Lab 6: Runtime Comparisons of Different Sorting Algorithms

Vashisth Tiwari CSC 172

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I. SUMMARY OF RESULTS

A. Tables

Note that NAN indicates an excessive runtime (> 10 minutes).

	Array Size (in thousands)							
Sorting	1	2	4	8	16	32	1000	
Java Default	0	0	0	0	1	1	40	
Bubble Sort	2	6	17	36	119	480	NAN	
Selection Sort	1	6	18	37	111	456	NAN	
Insertion Sort	1	3	4	10	12	42	27800	
Mergesort	0	0	0	1	2	4	105	
Quicksort	0	0	1	1	2	5	46	

TABLE I: List a

	Array Size (in thousands)							
Sorting	1	2	4	8	16	32	1000	
Java Default	0	0	0	1	0	0	2	
Bubble Sort	1	1	6	30	89	326	NAN	
Selection Sort	0	1	7	31	117	403	NAN	
Insertion Sort	0	0	0	0	0	0	1	
Mergesort	0	0	1	1	1	3	71	
Quicksort	0	0	0	0	1	2	11	

TABLE II: List b

	Array Size (in thousands)							
Sorting	1	2	4	8	16	32	1000	
Java Default	0	0	1	1	1	0	3	
Bubble Sort	1	1	6	22	60	244	NAN	
Selection Sort	1	1	5	24	85	337	NAN	
Insertion Sort	1	1	44	16	66	257	24462	
Mergesort	0	0	1	1	1	1	46	
Quicksort	1	1	0	0	0	1	13	
Mergesort	0	0	1	1	1	1	46	

TABLE III: List c

	Array Size (in thousands)							
Sorting	1	2	4	8	16	32	1000	
Java Default	0	0	0	0	0	0	2	
Bubble Sort	0	1	2	7	62	161	NAN	
Selection Sort	0	1	6	23	96	397	NAN	
Insertion Sort	0	0	0	0	1	0	1	
Mergesort	1	0	1	0	1	2	56	
Quicksort	0	0	0	0	$ _1$	1	11	

TABLE IV: List d

B. Plots

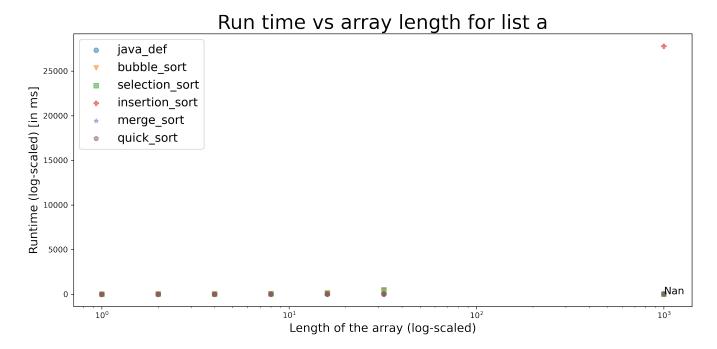


FIG. 1: Plot summarizing the comparison of run times for different sorting algorithms for List a (indicated in the legend) for array of different sizes

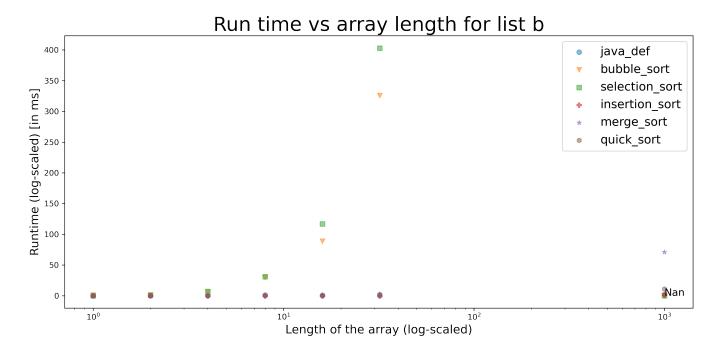


FIG. 2: Plot summarizing the comparison of run times for different sorting algorithms for List b (indicated in the legend) for array of different sizes

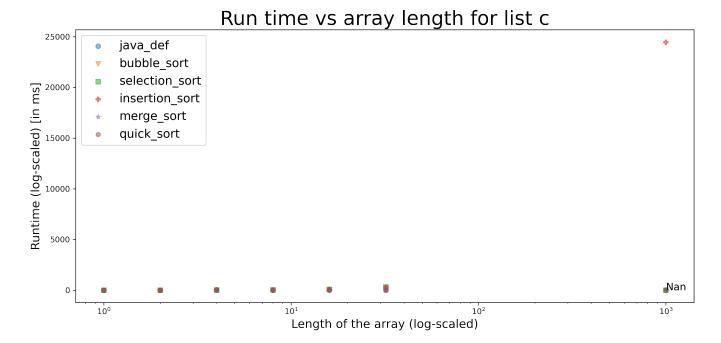


FIG. 3: Plot summarizing the comparison of run times for different sorting algorithms for List c (indicated in the legend) for array of different sizes

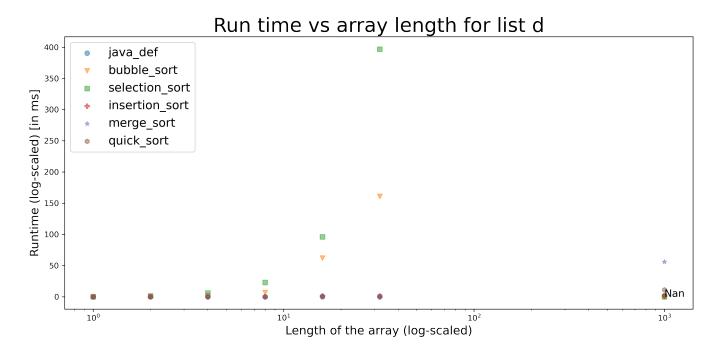


FIG. 4: Plot summarizing the comparison of run times for different sorting algorithms for List d (indicated in the legend) for array of different sizes

II. SCREENSHOTS FROM THE CODE

```
vashisth@Vashisths—MacBook—Pro src_vashisth % javac Sorting.java
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 1Kints.txt 0
defaultSort() a
                    0.0
                          20220410 153235 vtiwari2 1Kints.txt
defaultSort() b
                    0.0
                          20220410 153235
                                           vtiwari2 1Kints.txt
defaultSort() c
                    0.0
                          20220410 153235
                                           vtiwari2 1Kints.txt
defaultSort() d
                                           vtiwari2 1Kints.txt
                    0.0
                          20220410 153235
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 1Kints.txt 1
Bubble Sort a
                  2.0
                        20220410 153237 vtiwari2 1Kints.txt
Bubble Sort b
                  1.0
                        20220410 153237 vtiwari2
                                                   1Kints.txt
Bubble Sort c
                  1.0
                        20220410 153237
                                        vtiwari2 1Kints.txt
                  0.0
                        20220410 153237 vtiwari2 1Kints.txt
Bubble Sort d
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 1Kints.txt 2
Selection Sort a
                     1.0
                           20220410_153239 vtiwari2 1Kints.txt
Selection Sort b
                     0.0
                           20220410 153239 vtiwari2 1Kints.txt
Selection Sort c
                     1.0
                           20220410_153239 vtiwari2
                                                      1Kints.txt
Selection Sort d
                     0.0
                           20220410_153239 vtiwari2 1Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 1Kints.txt 3
                           20220410 153241 vtiwari2 1Kints.txt
Insertion Sort a
                     1.0
Insertion Sort b
                     0.0
                           20220410_153241 vtiwari2
                                                      1Kints.txt
Insertion Sort c
                     1.0
                           20220410 153241
                                            vtiwari2 1Kints.txt
Insertion Sort d
                     0.0
                           20220410_153241 vtiwari2 1Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 1Kints.txt 4
                 0.0
                       20220410_153243 vtiwari2 1Kints.txt
Merge Sort a
Merge Sort b
                 0.0
                       20220410 153243 vtiwari2 1Kints.txt
Merge Sort c
                 0.0
                       20220410_153243 vtiwari2 1Kints.txt
                 1.0
                       20220410_153243 vtiwari2 1Kints.txt
Merge Sort d
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 1Kints.txt 5
Quick Sort a
                 0.0
                       20220410_153245
                                        vtiwari2 1Kints.txt
Ouick Sort b
                 0.0
                       20220410 153245
                                        vtiwari2
                                                 1Kints.txt
Quick Sort c
                 0.0
                       20220410_153245
                                        vtiwari2
                                                  1Kints.txt
                       20220410 153245 vtiwari2 1Kints.txt
Quick Sort d
                 0.0
```

FIG. 5: 1k

```
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 2Kints.txt 0
                          20220410_153315 vtiwari2
defaultSort() a
                    0.0
                                                     2Kints.txt
defaultSort() b
                    0.0
                          20220410 153315 vtiwari2
                                                     2Kints.txt
defaultSort() c
                    0.0
                          20220410 153315 vtiwari2
                                                     2Kints.txt
defaultSort() d
                    0.0
                          20220410 153315 vtiwari2
                                                     2Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 2Kints.txt 1
                  6.0
                        20220410 153317 vtiwari2 2Kints.txt
Bubble Sort a
                        20220410 153317
                                                   2Kints.txt
Bubble Sort b
                  1.0
                                         vtiwari2
Bubble Sort c
                  1.0
                        20220410 153317 vtiwari2
                                                   2Kints.txt
                  1.0
                        20220410_153317 vtiwari2 2Kints.txt
Bubble Sort d
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 2Kints.txt 2
                           20220410 153320 vtiwari2
Selection Sort a
                     6.0
                                                      2Kints.txt
                     1.0
                           20220410 153320 vtiwari2
Selection Sort b
                                                      2Kints.txt
Selection Sort c
                           20220410 153320 vtiwari2
                                                      2Kints.txt
                     1.0
Selection Sort d
                     1.0
                           20220410_153320 vtiwari2
                                                      2Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 2Kints.txt 3
Insertion Sort a
                     3.0
                           20220410 153322 vtiwari2
                                                      2Kints.txt
Insertion Sort b
                     0.0
                           20220410 153322
                                            vtiwari2
                                                      2Kints.txt
Insertion Sort c
                     1.0
                           20220410 153322 vtiwari2
                                                      2Kints.txt
Insertion Sort d
                     0.0
                           20220410_153322 vtiwari2 2Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 2Kints.txt 4
Merge Sort a
                 0.0
                       20220410 153325
                                        vtiwari2 2Kints.txt
                                                  2Kints.txt
Merge Sort b
                 0.0
                       20220410_153325
                                        vtiwari2
Merge Sort c
                       20220410 153325
                 0.0
                                        vtiwari2 2Kints.txt
Merae Sort d
                 0.0
                       20220410 153325
                                        vtiwari2
                                                  2Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 2Kints.txt 5
                       20220410 153327
Ouick Sort a
                 0.0
                                        vtiwari2 2Kints.txt
                                        vtiwari2
Quick Sort b
                 0.0
                       20220410_153327
                                                  2Kints.txt
Quick Sort c
                 0.0
                       20220410 153327
                                        vtiwari2
                                                  2Kints.txt
Quick Sort d
                 0.0
                       20220410 153327
                                        vtiwari2
                                                  2Kints.txt
```

FIG. 6: 2k

```
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 4Kints.txt 0
                          20220410 153506
defaultSort() a
                    0.0
                                                     4Kints.txt
                                           vtiwari2
defaultSort() b
                          20220410 153506 vtiwari2
                    0.0
                                                     4Kints.txt
defaultSort() c
                    0.0
                          20220410 153506 vtiwari2
                                                    4Kints.txt
defaultSort() d
                    1.0
                          20220410_153506 vtiwari2
                                                    4Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 4Kints.txt 1
Bubble Sort a
                 17.0
                        20220410 153508
                                         vtiwari2 4Kints.txt
Bubble Sort b
                  6.0
                        20220410 153508
                                         vtiwari2 4Kints.txt
Bubble Sort c
                  6.0
                        20220410 153508
                                         vtiwari2 4Kints.txt
                  2.0
                        20220410_153508 vtiwari2 4Kints.txt
Bubble Sort d
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 4Kints.txt 2
Selection Sort a
                    18.0
                           20220410 153510
                                           vtiwari2 4Kints.txt
Selection Sort b
                     7.0
                           20220410_153510
                                            vtiwari2 4Kints.txt
                           20220410_153510 vtiwari2 4Kints.txt
Selection Sort c
                     5.0
Selection Sort d
                     6.0
                           20220410 153510 vtiwari2 4Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 4Kints.txt 3
Insertion Sort a
                     4.0
                           20220410 153511 vtiwari2 4Kints.txt
Insertion Sort b
                     0.0
                           20220410_153511 vtiwari2 4Kints.txt
                    44.0
                           20220410 153511 vtiwari2 4Kints.txt
Insertion Sort c
Insertion Sort d
                     0.0
                           20220410_153511 vtiwari2 4Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 4Kints.txt 4
                 0.0
                       20220410_153513 vtiwari2 4Kints.txt
Merge Sort a
Merge Sort b
                 1.0
                       20220410 153513
                                        vtiwari2 4Kints.txt
Merge Sort c
                 0.0
                       20220410 153513 vtiwari2
                                                  4Kints.txt
Merge Sort d
                 0.0
                       20220410_153513 vtiwari2
                                                  4Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 4Kints.txt 5
                 1.0
                       20220410 153515
Ouick Sort a
                                       vtiwari2 4Kints.txt
Quick Sort b
                 0.0
                       20220410_153515
                                        vtiwari2 4Kints.txt
Quick Sort c
                 0.0
                       20220410 153515
                                       vtiwari2
                                                  4Kints.txt
                 0.0
                       20220410_153515 vtiwari2 4Kints.txt
Quick Sort d
```

FIG. 7: 4k

```
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 8Kints.txt 0
defaultSort() a
                    0.0
                          20220410 153533
                                           vtiwari2 8Kints.txt
defaultSort() b
                    1.0
                                                     8Kints.txt
                          20220410 153533
                                           vtiwari2
                                           vtiwari2 8Kints.txt
defaultSort() c
                    1.0
                          20220410_153533
defaultSort() d
                    0.0
                          20220410 153533
                                           vtiwari2 8Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 8Kints.txt 1
                        20220410_153534
Bubble Sort a
                  36.0
                                         vtiwari2 8Kints.txt
Bubble Sort b
                 30.0
                        20220410 153534
                                                   8Kints.txt
                                         vtiwari2
Bubble Sort c
                  22.0
                        20220410 153534
                                         vtiwari2
                                                   8Kints.txt
Bubble Sort d
                  7.0
                        20220410_153534 vtiwari2 8Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 8Kints.txt 2
Selection Sort a
                    37.0
                           20220410 153536
                                            vtiwari2
                                                      8Kints.txt
Selection Sort b
                    31.0
                           20220410 153536 vtiwari2
                                                      8Kints.txt
Selection Sort c
                    24.0
                           20220410 153536 vtiwari2
                                                      8Kints.txt
Selection Sort d
                    23.0
                           20220410_153536
                                            vtiwari2
                                                      8Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 8Kints.txt 3
Insertion Sort a
                    10.0
                           20220410 153538 vtiwari2
                                                      8Kints.txt
Insertion Sort b
                     0.0
                           20220410_153538
                                            vtiwari2
                                                      8Kints.txt
Insertion Sort c
                    16.0
                           20220410_153538 vtiwari2
                                                      8Kints.txt
Insertion Sort d
                     1.0
                           20220410_153538 vtiwari2 8Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 8Kints.txt 4
                       20220410 153540 vtiwari2
                                                  8Kints.txt
Merge Sort a
                  1.0
Merge Sort b
                  1.0
                       20220410 153540 vtiwari2
                                                  8Kints.txt
Merge Sort c
                  1.0
                       20220410_153540 vtiwari2
                                                  8Kints.txt
Merge Sort d
                 0.0
                       20220410 153540 vtiwari2
                                                  8Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 8Kints.txt 5
Quick Sort a
                  1.0
                       20220410 153542
                                        vtiwari2
                                                  8Kints.txt
Quick Sort b
                 0.0
                       20220410 153542
                                        vtiwari2
                                                  8Kints.txt
                 0.0
Quick Sort c
                       20220410_153542
                                        vtiwari2
                                                  8Kints.txt
Quick Sort d
                  0.0
                       20220410 153542
                                        vtiwari2
                                                  8Kints.txt
```

FIG. 8: 8k

```
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 16Kints.txt 0
defaultSort() a
                    1.0
                          20220410 153610
                                           vtiwari2 16Kints.txt
defaultSort() b
                                                     16Kints.txt
                    0.0
                          20220410_153610
                                           vtiwari2
defaultSort() c
                    1.0
                          20220410 153610
                                           vtiwari2 16Kints.txt
defaultSort() d
                    0.0
                          20220410_153610
                                           vtiwari2 16Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 16Kints.txt 1
Bubble Sort a
                119.0
                        20220410 153612
                                         vtiwari2 16Kints.txt
Bubble Sort b
                 89.0
                        20220410 153612
                                         vtiwari2 16Kints.txt
Bubble Sort c
                 60.0
                        20220410 153612
                                         vtiwari2 16Kints.txt
^[[ABubble Sort d
                     62.0
                            20220410 153612 vtiwari2
                                                       16Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 16Kints.txt 2
                           20220410_153614 vtiwari2 16Kints.txt
Selection Sort a
                   111.0
Selection Sort b
                   117.0
                           20220410 153614
                                           vtiwari2
                                                      16Kints.txt
Selection Sort c
                    85.0
                           20220410 153614 vtiwari2 16Kints.txt
                    96.0
                           20220410 153614 vtiwari2 16Kints.txt
Selection Sort d
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 16Kints.txt 3
                    12.0
                           20220410_153616 vtiwari2 16Kints.txt
Insertion Sort a
Insertion Sort b
                     0.0
                           20220410 153616 vtiwari2 16Kints.txt
Insertion Sort c
                    66.0
                           20220410 153616 vtiwari2 16Kints.txt
Insertion Sort d
                     0.0
                           20220410 153616 vtiwari2 16Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 16Kints.txt 4
Merge Sort a
                 2.0
                       20220410 153618
                                       vtiwari2 16Kints.txt
Merge Sort b
                 1.0
                       20220410 153618
                                                  16Kints.txt
                                        vtiwari2
Merge Sort c
                 1.0
                       20220410 153618
                                                  16Kints.txt
                                       vtiwari2
Merge Sort d
                 1.0
                       20220410_153618 vtiwari2
                                                  16Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 16Kints.txt 5
Quick Sort a
                 2.0
                       20220410_153619
                                        vtiwari2
                                                  16Kints.txt
Ouick Sort b
                 1.0
                       20220410 153619
                                        vtiwari2
                                                  16Kints.txt
Quick Sort c
                 0.0
                       20220410_153619
                                        vtiwari2
                                                  16Kints.txt
                 1.0
                       20220410_153619 vtiwari2 16Kints.txt
Quick Sort d
```

FIG. 9: 16k

```
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 32Kints.txt 0
defaultSort() a
                    1.0
                          20220410 153712
                                           vtiwari2 32Kints.txt
defaultSort() b
                    0.0
                          20220410_153712
                                           vtiwari2 32Kints.txt
defaultSort() c
                    0.0
                          20220410 153712
                                           vtiwari2 32Kints.txt
defaultSort() d
                    0.0
                          20220410 153712
                                           vtiwari2 32Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 32Kints.txt 1
Bubble Sort a
                480.0
                        20220410_153714
                                         vtiwari2 32Kints.txt
Bubble Sort b
                326.0
                        20220410 153714
                                         vtiwari2 32Kints.txt
Bubble Sort c
                244.0
                        20220410 153715
                                         vtiwari2 32Kints.txt
                161.0
                        20220410_153715 vtiwari2 32Kints.txt
Bubble Sort d
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 32Kints.txt 2
Selection Sort a
                   456.0
                           20220410 153718 vtiwari2
                                                      32Kints.txt
Selection Sort b
                   403.0
                           20220410 153718 vtiwari2 32Kints.txt
Selection Sort c
                   337.0
                           20220410_153718 vtiwari2 32Kints.txt
                   397.0
Selection Sort d
                           20220410_153719 vtiwari2 32Kints.txt
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 32Kints.txt 3
Insertion Sort a
                    42.0
                           20220410 153721 vtiwari2 32Kints.txt
Insertion Sort b
                     0.0
                           20220410 153721 vtiwari2 32Kints.txt
Insertion Sort c
                   257.0
                           20220410_153721 vtiwari2 32Kints.txt
Insertion Sort d
                     0.0
                           20220410 153721 vtiwari2 32Kints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 32Kints.txt 4
                 4.0
                       20220410 153723 vtiwari2 32Kints.txt
Merge Sort a
Merge Sort b
                 3.0
                       20220410 153723
                                        vtiwari2 32Kints.txt
Merge Sort c
                 1.0
                                       vtiwari2 32Kints.txt
                       20220410_153723
                 2.0
                       20220410 153723 vtiwari2 32Kints.txt
Merge Sort d
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 32Kints.txt 5
Quick Sort a
                 5.0
                       20220410_153725
                                        vtiwari2 32Kints.txt
Ouick Sort b
                       20220410 153725
                 2.0
                                        vtiwari2 32Kints.txt
Quick Sort c
                 1.0
                       20220410_153725
                                        vtiwari2
                                                  32Kints.txt
Quick Sort d
                 1.0
                       20220410 153725
                                       vtiwari2 32Kints.txt
```

FIG. 10: 32k

```
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 1Mints.txt 0
defaultSort() a
                    40.0
                           20220410 153754
                                            vtiwari2
                                                     1Mints.txt
                                                      1Mints.txt
defaultSort() b
                     2.0
                           20220410_153754
                                            vtiwari2
defaultSort() c
                     3.0
                           20220410 153754
                                            vtiwari2
                                                     1Mints.txt
defaultSort() d
                     2.0
                           20220410 153754
                                            vtiwari2 1Mints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 1Mints.txt 1
^C<sup>%</sup>
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 1Mints.txt 2
^C<sup>용</sup>
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 1Mints.txt 3
Insertion Sort a 27800.0
                            20220410 153843 vtiwari2
                                                       1Mints.txt
                            20220410 153843 vtiwari2
Insertion Sort b
                      1.0
                                                       1Mints.txt
                            20220410 154248 vtiwari2
Insertion Sort c 244462.0
                                                       1Mints.txt
Insertion Sort d
                      1.0
                            20220410 154248 vtiwari2 1Mints.txt
vashisth@Vashisths-MacBook-Pro src_vashisth % java Sorting 1Mints.txt 4
                        20220410 154736 vtiwari2
Merge Sort a
                105.0
                                                   1Mints.txt
Merge Sort b
                 71.0
                        20220410 154736 vtiwari2
                                                   1Mints.txt
Merge Sort c
                 46.0
                        20220410 154736 vtiwari2
                                                   1Mints.txt
                                                   1Mints.txt
Merge Sort d
                 56.0
                        20220410_154737 vtiwari2
vashisth@Vashisths-MacBook-Pro src vashisth % java Sorting 1Mints.txt 5
Quick Sort a
                 46.0
                        20220410 154739
                                         vtiwari2
                                                   1Mints.txt
Quick Sort b
                 11.0
                        20220410 154739
                                         vtiwari2
                                                   1Mints.txt
Quick Sort c
                 13.0
                        20220410 154739
                                         vtiwari2
                                                   1Mints.txt
Quick Sort d
                 11.0
                        20220410 154739 vtiwari2 1Mints.txt
```

FIG. 11: 100k