Program Structures and Algorithms
Spring 2023(SEC –1)

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Task:
A cut-off (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 cut-off. If there are fewer elements to sort than the cut-off, then you should use the system sort instead.
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).
An appropriate combination of these.

Relationship Conclusion:

- For every computer machine the number of available threads will be its number of cores available in the processor. (In my case I have 10 core CPU, but available threads are 8 threads)
- Cut off value should be less than 25% of the array size.
- The minimum time can be achieved if,
    - Number of threads = Number of partitions
- So, in my case if the number of threads available is 8, the cut off value should be N/2^8.
- To use the full efficacy of the CPU, each thread one partition for available threads will be fast.

Evidence to support that conclusion:

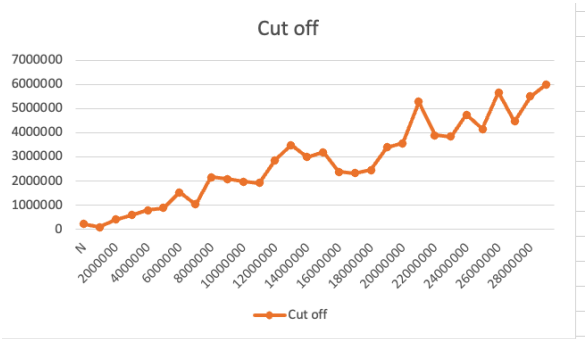
- From the below data and graphs we can infer that the minimum value is found only when the maximum threads available are used.
- Mostly the cut-off values are falling under 25%, no value is greater than 25%.

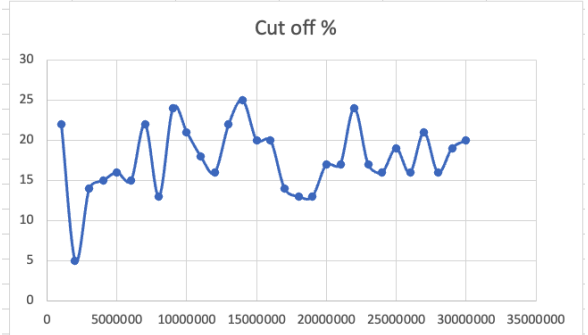
N	Cut off %	Cut off	Min Time	Available Threads	Used Threads
1000000	22	220000	22	8	8
2000000	5	100000	5	8	8
3000000	14	420000	14	8	8
4000000	15	600000	15	8	8
5000000	16	800000	16	8	8
6000000	15	900000	15	8	8
7000000	22	1540000	22	8	8
8000000	13	1040000	13	8	8
9000000	24	2160000	24	8	8
10000000	21	2100000	21	8	8
11000000	18	1980000	18	8	8
12000000	16	1920000	16	8	8
13000000	22	2860000	22	8	8
14000000	25	3500000	25	8	8
15000000	20	3000000	20	8	8
16000000	20	3200000	20	8	8
17000000	14	2380000	14	8	8
18000000	13	2340000	13	8	8
19000000	13	2470000	13	8	8
20000000	17	3400000	17	8	8
21000000	17	3570000	17	8	8
22000000	24	5280000	24	8	8
23000000	17	3910000	17	8	8
24000000	16	3840000	16	8	8
25000000	19	4750000	19	8	8
26000000	16	4160000	16	8	8
27000000	21	5670000	21	8	8
28000000	16	4480000	16	8	8
29000000	19	5510000	19	8	8
30000000	20	6000000	20	8	8

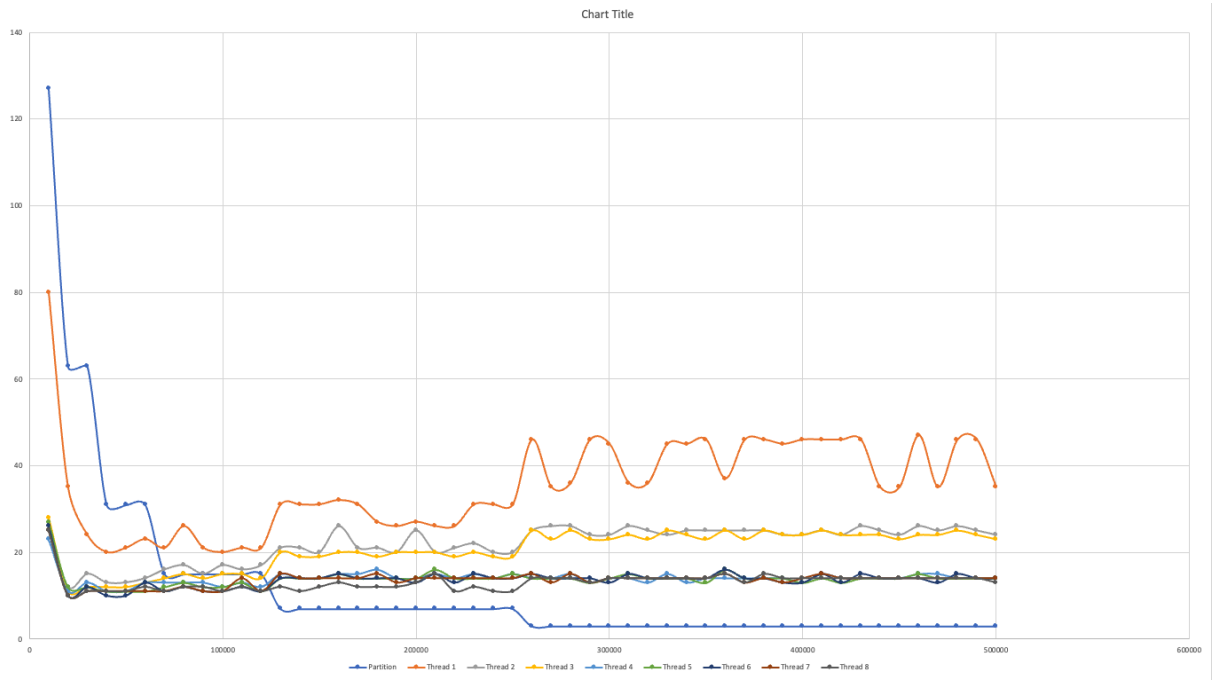
Cut Off	Partition	Thread 1	Thread 2	Thread 3	Thread 4	Thread 5	Thread 6	Thread 7	Thread 8
10000	127	80	25	28	23	27	26	25	25
20000	63	35	12	11	11	12	10	10	10
30000	63	24	15	12	13	12	12	11	11
40000	31	20	13	12	11	11	10	11	11
50000	31	21	13	12	11	11	10	11	11
60000	31	23	14	13	13	11	13	11	12
70000	15	21	16	14	13	12	11	11	11
80000	15	26	17	15	13	13	12	12	12
90000	15	21	15	14	13	12	11	11	12
100000	15	20	17	15	12	12	11	11	11
110000	15	21	16	15	13	13	12	14	12
120000	15	21	17	14	12	11	11	11	11
130000	7	31	21	20	15	14	14	15	12
140000	7	31	21	19	14	14	14	14	11
150000	7	31	20	19	14	14	14	14	12
160000	7	32	26	20	15	15	15	14	13
170000	7	31	21	20	15	14	14	14	12
180000	7	27	21	19	16	14	14	15	12
190000	7	26	20	20	14	14	14	13	12
200000	7	27	25	20	14	14	13	14	13
210000	7	26	20	20	15	16	15	14	15
220000	7	26	21	19	14	14	13	14	11
230000	7	31	22	20	15	14	15	14	12
240000	7	31	20	19	14	14	14	14	11
250000	7	31	20	19	15	15	14	14	11
260000	3	46	25	25	14	14	15	15	14
270000	3	35	26	23	14	14	14	13	14
280000	3	36	26	25	15	14	14	15	14
290000	3	46	24	23	13	13	14	13	13
300000	3	45	24	23	14	14	13	14	14
310000	3	36	26	24	14	15	15	14	14
320000	3	36	25	23	13	14	14	14	14
330000	3	45	24	25	15	14	14	14	14
340000	3	45	25	24	13	14	14	14	14
350000	3	46	25	23	14	13	14	14	14
360000	3	37	25	25	14	16	16	15	15
370000	3	46	25	23	14	14	14	13	13
380000	3	46	25	25	14	14	14	14	15
390000	3	45	24	24	14	14	13	13	14
400000	3	46	24	24	13	13	13	14	14
410000	3	46	25	25	15	14	15	15	14
420000	3	46	24	24	14	13	13	14	14
430000	3	46	26	24	14	14	15	14	14
440000	3	35	25	24	14	14	14	14	14
450000	3	35	24	23	14	14	14	14	14
460000	3	47	26	24	15	15	14	14	14
470000	3	35	25	24	15	14	13	14	14
480000	3	46	26	25	14	14	15	14	14
490000	3	46	25	24	14	14	14	14	14
500000	3	35	24	23	14	14	14	14	13

This comparison for one N value – 1000000 with multiple threads

Graphical Representation:







Unit Test Screenshots:

No unit test in this assignment