

Program Structures & Algorithms

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Assignment No. 4

Name: Weiyi Zhu

(NUID): 002108281

- **Task**

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

- **Relationship Conclusion**

In the experiments, I tried 3 different arrays with length (400000, 800000, 1600000). The numbers of threads are 2, 4, 8, 16, 32, 64 (each of them is 2^n). In each sort, the value of cutoff starts from 255000 to 500000. All the results are stored in the “Assignment_4” file. The values of cutoff and 10 times Time are in the **Evidence / Graph** section.

From the evidence blow, it can easily tell that when the value of thread become smaller, parallel sort may not be so quick as compared to System sort. For example, when degree of parallelism is larger than 16, the average time decreases. What's more, when cutoff is roughly between [255000, 500000], the time is smaller than the start value and ending value.

- **Evidence / Graph**

Size of Array:400000

Degree of parallelism: 2

cutoff: 255000 10times Time:440ms

cutoff: 260000	10times Time:230ms
cutoff: 265000	10times Time:171ms
cutoff: 270000	10times Time:175ms
cutoff: 275000	10times Time:162ms
cutoff: 280000	10times Time:165ms
cutoff: 285000	10times Time:162ms
cutoff: 290000	10times Time:166ms
cutoff: 295000	10times Time:163ms
cutoff: 300000	10times Time:164ms
cutoff: 305000	10times Time:161ms
cutoff: 310000	10times Time:164ms
cutoff: 315000	10times Time:163ms
cutoff: 320000	10times Time:166ms
cutoff: 325000	10times Time:160ms
cutoff: 330000	10times Time:174ms
cutoff: 335000	10times Time:162ms
cutoff: 340000	10times Time:167ms
cutoff: 345000	10times Time:163ms
cutoff: 350000	10times Time:170ms
cutoff: 355000	10times Time:162ms
cutoff: 360000	10times Time:167ms
cutoff: 365000	10times Time:165ms
cutoff: 370000	10times Time:169ms
cutoff: 375000	10times Time:167ms
cutoff: 380000	10times Time:164ms
cutoff: 385000	10times Time:163ms
cutoff: 390000	10times Time:163ms
cutoff: 395000	10times Time:164ms
cutoff: 400000	10times Time:164ms

cutoff: 405000	10times Time:260ms
cutoff: 410000	10times Time:257ms
cutoff: 415000	10times Time:262ms
cutoff: 420000	10times Time:262ms
cutoff: 425000	10times Time:258ms
cutoff: 430000	10times Time:255ms
cutoff: 435000	10times Time:258ms
cutoff: 440000	10times Time:257ms
cutoff: 445000	10times Time:260ms
cutoff: 450000	10times Time:256ms
cutoff: 455000	10times Time:257ms
cutoff: 460000	10times Time:256ms
cutoff: 465000	10times Time:254ms
cutoff: 470000	10times Time:256ms
cutoff: 475000	10times Time:256ms
cutoff: 480000	10times Time:256ms
cutoff: 485000	10times Time:260ms
cutoff: 490000	10times Time:271ms
cutoff: 495000	10times Time:263ms
cutoff: 500000	10times Time:258ms

Degree of parallelism: 4

cutoff: 255000	10times Time:172ms
cutoff: 260000	10times Time:164ms
cutoff: 265000	10times Time:163ms
cutoff: 270000	10times Time:162ms
cutoff: 275000	10times Time:162ms
cutoff: 280000	10times Time:162ms
cutoff: 285000	10times Time:160ms
cutoff: 290000	10times Time:163ms

cutoff: 295000	10times Time:161ms
cutoff: 300000	10times Time:161ms
cutoff: 305000	10times Time:162ms
cutoff: 310000	10times Time:162ms
cutoff: 315000	10times Time:161ms
cutoff: 320000	10times Time:163ms
cutoff: 325000	10times Time:162ms
cutoff: 330000	10times Time:161ms
cutoff: 335000	10times Time:162ms
cutoff: 340000	10times Time:162ms
cutoff: 345000	10times Time:162ms
cutoff: 350000	10times Time:161ms
cutoff: 355000	10times Time:166ms
cutoff: 360000	10times Time:175ms
cutoff: 365000	10times Time:165ms
cutoff: 370000	10times Time:165ms
cutoff: 375000	10times Time:163ms
cutoff: 380000	10times Time:174ms
cutoff: 385000	10times Time:162ms
cutoff: 390000	10times Time:164ms
cutoff: 395000	10times Time:159ms
cutoff: 400000	10times Time:164ms
cutoff: 405000	10times Time:255ms
cutoff: 410000	10times Time:255ms
cutoff: 415000	10times Time:256ms
cutoff: 420000	10times Time:256ms
cutoff: 425000	10times Time:257ms
cutoff: 430000	10times Time:259ms
cutoff: 435000	10times Time:256ms

cutoff: 440000	10times Time:256ms
cutoff: 445000	10times Time:255ms
cutoff: 450000	10times Time:257ms
cutoff: 455000	10times Time:258ms
cutoff: 460000	10times Time:259ms
cutoff: 465000	10times Time:255ms
cutoff: 470000	10times Time:257ms
cutoff: 475000	10times Time:257ms
cutoff: 480000	10times Time:255ms
cutoff: 485000	10times Time:256ms
cutoff: 490000	10times Time:256ms
cutoff: 495000	10times Time:255ms
cutoff: 500000	10times Time:265ms

Degree of parallelism: 8

cutoff: 255000	10times Time:167ms
cutoff: 260000	10times Time:164ms
cutoff: 265000	10times Time:162ms
cutoff: 270000	10times Time:163ms
cutoff: 275000	10times Time:160ms
cutoff: 280000	10times Time:163ms
cutoff: 285000	10times Time:162ms
cutoff: 290000	10times Time:163ms
cutoff: 295000	10times Time:162ms
cutoff: 300000	10times Time:163ms
cutoff: 305000	10times Time:161ms
cutoff: 310000	10times Time:163ms
cutoff: 315000	10times Time:162ms
cutoff: 320000	10times Time:164ms
cutoff: 325000	10times Time:162ms

cutoff: 330000	10times Time:162ms
cutoff: 335000	10times Time:162ms
cutoff: 340000	10times Time:163ms
cutoff: 345000	10times Time:162ms
cutoff: 350000	10times Time:162ms
cutoff: 355000	10times Time:162ms
cutoff: 360000	10times Time:167ms
cutoff: 365000	10times Time:163ms
cutoff: 370000	10times Time:163ms
cutoff: 375000	10times Time:162ms
cutoff: 380000	10times Time:163ms
cutoff: 385000	10times Time:163ms
cutoff: 390000	10times Time:163ms
cutoff: 395000	10times Time:163ms
cutoff: 400000	10times Time:163ms
cutoff: 405000	10times Time:255ms
cutoff: 410000	10times Time:255ms
cutoff: 415000	10times Time:255ms
cutoff: 420000	10times Time:255ms
cutoff: 425000	10times Time:256ms
cutoff: 430000	10times Time:255ms
cutoff: 435000	10times Time:256ms
cutoff: 440000	10times Time:255ms
cutoff: 445000	10times Time:254ms
cutoff: 450000	10times Time:254ms
cutoff: 455000	10times Time:255ms
cutoff: 460000	10times Time:255ms
cutoff: 465000	10times Time:255ms
cutoff: 470000	10times Time:254ms

cutoff: 475000	10times Time:255ms
cutoff: 480000	10times Time:254ms
cutoff: 485000	10times Time:254ms
cutoff: 490000	10times Time:258ms
cutoff: 495000	10times Time:256ms
cutoff: 500000	10times Time:256ms

Degree of parallelism: 16

cutoff: 255000	10times Time:163ms
cutoff: 260000	10times Time:165ms
cutoff: 265000	10times Time:163ms
cutoff: 270000	10times Time:164ms
cutoff: 275000	10times Time:163ms
cutoff: 280000	10times Time:163ms
cutoff: 285000	10times Time:162ms
cutoff: 290000	10times Time:163ms
cutoff: 295000	10times Time:161ms
cutoff: 300000	10times Time:162ms
cutoff: 305000	10times Time:161ms
cutoff: 310000	10times Time:161ms
cutoff: 315000	10times Time:161ms
cutoff: 320000	10times Time:163ms
cutoff: 325000	10times Time:161ms
cutoff: 330000	10times Time:162ms
cutoff: 335000	10times Time:161ms
cutoff: 340000	10times Time:164ms
cutoff: 345000	10times Time:162ms
cutoff: 350000	10times Time:163ms
cutoff: 355000	10times Time:161ms
cutoff: 360000	10times Time:163ms

cutoff: 365000	10times Time:161ms
cutoff: 370000	10times Time:162ms
cutoff: 375000	10times Time:162ms
cutoff: 380000	10times Time:162ms
cutoff: 385000	10times Time:162ms
cutoff: 390000	10times Time:164ms
cutoff: 395000	10times Time:162ms
cutoff: 400000	10times Time:164ms
cutoff: 405000	10times Time:255ms
cutoff: 410000	10times Time:255ms
cutoff: 415000	10times Time:254ms
cutoff: 420000	10times Time:254ms
cutoff: 425000	10times Time:256ms
cutoff: 430000	10times Time:256ms
cutoff: 435000	10times Time:255ms
cutoff: 440000	10times Time:258ms
cutoff: 445000	10times Time:256ms
cutoff: 450000	10times Time:258ms
cutoff: 455000	10times Time:256ms
cutoff: 460000	10times Time:258ms
cutoff: 465000	10times Time:265ms
cutoff: 470000	10times Time:256ms
cutoff: 475000	10times Time:256ms
cutoff: 480000	10times Time:256ms
cutoff: 485000	10times Time:256ms
cutoff: 490000	10times Time:258ms
cutoff: 495000	10times Time:255ms
cutoff: 500000	10times Time:260ms

Degree of parallelism: 32

cutoff: 255000	10times Time:181ms
cutoff: 260000	10times Time:180ms
cutoff: 265000	10times Time:162ms
cutoff: 270000	10times Time:167ms
cutoff: 275000	10times Time:169ms
cutoff: 280000	10times Time:176ms
cutoff: 285000	10times Time:165ms
cutoff: 290000	10times Time:169ms
cutoff: 295000	10times Time:177ms
cutoff: 300000	10times Time:175ms
cutoff: 305000	10times Time:171ms
cutoff: 310000	10times Time:171ms
cutoff: 315000	10times Time:173ms
cutoff: 320000	10times Time:174ms
cutoff: 325000	10times Time:175ms
cutoff: 330000	10times Time:173ms
cutoff: 335000	10times Time:171ms
cutoff: 340000	10times Time:174ms
cutoff: 345000	10times Time:177ms
cutoff: 350000	10times Time:169ms
cutoff: 355000	10times Time:171ms
cutoff: 360000	10times Time:173ms
cutoff: 365000	10times Time:177ms
cutoff: 370000	10times Time:169ms
cutoff: 375000	10times Time:172ms
cutoff: 380000	10times Time:169ms
cutoff: 385000	10times Time:164ms
cutoff: 390000	10times Time:165ms
cutoff: 395000	10times Time:165ms

cutoff: 400000	10times Time:165ms
cutoff: 405000	10times Time:260ms
cutoff: 410000	10times Time:261ms
cutoff: 415000	10times Time:262ms
cutoff: 420000	10times Time:261ms
cutoff: 425000	10times Time:258ms
cutoff: 430000	10times Time:263ms
cutoff: 435000	10times Time:263ms
cutoff: 440000	10times Time:256ms
cutoff: 445000	10times Time:259ms
cutoff: 450000	10times Time:256ms
cutoff: 455000	10times Time:258ms
cutoff: 460000	10times Time:257ms
cutoff: 465000	10times Time:257ms
cutoff: 470000	10times Time:257ms
cutoff: 475000	10times Time:256ms
cutoff: 480000	10times Time:256ms
cutoff: 485000	10times Time:255ms
cutoff: 490000	10times Time:255ms
cutoff: 495000	10times Time:256ms
cutoff: 500000	10times Time:256ms

Degree of parallelism: 64

cutoff: 255000	10times Time:164ms
cutoff: 260000	10times Time:163ms
cutoff: 265000	10times Time:160ms
cutoff: 270000	10times Time:162ms
cutoff: 275000	10times Time:159ms
cutoff: 280000	10times Time:161ms
cutoff: 285000	10times Time:161ms

cutoff: 290000	10times Time:161ms
cutoff: 295000	10times Time:161ms
cutoff: 300000	10times Time:164ms
cutoff: 305000	10times Time:163ms
cutoff: 310000	10times Time:162ms
cutoff: 315000	10times Time:160ms
cutoff: 320000	10times Time:162ms
cutoff: 325000	10times Time:160ms
cutoff: 330000	10times Time:161ms
cutoff: 335000	10times Time:162ms
cutoff: 340000	10times Time:162ms
cutoff: 345000	10times Time:161ms
cutoff: 350000	10times Time:165ms
cutoff: 355000	10times Time:161ms
cutoff: 360000	10times Time:162ms
cutoff: 365000	10times Time:161ms
cutoff: 370000	10times Time:160ms
cutoff: 375000	10times Time:160ms
cutoff: 380000	10times Time:162ms
cutoff: 385000	10times Time:160ms
cutoff: 390000	10times Time:160ms
cutoff: 395000	10times Time:162ms
cutoff: 400000	10times Time:164ms
cutoff: 405000	10times Time:256ms
cutoff: 410000	10times Time:255ms
cutoff: 415000	10times Time:256ms
cutoff: 420000	10times Time:254ms
cutoff: 425000	10times Time:256ms
cutoff: 430000	10times Time:256ms

cutoff: 435000	10times Time:257ms
cutoff: 440000	10times Time:261ms
cutoff: 445000	10times Time:261ms
cutoff: 450000	10times Time:260ms
cutoff: 455000	10times Time:266ms
cutoff: 460000	10times Time:260ms
cutoff: 465000	10times Time:267ms
cutoff: 470000	10times Time:263ms
cutoff: 475000	10times Time:260ms
cutoff: 480000	10times Time:259ms
cutoff: 485000	10times Time:257ms
cutoff: 490000	10times Time:258ms
cutoff: 495000	10times Time:260ms
cutoff: 500000	10times Time:259ms

Size of Array:800000

Degree of parallelism: 2

cutoff: 255000	10times Time:537ms
cutoff: 260000	10times Time:489ms
cutoff: 265000	10times Time:511ms
cutoff: 270000	10times Time:546ms
cutoff: 275000	10times Time:524ms
cutoff: 280000	10times Time:522ms
cutoff: 285000	10times Time:506ms
cutoff: 290000	10times Time:517ms
cutoff: 295000	10times Time:518ms
cutoff: 300000	10times Time:510ms
cutoff: 305000	10times Time:499ms
cutoff: 310000	10times Time:490ms
cutoff: 315000	10times Time:546ms

cutoff: 320000	10times Time:511ms
cutoff: 325000	10times Time:538ms
cutoff: 330000	10times Time:524ms
cutoff: 335000	10times Time:504ms
cutoff: 340000	10times Time:494ms
cutoff: 345000	10times Time:538ms
cutoff: 350000	10times Time:515ms
cutoff: 355000	10times Time:539ms
cutoff: 360000	10times Time:513ms
cutoff: 365000	10times Time:507ms
cutoff: 370000	10times Time:514ms
cutoff: 375000	10times Time:510ms
cutoff: 380000	10times Time:537ms
cutoff: 385000	10times Time:510ms
cutoff: 390000	10times Time:505ms
cutoff: 395000	10times Time:525ms
cutoff: 400000	10times Time:536ms
cutoff: 405000	10times Time:336ms
cutoff: 410000	10times Time:338ms
cutoff: 415000	10times Time:344ms
cutoff: 420000	10times Time:341ms
cutoff: 425000	10times Time:337ms
cutoff: 430000	10times Time:337ms
cutoff: 435000	10times Time:338ms
cutoff: 440000	10times Time:341ms
cutoff: 445000	10times Time:340ms
cutoff: 450000	10times Time:343ms
cutoff: 455000	10times Time:335ms
cutoff: 460000	10times Time:334ms

cutoff: 465000	10times Time:335ms
cutoff: 470000	10times Time:334ms
cutoff: 475000	10times Time:336ms
cutoff: 480000	10times Time:335ms
cutoff: 485000	10times Time:351ms
cutoff: 490000	10times Time:338ms
cutoff: 495000	10times Time:337ms
cutoff: 500000	10times Time:335ms

Degree of parallelism: 4

cutoff: 255000	10times Time:362ms
cutoff: 260000	10times Time:362ms
cutoff: 265000	10times Time:351ms
cutoff: 270000	10times Time:360ms
cutoff: 275000	10times Time:356ms
cutoff: 280000	10times Time:364ms
cutoff: 285000	10times Time:360ms
cutoff: 290000	10times Time:355ms
cutoff: 295000	10times Time:363ms
cutoff: 300000	10times Time:361ms
cutoff: 305000	10times Time:360ms
cutoff: 310000	10times Time:364ms
cutoff: 315000	10times Time:360ms
cutoff: 320000	10times Time:358ms
cutoff: 325000	10times Time:355ms
cutoff: 330000	10times Time:359ms
cutoff: 335000	10times Time:360ms
cutoff: 340000	10times Time:373ms
cutoff: 345000	10times Time:368ms
cutoff: 350000	10times Time:370ms

cutoff: 355000	10times Time:361ms
cutoff: 360000	10times Time:362ms
cutoff: 365000	10times Time:356ms
cutoff: 370000	10times Time:372ms
cutoff: 375000	10times Time:372ms
cutoff: 380000	10times Time:361ms
cutoff: 385000	10times Time:371ms
cutoff: 390000	10times Time:367ms
cutoff: 395000	10times Time:358ms
cutoff: 400000	10times Time:366ms
cutoff: 405000	10times Time:338ms
cutoff: 410000	10times Time:356ms
cutoff: 415000	10times Time:338ms
cutoff: 420000	10times Time:340ms
cutoff: 425000	10times Time:351ms
cutoff: 430000	10times Time:352ms
cutoff: 435000	10times Time:344ms
cutoff: 440000	10times Time:347ms
cutoff: 445000	10times Time:339ms
cutoff: 450000	10times Time:337ms
cutoff: 455000	10times Time:345ms
cutoff: 460000	10times Time:343ms
cutoff: 465000	10times Time:339ms
cutoff: 470000	10times Time:339ms
cutoff: 475000	10times Time:336ms
cutoff: 480000	10times Time:335ms
cutoff: 485000	10times Time:337ms
cutoff: 490000	10times Time:337ms
cutoff: 495000	10times Time:336ms

cutoff: 500000 10times Time:335ms

Degree of parallelism: 8

cutoff: 255000 10times Time:253ms

cutoff: 260000 10times Time:244ms

cutoff: 265000 10times Time:235ms

cutoff: 270000 10times Time:237ms

cutoff: 275000 10times Time:232ms

cutoff: 280000 10times Time:250ms

cutoff: 285000 10times Time:251ms

cutoff: 290000 10times Time:252ms

cutoff: 295000 10times Time:252ms

cutoff: 300000 10times Time:244ms

cutoff: 305000 10times Time:254ms

cutoff: 310000 10times Time:236ms

cutoff: 315000 10times Time:245ms

cutoff: 320000 10times Time:265ms

cutoff: 325000 10times Time:251ms

cutoff: 330000 10times Time:253ms

cutoff: 335000 10times Time:244ms

cutoff: 340000 10times Time:241ms

cutoff: 345000 10times Time:260ms

cutoff: 350000 10times Time:252ms

cutoff: 355000 10times Time:241ms

cutoff: 360000 10times Time:243ms

cutoff: 365000 10times Time:238ms

cutoff: 370000 10times Time:243ms

cutoff: 375000 10times Time:238ms

cutoff: 380000 10times Time:242ms

cutoff: 385000 10times Time:237ms

cutoff: 390000	10times Time:245ms
cutoff: 395000	10times Time:250ms
cutoff: 400000	10times Time:244ms
cutoff: 405000	10times Time:334ms
cutoff: 410000	10times Time:341ms
cutoff: 415000	10times Time:335ms
cutoff: 420000	10times Time:340ms
cutoff: 425000	10times Time:338ms
cutoff: 430000	10times Time:337ms
cutoff: 435000	10times Time:340ms
cutoff: 440000	10times Time:338ms
cutoff: 445000	10times Time:337ms
cutoff: 450000	10times Time:335ms
cutoff: 455000	10times Time:335ms
cutoff: 460000	10times Time:335ms
cutoff: 465000	10times Time:335ms
cutoff: 470000	10times Time:335ms
cutoff: 475000	10times Time:337ms
cutoff: 480000	10times Time:336ms
cutoff: 485000	10times Time:334ms
cutoff: 490000	10times Time:334ms
cutoff: 495000	10times Time:333ms
cutoff: 500000	10times Time:339ms

Degree of parallelism: 16

cutoff: 255000	10times Time:252ms
cutoff: 260000	10times Time:247ms
cutoff: 265000	10times Time:237ms
cutoff: 270000	10times Time:242ms
cutoff: 275000	10times Time:245ms

cutoff: 280000	10times Time:241ms
cutoff: 285000	10times Time:240ms
cutoff: 290000	10times Time:244ms
cutoff: 295000	10times Time:245ms
cutoff: 300000	10times Time:238ms
cutoff: 305000	10times Time:235ms
cutoff: 310000	10times Time:241ms
cutoff: 315000	10times Time:235ms
cutoff: 320000	10times Time:245ms
cutoff: 325000	10times Time:239ms
cutoff: 330000	10times Time:231ms
cutoff: 335000	10times Time:241ms
cutoff: 340000	10times Time:232ms
cutoff: 345000	10times Time:236ms
cutoff: 350000	10times Time:240ms
cutoff: 355000	10times Time:234ms
cutoff: 360000	10times Time:232ms
cutoff: 365000	10times Time:249ms
cutoff: 370000	10times Time:231ms
cutoff: 375000	10times Time:237ms
cutoff: 380000	10times Time:233ms
cutoff: 385000	10times Time:236ms
cutoff: 390000	10times Time:235ms
cutoff: 395000	10times Time:238ms
cutoff: 400000	10times Time:234ms
cutoff: 405000	10times Time:332ms
cutoff: 410000	10times Time:335ms
cutoff: 415000	10times Time:332ms
cutoff: 420000	10times Time:333ms

cutoff: 425000	10times Time:332ms
cutoff: 430000	10times Time:331ms
cutoff: 435000	10times Time:334ms
cutoff: 440000	10times Time:334ms
cutoff: 445000	10times Time:332ms
cutoff: 450000	10times Time:332ms
cutoff: 455000	10times Time:335ms
cutoff: 460000	10times Time:333ms
cutoff: 465000	10times Time:347ms
cutoff: 470000	10times Time:332ms
cutoff: 475000	10times Time:334ms
cutoff: 480000	10times Time:336ms
cutoff: 485000	10times Time:332ms
cutoff: 490000	10times Time:334ms
cutoff: 495000	10times Time:333ms
cutoff: 500000	10times Time:332ms

Degree of parallelism: 32

cutoff: 255000	10times Time:256ms
cutoff: 260000	10times Time:234ms
cutoff: 265000	10times Time:240ms
cutoff: 270000	10times Time:238ms
cutoff: 275000	10times Time:236ms
cutoff: 280000	10times Time:237ms
cutoff: 285000	10times Time:236ms
cutoff: 290000	10times Time:233ms
cutoff: 295000	10times Time:241ms
cutoff: 300000	10times Time:237ms
cutoff: 305000	10times Time:238ms
cutoff: 310000	10times Time:233ms

cutoff: 315000	10times Time:232ms
cutoff: 320000	10times Time:235ms
cutoff: 325000	10times Time:237ms
cutoff: 330000	10times Time:233ms
cutoff: 335000	10times Time:233ms
cutoff: 340000	10times Time:235ms
cutoff: 345000	10times Time:234ms
cutoff: 350000	10times Time:235ms
cutoff: 355000	10times Time:243ms
cutoff: 360000	10times Time:235ms
cutoff: 365000	10times Time:241ms
cutoff: 370000	10times Time:245ms
cutoff: 375000	10times Time:242ms
cutoff: 380000	10times Time:240ms
cutoff: 385000	10times Time:239ms
cutoff: 390000	10times Time:239ms
cutoff: 395000	10times Time:237ms
cutoff: 400000	10times Time:239ms
cutoff: 405000	10times Time:335ms
cutoff: 410000	10times Time:333ms
cutoff: 415000	10times Time:334ms
cutoff: 420000	10times Time:335ms
cutoff: 425000	10times Time:335ms
cutoff: 430000	10times Time:334ms
cutoff: 435000	10times Time:335ms
cutoff: 440000	10times Time:333ms
cutoff: 445000	10times Time:334ms
cutoff: 450000	10times Time:335ms
cutoff: 455000	10times Time:334ms

cutoff: 460000	10times Time:333ms
cutoff: 465000	10times Time:334ms
cutoff: 470000	10times Time:333ms
cutoff: 475000	10times Time:333ms
cutoff: 480000	10times Time:334ms
cutoff: 485000	10times Time:333ms
cutoff: 490000	10times Time:333ms
cutoff: 495000	10times Time:334ms
cutoff: 500000	10times Time:334ms

Degree of parallelism: 64

cutoff: 255000	10times Time:249ms
cutoff: 260000	10times Time:239ms
cutoff: 265000	10times Time:240ms
cutoff: 270000	10times Time:235ms
cutoff: 275000	10times Time:235ms
cutoff: 280000	10times Time:234ms
cutoff: 285000	10times Time:238ms
cutoff: 290000	10times Time:235ms
cutoff: 295000	10times Time:232ms
cutoff: 300000	10times Time:233ms
cutoff: 305000	10times Time:235ms
cutoff: 310000	10times Time:234ms
cutoff: 315000	10times Time:233ms
cutoff: 320000	10times Time:233ms
cutoff: 325000	10times Time:233ms
cutoff: 330000	10times Time:233ms
cutoff: 335000	10times Time:233ms
cutoff: 340000	10times Time:233ms
cutoff: 345000	10times Time:232ms

cutoff: 350000	10times Time:231ms
cutoff: 355000	10times Time:232ms
cutoff: 360000	10times Time:238ms
cutoff: 365000	10times Time:232ms
cutoff: 370000	10times Time:234ms
cutoff: 375000	10times Time:234ms
cutoff: 380000	10times Time:233ms
cutoff: 385000	10times Time:237ms
cutoff: 390000	10times Time:232ms
cutoff: 395000	10times Time:234ms
cutoff: 400000	10times Time:234ms
cutoff: 405000	10times Time:332ms
cutoff: 410000	10times Time:332ms
cutoff: 415000	10times Time:332ms
cutoff: 420000	10times Time:332ms
cutoff: 425000	10times Time:331ms
cutoff: 430000	10times Time:332ms
cutoff: 435000	10times Time:332ms
cutoff: 440000	10times Time:332ms
cutoff: 445000	10times Time:331ms
cutoff: 450000	10times Time:332ms
cutoff: 455000	10times Time:332ms
cutoff: 460000	10times Time:333ms
cutoff: 465000	10times Time:332ms
cutoff: 470000	10times Time:333ms
cutoff: 475000	10times Time:332ms
cutoff: 480000	10times Time:334ms
cutoff: 485000	10times Time:333ms
cutoff: 490000	10times Time:331ms

cutoff: 495000 10times Time:345ms

cutoff: 500000 10times Time:338ms

Size of Array:1600000

Degree of parallelism: 2

cutoff: 255000 10times Time:1008ms

cutoff: 260000 10times Time:987ms

cutoff: 265000 10times Time:998ms

cutoff: 270000 10times Time:985ms

cutoff: 275000 10times Time:951ms

cutoff: 280000 10times Time:936ms

cutoff: 285000 10times Time:980ms

cutoff: 290000 10times Time:875ms

cutoff: 295000 10times Time:968ms

cutoff: 300000 10times Time:955ms

cutoff: 305000 10times Time:994ms

cutoff: 310000 10times Time:921ms

cutoff: 315000 10times Time:997ms

cutoff: 320000 10times Time:920ms

cutoff: 325000 10times Time:970ms

cutoff: 330000 10times Time:1031ms

cutoff: 335000 10times Time:989ms

cutoff: 340000 10times Time:981ms

cutoff: 345000 10times Time:937ms

cutoff: 350000 10times Time:957ms

cutoff: 355000 10times Time:1015ms

cutoff: 360000 10times Time:986ms

cutoff: 365000 10times Time:992ms

cutoff: 370000 10times Time:962ms

cutoff: 375000 10times Time:931ms

cutoff: 380000	10times Time:936ms
cutoff: 385000	10times Time:984ms
cutoff: 390000	10times Time:959ms
cutoff: 395000	10times Time:964ms
cutoff: 400000	10times Time:966ms
cutoff: 405000	10times Time:731ms
cutoff: 410000	10times Time:731ms
cutoff: 415000	10times Time:745ms
cutoff: 420000	10times Time:736ms
cutoff: 425000	10times Time:750ms
cutoff: 430000	10times Time:747ms
cutoff: 435000	10times Time:751ms
cutoff: 440000	10times Time:727ms
cutoff: 445000	10times Time:730ms
cutoff: 450000	10times Time:736ms
cutoff: 455000	10times Time:749ms
cutoff: 460000	10times Time:746ms
cutoff: 465000	10times Time:734ms
cutoff: 470000	10times Time:741ms
cutoff: 475000	10times Time:732ms
cutoff: 480000	10times Time:737ms
cutoff: 485000	10times Time:742ms
cutoff: 490000	10times Time:749ms
cutoff: 495000	10times Time:736ms
cutoff: 500000	10times Time:740ms
Degree of parallelism: 4	
cutoff: 255000	10times Time:916ms
cutoff: 260000	10times Time:908ms
cutoff: 265000	10times Time:907ms

cutoff: 270000	10times Time:895ms
cutoff: 275000	10times Time:918ms
cutoff: 280000	10times Time:903ms
cutoff: 285000	10times Time:900ms
cutoff: 290000	10times Time:908ms
cutoff: 295000	10times Time:888ms
cutoff: 300000	10times Time:850ms
cutoff: 305000	10times Time:872ms
cutoff: 310000	10times Time:902ms
cutoff: 315000	10times Time:902ms
cutoff: 320000	10times Time:893ms
cutoff: 325000	10times Time:898ms
cutoff: 330000	10times Time:859ms
cutoff: 335000	10times Time:889ms
cutoff: 340000	10times Time:947ms
cutoff: 345000	10times Time:911ms
cutoff: 350000	10times Time:883ms
cutoff: 355000	10times Time:875ms
cutoff: 360000	10times Time:876ms
cutoff: 365000	10times Time:871ms
cutoff: 370000	10times Time:921ms
cutoff: 375000	10times Time:890ms
cutoff: 380000	10times Time:920ms
cutoff: 385000	10times Time:933ms
cutoff: 390000	10times Time:863ms
cutoff: 395000	10times Time:870ms
cutoff: 400000	10times Time:846ms
cutoff: 405000	10times Time:490ms
cutoff: 410000	10times Time:486ms

cutoff: 415000	10times Time:500ms
cutoff: 420000	10times Time:490ms
cutoff: 425000	10times Time:488ms
cutoff: 430000	10times Time:484ms
cutoff: 435000	10times Time:479ms
cutoff: 440000	10times Time:495ms
cutoff: 445000	10times Time:493ms
cutoff: 450000	10times Time:505ms
cutoff: 455000	10times Time:499ms
cutoff: 460000	10times Time:500ms
cutoff: 465000	10times Time:492ms
cutoff: 470000	10times Time:499ms
cutoff: 475000	10times Time:494ms
cutoff: 480000	10times Time:497ms
cutoff: 485000	10times Time:504ms
cutoff: 490000	10times Time:504ms
cutoff: 495000	10times Time:500ms
cutoff: 500000	10times Time:487ms

Degree of parallelism: 8

cutoff: 255000	10times Time:658ms
cutoff: 260000	10times Time:635ms
cutoff: 265000	10times Time:631ms
cutoff: 270000	10times Time:632ms
cutoff: 275000	10times Time:639ms
cutoff: 280000	10times Time:626ms
cutoff: 285000	10times Time:631ms
cutoff: 290000	10times Time:632ms
cutoff: 295000	10times Time:639ms
cutoff: 300000	10times Time:629ms

cutoff: 305000	10times Time:631ms
cutoff: 310000	10times Time:659ms
cutoff: 315000	10times Time:641ms
cutoff: 320000	10times Time:659ms
cutoff: 325000	10times Time:657ms
cutoff: 330000	10times Time:685ms
cutoff: 335000	10times Time:737ms
cutoff: 340000	10times Time:669ms
cutoff: 345000	10times Time:684ms
cutoff: 350000	10times Time:636ms
cutoff: 355000	10times Time:646ms
cutoff: 360000	10times Time:646ms
cutoff: 365000	10times Time:629ms
cutoff: 370000	10times Time:638ms
cutoff: 375000	10times Time:642ms
cutoff: 380000	10times Time:630ms
cutoff: 385000	10times Time:666ms
cutoff: 390000	10times Time:660ms
cutoff: 395000	10times Time:668ms
cutoff: 400000	10times Time:651ms
cutoff: 405000	10times Time:510ms
cutoff: 410000	10times Time:510ms
cutoff: 415000	10times Time:494ms
cutoff: 420000	10times Time:498ms
cutoff: 425000	10times Time:500ms
cutoff: 430000	10times Time:509ms
cutoff: 435000	10times Time:535ms
cutoff: 440000	10times Time:500ms
cutoff: 445000	10times Time:508ms

cutoff: 450000	10times Time:503ms
cutoff: 455000	10times Time:497ms
cutoff: 460000	10times Time:493ms
cutoff: 465000	10times Time:481ms
cutoff: 470000	10times Time:487ms
cutoff: 475000	10times Time:484ms
cutoff: 480000	10times Time:512ms
cutoff: 485000	10times Time:500ms
cutoff: 490000	10times Time:485ms
cutoff: 495000	10times Time:504ms
cutoff: 500000	10times Time:505ms

Degree of parallelism: 16

cutoff: 255000	10times Time:499ms
cutoff: 260000	10times Time:456ms
cutoff: 265000	10times Time:482ms
cutoff: 270000	10times Time:480ms
cutoff: 275000	10times Time:479ms
cutoff: 280000	10times Time:492ms
cutoff: 285000	10times Time:481ms
cutoff: 290000	10times Time:471ms
cutoff: 295000	10times Time:444ms
cutoff: 300000	10times Time:453ms
cutoff: 305000	10times Time:457ms
cutoff: 310000	10times Time:470ms
cutoff: 315000	10times Time:464ms
cutoff: 320000	10times Time:461ms
cutoff: 325000	10times Time:458ms
cutoff: 330000	10times Time:462ms
cutoff: 335000	10times Time:460ms

cutoff: 340000	10times Time:488ms
cutoff: 345000	10times Time:469ms
cutoff: 350000	10times Time:466ms
cutoff: 355000	10times Time:460ms
cutoff: 360000	10times Time:471ms
cutoff: 365000	10times Time:472ms
cutoff: 370000	10times Time:470ms
cutoff: 375000	10times Time:477ms
cutoff: 380000	10times Time:466ms
cutoff: 385000	10times Time:472ms
cutoff: 390000	10times Time:511ms
cutoff: 395000	10times Time:488ms
cutoff: 400000	10times Time:477ms
cutoff: 405000	10times Time:477ms
cutoff: 410000	10times Time:478ms
cutoff: 415000	10times Time:476ms
cutoff: 420000	10times Time:480ms
cutoff: 425000	10times Time:478ms
cutoff: 430000	10times Time:478ms
cutoff: 435000	10times Time:481ms
cutoff: 440000	10times Time:478ms
cutoff: 445000	10times Time:481ms
cutoff: 450000	10times Time:487ms
cutoff: 455000	10times Time:486ms
cutoff: 460000	10times Time:487ms
cutoff: 465000	10times Time:487ms
cutoff: 470000	10times Time:494ms
cutoff: 475000	10times Time:487ms
cutoff: 480000	10times Time:485ms

cutoff: 485000	10times Time:486ms
cutoff: 490000	10times Time:486ms
cutoff: 495000	10times Time:489ms
cutoff: 500000	10times Time:488ms

Degree of parallelism: 32

cutoff: 255000	10times Time:448ms
cutoff: 260000	10times Time:443ms
cutoff: 265000	10times Time:435ms
cutoff: 270000	10times Time:432ms
cutoff: 275000	10times Time:437ms
cutoff: 280000	10times Time:424ms
cutoff: 285000	10times Time:426ms
cutoff: 290000	10times Time:442ms
cutoff: 295000	10times Time:429ms
cutoff: 300000	10times Time:429ms
cutoff: 305000	10times Time:422ms
cutoff: 310000	10times Time:428ms
cutoff: 315000	10times Time:427ms
cutoff: 320000	10times Time:427ms
cutoff: 325000	10times Time:418ms
cutoff: 330000	10times Time:437ms
cutoff: 335000	10times Time:420ms
cutoff: 340000	10times Time:440ms
cutoff: 345000	10times Time:441ms
cutoff: 350000	10times Time:472ms
cutoff: 355000	10times Time:423ms
cutoff: 360000	10times Time:449ms
cutoff: 365000	10times Time:447ms
cutoff: 370000	10times Time:420ms

cutoff: 375000	10times Time:421ms
cutoff: 380000	10times Time:430ms
cutoff: 385000	10times Time:421ms
cutoff: 390000	10times Time:430ms
cutoff: 395000	10times Time:430ms
cutoff: 400000	10times Time:449ms
cutoff: 405000	10times Time:479ms
cutoff: 410000	10times Time:478ms
cutoff: 415000	10times Time:484ms
cutoff: 420000	10times Time:475ms
cutoff: 425000	10times Time:479ms
cutoff: 430000	10times Time:479ms
cutoff: 435000	10times Time:492ms
cutoff: 440000	10times Time:479ms
cutoff: 445000	10times Time:478ms
cutoff: 450000	10times Time:478ms
cutoff: 455000	10times Time:477ms
cutoff: 460000	10times Time:477ms
cutoff: 465000	10times Time:474ms
cutoff: 470000	10times Time:504ms
cutoff: 475000	10times Time:507ms
cutoff: 480000	10times Time:497ms
cutoff: 485000	10times Time:571ms
cutoff: 490000	10times Time:490ms
cutoff: 495000	10times Time:538ms
cutoff: 500000	10times Time:502ms

Degree of parallelism: 64

cutoff: 255000	10times Time:484ms
cutoff: 260000	10times Time:450ms

cutoff: 265000	10times Time:447ms
cutoff: 270000	10times Time:436ms
cutoff: 275000	10times Time:434ms
cutoff: 280000	10times Time:437ms
cutoff: 285000	10times Time:431ms
cutoff: 290000	10times Time:433ms
cutoff: 295000	10times Time:436ms
cutoff: 300000	10times Time:421ms
cutoff: 305000	10times Time:425ms
cutoff: 310000	10times Time:426ms
cutoff: 315000	10times Time:433ms
cutoff: 320000	10times Time:426ms
cutoff: 325000	10times Time:437ms
cutoff: 330000	10times Time:428ms
cutoff: 335000	10times Time:430ms
cutoff: 340000	10times Time:423ms
cutoff: 345000	10times Time:429ms
cutoff: 350000	10times Time:427ms
cutoff: 355000	10times Time:438ms
cutoff: 360000	10times Time:424ms
cutoff: 365000	10times Time:430ms
cutoff: 370000	10times Time:436ms
cutoff: 375000	10times Time:438ms
cutoff: 380000	10times Time:429ms
cutoff: 385000	10times Time:437ms
cutoff: 390000	10times Time:427ms
cutoff: 395000	10times Time:429ms
cutoff: 400000	10times Time:443ms
cutoff: 405000	10times Time:481ms

cutoff: 410000	10times Time:482ms
cutoff: 415000	10times Time:485ms
cutoff: 420000	10times Time:483ms
cutoff: 425000	10times Time:496ms
cutoff: 430000	10times Time:484ms
cutoff: 435000	10times Time:482ms
cutoff: 440000	10times Time:483ms
cutoff: 445000	10times Time:486ms
cutoff: 450000	10times Time:486ms
cutoff: 455000	10times Time:488ms
cutoff: 460000	10times Time:484ms
cutoff: 465000	10times Time:490ms
cutoff: 470000	10times Time:487ms
cutoff: 475000	10times Time:494ms
cutoff: 480000	10times Time:492ms
cutoff: 485000	10times Time:492ms
cutoff: 490000	10times Time:490ms
cutoff: 495000	10times Time:481ms
cutoff: 500000	10times Time:491ms

Process finished with exit code 0