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CS 146 Section 1
Programming Project 2

After running tests on array sizes ranging from 10,000 to 100,000,000, there are some notable observations. Surprisingly, there is very little time difference when sorting two arrays that have a size of 10,000 and 100,000. Depending on the output of the random number generator used to populate the arrays, sometimes the bigger array sorts quicker. The comparison count for two arrays that have a size of 10,000 and 100,000 are also relatively close. However, once the array size reaches a million, the sorting time and comparison count begin to increase dramatically. Also, the Randomized-Select algorithm does not result in a reduced sort time. The Randomized-Select algorithm used in the qs2 method is used to partition around the median and ensures that we have little imbalance when we recursively sort, however this results in extra work in order to identify the median.

Array Size	**10,000**	**100,000**	**1,000,000**	**10,000,000**	**100,000,000**
Total time of QS1 milliseconds	6	0	84	946	11444
Total time of QS2 milliseconds	4	3	148	1797	21622
Comparisons Count QS1	196521	222591	28888798	341002065	3789332942
Comparisons Count QS2	342215	421756	69257870	1009713352	12157037403

Program Log:

```
Setup 3 arrays of 10,000 elements:
Are arrays A and B equal prior to sort: true
Are arrays A and C equal prior to sort: true

Array of 10,000 Quicksort method 1:
Duration of QS1: 6 milliseconds
Comparison count of QS1: 196521

Array of 10,000 Quicksort java default method:
Duration of QS java default: 5 milliseconds

Array of 10,000 Quicksort method 2 (median):
Duration of QS2: 4 milliseconds
Comparison count of QS2: 342215

Are arrays A and B equal after sort: true
Are arrays A and C equal after sort: true
Is array A sorted: true
Is array B sorted: true
Is array C sorted: true
```

Setup 3 arrays of 100,000 elements:

```
Are arrays D and E equal prior to sort: true
Are arrays D and F equal prior to sort: true

Array of 100,000 Quicksort method 1:
Duration of QS1: 0 milliseconds
Comparison count of QS1: 222591

Array of 100,000 Quicksort java default method:
Duration of QS java default: 1 milliseconds

Array of 100,000 Quicksort method 2 (median):
Duration of QS2: 3 milliseconds
Comparison count of QS2: 421756

Are arrays D and E equal after sort: true
Are arrays D and F equal after sort: true
Is array D sorted: true
Is array E sorted: true
Is array F sorted: true
```

Setup 3 arrays of 1,000,000 elements:

```
Are arrays G and H equal prior to sort: true
Are arrays G and I equal prior to sort: true

Array of 1,000,000 Quicksort method 1:
Duration of QS1: 84 milliseconds
Comparison count of QS1: 28888798

Array of 1,000,000 Quicksort java default method:
Duration of QS java default: 95 milliseconds

Array of 1,000,000 Quicksort method 2 (median):
Duration of QS2: 148 milliseconds
Comparison count of QS2: 69257870

Are arrays G and H equal after sort: true
Are arrays G and I equal after sort: true
Is array G sorted: true
Is array H sorted: true
Is array I sorted: true
```

Setup 3 arrays of 10,000,000 elements:

```
Are arrays G and H equal prior to sort: true
Are arrays G and I equal prior to sort: true

Array of 10,000,000 Quicksort method 1:
Duration of QS1: 946 milliseconds
Comparison count of QS1: 341002065

Array of 10,000,000 Quicksort java default method:
Duration of QS java default: 842 milliseconds

Array of 10,000,000 Quicksort method 2 (median):
Duration of QS2: 1797 milliseconds
Comparison count of QS2: 1009713352

Are arrays J and K equal after sort: true
Are arrays J and L equal after sort: true
Is array G sorted: true
Is array H sorted: true
Is array I sorted: true
```

Setup 3 arrays of 100,000,000 elements:

```
Are arrays G and H equal prior to sort: true
Are arrays G and I equal prior to sort: true

Array of 100,000,000 Quicksort method 1:
Duration of QS1: 11444 milliseconds
Comparison count of QS1: 3789332942

Array of 100,000,000 Quicksort java default method:
Duration of QS java default: 9657 milliseconds

Array of 100,000,000 Quicksort method 2 (median):
Duration of QS2: 21622 milliseconds
Comparison count of QS2: 12157037403

Are arrays M and N equal after sort: true
Are arrays M and O equal after sort: true
Is array M sorted: true
Is array N sorted: true
Is array O sorted: true
```