INFO6205 Assignment 5 Parallel Sort

Ruizhe Zeng

1. .Program output(relatively fast methods are highlight in blue)

```
Array size : 1000000            cutoff? 100000          Percentage: 1/10                Degree of parallelism: 2                10times Time:865ms
Array size : 1000000            cutoff? 100000          Percentage: 1/10                Degree of parallelism: 4                10times Time:359ms
Array size : 1000000            cutoff? 100000          Percentage: 1/10                Degree of parallelism: 8                10times Time:331ms
Array size : 1000000            cutoff? 100000          Percentage: 1/10                Degree of parallelism: 16               10times Time:331ms
Array size : 1000000            cutoff? 100000          Percentage: 1/10                Degree of parallelism: 32               10times Time:334ms
Array size : 1000000            cutoff? 200000          Percentage: 2/10                Degree of parallelism: 2                10times Time:403ms
Array size : 1000000            cutoff? 200000          Percentage: 2/10                Degree of parallelism: 4                10times Time:347ms
Array size : 1000000            cutoff? 200000          Percentage: 2/10                Degree of parallelism: 8                10times Time:345ms
Array size : 1000000            cutoff? 200000          Percentage: 2/10                Degree of parallelism: 16               10times Time:334ms
Array size : 1000000            cutoff? 200000          Percentage: 2/10                Degree of parallelism: 32               10times Time:337ms
Array size : 1000000            cutoff? 300000          Percentage: 3/10                Degree of parallelism: 2                10times Time:407ms
Array size : 1000000            cutoff? 300000          Percentage: 3/10                Degree of parallelism: 4                10times Time:401ms
Array size : 1000000            cutoff? 300000          Percentage: 3/10                Degree of parallelism: 8                10times Time:405ms
Array size : 1000000            cutoff? 300000          Percentage: 3/10                Degree of parallelism: 16               10times Time:411ms
Array size : 1000000            cutoff? 300000          Percentage: 3/10                Degree of parallelism: 32               10times Time:416ms
Array size : 1000000            cutoff? 400000          Percentage: 4/10                Degree of parallelism: 2                10times Time:405ms
Array size : 1000000            cutoff? 400000          Percentage: 4/10                Degree of parallelism: 4                10times Time:404ms
Array size : 1000000            cutoff? 400000          Percentage: 4/10                Degree of parallelism: 8                10times Time:401ms
Array size : 1000000            cutoff? 400000          Percentage: 4/10                Degree of parallelism: 16               10times Time:395ms
Array size : 1000000            cutoff? 400000          Percentage: 4/10                Degree of parallelism: 32               10times Time:395ms
Array size : 1000000            cutoff? 500000          Percentage: 5/10                Degree of parallelism: 2                10times Time:402ms
Array size : 1000000            cutoff? 500000          Percentage: 5/10                Degree of parallelism: 4                10times Time:404ms
Array size : 1000000            cutoff? 500000          Percentage: 5/10                Degree of parallelism: 8                10times Time:405ms
Array size : 1000000            cutoff? 500000          Percentage: 5/10                Degree of parallelism: 16               10times Time:407ms
Array size : 1000000            cutoff? 500000          Percentage: 5/10                Degree of parallelism: 32               10times Time:397ms
Array size : 1000000            cutoff? 600000          Percentage: 6/10                Degree of parallelism: 2                10times Time:530ms
Array size : 1000000            cutoff? 600000          Percentage: 6/10                Degree of parallelism: 4                10times Time:519ms
Array size : 1000000            cutoff? 600000          Percentage: 6/10                Degree of parallelism: 8                10times Time:506ms
Array size : 1000000            cutoff? 600000          Percentage: 6/10                Degree of parallelism: 16               10times Time:517ms
Array size : 1000000            cutoff? 600000          Percentage: 6/10                Degree of parallelism: 32               10times Time:501ms
Array size : 1000000            cutoff? 700000          Percentage: 7/10                Degree of parallelism: 2                10times Time:512ms
Array size : 1000000            cutoff? 700000          Percentage: 7/10                Degree of parallelism: 4                10times Time:509ms
Array size : 1000000            cutoff? 700000          Percentage: 7/10                Degree of parallelism: 8                10times Time:503ms
Array size : 1000000            cutoff? 700000          Percentage: 7/10                Degree of parallelism: 16               10times Time:501ms
Array size : 1000000            cutoff? 700000          Percentage: 7/10                Degree of parallelism: 32               10times Time:500ms
Array size : 1000000            cutoff? 800000          Percentage: 8/10                Degree of parallelism: 2                10times Time:513ms
Array size : 1000000            cutoff? 800000          Percentage: 8/10                Degree of parallelism: 4                10times Time:481ms
Array size : 1000000            cutoff? 800000          Percentage: 8/10                Degree of parallelism: 8                10times Time:508ms
Array size : 1000000            cutoff? 800000          Percentage: 8/10                Degree of parallelism: 16               10times Time:508ms
Array size : 1000000            cutoff? 800000          Percentage: 8/10                Degree of parallelism: 32               10times Time:493ms
Array size : 1000000            cutoff? 900000          Percentage: 9/10                Degree of parallelism: 2                10times Time:540ms
Array size : 1000000            cutoff? 900000          Percentage: 9/10                Degree of parallelism: 4                10times Time:510ms
Array size : 1000000            cutoff? 900000          Percentage: 9/10                Degree of parallelism: 8                10times Time:517ms
Array size : 1000000            cutoff? 900000          Percentage: 9/10                Degree of parallelism: 16               10times Time:498ms
Array size : 1000000            cutoff? 900000          Percentage: 9/10                Degree of parallelism: 32               10times Time:491ms
Array size : 1000000            cutoff? 1000000                 Percentage: 10/10               Degree of parallelism: 2                10times Time:511ms
Array size : 1000000            cutoff? 1000000                 Percentage: 10/10               Degree of parallelism: 4                10times Time:529ms
Array size : 1000000            cutoff? 1000000                 Percentage: 10/10               Degree of parallelism: 8                10times Time:536ms
Array size : 1000000            cutoff? 1000000                 Percentage: 10/10               Degree of parallelism: 16               10times Time:502ms
Array size : 1000000            cutoff? 1000000                 Percentage: 10/10               Degree of parallelism: 32               10times Time:505ms
```

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Array size : 2000000            cutoff? 200000          Percentage: 1/10            Degree of parallelism: 2            10times Time:711ms
Array size : 2000000            cutoff? 200000          Percentage: 1/10            Degree of parallelism: 4            10times Time:653ms
Array size : 2000000            cutoff? 200000          Percentage: 1/10            Degree of parallelism: 8            10times Time:662ms
Array size : 2000000            cutoff? 200000          Percentage: 1/10            Degree of parallelism: 16           10times Time:660ms
Array size : 2000000            cutoff? 200000          Percentage: 1/10            Degree of parallelism: 32           10times Time:668ms
Array size : 2000000            cutoff? 400000          Percentage: 2/10            Degree of parallelism: 2            10times Time:658ms
Array size : 2000000            cutoff? 400000          Percentage: 2/10            Degree of parallelism: 4            10times Time:653ms
Array size : 2000000            cutoff? 400000          Percentage: 2/10            Degree of parallelism: 8            10times Time:661ms
Array size : 2000000            cutoff? 400000          Percentage: 2/10            Degree of parallelism: 16           10times Time:657ms
Array size : 2000000            cutoff? 400000          Percentage: 2/10            Degree of parallelism: 32           10times Time:651ms
Array size : 2000000            cutoff? 600000          Percentage: 3/10            Degree of parallelism: 2            10times Time:781ms
Array size : 2000000            cutoff? 600000          Percentage: 3/10            Degree of parallelism: 4            10times Time:790ms
Array size : 2000000            cutoff? 600000          Percentage: 3/10            Degree of parallelism: 8            10times Time:804ms
Array size : 2000000            cutoff? 600000          Percentage: 3/10            Degree of parallelism: 16           10times Time:775ms
Array size : 2000000            cutoff? 600000          Percentage: 3/10            Degree of parallelism: 32           10times Time:814ms
Array size : 2000000            cutoff? 800000          Percentage: 4/10            Degree of parallelism: 2            10times Time:790ms
Array size : 2000000            cutoff? 800000          Percentage: 4/10            Degree of parallelism: 4            10times Time:816ms
Array size : 2000000            cutoff? 800000          Percentage: 4/10            Degree of parallelism: 8            10times Time:806ms
Array size : 2000000            cutoff? 800000          Percentage: 4/10            Degree of parallelism: 16           10times Time:815ms
Array size : 2000000            cutoff? 800000          Percentage: 4/10            Degree of parallelism: 32           10times Time:808ms
Array size : 2000000            cutoff? 1000000                 Percentage: 5/10            Degree of parallelism: 2            10times Time:795ms
Array size : 2000000            cutoff? 1000000                 Percentage: 5/10            Degree of parallelism: 4            10times Time:797ms
Array size : 2000000            cutoff? 1000000                 Percentage: 5/10            Degree of parallelism: 8            10times Time:806ms
Array size : 2000000            cutoff? 1000000                 Percentage: 5/10            Degree of parallelism: 16           10times Time:824ms
Array size : 2000000            cutoff? 1000000                 Percentage: 5/10            Degree of parallelism: 32           10times Time:808ms
Array size : 2000000            cutoff? 1200000                 Percentage: 6/10            Degree of parallelism: 2            10times Time:1041ms
Array size : 2000000            cutoff? 1200000                 Percentage: 6/10            Degree of parallelism: 4            10times Time:1085ms
Array size : 2000000            cutoff? 1200000                 Percentage: 6/10            Degree of parallelism: 8            10times Time:1089ms
Array size : 2000000            cutoff? 1200000                 Percentage: 6/10            Degree of parallelism: 16           10times Time:1047ms
Array size : 2000000            cutoff? 1200000                 Percentage: 6/10            Degree of parallelism: 32           10times Time:1075ms
Array size : 2000000            cutoff? 1400000                 Percentage: 7/10            Degree of parallelism: 2            10times Time:1059ms
Array size : 2000000            cutoff? 1400000                 Percentage: 7/10            Degree of parallelism: 4            10times Time:1065ms
Array size : 2000000            cutoff? 1400000                 Percentage: 7/10            Degree of parallelism: 8            10times Time:1079ms
Array size : 2000000            cutoff? 1400000                 Percentage: 7/10            Degree of parallelism: 16           10times Time:1117ms
Array size : 2000000            cutoff? 1400000                 Percentage: 7/10            Degree of parallelism: 32           10times Time:1081ms
Array size : 2000000            cutoff? 1600000                 Percentage: 8/10            Degree of parallelism: 2            10times Time:1055ms
Array size : 2000000            cutoff? 1600000                 Percentage: 8/10            Degree of parallelism: 4            10times Time:1066ms
Array size : 2000000            cutoff? 1600000                 Percentage: 8/10            Degree of parallelism: 8            10times Time:1062ms
Array size : 2000000            cutoff? 1600000                 Percentage: 8/10            Degree of parallelism: 16           10times Time:1047ms
Array size : 2000000            cutoff? 1600000                 Percentage: 8/10            Degree of parallelism: 32           10times Time:1082ms
Array size : 2000000            cutoff? 1800000                 Percentage: 9/10            Degree of parallelism: 2            10times Time:1049ms
Array size : 2000000            cutoff? 1800000                 Percentage: 9/10            Degree of parallelism: 4            10times Time:1051ms
Array size : 2000000            cutoff? 1800000                 Percentage: 9/10            Degree of parallelism: 8            10times Time:1038ms
Array size : 2000000            cutoff? 1800000                 Percentage: 9/10            Degree of parallelism: 16           10times Time:1066ms
Array size : 2000000            cutoff? 1800000                 Percentage: 9/10            Degree of parallelism: 32           10times Time:1049ms
Array size : 2000000            cutoff? 2000000                 Percentage: 10/10           Degree of parallelism: 2            10times Time:1074ms
Array size : 2000000            cutoff? 2000000                 Percentage: 10/10           Degree of parallelism: 4            10times Time:1038ms
Array size : 2000000            cutoff? 2000000                 Percentage: 10/10           Degree of parallelism: 8            10times Time:1080ms
Array size : 2000000            cutoff? 2000000                 Percentage: 10/10           Degree of parallelism: 16           10times Time:1061ms
Array size : 2000000            cutoff? 2000000                 Percentage: 10/10           Degree of parallelism: 32           10times Time:1042ms
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Array size : 3000000    cutoff? 300000    Percentage: 1/10    Degree of parallelism: 2    10times Time:987ms
Array size : 3000000    cutoff? 300000    Percentage: 1/10    Degree of parallelism: 4    10times Time:993ms
Array size : 3000000    cutoff? 300000    Percentage: 1/10    Degree of parallelism: 8    10times Time:994ms
Array size : 3000000    cutoff? 300000    Percentage: 1/10    Degree of parallelism: 16    10times Time:972ms
Array size : 3000000    cutoff? 300000    Percentage: 1/10    Degree of parallelism: 32    10times Time:993ms
Array size : 3000000    cutoff? 600000    Percentage: 2/10    Degree of parallelism: 2    10times Time:972ms
Array size : 3000000    cutoff? 600000    Percentage: 2/10    Degree of parallelism: 4    10times Time:982ms
Array size : 3000000    cutoff? 600000    Percentage: 2/10    Degree of parallelism: 8    10times Time:984ms
Array size : 3000000    cutoff? 600000    Percentage: 2/10    Degree of parallelism: 16    10times Time:975ms
Array size : 3000000    cutoff? 600000    Percentage: 2/10    Degree of parallelism: 32    10times Time:979ms
Array size : 3000000    cutoff? 900000    Percentage: 3/10    Degree of parallelism: 2    10times Time:1250ms
Array size : 3000000    cutoff? 900000    Percentage: 3/10    Degree of parallelism: 4    10times Time:1236ms
Array size : 3000000    cutoff? 900000    Percentage: 3/10    Degree of parallelism: 8    10times Time:1212ms
Array size : 3000000    cutoff? 900000    Percentage: 3/10    Degree of parallelism: 16    10times Time:1215ms
Array size : 3000000    cutoff? 900000    Percentage: 3/10    Degree of parallelism: 32    10times Time:1193ms
Array size : 3000000    cutoff? 1200000    Percentage: 4/10    Degree of parallelism: 2    10times Time:1222ms
Array size : 3000000    cutoff? 1200000    Percentage: 4/10    Degree of parallelism: 4    10times Time:1226ms
Array size : 3000000    cutoff? 1200000    Percentage: 4/10    Degree of parallelism: 8    10times Time:1208ms
Array size : 3000000    cutoff? 1200000    Percentage: 4/10    Degree of parallelism: 16    10times Time:1242ms
Array size : 3000000    cutoff? 1200000    Percentage: 4/10    Degree of parallelism: 32    10times Time:1238ms
Array size : 3000000    cutoff? 1500000    Percentage: 5/10    Degree of parallelism: 2    10times Time:1263ms
Array size : 3000000    cutoff? 1500000    Percentage: 5/10    Degree of parallelism: 4    10times Time:1233ms
Array size : 3000000    cutoff? 1500000    Percentage: 5/10    Degree of parallelism: 8    10times Time:1210ms
Array size : 3000000    cutoff? 1500000    Percentage: 5/10    Degree of parallelism: 16    10times Time:1221ms
Array size : 3000000    cutoff? 1500000    Percentage: 5/10    Degree of parallelism: 32    10times Time:1230ms
Array size : 3000000    cutoff? 1800000    Percentage: 6/10    Degree of parallelism: 2    10times Time:1591ms
Array size : 3000000    cutoff? 1800000    Percentage: 6/10    Degree of parallelism: 4    10times Time:1617ms
Array size : 3000000    cutoff? 1800000    Percentage: 6/10    Degree of parallelism: 8    10times Time:1600ms
Array size : 3000000    cutoff? 1800000    Percentage: 6/10    Degree of parallelism: 16    10times Time:1581ms
Array size : 3000000    cutoff? 1800000    Percentage: 6/10    Degree of parallelism: 32    10times Time:1631ms
Array size : 3000000    cutoff? 2100000    Percentage: 7/10    Degree of parallelism: 2    10times Time:1640ms
Array size : 3000000    cutoff? 2100000    Percentage: 7/10    Degree of parallelism: 4    10times Time:1621ms
Array size : 3000000    cutoff? 2100000    Percentage: 7/10    Degree of parallelism: 8    10times Time:1565ms
Array size : 3000000    cutoff? 2100000    Percentage: 7/10    Degree of parallelism: 16    10times Time:1618ms
Array size : 3000000    cutoff? 2100000    Percentage: 7/10    Degree of parallelism: 32    10times Time:1626ms
Array size : 3000000    cutoff? 2400000    Percentage: 8/10    Degree of parallelism: 2    10times Time:1616ms
Array size : 3000000    cutoff? 2400000    Percentage: 8/10    Degree of parallelism: 4    10times Time:1611ms
Array size : 3000000    cutoff? 2400000    Percentage: 8/10    Degree of parallelism: 8    10times Time:1619ms
Array size : 3000000    cutoff? 2400000    Percentage: 8/10    Degree of parallelism: 16    10times Time:1611ms
Array size : 3000000    cutoff? 2400000    Percentage: 8/10    Degree of parallelism: 32    10times Time:1597ms
Array size : 3000000    cutoff? 2700000    Percentage: 9/10    Degree of parallelism: 2    10times Time:1625ms
Array size : 3000000    cutoff? 2700000    Percentage: 9/10    Degree of parallelism: 4    10times Time:1637ms
Array size : 3000000    cutoff? 2700000    Percentage: 9/10    Degree of parallelism: 8    10times Time:1611ms
Array size : 3000000    cutoff? 2700000    Percentage: 9/10    Degree of parallelism: 16    10times Time:1682ms
Array size : 3000000    cutoff? 2700000    Percentage: 9/10    Degree of parallelism: 32    10times Time:1616ms
Array size : 3000000    cutoff? 3000000    Percentage: 10/10    Degree of parallelism: 2    10times Time:1621ms
Array size : 3000000    cutoff? 3000000    Percentage: 10/10    Degree of parallelism: 4    10times Time:1626ms
Array size : 3000000    cutoff? 3000000    Percentage: 10/10    Degree of parallelism: 8    10times Time:1627ms
Array size : 3000000    cutoff? 3000000    Percentage: 10/10    Degree of parallelism: 16    10times Time:1621ms
Array size : 3000000    cutoff? 3000000    Percentage: 10/10    Degree of parallelism: 32    10times Time:1661ms
```

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Array size : 4000000            cutoff? 400000          Percentage: 1/10              Degree of parallelism: 2              10times Time:1336ms
Array size : 4000000            cutoff? 400000          Percentage: 1/10              Degree of parallelism: 4              10times Time:1337ms
Array size : 4000000            cutoff? 400000          Percentage: 1/10              Degree of parallelism: 8              10times Time:1306ms
Array size : 4000000            cutoff? 400000          Percentage: 1/10              Degree of parallelism: 16             10times Time:1291ms
Array size : 4000000            cutoff? 400000          Percentage: 1/10              Degree of parallelism: 32             10times Time:1314ms
Array size : 4000000            cutoff? 800000          Percentage: 2/10              Degree of parallelism: 2              10times Time:1323ms
Array size : 4000000            cutoff? 800000          Percentage: 2/10              Degree of parallelism: 4              10times Time:1339ms
Array size : 4000000            cutoff? 800000          Percentage: 2/10              Degree of parallelism: 8              10times Time:1312ms
Array size : 4000000            cutoff? 800000          Percentage: 2/10              Degree of parallelism: 16             10times Time:1325ms
Array size : 4000000            cutoff? 800000          Percentage: 2/10              Degree of parallelism: 32             10times Time:1308ms
Array size : 4000000            cutoff? 1200000         Percentage: 3/10              Degree of parallelism: 2              10times Time:1615ms
Array size : 4000000            cutoff? 1200000         Percentage: 3/10              Degree of parallelism: 4              10times Time:1600ms
Array size : 4000000            cutoff? 1200000         Percentage: 3/10              Degree of parallelism: 8              10times Time:1623ms
Array size : 4000000            cutoff? 1200000         Percentage: 3/10              Degree of parallelism: 16             10times Time:1617ms
Array size : 4000000            cutoff? 1200000         Percentage: 3/10              Degree of parallelism: 32             10times Time:1590ms
Array size : 4000000            cutoff? 1600000         Percentage: 4/10              Degree of parallelism: 2              10times Time:1640ms
Array size : 4000000            cutoff? 1600000         Percentage: 4/10              Degree of parallelism: 4              10times Time:1599ms
Array size : 4000000            cutoff? 1600000         Percentage: 4/10              Degree of parallelism: 8              10times Time:1626ms
Array size : 4000000            cutoff? 1600000         Percentage: 4/10              Degree of parallelism: 16             10times Time:1596ms
Array size : 4000000            cutoff? 1600000         Percentage: 4/10              Degree of parallelism: 32             10times Time:1594ms
Array size : 4000000            cutoff? 2000000         Percentage: 5/10              Degree of parallelism: 2              10times Time:1595ms
Array size : 4000000            cutoff? 2000000         Percentage: 5/10              Degree of parallelism: 4              10times Time:1589ms
Array size : 4000000            cutoff? 2000000         Percentage: 5/10              Degree of parallelism: 8              10times Time:1589ms
Array size : 4000000            cutoff? 2000000         Percentage: 5/10              Degree of parallelism: 16             10times Time:1609ms
Array size : 4000000            cutoff? 2000000         Percentage: 5/10              Degree of parallelism: 32             10times Time:1595ms
Array size : 4000000            cutoff? 2400000         Percentage: 6/10              Degree of parallelism: 2              10times Time:2167ms
Array size : 4000000            cutoff? 2400000         Percentage: 6/10              Degree of parallelism: 4              10times Time:2136ms
Array size : 4000000            cutoff? 2400000         Percentage: 6/10              Degree of parallelism: 8              10times Time:2124ms
Array size : 4000000            cutoff? 2400000         Percentage: 6/10              Degree of parallelism: 16             10times Time:2166ms
Array size : 4000000            cutoff? 2400000         Percentage: 6/10              Degree of parallelism: 32             10times Time:2171ms
Array size : 4000000            cutoff? 2800000         Percentage: 7/10              Degree of parallelism: 2              10times Time:2104ms
Array size : 4000000            cutoff? 2800000         Percentage: 7/10              Degree of parallelism: 4              10times Time:2129ms
Array size : 4000000            cutoff? 2800000         Percentage: 7/10              Degree of parallelism: 8              10times Time:2145ms
Array size : 4000000            cutoff? 2800000         Percentage: 7/10              Degree of parallelism: 16             10times Time:2138ms
Array size : 4000000            cutoff? 2800000         Percentage: 7/10              Degree of parallelism: 32             10times Time:2093ms
Array size : 4000000            cutoff? 3200000         Percentage: 8/10              Degree of parallelism: 2              10times Time:2147ms
Array size : 4000000            cutoff? 3200000         Percentage: 8/10              Degree of parallelism: 4              10times Time:2147ms
Array size : 4000000            cutoff? 3200000         Percentage: 8/10              Degree of parallelism: 8              10times Time:2176ms
Array size : 4000000            cutoff? 3200000         Percentage: 8/10              Degree of parallelism: 16             10times Time:2154ms
Array size : 4000000            cutoff? 3200000         Percentage: 8/10              Degree of parallelism: 32             10times Time:2143ms
Array size : 4000000            cutoff? 3600000         Percentage: 9/10              Degree of parallelism: 2              10times Time:2188ms
Array size : 4000000            cutoff? 3600000         Percentage: 9/10              Degree of parallelism: 4              10times Time:2151ms
Array size : 4000000            cutoff? 3600000         Percentage: 9/10              Degree of parallelism: 8              10times Time:2135ms
Array size : 4000000            cutoff? 3600000         Percentage: 9/10              Degree of parallelism: 16             10times Time:2145ms
Array size : 4000000            cutoff? 3600000         Percentage: 9/10              Degree of parallelism: 32             10times Time:2155ms
Array size : 4000000            cutoff? 4000000         Percentage: 10/10             Degree of parallelism: 2              10times Time:2205ms
Array size : 4000000            cutoff? 4000000         Percentage: 10/10             Degree of parallelism: 4              10times Time:2210ms
Array size : 4000000            cutoff? 4000000         Percentage: 10/10             Degree of parallelism: 8              10times Time:2095ms
Array size : 4000000            cutoff? 4000000         Percentage: 10/10             Degree of parallelism: 16             10times Time:2146ms
Array size : 4000000            cutoff? 4000000         Percentage: 10/10             Degree of parallelism: 32             10times Time:2214ms
```

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Array size : 8000000            cutoff? 800000          Percentage: 1/10              Degree of parallelism: 2              10times Time:3828ms
Array size : 8000000            cutoff? 800000          Percentage: 1/10              Degree of parallelism: 4              10times Time:2601ms
Array size : 8000000            cutoff? 800000          Percentage: 1/10              Degree of parallelism: 8              10times Time:2529ms
Array size : 8000000            cutoff? 800000          Percentage: 1/10              Degree of parallelism: 16             10times Time:2572ms
Array size : 8000000            cutoff? 800000          Percentage: 1/10              Degree of parallelism: 32             10times Time:2522ms
Array size : 8000000            cutoff? 1600000                 Percentage: 2/10              Degree of parallelism: 2              10times Time:2743ms
Array size : 8000000            cutoff? 1600000                 Percentage: 2/10              Degree of parallelism: 4              10times Time:2732ms
Array size : 8000000            cutoff? 1600000                 Percentage: 2/10              Degree of parallelism: 8              10times Time:2699ms
Array size : 8000000            cutoff? 1600000                 Percentage: 2/10              Degree of parallelism: 16             10times Time:2621ms
Array size : 8000000            cutoff? 1600000                 Percentage: 2/10              Degree of parallelism: 32             10times Time:2626ms
Array size : 8000000            cutoff? 2400000                 Percentage: 3/10              Degree of parallelism: 2              10times Time:3060ms
Array size : 8000000            cutoff? 2400000                 Percentage: 3/10              Degree of parallelism: 4              10times Time:3093ms
Array size : 8000000            cutoff? 2400000                 Percentage: 3/10              Degree of parallelism: 8              10times Time:3099ms
Array size : 8000000            cutoff? 2400000                 Percentage: 3/10              Degree of parallelism: 16             10times Time:3154ms
Array size : 8000000            cutoff? 2400000                 Percentage: 3/10              Degree of parallelism: 32             10times Time:3100ms
Array size : 8000000            cutoff? 3200000                 Percentage: 4/10              Degree of parallelism: 2              10times Time:3156ms
Array size : 8000000            cutoff? 3200000                 Percentage: 4/10              Degree of parallelism: 4              10times Time:3153ms
Array size : 8000000            cutoff? 3200000                 Percentage: 4/10              Degree of parallelism: 8              10times Time:3104ms
Array size : 8000000            cutoff? 3200000                 Percentage: 4/10              Degree of parallelism: 16             10times Time:3149ms
Array size : 8000000            cutoff? 3200000                 Percentage: 4/10              Degree of parallelism: 32             10times Time:3090ms
Array size : 8000000            cutoff? 4000000                 Percentage: 5/10              Degree of parallelism: 2              10times Time:3065ms
Array size : 8000000            cutoff? 4000000                 Percentage: 5/10              Degree of parallelism: 4              10times Time:3142ms
Array size : 8000000            cutoff? 4000000                 Percentage: 5/10              Degree of parallelism: 8              10times Time:3200ms
Array size : 8000000            cutoff? 4000000                 Percentage: 5/10              Degree of parallelism: 16             10times Time:3148ms
Array size : 8000000            cutoff? 4000000                 Percentage: 5/10              Degree of parallelism: 32             10times Time:3115ms
Array size : 8000000            cutoff? 4800000                 Percentage: 6/10              Degree of parallelism: 2              10times Time:4246ms
Array size : 8000000            cutoff? 4800000                 Percentage: 6/10              Degree of parallelism: 4              10times Time:4311ms
Array size : 8000000            cutoff? 4800000                 Percentage: 6/10              Degree of parallelism: 8              10times Time:4333ms
Array size : 8000000            cutoff? 4800000                 Percentage: 6/10              Degree of parallelism: 16             10times Time:4342ms
Array size : 8000000            cutoff? 4800000                 Percentage: 6/10              Degree of parallelism: 32             10times Time:4285ms
Array size : 8000000            cutoff? 5600000                 Percentage: 7/10              Degree of parallelism: 2              10times Time:4269ms
Array size : 8000000            cutoff? 5600000                 Percentage: 7/10              Degree of parallelism: 4              10times Time:4323ms
Array size : 8000000            cutoff? 5600000                 Percentage: 7/10              Degree of parallelism: 8              10times Time:4348ms
Array size : 8000000            cutoff? 5600000                 Percentage: 7/10              Degree of parallelism: 16             10times Time:4323ms
Array size : 8000000            cutoff? 5600000                 Percentage: 7/10              Degree of parallelism: 32             10times Time:4328ms
Array size : 8000000            cutoff? 6400000                 Percentage: 8/10              Degree of parallelism: 2              10times Time:4382ms
Array size : 8000000            cutoff? 6400000                 Percentage: 8/10              Degree of parallelism: 4              10times Time:4396ms
Array size : 8000000            cutoff? 6400000                 Percentage: 8/10              Degree of parallelism: 8              10times Time:4427ms
Array size : 8000000            cutoff? 6400000                 Percentage: 8/10              Degree of parallelism: 16             10times Time:4316ms
Array size : 8000000            cutoff? 6400000                 Percentage: 8/10              Degree of parallelism: 32             10times Time:4257ms
Array size : 8000000            cutoff? 7200000                 Percentage: 9/10              Degree of parallelism: 2              10times Time:4274ms
Array size : 8000000            cutoff? 7200000                 Percentage: 9/10              Degree of parallelism: 4              10times Time:4283ms
Array size : 8000000            cutoff? 7200000                 Percentage: 9/10              Degree of parallelism: 8              10times Time:4255ms
Array size : 8000000            cutoff? 7200000                 Percentage: 9/10              Degree of parallelism: 16             10times Time:4365ms
Array size : 8000000            cutoff? 7200000                 Percentage: 9/10              Degree of parallelism: 32             10times Time:4308ms
Array size : 8000000            cutoff? 8000000                 Percentage: 10/10             Degree of parallelism: 2              10times Time:4356ms
Array size : 8000000            cutoff? 8000000                 Percentage: 10/10             Degree of parallelism: 4              10times Time:4386ms
Array size : 8000000            cutoff? 8000000                 Percentage: 10/10             Degree of parallelism: 8              10times Time:4330ms
Array size : 8000000            cutoff? 8000000                 Percentage: 10/10             Degree of parallelism: 16             10times Time:4325ms
Array size : 8000000            cutoff? 8000000                 Percentage: 10/10             Degree of parallelism: 32             10times Time:4288ms
```

```
Array size : 16000000 cutoff? 1600000 Percentage: 1/10 Degree of parallelism: 2 10times Time:5141ms
Array size : 16000000 cutoff? 1600000 Percentage: 1/10 Degree of parallelism: 4 10times Time:5067ms
Array size : 16000000 cutoff? 1600000 Percentage: 1/10 Degree of parallelism: 8 10times Time:5073ms
Array size : 16000000 cutoff? 1600000 Percentage: 1/10 Degree of parallelism: 16 10times Time:5055ms
Array size : 16000000 cutoff? 1600000 Percentage: 1/10 Degree of parallelism: 32 10times Time:5017ms
Array size : 16000000 cutoff? 3200000 Percentage: 2/10 Degree of parallelism: 2 10times Time:5346ms
Array size : 16000000 cutoff? 3200000 Percentage: 2/10 Degree of parallelism: 4 10times Time:5342ms
Array size : 16000000 cutoff? 3200000 Percentage: 2/10 Degree of parallelism: 8 10times Time:5263ms
Array size : 16000000 cutoff? 3200000 Percentage: 2/10 Degree of parallelism: 16 10times Time:5293ms
Array size : 16000000 cutoff? 3200000 Percentage: 2/10 Degree of parallelism: 32 10times Time:5221ms
Array size : 16000000 cutoff? 4800000 Percentage: 3/10 Degree of parallelism: 2 10times Time:6244ms
Array size : 16000000 cutoff? 4800000 Percentage: 3/10 Degree of parallelism: 4 10times Time:6317ms
Array size : 16000000 cutoff? 4800000 Percentage: 3/10 Degree of parallelism: 8 10times Time:6246ms
Array size : 16000000 cutoff? 4800000 Percentage: 3/10 Degree of parallelism: 16 10times Time:6733ms
Array size : 16000000 cutoff? 4800000 Percentage: 3/10 Degree of parallelism: 32 10times Time:7095ms
Array size : 16000000 cutoff? 6400000 Percentage: 4/10 Degree of parallelism: 2 10times Time:7049ms
Array size : 16000000 cutoff? 6400000 Percentage: 4/10 Degree of parallelism: 4 10times Time:6500ms
Array size : 16000000 cutoff? 6400000 Percentage: 4/10 Degree of parallelism: 8 10times Time:6403ms
Array size : 16000000 cutoff? 6400000 Percentage: 4/10 Degree of parallelism: 16 10times Time:6405ms
Array size : 16000000 cutoff? 6400000 Percentage: 4/10 Degree of parallelism: 32 10times Time:6370ms
Array size : 16000000 cutoff? 8000000 Percentage: 5/10 Degree of parallelism: 2 10times Time:6218ms
Array size : 16000000 cutoff? 8000000 Percentage: 5/10 Degree of parallelism: 4 10times Time:6415ms
Array size : 16000000 cutoff? 8000000 Percentage: 5/10 Degree of parallelism: 8 10times Time:6337ms
Array size : 16000000 cutoff? 8000000 Percentage: 5/10 Degree of parallelism: 16 10times Time:6285ms
Array size : 16000000 cutoff? 8000000 Percentage: 5/10 Degree of parallelism: 32 10times Time:6246ms
Array size : 16000000 cutoff? 9600000 Percentage: 6/10 Degree of parallelism: 2 10times Time:8667ms
Array size : 16000000 cutoff? 9600000 Percentage: 6/10 Degree of parallelism: 4 10times Time:8546ms
Array size : 16000000 cutoff? 9600000 Percentage: 6/10 Degree of parallelism: 8 10times Time:8726ms
Array size : 16000000 cutoff? 9600000 Percentage: 6/10 Degree of parallelism: 16 10times Time:8855ms
Array size : 16000000 cutoff? 9600000 Percentage: 6/10 Degree of parallelism: 32 10times Time:8561ms
Array size : 16000000 cutoff? 11200000 Percentage: 7/10 Degree of parallelism: 2 10times Time:8602ms
Array size : 16000000 cutoff? 11200000 Percentage: 7/10 Degree of parallelism: 4 10times Time:8797ms
Array size : 16000000 cutoff? 11200000 Percentage: 7/10 Degree of parallelism: 8 10times Time:9048ms
Array size : 16000000 cutoff? 11200000 Percentage: 7/10 Degree of parallelism: 16 10times Time:8699ms
Array size : 16000000 cutoff? 11200000 Percentage: 7/10 Degree of parallelism: 32 10times Time:8813ms
Array size : 16000000 cutoff? 12800000 Percentage: 8/10 Degree of parallelism: 2 10times Time:8750ms
Array size : 16000000 cutoff? 12800000 Percentage: 8/10 Degree of parallelism: 4 10times Time:8655ms
Array size : 16000000 cutoff? 12800000 Percentage: 8/10 Degree of parallelism: 8 10times Time:8511ms
Array size : 16000000 cutoff? 12800000 Percentage: 8/10 Degree of parallelism: 16 10times Time:8528ms
Array size : 16000000 cutoff? 12800000 Percentage: 8/10 Degree of parallelism: 32 10times Time:8736ms
Array size : 16000000 cutoff? 14400000 Percentage: 9/10 Degree of parallelism: 2 10times Time:8713ms
Array size : 16000000 cutoff? 14400000 Percentage: 9/10 Degree of parallelism: 4 10times Time:8669ms
Array size : 16000000 cutoff? 14400000 Percentage: 9/10 Degree of parallelism: 8 10times Time:8693ms
Array size : 16000000 cutoff? 14400000 Percentage: 9/10 Degree of parallelism: 16 10times Time:8633ms
Array size : 16000000 cutoff? 14400000 Percentage: 9/10 Degree of parallelism: 32 10times Time:8562ms
Array size : 16000000 cutoff? 16000000 Percentage: 10/10 Degree of parallelism: 2 10times Time:8568ms
Array size : 16000000 cutoff? 16000000 Percentage: 10/10 Degree of parallelism: 4 10times Time:8606ms
Array size : 16000000 cutoff? 16000000 Percentage: 10/10 Degree of parallelism: 8 10times Time:8560ms
Array size : 16000000 cutoff? 16000000 Percentage: 10/10 Degree of parallelism: 16 10times Time:8547ms
Array size : 16000000 cutoff? 16000000 Percentage: 10/10 Degree of parallelism: 32 10times Time:8587ms
```

```
32000000 cutoff? 3200000 Percentage: 1/10 Degree of parallelism: 2 10times Time:9739ms
32000000 cutoff? 3200000 Percentage: 1/10 Degree of parallelism: 4 10times Time:9730ms
32000000 cutoff? 3200000 Percentage: 1/10 Degree of parallelism: 8 10times Time:9807ms
32000000 cutoff? 3200000 Percentage: 1/10 Degree of parallelism: 16 10times Time:9869ms
32000000 cutoff? 3200000 Percentage: 1/10 Degree of parallelism: 32 10times Time:9767ms
32000000 cutoff? 6400000 Percentage: 2/10 Degree of parallelism: 2 10times Time:10322ms
32000000 cutoff? 6400000 Percentage: 2/10 Degree of parallelism: 4 10times Time:10311ms
32000000 cutoff? 6400000 Percentage: 2/10 Degree of parallelism: 8 10times Time:10418ms
32000000 cutoff? 6400000 Percentage: 2/10 Degree of parallelism: 16 10times Time:10378ms
32000000 cutoff? 6400000 Percentage: 2/10 Degree of parallelism: 32 10times Time:10446ms
32000000 cutoff? 9600000 Percentage: 3/10 Degree of parallelism: 2 10times Time:12531ms
32000000 cutoff? 9600000 Percentage: 3/10 Degree of parallelism: 4 10times Time:12571ms
32000000 cutoff? 9600000 Percentage: 3/10 Degree of parallelism: 8 10times Time:12602ms
32000000 cutoff? 9600000 Percentage: 3/10 Degree of parallelism: 16 10times Time:12673ms
32000000 cutoff? 9600000 Percentage: 3/10 Degree of parallelism: 32 10times Time:12528ms
32000000 cutoff? 12800000 Percentage: 4/10 Degree of parallelism: 2 10times Time:12509ms
32000000 cutoff? 12800000 Percentage: 4/10 Degree of parallelism: 4 10times Time:12538ms
32000000 cutoff? 12800000 Percentage: 4/10 Degree of parallelism: 8 10times Time:12565ms
32000000 cutoff? 12800000 Percentage: 4/10 Degree of parallelism: 16 10times Time:12577ms
32000000 cutoff? 12800000 Percentage: 4/10 Degree of parallelism: 32 10times Time:12538ms
32000000 cutoff? 16000000 Percentage: 5/10 Degree of parallelism: 2 10times Time:12590ms
32000000 cutoff? 16000000 Percentage: 5/10 Degree of parallelism: 4 10times Time:12667ms
32000000 cutoff? 16000000 Percentage: 5/10 Degree of parallelism: 8 10times Time:12529ms
32000000 cutoff? 16000000 Percentage: 5/10 Degree of parallelism: 16 10times Time:12658ms
32000000 cutoff? 16000000 Percentage: 5/10 Degree of parallelism: 32 10times Time:12534ms
32000000 cutoff? 19200000 Percentage: 6/10 Degree of parallelism: 2 10times Time:17590ms
32000000 cutoff? 19200000 Percentage: 6/10 Degree of parallelism: 4 10times Time:17629ms
32000000 cutoff? 19200000 Percentage: 6/10 Degree of parallelism: 8 10times Time:17546ms
32000000 cutoff? 19200000 Percentage: 6/10 Degree of parallelism: 16 10times Time:17639ms
32000000 cutoff? 19200000 Percentage: 6/10 Degree of parallelism: 32 10times Time:17487ms
32000000 cutoff? 22400000 Percentage: 7/10 Degree of parallelism: 2 10times Time:17462ms
32000000 cutoff? 22400000 Percentage: 7/10 Degree of parallelism: 4 10times Time:18159ms
32000000 cutoff? 22400000 Percentage: 7/10 Degree of parallelism: 8 10times Time:17456ms
32000000 cutoff? 22400000 Percentage: 7/10 Degree of parallelism: 16 10times Time:17459ms
32000000 cutoff? 22400000 Percentage: 7/10 Degree of parallelism: 32 10times Time:17764ms
32000000 cutoff? 25600000 Percentage: 8/10 Degree of parallelism: 2 10times Time:17518ms
32000000 cutoff? 25600000 Percentage: 8/10 Degree of parallelism: 4 10times Time:17659ms
32000000 cutoff? 25600000 Percentage: 8/10 Degree of parallelism: 8 10times Time:17713ms
32000000 cutoff? 25600000 Percentage: 8/10 Degree of parallelism: 16 10times Time:17624ms
32000000 cutoff? 25600000 Percentage: 8/10 Degree of parallelism: 32 10times Time:17859ms
32000000 cutoff? 28800000 Percentage: 9/10 Degree of parallelism: 2 10times Time:17604ms
32000000 cutoff? 28800000 Percentage: 9/10 Degree of parallelism: 4 10times Time:17736ms
32000000 cutoff? 28800000 Percentage: 9/10 Degree of parallelism: 8 10times Time:17969ms
32000000 cutoff? 28800000 Percentage: 9/10 Degree of parallelism: 16 10times Time:17679ms
32000000 cutoff? 28800000 Percentage: 9/10 Degree of parallelism: 32 10times Time:17763ms
32000000 cutoff? 32000000 Percentage: 10/10 Degree of parallelism: 2 10times Time:17656ms
32000000 cutoff? 32000000 Percentage: 10/10 Degree of parallelism: 4 10times Time:17677ms
32000000 cutoff? 32000000 Percentage: 10/10 Degree of parallelism: 8 10times Time:17485ms
32000000 cutoff? 32000000 Percentage: 10/10 Degree of parallelism: 16 10times Time:17667ms
32000000 cutoff? 32000000 Percentage: 10/10 Degree of parallelism: 32 10times Time:17769ms
```

```
Array size : 64000000 cutoff? 6400000 Percentage: 1/10 Degree of parallelism: 2 10times Time:18889ms
Array size : 64000000 cutoff? 6400000 Percentage: 1/10 Degree of parallelism: 4 10times Time:18924ms
Array size : 64000000 cutoff? 6400000 Percentage: 1/10 Degree of parallelism: 8 10times Time:19115ms
Array size : 64000000 cutoff? 6400000 Percentage: 1/10 Degree of parallelism: 16 10times Time:18958ms
Array size : 64000000 cutoff? 6400000 Percentage: 1/10 Degree of parallelism: 32 10times Time:19041ms
Array size : 64000000 cutoff? 12800000 Percentage: 2/10 Degree of parallelism: 2 10times Time:20277ms
Array size : 64000000 cutoff? 12800000 Percentage: 2/10 Degree of parallelism: 4 10times Time:20281ms
Array size : 64000000 cutoff? 12800000 Percentage: 2/10 Degree of parallelism: 8 10times Time:20232ms
Array size : 64000000 cutoff? 12800000 Percentage: 2/10 Degree of parallelism: 16 10times Time:20322ms
Array size : 64000000 cutoff? 12800000 Percentage: 2/10 Degree of parallelism: 32 10times Time:20295ms
Array size : 64000000 cutoff? 19200000 Percentage: 3/10 Degree of parallelism: 2 10times Time:25224ms
Array size : 64000000 cutoff? 19200000 Percentage: 3/10 Degree of parallelism: 4 10times Time:25013ms
Array size : 64000000 cutoff? 19200000 Percentage: 3/10 Degree of parallelism: 8 10times Time:24910ms
Array size : 64000000 cutoff? 19200000 Percentage: 3/10 Degree of parallelism: 16 10times Time:25048ms
Array size : 64000000 cutoff? 19200000 Percentage: 3/10 Degree of parallelism: 32 10times Time:24927ms
Array size : 64000000 cutoff? 25600000 Percentage: 4/10 Degree of parallelism: 2 10times Time:25026ms
Array size : 64000000 cutoff? 25600000 Percentage: 4/10 Degree of parallelism: 4 10times Time:25102ms
Array size : 64000000 cutoff? 25600000 Percentage: 4/10 Degree of parallelism: 8 10times Time:25254ms
Array size : 64000000 cutoff? 25600000 Percentage: 4/10 Degree of parallelism: 16 10times Time:25505ms
Array size : 64000000 cutoff? 25600000 Percentage: 4/10 Degree of parallelism: 32 10times Time:25320ms
Array size : 64000000 cutoff? 32000000 Percentage: 5/10 Degree of parallelism: 2 10times Time:25824ms
Array size : 64000000 cutoff? 32000000 Percentage: 5/10 Degree of parallelism: 4 10times Time:25300ms
Array size : 64000000 cutoff? 32000000 Percentage: 5/10 Degree of parallelism: 8 10times Time:25021ms
Array size : 64000000 cutoff? 32000000 Percentage: 5/10 Degree of parallelism: 16 10times Time:25028ms
Array size : 64000000 cutoff? 32000000 Percentage: 5/10 Degree of parallelism: 32 10times Time:25165ms
Array size : 64000000 cutoff? 38400000 Percentage: 6/10 Degree of parallelism: 2 10times Time:36012ms
Array size : 64000000 cutoff? 38400000 Percentage: 6/10 Degree of parallelism: 4 10times Time:35761ms
Array size : 64000000 cutoff? 38400000 Percentage: 6/10 Degree of parallelism: 8 10times Time:36305ms
Array size : 64000000 cutoff? 38400000 Percentage: 6/10 Degree of parallelism: 16 10times Time:36732ms
Array size : 64000000 cutoff? 38400000 Percentage: 6/10 Degree of parallelism: 32 10times Time:36625ms
Array size : 64000000 cutoff? 44800000 Percentage: 7/10 Degree of parallelism: 2 10times Time:36863ms
Array size : 64000000 cutoff? 44800000 Percentage: 7/10 Degree of parallelism: 4 10times Time:36705ms
Array size : 64000000 cutoff? 44800000 Percentage: 7/10 Degree of parallelism: 8 10times Time:36617ms
Array size : 64000000 cutoff? 44800000 Percentage: 7/10 Degree of parallelism: 16 10times Time:36197ms
Array size : 64000000 cutoff? 44800000 Percentage: 7/10 Degree of parallelism: 32 10times Time:36442ms
Array size : 64000000 cutoff? 51200000 Percentage: 8/10 Degree of parallelism: 2 10times Time:36449ms
Array size : 64000000 cutoff? 51200000 Percentage: 8/10 Degree of parallelism: 4 10times Time:36399ms
Array size : 64000000 cutoff? 51200000 Percentage: 8/10 Degree of parallelism: 8 10times Time:36920ms
Array size : 64000000 cutoff? 51200000 Percentage: 8/10 Degree of parallelism: 16 10times Time:36661ms
Array size : 64000000 cutoff? 51200000 Percentage: 8/10 Degree of parallelism: 32 10times Time:36351ms
Array size : 64000000 cutoff? 57600000 Percentage: 9/10 Degree of parallelism: 2 10times Time:36041ms
Array size : 64000000 cutoff? 57600000 Percentage: 9/10 Degree of parallelism: 4 10times Time:36693ms
Array size : 64000000 cutoff? 57600000 Percentage: 9/10 Degree of parallelism: 8 10times Time:36707ms
Array size : 64000000 cutoff? 57600000 Percentage: 9/10 Degree of parallelism: 16 10times Time:36619ms
Array size : 64000000 cutoff? 57600000 Percentage: 9/10 Degree of parallelism: 32 10times Time:36561ms
Array size : 64000000 cutoff? 64000000 Percentage: 10/10 Degree of parallelism: 2 10times Time:36779ms
Array size : 64000000 cutoff? 64000000 Percentage: 10/10 Degree of parallelism: 4 10times Time:36591ms
Array size : 64000000 cutoff? 64000000 Percentage: 10/10 Degree of parallelism: 8 10times Time:37041ms
Array size : 64000000 cutoff? 64000000 Percentage: 10/10 Degree of parallelism: 16 10times Time:36700ms
Array size : 64000000 cutoff? 64000000 Percentage: 10/10 Degree of parallelism: 32 10times Time:36257ms
```

2.Conclution

Base on my observation I find following relationships:

1. **The most significant factor that caused running time to increase is the length of the input array size. The running time will increase when the length of the array increases.**
2. **When the cutoff's size = 10% - 20% of input array size, the running time is relatively faster than other cutoffs.**
3. **When the cutoff's size = 20% - 50% of input array size, the running time is very close to each other in this range, normally it will be a little slower than it was between 10%-20%.**
4. **If the cutoff's size is greater than 50% of input array size, the running time will go up immediately and make a significant difference with the cutoff's size =50%. So do not make the cutoff's size > 50% !**
5. **The num of threads does not have much effect on the time run, but on average the num of threads = 32 will have a slight advantage among others.**

Based on the data and my analysis, pick cutoff's size equals 20% or 50% input array size, and 32 num of threads is a reasonable selection.