Program Structures and Algorithms
Spring 2023(SEC –03)

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Task:
Assignment 5 (Parallel Sorting)

Relationship Conclusion:

1. Relation between thread numbers and time. From Table 1, we can see that when the thread number is greater than 32, time usage becomes stable. So, the thread number should be a number equal to or greater than the machine core.
2. Relation between cutoff and time. From P1 to P5, we can see that for different input sizes, the relation between cutoff and time follows the same pattern. When the cutoff is too small, it may take too much time for context switching. When the cutoff is too big, it loses concurrency. There is a turning point where we can sort in the shortest time. From P6 and Table 7, we can see that the best cutoff is approximately 1/625 of the problem size.
3. The time complexity of Parallel Sorting. Parallel Sorting is a merge sort that takes advantage of concurrency. The time complexity is still O(nlogn). The hardware influences the coefficient. In my computer, the relation is y = 10^(-5)*n*logn. 2 to 3 times faster than system sort.

Evidence to support that conclusion:

Thread	Time
1	106.5
2	87.9
4	83
8	83.9
16	64.7
32	56.8
64	59.3
128	59.8
256	59.7
512	65
1024	62
2048	54.9
4096	55.3

Table 1. Relation between Thread numbers and time

cutoff	Time
1000	149.1
2000	72.4
4000	61.9
8000	56.5
16000	53.1
32000	51.2
64000	50.6
128000	50.2
256000	52
512000	55.5
1024000	77.7
2048000	124.2

Table 2. Relation between cutoff and time when size = 2000000

cutoff	Time
1000	349.1
2000	225.2
4000	162.4
8000	132.4
16000	117.1
32000	110.6
64000	104.3
128000	102.3
256000	101
512000	103.6
1024000	113.8
2048000	161.2
4096000	262.2

Table 3. Relation between cutoff and time when size = 4000000

cutoff	Time
1000	879.1
2000	453.7
4000	363.9
8000	310.6
16000	281.7
32000	270.4
64000	246.3
128000	234.8
256000	229.2
512000	248.1
1024000	250.3
2048000	270.9
4096000	368.8
8192000	578.2

Table 4. Relation between cutoff and time when size = 8000000

cutoff	Time
2000	1076.9
4000	740.2
8000	617.4
16000	590.1
32000	515.9
64000	500.6
128000	486
256000	479.9
512000	466
1024000	513.9
2048000	480.8
4096000	519.9
8192000	735.3
16384000	1160.2

Table 5. Relation between cutoff and time when size = 16000000

cutoff	Time
4000	2348
8000	1825.3
16000	1219.5
32000	1092.3
64000	1053.6
128000	1072.8
256000	1026.5
512000	953.3
1024000	956.1
2048000	948.9
4096000	930.9
8192000	1104.6
16384000	1513.1
32768000	2457.6

Table 6. Relation between cutoff and time when size = 32000000

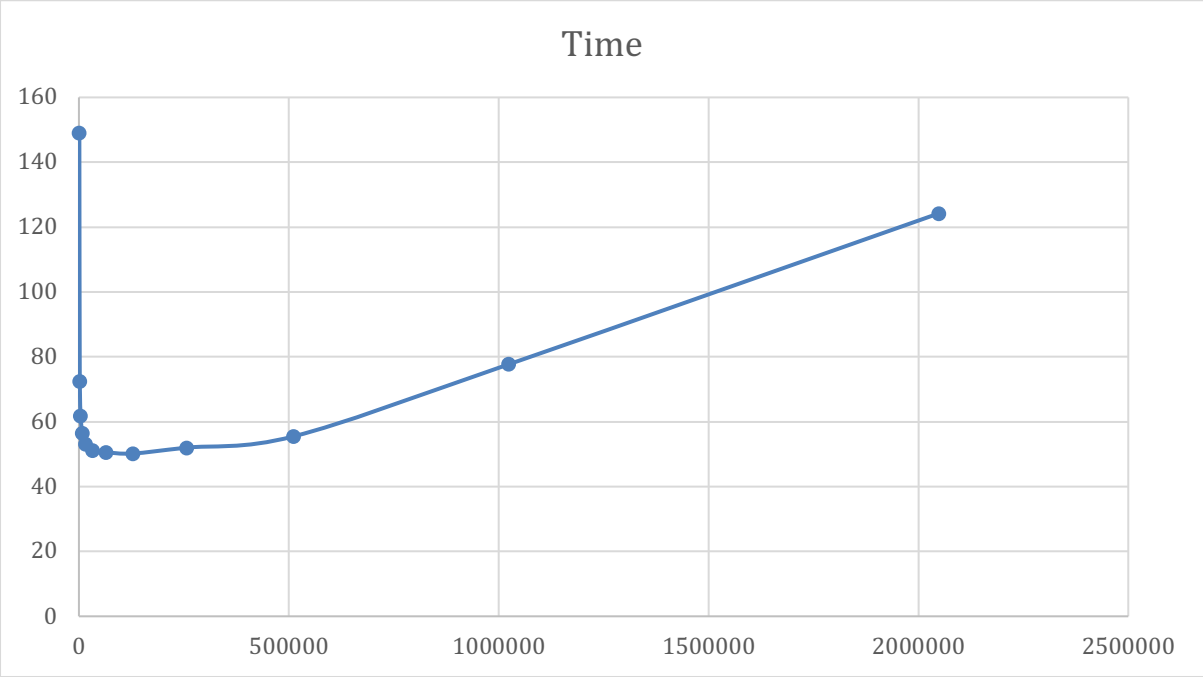
Size	Best Cutoff
2000000	32000
4000000	64000
8000000	128000
16000000	256000
32000000	512000

Table 7. Relation between size and best cutoff

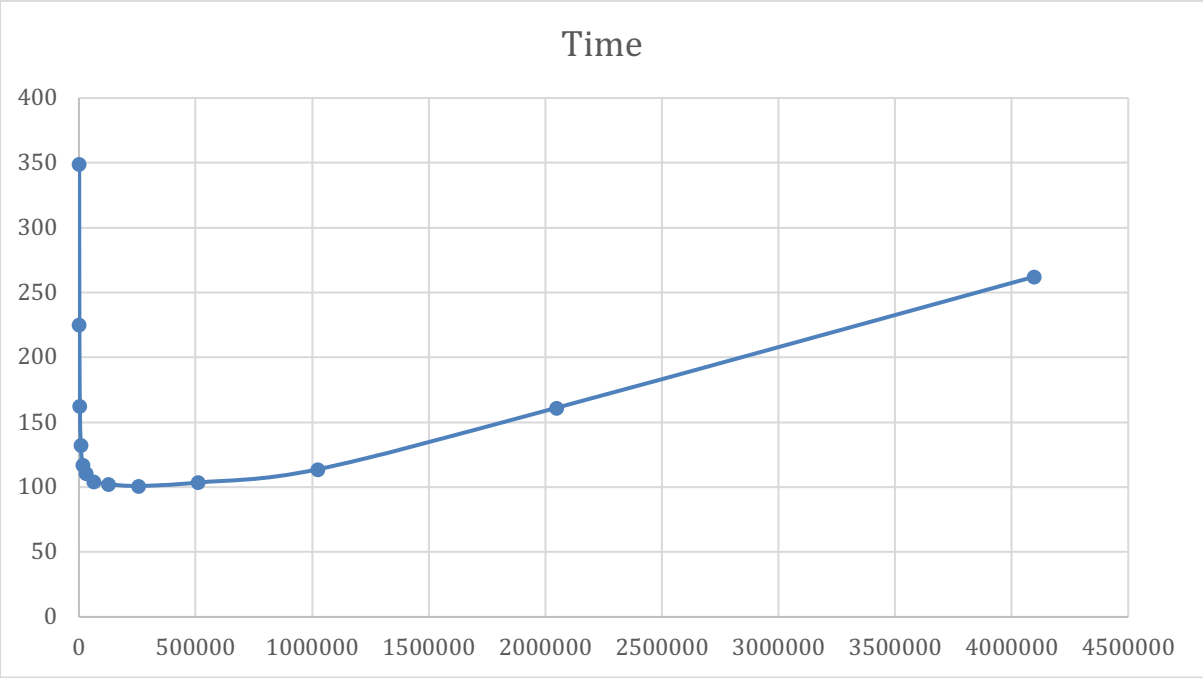
Size	Time	LogSize	LogTime
2000000	50.2	20.9315686	5.64961546
4000000	101	21.9315686	6.65821148
8000000	229.2	22.9315686	7.84046323
16000000	466	23.9315686	8.86418614
32000000	930.9	24.9315686	9.86248239

Table 8. Relation between size and best time

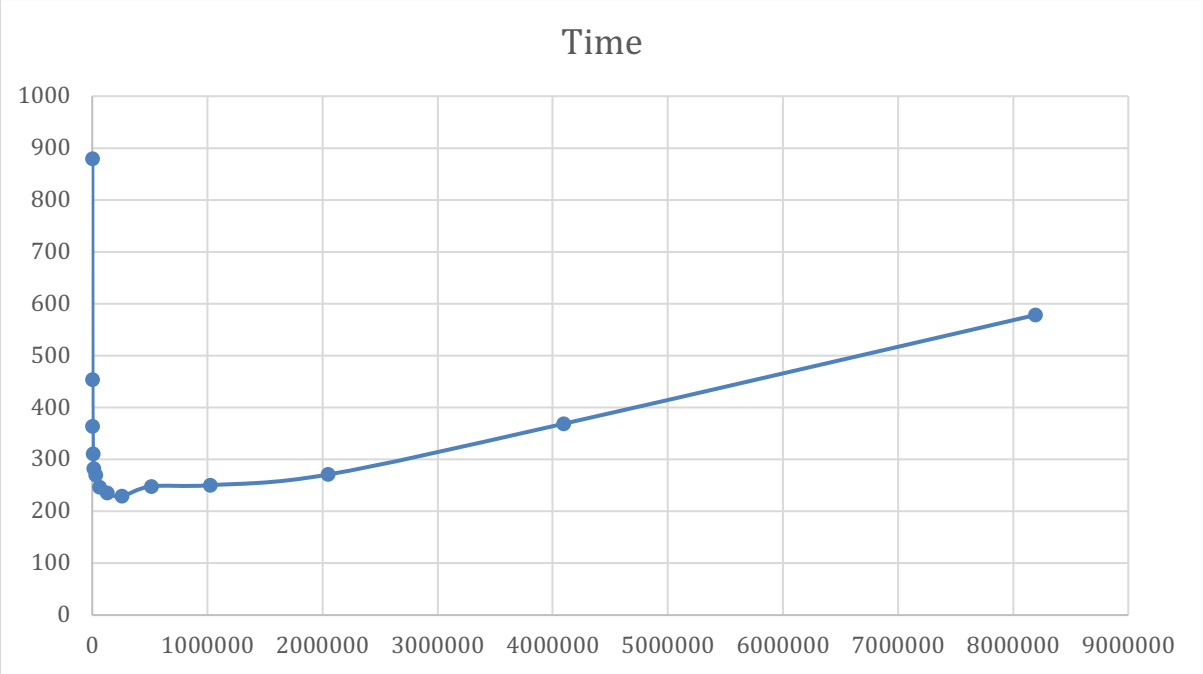
Graphical Representation:



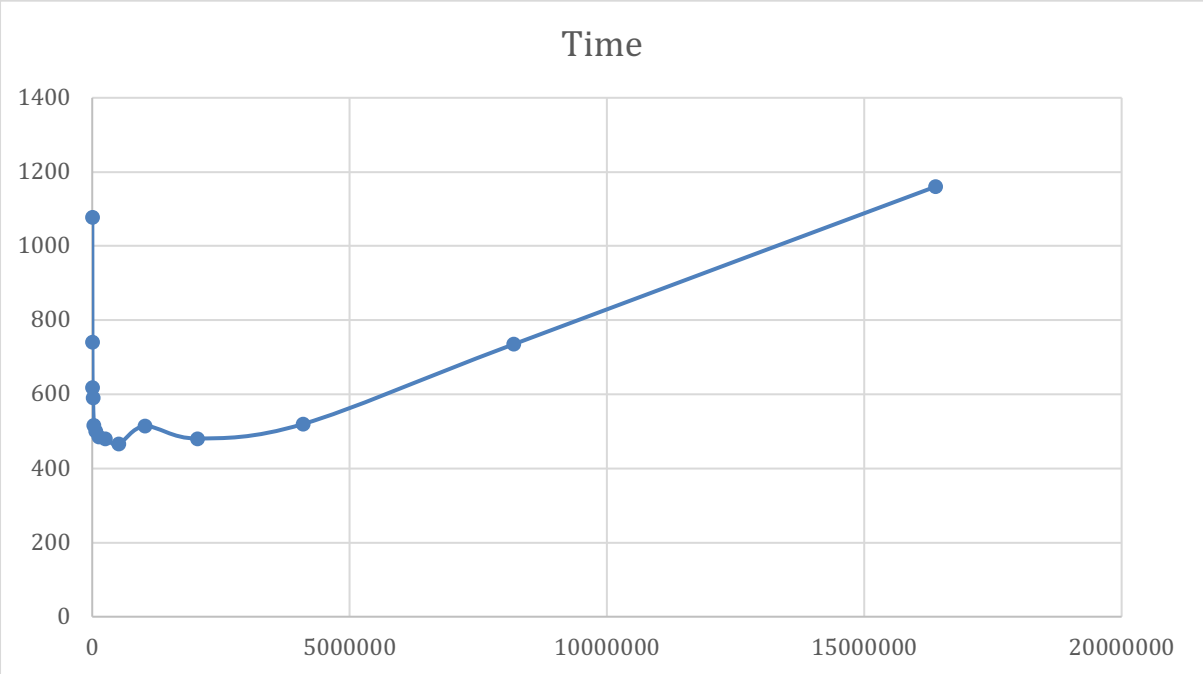
P1. Relation between cutoff and time when size = 2000000



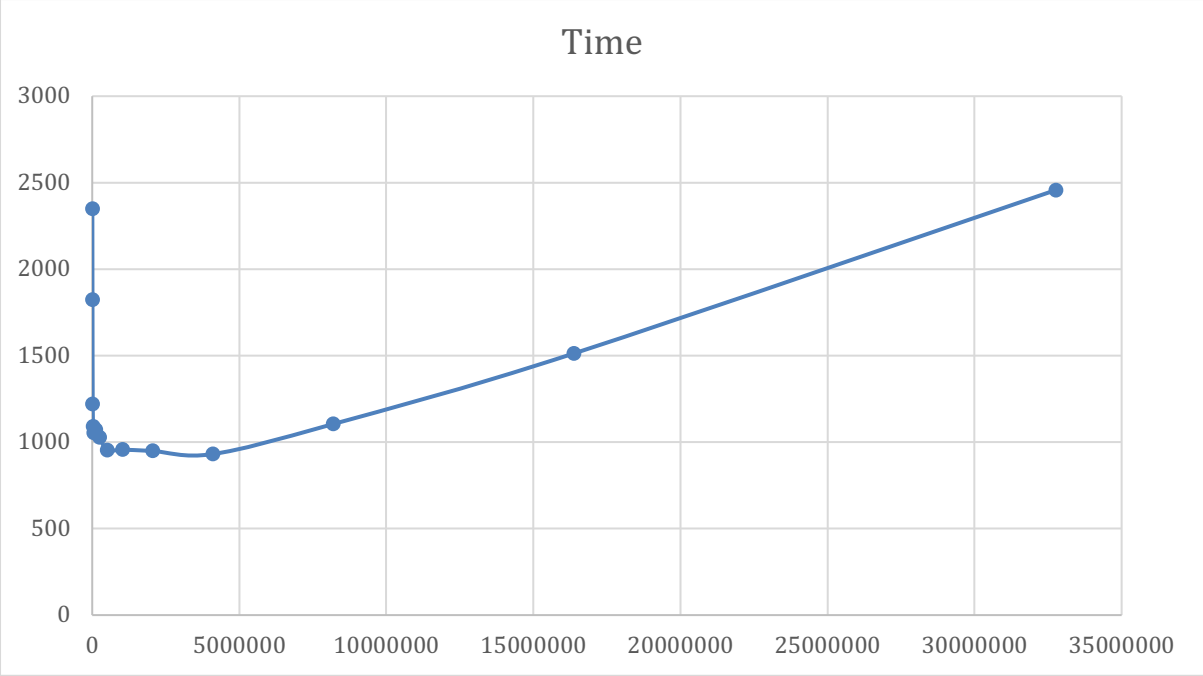
P2. Relation between cutoff and time when size = 4000000



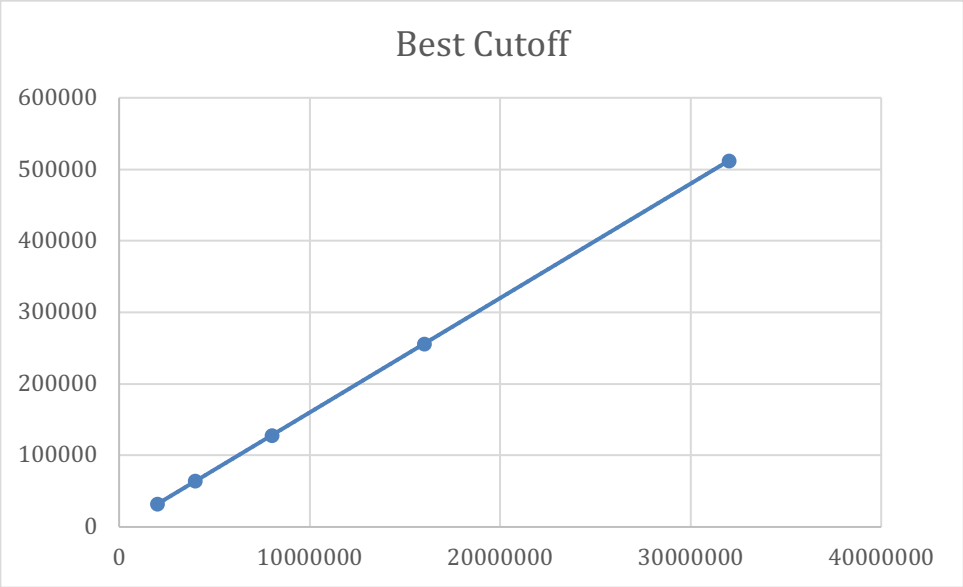
P3. Relation between cutoff and time when size = 8000000



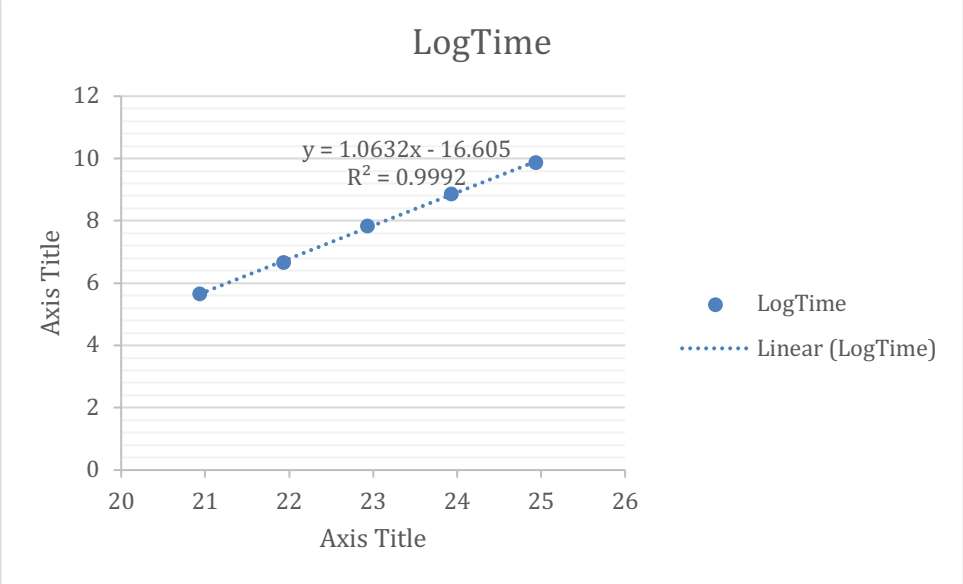
P4. Relation between cutoff and time when size = 16000000



P5. Relation between cutoff and time when size = 32000000



P6. Relation between size and best cutoff



P7. Relation between size and best time