**Bubble Sort**

**Implementation:**

void bubble\_sort(int arr[],int n)

{

int i,j,temp,flag;

for(i=0; i<n-1; i++)

{

flag = 0;

for(j=0; j<n-i-1; j++)

{

if(arr[j]>arr[j+1])

{

temp = arr[j];

arr[j] = arr[j+1];

arr[j+1] = temp;

flag = 1;

}

}

if(flag==0)

{

break;

}

}

}

**Analysis:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5 | 4 | 3 | 2 | 1 |

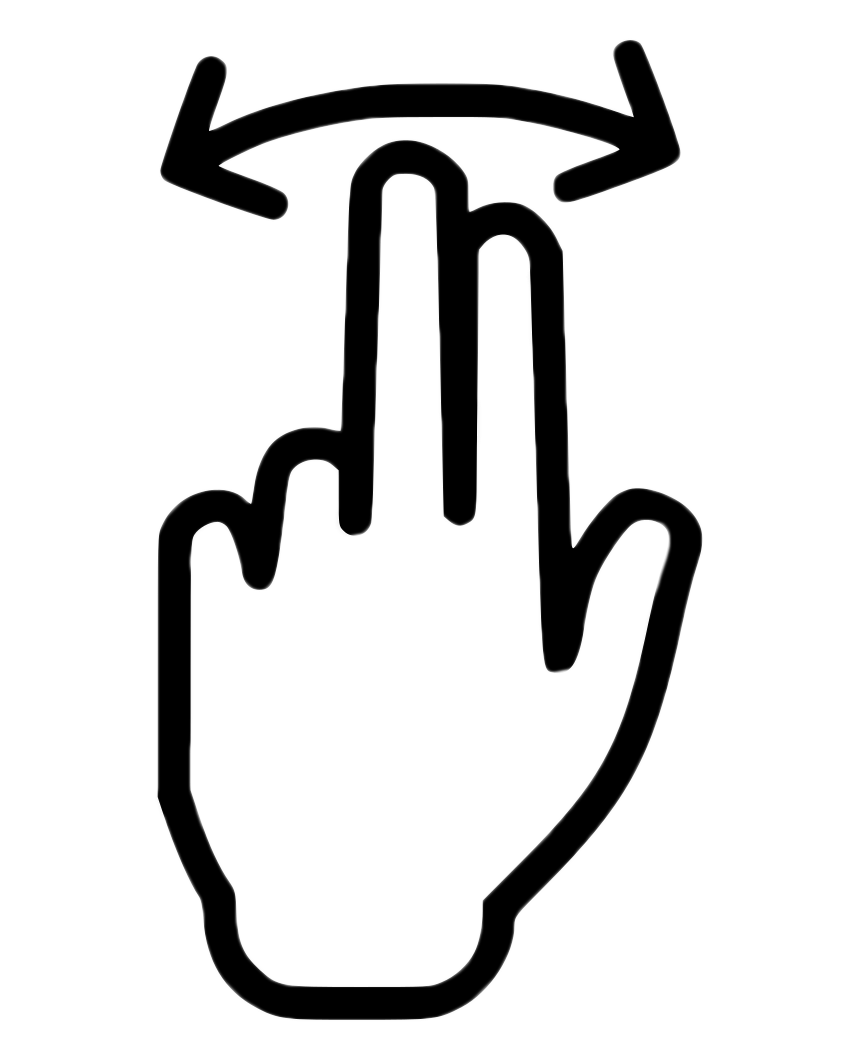
Let us consider an array of 5 elements, that means n=5. Sorting this array using bubble sort algorithm given bellow:

**Step 1:** For 1st iteration of outer loop (when i=0), i<n-1 which is true

j<n-i-1 = j<5-0-1 = j<4, j will continue till 3.

Entering in the inner loop, j=0, j<4 which is true.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5 | 4 | 3 | 2 | 1 |



For j=0;

arr[j]>arr[j+1], that means 5 is greater than 4. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4 | 5 | 3 | 2 | 1 |

For j=1;

arr[j]>arr[j+1], that means 5 is greater than 3. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4 | 3 | 5 | 2 | 1 |

For j=2;

arr[j]>arr[j+1], that means 5 is greater than 2. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4 | 3 | 2 | 5 | 1 |

For j=3;

arr[j]>arr[j+1], that means 5 is greater than 1. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4 | 3 | 2 | 1 | 5 |

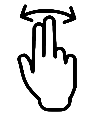
Total condition checked for 1st iteration is 4.

**Step 2:** For 2nd iteration of outer loop (when i=1), i<n-1 which is true

j<n-i-1 = j<5-1-1 = j<3, j will continue till 2.

Entering in the inner loop, j=0, j<3 which is true.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 4 | 3 | 2 | 1 | 5 |



For j=0;

arr[j]>arr[j+1], that means 4 is greater than 3. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 3 | 4 | 2 | 1 | 5 |

For j=1;

arr[j]>arr[j+1], that means 4 is greater than 2. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 3 | 2 | 4 | 1 | 5 |

For j=2;

arr[j]>arr[j+1], that means 4 is greater than 1. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 3 | 2 | 1 | 4 | 5 |

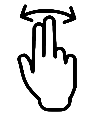
Total condition checked for 2nd iteration is 3.

**Step 3:** For 3rd iteration of outer loop (when i=2), i<n-1 which is true

j<n-i-1 = j<5-2-1 = j<2, j will continue till 1.

Entering in the inner loop, j=0, j<2 which is true.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 3 | 2 | 1 | 4 | 5 |



For j=0;

arr[j]>arr[j+1], that means 3 is greater than 2. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2 | 3 | 1 | 4 | 5 |

For j = 1;

arr[j]>arr[j+1], that means 3 is greater than 1. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2 | 1 | 3 | 4 | 5 |

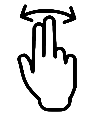
Total condition checked for 3rd iteration is 2.

**Step 4:** For 4th iteration of outer loop (when i=3), i<n-1 which is true

j<n-i-1 = j<5-3-1 = j<1, j will continue only for j=0.

Entering in the inner loop, j=0, j<1 which is true.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 2 | 1 | 3 | 4 | 5 |



For j=0;

arr[j]>arr[j+1], that means 2 is greater than 1. Therefore, a swap will occur. After swapping the array will be like this,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 |

In step 4 Total condition checked for 4th iteration is 1.

After entering in the Outer loop i=4 but i<n-1 which is not true and the inner loop will not execute here and terminate the process.

In the meantime, it is observed that the array becomes sorted.

Therefore, when n = 5,

The total number of condition checked is 4+3+2+1 times.

**Worst Case:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5 | 4 | 3 | 2 | 1 |

For reversely sorted array elements, if there are n elements, for all iteration the total checked condition will be (n-1) +(n-2) +(n-3) +………………………+3+2+1

This equation can be written as,

=

= which is a polynomial equation. Considering the Highest order of n is 2.

Therefore, we can say that in worst case, the complexity of bubble sort is O().

**Best Case:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 |

If the array is already sorted, then only inner loop will execute for (n-1) times.

Therefore, in best case the complexity of bubble sort is O(n).