INFO 6205

PROGRAM STRUCTURE AND ALGORITHMS

ASSIGNMENT 5 – PARALLEL SORT

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TASK:

implement a parallel sorting algorithm such that each partition of the array is sorted in parallel. You will consider two different schemes for deciding whether to sort in parallel.

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).

OUTPUT OF ARRAY SIZE 2000:

Degree of parallelism: 2

cutoff : 200	10times Time: 234ms
cutoff : 300	10times Time: 35ms
cutoff : 400	10times Time: 26ms
cutoff : 500	10times Time: 22ms
cutoff : 600	10times Time: 7ms
cutoff : 700	10times Time: 8ms
cutoff : 800	10times Time: 4ms
cutoff : 900	10times Time: 7ms
cutoff : 1000	10times Time: 4ms
cutoff : 1100	10times Time: 6ms
cutoff : 1200	10times Time: 11ms
cutoff : 1300	10times Time: 1ms
cutoff : 1400	10times Time: 1ms
cutoff : 1500	10times Time: 2ms
cutoff : 1600	10times Time: 1ms
cutoff : 1700	10times Time: 1ms
cutoff : 1800	10times Time: 2ms
cutoff : 1900	10times Time: 1ms

cutoff : 2000 10times Time: 2ms
Degree of parallelism: 3
cutoff : 200 10times Time: 25ms
cutoff : 300 10times Time: 6ms
cutoff : 400 10times Time: 30ms
cutoff : 500 10times Time: 6ms
cutoff : 600 10times Time: 2ms
cutoff : 700 10times Time: 1ms
cutoff : 800 10times Time: 2ms
cutoff : 900 10times Time: 1ms
cutoff : 1000 10times Time: 13ms
cutoff : 1100 10times Time: 1ms
cutoff : 1200 10times Time: 1ms
cutoff : 1300 10times Time: 1ms
cutoff : 1400 10times Time: 0ms
cutoff : 1500 10times Time: 1ms
cutoff : 1600 10times Time: 1ms
cutoff : 1700 10times Time: 1ms
cutoff : 1800 10times Time: 1ms
cutoff : 1900 10times Time: 1ms
cutoff : 2000 10times Time: 1ms
Degree of parallelism: 4
cutoff : 200 10times Time: 12ms
cutoff : 300 10times Time: 8ms
cutoff : 400 10times Time: 7ms
cutoff : 500 10times Time: 2ms
cutoff : 600 10times Time: 1ms
cutoff : 700 10times Time: 1ms
cutoff : 800 10times Time: 1ms
cutoff : 900 10times Time: 1ms
cutoff : 1000 10times Time: 1ms
cutoff : 1100 10times Time: 1ms
cutoff : 1200 10times Time: 1ms
cutoff : 1300 10times Time: 1ms
cutoff : 1400 10times Time: 1ms
cutoff : 1500 10times Time: 1ms
cutoff : 1600 10times Time: 1ms
cutoff : 1700 10times Time: 0ms
cutoff : 1800 10times Time: 1ms
cutoff : 1900 10times Time: 1ms
cutoff : 2000 10times Time: 2ms

Degree of parallelism: 5
cutoff : 200 10times Time: 15ms
cutoff : 300 10times Time: 1ms
cutoff : 400 10times Time: 2ms
cutoff : 500 10times Time: 2ms
cutoff : 600 10times Time: 6ms
cutoff : 700 10times Time: 1ms
cutoff : 800 10times Time: 2ms
cutoff : 900 10times Time: 1ms
cutoff : 1000 10times Time: 1ms
cutoff : 1100 10times Time: 1ms
cutoff : 1200 10times Time: 1ms
cutoff : 1300 10times Time: 0ms
cutoff : 1400 10times Time: 1ms
cutoff : 1500 10times Time: 1ms
cutoff : 1600 10times Time: 1ms
cutoff : 1700 10times Time: 1ms
cutoff : 1800 10times Time: 1ms
cutoff : 1900 10times Time: 1ms
cutoff : 2000 10times Time: 1ms
Degree of parallelism: 6
cutoff : 200 10times Time: 8ms
cutoff : 300 10times Time: 8ms
cutoff : 400 10times Time: 2ms
cutoff : 500 10times Time: 18ms
cutoff : 600 10times Time: 2ms
cutoff : 700 10times Time: 2ms
cutoff : 800 10times Time: 3ms
cutoff : 900 10times Time: 1ms
cutoff : 1000 10times Time: 2ms
cutoff : 1100 10times Time: 4ms
cutoff : 1200 10times Time: 3ms
cutoff : 1300 10times Time: 1ms
cutoff : 1400 10times Time: 1ms
cutoff : 1500 10times Time: 1ms
cutoff : 1600 10times Time: 0ms
cutoff : 1700 10times Time: 1ms
cutoff : 1800 10times Time: 1ms
cutoff : 1900 10times Time: 1ms
cutoff : 2000 10times Time: 1ms
Degree of parallelism: 7

cutoff : 200 10times Time: 27ms
cutoff : 300 10times Time: 2ms
cutoff : 400 10times Time: 1ms
cutoff : 500 10times Time: 2ms
cutoff : 600 10times Time: 2ms
cutoff : 700 10times Time: 4ms
cutoff : 800 10times Time: 2ms
cutoff : 900 10times Time: 1ms
cutoff : 1000 10times Time: 1ms
cutoff : 1100 10times Time: 2ms
cutoff : 1200 10times Time: 2ms
cutoff : 1300 10times Time: 1ms
cutoff : 1400 10times Time: 1ms
cutoff : 1500 10times Time: 0ms
cutoff : 1600 10times Time: 1ms
cutoff : 1700 10times Time: 1ms
cutoff : 1800 10times Time: 1ms
cutoff : 1900 10times Time: 1ms
cutoff : 2000 10times Time: 0ms
Degree of parallelism: 8
cutoff : 200 10times Time: 13ms
cutoff : 300 10times Time: 2ms
cutoff : 400 10times Time: 2ms
cutoff : 500 10times Time: 2ms
cutoff : 600 10times Time: 1ms
cutoff : 700 10times Time: 1ms
cutoff : 800 10times Time: 1ms
cutoff : 900 10times Time: 1ms
cutoff : 1000 10times Time: 1ms
cutoff : 1100 10times Time: 1ms
cutoff : 1200 10times Time: 1ms
cutoff : 1300 10times Time: 1ms
cutoff : 1400 10times Time: 0ms
cutoff : 1500 10times Time: 1ms
cutoff : 1600 10times Time: 1ms
cutoff : 1700 10times Time: 2ms
cutoff : 1800 10times Time: 1ms
cutoff : 1900 10times Time: 1ms
cutoff : 2000 10times Time: 2ms
Degree of parallelism: 9
cutoff : 200 10times Time: 48ms

cutoff : 300 10times Time: 2ms
cutoff : 400 10times Time: 1ms
cutoff : 500 10times Time: 1ms
cutoff : 600 10times Time: 2ms
cutoff : 700 10times Time: 8ms
cutoff : 800 10times Time: 4ms
cutoff : 900 10times Time: 4ms
cutoff : 1000 10times Time: 4ms
cutoff : 1100 10times Time: 3ms
cutoff : 1200 10times Time: 2ms
cutoff : 1300 10times Time: 2ms
cutoff : 1400 10times Time: 3ms
cutoff : 1500 10times Time: 2ms
cutoff : 1600 10times Time: 4ms
cutoff : 1700 10times Time: 1ms
cutoff : 1800 10times Time: 1ms
cutoff : 1900 10times Time: 1ms
cutoff : 2000 10times Time: 1ms
Degree of parallelism: 10
cutoff : 200 10times Time: 86ms
cutoff : 300 10times Time: 2ms
cutoff : 400 10times Time: 1ms
cutoff : 500 10times Time: 2ms
cutoff : 600 10times Time: 1ms
cutoff : 700 10times Time: 1ms
cutoff : 800 10times Time: 1ms
cutoff : 900 10times Time: 1ms
cutoff : 1000 10times Time: 1ms
cutoff : 1100 10times Time: 1ms
cutoff : 1200 10times Time: 1ms
cutoff : 1300 10times Time: 1ms
cutoff : 1400 10times Time: 1ms
cutoff : 1500 10times Time: 0ms
cutoff : 1600 10times Time: 6ms
cutoff : 1700 10times Time: 3ms
cutoff : 1800 10times Time: 3ms
cutoff : 1900 10times Time: 2ms
cutoff : 2000 10times Time: 2ms

OUTPUT OF ARRAY SIZE 100000

Degree of parallelism: 2
cutoff 200 10times Time 1308ms
cutoff 300 10times Time 1044ms
cutoff 400 10times Time 501ms
cutoff 500 10times Time 249ms
cutoff 600 10times Time 259ms
cutoff 700 10times Time 150ms
cutoff 800 10times Time 118ms
cutoff 900 10times Time 76ms
cutoff 1000 10times Time 110ms
cutoff 1100 10times Time 72ms
cutoff 1200 10times Time 104ms
cutoff 1300 10times Time 125ms
cutoff 1400 10times Time 76ms
cutoff 1500 10times Time 112ms
cutoff 1600 10times Time 62ms
cutoff 1700 10times Time 56ms
cutoff 1800 10times Time 60ms
cutoff 1900 10times Time 59ms
cutoff 2000 10times Time 56ms
Degree of parallelism: 3
cutoff 200 10times Time 749ms
cutoff 300 10times Time 554ms
cutoff 400 10times Time 123ms
cutoff 500 10times Time 189ms
cutoff 600 10times Time 136ms
cutoff 700 10times Time 151ms
cutoff 800 10times Time 79ms
cutoff 900 10times Time 78ms
cutoff 1000 10times Time 83ms
cutoff 1100 10times Time 75ms
cutoff 1200 10times Time 83ms
cutoff 1300 10times Time 75ms
cutoff 1400 10times Time 77ms
cutoff 1500 10times Time 75ms
cutoff 1600 10times Time 63ms
cutoff 1700 10times Time 60ms
cutoff 1800 10times Time 57ms
cutoff 1900 10times Time 62ms
cutoff 2000 10times Time 58ms
Degree of parallelism: 4
cutoff 200 10times Time 651ms
cutoff 300 10times Time 503ms
cutoff 400 10times Time 195ms

cutoff 500 10times Time 117ms
cutoff 600 10times Time 117ms
cutoff 700 10times Time 114ms
cutoff 800 10times Time 90ms
cutoff 900 10times Time 76ms
cutoff 1000 10times Time 80ms
cutoff 1100 10times Time 77ms
cutoff 1200 10times Time 77ms
cutoff 1300 10times Time 75ms
cutoff 1400 10times Time 73ms
cutoff 1500 10times Time 72ms
cutoff 1600 10times Time 62ms
cutoff 1700 10times Time 62ms
cutoff 1800 10times Time 61ms
cutoff 1900 10times Time 60ms
cutoff 2000 10times Time 58ms
Degree of parallelism: 5
cutoff 200 10times Time 802ms
cutoff 300 10times Time 514ms
cutoff 400 10times Time 112ms
cutoff 500 10times Time 161ms
cutoff 600 10times Time 126ms
cutoff 700 10times Time 131ms
cutoff 800 10times Time 74ms
cutoff 900 10times Time 73ms
cutoff 1000 10times Time 86ms
cutoff 1100 10times Time 85ms
cutoff 1200 10times Time 93ms
cutoff 1300 10times Time 97ms
cutoff 1400 10times Time 76ms
cutoff 1500 10times Time 71ms
cutoff 1600 10times Time 60ms
cutoff 1700 10times Time 57ms
cutoff 1800 10times Time 59ms
cutoff 1900 10times Time 60ms
cutoff 2000 10times Time 60ms
Degree of parallelism: 6
cutoff 200 10times Time 790ms
cutoff 300 10times Time 632ms
cutoff 400 10times Time 324ms
cutoff 500 10times Time 139ms
cutoff 600 10times Time 149ms
cutoff 700 10times Time 140ms
cutoff 800 10times Time 98ms
cutoff 900 10times Time 95ms
cutoff 1000 10times Time 79ms

cutoff 1100 10times Time 85ms
cutoff 1200 10times Time 90ms
cutoff 1300 10times Time 79ms
cutoff 1400 10times Time 84ms
cutoff 1500 10times Time 82ms
cutoff 1600 10times Time 60ms
cutoff 1700 10times Time 69ms
cutoff 1800 10times Time 63ms
cutoff 1900 10times Time 71ms
cutoff 2000 10times Time 70ms

Degree of parallelism: 7

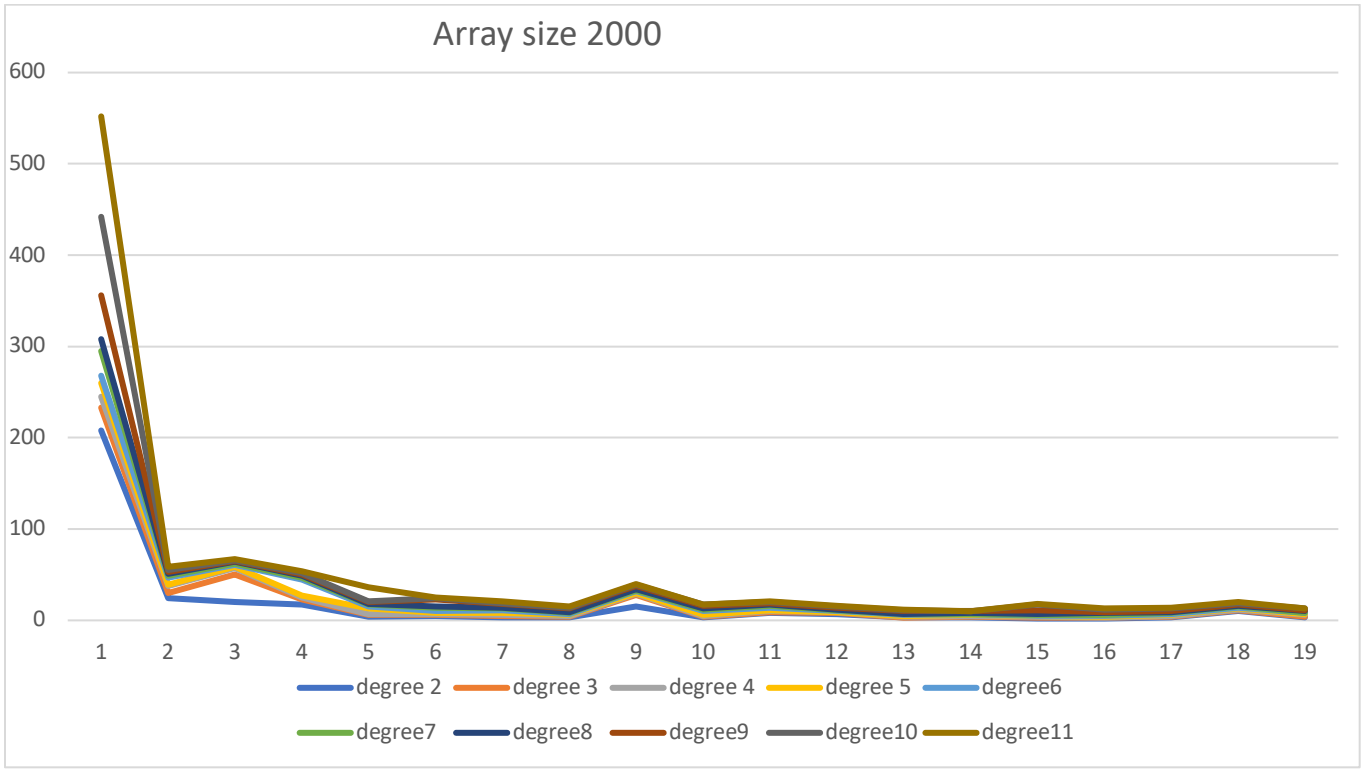
cutoff 200 10times Time 758ms
cutoff 300 10times Time 530ms
cutoff 400 10times Time 150ms
cutoff 500 10times Time 180ms
cutoff 600 10times Time 201ms
cutoff 700 10times Time 115ms
cutoff 800 10times Time 88ms
cutoff 900 10times Time 80ms
cutoff 1000 10times Time 86ms
cutoff 1100 10times Time 95ms
cutoff 1200 10times Time 87ms
cutoff 1300 10times Time 93ms
cutoff 1400 10times Time 96ms
cutoff 1500 10times Time 88ms
cutoff 1600 10times Time 78ms
cutoff 1700 10times Time 62ms
cutoff 1800 10times Time 57ms
cutoff 1900 10times Time 73ms
cutoff 2000 10times Time 61ms

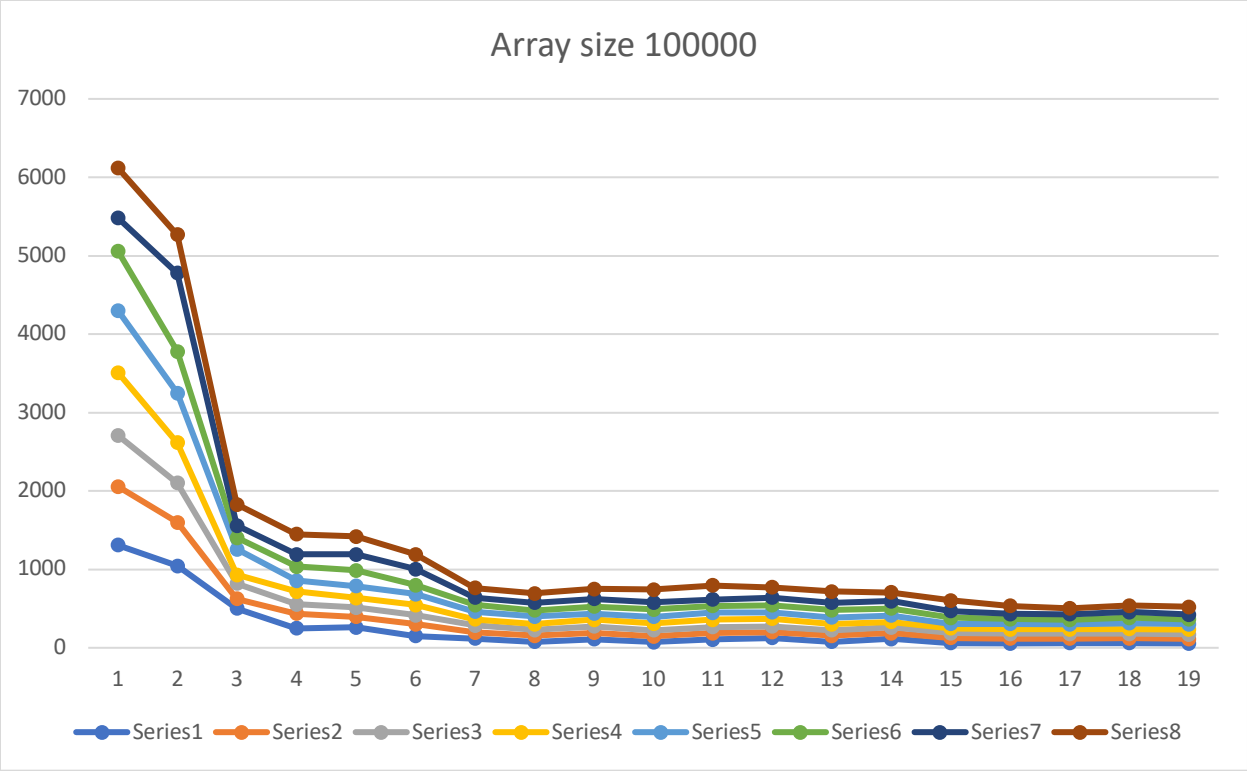
Degree of parallelism: 8

cutoff 200 10times Time 423ms
cutoff 300 10times Time 1003ms
cutoff 400 10times Time 153ms
cutoff 500 10times Time 156ms
cutoff 600 10times Time 205ms
cutoff 700 10times Time 203ms
cutoff 800 10times Time 92ms
cutoff 900 10times Time 96ms
cutoff 1000 10times Time 98ms
cutoff 1100 10times Time 90ms
cutoff 1200 10times Time 82ms
cutoff 1300 10times Time 98ms
cutoff 1400 10times Time 92ms
cutoff 1500 10times Time 95ms
cutoff 1600 10times Time 85ms

cutoff 1700 10times Time 67ms
cutoff 1800 10times Time 73ms
cutoff 1900 10times Time 72ms
cutoff 2000 10times Time 62ms
Degree of parallelism: 9
cutoff 200 10times Time 637ms
cutoff 300 10times Time 490ms
cutoff 400 10times Time 268ms
cutoff 500 10times Time 258ms
cutoff 600 10times Time 228ms
cutoff 700 10times Time 189ms
cutoff 800 10times Time 123ms
cutoff 900 10times Time 121ms
cutoff 1000 10times Time 128ms
cutoff 1100 10times Time 162ms
cutoff 1200 10times Time 180ms
cutoff 1300 10times Time 127ms
cutoff 1400 10times Time 142ms
cutoff 1500 10times Time 111ms
cutoff 1600 10times Time 133ms
cutoff 1700 10times Time 101ms
cutoff 1800 10times Time 73ms
cutoff 1900 10times Time 83ms
cutoff 2000 10times Time 97ms

OUTPUT GRAPHS:





Observations:

- Form the above observations, I feel that after around 25% the graphs are showing almost the same pattern. Hence
- The following experiment is done on array of size 2000 and 100000.
- I would say degree 5 or 4 would be an idea degree. As there is no remarkable improvement in the performance with the increase of the degree of parallelism.