

Program Structure and Algorithms (INFO-6205 SEC01)

Assignment – 4

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TASK

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

1. A cutoff (defaults to, say, 1000) which you will update according to the first argument in the command line when running. It's your job to experiment and come up with a good value for this cutoff. If there are fewer elements to sort than the cutoff, then you should use the system sort instead.
2. Recursion depth or the number of available threads. Using this determination, you might decide on an ideal number (t) of separate threads (stick to powers of 2) and arrange for that number of partitions to be parallelized (by preventing recursion after the depth of $\lg t$ is reached).
3. An appropriate combination of these.

CONCLUSION

From the observations we can conclude that 4 threads are a good choice and using thread beyond them would not do much improvement in the performance.

We can conclude the following:

$$t = 2^d$$

where,

$$\begin{aligned} t &= \text{threads,} \\ d &= \text{recursion depth} \end{aligned}$$

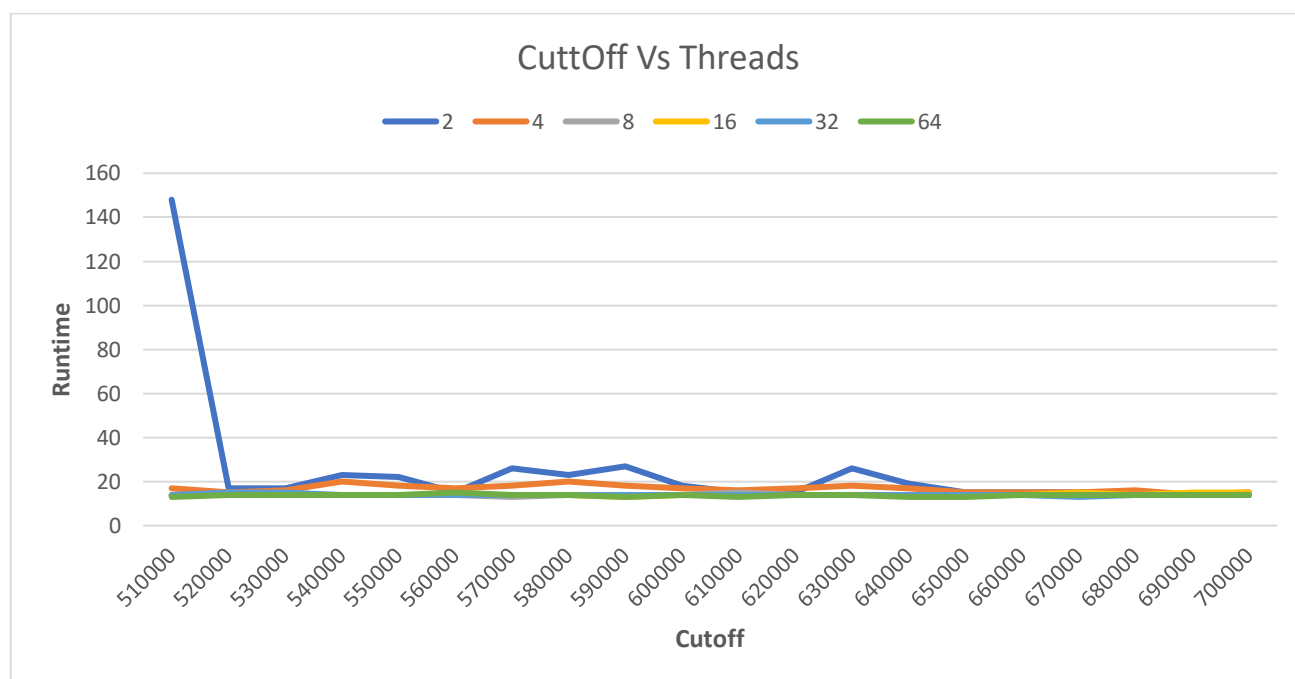
So, Maximum depth possible would be:

$$\lg (\text{ArraySize}/\text{cutoff})$$

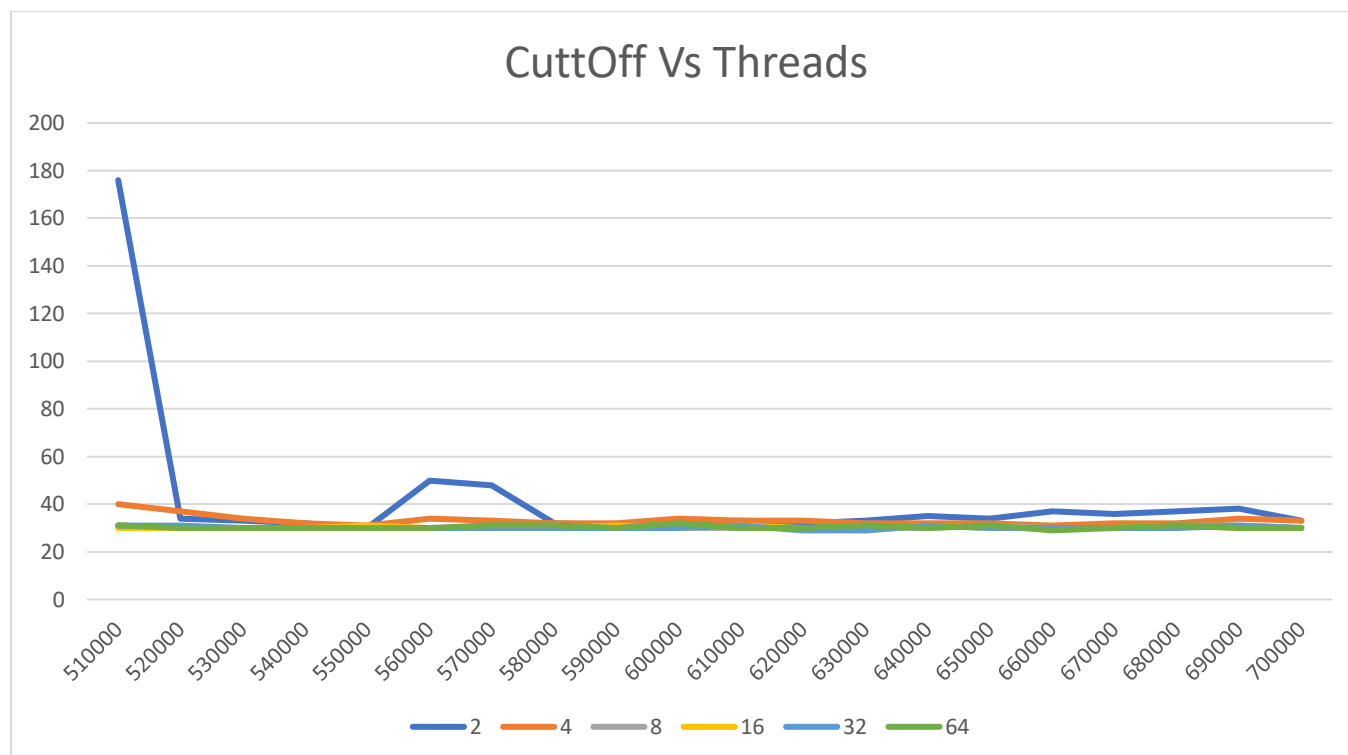
The depth will not be more than the maximum depth as partitioned array reaches the cutoff.

EVIDENCE

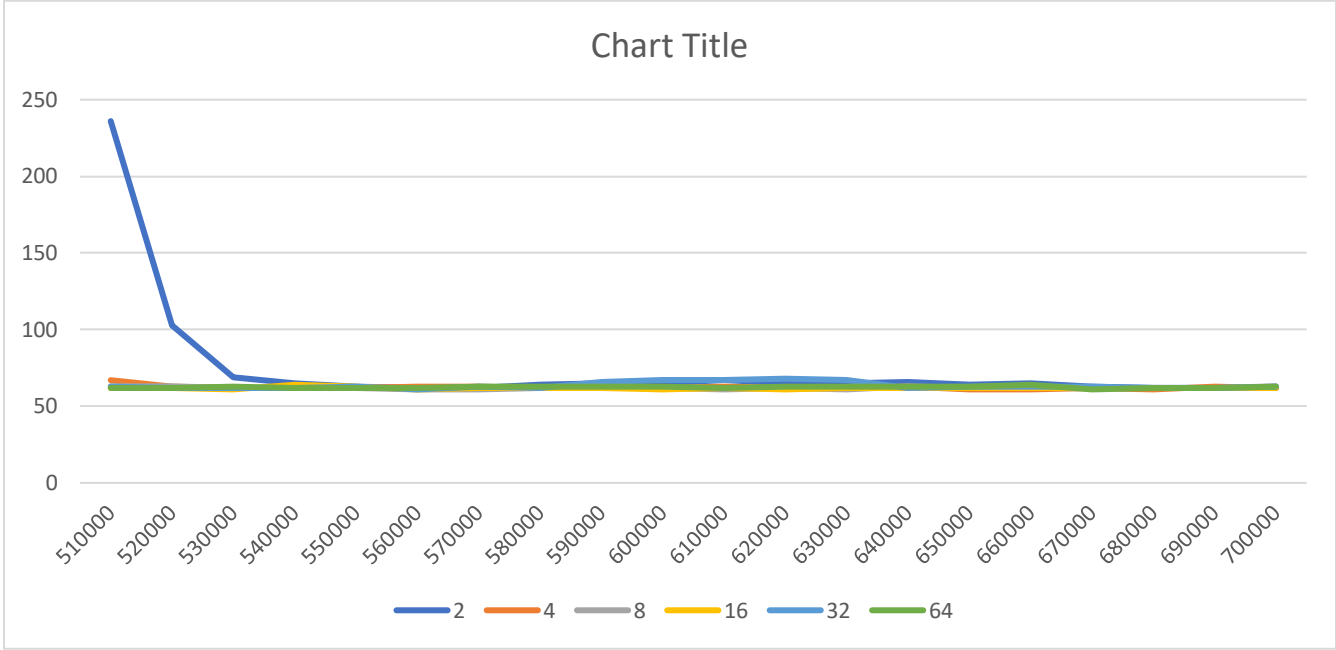
Array Size =	30000		Threads			
Cutoff	2	4	8	16	32	64
510000	148	17	14	14	14	13
520000	17	15	14	14	15	14
530000	17	16	14	14	15	14
540000	23	20	14	14	14	14
550000	22	18	14	14	14	14
560000	15	17	14	14	14	15
570000	26	18	13	14	14	14
580000	23	20	14	14	14	14
590000	27	18	14	13	14	13
600000	18	17	14	14	14	14
610000	15	16	15	14	14	13
620000	15	17	14	14	14	14
630000	26	18	14	14	14	14
640000	19	17	14	14	14	13
650000	15	15	14	14	14	13
660000	15	15	14	14	14	14
670000	15	15	14	15	13	14
680000	14	16	14	14	14	14
690000	14	14	14	15	14	14
700000	14	15	14	15	14	14



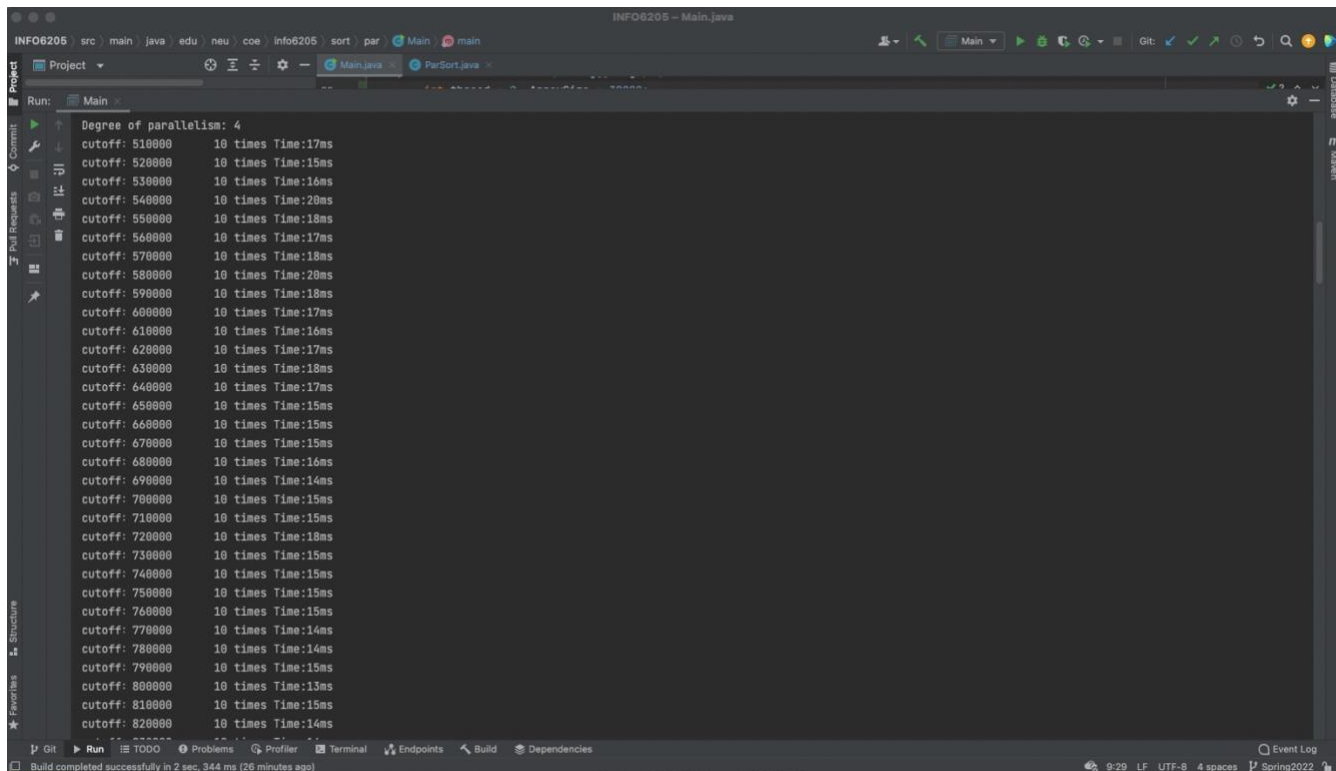
Array Size =	60000		Threads			
Cutoff	2	4	8	16	32	64
510000	176	40	31	30	31	31
520000	34	37	30	30	31	30
530000	33	34	30	30	30	30
540000	32	32	30	30	30	30
550000	30	31	30	31	30	30
560000	50	34	30	30	30	30
570000	48	33	30	30	30	31
580000	32	32	30	30	30	31
590000	31	32	30	31	30	30
600000	31	34	30	30	30	32
610000	33	33	30	31	31	30
620000	32	33	30	30	29	30
630000	33	32	30	29	29	31
640000	35	32	30	31	31	30
650000	34	32	31	30	30	31
660000	37	31	30	30	30	29
670000	36	32	30	30	30	30
680000	37	32	31	31	30	31
690000	38	34	31	30	31	30
700000	33	33	30	30	30	30



Array Size =	120000		Threads			
Cutoff	2	4	8	16	32	64
510000	236	67	63	62	63	62
520000	103	63	63	62	62	62
530000	69	62	62	61	62	63
540000	65	62	62	64	62	62
550000	63	62	62	63	63	62
560000	62	63	61	61	61	62
570000	62	63	61	62	63	63
580000	64	62	62	62	62	63
590000	65	62	63	62	66	63
600000	65	62	62	61	67	63
610000	67	63	61	62	67	62
620000	65	62	62	61	68	63
630000	65	62	61	62	67	63
640000	66	63	63	62	62	63
650000	64	61	62	62	63	63
660000	65	61	62	62	63	64
670000	63	62	62	62	63	61
680000	62	61	62	62	62	62
690000	62	63	62	62	62	62
700000	62	62	63	62	63	63



Array Size = 30000



INFO6205 - Main.java

src | main | java | edu | neu | coe | info6205 | sort | par | Main | main

Run: Main

```
Degree of parallelism: 32
cutoff: 510000 10 times Time:14ms
cutoff: 520000 10 times Time:15ms
cutoff: 530000 10 times Time:15ms
cutoff: 540000 10 times Time:14ms
cutoff: 550000 10 times Time:14ms
cutoff: 560000 10 times Time:14ms
cutoff: 570000 10 times Time:14ms
cutoff: 580000 10 times Time:14ms
cutoff: 590000 10 times Time:14ms
cutoff: 600000 10 times Time:14ms
cutoff: 610000 10 times Time:14ms
cutoff: 620000 10 times Time:14ms
cutoff: 630000 10 times Time:14ms
cutoff: 640000 10 times Time:14ms
cutoff: 650000 10 times Time:14ms
cutoff: 660000 10 times Time:14ms
cutoff: 670000 10 times Time:13ms
cutoff: 680000 10 times Time:14ms
cutoff: 690000 10 times Time:14ms
cutoff: 700000 10 times Time:14ms
cutoff: 710000 10 times Time:14ms
cutoff: 720000 10 times Time:13ms
cutoff: 730000 10 times Time:14ms
cutoff: 740000 10 times Time:14ms
cutoff: 750000 10 times Time:14ms
cutoff: 760000 10 times Time:13ms
cutoff: 770000 10 times Time:14ms
cutoff: 780000 10 times Time:14ms
cutoff: 790000 10 times Time:14ms
cutoff: 800000 10 times Time:14ms
cutoff: 810000 10 times Time:14ms
cutoff: 820000 10 times Time:15ms
cutoff: 830000 10 times Time:14ms
```

Build completed successfully in 2 sec, 344 ms (27 minutes ago)

223:39 LF UTF-8 4 spaces Spring2022

INFO6205 - Main.java

src | main | java | edu | neu | coe | info6205 | sort | par | Main | main

Run: Main

```
Degree of parallelism: 64
cutoff: 510000 10 times Time:13ms
cutoff: 520000 10 times Time:14ms
cutoff: 530000 10 times Time:14ms
cutoff: 540000 10 times Time:14ms
cutoff: 550000 10 times Time:14ms
cutoff: 560000 10 times Time:15ms
cutoff: 570000 10 times Time:14ms
cutoff: 580000 10 times Time:14ms
cutoff: 590000 10 times Time:13ms
cutoff: 600000 10 times Time:14ms
cutoff: 610000 10 times Time:13ms
cutoff: 620000 10 times Time:14ms
cutoff: 630000 10 times Time:14ms
cutoff: 640000 10 times Time:13ms
cutoff: 650000 10 times Time:13ms
cutoff: 660000 10 times Time:14ms
cutoff: 670000 10 times Time:14ms
cutoff: 680000 10 times Time:14ms
cutoff: 690000 10 times Time:14ms
cutoff: 700000 10 times Time:14ms
cutoff: 710000 10 times Time:14ms
cutoff: 720000 10 times Time:14ms
cutoff: 730000 10 times Time:14ms
cutoff: 740000 10 times Time:14ms
cutoff: 750000 10 times Time:14ms
cutoff: 760000 10 times Time:13ms
cutoff: 770000 10 times Time:14ms
cutoff: 780000 10 times Time:14ms
cutoff: 790000 10 times Time:14ms
cutoff: 800000 10 times Time:14ms
cutoff: 810000 10 times Time:14ms
cutoff: 820000 10 times Time:14ms
```

Build completed successfully in 2 sec, 344 ms (27 minutes ago)

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ArraySize=60000

The screenshot shows an IDE window titled "INFO6205 - Main.java". The "Run" tab is active, displaying the output of a Java program. The output starts with "Array Size is: 60000" and "Degree of parallelism: 2". It then lists 20 iterations of a cutoff value and a time measurement, each preceded by "10 times". The cutoff values range from 510000 to 810000 in increments of 10000. The time measurements range from 176ms to 31ms. The status bar at the bottom indicates "Build completed successfully in 2 sec, 593 ms (4 minutes ago)".

```
INFO6205 src \ main \ java \ edu \ neu \ coe \ info6205 \ sort \ par \ Main \ main
Run: Main
/Library/Java/JavaVirtualMachines/jdk-17.0.1.jdk/contents/Home/bin/java ...
Array Size is: 60000
Degree of parallelism: 2
cutoff: 510000 10 times Time:176ms
cutoff: 520000 10 times Time:34ms
cutoff: 530000 10 times Time:33ms
cutoff: 540000 10 times Time:32ms
cutoff: 550000 10 times Time:30ms
cutoff: 560000 10 times Time:50ms
cutoff: 570000 10 times Time:48ms
cutoff: 580000 10 times Time:32ms
cutoff: 590000 10 times Time:31ms
cutoff: 600000 10 times Time:31ms
cutoff: 610000 10 times Time:33ms
cutoff: 620000 10 times Time:32ms
cutoff: 630000 10 times Time:33ms
cutoff: 640000 10 times Time:35ms
cutoff: 650000 10 times Time:34ms
cutoff: 660000 10 times Time:37ms
cutoff: 670000 10 times Time:36ms
cutoff: 680000 10 times Time:37ms
cutoff: 690000 10 times Time:38ms
cutoff: 700000 10 times Time:33ms
cutoff: 710000 10 times Time:34ms
cutoff: 720000 10 times Time:34ms
cutoff: 730000 10 times Time:37ms
cutoff: 740000 10 times Time:39ms
cutoff: 750000 10 times Time:38ms
cutoff: 760000 10 times Time:38ms
cutoff: 770000 10 times Time:36ms
cutoff: 780000 10 times Time:37ms
cutoff: 790000 10 times Time:32ms
cutoff: 800000 10 times Time:31ms
cutoff: 810000 10 times Time:36ms
Build completed successfully in 2 sec, 593 ms (4 minutes ago)
```

The screenshot shows the same IDE window as above, but with the "Degree of parallelism" set to 4. The output now lists 20 iterations of a cutoff value and a time measurement, each preceded by "10 times". The cutoff values range from 510000 to 820000 in increments of 10000. The time measurements range from 28ms to 48ms. The status bar at the bottom indicates "Build completed successfully in 2 sec, 593 ms (4 minutes ago)".

```
INFO6205 src \ main \ java \ edu \ neu \ coe \ info6205 \ sort \ par \ Main \ main
Run: Main
Degree of parallelism: 4
cutoff: 510000 10 times Time:48ms
cutoff: 520000 10 times Time:37ms
cutoff: 530000 10 times Time:34ms
cutoff: 540000 10 times Time:32ms
cutoff: 550000 10 times Time:31ms
cutoff: 560000 10 times Time:34ms
cutoff: 570000 10 times Time:33ms
cutoff: 580000 10 times Time:32ms
cutoff: 590000 10 times Time:32ms
cutoff: 600000 10 times Time:34ms
cutoff: 610000 10 times Time:33ms
cutoff: 620000 10 times Time:33ms
cutoff: 630000 10 times Time:32ms
cutoff: 640000 10 times Time:32ms
cutoff: 650000 10 times Time:32ms
cutoff: 660000 10 times Time:31ms
cutoff: 670000 10 times Time:32ms
cutoff: 680000 10 times Time:32ms
cutoff: 690000 10 times Time:34ms
cutoff: 700000 10 times Time:33ms
cutoff: 710000 10 times Time:32ms
cutoff: 720000 10 times Time:31ms
cutoff: 730000 10 times Time:30ms
cutoff: 740000 10 times Time:30ms
cutoff: 750000 10 times Time:32ms
cutoff: 760000 10 times Time:32ms
cutoff: 770000 10 times Time:31ms
cutoff: 780000 10 times Time:31ms
cutoff: 790000 10 times Time:32ms
cutoff: 800000 10 times Time:30ms
cutoff: 810000 10 times Time:30ms
cutoff: 820000 10 times Time:30ms
cutoff: 830000 10 times Time:30ms
Build completed successfully in 2 sec, 593 ms (4 minutes ago)
```


The screenshot shows an IDE window titled "INFO6205 - Main.java". The "Run" console displays the following output:

```
INFO6205 src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Run: Main
Degree of parallelism: 8
cutoff: 510000 10 times Time:31ms
cutoff: 520000 10 times Time:30ms
cutoff: 530000 10 times Time:30ms
cutoff: 540000 10 times Time:30ms
cutoff: 550000 10 times Time:30ms
cutoff: 560000 10 times Time:30ms
cutoff: 570000 10 times Time:30ms
cutoff: 580000 10 times Time:30ms
cutoff: 590000 10 times Time:30ms
cutoff: 600000 10 times Time:30ms
cutoff: 610000 10 times Time:30ms
cutoff: 620000 10 times Time:30ms
cutoff: 630000 10 times Time:30ms
cutoff: 640000 10 times Time:30ms
cutoff: 650000 10 times Time:31ms
cutoff: 660000 10 times Time:30ms
cutoff: 670000 10 times Time:30ms
cutoff: 680000 10 times Time:31ms
cutoff: 690000 10 times Time:31ms
cutoff: 700000 10 times Time:30ms
cutoff: 710000 10 times Time:31ms
cutoff: 720000 10 times Time:31ms
cutoff: 730000 10 times Time:30ms
cutoff: 740000 10 times Time:30ms
cutoff: 750000 10 times Time:30ms
cutoff: 760000 10 times Time:30ms
cutoff: 770000 10 times Time:30ms
cutoff: 780000 10 times Time:31ms
cutoff: 790000 10 times Time:31ms
cutoff: 800000 10 times Time:31ms
cutoff: 810000 10 times Time:31ms
cutoff: 820000 10 times Time:30ms
cutoff: 830000 10 times Time:31ms
```

The status bar at the bottom indicates: "Build completed successfully in 2 sec, 593 ms (5 minutes ago)". The system clock shows 11:39, and the IDE is running on a Mac with UTF-8 encoding and 4 spaces.

The screenshot shows the same IDE window with the "Run" console displaying the following output:

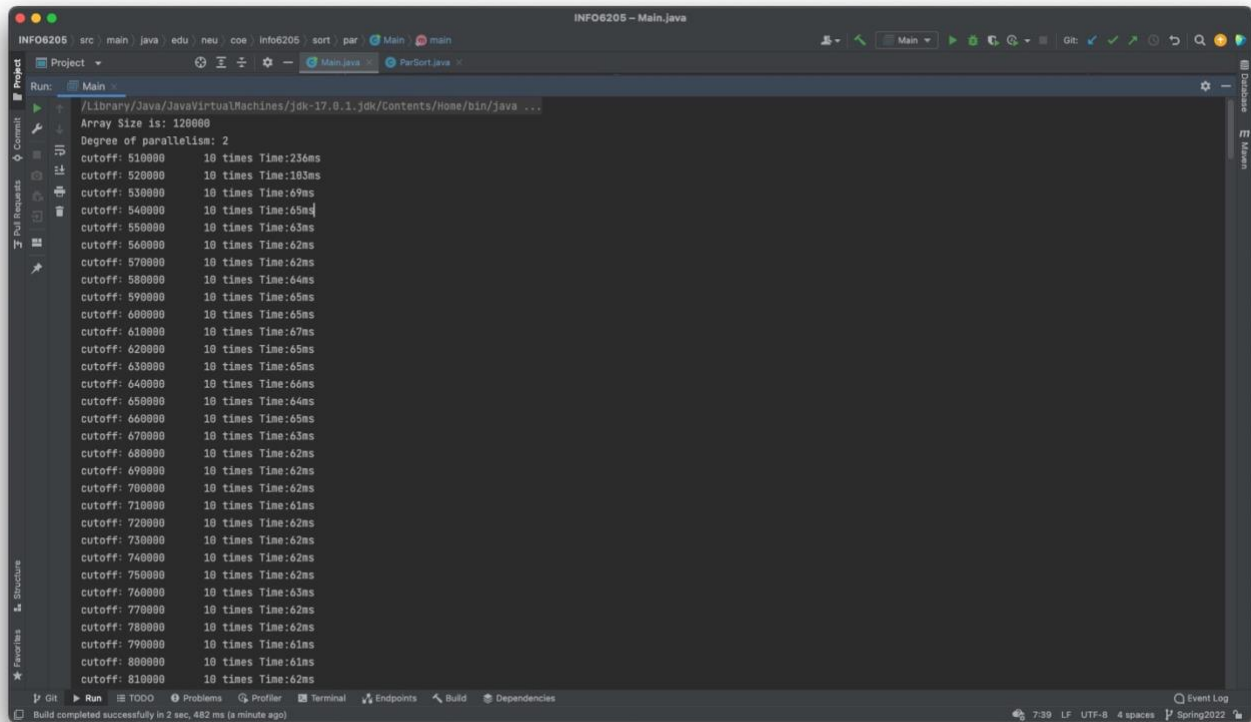
```
INFO6205 src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Run: Main
Degree of parallelism: 16
cutoff: 510000 10 times Time:30ms
cutoff: 520000 10 times Time:30ms
cutoff: 530000 10 times Time:30ms
cutoff: 540000 10 times Time:30ms
cutoff: 550000 10 times Time:31ms
cutoff: 560000 10 times Time:30ms
cutoff: 570000 10 times Time:30ms
cutoff: 580000 10 times Time:30ms
cutoff: 590000 10 times Time:31ms
cutoff: 600000 10 times Time:30ms
cutoff: 610000 10 times Time:31ms
cutoff: 620000 10 times Time:30ms
cutoff: 630000 10 times Time:30ms
cutoff: 640000 10 times Time:29ms
cutoff: 650000 10 times Time:31ms
cutoff: 660000 10 times Time:30ms
cutoff: 670000 10 times Time:30ms
cutoff: 680000 10 times Time:31ms
cutoff: 690000 10 times Time:30ms
cutoff: 700000 10 times Time:30ms
cutoff: 710000 10 times Time:31ms
cutoff: 720000 10 times Time:30ms
cutoff: 730000 10 times Time:30ms
cutoff: 740000 10 times Time:30ms
cutoff: 750000 10 times Time:30ms
cutoff: 760000 10 times Time:30ms
cutoff: 770000 10 times Time:30ms
cutoff: 780000 10 times Time:31ms
cutoff: 790000 10 times Time:31ms
cutoff: 800000 10 times Time:31ms
cutoff: 810000 10 times Time:30ms
cutoff: 820000 10 times Time:30ms
cutoff: 830000 10 times Time:30ms
```

The status bar at the bottom indicates: "Build completed successfully in 2 sec, 593 ms (5 minutes ago)". The system clock shows 11:39, and the IDE is running on a Mac with UTF-8 encoding and 4 spaces.

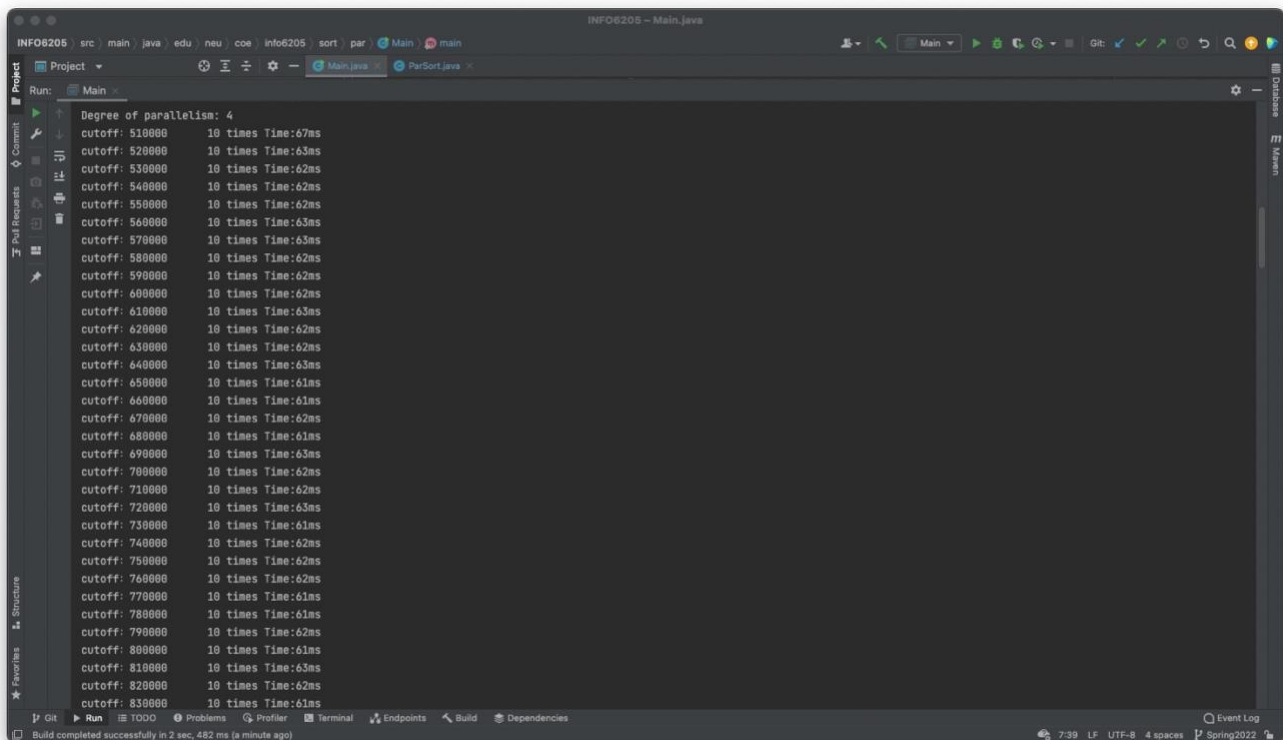
```
INFO6205 - Main.java
src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Project
Run: Main
Degree of parallelism: 32
cutoff: 510000 10 times Time:31ms
cutoff: 520000 10 times Time:31ms
cutoff: 530000 10 times Time:30ms
cutoff: 540000 10 times Time:30ms
cutoff: 550000 10 times Time:30ms
cutoff: 560000 10 times Time:30ms
cutoff: 570000 10 times Time:30ms
cutoff: 580000 10 times Time:30ms
cutoff: 590000 10 times Time:30ms
cutoff: 600000 10 times Time:30ms
cutoff: 610000 10 times Time:31ms
cutoff: 620000 10 times Time:29ms
cutoff: 630000 10 times Time:29ms
cutoff: 640000 10 times Time:31ms
cutoff: 650000 10 times Time:30ms
cutoff: 660000 10 times Time:30ms
cutoff: 670000 10 times Time:30ms
cutoff: 680000 10 times Time:30ms
cutoff: 690000 10 times Time:31ms
cutoff: 700000 10 times Time:30ms
cutoff: 710000 10 times Time:30ms
cutoff: 720000 10 times Time:31ms
cutoff: 730000 10 times Time:30ms
cutoff: 740000 10 times Time:30ms
cutoff: 750000 10 times Time:30ms
cutoff: 760000 10 times Time:30ms
cutoff: 770000 10 times Time:31ms
cutoff: 780000 10 times Time:31ms
cutoff: 790000 10 times Time:31ms
cutoff: 800000 10 times Time:31ms
cutoff: 810000 10 times Time:30ms
cutoff: 820000 10 times Time:30ms
cutoff: 830000 10 times Time:31ms
Build completed successfully in 2 sec, 593 ms (5 minutes ago)
225:39 LF UTF-8 4 spaces Spring2022
```

```
INFO6205 - Main.java
src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Project
Run: Main
Degree of parallelism: 64
cutoff: 510000 10 times Time:31ms
cutoff: 520000 10 times Time:30ms
cutoff: 530000 10 times Time:30ms
cutoff: 540000 10 times Time:30ms
cutoff: 550000 10 times Time:30ms
cutoff: 560000 10 times Time:30ms
cutoff: 570000 10 times Time:31ms
cutoff: 580000 10 times Time:31ms
cutoff: 590000 10 times Time:30ms
cutoff: 600000 10 times Time:32ms
cutoff: 610000 10 times Time:30ms
cutoff: 620000 10 times Time:30ms
cutoff: 630000 10 times Time:31ms
cutoff: 640000 10 times Time:30ms
cutoff: 650000 10 times Time:31ms
cutoff: 660000 10 times Time:29ms
cutoff: 670000 10 times Time:30ms
cutoff: 680000 10 times Time:31ms
cutoff: 690000 10 times Time:30ms
cutoff: 700000 10 times Time:30ms
cutoff: 710000 10 times Time:31ms
cutoff: 720000 10 times Time:29ms
cutoff: 730000 10 times Time:29ms
cutoff: 740000 10 times Time:30ms
cutoff: 750000 10 times Time:31ms
cutoff: 760000 10 times Time:30ms
cutoff: 770000 10 times Time:31ms
cutoff: 780000 10 times Time:30ms
cutoff: 790000 10 times Time:30ms
cutoff: 800000 10 times Time:30ms
cutoff: 810000 10 times Time:37ms
cutoff: 820000 10 times Time:30ms
cutoff: 830000 10 times Time:31ms
Build completed successfully in 2 sec, 593 ms (5 minutes ago)
274:39 LF UTF-8 4 spaces Spring2022
```

Array Size=120000



```
INFO6205 - Main.java
src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Run: Main
/Library/Java/JavaVirtualMachines/jdk-17.0.1.jdk/Contents/Home/bin/java ...
Array Size is: 120000
Degree of parallelism: 2
cutoff: 510000 10 times Time:236ms
cutoff: 520000 10 times Time:183ms
cutoff: 530000 10 times Time:69ms
cutoff: 540000 10 times Time:65ms
cutoff: 550000 10 times Time:63ms
cutoff: 560000 10 times Time:62ms
cutoff: 570000 10 times Time:62ms
cutoff: 580000 10 times Time:64ms
cutoff: 590000 10 times Time:65ms
cutoff: 600000 10 times Time:65ms
cutoff: 610000 10 times Time:67ms
cutoff: 620000 10 times Time:65ms
cutoff: 630000 10 times Time:65ms
cutoff: 640000 10 times Time:66ms
cutoff: 650000 10 times Time:64ms
cutoff: 660000 10 times Time:65ms
cutoff: 670000 10 times Time:65ms
cutoff: 680000 10 times Time:62ms
cutoff: 690000 10 times Time:62ms
cutoff: 700000 10 times Time:62ms
cutoff: 710000 10 times Time:61ms
cutoff: 720000 10 times Time:62ms
cutoff: 730000 10 times Time:62ms
cutoff: 740000 10 times Time:62ms
cutoff: 750000 10 times Time:62ms
cutoff: 760000 10 times Time:63ms
cutoff: 770000 10 times Time:62ms
cutoff: 780000 10 times Time:62ms
cutoff: 790000 10 times Time:61ms
cutoff: 800000 10 times Time:61ms
cutoff: 810000 10 times Time:62ms
```



```
INFO6205 - Main.java
src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Run: Main
Degree of parallelism: 4
cutoff: 510000 10 times Time:67ms
cutoff: 520000 10 times Time:63ms
cutoff: 530000 10 times Time:62ms
cutoff: 540000 10 times Time:62ms
cutoff: 550000 10 times Time:62ms
cutoff: 560000 10 times Time:63ms
cutoff: 570000 10 times Time:63ms
cutoff: 580000 10 times Time:62ms
cutoff: 590000 10 times Time:62ms
cutoff: 600000 10 times Time:62ms
cutoff: 610000 10 times Time:63ms
cutoff: 620000 10 times Time:62ms
cutoff: 630000 10 times Time:62ms
cutoff: 640000 10 times Time:63ms
cutoff: 650000 10 times Time:61ms
cutoff: 660000 10 times Time:61ms
cutoff: 670000 10 times Time:62ms
cutoff: 680000 10 times Time:61ms
cutoff: 690000 10 times Time:63ms
cutoff: 700000 10 times Time:62ms
cutoff: 710000 10 times Time:62ms
cutoff: 720000 10 times Time:63ms
cutoff: 730000 10 times Time:61ms
cutoff: 740000 10 times Time:62ms
cutoff: 750000 10 times Time:62ms
cutoff: 760000 10 times Time:62ms
cutoff: 770000 10 times Time:61ms
cutoff: 780000 10 times Time:61ms
cutoff: 790000 10 times Time:62ms
cutoff: 800000 10 times Time:61ms
cutoff: 810000 10 times Time:63ms
cutoff: 820000 10 times Time:62ms
cutoff: 830000 10 times Time:61ms
```

```
INFO6205 - Main.java
src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Run: Main
Degree of parallelism: 8
cutoff: 510000 10 times Time:63ms
cutoff: 520000 10 times Time:63ms
cutoff: 530000 10 times Time:62ms
cutoff: 540000 10 times Time:62ms
cutoff: 550000 10 times Time:62ms
cutoff: 560000 10 times Time:61ms
cutoff: 570000 10 times Time:61ms
cutoff: 580000 10 times Time:62ms
cutoff: 590000 10 times Time:63ms
cutoff: 600000 10 times Time:62ms
cutoff: 610000 10 times Time:61ms
cutoff: 620000 10 times Time:62ms
cutoff: 630000 10 times Time:61ms
cutoff: 640000 10 times Time:63ms
cutoff: 650000 10 times Time:62ms
cutoff: 660000 10 times Time:62ms
cutoff: 670000 10 times Time:62ms
cutoff: 680000 10 times Time:62ms
cutoff: 690000 10 times Time:62ms
cutoff: 700000 10 times Time:63ms
cutoff: 710000 10 times Time:62ms
cutoff: 720000 10 times Time:62ms
cutoff: 730000 10 times Time:62ms
cutoff: 740000 10 times Time:62ms
cutoff: 750000 10 times Time:62ms
cutoff: 760000 10 times Time:62ms
cutoff: 770000 10 times Time:62ms
cutoff: 780000 10 times Time:62ms
cutoff: 790000 10 times Time:62ms
cutoff: 800000 10 times Time:62ms
cutoff: 810000 10 times Time:63ms
cutoff: 820000 10 times Time:62ms
cutoff: 830000 10 times Time:62ms
Build completed successfully in 2 sec, 482 ms (a minute ago)
```

```
INFO6205 - Main.java
src | main | java | edu | neu | coe | info6205 | sort | par | Main | main
Run: Main
Degree of parallelism: 16
cutoff: 510000 10 times Time:62ms
cutoff: 520000 10 times Time:62ms
cutoff: 530000 10 times Time:61ms
cutoff: 540000 10 times Time:64ms
cutoff: 550000 10 times Time:63ms
cutoff: 560000 10 times Time:61ms
cutoff: 570000 10 times Time:62ms
cutoff: 580000 10 times Time:62ms
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cutoff: 670000 10 times Time:62ms
cutoff: 680000 10 times Time:62ms
cutoff: 690000 10 times Time:62ms
cutoff: 700000 10 times Time:62ms
cutoff: 710000 10 times Time:63ms
cutoff: 720000 10 times Time:64ms
cutoff: 730000 10 times Time:62ms
cutoff: 740000 10 times Time:62ms
cutoff: 750000 10 times Time:68ms
cutoff: 760000 10 times Time:62ms
cutoff: 770000 10 times Time:63ms
cutoff: 780000 10 times Time:61ms
cutoff: 790000 10 times Time:62ms
cutoff: 800000 10 times Time:62ms
cutoff: 810000 10 times Time:62ms
cutoff: 820000 10 times Time:62ms
cutoff: 830000 10 times Time:62ms
Build completed successfully in 2 sec, 482 ms (a minute ago)
```

INFO6205 - Main.java

src | main | java | edu | neu | coe | info6205 | sort | par | Main | main

Run: Main

```
Degree of parallelism: 32
cutoff: 510000 10 times Time:65ms
cutoff: 520000 10 times Time:62ms
cutoff: 530000 10 times Time:62ms
cutoff: 540000 10 times Time:62ms
cutoff: 550000 10 times Time:65ms
cutoff: 560000 10 times Time:61ms
cutoff: 570000 10 times Time:65ms
cutoff: 580000 10 times Time:62ms
cutoff: 590000 10 times Time:66ms
cutoff: 600000 10 times Time:67ms
cutoff: 610000 10 times Time:67ms
cutoff: 620000 10 times Time:68ms
cutoff: 630000 10 times Time:67ms
cutoff: 640000 10 times Time:62ms
cutoff: 650000 10 times Time:65ms
cutoff: 660000 10 times Time:65ms
cutoff: 670000 10 times Time:65ms
cutoff: 680000 10 times Time:62ms
cutoff: 690000 10 times Time:62ms
cutoff: 700000 10 times Time:65ms
cutoff: 710000 10 times Time:65ms
cutoff: 720000 10 times Time:65ms
cutoff: 730000 10 times Time:62ms
cutoff: 740000 10 times Time:65ms
cutoff: 750000 10 times Time:62ms
cutoff: 760000 10 times Time:65ms
cutoff: 770000 10 times Time:65ms
cutoff: 780000 10 times Time:62ms
cutoff: 790000 10 times Time:65ms
cutoff: 800000 10 times Time:67ms
cutoff: 810000 10 times Time:65ms
cutoff: 820000 10 times Time:65ms
cutoff: 830000 10 times Time:62ms
```

Build completed successfully in 2 sec, 482 ms (a minute ago)

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INFO6205 - Main.java

src | main | java | edu | neu | coe | info6205 | sort | par | Main | main

Run: Main

```
Degree of parallelism: 64
cutoff: 510000 10 times Time:62ms
cutoff: 520000 10 times Time:62ms
cutoff: 530000 10 times Time:65ms
cutoff: 540000 10 times Time:62ms
cutoff: 550000 10 times Time:62ms
cutoff: 560000 10 times Time:62ms
cutoff: 570000 10 times Time:65ms
cutoff: 580000 10 times Time:65ms
cutoff: 590000 10 times Time:65ms
cutoff: 600000 10 times Time:65ms
cutoff: 610000 10 times Time:62ms
cutoff: 620000 10 times Time:65ms
cutoff: 630000 10 times Time:65ms
cutoff: 640000 10 times Time:65ms
cutoff: 650000 10 times Time:65ms
cutoff: 660000 10 times Time:64ms
cutoff: 670000 10 times Time:61ms
cutoff: 680000 10 times Time:62ms
cutoff: 690000 10 times Time:62ms
cutoff: 700000 10 times Time:65ms
cutoff: 710000 10 times Time:62ms
cutoff: 720000 10 times Time:65ms
cutoff: 730000 10 times Time:65ms
cutoff: 740000 10 times Time:62ms
cutoff: 750000 10 times Time:62ms
cutoff: 760000 10 times Time:64ms
cutoff: 770000 10 times Time:65ms
cutoff: 780000 10 times Time:62ms
cutoff: 790000 10 times Time:65ms
cutoff: 800000 10 times Time:64ms
cutoff: 810000 10 times Time:62ms
cutoff: 820000 10 times Time:65ms
cutoff: 830000 10 times Time:62ms
```

Build completed successfully in 2 sec, 482 ms (a minute ago)

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