

## Program Structure & Algorithms

Fall 2024

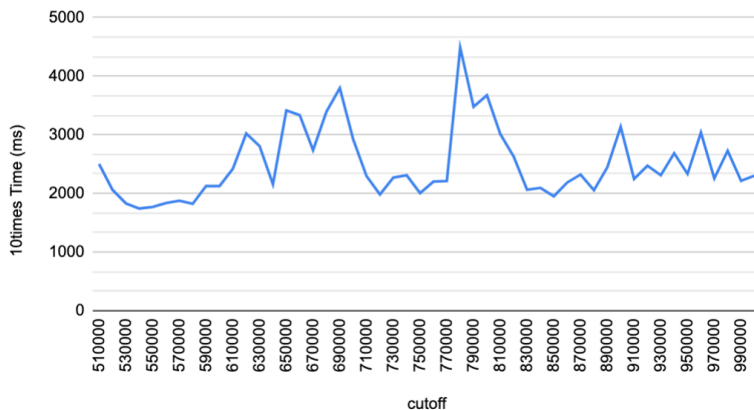
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By running the given code, I got the following result:

```
(base) MacBook-Air-2:INF06205 xinyixu$ /usr/bin/env /Library/Java/JavaVirtualMachines/
ar/folders/vh/9vtmz8vx6mx9ytdmxfbw17h0000gn/T/cp_3vb8eygk129k26o59yraswwwz.argfile edu
Degree of parallelism: 3
cutoff: 510000      10times Time:2502ms
cutoff: 520000      10times Time:2062ms
cutoff: 530000      10times Time:1831ms
cutoff: 540000      10times Time:1743ms
cutoff: 550000      10times Time:1770ms
cutoff: 560000      10times Time:1835ms
cutoff: 570000      10times Time:1877ms
cutoff: 580000      10times Time:1822ms
cutoff: 590000      10times Time:2127ms
cutoff: 600000      10times Time:2125ms
cutoff: 610000      10times Time:2420ms
cutoff: 620000      10times Time:3022ms
cutoff: 630000      10times Time:2808ms
cutoff: 640000      10times Time:2155ms
cutoff: 650000      10times Time:3416ms
cutoff: 660000      10times Time:3336ms
cutoff: 670000      10times Time:2738ms
cutoff: 680000      10times Time:3395ms
cutoff: 690000      10times Time:3798ms
cutoff: 700000      10times Time:2922ms
cutoff: 710000      10times Time:2294ms
cutoff: 720000      10times Time:1982ms
cutoff: 730000      10times Time:2269ms
cutoff: 740000      10times Time:2309ms
cutoff: 750000      10times Time:2004ms
cutoff: 760000      10times Time:2202ms
cutoff: 770000      10times Time:2211ms
cutoff: 780000      10times Time:4488ms
cutoff: 790000      10times Time:3479ms
cutoff: 800000      10times Time:3676ms
cutoff: 810000      10times Time:3012ms
cutoff: 820000      10times Time:2629ms
cutoff: 830000      10times Time:2063ms
cutoff: 840000      10times Time:2094ms
cutoff: 850000      10times Time:1951ms
cutoff: 860000      10times Time:2186ms
cutoff: 870000      10times Time:2323ms
cutoff: 880000      10times Time:2056ms
cutoff: 890000      10times Time:2445ms
cutoff: 900000      10times Time:3137ms
cutoff: 910000      10times Time:2247ms
cutoff: 920000      10times Time:2473ms
```

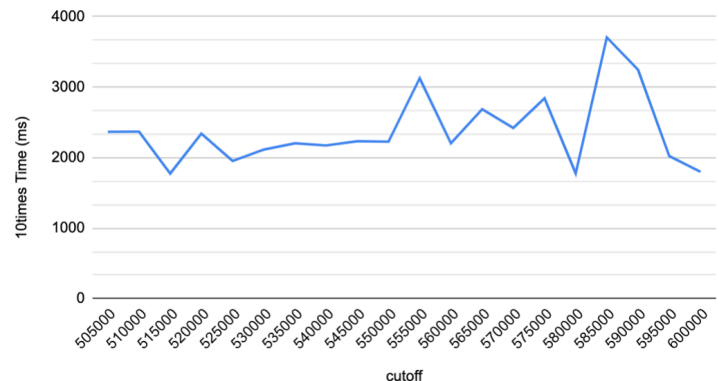
10times Time (ms) vs. cutoff



Using the data above to draw a graph, I found that the run time is the lowest when the cutoff is between 510000 and 600000. Then, I narrowed down the range and got the following result:

```
(base) MacBook-Air-2:INF06205 xinyixu$ cd /Users/xi
Machines/jdk-22.jdk/Contents/Home/bin/java @/var/fo
gfile edu.neu.coe.info6205.sort.par.Main
Degree of parallelism: 3
cutoff: 505000      10times Time:2367ms
cutoff: 510000      10times Time:2370ms
cutoff: 515000      10times Time:1775ms
cutoff: 520000      10times Time:2341ms
cutoff: 525000      10times Time:1954ms
cutoff: 530000      10times Time:2116ms
cutoff: 535000      10times Time:2204ms
cutoff: 540000      10times Time:2173ms
cutoff: 545000      10times Time:2234ms
cutoff: 550000      10times Time:2228ms
cutoff: 555000      10times Time:3127ms
cutoff: 560000      10times Time:2204ms
cutoff: 565000      10times Time:2688ms
cutoff: 570000      10times Time:2422ms
cutoff: 575000      10times Time:2843ms
cutoff: 580000      10times Time:1777ms
cutoff: 585000      10times Time:3705ms
cutoff: 590000      10times Time:3247ms
cutoff: 595000      10times Time:2023ms
cutoff: 600000      10times Time:1800ms
```

10times Time (ms) vs. cutoff



Since got the relatively best-performing area, I turned to look at the influence of threads 2, 4, 8 and 16, and the result shown as following:

Degree of parallelism: 2

```
cutoff: 505000      10times Time:2775ms
cutoff: 510000      10times Time:2253ms
cutoff: 515000      10times Time:2272ms
cutoff: 520000      10times Time:2256ms
cutoff: 525000      10times Time:2196ms
cutoff: 530000      10times Time:2321ms
cutoff: 535000      10times Time:2293ms
cutoff: 540000      10times Time:2436ms
cutoff: 545000      10times Time:2210ms
cutoff: 550000      10times Time:2991ms
cutoff: 555000      10times Time:2195ms
cutoff: 560000      10times Time:2597ms
cutoff: 565000      10times Time:2309ms
cutoff: 570000      10times Time:2326ms
cutoff: 575000      10times Time:2643ms
cutoff: 580000      10times Time:2755ms
cutoff: 585000      10times Time:2249ms
cutoff: 590000      10times Time:2298ms
cutoff: 595000      10times Time:2164ms
cutoff: 600000      10times Time:2192ms
```

Degree of parallelism: 4

```
cutoff: 505000      10times Time:2233ms
cutoff: 510000      10times Time:2614ms
cutoff: 515000      10times Time:1749ms
cutoff: 520000      10times Time:1706ms
cutoff: 525000      10times Time:1926ms
cutoff: 530000      10times Time:1616ms
cutoff: 535000      10times Time:1821ms
cutoff: 540000      10times Time:2926ms
cutoff: 545000      10times Time:3083ms
cutoff: 550000      10times Time:3038ms
cutoff: 555000      10times Time:2992ms
cutoff: 560000      10times Time:2238ms
cutoff: 565000      10times Time:1703ms
cutoff: 570000      10times Time:2101ms
cutoff: 575000      10times Time:1872ms
cutoff: 580000      10times Time:2143ms
cutoff: 585000      10times Time:2192ms
cutoff: 590000      10times Time:2867ms
cutoff: 595000      10times Time:2568ms
cutoff: 600000      10times Time:3284ms
```

Degree of parallelism: 8

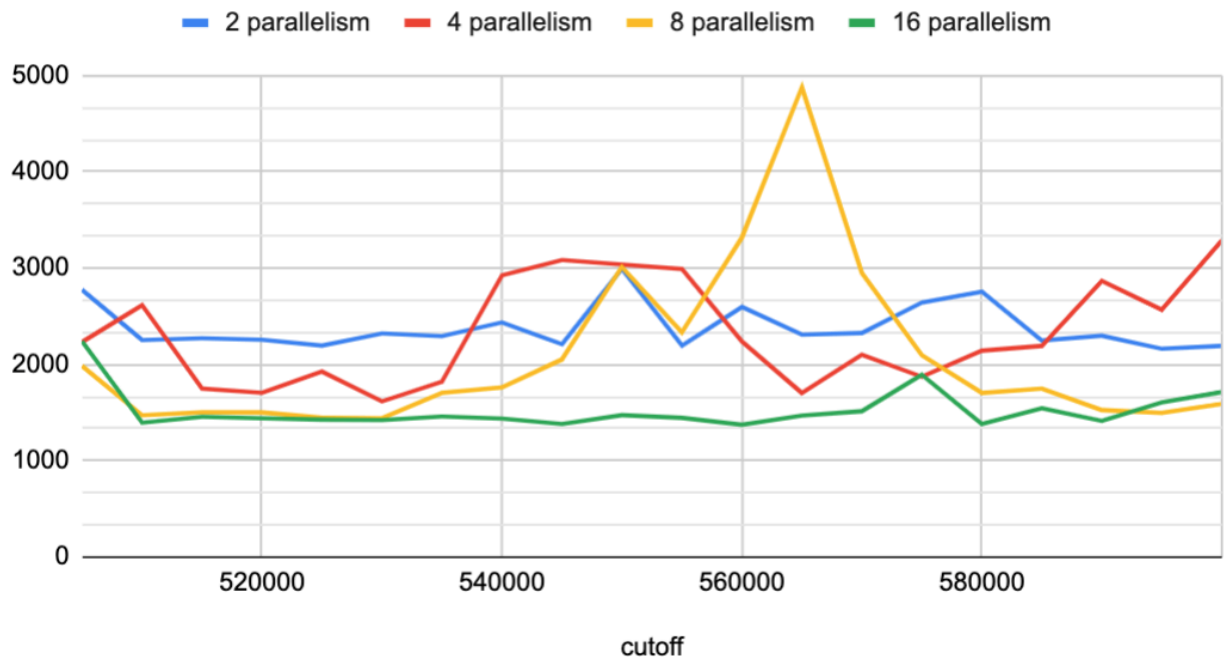
```
cutoff: 505000      10times Time:1984ms
cutoff: 510000      10times Time:1472ms
cutoff: 515000      10times Time:1504ms
cutoff: 520000      10times Time:1501ms
cutoff: 525000      10times Time:1448ms
cutoff: 530000      10times Time:1441ms
cutoff: 535000      10times Time:1705ms
cutoff: 540000      10times Time:1761ms
cutoff: 545000      10times Time:2051ms
cutoff: 550000      10times Time:3011ms
cutoff: 555000      10times Time:2334ms
cutoff: 560000      10times Time:3318ms
cutoff: 565000      10times Time:4877ms
cutoff: 570000      10times Time:2950ms
cutoff: 575000      10times Time:2094ms
cutoff: 580000      10times Time:1704ms
cutoff: 585000      10times Time:1748ms
cutoff: 590000      10times Time:1526ms
cutoff: 595000      10times Time:1497ms
cutoff: 600000      10times Time:1591ms
```

Degree of parallelism: 16

```
cutoff: 505000      10times Time:2241ms
cutoff: 510000      10times Time:1395ms
cutoff: 515000      10times Time:1456ms
cutoff: 520000      10times Time:1440ms
cutoff: 525000      10times Time:1427ms
cutoff: 530000      10times Time:1423ms
cutoff: 535000      10times Time:1459ms
cutoff: 540000      10times Time:1438ms
cutoff: 545000      10times Time:1382ms
cutoff: 550000      10times Time:1473ms
cutoff: 555000      10times Time:1446ms
cutoff: 560000      10times Time:1374ms
cutoff: 565000      10times Time:1469ms
cutoff: 570000      10times Time:1514ms
cutoff: 575000      10times Time:1894ms
cutoff: 580000      10times Time:1382ms
cutoff: 585000      10times Time:1545ms
cutoff: 590000      10times Time:1413ms
cutoff: 595000      10times Time:1607ms
cutoff: 600000      10times Time:1713ms
```

It is more clear to conclude with the chart:

## 10times Time (ms) vs. cutoff



As the degree of parallelism increases (from 4 to 16 threads), the execution time tends to decrease, but there are still some extreme run times for some cases.

Larger cutoffs tend to result in better performance.

There isn't a common-used best parallelism; the optimal number of threads depends on both the cutoff value and the specific characteristics of the dataset.