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Program Structures & Algorithms Fall 2021

Assignment No. 05

Task:

1. To implement a parallel sorting algorithm such that each partition of the array is sorted in parallel.
2. You should run with many different array sizes (they must be sufficiently large to make parallel sorting worthwhile, obviously) and different cut-off schemes.

Relationship Conclusion:

1. Considering large range of cut off values for the large array sizes , the time for execution of sorting the array is performing better when the cut off value is close to the half the array size.
2. Cut off should be $N/2$

Findings:

The experiment is performed considering large values for different array sizes {2000000, 2500000, 3000000, 3500000} and multiple cut off values ranging from 510000 to 1010000 with degrees of parallelisms 2 and 4. Below are the experiment values for each array size and parallelism.

Degree of parallelism: 2	Array Size - 2000000
cutoff : 510000	10times Time:1459ms
cutoff : 530000	10times Time:1295ms
cutoff : 550000	10times Time:1312ms
cutoff : 570000	10times Time:1313ms
cutoff : 590000	10times Time:1306ms
cutoff : 610000	10times Time:1306ms
cutoff : 630000	10times Time:1316ms
cutoff : 650000	10times Time:1316ms
cutoff : 670000	10times Time:1312ms
cutoff : 690000	10times Time:1262ms
cutoff : 710000	10times Time:1243ms
cutoff : 730000	10times Time:1267ms
cutoff : 750000	10times Time:1252ms

cutoff : 770000	10times Time:1282ms
cutoff : 790000	10times Time:1312ms
cutoff : 810000	10times Time:1311ms
cutoff : 830000	10times Time:1331ms
cutoff : 850000	10times Time:1318ms
cutoff : 870000	10times Time:1289ms
cutoff : 890000	10times Time:1261ms
cutoff : 910000	10times Time:1254ms
cutoff : 930000	10times Time:1250ms
cutoff : 950000	10times Time:1251ms
cutoff : 970000	10times Time:1500ms
cutoff : 990000	10times Time:1335ms
cutoff : 1010000	10times Time:977ms

Degree of parallelism: 2 Array Size - 2500000

cutoff : 510000	10times Time:1631ms
cutoff : 530000	10times Time:1342ms
cutoff : 550000	10times Time:1393ms
cutoff : 570000	10times Time:1330ms
cutoff : 590000	10times Time:1371ms
cutoff : 610000	10times Time:1408ms
cutoff : 630000	10times Time:1312ms
cutoff : 650000	10times Time:1324ms
cutoff : 670000	10times Time:1327ms
cutoff : 690000	10times Time:1326ms
cutoff : 710000	10times Time:1292ms
cutoff : 730000	10times Time:1323ms
cutoff : 750000	10times Time:1300ms
cutoff : 770000	10times Time:1312ms
cutoff : 790000	10times Time:1502ms
cutoff : 810000	10times Time:1289ms
cutoff : 830000	10times Time:1347ms
cutoff : 850000	10times Time:1340ms
cutoff : 870000	10times Time:1356ms
cutoff : 890000	10times Time:1330ms
cutoff : 910000	10times Time:1358ms
cutoff : 930000	10times Time:1363ms
cutoff : 950000	10times Time:1308ms
cutoff : 970000	10times Time:1339ms
cutoff : 990000	10times Time:1284ms
cutoff : 1010000	10times Time:1284ms

Degree of parallelism: 2 Array Size - 3000000

cutoff : 510000	10times Time:1983ms
cutoff : 530000	10times Time:1600ms
cutoff : 550000	10times Time:1544ms
cutoff : 570000	10times Time:1632ms
cutoff : 590000	10times Time:1615ms
cutoff : 610000	10times Time:1673ms
cutoff : 630000	10times Time:1585ms
cutoff : 650000	10times Time:1653ms

cutoff : 670000	10times Time:1577ms
cutoff : 690000	10times Time:1486ms
cutoff : 710000	10times Time:1742ms
cutoff : 730000	10times Time:1657ms
cutoff : 750000	10times Time:1600ms
cutoff : 770000	10times Time:1596ms
cutoff : 790000	10times Time:1636ms
cutoff : 810000	10times Time:1632ms
cutoff : 830000	10times Time:1571ms
cutoff : 850000	10times Time:1483ms
cutoff : 870000	10times Time:1550ms
cutoff : 890000	10times Time:1762ms
cutoff : 910000	10times Time:1563ms
cutoff : 930000	10times Time:1599ms
cutoff : 950000	10times Time:1634ms
cutoff : 970000	10times Time:1606ms
cutoff : 990000	10times Time:1630ms
cutoff : 1010000	10times Time:1617ms

Degree of parallelism: 2 Array Size - 3500000

cutoff : 510000	10times Time:2235ms
cutoff : 530000	10times Time:1902ms
cutoff : 550000	10times Time:1874ms
cutoff : 570000	10times Time:1911ms
cutoff : 590000	10times Time:1954ms
cutoff : 610000	10times Time:1883ms
cutoff : 630000	10times Time:1878ms
cutoff : 650000	10times Time:1914ms
cutoff : 670000	10times Time:1807ms
cutoff : 690000	10times Time:2036ms
cutoff : 710000	10times Time:1926ms
cutoff : 730000	10times Time:1908ms
cutoff : 750000	10times Time:1868ms
cutoff : 770000	10times Time:1923ms
cutoff : 790000	10times Time:1891ms
cutoff : 810000	10times Time:1815ms
cutoff : 830000	10times Time:1795ms
cutoff : 850000	10times Time:1891ms
cutoff : 870000	10times Time:1854ms
cutoff : 890000	10times Time:2167ms
cutoff : 910000	10times Time:1963ms
cutoff : 930000	10times Time:1936ms
cutoff : 950000	10times Time:1892ms
cutoff : 970000	10times Time:1894ms
cutoff : 990000	10times Time:1905ms
cutoff : 1010000	10times Time:1899ms

Degree of parallelism: 4 Array Size - 2000000

cutoff : 510000	10times Time:1341ms
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cutoff : 530000	10times Time:1057ms
cutoff : 550000	10times Time:1034ms
cutoff : 570000	10times Time:1005ms
cutoff : 590000	10times Time:1080ms
cutoff : 610000	10times Time:1092ms
cutoff : 630000	10times Time:1067ms
cutoff : 650000	10times Time:1084ms
cutoff : 670000	10times Time:1074ms
cutoff : 690000	10times Time:1073ms
cutoff : 710000	10times Time:1085ms
cutoff : 730000	10times Time:1081ms
cutoff : 750000	10times Time:1090ms
cutoff : 770000	10times Time:1101ms
cutoff : 790000	10times Time:1086ms
cutoff : 810000	10times Time:1103ms
cutoff : 830000	10times Time:1025ms
cutoff : 850000	10times Time:1020ms
cutoff : 870000	10times Time:1046ms
cutoff : 890000	10times Time:1035ms
cutoff : 910000	10times Time:1117ms
cutoff : 930000	10times Time:1302ms
cutoff : 950000	10times Time:1107ms
cutoff : 970000	10times Time:1134ms
cutoff : 990000	10times Time:1098ms
cutoff : 1010000	10times Time:975ms

Degree of parallelism: 4 Array Size - 2500000

cutoff : 510000	10times Time:1723ms
cutoff : 530000	10times Time:1362ms
cutoff : 550000	10times Time:1429ms
cutoff : 570000	10times Time:1485ms
cutoff : 590000	10times Time:1454ms
cutoff : 610000	10times Time:1469ms
cutoff : 630000	10times Time:948ms
cutoff : 650000	10times Time:955ms
cutoff : 670000	10times Time:947ms
cutoff : 690000	10times Time:946ms
cutoff : 710000	10times Time:934ms
cutoff : 730000	10times Time:1072ms
cutoff : 750000	10times Time:1007ms
cutoff : 770000	10times Time:970ms
cutoff : 790000	10times Time:960ms
cutoff : 810000	10times Time:965ms
cutoff : 830000	10times Time:987ms
cutoff : 850000	10times Time:993ms
cutoff : 870000	10times Time:984ms
cutoff : 890000	10times Time:988ms
cutoff : 910000	10times Time:931ms
cutoff : 930000	10times Time:935ms
cutoff : 950000	10times Time:937ms
cutoff : 970000	10times Time:936ms
cutoff : 990000	10times Time:954ms

cutoff : 1010000 10times Time:950ms

Degree of parallelism: 4 Array Size - 3000000

cutoff : 510000	10times Time:2065ms
cutoff : 530000	10times Time:1730ms
cutoff : 550000	10times Time:1730ms
cutoff : 570000	10times Time:1770ms
cutoff : 590000	10times Time:1791ms
cutoff : 610000	10times Time:1829ms
cutoff : 630000	10times Time:1812ms
cutoff : 650000	10times Time:1757ms
cutoff : 670000	10times Time:1720ms
cutoff : 690000	10times Time:1863ms
cutoff : 710000	10times Time:1833ms
cutoff : 730000	10times Time:1833ms
cutoff : 750000	10times Time:1843ms
cutoff : 770000	10times Time:1239ms
cutoff : 790000	10times Time:1205ms
cutoff : 810000	10times Time:1217ms
cutoff : 830000	10times Time:1193ms
cutoff : 850000	10times Time:1171ms
cutoff : 870000	10times Time:1177ms
cutoff : 890000	10times Time:1429ms
cutoff : 910000	10times Time:1231ms
cutoff : 930000	10times Time:1190ms
cutoff : 950000	10times Time:1209ms
cutoff : 970000	10times Time:1235ms
cutoff : 990000	10times Time:1237ms
cutoff : 1010000	10times Time:1287ms

Degree of parallelism: 4 Array Size - 3500000

cutoff : 510000	10times Time:2329ms
cutoff : 530000	10times Time:2093ms
cutoff : 550000	10times Time:2083ms
cutoff : 570000	10times Time:2093ms
cutoff : 590000	10times Time:2083ms
cutoff : 610000	10times Time:2097ms
cutoff : 630000	10times Time:2137ms
cutoff : 650000	10times Time:2155ms
cutoff : 670000	10times Time:2097ms
cutoff : 690000	10times Time:1995ms
cutoff : 710000	10times Time:2184ms
cutoff : 730000	10times Time:2138ms
cutoff : 750000	10times Time:2125ms
cutoff : 770000	10times Time:2162ms
cutoff : 790000	10times Time:2070ms
cutoff : 810000	10times Time:1998ms
cutoff : 830000	10times Time:1979ms
cutoff : 850000	10times Time:2018ms
cutoff : 870000	10times Time:2007ms
cutoff : 890000	10times Time:1390ms
cutoff : 910000	10times Time:1426ms

cutoff : 930000	10times Time:1618ms
cutoff : 950000	10times Time:1481ms
cutoff : 970000	10times Time:1504ms
cutoff : 990000	10times Time:1470ms
cutoff : 1010000	10times Time:1472ms

Output Screenshots:

Array Size – 2000000

Degree of parallelism – 2

The screenshot shows the Eclipse IDE with a Java project. The code in `Main.java` defines a `ParSort` class with a `cutoff` attribute and a `sort` method. The `sort` method uses a recursive approach with a `cutoff` of 100000. The console output shows the execution results for various cutoff values, with the degree of parallelism set to 2.

```

27 Random random = new Random();
28 int[] array = new int[2000000];
29 ArrayList<Long> timeList = new ArrayList<>();
30 for (int j = 50; j <= 100; j++) {
31     ParSort cutoff = 100000 * (j + 1);
32
33     long time;
34     long startTime = System.currentTimeMillis();
35     for (int i = 0; i < 10; i++) {
36         for (int l = 0; l < array.length; l++) array[l] = random.nextInt(10000000);
37         ParSort cutoff.sort(array, 0, array.length);
38     }
39     timeList.add(new Long(System.currentTimeMillis() - startTime));
40 }
41
42 public static void main(String[] args) {
43     ParSort cutoff = new ParSort(100000);
44     cutoff.sort(array, 0, array.length);
45 }

```

Console Output:

```

-terminated- Main [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\java.exe (10-Nov-2021, 1:44:26 pm - 1:45:00 pm)
Degree of parallelism: 2
cutoff: 510000 10times Time:1459ms
cutoff: 530000 10times Time:1295ms
cutoff: 550000 10times Time:1312ms
cutoff: 570000 10times Time:1313ms
cutoff: 590000 10times Time:1306ms
cutoff: 610000 10times Time:1306ms
cutoff: 630000 10times Time:1313ms
cutoff: 650000 10times Time:1316ms
cutoff: 670000 10times Time:1312ms
cutoff: 690000 10times Time:1263ms
cutoff: 710000 10times Time:1243ms
cutoff: 730000 10times Time:1267ms
cutoff: 750000 10times Time:1252ms
cutoff: 770000 10times Time:1282ms
cutoff: 790000 10times Time:1312ms
cutoff: 810000 10times Time:1311ms
cutoff: 830000 10times Time:1331ms
cutoff: 850000 10times Time:1313ms
cutoff: 870000 10times Time:1289ms
cutoff: 890000 10times Time:1261ms
cutoff: 910000 10times Time:1254ms
cutoff: 930000 10times Time:1250ms
cutoff: 950000 10times Time:1251ms
cutoff: 970000 10times Time:1508ms
cutoff: 990000 10times Time:1335ms
cutoff: 1010000 10times Time:977ms

```

Array Size – 2500000

Degree of parallelism – 2

```
28 Random random = new Random();
29 int[] array = new int[2000000];
30 ArrayList<Long> timeList = new ArrayList<>();
31 for (int j = 50; j <= 100; j++) {
32     ParallelSort cutoff = 10000 * (j + 1);
33 }
34 long time;
35 long startTime = System.currentTimeMillis();
36 for (int t = 0; t < 10; t++) {
37     for (int i = 0; i < array.length; i++) array[i] = random.nextInt(10000000);
38     ParallelSort cutoff = new ParallelSort(array.length);
39 }
```

terminated: Main [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\java.exe (10-Nov-2021, 1:46:01 pm - 1:46:37 pm)

Degree of parallelism: 2	
cutoff: 510000	10Times Time: 1633ms
cutoff: 530000	10Times Time: 132ms
cutoff: 550000	10Times Time: 139ms
cutoff: 570000	10Times Time: 133ms
cutoff: 590000	10Times Time: 137ms
cutoff: 610000	10Times Time: 140ms
cutoff: 630000	10Times Time: 131ms
cutoff: 650000	10Times Time: 122ms
cutoff: 670000	10Times Time: 132ms
cutoff: 690000	10Times Time: 132ms
cutoff: 710000	10Times Time: 129ms
cutoff: 730000	10Times Time: 132ms
cutoff: 750000	10Times Time: 130ms
cutoff: 770000	10Times Time: 131ms
cutoff: 790000	10Times Time: 150ms
cutoff: 810000	10Times Time: 120ms
cutoff: 830000	10Times Time: 134ms
cutoff: 850000	10Times Time: 134ms
cutoff: 870000	10Times Time: 135ms
cutoff: 890000	10Times Time: 133ms
cutoff: 910000	10Times Time: 135ms
cutoff: 930000	10Times Time: 136ms
cutoff: 950000	10Times Time: 130ms
cutoff: 970000	10Times Time: 133ms
cutoff: 990000	10Times Time: 128ms
cutoff: 1010000	10Times Time: 128ms

Array Size – 3000000

Degree of parallelism – 2

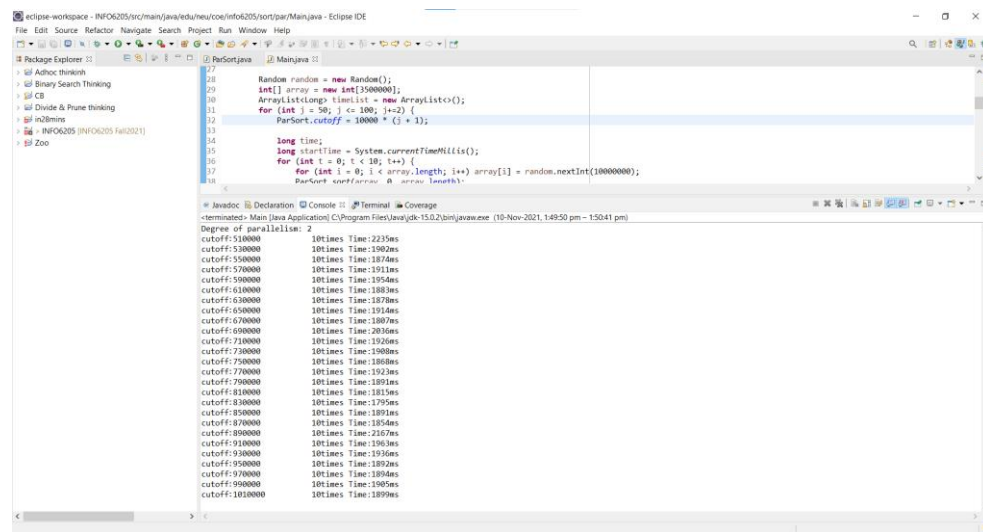
```
27 Random random = new Random();
28 int[] array = new int[3000000];
29 ArrayList<Long> timeList = new ArrayList<>();
30 for (int j = 50; j <= 100; j++) {
31     ParallelSort cutoff = 10000 * (j + 1);
32 }
33 long time;
34 long startTime = System.currentTimeMillis();
35 for (int t = 0; t < 10; t++) {
36     for (int i = 0; i < array.length; i++) array[i] = random.nextInt(10000000);
37     ParallelSort cutoff = new ParallelSort(array.length);
38 }
```

terminated: Main [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\java.exe (10-Nov-2021, 1:47:38 pm - 1:48:21 pm)

Degree of parallelism: 2	
cutoff: 510000	10Times Time: 1902ms
cutoff: 530000	10Times Time: 160ms
cutoff: 550000	10Times Time: 154ms
cutoff: 570000	10Times Time: 161ms
cutoff: 590000	10Times Time: 161ms
cutoff: 610000	10Times Time: 167ms
cutoff: 630000	10Times Time: 158ms
cutoff: 650000	10Times Time: 165ms
cutoff: 670000	10Times Time: 157ms
cutoff: 690000	10Times Time: 148ms
cutoff: 710000	10Times Time: 174ms
cutoff: 730000	10Times Time: 160ms
cutoff: 750000	10Times Time: 159ms
cutoff: 770000	10Times Time: 163ms
cutoff: 790000	10Times Time: 163ms
cutoff: 810000	10Times Time: 157ms
cutoff: 830000	10Times Time: 148ms
cutoff: 850000	10Times Time: 156ms
cutoff: 870000	10Times Time: 155ms
cutoff: 890000	10Times Time: 176ms
cutoff: 910000	10Times Time: 156ms
cutoff: 930000	10Times Time: 159ms
cutoff: 950000	10Times Time: 163ms
cutoff: 970000	10Times Time: 166ms
cutoff: 990000	10Times Time: 163ms
cutoff: 1010000	10Times Time: 161ms

Array Size – 3500000

Degree of parallelism – 2



The screenshot shows the Eclipse IDE with a Java project named 'INFO6205'. The package explorer on the left shows a package 'INFO6205' containing a file 'Main.java'. The editor displays the code for 'Main.java', which includes a 'ParSort' class and a 'main' method. The code uses a 'Random' object to generate an array of 3,500,000 integers and sorts it using a parallel sorting algorithm. The console output shows the execution results, including the degree of parallelism (2) and a list of cutoffs and times for each iteration.

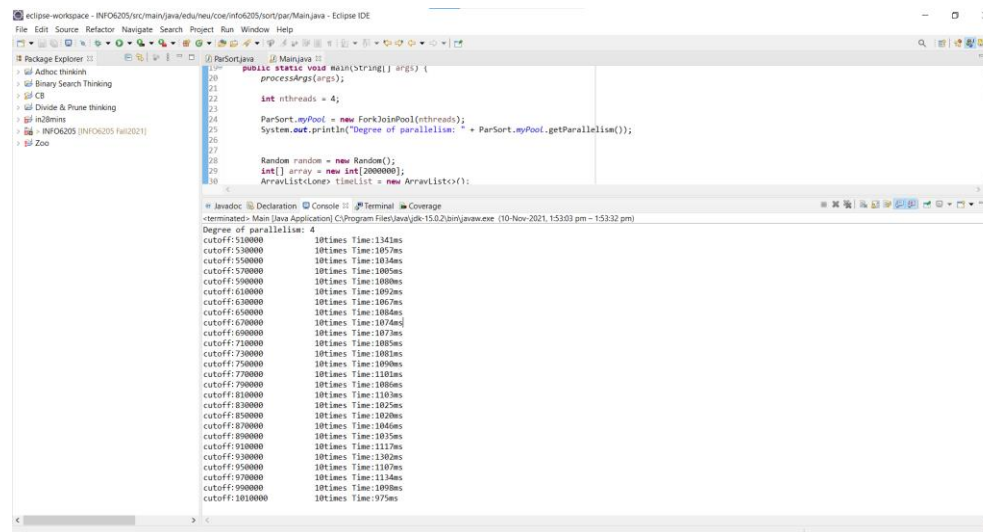
```
27 Random random = new Random();
28
29 int[] array = new int[3500000];
30 ArrayList<Long> timeList = new ArrayList<>();
31 for (int j = 50; j < 100; j++) {
32     ParSort cutoff = 10000 * (j + 1);
33
34     long time;
35     long startTime = System.currentTimeMillis();
36     for (int i = 0; i < array.length; i++) array[i] = random.nextInt(10000000);
37     ParSort sort(array, 0, array.length);
38 }
```

Console Output:

```
<terminated> Main [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\java.exe (10-Nov-2021, 1:49:50 pm - 1:50:41 pm)
Degree of parallelism: 2
cutoff:510000 10Times Time:2235ms
cutoff:530000 10Times Time:1902ms
cutoff:550000 10Times Time:1874ms
cutoff:570000 10Times Time:1911ms
cutoff:590000 10Times Time:1954ms
cutoff:610000 10Times Time:1893ms
cutoff:630000 10Times Time:1878ms
cutoff:650000 10Times Time:1914ms
cutoff:670000 10Times Time:1807ms
cutoff:690000 10Times Time:2036ms
cutoff:710000 10Times Time:1926ms
cutoff:730000 10Times Time:1908ms
cutoff:750000 10Times Time:1868ms
cutoff:770000 10Times Time:1923ms
cutoff:790000 10Times Time:1891ms
cutoff:810000 10Times Time:1815ms
cutoff:830000 10Times Time:1795ms
cutoff:850000 10Times Time:1891ms
cutoff:870000 10Times Time:1854ms
cutoff:890000 10Times Time:1867ms
cutoff:910000 10Times Time:1963ms
cutoff:930000 10Times Time:1936ms
cutoff:950000 10Times Time:1992ms
cutoff:970000 10Times Time:1894ms
cutoff:990000 10Times Time:1905ms
cutoff:1010000 10Times Time:1899ms
```

Array Size – 2000000

Degree of parallelism – 4



The screenshot shows the Eclipse IDE with a Java project named 'INFO6205'. The package explorer on the left shows a package 'INFO6205' containing a file 'Main.java'. The editor displays the code for 'Main.java', which includes a 'ParSort' class and a 'main' method. The code uses a 'Random' object to generate an array of 2,000,000 integers and sorts it using a parallel sorting algorithm. The console output shows the execution results, including the degree of parallelism (4) and a list of cutoffs and times for each iteration.

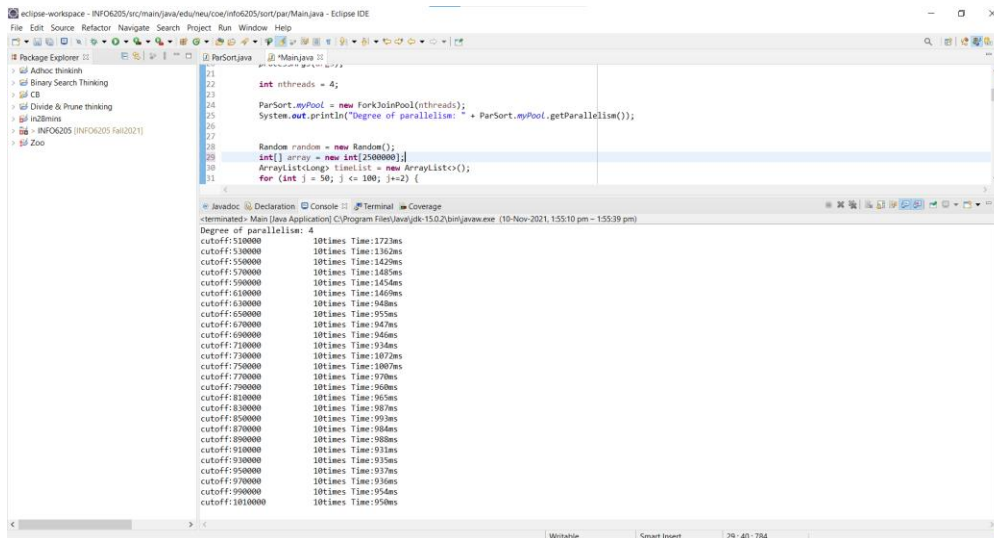
```
10 public static void main(String[] args) {
11     processArgs(args);
12
13     int nthreads = 4;
14
15     ParSort.myPool = new ForkJoinPool(nthreads);
16     System.out.println("Degree of parallelism: " + ParSort.myPool.getParallelism());
17
18     Random random = new Random();
19     int[] array = new int[2000000];
20     ArrayList<Long> timeList = new ArrayList<>();
21 }
```

Console Output:

```
<terminated> Main [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\java.exe (10-Nov-2021, 1:53:03 pm - 1:53:32 pm)
Degree of parallelism: 4
cutoff:510000 10Times Time:1341ms
cutoff:530000 10Times Time:1057ms
cutoff:550000 10Times Time:1034ms
cutoff:570000 10Times Time:1005ms
cutoff:590000 10Times Time:1080ms
cutoff:610000 10Times Time:1093ms
cutoff:630000 10Times Time:1067ms
cutoff:650000 10Times Time:1084ms
cutoff:670000 10Times Time:1074ms
cutoff:690000 10Times Time:1077ms
cutoff:710000 10Times Time:1085ms
cutoff:730000 10Times Time:1083ms
cutoff:750000 10Times Time:1096ms
cutoff:770000 10Times Time:1103ms
cutoff:790000 10Times Time:1086ms
cutoff:810000 10Times Time:1103ms
cutoff:830000 10Times Time:1025ms
cutoff:850000 10Times Time:1020ms
cutoff:870000 10Times Time:1040ms
cutoff:890000 10Times Time:1035ms
cutoff:910000 10Times Time:1112ms
cutoff:930000 10Times Time:1302ms
cutoff:950000 10Times Time:1107ms
cutoff:970000 10Times Time:1134ms
cutoff:990000 10Times Time:1099ms
cutoff:1010000 10Times Time:975ms
```


Array Size – 2500000

Degree of parallelism – 4

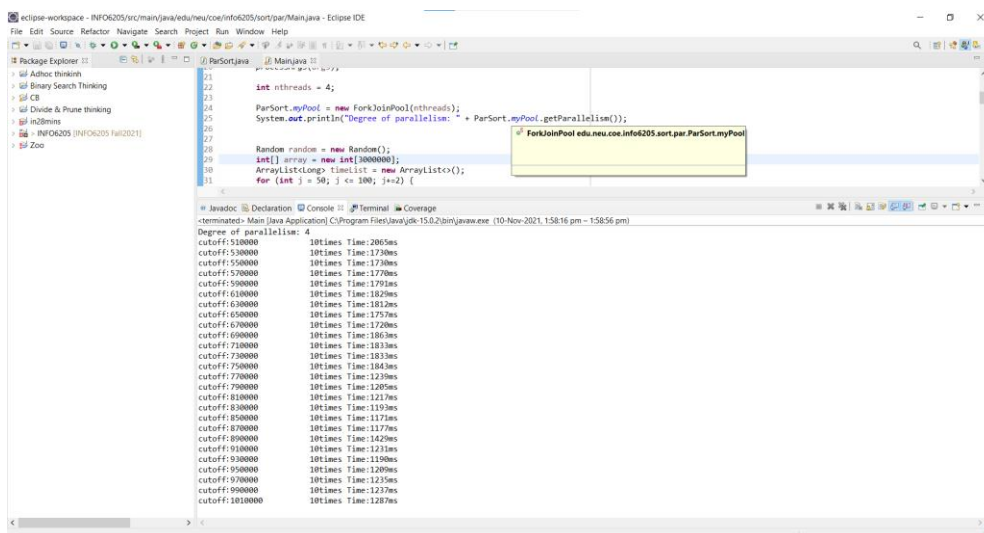


```
21
22
23     int nthreads = 4;
24     ParSort.myPool = new ForkJoinPool(nthreads);
25     System.out.println("Degree of parallelism: " + ParSort.myPool.getParallelism());
26
27
28     Random random = new Random();
29     int[] array = new int[2500000];
30     ArrayList<Long> timeList = new ArrayList<>();
31     for (int j = 50; j <= 100; j+=2) {
```

```
<terminated> Main [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\javaw.exe (10-Nov-2021, 1:55:10 pm - 1:55:39 pm)
Degree of parallelism: 4
cutoff:530000    10Times Time:1723ms
cutoff:550000    10Times Time:1362ms
cutoff:550000    10Times Time:1429ms
cutoff:570000    10Times Time:1485ms
cutoff:590000    10Times Time:1454ms
cutoff:610000    10Times Time:1469ms
cutoff:630000    10Times Time:1648ms
cutoff:650000    10Times Time:1955ms
cutoff:670000    10Times Time:1647ms
cutoff:690000    10Times Time:1648ms
cutoff:710000    10Times Time:1934ms
cutoff:730000    10Times Time:1072ms
cutoff:750000    10Times Time:1807ms
cutoff:770000    10Times Time:1970ms
cutoff:790000    10Times Time:1968ms
cutoff:810000    10Times Time:1965ms
cutoff:830000    10Times Time:1987ms
cutoff:850000    10Times Time:1993ms
cutoff:870000    10Times Time:1984ms
cutoff:890000    10Times Time:1988ms
cutoff:910000    10Times Time:1931ms
cutoff:930000    10Times Time:1935ms
cutoff:950000    10Times Time:1937ms
cutoff:970000    10Times Time:1936ms
cutoff:990000    10Times Time:1954ms
cutoff:1010000   10Times Time:1950ms
```

Array Size – 3000000

Degree of parallelism – 4

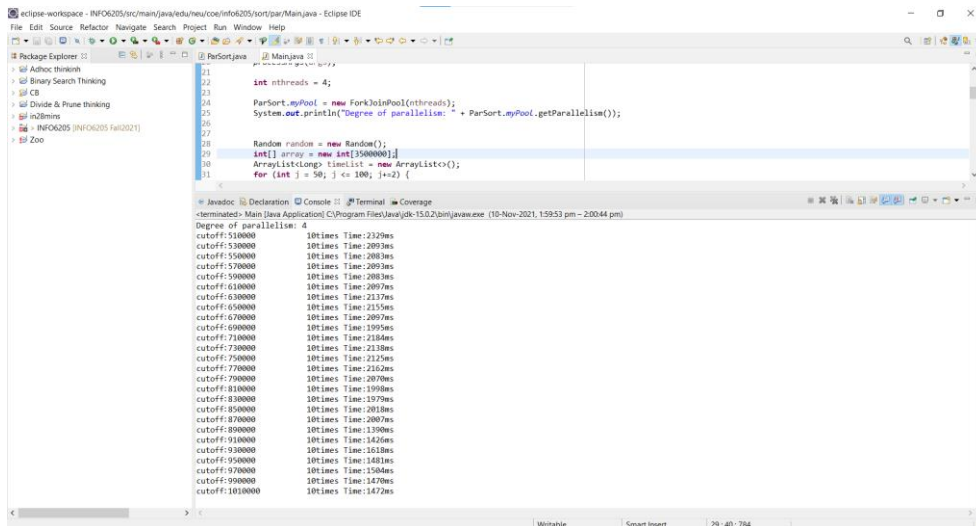


```
21
22
23     int nthreads = 4;
24     ParSort.myPool = new ForkJoinPool(nthreads);
25     System.out.println("Degree of parallelism: " + ParSort.myPool.getParallelism());
26
27
28     Random random = new Random();
29     int[] array = new int[3000000];
30     ArrayList<Long> timeList = new ArrayList<>();
31     for (int j = 50; j <= 100; j+=2) {
```

```
<terminated> Main [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\javaw.exe (10-Nov-2021, 1:58:16 pm - 1:58:56 pm)
Degree of parallelism: 4
cutoff:530000    10Times Time:2005ms
cutoff:550000    10Times Time:1730ms
cutoff:550000    10Times Time:1730ms
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cutoff:930000    10Times Time:1150ms
cutoff:950000    10Times Time:1200ms
cutoff:970000    10Times Time:1235ms
cutoff:990000    10Times Time:1237ms
cutoff:1010000   10Times Time:1287ms
```

Array Size – 3500000

Degree of parallelism – 4



The screenshot shows the Eclipse IDE with a Java project. The Package Explorer on the left shows a package named 'INFO6205' containing a file 'Main.java'. The editor displays the source code of 'Main.java', which is a parallel sorting program. The code defines a 'ParSort' class with a 'myPool' attribute and a 'main' method. The 'main' method sets the number of threads to 4, creates a 'ParSort' object, and prints the degree of parallelism. It then generates a random array of 3,500,000 integers and sorts it using a parallel merge sort algorithm. The 'main' method also prints the start and end times of the sorting process.

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