

Lab 3 (Analysis of Sorting Algorithms)

CSC 172 (Data Structures and Algorithms)

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Screenshots of Outputs:

```
Command Prompt

D:\CSC172\Lab03\Lab7>javac Sorting.java

D:\CSC172\Lab03\Lab7>java Sorting 1Kints.txt 0
Arrays.sort() a 0.0 20240922_224826 ebozogl 1Kints.txt
Arrays.sort() b 0.0 20240922_224826 ebozogl 1Kints.txt
Arrays.sort() c 0.0 20240922_224826 ebozogl 1Kints.txt
Arrays.sort() d 1.0 20240922_224826 ebozogl 1Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 2Kints.txt 0
Arrays.sort() a 0.0 20240922_224838 ebozogl 2Kints.txt
Arrays.sort() b 0.0 20240922_224838 ebozogl 2Kints.txt
Arrays.sort() c 0.0 20240922_224838 ebozogl 2Kints.txt
Arrays.sort() d 1.0 20240922_224838 ebozogl 2Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 4Kints.txt 0
Arrays.sort() a 0.0 20240922_224841 ebozogl 4Kints.txt
Arrays.sort() b 0.0 20240922_224841 ebozogl 4Kints.txt
Arrays.sort() c 0.0 20240922_224841 ebozogl 4Kints.txt
Arrays.sort() d 0.0 20240922_224841 ebozogl 4Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 8Kints.txt 0
Arrays.sort() a 1.0 20240922_224845 ebozogl 8Kints.txt
Arrays.sort() b 0.0 20240922_224845 ebozogl 8Kints.txt
Arrays.sort() c 1.0 20240922_224845 ebozogl 8Kints.txt
Arrays.sort() d 1.0 20240922_224845 ebozogl 8Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 16Kints.txt 0
Arrays.sort() a 1.0 20240922_224849 ebozogl 16Kints.txt
Arrays.sort() b 0.0 20240922_224849 ebozogl 16Kints.txt
Arrays.sort() c 0.0 20240922_224849 ebozogl 16Kints.txt
Arrays.sort() d 0.0 20240922_224849 ebozogl 16Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 32Kints.txt 0
Arrays.sort() a 6.0 20240922_224852 ebozogl 32Kints.txt
Arrays.sort() b 1.0 20240922_224852 ebozogl 32Kints.txt
Arrays.sort() c 1.0 20240922_224852 ebozogl 32Kints.txt
Arrays.sort() d 6.0 20240922_224852 ebozogl 32Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 1Mints.txt 0
Arrays.sort() a 62.0 20240922_224856 ebozogl 1Mints.txt
Arrays.sort() b 3.0 20240922_224857 ebozogl 1Mints.txt
Arrays.sort() c 4.0 20240922_224857 ebozogl 1Mints.txt
Arrays.sort() d 33.0 20240922_224857 ebozogl 1Mints.txt

D:\CSC172\Lab03\Lab7>
```

```
D:\CSC172\Lab03\Lab7>java Sorting 1Kints.txt 2
Selection Sort a 1.0 20240922_230905 ebozogl 1Kints.txt
Selection Sort b 4.0 20240922_230905 ebozogl 1Kints.txt
Selection Sort c 0.0 20240922_230905 ebozogl 1Kints.txt
Selection Sort d 1.0 20240922_230905 ebozogl 1Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 2Kints.txt 2
Selection Sort a 3.0 20240922_230909 ebozogl 2Kints.txt
Selection Sort b 1.0 20240922_230909 ebozogl 2Kints.txt
Selection Sort c 4.0 20240922_230909 ebozogl 2Kints.txt
Selection Sort d 1.0 20240922_230909 ebozogl 2Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 4Kints.txt 2
Selection Sort a 9.0 20240922_230912 ebozogl 4Kints.txt
Selection Sort b 8.0 20240922_230912 ebozogl 4Kints.txt
Selection Sort c 3.0 20240922_230912 ebozogl 4Kints.txt
Selection Sort d 3.0 20240922_230912 ebozogl 4Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 8Kints.txt 2
Selection Sort a 21.0 20240922_230916 ebozogl 8Kints.txt
Selection Sort b 19.0 20240922_230916 ebozogl 8Kints.txt
Selection Sort c 13.0 20240922_230916 ebozogl 8Kints.txt
Selection Sort d 18.0 20240922_230916 ebozogl 8Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 16Kints.txt 2
Selection Sort a 73.0 20240922_230919 ebozogl 16Kints.txt
Selection Sort b 78.0 20240922_230919 ebozogl 16Kints.txt
Selection Sort c 51.0 20240922_230920 ebozogl 16Kints.txt
Selection Sort d 72.0 20240922_230920 ebozogl 16Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 32Kints.txt 2
Selection Sort a 286.0 20240922_230922 ebozogl 32Kints.txt
Selection Sort b 175.0 20240922_230923 ebozogl 32Kints.txt
Selection Sort c 177.0 20240922_230923 ebozogl 32Kints.txt
Selection Sort d 152.0 20240922_230923 ebozogl 32Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 1Mints.txt 2
Selection Sort a 330886.0 20240922_231500 ebozogl 1Mints.txt
^C
```

```
D:\CSC172\Lab03\Lab7>java Sorting 1Kints.txt 1
Bubble Sort a 3.0 20240922_225444 ebozogl 1Kints.txt
Bubble Sort b 0.0 20240922_225444 ebozogl 1Kints.txt
Bubble Sort c 1.0 20240922_225444 ebozogl 1Kints.txt
Bubble Sort d 2.0 20240922_225444 ebozogl 1Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 2Kints.txt 1
Bubble Sort a 4.0 20240922_225449 ebozogl 2Kints.txt
Bubble Sort b 0.0 20240922_225449 ebozogl 2Kints.txt
Bubble Sort c 3.0 20240922_225449 ebozogl 2Kints.txt
Bubble Sort d 1.0 20240922_225449 ebozogl 2Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 4Kints.txt 1
Bubble Sort a 11.0 20240922_225453 ebozogl 4Kints.txt
Bubble Sort b 0.0 20240922_225453 ebozogl 4Kints.txt
Bubble Sort c 11.0 20240922_225453 ebozogl 4Kints.txt
Bubble Sort d 3.0 20240922_225453 ebozogl 4Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 8Kints.txt 1
Bubble Sort a 37.0 20240922_225459 ebozogl 8Kints.txt
Bubble Sort b 1.0 20240922_225500 ebozogl 8Kints.txt
Bubble Sort c 42.0 20240922_225500 ebozogl 8Kints.txt
Bubble Sort d 32.0 20240922_225500 ebozogl 8Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 16Kints.txt 1
Bubble Sort a 202.0 20240922_225509 ebozogl 16Kints.txt
Bubble Sort b 0.0 20240922_225509 ebozogl 16Kints.txt
Bubble Sort c 141.0 20240922_225509 ebozogl 16Kints.txt
Bubble Sort d 129.0 20240922_225509 ebozogl 16Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 32Kints.txt 1
Bubble Sort a 1019.0 20240922_225514 ebozogl 32Kints.txt
Bubble Sort b 0.0 20240922_225514 ebozogl 32Kints.txt
Bubble Sort c 556.0 20240922_225514 ebozogl 32Kints.txt
Bubble Sort d 272.0 20240922_225514 ebozogl 32Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 1Mints.txt 1
^C
D:\CSC172\Lab03\Lab7>java Sorting 1Kints.txt 3
Quick Sort a 1.0 20240922_233057 ebozogl 1Kints.txt
Quick Sort b 2.0 20240922_233057 ebozogl 1Kints.txt
Quick Sort c 1.0 20240922_233057 ebozogl 1Kints.txt
Quick Sort d 1.0 20240922_233057 ebozogl 1Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 2Kints.txt 3
Quick Sort a 4.0 20240922_233106 ebozogl 2Kints.txt
Quick Sort b 264.0 20240922_233106 ebozogl 2Kints.txt
Quick Sort c 224.0 20240922_233107 ebozogl 2Kints.txt
Quick Sort d 1.0 20240922_233107 ebozogl 2Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 4Kints.txt 3
Quick Sort a 1.0 20240922_233159 ebozogl 4Kints.txt
Quick Sort b 1.0 20240922_233159 ebozogl 4Kints.txt
Quick Sort c 1.0 20240922_233159 ebozogl 4Kints.txt
Quick Sort d 0.0 20240922_233159 ebozogl 4Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 8Kints.txt 3
Quick Sort a 1.0 20240922_233202 ebozogl 8Kints.txt
Quick Sort b 5.0 20240922_233202 ebozogl 8Kints.txt
Quick Sort c 1.0 20240922_233202 ebozogl 8Kints.txt
Quick Sort d 0.0 20240922_233202 ebozogl 8Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 16Kints.txt 3
Quick Sort a 1.0 20240922_233206 ebozogl 16Kints.txt
Quick Sort b 8.0 20240922_233206 ebozogl 16Kints.txt
Quick Sort c 4.0 20240922_233206 ebozogl 16Kints.txt
Quick Sort d 0.0 20240922_233206 ebozogl 16Kints.txt

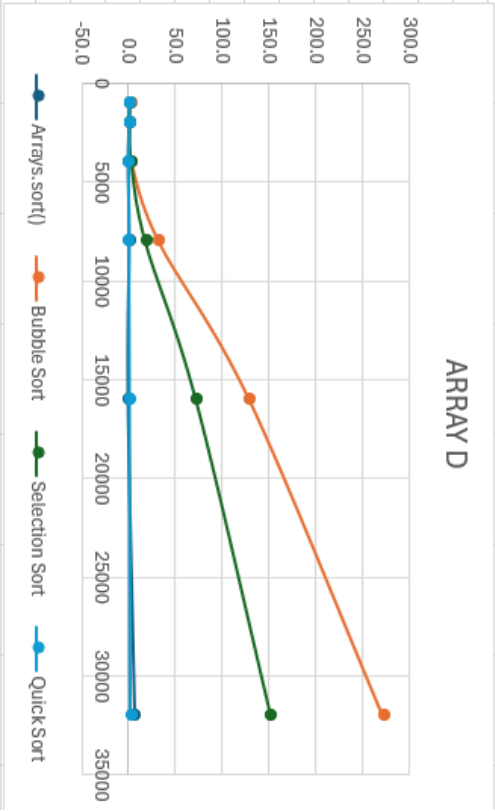
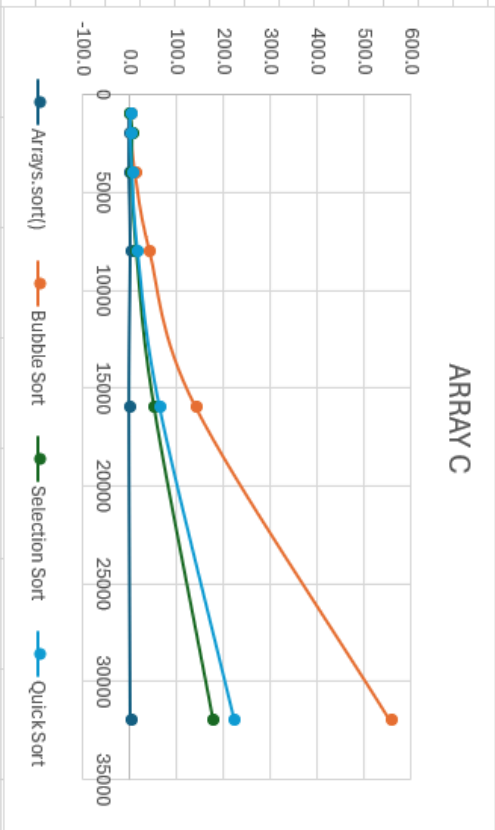
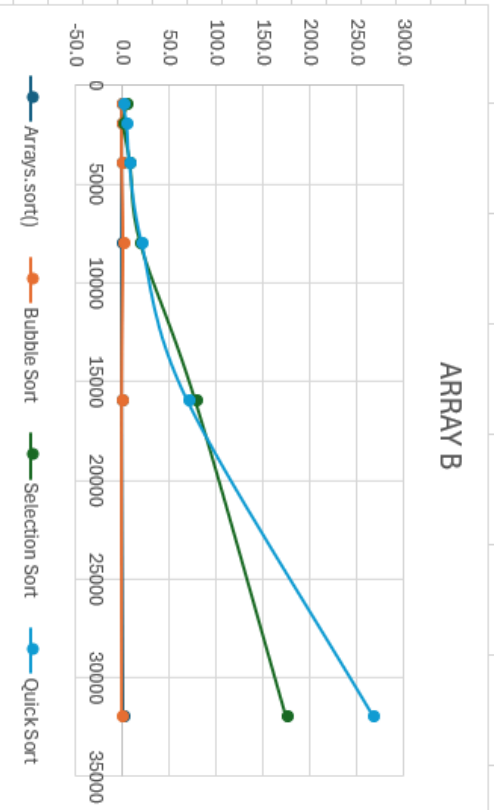
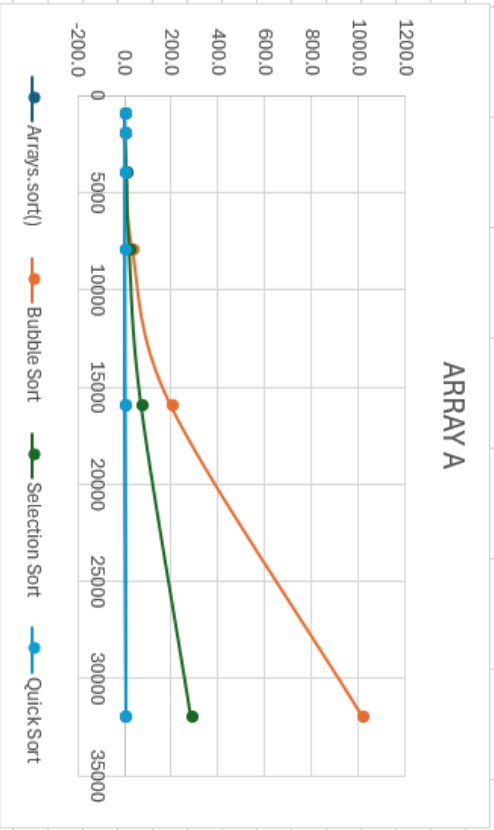
D:\CSC172\Lab03\Lab7>java Sorting 32Kints.txt 3
Quick Sort a 1.0 20240922_233212 ebozogl 32Kints.txt
Quick Sort b 21.0 20240922_233212 ebozogl 32Kints.txt
Quick Sort c 16.0 20240922_233212 ebozogl 32Kints.txt
Quick Sort d 0.0 20240922_233213 ebozogl 32Kints.txt

D:\CSC172\Lab03\Lab7>java Sorting 1Mints.txt 3
Quick Sort a 66.0 20240922_233245 ebozogl 1Mints.txt
Quick Sort b 366897.0 20240922_233852 ebozogl 1Mints.txt
Quick Sort c 219598.0 20240922_234232 ebozogl 1Mints.txt
Quick Sort d 61.0 20240922_234232 ebozogl 1Mints.txt
```

Data Tables:

ARRAY A								
Algorithm	1000	2000	4000	8000	16000	32000	1000000	
Arrays.sort()	0.0	0.0	2.0	1.0	1.0	6.0	62.0	
Bubble Sort	3.0	4.0	11.0	37.0	202.0	1019.0		
Selection Sort	1.0	3.0	9.0	21.0	73.0	286.0		
Quick Sort	1.0	1.0	0.0	1.0	2.0	4.0	66.0	
ARRAY B								
Algorithm	1000	2000	4000	8000	16000	32000	1000000	
Arrays.sort()	0.0	0.0	0.0	0.0	0.0	1.0	3.0	
Bubble Sort	0.0	0.0	0.0	1.0	0.0	0.0		
Selection Sort	4.0	1.0	8.0	19.0	78.0	175.0		
Quick Sort	1.0	5.0	8.0	21.0	70.0	268.0	366897.0	
ARRAY C								
Algorithm	1000	2000	4000	8000	16000	32000	1000000	
Arrays.sort()	0.0	0.0	0.0	1.0	0.0	1.0	4.0	
Bubble Sort	1.0	3.0	11.0	42.0	141.0	556.0		
Selection Sort	0.0	4.0	3.0	13.0	51.0	177.0		
Quick Sort	1.0	1.0	4.0	16.0	63.0	222.0	219598.0	
ARRAY D								
Algorithm	1000	2000	4000	8000	16000	32000	1000000	
Arrays.sort()	1.0	1.0	0.0	1.0	0.0	6.0	33.0	
Bubble Sort	2.0	1.0	3.0	32.0	129.0	272.0		
Selection Sort	1.0	1.0	3.0	18.0	72.0	152.0		
Quick Sort	1.0	1.0	0.0	0.0	1.0	2.0	61.0	

Graph Representation:



Comments:

I've created scatter plots to visualize the performance of different sorting algorithms across various array sizes for four array types (A, B, C, D). My main observations are that `Arrays.sort()` consistently outperforms other algorithms, while Bubble Sort shows the worst performance, especially as array sizes increase. Quick Sort and Selection Sort fall between these extremes. The differences in time complexity become more evident with larger arrays, with Bubble Sort's performance degrading rapidly. Interestingly, the different array types seem to affect algorithm performance, suggesting varying levels of pre-sortedness or distribution in the data. I used a linear scale for the plots, which effectively shows differences at smaller array sizes. To keep other algorithms visible, I excluded the 1M element data for `Arrays.sort()` and Quick Sort. Overall, these visualizations clearly compare sorting algorithm efficiencies, highlighting how algorithm choice significantly impacts performance based on data characteristics and size.

Step 3

Now you will produce a report summarizing your findings.

1. Provide four tables (For four arrays a,b,c, and d respectively). Each row (or record) should provide the run- time for using any particular sorting algorithms, where the columns are for the size of the input. Please re- fer: http://lti.cs.vt.edu/LTI_ruby/Books/CS172/html/SortingEmpirical.html Table 9.15.1 for the format. Each table should have six (6) rows (representing six sorting algorithms) and seven(7) columns (representing seven data files).
2. Generate four plots for four arrays. Use the data from the earlier table to plot the relative performance of each algorithm. Use Logarithmic scale for x-Axis depicting input size. Comment on your finding. Save the screenshots, tables, plots, and your findings as `Lab7Report. pdf` .

