 | 14 | 18.2 | 5.528109984 |
| 4000 | 13 | 15 | 34 | 15 | 17 | 14 | 26 | 17 | 15 | 15 | 18.1 | 6.31585307 |
| 8000 | 23 | 15 | 21 | 14 | 15 | 14 | 20 | 20 | 15 | 15 | 17.2 | 3.218695388 |
| 16000 | 14 | 16 | 20 | 15 | 16 | 14 | 17 | 18 | 15 | 15 | 16 | 1.788854382 |
| 32000 | 15 | 16 | 24 | 15 | 17 | 15 | 16 | 21 | 16 | 15 | 17 | 2.898275349 |
| 64000 | 20 | 17 | 20 | 17 | 18 | 16 | 17 | 25 | 17 | 17 | 18.4 | 2.537715508 |
| 128000 | 24 | 20 | 28 | 20 | 20 | 18 | 19 | 25 | 19 | 19 | 21.2 | 3.12409987 |
| 256000 | 35 | 26 | 32 | 24 | 29 | 23 | 24 | 34 | 25 | 24 | 27.6 | 4.317406629 |
| 512000 | 297 | 59 | 39 | 60 | 69 | 33 | 64 | 82 | 35 | 35 | 77.3 | 74.95205134 |
| 1024000 | 228 | 58 | 98 | 96 | 64 | 107 | 59 | 76 | 87 | 88 | 96.1 | 46.83043882 |
| 2048000 | 370 | 118 | 194 | 103 | 181 | 94 | 117 | 297 | 99 | 96 | 166.9 | 91.11800042 |
| 4096000 | 738 | 381 | 514 | 341 | 471 | 400 | 437 | 550 | 478 | 440 | 475 | 105.5585146 |
| 8192000 | 1375 | 695 | 882 | 827 | 870 | 924 | 833 | 1001 | 740 | 753 | 890 | 183.215174 |
| 16384000 | 2635 | 1301 | 1891 | 1595 | 1591 | 1308 | 1434 | 1960 | 1471 | 1315 | 1650 | 395.0441621 |
| 32768000 | 5017 | 2657 | 3620 | 2830 | 2966 | 2710 | 2959 | 3887 | 2987 | 2656 | 3229 | 711.8635333 |
| 65536000 | 6637 | 5099 | 5429 | 5204 | 5585 | 5013 | 5173 | 6231 | 5333 | 5188 | 5489 | 505.5667711 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 39 | 30 | 27 | 26 | 29 | 27 | 27 | 29 | 27 | 31 | 29.2 | 3.6 |
| 2000 | 54 | 33 | 28 | 27 | 28 | 28 | 26 | 30 | 28 | 36 | 31.8 | 7.93473377 |
| 4000 | 48 | 26 | 28 | 26 | 37 | 28 | 27 | 29 | 26 | 28 | 30.3 | 6.649060084 |
| 8000 | 130 | 26 | 28 | 26 | 31 | 28 | 30 | 49 | 30 | 28 | 40.6 | 30.46703136 |
| 16000 | 106 | 30 | 28 | 26 | 29 | 41 | 28 | 59 | 27 | 28 | 40.2 | 23.94911272 |
| 32000 | 75 | 28 | 28 | 27 | 34 | 42 | 27 | 43 | 28 | 29 | 36.1 | 14.1876707 |
| 64000 | 219 | 42 | 31 | 74 | 39 | 62 | 29 | 42 | 29 | 54 | 62.1 | 54.15246993 |
| 128000 | 147 | 49 | 39 | 39 | 34 | 35 | 60 | 63 | 60 | 51 | 57.7 | 31.48031131 |
| 256000 | 171 | 43 | 40 | 37 | 42 | 39 | 38 | 130 | 45 | 38 | 62.3 | 45.10443437 |
| 512000 | 192 | 54 | 78 | 47 | 73 | 49 | 47 | 190 | 51 | 46 | 82.7 | 55.16892241 |
| 1024000 | 326 | 178 | 95 | 68 | 130 | 101 | 71 | 241 | 128 | 97 | 143.5 | 78.55093889 |
| 2048000 | 475 | 309 | 213 | 236 | 218 | 293 | 256 | 349 | 285 | 287 | 292.1 | 72.97321426 |
| 4096000 | 812 | 535 | 398 | 438 | 454 | 416 | 452 | 569 | 491 | 449 | 501.4 | 114.7677655 |
| 8192000 | 1470 | 748 | 798 | 838 | 706 | 718 | 883 | 970 | 949 | 862 | 894.2 | 210.1688845 |
| 16384000 | 2521 | 1314 | 1659 | 1598 | 1415 | 1459 | 1525 | 1791 | 1322 | 1541 | 1615 | 332.9258927 |
| 32768000 | 4982 | 2497 | 2504 | 2945 | 2751 | 2811 | 3103 | 2866 | 2765 | 2884 | 3011 | 680.0129116 |
| 65536000 | 6634 | 4953 | 4981 | 5220 | 4855 | 4996 | 5295 | 5952 | 5296 | 5075 | 5326 | 526.0923968 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 154 | 53 | 55 | 50 | 54 | 67 | 52 | 90 | 55 | 53 | 68.3 | 30.73125445 |
| 2000 | 125 | 53 | 54 | 51 | 80 | 57 | 52 | 65 | 92 | 52 | 68.1 | 23.0670761 |
| 4000 | 104 | 54 | 55 | 50 | 57 | 70 | 51 | 54 | 68 | 52 | 61.5 | 15.58364527 |
| 8000 | 195 | 82 | 80 | 63 | 57 | 82 | 74 | 85 | 76 | 69 | 86.3 | 37.21840942 |
| 16000 | 182 | 101 | 60 | 70 | 78 | 54 | 63 | 57 | 56 | 66 | 78.7 | 36.87560169 |
| 32000 | 248 | 55 | 56 | 53 | 59 | 52 | 53 | 56 | 57 | 54 | 74.3 | 57.93453202 |
| 64000 | 333 | 639 | 58 | 54 | 66 | 55 | 68 | 106 | 132 | 57 | 156.8 | 179.8726216 |
| 128000 | 299 | 133 | 134 | 122 | 143 | 134 | 136 | 164 | 139 | 115 | 151.9 | 50.53404793 |
| 256000 | 275 | 155 | 135 | 136 | 174 | 138 | 104 | 178 | 154 | 155 | 160.4 | 43.18610888 |
| 512000 | 338 | 169 | 200 | 202 | 210 | 162 | 174 | 191 | 174 | 203 | 202.3 | 47.89791227 |
| 1024000 | 423 | 278 | 208 | 228 | 202 | 157 | 227 | 212 | 249 | 186 | 237 | 69.49388462 |
| 2048000 | 633 | 358 | 329 | 348 | 300 | 305 | 359 | 442 | 392 | 266 | 373.2 | 98.54217371 |
| 4096000 | 976 | 515 | 509 | 531 | 521 | 499 | 487 | 523 | 546 | 512 | 561.9 | 138.8981281 |
| 8192000 | 1600 | 847 | 1033 | 951 | 906 | 741 | 871 | 986 | 881 | 860 | 967.6 | 224.2579764 |
| 16384000 | 2225 | 1629 | 2243 | 1316 | 1613 | 1368 | 1377 | 1626 | 1648 | 1363 | 1641 | 321.215753 |
| 32768000 | 4933 | 3208 | 3133 | 2606 | 2968 | 2753 | 3008 | 3126 | 3025 | 2682 | 3144 | 626.4553935 |
| 65536000 | 6549 | 5292 | 5275 | 4717 | 5338 | 5165 | 5306 | 5887 | 5139 | 5097 | 5377 | 476.8081899 |

**Experiment 3:Random Data Set: Windows 10 VM 2 Processors: All Runs, ms**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4000 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.5 | 4.5 |
| 8000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16000 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 15 | 0 | 3 | 6 |
| 32000 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 1.5 | 4.5 |
| 64000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 128000 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 16 | 0 | 0 | 3.1 | 6.20403095 |
| 256000 | 16 | 0 | 15 | 0 | 0 | 16 | 16 | 0 | 16 | 0 | 7.9 | 7.90506167 |
| 512000 | 31 | 15 | 32 | 16 | 16 | 16 | 31 | 16 | 31 | 16 | 22 | 7.56306816 |
| 1024000 | 47 | 32 | 46 | 48 | 47 | 47 | 47 | 32 | 47 | 30 | 42.3 | 7.21179589 |
| 2048000 | 141 | 78 | 77 | 78 | 94 | 77 | 78 | 77 | 78 | 78 | 85.6 | 19.10602 |
| 4096000 | 156 | 172 | 171 | 157 | 172 | 172 | 187 | 172 | 157 | 172 | 168.8 | 9.10823803 |
| 8192000 | 329 | 344 | 328 | 344 | 343 | 313 | 344 | 328 | 328 | 360 | 336.1 | 12.5972219 |
| 16384000 | 657 | 656 | 655 | 734 | 703 | 687 | 735 | 702 | 642 | 718 | 688.9 | 32.907294 |
| 32768000 | 1281 | 1297 | 1313 | 1406 | 1313 | 1391 | 1390 | 1391 | 1437 | 1391 | 1361 | 51.4256745 |
| 65536000 | 2562 | 2594 | 2626 | 2812 | 2704 | 2734 | 2875 | 2984 | 2781 | 2718 | 2739 | 123.461735 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 thread |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 109 | 31 | 31 | 32 | 31 | 31 | 30 | 46 | 31 | 31 | 40.3 | 23.3368807 |
| 2000 | 47 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 32.6 | 4.8 |
| 4000 | 46 | 31 | 31 | 31 | 32 | 16 | 31 | 32 | 16 | 16 | 28.2 | 9.07524104 |
| 8000 | 32 | 31 | 32 | 31 | 31 | 31 | 32 | 31 | 31 | 31 | 31.3 | 0.45825757 |
| 16000 | 15 | 31 | 31 | 31 | 31 | 31 | 15 | 31 | 31 | 31 | 27.8 | 6.4 |
| 32000 | 16 | 16 | 31 | 32 | 31 | 16 | 32 | 31 | 31 | 32 | 26.8 | 7.08237248 |
| 64000 | 31 | 15 | 16 | 31 | 32 | 15 | 31 | 32 | 32 | 31 | 26.6 | 7.39188745 |
| 128000 | 31 | 47 | 47 | 31 | 31 | 31 | 31 | 46 | 31 | 31 | 35.7 | 7.18401002 |
| 256000 | 31 | 32 | 31 | 47 | 47 | 32 | 31 | 31 | 47 | 31 | 36 | 7.21110255 |
| 512000 | 47 | 46 | 47 | 63 | 46 | 46 | 47 | 47 | 47 | 47 | 48.3 | 4.92036584 |
| 1024000 | 94 | 78 | 77 | 78 | 94 | 63 | 77 | 78 | 62 | 78 | 77.9 | 9.9744674 |
| 2048000 | 125 | 140 | 110 | 110 | 125 | 141 | 125 | 110 | 110 | 108 | 120.4 | 12.0764233 |
| 4096000 | 219 | 235 | 204 | 202 | 234 | 219 | 218 | 203 | 203 | 219 | 215.6 | 11.8 |
| 8192000 | 391 | 391 | 407 | 391 | 407 | 391 | 406 | 375 | 376 | 423 | 395.8 | 14.1830885 |
| 16384000 | 703 | 736 | 734 | 796 | 781 | 766 | 781 | 798 | 782 | 797 | 767.4 | 30.764265 |
| 32768000 | 1359 | 1376 | 1359 | 1500 | 1358 | 1468 | 1485 | 1454 | 1469 | 1468 | 1429.6 | 55.7587661 |
| 65536000 | 2765 | 2766 | 2671 | 2874 | 2796 | 2812 | 2765 | 2983 | 2906 | 2813 | 2815.1 | 82.762854 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 32 | 46 | 31 | 47 | 47 | 32 | 32 | 48 | 31 | 30 | 37.6 | 7.70973411 |
| 2000 | 47 | 47 | 47 | 31 | 32 | 46 | 46 | 46 | 31 | 31 | 40.4 | 7.48598691 |
| 4000 | 31 | 31 | 31 | 46 | 46 | 31 | 47 | 47 | 47 | 47 | 40.4 | 7.68374908 |
| 8000 | 31 | 31 | 47 | 47 | 31 | 47 | 32 | 47 | 31 | 32 | 37.6 | 7.68374908 |
| 16000 | 47 | 47 | 31 | 32 | 47 | 31 | 46 | 47 | 32 | 31 | 39.1 | 7.71297608 |
| 32000 | 47 | 32 | 31 | 46 | 31 | 32 | 31 | 31 | 46 | 31 | 35.8 | 6.91086102 |
| 64000 | 31 | 31 | 32 | 47 | 31 | 47 | 47 | 47 | 31 | 31 | 37.5 | 7.76208735 |
| 128000 | 47 | 31 | 31 | 47 | 32 | 31 | 31 | 47 | 63 | 30 | 39 | 10.7424392 |
| 256000 | 46 | 47 | 46 | 47 | 47 | 47 | 32 | 62 | 47 | 47 | 46.8 | 6.72011905 |
| 512000 | 79 | 62 | 47 | 63 | 62 | 47 | 47 | 62 | 46 | 47 | 56.2 | 10.5337553 |
| 1024000 | 63 | 78 | 62 | 62 | 62 | 61 | 62 | 79 | 78 | 62 | 66.9 | 7.50266619 |
| 2048000 | 94 | 109 | 94 | 110 | 94 | 94 | 94 | 109 | 93 | 93 | **98.4** | 7.17216843 |
| 4096000 | 141 | 187 | 171 | 156 | 156 | 155 | 186 | 172 | 156 | 156 | 163.6 | 14.1081537 |
| 8192000 | 281 | 297 | 328 | 296 | 281 | 297 | 265 | 359 | 266 | 282 | 295.2 | 27.3780934 |
| 16384000 | 484 | 546 | 515 | 594 | 531 | 530 | 516 | 547 | 548 | 546 | 535.7 | 27.265546 |
| 32768000 | 953 | 1000 | 953 | 1063 | 999 | 1031 | 1079 | 1031 | 1000 | 953 | 1006.2 | 42.8667703 |
| 65536000 | 1718 | 1703 | 1797 | 2125 | 2032 | 2124 | 2125 | 2000 | 1970 | 1953 | 1954.7 | 154.654486 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 78 | 63 | 62 | 63 | 63 | 63 | 62 | 62 | 63 | 62 | 64.1 | 4.65725241 |
| 2000 | 78 | 47 | 63 | 77 | 62 | 61 | 63 | 63 | 78 | 79 | 67.1 | 9.9744674 |
| 4000 | 63 | 62 | 62 | 63 | 63 | 63 | 63 | 78 | 63 | 62 | 64.2 | 4.621688 |
| 8000 | 157 | 63 | 47 | 62 | 62 | 47 | 62 | 63 | 47 | 62 | 67.2 | 30.7109101 |
| 16000 | 62 | 63 | 62 | 63 | 62 | 62 | 62 | 78 | 62 | 63 | 63.9 | 4.72122865 |
| 32000 | 63 | 47 | 63 | 63 | 63 | 63 | 63 | 63 | 62 | 63 | 61.3 | 4.77598157 |
| 64000 | 62 | 62 | 47 | 62 | 63 | 63 | 62 | 62 | 63 | 62 | 60.8 | 4.621688 |
| 128000 | 62 | 62 | 62 | 78 | 62 | 62 | 79 | 62 | 62 | 63 | 65.4 | 6.56048779 |
| 256000 | 63 | 78 | 63 | 78 | 63 | 63 | 78 | 62 | 78 | 62 | 68.8 | 7.52063827 |
| 512000 | 62 | 63 | 77 | 78 | 78 | 78 | 77 | 79 | 79 | 62 | 73.3 | 7.21179589 |
| 1024000 | 78 | 78 | 95 | 79 | 94 | 77 | 94 | 93 | 94 | 78 | 86 | 8.02496106 |
| 2048000 | 110 | 109 | 109 | 109 | 93 | 93 | 108 | 125 | 109 | 110 | 107.5 | 8.65158945 |
| 4096000 | 172 | 173 | 156 | 172 | 172 | 156 | 141 | 171 | 156 | 156 | 162.5 | 10.413933 |
| 8192000 | 249 | 250 | 266 | 251 | 265 | 266 | 281 | 313 | 250 | 265 | 265.6 | 18.6021504 |
| 16384000 | 626 | 454 | 454 | 515 | 468 | 500 | 484 | 484 | 485 | 468 | 493.8 | 47.6797651 |
| 32768000 | 844 | 828 | 828 | 891 | 858 | 938 | 891 | 860 | 859 | 876 | 867.3 | 31.6829607 |
| 65536000 | 1609 | 1609 | 1641 | 1765 | 1609 | 1703 | 1719 | 1672 | 1671 | 1578 | 1657.6 | 56.0806562 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 125 | 110 | 124 | 126 | 124 | 110 | 125 | 110 | 140 | 125 | 121.9 | 8.98276127 |
| 2000 | 125 | 124 | 126 | 124 | 126 | 140 | 125 | 108 | 125 | 124 | 124.7 | 7.19791637 |
| 4000 | 125 | 110 | 140 | 141 | 125 | 110 | 126 | 110 | 110 | 125 | 122.2 | 11.4175304 |
| 8000 | 124 | 125 | 141 | 141 | 140 | 140 | 124 | 125 | 124 | 141 | 132.5 | 8.11480129 |
| 16000 | 125 | 109 | 141 | 125 | 141 | 109 | 109 | 109 | 110 | 125 | 120.3 | 12.4100766 |
| 32000 | 125 | 126 | 109 | 125 | 141 | 110 | 125 | 125 | 125 | 141 | 125.2 | 9.96794864 |
| 64000 | 110 | 108 | 109 | 125 | 125 | 110 | 125 | 110 | 125 | 124 | 117.1 | 7.72593036 |
| 128000 | 125 | 126 | 126 | 140 | 140 | 124 | 125 | 109 | 125 | 126 | 126.6 | 8.27284715 |
| 256000 | 141 | 124 | 124 | 141 | 125 | 126 | 141 | 125 | 125 | 124 | 129.6 | 7.48598691 |
| 512000 | 140 | 125 | 125 | 141 | 125 | 140 | 125 | 124 | 126 | 141 | 131.2 | 7.61314652 |
| 1024000 | 157 | 140 | 124 | 140 | 140 | 140 | 141 | 141 | 141 | 140 | 140.4 | 7.39188745 |
| 2048000 | 140 | 172 | 172 | 156 | 156 | 172 | 156 | 155 | 156 | 157 | 159.2 | 9.61041102 |
| 4096000 | 203 | 235 | 203 | 219 | 202 | 218 | 204 | 203 | 204 | 218 | 210.9 | 10.5304321 |
| 8192000 | 312 | 312 | 313 | 312 | 312 | 329 | 328 | 297 | 313 | 313 | 314.1 | 8.53756406 |
| 16384000 | 499 | 485 | 500 | 545 | 516 | 532 | 515 | 515 | 516 | 501 | 512.4 | 16.4328938 |
| 32768000 | 875 | 859 | 874 | 938 | 907 | 906 | 968 | 891 | 922 | 953 | 909.3 | 34.1234523 |
| 65536000 | 1766 | 1625 | 1656 | 1719 | 1671 | 1751 | 1750 | 1781 | 1703 | 1734 | 1715.6 | 48.4895865 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 265 | 218 | 250 | 265 | 219 | 234 | 267 | 265 | 250 | 249 | 248.2 | 17.8146008 |
| 2000 | 250 | 235 | 265 | 250 | 249 | 251 | 265 | 249 | 235 | 251 | 250 | 9.50789146 |
| 4000 | 250 | 235 | 266 | 266 | 267 | 218 | 266 | 267 | 265 | 265 | 256.5 | 16.1941347 |
| 8000 | 250 | 218 | 250 | 265 | 249 | 250 | 249 | 249 | 250 | 251 | 248.1 | 11.0313191 |
| 16000 | 265 | 235 | 249 | 250 | 250 | 219 | 266 | 266 | 266 | 250 | 251.6 | 14.6778745 |
| 32000 | 249 | 234 | 267 | 250 | 250 | 219 | 281 | 266 | 265 | 265 | 254.6 | 17.211624 |
| 64000 | 266 | 235 | 265 | 313 | 265 | 250 | 267 | 249 | 266 | 250 | 262.6 | 19.6428104 |
| 128000 | 266 | 234 | 249 | 250 | 250 | 234 | 264 | 250 | 250 | 281 | 252.8 | 13.5926451 |
| 256000 | 234 | 234 | 251 | 281 | 219 | 219 | 250 | 266 | 251 | 250 | 245.5 | 18.5755215 |
| 512000 | 234 | 234 | 264 | 265 | 235 | 219 | 250 | 250 | 250 | 250 | 245.1 | 13.7072973 |
| 1024000 | 281 | 250 | 282 | 250 | 250 | 265 | 249 | 266 | 250 | 281 | 262.4 | 13.7491818 |
| 2048000 | 265 | 265 | 296 | 281 | 265 | 265 | 265 | 282 | 265 | 312 | 276.1 | 15.7572206 |
| 4096000 | 313 | 312 | 328 | 313 | 313 | 313 | 328 | 328 | 313 | 327 | 318.8 | 7.31846979 |
| 8192000 | 407 | 391 | 406 | 437 | 406 | 453 | 422 | 421 | 406 | 406 | 415.5 | 17.2467388 |
| 16384000 | 625 | 610 | 593 | 656 | 610 | 625 | 688 | 625 | 640 | 609 | 628.1 | 26.0555176 |
| 32768000 | 985 | 985 | 1016 | 1031 | 1047 | 984 | 1094 | 1016 | 1016 | 999 | 1017.3 | 32.3853362 |
| 65536000 | 1749 | 1735 | 1750 | 1875 | 1797 | 1860 | 1859 | 1765 | 1844 | 1766 | 1800 | 51.3400429 |

**Experiment 4: Random Data Set: Ubuntu VM 2 Processors ( ms)**

**No threads**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** | 0.1 | 0.3 |
| 2000 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1.3 | 3.579106034 |
| 4000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.3 |
| 8000 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.3 |
| 16000 | 2 | 5 | 1 | 0 | 0 | 0 | 5 | 1 | 0 | 1 | 1.5 | 1.857417562 |
| 32000 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1.3 | 0.640312424 |
| 64000 | 7 | 2 | 3 | 4 | 2 | 2 | 3 | 2 | 2 | 2 | 2.9 | 1.513274595 |
| 128000 | 4 | 4 | 7 | 4 | 4 | 7 | 5 | 7 | 5 | 4 | 5.1 | 1.3 |
| 256000 | 9 | 12 | 9 | 9 | 12 | 16 | 8 | 10 | 10 | 14 | 10.9 | 2.42693222 |
| 512000 | 34 | 25 | 27 | 27 | 19 | 21 | 24 | 19 | 26 | 29 | 25.1 | 4.414748011 |
| 1024000 | 50 | 48 | 50 | 51 | 62 | 50 | 48 | 49 | 51 | 50 | 50.9 | 3.832753579 |
| 2048000 | 164 | 110 | 106 | 115 | 96 | 94 | 99 | 106 | 128 | 103 | 112.1 | 19.68476568 |
| 4096000 | 427 | 219 | 231 | 185 | 200 | 184 | 238 | 201 | 262 | 204 | 235.1 | 68.05652063 |
| 8192000 | 418 | 383 | 389 | 403 | 388 | 373 | 412 | 393 | 353 | 396 | 390.8 | 17.85385113 |
| 16384000 | 783 | 744 | 777 | 795 | 785 | 737 | 697 | 726 | 671 | 760 | 747.5 | 38.64776837 |
| 32768000 | 1486 | 1481 | 1526 | 1488 | 1540 | 1434 | 1406 | 1478 | 1507 | 1450 | 1479.6 | 38.78195457 |
| 65536000 | 3208 | 2864 | 3031 | 3092 | 3136 | 2794 | 2807 | 2988 | 2843 | 2765 | 2952.8 | 150.7002322 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 thread |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 42 | 21 | 16 | 14 | 25 | 16 | 31 | 18 | 28 | 19 | 23 | 8.23407554 |
| 2000 | 53 | 16 | 25 | 9 | 4 | 7 | 18 | 14 | 7 | 25 | 17.8 | 13.64404632 |
| 4000 | 36 | 27 | 6 | 6 | 5 | 14 | 33 | 15 | 19 | 18 | 17.9 | 10.54940757 |
| 8000 | 60 | 28 | 5 | 5 | 6 | 20 | 31 | 20 | 35 | 23 | 23.3 | 15.98780785 |
| 16000 | 48 | 16 | 18 | 12 | 12 | 6 | 19 | 6 | 16 | 25 | 17.8 | 11.47867588 |
| 32000 | 21 | 38 | 21 | 7 | 6 | 15 | 20 | 7 | 25 | 15 | 17.5 | 9.340770846 |
| 64000 | 33 | 40 | 8 | 10 | 7 | 27 | 13 | 14 | 24 | 17 | 19.3 | 10.65879918 |
| 128000 | 42 | 44 | 31 | 12 | 17 | 15 | 34 | 11 | 39 | 54 | 29.9 | 14.46685868 |
| 256000 | 36 | 57 | 22 | 21 | 20 | 36 | 27 | 32 | 55 | 49 | 35.5 | 13.20037878 |
| 512000 | 105 | 59 | 36 | 58 | 34 | 37 | 53 | 31 | 79 | 65 | 55.7 | 22.14068653 |
| 1024000 | 87 | 95 | 55 | 110 | 65 | 60 | 80 | 70 | 128 | 95 | 84.5 | 22.02385071 |
| 2048000 | 167 | 139 | 167 | 162 | 190 | 141 | 196 | 131 | 152 | 147 | 159.2 | 20.41470059 |
| 4096000 | 290 | 215 | 256 | 288 | 293 | 290 | 254 | 250 | 255 | 253 | 264.4 | 23.9382539 |
| 8192000 | 531 | 433 | 509 | 515 | 488 | 497 | 487 | 455 | 463 | 408 | 478.6 | 36.54640885 |
| 16384000 | 928 | 965 | 962 | 930 | 935 | 852 | 929 | 818 | 909 | 930 | 915.8 | 43.96771543 |
| 32768000 | 1691 | 1557 | 1712 | 1683 | 1761 | 1653 | 1695 | 1562 | 1753 | 1677 | 1674.4 | 65.38073111 |
| 65536000 | 3057 | 3218 | 3505 | 3113 | 3433 | 3050 | 3444 | 3128 | 3290 | 3317 | 3255.5 | 159.3306311 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 29 | 18 | 13 | 21 | 20 | 47 | 37 | 36 | 29 | 18 | 26.8 | 10.15677114 |
| 2000 | 20 | 12 | 24 | 30 | 25 | 25 | 23 | 13 | 37 | 19 | 22.8 | 7.068238819 |
| 4000 | 33 | 36 | 33 | 29 | 10 | 23 | 37 | 15 | 27 | 15 | 25.8 | 9.141115906 |
| 8000 | 29 | 9 | 35 | 10 | 29 | 32 | 40 | 23 | 20 | 32 | 25.9 | 9.782126558 |
| 16000 | 18 | 41 | 44 | 19 | 22 | 16 | 26 | 32 | 27 | 10 | 25.5 | 10.33682737 |
| 32000 | 30 | 10 | 27 | 28 | 24 | 84 | 14 | 19 | 29 | 34 | 29.9 | 19.38788281 |
| 64000 | 30 | 34 | 49 | 17 | 30 | 65 | 34 | 32 | 29 | 13 | 33.3 | 14.0431478 |
| 128000 | 62 | 20 | 47 | 33 | 37 | 60 | 22 | 36 | 19 | 36 | 37.2 | 14.52446212 |
| 256000 | 73 | 43 | 64 | 68 | 25 | 87 | 36 | 53 | 57 | 19 | 52.5 | 20.60218435 |
| 512000 | 79 | 33 | 108 | 79 | 64 | 45 | 51 | 59 | 44 | 34 | 59.6 | 22.37945486 |
| 1024000 | 122 | 75 | 118 | 147 | 71 | 80 | 120 | 101 | 138 | 108 | 108 | 24.8032256 |
| 2048000 | 171 | 189 | 222 | 145 | 149 | 221 | 143 | 202 | 186 | 227 | **185.5** | 30.96530316 |
| 4096000 | 276 | 266 | 288 | 251 | 283 | 291 | 282 | 241 | 331 | 273 | 278.2 | 23.21551206 |
| 8192000 | 460 | 457 | 401 | 489 | 502 | 466 | 411 | 426 | 427 | 432 | 447.1 | 31.45933884 |
| 16384000 | 767 | 714 | 767 | 771 | 721 | 706 | 724 | 664 | 689 | 755 | 727.8 | 34.61444785 |
| 32768000 | 1281 | 1336 | 1369 | 1419 | 1325 | 1268 | 1302 | 1396 | 1251 | 1297 | 1324.4 | 52.82461547 |
| 65536000 | 2500 | 2542 | 2427 | 2563 | 2542 | 2157 | 2492 | 2335 | 2905 | 2539 | 2500.2 | 179.80812 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 60 | 55 | 78 | 35 | 57 | 52 | 49 | 42 | 86 | 75 | 58.9 | 15.43016526 |
| 2000 | 32 | 35 | 36 | 53 | 70 | 51 | 66 | 89 | 31 | 65 | 52.8 | 18.54615863 |
| 4000 | 26 | 61 | 46 | 23 | 88 | 72 | 56 | 39 | 15 | 69 | 49.5 | 22.60641502 |
| 8000 | 54 | 104 | 41 | 31 | 82 | 92 | 93 | 60 | 91 | 73 | 72.1 | 23.31716106 |
| 16000 | 56 | 77 | 76 | 45 | 45 | 63 | 64 | 62 | 45 | 67 | 60 | 11.4629839 |
| 32000 | 66 | 70 | 61 | 21 | 48 | 62 | 54 | 59 | 43 | 89 | 57.3 | 17.02967997 |
| 64000 | 60 | 117 | 56 | 26 | 117 | 91 | 64 | 59 | 55 | 80 | 72.5 | 27.40529146 |
| 128000 | 119 | 87 | 93 | 71 | 48 | 51 | 70 | 101 | 78 | 45 | 76.3 | 23.06100605 |
| 256000 | 97 | 56 | 96 | 116 | 108 | 74 | 55 | 61 | 125 | 63 | 85.1 | 25.05374224 |
| 512000 | 140 | 141 | 137 | 91 | 100 | 134 | 117 | 139 | 127 | 74 | 120 | 22.58760722 |
| 1024000 | 170 | 100 | 179 | 116 | 137 | 147 | 183 | 181 | 126 | 128 | 146.7 | 28.4184799 |
| 2048000 | 209 | 221 | 164 | 238 | 212 | 172 | 308 | 194 | 214 | 193 | 212.5 | 38.17394399 |
| 4096000 | 329 | 322 | 361 | 355 | 342 | 267 | 347 | 297 | 345 | 289 | 325.4 | 29.72608282 |
| 8192000 | 440 | 478 | 512 | 520 | 500 | 466 | 459 | 432 | 446 | 515 | 476.8 | 31.3808859 |
| 16384000 | 681 | 692 | 726 | 824 | 696 | 646 | 866 | 714 | 821 | 703 | 736.9 | 69.42254677 |
| 32768000 | 1212 | 1301 | 1262 | 1450 | 1404 | 1145 | 1434 | 1348 | 1353 | 1341 | 1325 | 92.21171292 |
| 65536000 | 2491 | 2588 | 2607 | 2560 | 2704 | 2209 | 2737 | 2501 | 2446 | 2539 | 2538.2 | 139.7088401 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 76 | 100 | 66 | 81 | 92 | 124 | 151 | 142 | 119 | 115 | 106.6 | 26.92285275 |
| 2000 | 85 | 122 | 107 | 97 | 176 | 88 | 90 | 70 | 151 | 93 | 107.9 | 31.16552583 |
| 4000 | 126 | 108 | 64 | 132 | 94 | 187 | 112 | 84 | 125 | 166 | 119.8 | 34.82183223 |
| 8000 | 118 | 78 | 68 | 150 | 97 | 153 | 201 | 114 | 101 | 161 | 124.1 | 39.32035096 |
| 16000 | 148 | 111 | 120 | 155 | 123 | 61 | 124 | 140 | 84 | 117 | 118.3 | 26.96683148 |
| 32000 | 108 | 98 | 116 | 115 | 132 | 182 | 139 | 100 | 132 | 88 | 121 | 25.64371268 |
| 64000 | 169 | 103 | 89 | 140 | 121 | 115 | 140 | 108 | 157 | 130 | 127.2 | 23.60423691 |
| 128000 | 122 | 100 | 81 | 126 | 123 | 167 | 147 | 87 | 141 | 117 | 121.1 | 25.36710468 |
| 256000 | 125 | 109 | 159 | 163 | 82 | 111 | 145 | 108 | 113 | 140 | 125.5 | 24.4059419 |
| 512000 | 187 | 141 | 105 | 178 | 123 | 150 | 232 | 139 | 162 | 129 | 154.6 | 34.93765877 |
| 1024000 | 152 | 257 | 511 | 227 | 179 | 219 | 293 | 181 | 260 | 177 | 245.6 | 98.05631035 |
| 2048000 | 328 | 269 | 295 | 301 | 326 | 223 | 367 | 194 | 277 | 227 | 280.7 | 51.21923467 |
| 4096000 | 405 | 401 | 431 | 399 | 354 | 396 | 470 | 346 | 459 | 376 | 403.7 | 38.54361166 |
| 8192000 | 582 | 589 | 573 | 567 | 598 | 558 | 603 | 537 | 529 | 574 | 571 | 23.05645246 |
| 16384000 | 825 | 920 | 963 | 914 | 904 | 816 | 977 | 829 | 817 | 794 | 875.9 | 63.67801819 |
| 32768000 | 1349 | 1456 | 1524 | 1396 | 1462 | 1288 | 1460 | 1370 | 1383 | 1346 | 1403.4 | 67.16129838 |
| 65536000 | 2536 | 2794 | 2569 | 2523 | 2708 | 2303 | 2797 | 2420 | 2501 | 2601 | 2575.2 | 149.4508615 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| 1000 | 251 | 232 | 225 | 212 | 253 | 248 | 229 | 171 | 208 | 173 | 220.2 | 28.10978477 |
| 2000 | 190 | 274 | 222 | 267 | 222 | 258 | 212 | 191 | 183 | 237 | 225.6 | 31.18717685 |
| 4000 | 263 | 217 | 323 | 170 | 194 | 222 | 226 | 231 | 267 | 207 | 232 | 40.91698914 |
| 8000 | 255 | 286 | 296 | 222 | 180 | 266 | 198 | 191 | 188 | 169 | 225.1 | 44.45998201 |
| 16000 | 196 | 139 | 246 | 279 | 219 | 190 | 254 | 207 | 151 | 181 | 206.2 | 42.30555519 |
| 32000 | 290 | 179 | 243 | 234 | 219 | 213 | 269 | 192 | 239 | 209 | 228.7 | 32.0407553 |
| 64000 | 277 | 296 | 190 | 292 | 213 | 254 | 199 | 195 | 227 | 226 | 236.9 | 38.22159076 |
| 128000 | 575 | 246 | 247 | 284 | 271 | 268 | 297 | 190 | 304 | 189 | 287.1 | 103.0790473 |
| 256000 | 164 | 299 | 218 | 209 | 221 | 199 | 331 | 271 | 309 | 231 | 245.2 | 51.5340664 |
| 512000 | 230 | 313 | 338 | 260 | 213 | 246 | 254 | 233 | 298 | 286 | 267.1 | 38.18232575 |
| 1024000 | 351 | 460 | 367 | 274 | 304 | 284 | 332 | 322 | 330 | 251 | 327.5 | 55.57382477 |
| 2048000 | 460 | 302 | 396 | 355 | 405 | 360 | 382 | 387 | 410 | 459 | 391.6 | 44.98710926 |
| 4096000 | 573 | 442 | 601 | 529 | 592 | 567 | 500 | 514 | 437 | 562 | 531.7 | 55.36072615 |
| 8192000 | 732 | 856 | 795 | 802 | 745 | 749 | 825 | 627 | 747 | 763 | 764.1 | 59.37920511 |
| 16384000 | 981 | 1192 | 1160 | 1129 | 1050 | 947 | 1231 | 966 | 1013 | 1042 | 1071.1 | 95.22231881 |
| 32768000 | 1401 | 1683 | 1781 | 1733 | 1476 | 1248 | 1772 | 1452 | 1449 | 1451 | 1544.6 | 173.7867659 |
| 65536000 | 2595 | 3144 | 2866 | 2855 | 2751 | 2421 | 3085 | 2398 | 2454 | 2685 | 2725.4 | 251.7741845 |

**Experiment 5:Random Data Set: Windows 10 Laptop (ms)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.6 |
| 2000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.3 |
| 4000 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0.5 | 0.5 |
| 8000 | 3 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0.5 | 0.92195445 |
| 16000 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0.6 | 0.48989795 |
| 32000 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.9 | 0.3 |
| 64000 | 3 | 2 | 0 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2.2 | 0.87177979 |
| 128000 | 4 | 4 | 0 | 4 | 5 | 4 | 5 | 5 | 5 | 5 | 4.1 | 1.44568323 |
| 256000 | 9 | 8 | 22 | 9 | 9 | 8 | 10 | 9 | 8 | 8 | 10 | 4.04969135 |
| 512000 | 17 | 17 | 16 | 17 | 17 | 17 | 22 | 17 | 18 | 19 | 17.7 | 1.61554944 |
| 1024000 | 37 | 36 | 31 | 39 | 42 | 39 | 48 | 41 | 42 | 39 | 39.4 | 4.22374242 |
| 2048000 | 81 | 79 | 63 | 79 | 80 | 79 | 85 | 81 | 79 | 78 | 78.4 | 5.46260011 |
| 4096000 | 162 | 158 | 147 | 152 | 153 | 151 | 161 | 155 | 150 | 161 | 155 | 4.97995984 |
| 8192000 | 314 | 312 | 300 | 308 | 312 | 307 | 352 | 307 | 311 | 307 | 313 | 13.5277493 |
| 16384000 | 633 | 652 | 601 | 606 | 606 | 612 | 627 | 603 | 621 | 628 | 618.9 | 15.4948379 |
| 32768000 | 1265 | 1263 | 1184 | 1205 | 1216 | 1228 | 1222 | 1214 | 1246 | 1235 | 1227.8 | 24.0989626 |
| 65536000 | 2502 | 2493 | 2450 | 2451 | 2456 | 2454 | 2523 | 2458 | 2488 | 2537 | 2481.2 | 30.459153 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run/elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 20 | 18 | 15 | 14 | 15 | 13 | 12 | 15 | 15 | 15 | 15.2 | 2.18174242 |
| 2000 | 19 | 11 | 0 | 11 | 10 | 11 | 11 | 12 | 11 | 11 | 10.7 | 4.31393092 |
| 4000 | 14 | 12 | 16 | 11 | 12 | 11 | 10 | 11 | 11 | 11 | 11.9 | 1.7 |
| 8000 | 13 | 11 | 16 | 11 | 12 | 11 | 11 | 11 | 11 | 12 | 11.9 | 1.5132746 |
| 16000 | 17 | 13 | 15 | 11 | 12 | 12 | 13 | 12 | 12 | 11 | 12.8 | 1.77763888 |
| 32000 | 14 | 12 | 14 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12.4 | 0.8 |
| 64000 | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13.3 | 0.45825757 |
| 128000 | 18 | 16 | 6 | 16 | 16 | 16 | 15 | 16 | 17 | 15 | 15.1 | 3.14483704 |
| 256000 | 26 | 21 | 32 | 26 | 24 | 24 | 25 | 24 | 25 | 24 | 25.1 | 2.66270539 |
| 512000 | 46 | 47 | 46 | 43 | 40 | 48 | 47 | 41 | 39 | 46 | 44.3 | 3.1 |
| 1024000 | 79 | 58 | 68 | 58 | 60 | 59 | 58 | 60 | 56 | 62 | 61.8 | 6.52380257 |
| 2048000 | 122 | 98 | 116 | 106 | 122 | 109 | 117 | 120 | 118 | 119 | 114.7 | 7.47060908 |
| 4096000 | 203 | 180 | 201 | 204 | 202 | 218 | 198 | 202 | 203 | 211 | 202.2 | 9.18477 |
| 8192000 | 354 | 369 | 378 | 357 | 351 | 334 | 354 | 342 | 367 | 338 | 354.4 | 13.3656276 |
| 16384000 | 665 | 771 | 670 | 642 | 654 | 666 | 670 | 649 | 653 | 679 | 671.9 | 34.7230471 |
| 32768000 | 1298 | 1437 | 1301 | 1260 | 1270 | 1274 | 1260 | 1250 | 1289 | 1334 | 1297.3 | 52.2054595 |
| 65536000 | 2509 | 2550 | 2549 | 2504 | 2597 | 2504 | 2486 | 2489 | 2486 | 2608 | 2528.2 | 43.182867 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 22 | 21 | 20 | 22 | 21 | 20 | 19 | 20 | 19 | 19 | 20.3 | 1.1 |
| 2000 | 24 | 18 | 15 | 16 | 19 | 19 | 22 | 17 | 24 | 22 | 19.6 | 3.0724583 |
| 4000 | 18 | 19 | 16 | 16 | 21 | 20 | 16 | 16 | 21 | 16 | 17.9 | 2.07123152 |
| 8000 | 18 | 18 | 31 | 16 | 17 | 20 | 17 | 16 | 20 | 16 | 18.9 | 4.27668096 |
| 16000 | 17 | 19 | 22 | 16 | 16 | 20 | 17 | 16 | 19 | 17 | 17.9 | 1.92093727 |
| 32000 | 17 | 18 | 16 | 16 | 16 | 21 | 21 | 17 | 20 | 18 | 18 | 1.8973666 |
| 64000 | 18 | 19 | 15 | 17 | 17 | 19 | 21 | 17 | 20 | 25 | 18.8 | 2.63818119 |
| 128000 | 18 | 20 | 16 | 21 | 18 | 18 | 27 | 17 | 22 | 23 | 20 | 3.16227766 |
| 256000 | 23 | 21 | 16 | 27 | 29 | 20 | 27 | 27 | 29 | 25 | 24.4 | 4.07921561 |
| 512000 | 31 | 32 | 22 | 37 | 39 | 32 | 39 | 38 | 39 | 33 | 34.2 | 5.11468474 |
| 1024000 | 40 | 37 | 47 | 42 | 43 | 44 | 43 | 45 | 44 | 44 | 42.9 | 2.62488095 |
| 2048000 | 63 | 69 | 66 | 58 | 60 | 60 | 60 | 71 | 58 | 58 | **62.3** | 4.53982379 |
| 4096000 | 123 | 139 | 100 | 105 | 106 | 117 | 103 | 104 | 108 | 109 | 111.4 | 11.2712022 |
| 8192000 | 206 | 223 | 200 | 198 | 208 | 214 | 214 | 212 | 204 | 228 | 210.7 | 9.07799537 |
| 16384000 | 390 | 397 | 384 | 376 | 379 | 382 | 377 | 378 | 382 | 376 | 382.1 | 6.44127317 |
| 32768000 | 750 | 849 | 770 | 728 | 724 | 731 | 732 | 727 | 722 | 773 | 750.6 | 37.2617767 |
| 65536000 | 1472 | 1576 | 1471 | 1453 | 1459 | 1459 | 1444 | 1462 | 1449 | 1511 | 1475.6 | 37.8423044 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 37 | 30 | 21 | 29 | 30 | 33 | 28 | 34 | 29 | 31 | 30.2 | 4.01995025 |
| 2000 | 63 | 29 | 32 | 28 | 28 | 30 | 29 | 32 | 28 | 30 | 32.9 | 10.1336075 |
| 4000 | 37 | 29 | 31 | 28 | 29 | 29 | 29 | 29 | 28 | 30 | 29.9 | 2.50798724 |
| 8000 | 32 | 30 | 37 | 28 | 28 | 29 | 28 | 28 | 28 | 28 | 29.6 | 2.76405499 |
| 16000 | 31 | 31 | 16 | 31 | 28 | 29 | 28 | 28 | 28 | 28 | 27.8 | 4.14246304 |
| 32000 | 37 | 29 | 31 | 27 | 28 | 28 | 28 | 29 | 28 | 28 | 29.3 | 2.75862284 |
| 64000 | 32 | 31 | 31 | 29 | 29 | 32 | 30 | 30 | 28 | 29 | 30.1 | 1.3 |
| 128000 | 31 | 31 | 38 | 31 | 33 | 30 | 31 | 31 | 32 | 30 | 31.8 | 2.22710575 |
| 256000 | 37 | 31 | 31 | 31 | 32 | 30 | 32 | 31 | 30 | 30 | 31.5 | 1.96214169 |
| 512000 | 32 | 34 | 37 | 33 | 34 | 33 | 33 | 35 | 35 | 33 | 33.9 | 1.37477271 |
| 1024000 | 51 | 40 | 47 | 42 | 46 | 42 | 43 | 47 | 42 | 44 | 44.4 | 3.13687743 |
| 2048000 | 63 | 64 | 82 | 62 | 60 | 60 | 60 | 61 | 64 | 61 | 63.7 | 6.27773845 |
| 4096000 | 101 | 104 | 116 | 101 | 108 | 99 | 104 | 103 | 101 | 103 | 104 | 4.6260134 |
| 8192000 | 185 | 225 | 216 | 186 | 188 | 181 | 189 | 188 | 212 | 187 | 195.7 | 14.8327341 |
| 16384000 | 353 | 362 | 354 | 482 | 341 | 348 | 343 | 340 | 342 | 367 | 363.2 | 40.5433102 |
| 32768000 | 669 | 766 | 701 | 654 | 652 | 655 | 651 | 654 | 654 | 687 | 674.3 | 34.5833775 |
| 65536000 | 1303 | 1279 | 1332 | 1283 | 1281 | 1279 | 1277 | 1279 | 1272 | 1277 | 1286.2 | 17.1569228 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 54 | 55 | 55 | 55 | 55 | 54 | 55 | 55 | 55 | 55 | 54.8 | 0.4 |
| 2000 | 62 | 57 | 57 | 57 | 54 | 55 | 56 | 56 | 55 | 55 | 56.4 | 2.10713075 |
| 4000 | 53 | 56 | 56 | 54 | 56 | 56 | 56 | 55 | 56 | 55 | 55.3 | 1.00498756 |
| 8000 | 63 | 57 | 60 | 57 | 57 | 57 | 56 | 59 | 57 | 57 | 58 | 2 |
| 16000 | 53 | 55 | 56 | 57 | 55 | 56 | 56 | 55 | 55 | 56 | 55.4 | 1.0198039 |
| 32000 | 47 | 55 | 55 | 55 | 55 | 56 | 55 | 55 | 57 | 56 | 54.6 | 2.61533937 |
| 64000 | 69 | 56 | 56 | 56 | 56 | 59 | 57 | 55 | 56 | 56 | 57.6 | 3.92937654 |
| 128000 | 53 | 61 | 57 | 59 | 59 | 60 | 59 | 58 | 57 | 57 | 58 | 2.0976177 |
| 256000 | 63 | 58 | 60 | 57 | 59 | 57 | 58 | 57 | 60 | 58 | 58.7 | 1.79164729 |
| 512000 | 69 | 61 | 63 | 64 | 64 | 63 | 62 | 63 | 63 | 64 | 63.6 | 2.00997512 |
| 1024000 | 69 | 71 | 119 | 75 | 74 | 76 | 73 | 72 | 72 | 73 | 77.4 | 13.9942845 |
| 2048000 | 84 | 86 | 92 | 83 | 86 | 83 | 82 | 84 | 84 | 82 | 84.6 | 2.8 |
| 4096000 | 122 | 121 | 120 | 124 | 121 | 116 | 118 | 118 | 119 | 120 | 119.9 | 2.16564078 |
| 8192000 | 200 | 199 | 202 | 209 | 201 | 197 | 197 | 199 | 200 | 201 | 200.5 | 3.23264598 |
| 16384000 | 369 | 353 | 360 | 352 | 353 | 354 | 351 | 350 | 353 | 356 | 355.1 | 5.33760246 |
| 32768000 | 686 | 663 | 678 | 661 | 661 | 663 | 661 | 662 | 661 | 661 | 665.7 | 8.37914077 |
| 65536000 | 1311 | 1291 | 1667 | 1286 | 1288 | 1291 | 1284 | 1286 | 1285 | 1285 | 1327.4 | 113.448843 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 threads |  |  |  |  |  |  |  |  |  |  |  |  |
| Run  elements | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Average | Standard Dev |
| 1000 | 103 | 110 | 115 | 108 | 107 | 106 | 108 | 108 | 112 | 108 | 108.5 | 3.10644491 |
| 2000 | 122 | 110 | 110 | 109 | 109 | 108 | 109 | 111 | 111 | 112 | 111.1 | 3.80657326 |
| 4000 | 118 | 109 | 115 | 149 | 148 | 150 | 150 | 149 | 147 | 147 | 138.2 | 16.0049992 |
| 8000 | 119 | 111 | 112 | 113 | 113 | 112 | 114 | 113 | 112 | 111 | 113 | 2.19089023 |
| 16000 | 104 | 127 | 110 | 111 | 111 | 113 | 112 | 110 | 111 | 112 | 112.1 | 5.48543526 |
| 32000 | 121 | 203 | 110 | 112 | 113 | 112 | 112 | 112 | 112 | 112 | 121.9 | 27.1788521 |
| 64000 | 111 | 111 | 112 | 113 | 112 | 110 | 111 | 112 | 111 | 112 | 111.5 | 0.80622577 |
| 128000 | 101 | 118 | 111 | 114 | 114 | 114 | 114 | 114 | 113 | 114 | 112.7 | 4.22018957 |
| 256000 | 116 | 113 | 113 | 112 | 112 | 113 | 113 | 113 | 113 | 113 | 113.1 | 1.04403065 |
| 512000 | 122 | 119 | 119 | 120 | 118 | 116 | 118 | 117 | 119 | 117 | 118.5 | 1.62788206 |
| 1024000 | 118 | 122 | 123 | 117 | 116 | 117 | 119 | 118 | 116 | 116 | 118.2 | 2.35796522 |
| 2048000 | 132 | 137 | 133 | 134 | 133 | 132 | 132 | 134 | 134 | 135 | 133.6 | 1.49666295 |
| 4096000 | 166 | 164 | 163 | 160 | 161 | 163 | 157 | 162 | 160 | 160 | 161.6 | 2.41660919 |
| 8192000 | 231 | 244 | 486 | 244 | 241 | 240 | 243 | 248 | 241 | 241 | 265.9 | 73.482583 |
| 16384000 | 386 | 389 | 488 | 383 | 383 | 381 | 382 | 383 | 383 | 378 | 393.6 | 31.5854397 |
| 32768000 | 702 | 689 | 729 | 691 | 699 | 688 | 690 | 687 | 691 | 691 | 695.7 | 11.9920807 |
| 65536000 | 1323 | 1314 | 1384 | 1308 | 1400 | 1306 | 1303 | 1307 | 1307 | 1306 | 1325.8 | 33.7158716 |

**Data Set Average Times (ms)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| No threads:  elements | Random | Discrete | Uniform | Bernoulli | Gaussian | Zero | Standard  Deviation |
| 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4000 | 1.5 | 0 | 0 | 0 | 0 | 0 | 0.559017 |
| 8000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16000 | 3 | 0 | 0 | 1.6 | 1.5 | 3.3 | 1.289272 |
| 32000 | 1.5 | 3 | 0 | 3.3 | 0 | 0 | 1.414214 |
| 64000 | 0 | 1.6 | 0 | 3.2 | 1.6 | 4.6 | 1.650926 |
| 128000 | 3.1 | 3.2 | 3.2 | 4.7 | 8.1 | 1.5 | 2.066935 |
| 256000 | 7.9 | 4.9 | 10.9 | 7.8 | 9.4 | 10.9 | 2.083 |
| 512000 | 22 | 18.8 | 20.6 | 19.1 | 17.4 | 19 | 1.458786 |
| 1024000 | 42.3 | 41.8 | 40.2 | 41.1 | 36.1 | 34.2 | 3.042705 |
| 2048000 | 85.6 | 82.8 | 79.7 | 82.9 | 79.4 | 76.6 | 2.928405 |
| 4096000 | 168.8 | 165.8 | 163.8 | 171.9 | 164.3 | 162.5 | 3.226668 |
| 8192000 | 336.1 | 337.4 | 337.4 | 332.8 | 332.7 | 329.6 | 2.868023 |
| 16384000 | 688.9 | 690.9 | 690.6 | 681 | 684.5 | 698.4 | 5.458556 |
| 32768000 | 1361 | 1351.2 | 1351.8 | 1353 | 1362.6 | 1359.7 | 4.656805 |
| 65536000 | 2739 | 2711 | 2715.9 | 2698.4 | 2717.7 | 2734.5 | 13.77721 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 Thread  elements | Random | Discrete | Uniform | Bernoulli | Gaussian | Zero | Standard  Deviation |
| 1000 | 40.3 | 34.1 | 34 | 35.7 | 34.2 | 32.2 | 2.543892 |
| 2000 | 32.6 | 31.3 | 32.9 | 26.5 | 31.1 | 29.7 | 2.145085 |
| 4000 | 28.2 | 28 | 28 | 26.5 | 31.4 | 28.2 | 1.472432 |
| 8000 | 31.3 | 23.4 | 31.4 | 31.4 | 31.1 | 26.4 | 3.140418 |
| 16000 | 27.8 | 34.3 | 31.1 | 26.5 | 33 | 28.1 | 2.866279 |
| 32000 | 26.8 | 27.9 | 29.7 | 31.3 | 31.1 | 26.8 | 1.873203 |
| 64000 | 26.6 | 28.1 | 32.7 | 29.8 | 32.7 | 28 | 2.347161 |
| 128000 | 35.7 | 32.6 | 36 | 31.1 | 32.7 | 37.5 | 2.264705 |
| 256000 | 36 | 38.8 | 40.6 | 37.4 | 42.2 | 36 | 2.30579 |
| 512000 | 48.3 | 51.7 | 53.3 | 54.4 | 57.5 | 51.6 | 2.822528 |
| 1024000 | 77.9 | 76.5 | 71.9 | 78 | 88.8 | 72.2 | 5.605578 |
| 2048000 | 120.4 | 120.3 | 123.2 | 121.6 | 128 | 116.9 | 3.382143 |
| 4096000 | 215.6 | 217.2 | 215.6 | 212.4 | 221.9 | 204.9 | 5.179768 |
| 8192000 | 395.8 | 387.5 | 392.4 | 385.8 | 393.7 | 392.2 | 3.480741 |
| 16384000 | 767.4 | 764.2 | 756.1 | 751.3 | 758.2 | 768.6 | 6.256907 |
| 32768000 | 1429.6 | 1431.3 | 1429.6 | 1436.1 | 1434.5 | 1448.4 | 6.493437 |
| 65536000 | 2815.1 | 2779.7 | 2759.3 | 2760.8 | 2720.2 | 2787.3 | 29.17076 |
| 2 threads:  elements | Random | Discrete | Uniform | Bernoulli | Gaussian | Zero | Standard  Deviation |
| 1000 | 37.6 | 41.8 | 42.2 | 38.5 | 40.2 | 39 | 1.685642 |
| 2000 | 40.4 | 34.4 | 40.4 | 42.2 | 36.1 | 42.1 | 2.969661 |
| 4000 | 40.4 | 42.2 | 39.3 | 37.6 | 35.9 | 37.4 | 2.088859 |
| 8000 | 37.6 | 35.8 | 36 | 32.5 | 36.1 | 34.4 | 1.594783 |
| 16000 | 39.1 | 40.6 | 35.9 | 40.7 | 33.1 | 36.2 | 2.767671 |
| 32000 | 35.8 | 32.8 | 38.9 | 35.8 | 37.5 | 39.2 | 2.181488 |
| 64000 | 37.5 | 40.5 | 34.4 | 39.2 | 40.4 | 35.9 | 2.275534 |
| 128000 | 39 | 37 | 39.1 | 34.2 | 40.4 | 40.7 | 2.226357 |
| 256000 | 46.8 | 42.4 | 38.6 | 39.1 | 43.5 | 40.5 | 2.812719 |
| 512000 | 56.2 | 51.4 | 47 | 51.3 | 51 | 51.7 | 2.66625 |
| 1024000 | 66.9 | 65.8 | 70.1 | 67.2 | 69.9 | 66.9 | 1.616581 |
| 2048000 | 98.4 | 99.7 | 95.2 | 93.7 | 101.5 | 96.8 | 2.64118 |
| 4096000 | 163.6 | 159.8 | 165.4 | 162.3 | 162.6 | 153.3 | 3.893014 |
| 8192000 | 295.2 | 282.6 | 292.1 | 287.5 | 284.4 | 281.5 | 4.993134 |
| 16384000 | 535.7 | 534.5 | 532.7 | 546.9 | 531.3 | 535.9 | 5.065789 |
| 32768000 | 1006.2 | 1027.9 | 1001.7 | 1004.8 | 1009.4 | 999.8 | 9.290138 |
| 65536000 | 1954.7 | 1892.2 | 1859.2 | 1851.8 | 1829.6 | 1934.7 | 45.07818 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 4 Thread  elements | Random | Discrete | Uniform | Bernoulli | Gaussian | Zero | Standard  Deviation |
| 1000 | 64.1 | 65.5 | 63.9 | 62.5 | 60.7 | 64.2 | 1.519229 |
| 2000 | 67.1 | 62.3 | 64.2 | 60.8 | 56.2 | 62.5 | 3.318341 |
| 4000 | 64.2 | 64.2 | 59.3 | 54.5 | 58.1 | 59.3 | 3.417927 |
| 8000 | 67.2 | 60.8 | 64.2 | 64.4 | 64.2 | 60.8 | 2.236068 |
| 16000 | 63.9 | 62.7 | 56.2 | 59.5 | 60.7 | 61.1 | 2.452493 |
| 32000 | 61.3 | 66.9 | 64.2 | 60.7 | 56.2 | 64.3 | 3.404246 |
| 64000 | 60.8 | 65.8 | 59.3 | 56.2 | 62.4 | 60.8 | 2.913427 |
| 128000 | 65.4 | 67.5 | 61 | 60.9 | 59.1 | 65.7 | 3.068478 |
| 256000 | 68.8 | 70 | 65.4 | 68.7 | 67.3 | 65.4 | 1.74069 |
| 512000 | 73.3 | 73.5 | 74.6 | 68.1 | 74.6 | 72.1 | 2.226357 |
| 1024000 | 86 | 90.6 | 89.1 | 84.4 | 80.8 | 84.2 | 3.252563 |
| 2048000 | 107.5 | 109.2 | 109.1 | 106.3 | 107.2 | 109.5 | 1.195361 |
| 4096000 | 162.5 | 159.3 | 159.1 | 159.4 | 157.4 | 164 | 2.243076 |
| 8192000 | 265.6 | 207.75 | 256.5 | 257.4 | 259.3 | 262.4 | 19.80039 |
| 16384000 | 493.8 | 484.5 | 470.3 | 470 | 468.9 | 482.8 | 9.310821 |
| 32768000 | 867.3 | 867.3 | 864.3 | 850.1 | 856 | 882.4 | 10.1301 |
| 65536000 | 1657.6 | 1645.3 | 1640.3 | 1638.9 | 1589 | 1664.1 | 24.21129 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 8 threads:  elements | Random | Discrete | Uniform | Bernoulli | Gaussian | Zero | Standard  Deviation |
| 1000 | 121.9 | 120.2 | 119.8 | 121.7 | 118.5 | 123.2 | 1.548566 |
| 2000 | 124.7 | 118.7 | 122.2 | 123.3 | 118.5 | 118.8 | 2.476332 |
| 4000 | 122.2 | 122 | 126.5 | 118.6 | 112.3 | 120.2 | 4.317407 |
| 8000 | 132.5 | 124.9 | 120.4 | 126.9 | 119 | 123.5 | 4.43421 |
| 16000 | 120.3 | 120.4 | 126.4 | 117.3 | 121.8 | 118.7 | 2.870201 |
| 32000 | 125.2 | 123.4 | 118.7 | 120.2 | 117 | 125.2 | 3.180365 |
| 64000 | 117.1 | 121.9 | 115.7 | 117.3 | 118.6 | 120.5 | 2.113778 |
| 128000 | 126.6 | 128.1 | 120.3 | 123.2 | 121.5 | 126.1 | 2.829016 |
| 256000 | 129.6 | 128.1 | 122 | 123.4 | 117.4 | 126.8 | 4.125429 |
| 512000 | 131.2 | 132.6 | 125 | 131 | 124.9 | 126.5 | 3.150485 |
| 1024000 | 140.4 | 138.8 | 138.7 | 144.9 | 145.2 | 139.1 | 2.791306 |
| 2048000 | 159.2 | 164 | 160.9 | 160.7 | 164 | 170.2 | 3.601234 |
| 4096000 | 210.9 | 214 | 209.2 | 206.2 | 204.4 | 202.9 | 3.830434 |
| 8192000 | 314.1 | 309.2 | 312.6 | 306.5 | 304.4 | 307.7 | 3.368193 |
| 16384000 | 512.4 | 513.8 | 548.4 | 515.5 | 508 | 521.6 | 13.35137 |
| 32768000 | 909.3 | 902.9 | 904.5 | 899.9 | 901.1 | 926.5 | 9.064706 |
| 65536000 | 1715.6 | 1695.1 | 1735.7 | 1690.1 | 1670.5 | 1717.2 | 21.24599 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 16 Thread  elements | Random | Discrete | Uniform | Bernoulli | Gaussian | Zero | Standard  Deviation |
| 1000 | 248.2 | 241.9 | 239.1 | 242 | 240.6 | 239 | 3.097849 |
| 2000 | 250 | 248.7 | 239 | 249.9 | 235.9 | 246.9 | 5.554178 |
| 4000 | 256.5 | 249.9 | 248.5 | 247 | 243.6 | 254.8 | 4.425212 |
| 8000 | 248.1 | 253 | 268.7 | 256 | 242.2 | 251.4 | 8.148347 |
| 16000 | 251.6 | 250.2 | 248.5 | 259.5 | 245.1 | 253.4 | 4.456986 |
| 32000 | 254.6 | 251.2 | 251.6 | 254.8 | 239 | 252.9 | 5.397659 |
| 64000 | 262.6 | 248.5 | 251.6 | 250 | 237.6 | 247 | 7.361103 |
| 128000 | 252.8 | 242.4 | 265.6 | 238.9 | 241.9 | 248.4 | 8.978431 |
| 256000 | 245.5 | 245.4 | 249.9 | 246.9 | 245.2 | 257.7 | 4.446597 |
| 512000 | 245.1 | 248.1 | 256.3 | 243.5 | 247 | 259.5 | 5.898705 |
| 1024000 | 262.4 | 259.1 | 250 | 251.5 | 254.2 | 273.4 | 7.929831 |
| 2048000 | 276.1 | 276.5 | 282.8 | 276.6 | 270 | 287.3 | 5.493456 |
| 4096000 | 318.8 | 323.2 | 337.1 | 329.8 | 318.5 | 332.6 | 7.005633 |
| 8192000 | 415.5 | 409.1 | 414.2 | 418.5 | 421.4 | 407.8 | 4.808124 |
| 16384000 | 628.1 | 611 | 618.8 | 621.9 | 640.5 | 616.8 | 9.428812 |
| 32768000 | 1017.3 | 996.9 | 1015.5 | 1029.8 | 1040.8 | 1012.2 | 13.79188 |
| 65536000 | 1800 | 1792.4 | 1798.1 | 1845.6 | 1740.4 | 1820.5 | 31.91562 |