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Program Structures & Algorithms
Fall 2021
Assignment No. 5

- ## Task (List down the tasks performed in the Assignment)
  - Create a parallel sorting method that sorts each partition in concurrently.
  - Implement a cut off that will update and experiment to get a reasonable value for this cut off.
  - Decide on an optimal number of different threads with commitment.
- ## Implementation:
  - We begin by performing the task for different array sizes. Initial array size is 2 mil, we perform the tasks for 2 mil and4 mil.

```
System.out.println("Degree of parallelism: " + Fork
Random random = new Random();
int[] array = new int[2000000];
ArrayList<Long> timeList = new ArrayList<>();
```

  - The second task is to perform task for different thread count.
    - We achieve this by externally implement the thread count and passing it to the ForkJoinPool.java executor, which in turn calls the CompletableFuture.java supplyAsync method with the thread count and supply.

- ## Observations & Analysis:

Cut-off	Thread -1	Thread -2	Thread -4	Thread -8	Thread -16	Thread -32
Average	2,058	2,097	2,129	2,226	2,165	2,287
Max	2,702	2,427	2,571	2,849	2,428	3,202
Min	1,884	1,976	1,933	2,078	2,050	2,041

Table.1: Data for different threads and call off for 2 mil elements

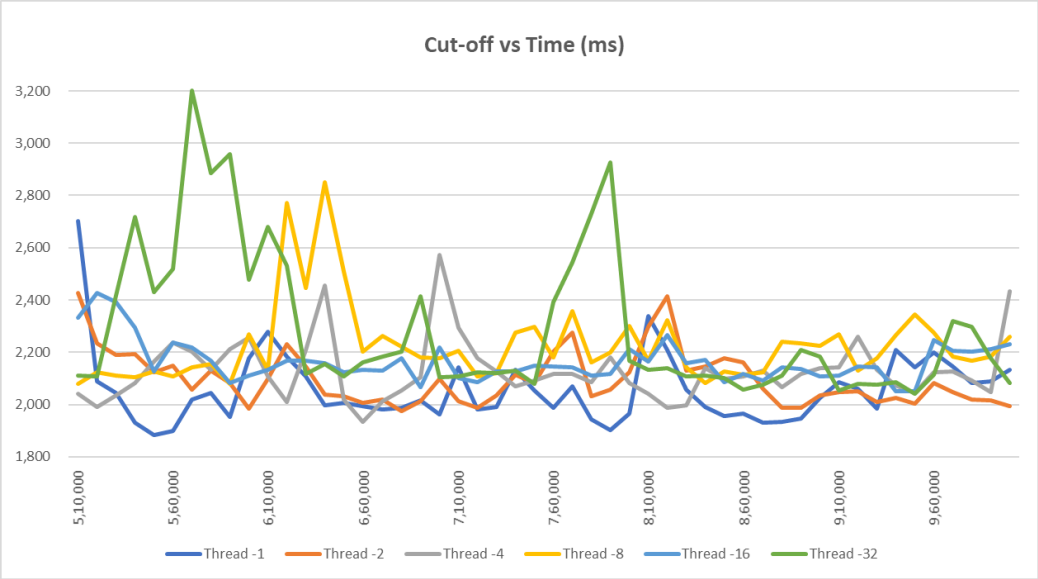


Fig.1: Cut-off vs Time for 2 Mil elements

Cut-off	Thread -1	Thread -2	Thread -4	Thread -8	Thread -16	Thread -32
Average	4,827	4,856	4,812	4,993	5,000	4,970
Max	6,720	5,375	6,445	7,298	5,816	6,903
Min	4,466	4,568	4,587	4,539	4,541	4,578

Table.2: Data for different threads and call off for 4 mil elements

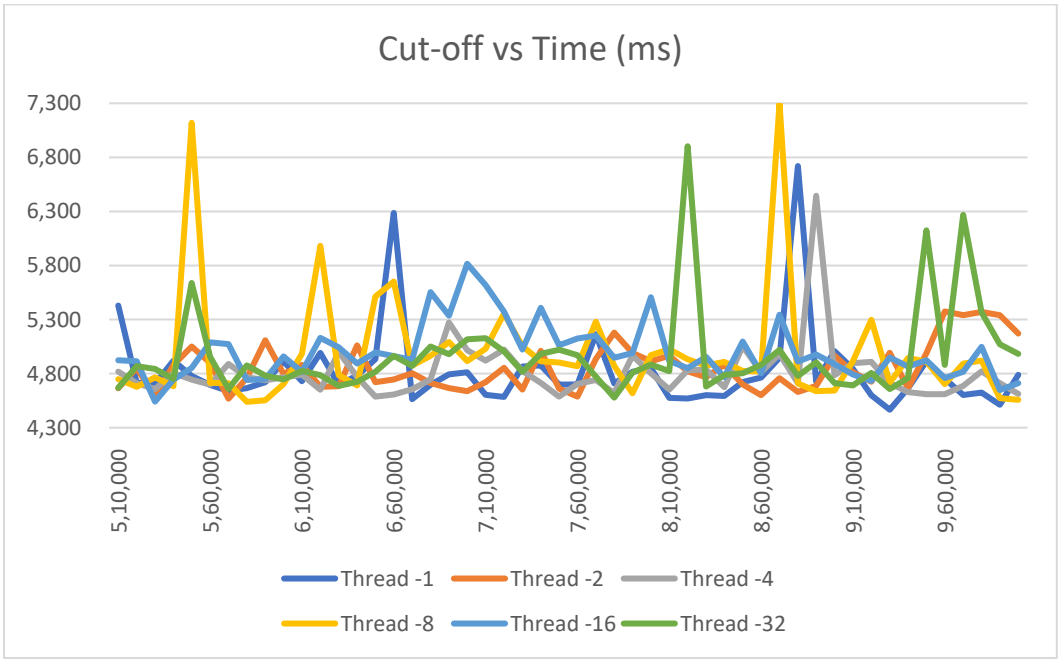


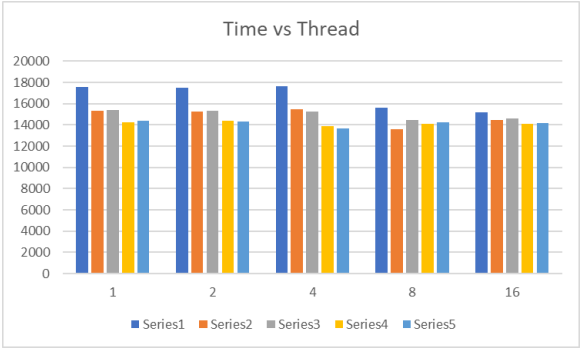
Fig.2: Cut-off vs Time for 4 Mil elements

- **Execution time against number of threads:**

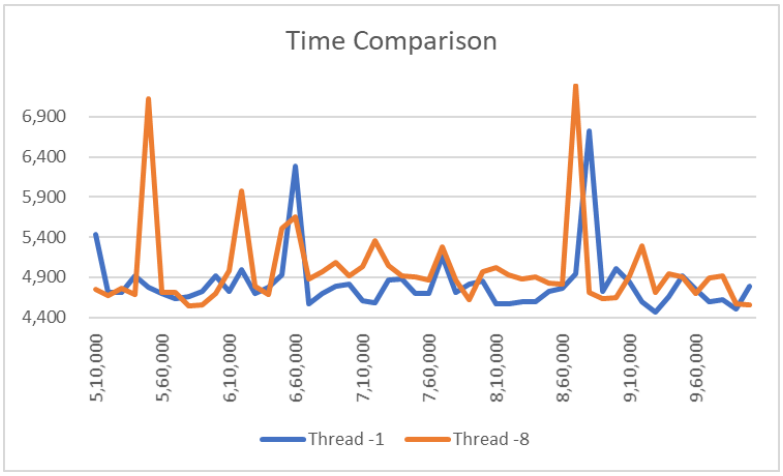
For the experiment, we have kept the cutoff (from 20000 to 100000) and input size of random array fixed (10 million primitive int), the execution time is recorded against the number of threads provided in the pool. The same is plotted using a bar graph (as shown the above screenshot).

It is observed that the execution time to sort 10 million primitive integers over threads 1,2,4 give almost the same performance whereas it falls when the thread pool is increased to 8. However, it shows no significant gain when the thread pool is further increased to hold 16 threads.

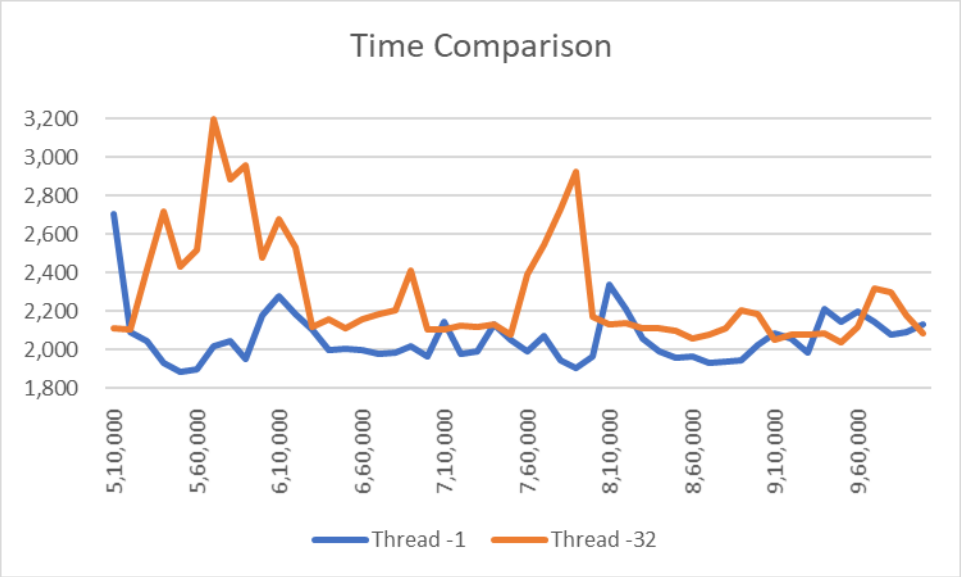
Number of threads	Time in ms				
1	17599	15329	15400	14282	14403
2	17495	15287	15353	14400	14332
4	17671	15465	15288	13865	13665
8	15647	13608	14453	14100	14237
16	15220	14491	14641	14087	14170
Cutoff	**20000**	**40000**	**60000**	**80000**	**100000**



- # Conclusion:



- We can infer that the quickest cut-off range is from 650,000 to 750,000. Considering the experimental errors.



- When the cut-off size is too small, single-threaded sort is the in multithreaded sorting algorithms , the overhead of managing so many partitions becomes too large.

- After 16 threads, we have diminishing returns and benefits.

- **Note:** The above results are for my system and may provide different values for other systems. But the conclusion will remain same.