iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: VII Month of publication: July 2020

DOI: http://doi.org/10.22214/ijraset.2020.7042

Bilateral Selection Sort

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Abstract: In today's digital world data is playing wide role and the amount of the is growing drastically. Sorting of data makes it easier to handle data in large scale. There are many sorting techniques are available for sorting of data. Some of these techniques are Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Merge Sort, Heap Sort, etc. Some sorting techniques work faster for small amount of data and some work faster for large amount of data.

I. INTRODUCTION

Sorting is process of arranging list of elements to ascending and descending order Information/data growth in digital world leads to rapid development of sorting algorithm. The sorting algorithms with increased performance and decreased complexity attracts researcher's attention towards sorting techniques. Selection sort algorithm is used to sort elements based on min elements for ascending sort and max element for descending sort. On other hand bilateral sorting implies to sort elements by finding smallest and largest element at same time and swapping with start and end position of unsorted array.

II. ANALYSIS OF OLD SELECTION SORT ALGORITHM [1]

A. Selection Sort

This is a very easy sorting algorithm to understand and is very useful when dealing with small amounts of data. However, as with Bubble sorting, a lot of data really slows it down. Selection sort does have one advantage over other sort techniques. Although it does many comparisons, it does the least amount of data moving. Thus, if your data has small keys but large data area, then selection sorting may be the quickest.

B. Pseudo Code of Old Selection Sort

Algorithm SelectionSort (X, n) =>X [0...n-1]
For i ← n – 1 to 0
IndexOfLarge ← 0
For j←1 to i
If (X[j]>X [IndexOfLarge))
IndexOfLarge ← large ←X [IndexOfLarge]
X [IndexOfLarge] ← X[i]
X[i] ← Large

III. ANALYSIS OF BILATERAL SELECTION SORT (BSS) ALGORITHM

The idea behind the BSS is to make a better version of selection sort and reduce the time complexity of selection sort by minimizing the number of iterations i.e. by selecting smallest and largest element at same time and putting them to their appropriate place to get sorted elements. The time complexity of selection sort is O(N2) whereas the time complexity of BSS is also O(N2).Even if it's O(N2) the bilateral performs better because there are less number of iterations as two elements are sorted at a time.

A. Algorithm

1) *Step 1:* Set MIN AND MAX to location 0
2) *Step 2:* Set leftshrink = i and rightshrink= n
3) *Step 3:* Search the minimum and maximum element in the list
4) *Step 4:* Swap the minimum with List[leftshrink] and Maximum with List[rightshrink]
5) *Step 5:* Increment min point and decrement max point
6) *Step 6:* Decrement rightshrink
7) *Step 7:* Repeat until List/2

B. Pseudo code

```
START PROCEDURE
   list: Array of elements
   n: Size of list
   rightshrink: n-1
   FOR i = 0 till n/2
     min = i
     max = i
     FOR leftshrink = i till rightshrink
       IF list[leftshrink] > max
          THEN max = list[ leftshrink ] AND   getindexmax = leftshrink
       ELSE IF list [leftshrink] < min
          THEN min = list [ leftshrink ] AND getindexmin = leftshrink

      END-FOR
     Swap in list (list[ i ] with list[getindexmin])
          IF list[ getindexmax ] == max
               Swap in list ( list[ rightshrink ] with          list[getindexmin ])
          ELSE
               Swap in list ( list[ rightshrink ] with        list [ getindexmax ])
           --rightshrink
   END-FOR
END PROCEDURE
```

C. Code

```
public void BSS(int[] arr)
{
    int n = arr.length;
    int rightshrink=n-1;
    int temp=0,min,max,getindexmin,getindexmax;
    for(int i = 0;i < n/2; i++) {
         min = max = arr[i];
         getindexmin = getindexmax = i;
         for (int leftshrink = i; leftshrink <= rightshrink; leftshrink++){
           if (arr[leftshrink] > max){
                max = arr[leftshrink];
                getindexmax = leftshrink;
             }
           else if (arr[leftshrink] < min){
                min = arr[leftshrink];
                getindexmin = leftshrink;
           }
     }
     temp = arr[i];
     arr[i]=arr[getindexmin];
     arr[getindexmin]=temp;
     if (arr[getindexmin] == max) {
          temp = arr[rightshrink];
          arr[rightshrink] =arr[getindexmin];
          arr[getindexmin] =temp;
```

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VII July 2020- Available at www.ijraset.com

```
        }
        else {
            temp = arr[rightshrink];
            arr[rightshrink] =arr[getindexmax];
            arr[getindexmax] =temp;
        }
        --rightshrink;
        }
}
```

IV. BREAK DOWN ANALYSIS OF SELECTION SORT WITH BILATERAL SELECTION SORT

BSS Sort works with same structure as Selection sort follows. But the iterations are dynamically calculated on the size of data which needs to be sort. Selection Sort has the complexity of O(n2) for the best case , worst case and average case. BSS complexity is been derived (n/2)*(n/2) = O(n2).
Following is the breakdown for every iteration for better understanding.

A. Considering Data of 5 Elements

Selection Sort

Outer Loop	1	2	3	4
Inner Loop	4	3	2	1
Total : Outer Loop total(4) x (Total Inner Loop(4+3+2+1)) = 14				

Bilateral Selection Sort

Outer Loop	1	2
Inner Loop	5	3
Total : Outer Loop total(2) x (Total Inner Loop(5+3)) = 10		

B. Considering Data of 6 Elements

Selection Sort

Outer Loop	1	2	3	4	5
Inner Loop	5	4	3	2	1
Total : Outer Loop total(5) x (Total Inner Loop(5+4+3+2+1)) = 20					

Bilateral Selection Sort

Outer Loop	1	2	3
Inner Loop	6	4	2
Total : Outer Loop total(3) x (Total Inner Loop(6+4+2)) = 15			

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C. Considering Data of 7 Elements

Selection Sort

Outer Loop	1	2	3	4	5	6
Inner Loop	6	5	4	3	2	1
Total : Outer Loop total(6) x (Total Inner Loop(6+5+4+3+2+1)) = 27						

Bilateral Selection Sort

Outer Loop	1	2	3
Inner Loop	7	5	3
Total : Outer Loop total(3) x (Total Inner Loop(7+5+3)) = 18			

D. Considering Data of 8 Elements

Selection Sort

Outer Loop	1	2	3	4	5	6	7
Inner Loop	7	6	5	4	3	2	1
Total : Outer Loop total(7) x (Total Inner Loop(7+6+5+4+3+2+1)) = 35							

Bilateral Selection Sort

Outer Loop	1	2	3	4
Inner Loop	8	6	4	2
Total : Outer Loop total(4) x (Total Inner Loop(8+6+4+2)) = 24				

E. Considering Data of 9 Elements

Selection Sort

Outer Loop	1	2	3	4	5	6	7	8
Inner Loop	8	7	6	5	4	3	2	1
Total : Outer Loop total(8) x (Total Inner Loop(8+7+6+5+4+3+2+1)) = 44								

Bilateral Selection Sort

Outer Loop	1	2	3	4
Inner Loop	9	7	5	3
Total : Outer Loop total(4) x (Total Inner Loop(9+7+5+3)) = 28				

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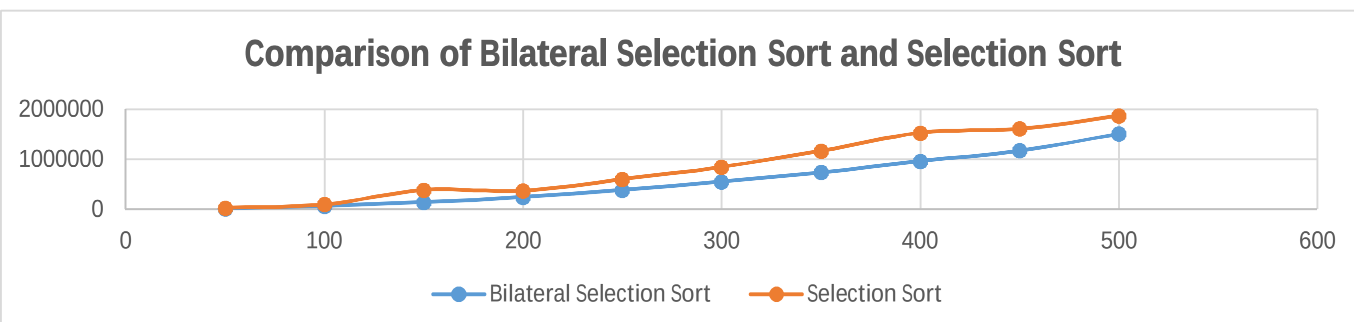
F. Considering Data of 10 Elements

Selection Sort

Outer Loop	1	2	3	4	5	6	7	8	9
Inner Loop	9	8	7	6	5	4	3	2	1
Total : Outer Loop total(9) x (Total Inner Loop(9+8+7+6+5+4+3+2+1)) = 54									

Selection Sort											
Data	Execution Times (Random Values)										Average
50	31852	33621	34683	33975	32913	32205	33267	32559	33974	34328	33337.7
100	99093	99447	100508	98739	99801	108648	107233	110064	110772	109710	104401.5
150	380801	397081	360274	389295	373369	384694	489449	371954	400266	370184	391736.7
200	380093	394957	372661	382924	364167	370538	363105	382924	370598	373369	375533.6
250	557753	597744	667110	595975	609777	597744	581819	667110	586773	607299	606910.4
300	774696	858218	889362	818935	1098519	819289	818934	822119	826012	794869	852095.3
350	1134971	1463748	1113737	1111967	1208583	1131432	1231940	1095334	1111968	1098873	1170255.3
400	1408893	1572396	1851981	1477197	1486397	1466226	1561779	1498077	1570981	1443222	1533714.9
450	1634330	1580537	1605663	1604601	1550809	1509402	1778723	1567442	1508693	1778723	1611892.3
500	1805266	2306040	1756781	2306040	1716081	1619465	1712189	1805265	1847026	1874985	1874913.8

Bilateral Selection Sort											
Data	Execution Times (Random Values)										Average
50	22650	24066	22649	24066	22650	22650	24420	24065	24066	21942	23322.4
100	77151	75382	76798	75382	75382	77151	72550	78212	77151	72550	75770.9
150	148993	145455	153949	154656	145455	151825	150056	157488	151825	150055	150975.7
200	251625	248794	248441	252688	253749	248086	251626	249148	253042	241363	249856.2
250	385401	473170	379739	392480	377615	391064	381863	374785	379739	377615	391347.1
300	546428	543950	541827	634904	560938	599868	539704	545012	534749	536165	558354.5
350	724088	723026	858925	717010	760894	717010	719488	740014	746030	723381	742986.6
400	928291	927583	1028800	993409	935369	972175	935015	971467	1067375	938200	969768.4
450	1173192	1190534	1173901	1180271	1179563	1166822	1179563	1163991	1180978	1177086	1176590.1
500	1445345	1463394	1579829	1455255	1533113	1515772	1519665	1498431	1594338	1515418	1512056



Bilateral Selection Sort

Outer Loop	1	2	3	4	5
Inner Loop	10	8	6	4	2
Total : Outer Loop total(5) x (Total Inner Loop(10+8+6+4+2)) = 35					

As per the understanding from the breakdown analysis we find the pattern of total iteration between both the selection sort and bilateral selection sort as follow:

Total Loop Iterations

No of data	5	6	7	8	9	10	11	12	13	14	15
Selection Sort	14	20	27	35	44	54	65	77	90	104	119
Bilateral Selection Sort	10	15	18	24	28	35	40	48	54	63	70

This data shows the iterations of selection sort with respect to bilateral selection sort and number of iterations in bilateral sort is lesser which makes it faster than selection sort.

V. COMPARISON ANALYSIS OF SELECTION SORT AND BILATERAL SELECTION SORT (BSS)

The following table shows the detailed analysis of Bilateral Selection Sort and its performance with respect to Selection Sort Algorithm in nanoseconds.

The above analysis for the comparison between Bilateral Selection Sort and Selection Sort Algorithm is derived from the following constraints

Dataset of random 50 to 500 numbers are applied on Bilateral Selection Sort and the same dataset is applied on the Selection Sort for the analysis.

The following dataset is applied 10 times for more accurate result because on every execution of algorithm the CPU internally processes different task on each thread in the operating system so output execution in nano time differs every time so to get precise result the random same dataset is applied for 2 times of 1st Iteration of result.

Formula for execution time of algorithm is followed as:

long startTime = System.*nanoTime*();
BilateralSelectionSortAlgorithm(array)
OR
SelectionSortAlgorithm(array);
long elapsedTime = System.*nanoTime*() - startTime;

As per the analysis the derived output is been tested

No. of data	Selection Sort	Bilateral Selection Sort	Total
50	10	10	20
100	10	10	20
150	10	10	20
200	10	10	20
250	10	10	20
300	10	10	20
350	10	10	20
400	10	10	20
450	10	10	20
500	10	10	20
Total			200

Therefore the comparison chart of Bilateral Selection Sort and Selection Sort is derived where it results to Bilateral Selection Sort Algorithm works faster compare to Selection Sort Algorithm in sorting data.

VI. CONCLUSION

Logic of Bilateral Selection Sort is based on the Selection sort algorithm. The main difference in Selection sort and Bilateral Selection Sort is that the Selection sort sorts the data from one end i.e. from largest element of array to smallest element or from smallest to largest but the later starts sorting from both ends and finds the largest and smallest data elements of array in single iteration and places those at their appropriate locations then during second iteration it sorts the second largest and second smallest elements from the remaining array data and places those in their appropriate locations in the array. Similarly, it sorts rest of the data elements and puts those in their proper positions. Bilateral Selection Sort sorts the data in half iterations as compared to selection sort technique. The improvement is also of the order.

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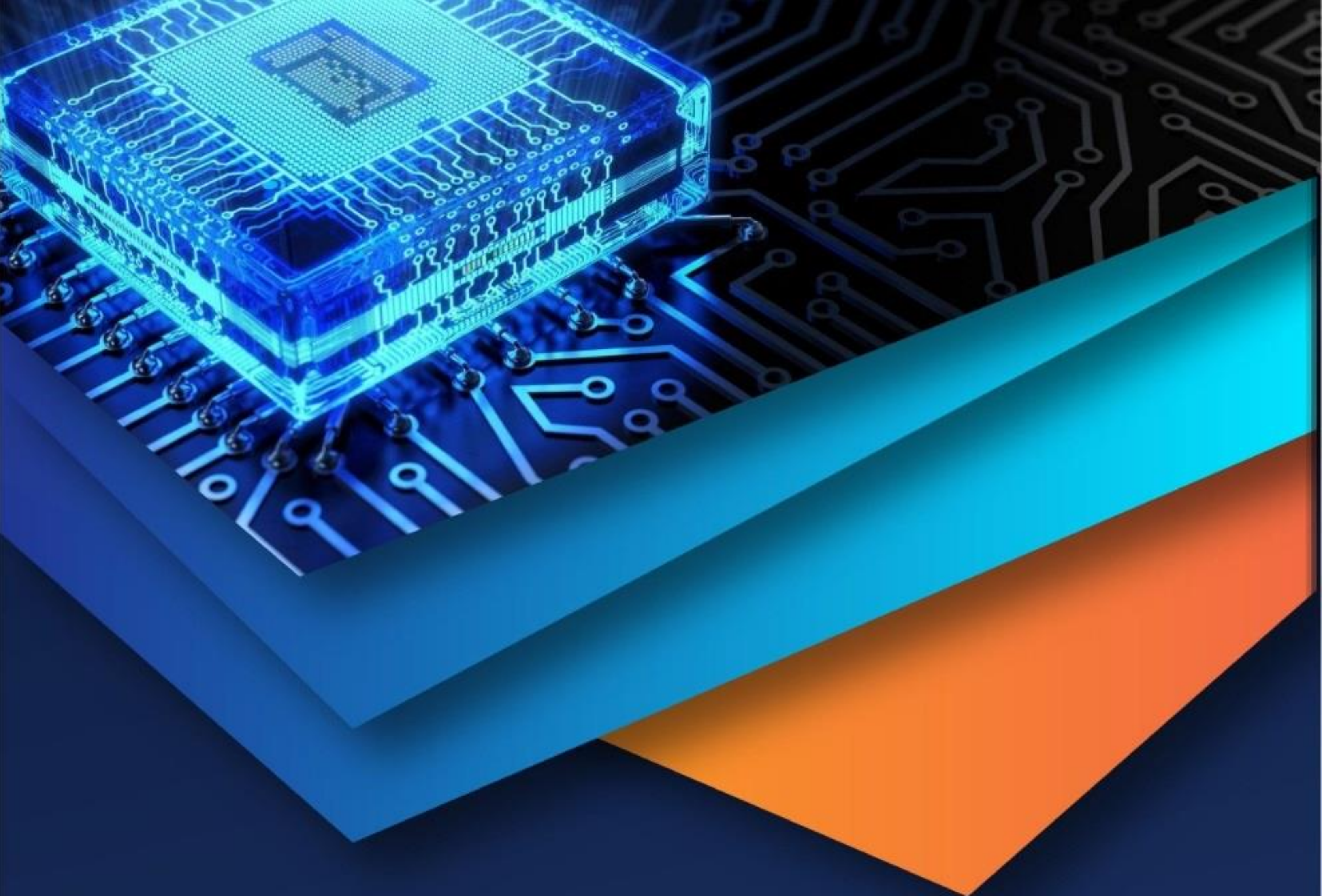

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