

Lab 3 Report - Analysis of Sorting Algorithms

Dane Backbier

Table #1: n vs. T(n) for Array A

Array: a	T(n) (ms)					
n	Arrays.sort()	Bubble Sort	Selection Sort	Insertion Sort	Merge Sort	Quick Sort
1000	0	15	9	13	1	1
2000	1	18	12	18	1	1
4000	1	25	20	25	3	2
8000	1	64	46	43	4	4
16000	2	217	154	125	9	6
32000	4	816	585	460	10	11
1000000	18	908026	1942797	435028	241	62

Table #2: n vs. T(n) for Array B

Array: b	T(n) (ms)					
n	Arrays.sort()	Bubble Sort	Selection Sort	Insertion Sort	Merge Sort	Quick Sort
1000	0	17	3	0	0	0
2000	0	7	8	0	2	0
4000	0	12	9	0	1	0
8000	0	51	40	0	1	0
16000	1	198	155	0	3	1
32000	1	821	599	0	8	1
1000000	2	902873	1942756	7	56	34

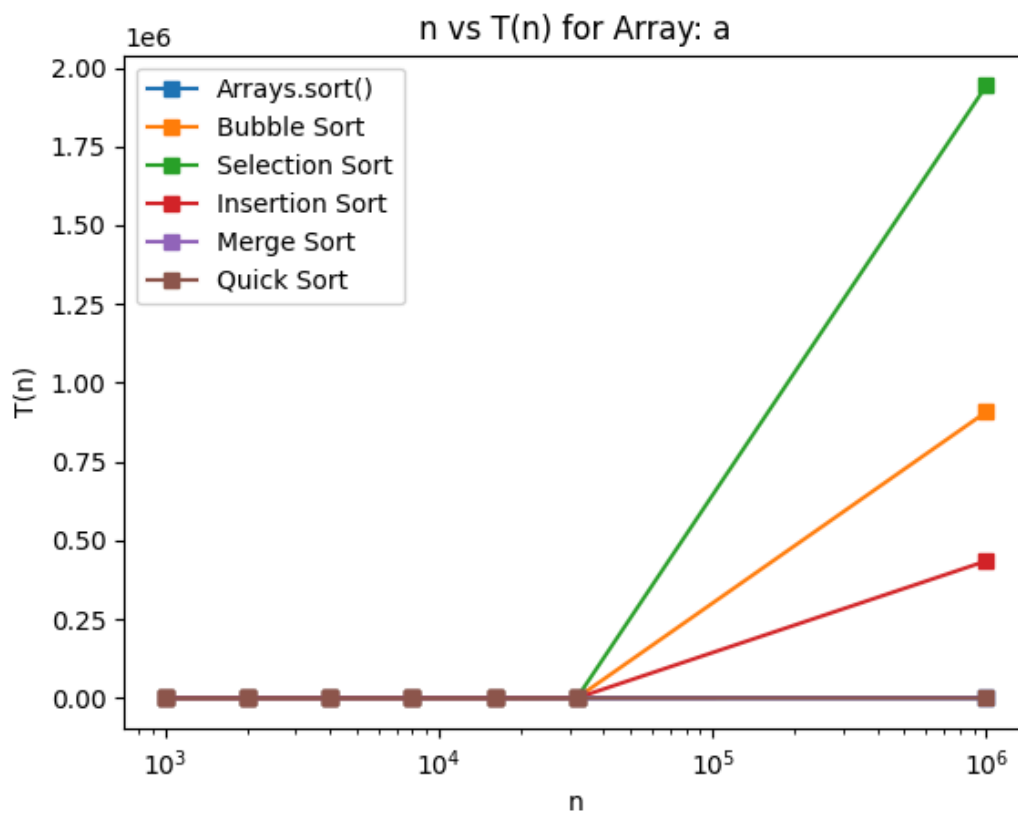
Table #3: n vs. T(n) for Array C

Array: c	T(n) (ms)					
n	Arrays.sort()	Bubble Sort	Selection Sort	Insertion Sort	Merge Sort	Quick Sort
1000	0	0	6	0	0	0
2000	0	1	8	0	1	0
4000	0	7	18	0	0	0
8000	1	21	52	0	1	0
16000	0	85	143	1	3	1
32000	1	342	702	1	10	2
1000000	1	393691	647546	2	56	34

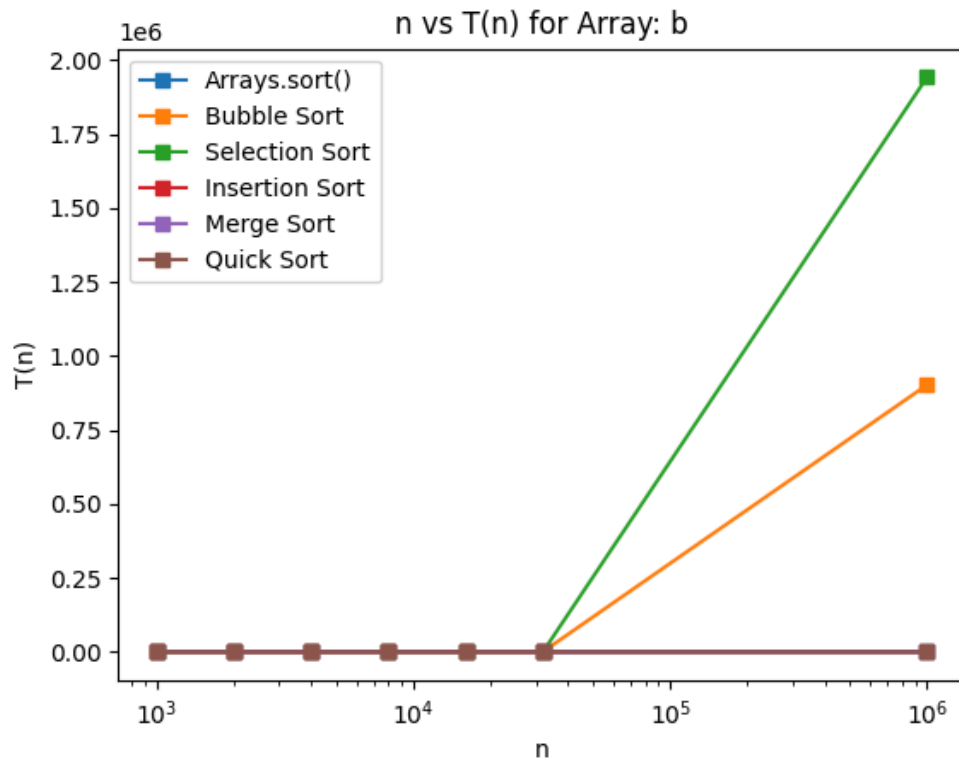
Table #4: n vs. T(n) for Array D

Array: d	T(n) (ms)					
	Arrays.sort()	Bubble Sort	Selection Sort	Insertion Sort	Merge Sort	Quick Sort
1000	0	1	2	0	1	0
2000	0	2	7	0	0	0
4000	0	15	15	0	1	0
8000	0	49	34	0	2	0
16000	0	201	152	1	3	1
32000	1	795	597	1	11	2
1000000	6	391101	651894	2	55	35

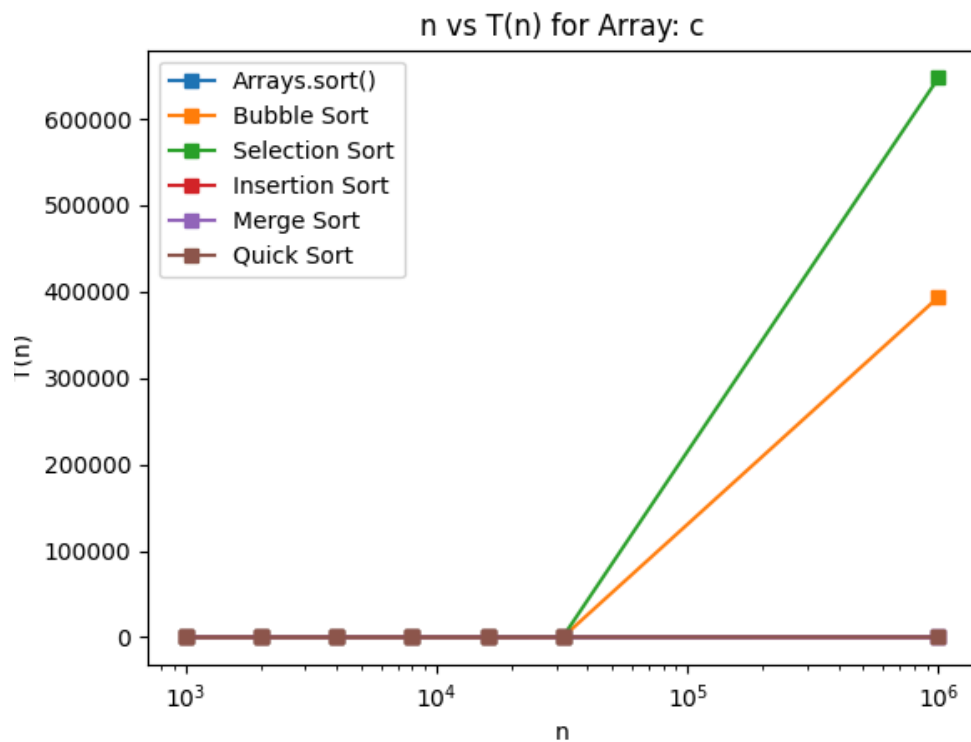
Graph #1: n vs T(n) for Array A



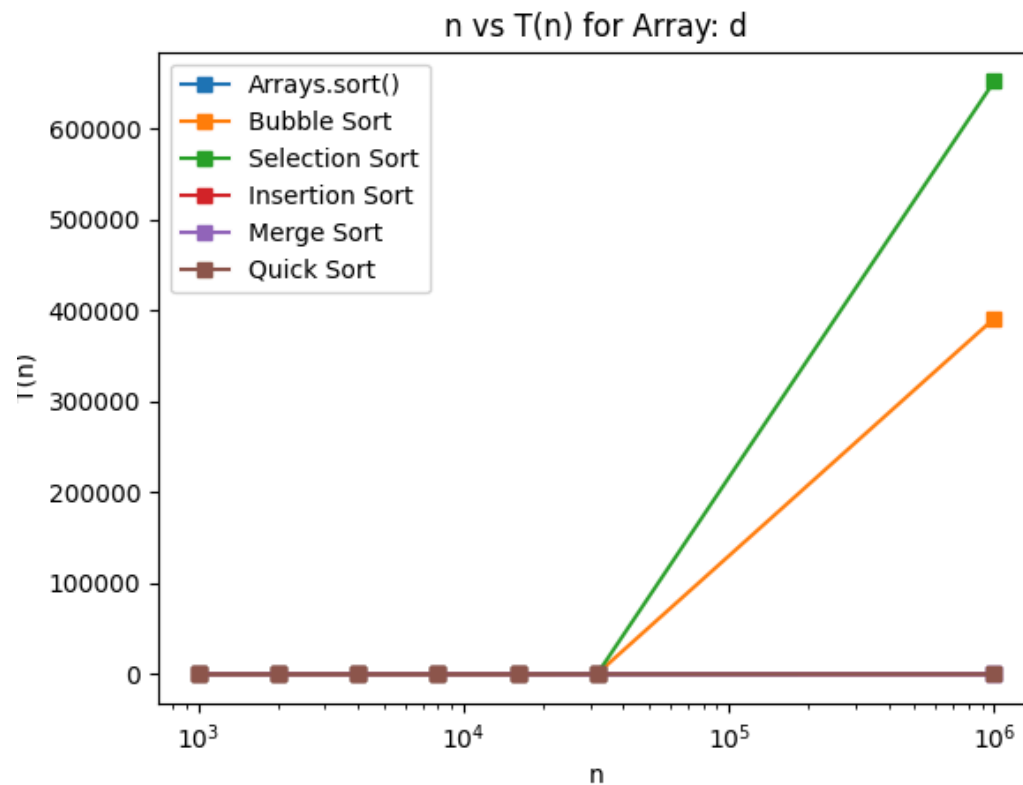
Graph #2: n vs. T(n) for Array B



Graph #3: n vs. T(n) for Array C



Graph #4: n vs. T(n) for Array D



Comments:

Graphs 1 through 4 all show a similar pattern, with bubble sort and selection sort separating from the rest of the algorithms for 1Mints.txt, which makes sense since these two algorithms have the highest time complexity of $O(n^2)$. One surprising thing to note is that in Graph #1, insertion sort also breaks away from the rest, but in the other graphs, the runtime of insertion sort increases so slightly that you can't see it, similar to the Java default, merge, and quick sort.

Shifting focus to the tables, as it's easier to understand the data there, it can be seen how superior Arrays.sort() is compared to the other algorithms. Algorithms like merge sort and quick sort are partially able to compete with the Java default; however, at $n = 1000000$, they begin to diverge significantly. Even insertion sort in its best case (already sorted, array b) was slower than Arrays.sort() for 1 million integers. Interestingly, the runtimes for quick sort for arrays b, c, and d are all very similar.

Appendix 1A: Output Screenshot for Arrays.sort()

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Kints.txt
Arrays.sort() a      0.0  20250915_161501  dbackbie  1Kints.txt
Arrays.sort() b      0.0  20250915_161501  dbackbie  1Kints.txt
Arrays.sort() c      0.0  20250915_161501  dbackbie  1Kints.txt
Arrays.sort() d      0.0  20250915_161501  dbackbie  1Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 2Kints.txt
Arrays.sort() a      1.0  20250915_161505  dbackbie  2Kints.txt
Arrays.sort() b      0.0  20250915_161505  dbackbie  2Kints.txt
Arrays.sort() c      0.0  20250915_161505  dbackbie  2Kints.txt
Arrays.sort() d      0.0  20250915_161505  dbackbie  2Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 4Kints.txt
Arrays.sort() a      1.0  20250915_161511  dbackbie  4Kints.txt
Arrays.sort() b      0.0  20250915_161511  dbackbie  4Kints.txt
Arrays.sort() c      0.0  20250915_161511  dbackbie  4Kints.txt
Arrays.sort() d      0.0  20250915_161511  dbackbie  4Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 8Kints.txt
Arrays.sort() a      1.0  20250915_161516  dbackbie  8Kints.txt
Arrays.sort() b      0.0  20250915_161516  dbackbie  8Kints.txt
Arrays.sort() c      1.0  20250915_161516  dbackbie  8Kints.txt
Arrays.sort() d      0.0  20250915_161516  dbackbie  8Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 16Kints.txt
Arrays.sort() a      2.0  20250915_161525  dbackbie  16Kints.txt
Arrays.sort() b      1.0  20250915_161525  dbackbie  16Kints.txt
Arrays.sort() c      0.0  20250915_161525  dbackbie  16Kints.txt
Arrays.sort() d      0.0  20250915_161525  dbackbie  16Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 32Kints.txt
Arrays.sort() a      4.0  20250915_161538  dbackbie  32Kints.txt
Arrays.sort() b      1.0  20250915_161538  dbackbie  32Kints.txt
Arrays.sort() c      1.0  20250915_161538  dbackbie  32Kints.txt
Arrays.sort() d      1.0  20250915_161538  dbackbie  32Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Mints.txt
Arrays.sort() a     18.0  20250915_161545  dbackbie  1Mints.txt
Arrays.sort() b      2.0  20250915_161545  dbackbie  1Mints.txt
Arrays.sort() c      1.0  20250915_161545  dbackbie  1Mints.txt
Arrays.sort() d      6.0  20250915_161545  dbackbie  1Mints.txt
```

Appendix 1B: Output Screenshots for Bubble Sort

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Kints.txt
Bubble Sort a      15.0    20250915_162952    dbackbie    1Kints.txt
Bubble Sort b      17.0    20250915_162952    dbackbie    1Kints.txt
Bubble Sort c       0.0    20250915_162952    dbackbie    1Kints.txt
Bubble Sort d       1.0    20250915_162952    dbackbie    1Kints.txt
```

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 2Kints.txt
Bubble Sort a      18.0    20250915_163002    dbackbie    2Kints.txt
Bubble Sort b       7.0    20250915_163002    dbackbie    2Kints.txt
Bubble Sort c       1.0    20250915_163002    dbackbie    2Kints.txt
Bubble Sort d       2.0    20250915_163002    dbackbie    2Kints.txt
```

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 4Kints.txt
Bubble Sort a      25.0    20250915_163008    dbackbie    4Kints.txt
Bubble Sort b      12.0    20250915_163008    dbackbie    4Kints.txt
Bubble Sort c       7.0    20250915_163008    dbackbie    4Kints.txt
Bubble Sort d      15.0    20250915_163008    dbackbie    4Kints.txt
```

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 8Kints.txt
Bubble Sort a      64.0    20250915_163013    dbackbie    8Kints.txt
Bubble Sort b      51.0    20250915_163013    dbackbie    8Kints.txt
Bubble Sort c      21.0    20250915_163013    dbackbie    8Kints.txt
Bubble Sort d      49.0    20250915_163013    dbackbie    8Kints.txt
```

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 16Kints.txt
Bubble Sort a     217.0    20250915_163021    dbackbie    16Kints.txt
Bubble Sort b     198.0    20250915_163021    dbackbie    16Kints.txt
Bubble Sort c      85.0    20250915_163021    dbackbie    16Kints.txt
Bubble Sort d     201.0    20250915_163021    dbackbie    16Kints.txt
```

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 32Kints.txt
Bubble Sort a     816.0    20250915_163033    dbackbie    32Kints.txt
Bubble Sort b     821.0    20250915_163033    dbackbie    32Kints.txt
Bubble Sort c     342.0    20250915_163033    dbackbie    32Kints.txt
Bubble Sort d     795.0    20250915_163033    dbackbie    32Kints.txt
```

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Mints.txt
Bubble Sort a    908026.0    20250915_163103    dbackbie    1Mints.txt
Bubble Sort b    902873.0    20250915_163103    dbackbie    1Mints.txt
Bubble Sort c   393591.0    20250915_163103    dbackbie    1Mints.txt
Bubble Sort d   391101.0    20250915_163103    dbackbie    1Mints.txt
```


Appendix 1C: Output Screenshot for Selection Sort

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Kints.txt
Selection Sort a      9.0    20250915_205056  dbackbie  1Kints.txt
Selection Sort b      3.0    20250915_205056  dbackbie  1Kints.txt
Selection Sort c      6.0    20250915_205056  dbackbie  1Kints.txt
Selection Sort d      2.0    20250915_205056  dbackbie  1Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 2Kints.txt
Selection Sort a     12.0    20250915_205101  dbackbie  2Kints.txt
Selection Sort b      8.0    20250915_205101  dbackbie  2Kints.txt
Selection Sort c      8.0    20250915_205101  dbackbie  2Kints.txt
Selection Sort d      7.0    20250915_205101  dbackbie  2Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 4Kints.txt
Selection Sort a     20.0    20250915_205109  dbackbie  4Kints.txt
Selection Sort b      9.0    20250915_205109  dbackbie  4Kints.txt
Selection Sort c     18.0    20250915_205109  dbackbie  4Kints.txt
Selection Sort d     15.0    20250915_205109  dbackbie  4Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 8Kints.txt
Selection Sort a     46.0    20250915_205116  dbackbie  8Kints.txt
Selection Sort b     40.0    20250915_205116  dbackbie  8Kints.txt
Selection Sort c     52.0    20250915_205116  dbackbie  8Kints.txt
Selection Sort d     34.0    20250915_205116  dbackbie  8Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 16Kints.txt
Selection Sort a    154.0    20250915_205122  dbackbie 16Kints.txt
Selection Sort b    155.0    20250915_205122  dbackbie 16Kints.txt
Selection Sort c    143.0    20250915_205122  dbackbie 16Kints.txt
Selection Sort d    152.0    20250915_205122  dbackbie 16Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 32Kints.txt
Selection Sort a    585.0    20250915_205128  dbackbie 32Kints.txt
Selection Sort b    599.0    20250915_205128  dbackbie 32Kints.txt
Selection Sort c    702.0    20250915_205128  dbackbie 32Kints.txt
Selection Sort d    597.0    20250915_205128  dbackbie 32Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Mints.txt
Selection Sort a 1942797.0    20250915_205143  dbackbie 1Mints.txt
Selection Sort b 1942756.0    20250915_205143  dbackbie 1Mints.txt
Selection Sort c  647546.0    20250915_205143  dbackbie 1Mints.txt
Selection Sort d  651894.0    20250915_205143  dbackbie 1Mints.txt
```

Appendix 1D: Output Screenshot for Insertion Sort

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Kints.txt
Insertion Sort a      13.0   20250916_110310   dbackbie   1Kints.txt
Insertion Sort b       0.0   20250916_110310   dbackbie   1Kints.txt
Insertion Sort c       0.0   20250916_110310   dbackbie   1Kints.txt
Insertion Sort d       0.0   20250916_110310   dbackbie   1Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 2Kints.txt
Insertion Sort a      18.0   20250916_110320   dbackbie   2Kints.txt
Insertion Sort b       0.0   20250916_110320   dbackbie   2Kints.txt
Insertion Sort c       0.0   20250916_110320   dbackbie   2Kints.txt
Insertion Sort d       0.0   20250916_110320   dbackbie   2Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 4Kints.txt
Insertion Sort a      25.0   20250916_110323   dbackbie   4Kints.txt
Insertion Sort b       0.0   20250916_110323   dbackbie   4Kints.txt
Insertion Sort c       0.0   20250916_110323   dbackbie   4Kints.txt
Insertion Sort d       0.0   20250916_110323   dbackbie   4Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 8Kints.txt
Insertion Sort a      43.0   20250916_110329   dbackbie   8Kints.txt
Insertion Sort b       0.0   20250916_110329   dbackbie   8Kints.txt
Insertion Sort c       0.0   20250916_110329   dbackbie   8Kints.txt
Insertion Sort d       0.0   20250916_110329   dbackbie   8Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 16Kints.txt
Insertion Sort a     125.0   20250916_110334   dbackbie   16Kints.txt
Insertion Sort b       0.0   20250916_110334   dbackbie   16Kints.txt
Insertion Sort c       1.0   20250916_110334   dbackbie   16Kints.txt
Insertion Sort d       1.0   20250916_110334   dbackbie   16Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 32Kints.txt
Insertion Sort a     460.0   20250916_110339   dbackbie   32Kints.txt
Insertion Sort b       0.0   20250916_110339   dbackbie   32Kints.txt
Insertion Sort c       1.0   20250916_110339   dbackbie   32Kints.txt
Insertion Sort d       1.0   20250916_110339   dbackbie   32Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Mints.txt
Insertion Sort a  435028.0   20250916_110348   dbackbie   1Mints.txt
Insertion Sort b       7.0   20250916_110348   dbackbie   1Mints.txt
Insertion Sort c       2.0   20250916_110348   dbackbie   1Mints.txt
Insertion Sort d       2.0   20250916_110348   dbackbie   1Mints.txt
```


Appendix 1E: Output Screenshot for Merge Sort

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Kints.txt
Merge Sort a      1.0    20250916_112107  dbackbie  1Kints.txt
Merge Sort b      0.0    20250916_112107  dbackbie  1Kints.txt
Merge Sort c      0.0    20250916_112107  dbackbie  1Kints.txt
Merge Sort d      1.0    20250916_112107  dbackbie  1Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 2Kints.txt
Merge Sort a      1.0    20250916_112111  dbackbie  2Kints.txt
Merge Sort b      2.0    20250916_112111  dbackbie  2Kints.txt
Merge Sort c      1.0    20250916_112111  dbackbie  2Kints.txt
Merge Sort d      0.0    20250916_112111  dbackbie  2Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 4Kints.txt
Merge Sort a      3.0    20250916_112117  dbackbie  4Kints.txt
Merge Sort b      1.0    20250916_112117  dbackbie  4Kints.txt
Merge Sort c      0.0    20250916_112117  dbackbie  4Kints.txt
Merge Sort d      1.0    20250916_112117  dbackbie  4Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 8Kints.txt
Merge Sort a      4.0    20250916_112133  dbackbie  8Kints.txt
Merge Sort b      1.0    20250916_112133  dbackbie  8Kints.txt
Merge Sort c      1.0    20250916_112133  dbackbie  8Kints.txt
Merge Sort d      2.0    20250916_112133  dbackbie  8Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 16Kints.txt
Merge Sort a      9.0    20250916_112141  dbackbie  16Kints.txt
Merge Sort b      3.0    20250916_112141  dbackbie  16Kints.txt
Merge Sort c      3.0    20250916_112141  dbackbie  16Kints.txt
Merge Sort d      3.0    20250916_112141  dbackbie  16Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 32Kints.txt
Merge Sort a     10.0    20250916_112146  dbackbie  32Kints.txt
Merge Sort b      8.0    20250916_112146  dbackbie  32Kints.txt
Merge Sort c     10.0    20250916_112146  dbackbie  32Kints.txt
Merge Sort d     11.0    20250916_112146  dbackbie  32Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Mints.txt
Merge Sort a    241.0    20250916_112155  dbackbie  1Mints.txt
Merge Sort b     56.0    20250916_112155  dbackbie  1Mints.txt
Merge Sort c     56.0    20250916_112155  dbackbie  1Mints.txt
Merge Sort d     55.0    20250916_112155  dbackbie  1Mints.txt
```

Appendix 1F: Output Screenshot for Quick Sort

```
C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Kints.txt
Quick Sort a      1.0   20250916_113804   dbackbie 1Kints.txt
Quick Sort b      0.0   20250916_113804   dbackbie 1Kints.txt
Quick Sort c      0.0   20250916_113804   dbackbie 1Kints.txt
Quick Sort d      0.0   20250916_113804   dbackbie 1Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 2Kints.txt
Quick Sort a      1.0   20250916_113814   dbackbie 2Kints.txt
Quick Sort b      0.0   20250916_113814   dbackbie 2Kints.txt
Quick Sort c      0.0   20250916_113814   dbackbie 2Kints.txt
Quick Sort d      0.0   20250916_113814   dbackbie 2Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 4Kints.txt
Quick Sort a      2.0   20250916_113818   dbackbie 4Kints.txt
Quick Sort b      0.0   20250916_113818   dbackbie 4Kints.txt
Quick Sort c      0.0   20250916_113818   dbackbie 4Kints.txt
Quick Sort d      0.0   20250916_113818   dbackbie 4Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 8Kints.txt
Quick Sort a      4.0   20250916_113821   dbackbie 8Kints.txt
Quick Sort b      0.0   20250916_113821   dbackbie 8Kints.txt
Quick Sort c      0.0   20250916_113821   dbackbie 8Kints.txt
Quick Sort d      0.0   20250916_113821   dbackbie 8Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 16Kints.txt
Quick Sort a      6.0   20250916_113827   dbackbie 16Kints.txt
Quick Sort b      1.0   20250916_113827   dbackbie 16Kints.txt
Quick Sort c      1.0   20250916_113827   dbackbie 16Kints.txt
Quick Sort d      1.0   20250916_113827   dbackbie 16Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 32Kints.txt
Quick Sort a     11.0   20250916_113832   dbackbie 32Kints.txt
Quick Sort b      1.0   20250916_113832   dbackbie 32Kints.txt
Quick Sort c      2.0   20250916_113832   dbackbie 32Kints.txt
Quick Sort d      2.0   20250916_113832   dbackbie 32Kints.txt

C:\Users\daneb\.vscode\CSC 172\Labs\Lab3>java Sorting 1Mints.txt
Quick Sort a     62.0   20250916_113839   dbackbie 1Mints.txt
Quick Sort b     34.0   20250916_113839   dbackbie 1Mints.txt
Quick Sort c     34.0   20250916_113839   dbackbie 1Mints.txt
Quick Sort d     35.0   20250916_113839   dbackbie 1Mints.txt
```