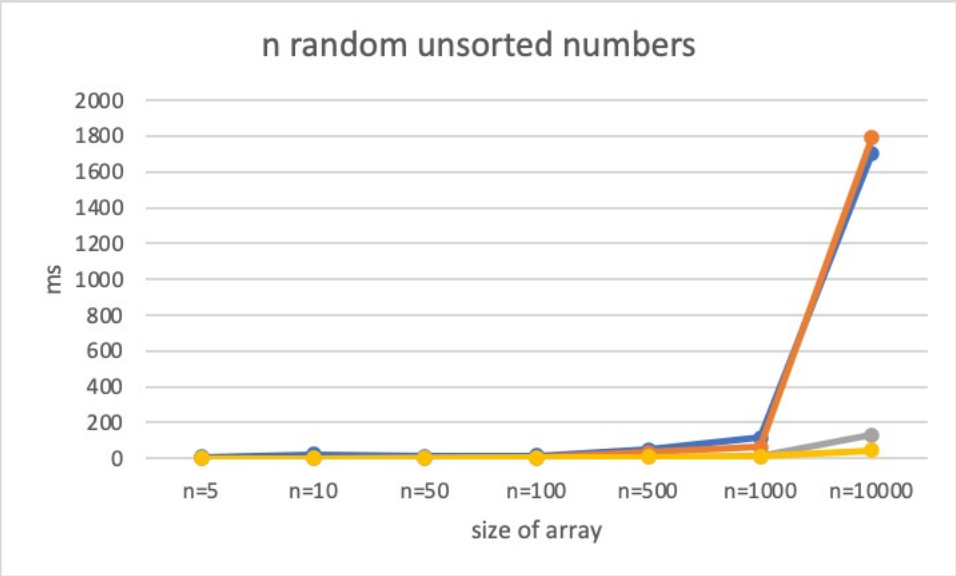
Q2

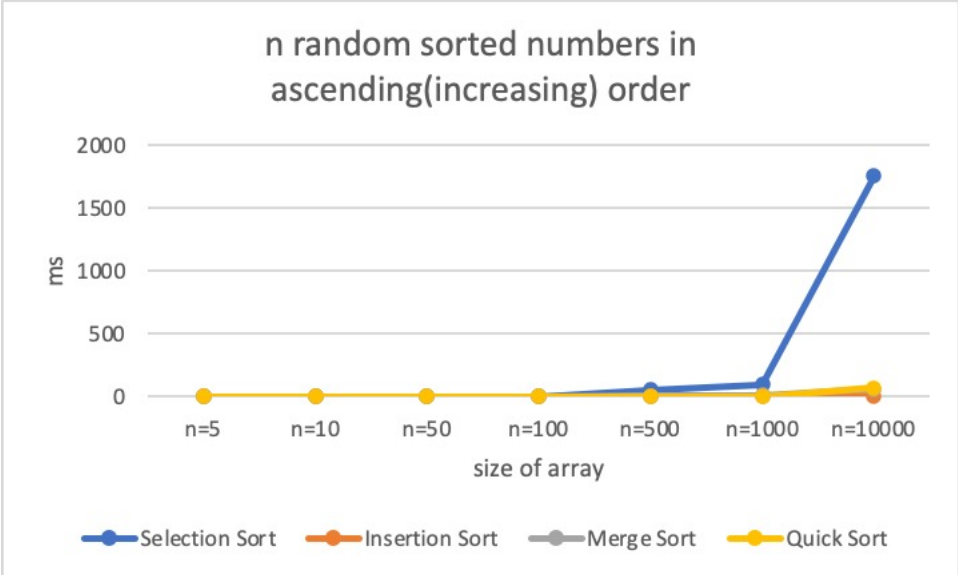
n random unsorted numbers:

Algorithm	n=5	n=10	n=50	n=100	n=500	n=1000	n=10000
Selection Sort	8.18494	20.81892	11.43213	13.0558	49.81161	116.92278	1703.62903
Insertion Sort	0.09548	0.12515	0.4453	2.28715	34.08061	61.20072	1792.21928
Merge Sort	0.20406	0.34279	2.16947	1.61143	7.97337	12.49275	128.74144
Quick Sort	0.13865	0.23557	0.34798	1.9622	6.77097	10.21593	43.52293



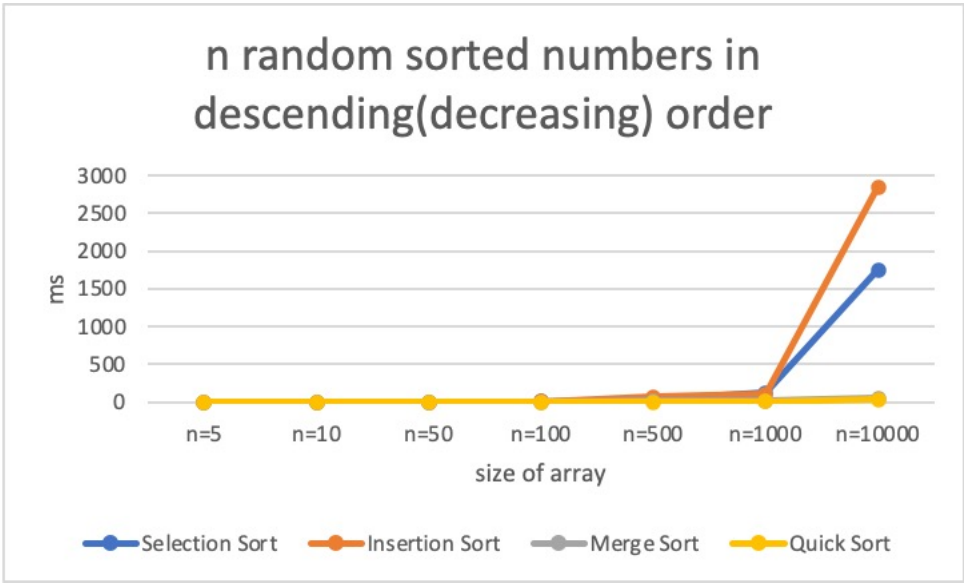
n random sorted numbers in ascending(increasing) order:

Algorithm	n=5	n=10	n=50	n=100	n=500	n=1000	n=10000
Selection Sort	0.07431	0.16909	3.09277	3.29725	53.87743	97.79655	1753.07329
Insertion Sort	0.06849	0.0801	0.08382	0.10571	0.33963	0.70986	6.83453
Merge Sort	0.1961	0.2559	0.76144	1.39256	7.53997	12.47577	62.27649
Quick Sort	0.07725	0.15246	0.16608	0.36361	0.77268	1.45553	71.86234



n random sorted numbers in descending(decreasing) order:

Algorithm	n=5	n=10	n=50	n=100	n=500	n=1000	n=10000
Selection Sort	0.07972	0.172	1.98737	3.10357	46.71075	118.40056	1753.45876
Insertion Sort	0.08319	0.20924	0.9055	2.60239	73.32035	107.80084	2849.55394
Merge Sort	0.18205	0.34931	0.76303	1.3621	12.21739	16.78406	51.91658
Quick Sort	0.1102	0.17365	0.2529	0.39084	2.47204	4.47844	30.74935



Discussion:

Selection Sort: O(n^2)
Insertion Sort: O(n^2)
Merge Sort: O(nlogn)
Quick Sort: O(n^2) expected O(nlogn)

Comparing the sortedness of the input array, when the input array is sorted, merge sort will spend less time than input an unsorted array. Especially, if the sorted array and insertion sort algorithm have the same direction for example, both are ascending, then this algorithm will greatly reduce the running time, because it does not need to swap. For other two algorithms, the sortedness hardly affected on them.

As for the influence of the array size "n" suppose the input array is unsorted, when n is small, selection sort and insertion sort may faster than merge and quick sort. However, when n is big enough, merge sort and quick sort are much faster than selection and insertion sort.

I expected quick sort is faster than merge sort when the array is sorted, because they at that time both big-O is O(nlog(n)) and merge sort spends more space memory. But the test shows that quick sort is slower than merge when array is in ascending order (I set both algorithm in sorting ascending) but faster in descending.

Code:

```
public static void main (String[] args) {
        int size = 10; //SIZE input(5, 10, 50, 100, 500, 1000, 10000)
        ArrayList<Integer> list = new ArrayList<>(size+1);
        for (int i = 0; i <= size; i++){
            list.add(i);
        }
        Integer[] a = new Integer[size];
        for (int count = 0; count < size; count++){
            a[count] = list.remove((int)(Math.random() * list.size()));
        }
        // output a sorted list, true is des and false is asc
        //SortingAlgorithms.quickSort(a, true);

        Integer[] selection = new Integer[size];
        Integer[] insertion = new Integer[size];
        Integer[] merge = new Integer[size];
        Integer[] quick = new Integer[size];

        System.arraycopy(a, 0, selection, 0, a.length);
        System.arraycopy(a, 0, insertion, 0, a.length);
```

```
System.arraycopy(a, 0, merge, 0, a.length);
System.arraycopy(a, 0, quick, 0, a.length);

double startTime=System.nanoTime();
SortingAlgorithms.selectionSort(selection, false);
double endTime=System.nanoTime();
System.out.println("selection： "+(endTime.
startTime)/100000+"ms");

startTime=System.nanoTime();
SortingAlgorithms.insertionSort(insertion, false);
endTime=System.nanoTime();
System.out.println("insertion： "+(endTime-
startTime)/100000+"ms");

startTime=System.nanoTime();
SortingAlgorithms.mergeSort(merge, false);
endTime=System.nanoTime();
System.out.println("merge： "+(endTime-startTime)/100000+"ms");

startTime=System.nanoTime();
SortingAlgorithms.quickSort(quick, false);
endTime=System.nanoTime();
System.out.println("quick： "+(endTime-startTime)/100000+"ms");
```