Logo

Description automatically generated with medium confidence

**Data Structure and Algorithm**

**SUBMITTED TO:**

**Sir. Kaleem**

**SUBMITTED BY:**

**Ahtisham Ahmed**

**FA21-BSCS/014**

# **BUBBLE SORT:**

## **Code:**

void bubble(int arr[], int n)

{

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

{

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

{

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

{

swap(arr[j], arr[j + 1]);

}

}

}

}

**Explanation:**

|  |  |  |
| --- | --- | --- |
| **BEST CASE** | **AVERAGE CASE** | **WORST CASE** |
| O(n) | O(n2) | O(n2) |

**BEST CASE:**

In best case O (n) the array which has to be sorted is already sorted.

**WORST CASE:**

In worst case O (n2) the array which have to be sorted is not sorted and we will have to use 2 loops in order to sort the array.

# **SELECTION SORT:**

## **Code:**

int max(int arr[], int start, int end)

{

int max = arr[start];

int index = start;

for (int i = start; i < end; i++)

{

if (arr[i] > max)

{

max = arr[i];

index = i;

}

}

return index;

}

void ss(int arr[], int size)

{

for (int i = 0;i < size;i++)

{

int index = max(arr, i, size);

swap(arr[index], arr[i]);

}

}

**Explanation:**

|  |  |  |
| --- | --- | --- |
| **BEST CASE** | **AVERAGE CASE** | **WORST CASE** |
| O(n2) | O(n2) | O(n2) |

**BEST CASE:**

In best case O (n2) even if the array is already sorted we will need 2 loops.

**WORST CASE:**

In worst case O (n2) the array which have to be sorted is not sorted and we will have to use 2 loops in order to sort the array.

# **INSERTION SORT:**

## **Code:**

void insertionSort(int \*array, int size) {

   int key, j;

   for(int i = 1; i<size; i++) {

      key = array[i];

      j = i;

      while(j > 0 && array[j-1]>key) {

         array[j] = array[j-1];

         j--;

      }

      array[j] = key;

   }

}

**Explanation:**

|  |  |  |
| --- | --- | --- |
| **BEST CASE** | **AVERAGE CASE** | **WORST CASE** |
| O(n) | O(n2) | O(n2) |

**BEST CASE:**

In best case O (n) even if the array is already sorted we will need 1 loop tochek if the array is sorted.

**WORST CASE:**

In worst case O (n2) the array which have to be sorted is not sorted and we will have to use 2 loops in order to sort the array.

# **QUICK SORT:**

## **Code:**

void swap(int\* a, int\* b)

{

int t = \*a;

\*a = \*b;

\*b = t;

}

int partition(int arr[], int low, int high)

{

int pivot = arr[high];

int i = (low - 1);

for (int j = low; j <= high - 1; j++)

{

if (arr[j] <= pivot)

{

i++;

swap(&arr[i], &arr[j]);

}

}

swap(&arr[i + 1], &arr[high]);

return (i + 1);

}

void quickSort(int arr[], int low, int high)

{

if (low < high)

{

int pi = partition(arr, low, high);

quickSort(arr, low, pi - 1);

quickSort(arr, pi + 1, high);

}

}

**Explanation:**

|  |  |  |
| --- | --- | --- |
| **BEST CASE** | **AVERAGE CASE** | **WORST CASE** |
| O(n log(n)) | O(n log(n)) | O(n2) |

**BEST CASE:**

In best case O(n log(n)) even if the array is already sorted we will need to partition the array and check if the array is sorted through a loop.

**WORST CASE:**

In worst case O (n2) the array which have to be sorted is not sorted and we will have to use 2 loops in order to sort the array.

# **MERGE SORT:**

## **Code:**

void merge(int \*array, int l, int m, int r)

{   int i, j, k, nl, nr;

   //size of left and right sub-arrays

   nl = m-l+1; nr = r-m;

   int larr[nl], rarr[nr];

   //fill left and right sub-arrays

   for(i = 0; i<nl; i++)

      larr[i] = array[l+i];

   for(j = 0; j<nr; j++)

      rarr[j] = array[m+1+j];

   i = 0; j = 0; k = l;

   //marge temp arrays to real array

   while(i < nl && j<nr) {

      if(larr[i] <= rarr[j]) {

         array[k] = larr[i];

         i++;

      }else{

         array[k] = rarr[j];

         j++;

      }

      k++;

   }

while(i<nl) { //extra element in left array

array[k] = larr[i];

i++; k++;

}

while(j<nr) { //extra element in right array

array[k] = rarr[j];

j++; k++;

}

}

void mergeSort(int \*array, int l, int r) {

int m;

if(l < r) {

int m = l+(r-l)/2;

// Sort first and second arrays

mergeSort(array, l, m);

mergeSort(array, m+1, r);

merge(array, l, m, r);

}

**Explanation:**

|  |  |  |
| --- | --- | --- |
| **BEST CASE** | **AVERAGE CASE** | **WORST CASE** |
| O(n log(n)) | O(n log(n)) | O(n log(n)) |

**BEST CASE:**

In best case O(n log(n)) even if the array is already sorted we will need to partition the array and check if the array is sorted through a loop.

**WORST CASE:**

In worst case O(n log(n)) the array which have to be sorted is not sorted and we will have to partition the array and sort using a loop.

# **CONCULSION**

In conclusion the best sorting algorithm according to bigO notation is merge sort. Merge sort best and worst cases are:

|  |  |  |
| --- | --- | --- |
| **BEST CASE** | **AVERAGE CASE** | **WORST CASE** |
| O(n log(n)) | O(n log(n)) | O(n log(n)) |

The reason merge sort is the ideal sorting algorithm because merging sort uses divide and conquer. It is really fast and the best and worst and average case are the same. The only downside of merge sort is that it take quite a lot of memory. Quick sort is almost the same merge sort but in quick sort the worst case scenario is O (n2) .if you pick the wrong pivot element it could take a lot of time.