Bubble Sort

Bubble Sort is the simplest sorting algorithm that works by repeatedly swapping the adjacent elements if they are in wrong order.

Example:

First Pass:

(**5** **1** 4 2 8) –> (**1** **5** 4 2 8), Here, algorithm compares the first two elements, and swaps since 5 > 1.

(1 **5** **4** 2 8) –> (1 **4** **5** 2 8), Swap since 5 > 4

(1 4 **5** **2** 8) –> (1 4 **2** **5** 8), Swap since 5 > 2

(1 4 2 **5** **8**) –> (1 4 2 **5** **8**), Now, since these elements are already in order (8 > 5), algorithm does not swap them.

Second Pass:

(**1** **4** 2 5 8) –> (**1** **4** 2 5 8)

(1 **4 2** 5 8) –> (1 **2 4** 5 8), Swap since 4 > 2
(1 2 **4 5** 8) –> (1 2 **4 5** 8)
(1 2 4 **5 8**) –> (1 2 4 **5 8**)
Now, the array is already sorted, but our algorithm does not know if it is completed. The algorithm needs one **whole** pass without **any** swap to know it is sorted.

Third Pass:
(**1 2** 4 5 8) –> (**1 2** 4 5 8)
(1 **2 4** 5 8) –> (1 **2 4** 5 8)
(1 2 **4 5** 8) –> (1 2 **4 5** 8)
(1 2 4 **5 8**) –> (1 2 4 **5 8**)

Recommended: Please solve it on "*PRACTICE*" first, before moving on to the solution.

Following is the implementations of Bubble Sort.

C++

```
// C++ program for implementation of Bubble sort
#include <bits/stdc++.h>
using namespace std;

void swap(int *xp, int *yp)
{
    int temp = *xp;
    *xp = *yp;
    *yp = temp;
}

// A function to implement bubble sort
void bubbleSort(int arr[], int n)
{
    int i, j;
    for (i = 0; i < n-1; i++)

    // Last i elements are already in place
    for (j = 0; j < n-i-1; j++)
        if (arr[j] > arr[j+1])
            swap(&arr[j], &arr[j+1]);
}
```

```
/* Function to print an array */
void printArray(int arr[], int size)
{
    int i;
    for (i = 0; i < size; i++)
        cout << arr[i] << " ";
    cout << endl;
}

// Driver code
int main()
{
    int arr[] = {64, 34, 25, 12, 22, 11, 90};
    int n = sizeof(arr)/sizeof(arr[0]);
    bubbleSort(arr, n);
    cout<<"Sorted array: \n";
    printArray(arr, n);
    return 0;
}

// This code is contributed by rathbhupendra
```

C

```
// C program for implementation of Bubble sort
#include <stdio.h>

void swap(int *xp, int *yp)
{
    int temp = *xp;
    *xp = *yp;
    *yp = temp;
}

// A function to implement bubble sort
void bubbleSort(int arr[], int n)
{
   int i, j;
   for (i = 0; i < n-1; i++)

       // Last i elements are already in place
       for (j = 0; j < n-i-1; j++)
           if (arr[j] > arr[j+1])
              swap(&arr[j], &arr[j+1]);
}

/* Function to print an array */
void printArray(int arr[], int size)
```

```
{
    int i;
    for (i=0; i < size; i++)
        printf("%d ", arr[i]);
    printf("\n");
}

// Driver program to test above functions
int main()
{
    int arr[] = {64, 34, 25, 12, 22, 11, 90};
    int n = sizeof(arr)/sizeof(arr[0]);
    bubbleSort(arr, n);
    printf("Sorted array: \n");
    printArray(arr, n);
    return 0;
}
```

Java

```
// Java program for implementation of Bubble Sort
class BubbleSort
{
    void bubbleSort(int arr[])
    {
        int n = arr.length;
        for (int i = 0; i < n-1; i++)
            for (int j = 0; j < n-i-1; j++)
                if (arr[j] > arr[j+1])
                {
                    // swap arr[j+1] and arr[i]
                    int temp = arr[j];
                    arr[j] = arr[j+1];
                    arr[j+1] = temp;
                }
    }

    /* Prints the array */
    void printArray(int arr[])
    {
        int n = arr.length;
        for (int i=0; i<n; ++i)
            System.out.print(arr[i] + " ");
        System.out.println();
    }

    // Driver method to test above
    public static void main(String args[])
```

```
    {
        BubbleSort ob = new BubbleSort();
        int arr[] = {64, 34, 25, 12, 22, 11, 90};
        ob.bubbleSort(arr);
        System.out.println("Sorted array");
        ob.printArray(arr);
    }
}
/* This code is contributed by Rajat Mishra */
```

Python

```
# Python program for implementation of Bubble Sort

def bubbleSort(arr):
    n = len(arr)

    # Traverse through all array elements
    for i in range(n):

        # Last i elements are already in place
        for j in range(0, n-i-1):

            # traverse the array from 0 to n-i-1
            # Swap if the element found is greater
            # than the next element
            if arr[j] > arr[j+1] :
                arr[j], arr[j+1] = arr[j+1], arr[j]

# Driver code to test above
arr = [64, 34, 25, 12, 22, 11, 90]

bubbleSort(arr)

print ("Sorted array is:")
for i in range(len(arr)):
    print ("%d" %arr[i]),
```

C#

```
// C# program for implementation
// of Bubble Sort
using System;

class GFG
{
```

```
    static void bubbleSort(int []arr)
    {
        int n = arr.Length;
        for (int i = 0; i < n - 1; i++)
            for (int j = 0; j < n - i - 1; j++)
                if (arr[j] > arr[j + 1])
                {
                    // swap temp and arr[i]
                    int temp = arr[j];
                    arr[j] = arr[j + 1];
                    arr[j + 1] = temp;
                }
    }

    /* Prints the array */
    static void printArray(int []arr)
    {
        int n = arr.Length;
        for (int i = 0; i < n; ++i)
            Console.Write(arr[i] + " ");
        Console.WriteLine();
    }

    // Driver method
    public static void Main()
    {
        int []arr = {64, 34, 25, 12, 22, 11, 90};
        bubbleSort(arr);
        Console.WriteLine("Sorted array");
        printArray(arr);
    }

}

// This code is contributed by Sam007
```

PHP

```
<?php
// PHP program for implementation
// of Bubble Sort

function bubbleSort(&$arr)
{
    $n = sizeof($arr);

    // Traverse through all array elements
    for($i = 0; $i < $n; $i++)
```

```
    {
        // Last i elements are already in place
        for ($j = 0; $j < $n - $i - 1; $j++)
        {
            // traverse the array from 0 to n-i-1
            // Swap if the element found is greater
            // than the next element
            if ($arr[$j] > $arr[$j+1])
            {
                $t = $arr[$j];
                $arr[$j] = $arr[$j+1];
                $arr[$j+1] = $t;
            }
        }
    }
}

// Driver code to test above
$arr = array(64, 34, 25, 12, 22, 11, 90);

$len = sizeof($arr);
bubbleSort($arr);

echo "Sorted array : \n";

for ($i = 0; $i < $len; $i++)
    echo $arr[$i]." ";

// This code is contributed by ChitraNayal.
?>
```

Output:

```
Sorted array:
11 12 22 25 34 64 90
```

<!—-**Illustration :**

		0	1	2	3	4	5	6	7
i = 0	j								
	0	5	3	1	9	8	2	4	7
	1	3	5	1	9	8	2	4	7
	2	3	1	5	9	8	2	4	7
	3	3	1	5	9	8	2	4	7
	4	3	1	5	8	9	2	4	7
	5	3	1	5	8	2	9	4	7
	6	3	1	5	8	2	4	9	7
i=1	0	3	1	5	8	2	4	7	9
	1	1	3	5	8	2	4	7	
	2	1	3	5	8	2	4	7	
	3	1	3	5	8	2	4	7	
	4	1	3	5	2	8	4	7	
	5	1	3	5	2	4	8	7	
i=2	0	1	3	5	2	4	7	8	
	1	1	3	5	2	4	7		
	2	1	3	5	2	4	7		
	3	1	3	2	5	4	7		
	4	1	3	2	4	5	7		
i=3	0	1	3	2	4	5	7		
	1	1	3	2	4	5			
	2	1	2	3	4	5			
	3	1	2	3	4	5			
i=4	0	1	2	3	4	5			
	1	1	2	3	4				
	2	1	2	3	4				
i=5	0	1	2	3	4				
	1	1	2	3					
i=6	0	1	2	3					
		1	2						

—>

Optimized Implementation:

The above function always runs O(n^2) time even if the array is sorted. It can be optimized by stopping the algorithm if inner loop didn't cause any swap.

CPP

```
// Optimized implementation of Bubble sort
#include <stdio.h>

void swap(int *xp, int *yp)
{
    int temp = *xp;
    *xp = *yp;
    *yp = temp;
}

// An optimized version of Bubble Sort
void bubbleSort(int arr[], int n)
{
   int i, j;
   bool swapped;
   for (i = 0; i < n-1; i++)
```

```
    {
      swapped = false;
      for (j = 0; j < n-i-1; j++)
      {
         if (arr[j] > arr[j+1])
         {
            swap(&arr[j], &arr[j+1]);
            swapped = true;
         }
      }

      // IF no two elements were swapped by inner loop, then break
      if (swapped == false)
         break;
    }
}

/* Function to print an array */
void printArray(int arr[], int size)
{
    int i;
    for (i=0; i < size; i++)
        printf("%d ", arr[i]);
    printf("n");
}

// Driver program to test above functions
int main()
{
    int arr[] = {64, 34, 25, 12, 22, 11, 90};
    int n = sizeof(arr)/sizeof(arr[0]);
    bubbleSort(arr, n);
    printf("Sorted array: \n");
    printArray(arr, n);
    return 0;
}
```

Java

```
// Optimized java implementation
// of Bubble sort
import java.io.*;

class GFG
{
    // An optimized version of Bubble Sort
    static void bubbleSort(int arr[], int n)
    {
```

```
        int i, j, temp;
        boolean swapped;
        for (i = 0; i < n - 1; i++)
        {
            swapped = false;
            for (j = 0; j < n - i - 1; j++)
            {
                if (arr[j] > arr[j + 1])
                {
                    // swap arr[j] and arr[j+1]
                    temp = arr[j];
                    arr[j] = arr[j + 1];
                    arr[j + 1] = temp;
                    swapped = true;
                }
            }

            // IF no two elements were
            // swapped by inner loop, then break
            if (swapped == false)
                break;
        }
    }

    // Function to print an array
    static void printArray(int arr[], int size)
    {
        int i;
        for (i = 0; i < size; i++)
            System.out.print(arr[i] + " ");
        System.out.println();
    }

    // Driver program
    public static void main(String args[])
    {
        int arr[] = { 64, 34, 25, 12, 22, 11, 90 };
        int n = arr.length;
        bubbleSort(arr, n);
        System.out.println("Sorted array: ");
        printArray(arr, n);
    }
}


// This code is contributed
// by Nikita Tiwari.
```

Python3

```python
# Python3 Optimized implementation
# of Bubble sort

# An optimized version of Bubble Sort
def bubbleSort(arr):
    n = len(arr)

    # Traverse through all array elements
    for i in range(n):
        swapped = False

        # Last i elements are already
        #  in place
        for j in range(0, n-i-1):

            # traverse the array from 0 to
            # n-i-1. Swap if the element
            # found is greater than the
            # next element
            if arr[j] > arr[j+1] :
                arr[j], arr[j+1] = arr[j+1], arr[j]
                swapped = True

        # IF no two elements were swapped
        # by inner loop, then break
        if swapped == False:
            break

# Driver code to test above
arr = [64, 34, 25, 12, 22, 11, 90]

bubbleSort(arr)

print ("Sorted array :")
for i in range(len(arr)):
    print ("%d" %arr[i],end=" ")

# This code is contributed by Shreyanshi Arun
```

C#

```csharp
// Optimized C# implementation
// of Bubble sort
using System;

class GFG
{
    // An optimized version of Bubble Sort
```

```
    static void bubbleSort(int []arr, int n)
    {
        int i, j, temp;
        bool swapped;
        for (i = 0; i < n - 1; i++)
        {
            swapped = false;
            for (j = 0; j < n - i - 1; j++)
            {
                if (arr[j] > arr[j + 1])
                {
                    // swap arr[j] and arr[j+1]
                    temp = arr[j];
                    arr[j] = arr[j + 1];
                    arr[j + 1] = temp;
                    swapped = true;
                }
            }

            // IF no two elements were
            // swapped by inner loop, then break
            if (swapped == false)
                break;
        }
    }

    // Function to print an array
    static void printArray(int []arr, int size)
    {
        int i;
        for (i = 0; i < size; i++)
            Console.Write(arr[i] + " ");
        Console.WriteLine();
    }

    // Driver method
    public static void Main()
    {
        int []arr = {64, 34, 25, 12, 22, 11, 90};
        int n = arr.Length;
        bubbleSort(arr,n);
        Console.WriteLine("Sorted array");
        printArray(arr,n);
    }

}
// This code is contributed by Sam007
```

PHP

```php
<?php
// PHP Optimized implementation
// of Bubble sort

// An optimized version of Bubble Sort
function bubbleSort(&$arr)
{
    $n = sizeof($arr);

    // Traverse through all array elements
    for($i = 0; $i < $n; $i++)
    {
        $swapped = False;

        // Last i elements are already
        // in place
        for ($j = 0; $j < $n - $i - 1; $j++)
        {

            // traverse the array from 0 to
            // n-i-1. Swap if the element
            // found is greater than the
            // next element
            if ($arr[$j] > $arr[$j+1])
            {
                $t = $arr[$j];
                $arr[$j] = $arr[$j+1];
                $arr[$j+1] = $t;
                $swapped = True;
            }
        }

        // IF no two elements were swapped
        // by inner loop, then break
        if ($swapped == False)
            break;
    }
}

// Driver code to test above
$arr = array(64, 34, 25, 12, 22, 11, 90);
$len = sizeof($arr);
bubbleSort($arr);

echo "Sorted array : \n";

for($i = 0; $i < $len; $i++)
    echo $arr[$i]." ";

// This code is contributed by ChitraNayal.
?>
```

Output:

```
Sorted array:
11 12 22 25 34 64 90
```


Worst and Average Case Time Complexity: O(n*n). Worst case occurs when array is reverse sorted.

Best Case Time Complexity: O(n). Best case occurs when array is already sorted.

Auxiliary Space: O(1)

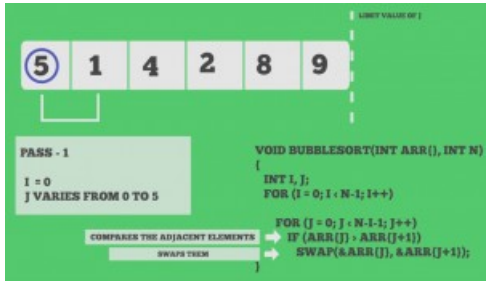
Boundary Cases: Bubble sort takes minimum time (Order of n) when elements are already sorted.

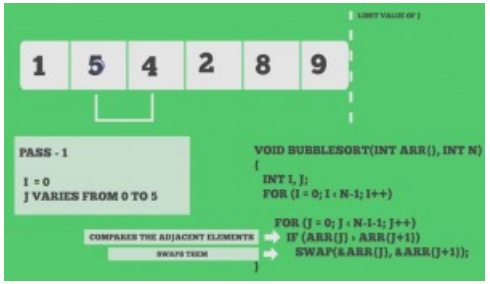
Sorting In Place: Yes

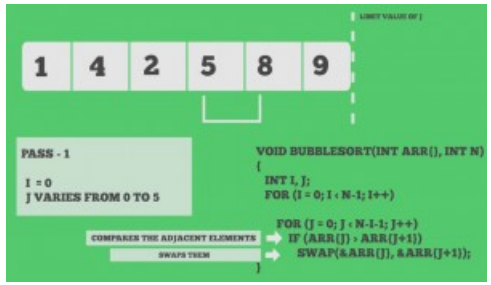
Stable: Yes

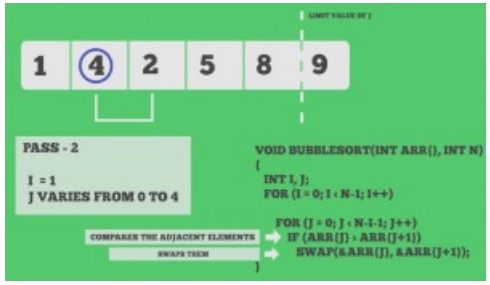
Due to its simplicity, bubble sort is often used to introduce the concept of a sorting algorithm.
In computer graphics it is popular for its capability to detect a very small error (like swap of just two elements) in almost-sorted arrays and fix it with just linear complexity (2n). For example, it is used in a polygon filling algorithm, where bounding lines are sorted by their x coordinate at a specific scan line (a line parallel to x axis) and with incrementing y their order changes (two elements are swapped) only at intersections of two lines (Source: Wikipedia)

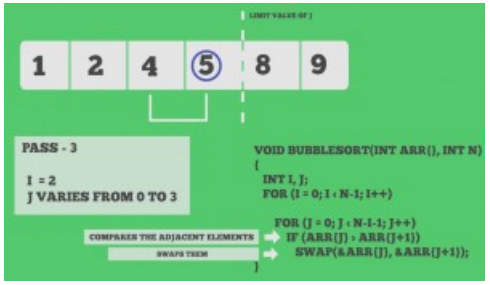
Snapshots:

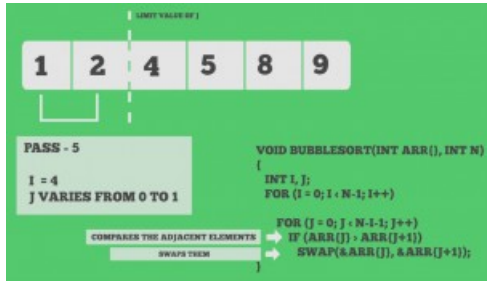












Quiz on Bubble Sort

Other Sorting Algorithms on GeeksforGeeks/GeeksQuiz:

- Selection Sort
- Insertion Sort
- Merge Sort
- Heap Sort
- QuickSort
- Radix Sort
- Counting Sort
- Bucket Sort
- ShellSort

Recursive Bubble Sort

Coding practice for sorting.

Reference:

- Wikipedia – Bubble Sort
- Image Source

Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above

Recommended Posts:

Comparison among Bubble Sort, Selection Sort and Insertion Sort

Recursive Bubble Sort

C Program for Bubble Sort

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Bubble sort using two Stacks

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Sorting Strings using Bubble Sort

Python Program for Bubble Sort

Java Program for Bubble Sort

Sorting Algorithms Visualization : Bubble Sort

Bubble Sort On Doubly Linked List

C Program for Bubble Sort on Linked List

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