December 12, 2021 ▪ Arrays / Data Structure

Merge two Sorted Arrays Without Extra Space

Problem statement: Given two sorted arrays **arr1[]** and **arr2[]** of sizes **n** and **m** in non-decreasing order. Merge them in sorted order. Modify arr1 so that it contains the first N elements and modify arr2 so that it contains the last M elements.

Examples:

```
Example 1:

Input:
n = 4, arr1[] = [1 4 8 10]
m = 5, arr2[] = [2 3 9]

Output:
arr1[] = [1 2 3 4]
arr2[] = [8 9 10]

Explanation:
After merging the two non-decreasing arrays, we get, 1,2,3,4,8,9,10.

Example2:

Input:
n = 4, arr1[] = [1 3 5 7]
m = 5, arr2[] = [0 2 6 8 9]

Output:
arr1[] = [0 1 2 3]
arr2[] = [5 6 7 8 9]

Explanation:
After merging the two non-decreasing arrays, we get, 0 1 2 3 5 6 7 8 9.
```

Solution:

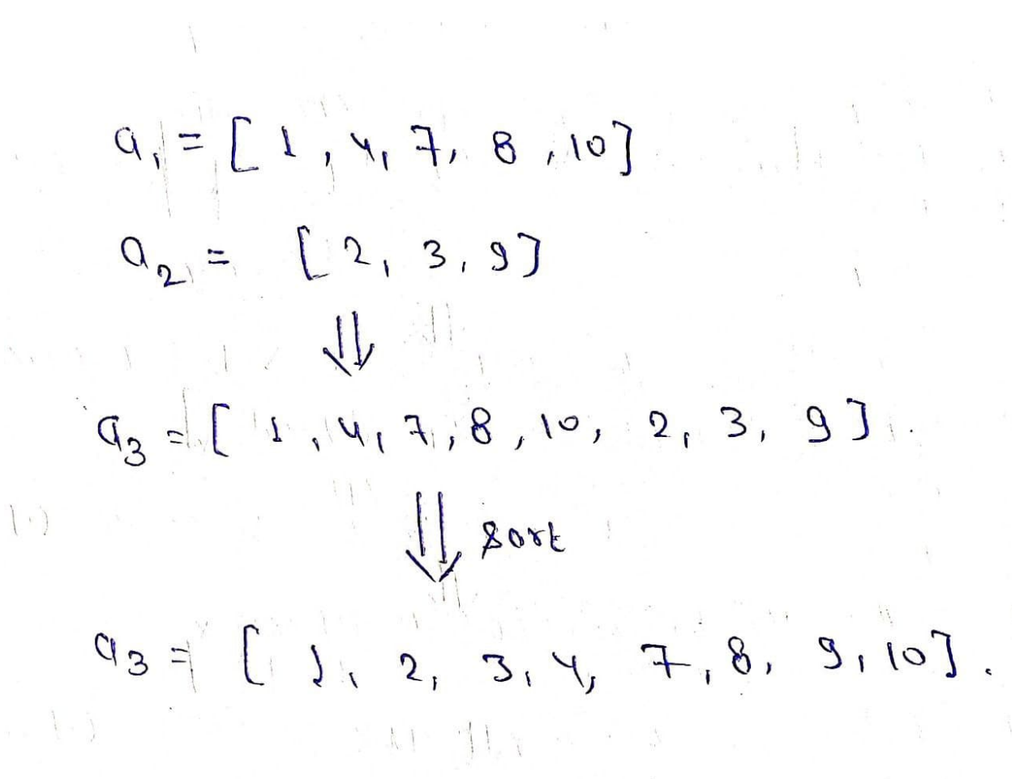
Disclaimer. Don't jump directly to the solution, try it out yourself first.

Solution1: Brute Force-

Intuition: We can use a new array of size n+m and put all elements of arr1 and arr2 in it, and sort it. After sorting it, but all the elements in arr1 and arr2.

Approach:

- Make an arr3 of size n+m.
- Put elements arr1 and arr2 in arr3.
- Sort the arr3.
- Now first fill the arr1 and then fill remaining elements in arr2.



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Code:

C++ Code

```
#include<bits/stdc++.h>
using namespace std;
void merge(int arr1[], int arr2[], int n, int m) {
    int arr3[n+m];
    int k = 0;
    for (int i = 0; i < n; i++) {
      arr3[k++] = arr1[i];
    }
    for (int i = 0; i < m; i++) {
      arr3[k++] = arr2[i];
    }
    sort(arr3,arr3+m+n);
    k = 0;
    for (int i = 0; i < n; i++) {
      arr1[i] = arr3[k++];
    }
    for (int i = 0; i < m; i++) {
      arr2[i] = arr3[k++];
    }

  }
int main() {
    int arr1[] = {1,4,7,8,10};
    int arr2[] = {2,3,9};
    cout<<"Before merge:"<<endl;
    for (int i = 0; i < 5; i++) {
      cout<<arr1[i]<<" ";
    }
    cout<<endl;
    for (int i = 0; i < 3; i++) {
      cout<<arr2[i]<<" ";
    }
    cout<<endl;
    merge(arr1, arr2, 5, 3);
    cout<<"After merge:"<<endl;
    for (int i = 0; i <5; i++) {
      cout<<arr1[i]<<" ";
    }
    cout<<endl;
    for (int i = 0; i < 3; i++) {
      cout<<arr2[i]<<" ";
    }

  }
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n*log(n))+O(n)+O(n)

Space Complexity: O(n)

Java Code

```
import java.util.*;

public class tuf {

  public static void main(String[] args) {
    int arr1[] = {1,4,7,8,10};
    int arr2[] = {2,3,9};
    System.out.println("Before merge:");
    for (int i = 0; i < arr1.length; i++) {
      System.out.print(arr1[i] + " ");
    }
    System.out.println();
    for (int i = 0; i < arr2.length; i++) {
      System.out.print(arr2[i] + " ");
    }
    System.out.println();
    merge(arr1, arr2, arr1.length, arr2.length);
    System.out.println("After merge:");
    for (int i = 0; i < arr1.length; i++) {
      System.out.print(arr1[i] + " ");
    }
    System.out.println();
    for (int i = 0; i < arr2.length; i++) {
      System.out.print(arr2[i] + " ");
    }

  }
```

```
  static void merge(int[] arr1, int arr2[], int n, int m) {
    int arr3[] = new int[n + m];
    int k = 0;
    for (int i = 0; i < n; i++) {
      arr3[k++] = arr1[i];
    }
    for (int i = 0; i < m; i++) {
      arr3[k++] = arr2[i];
    }
    Arrays.sort(arr3);
    k = 0;
    for (int i = 0; i < n; i++) {
      arr1[i] = arr3[k++];
    }
    for (int i = 0; i < m; i++) {
      arr2[i] = arr3[k++];
    }

  }
}
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n*log(n))+O(n)+O(n)

Space Complexity: O(n)

Python Code

```
from typing import List
def merge(arr1: List[int], arr2: List[int], n: int, m: int) -> None:
    arr3 = [0] * (n + m)
    k = 0
    for i in range(n):
        arr3[k] = arr1[i]
        k += 1
    for i in range(m):
        arr3[k] = arr2[i]
        k += 1
    arr3.sort()
    k = 0
    for i in range(n):
        arr1[i] = arr3[k]
        k += 1
    for i in range(m):
        arr2[i] = arr3[k]
        k += 1




if __name__ == "__main__":
    arr1 = [1, 4, 7, 8, 10]
    arr2 = [2, 3, 9]
    print("Before merge:")
    print(*arr1)
    print(*arr2)
    merge(arr1, arr2, 5, 3)
    print("After merge:")
    print(*arr1)
    print(*arr2)
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n*log(n))+O(n)+O(n)

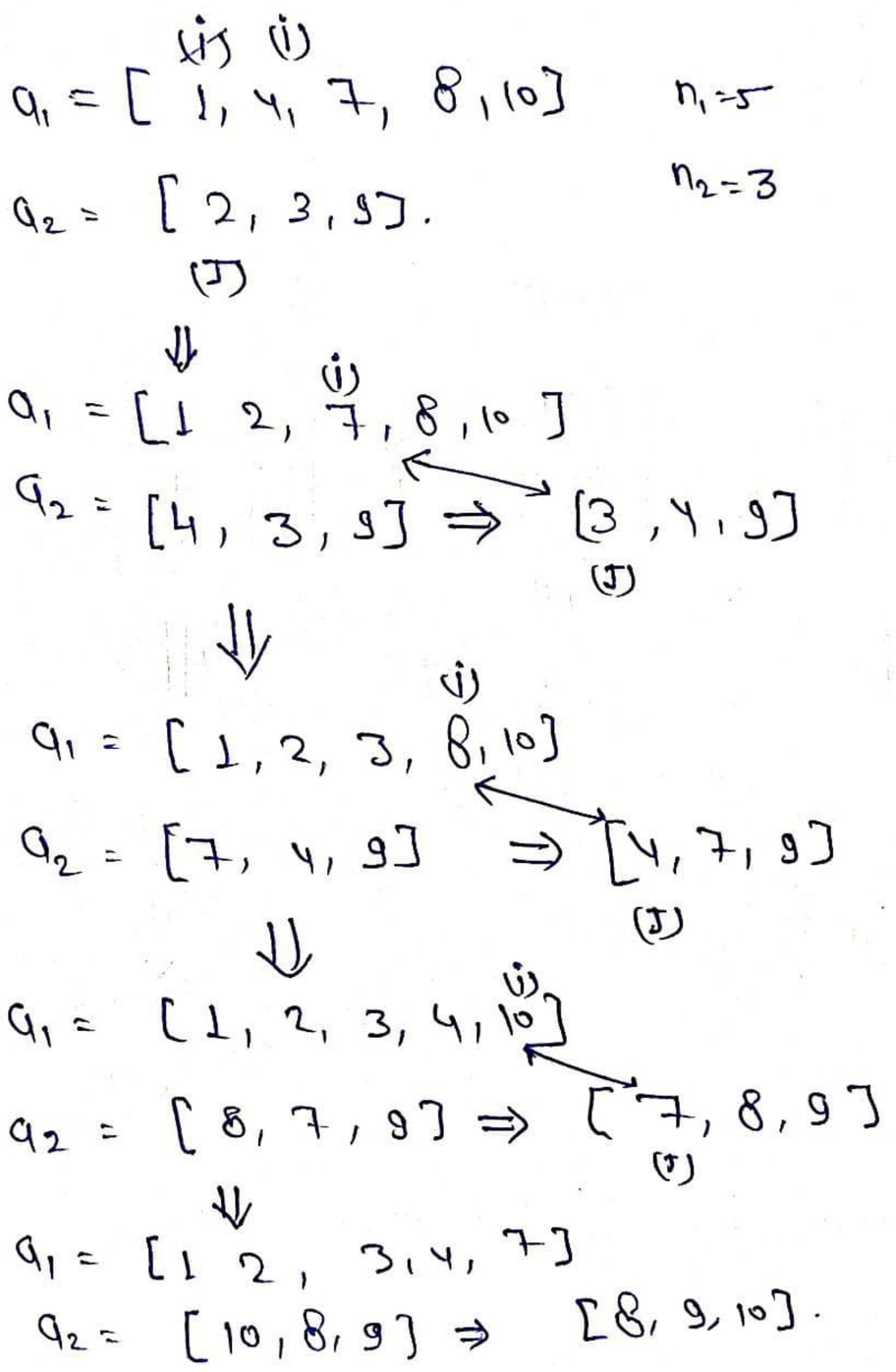
Space Complexity: O(n)

Solution 2: Without using space-

Intuition: We can think of Iterating in arr1 and whenever we encounter an element that is greater than the first element of arr2, just swap it. Now rearrange the arr2 in a sorted manner, after completion of the loop we will get elements of both the arrays in non-decreasing order.

Approach:

- Use a for loop in arr1.
- Whenever we get any element in arr1 which is greater than the first element of arr2,swap it.
- Rearrange arr2.
- Repeat the process.



Code:

C++ Code

```
#include<bits/stdc++.h>

using namespace std;
void merge(int arr1[], int arr2[], int n, int m) {
  // code here
  int i, k;
  for (i = 0; i < n; i++) {
    // take first element from arr1
    // compare it with first element of second array
    // if condition match, then swap
    if (arr1[i] > arr2[0]) {
      int temp = arr1[i];
      arr1[i] = arr2[0];
      arr2[0] = temp;
    }

    // then sort the second array
    // put the element in its correct position
    // so that next cycle can swap elements correctly
    int first = arr2[0];
    // insertion sort is used here
    for (k = 1; k < m && arr2[k] < first; k++) {
      arr2[k - 1] = arr2[k];
    }
    arr2[k - 1] = first;
  }
}
int main() {
  int arr1[] = {1,4,7,8,10};
  int arr2[] = {2,3,9};
  cout << "Before merge:" << endl;
  for (int i = 0; i < 5; i++) {
    cout << arr1[i] << " ";
  }
  cout << endl;
  for (int i = 0; i < 3; i++) {
    cout << arr2[i] << " ";
  }
  cout << endl;
  merge(arr1, arr2, 5, 3);
  cout << "After merge:" << endl;
  for (int i = 0; i < 5; i++) {
```

```
    cout << arr1[i] << " ";
  }
  cout << endl;
  for (int i = 0; i < 3; i++) {
    cout << arr2[i] << " ";
  }

}
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n*m)

Space Complexity: O(1)

Java Code

```
public class tuf {

  public static void main(String[] args) {
    int arr1[] = {1,4,7,8,10};
    int arr2[] = {2,3,9};
    System.out.println("Before merge:");
    for (int i = 0; i < arr1.length; i++) {
      System.out.print(arr1[i] + " ");
    }
    System.out.println();
    for (int i = 0; i < arr2.length; i++) {
      System.out.print(arr2[i] + " ");
    }
    System.out.println();
    merge(arr1, arr2, arr1.length, arr2.length);
    System.out.println("After merge:");
    for (int i = 0; i < arr1.length; i++) {
      System.out.print(arr1[i] + " ");
    }
    System.out.println();
    for (int i = 0; i < arr2.length; i++) {
      System.out.print(arr2[i] + " ");
    }

  }
  static void merge(int[] arr1, int arr2[], int n, int m) {
    // code here
    int i, k;
    for (i = 0; i < n; i++) {
      // take first element from arr1
      // compare it with first element of second array
      // if condition match, then swap
      if (arr1[i] > arr2[0]) {
        int temp = arr1[i];
        arr1[i] = arr2[0];
        arr2[0] = temp;
      }

      // then sort the second array
      // put the element in its correct position
      // so that next cycle can swap elements correctly
      int first = arr2[0];
      // insertion sort is used here
      for (k = 1; k < m && arr2[k] < first; k++) {
        arr2[k - 1] = arr2[k];
      }
      arr2[k - 1] = first;
    }
  }
}
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n*m)

Space Complexity: O(1)

Python Code

```python
from typing import List


def merge(arr1: List[int], arr2: List[int], n: int, m: int) -> None:
    for i in range(n):
        if arr1[i] > arr2[0]:
            arr1[i], arr2[0] = arr2[0], arr1[i]
        first = arr2[0]
        k = 1
        while k < m and arr2[k] < first:
            arr2[k - 1] = arr2[k]
            k += 1
        arr2[k - 1] = first




if __name__ == "__main__":
    arr1 = [1, 4, 7, 8, 10]
    arr2 = [2, 3, 9]
    print("Before merge:")
    print(*arr1)
    print(*arr2)
    merge(arr1, arr2, 5, 3)
    print("After merge:")
    print(*arr1)
    print(*arr2)
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

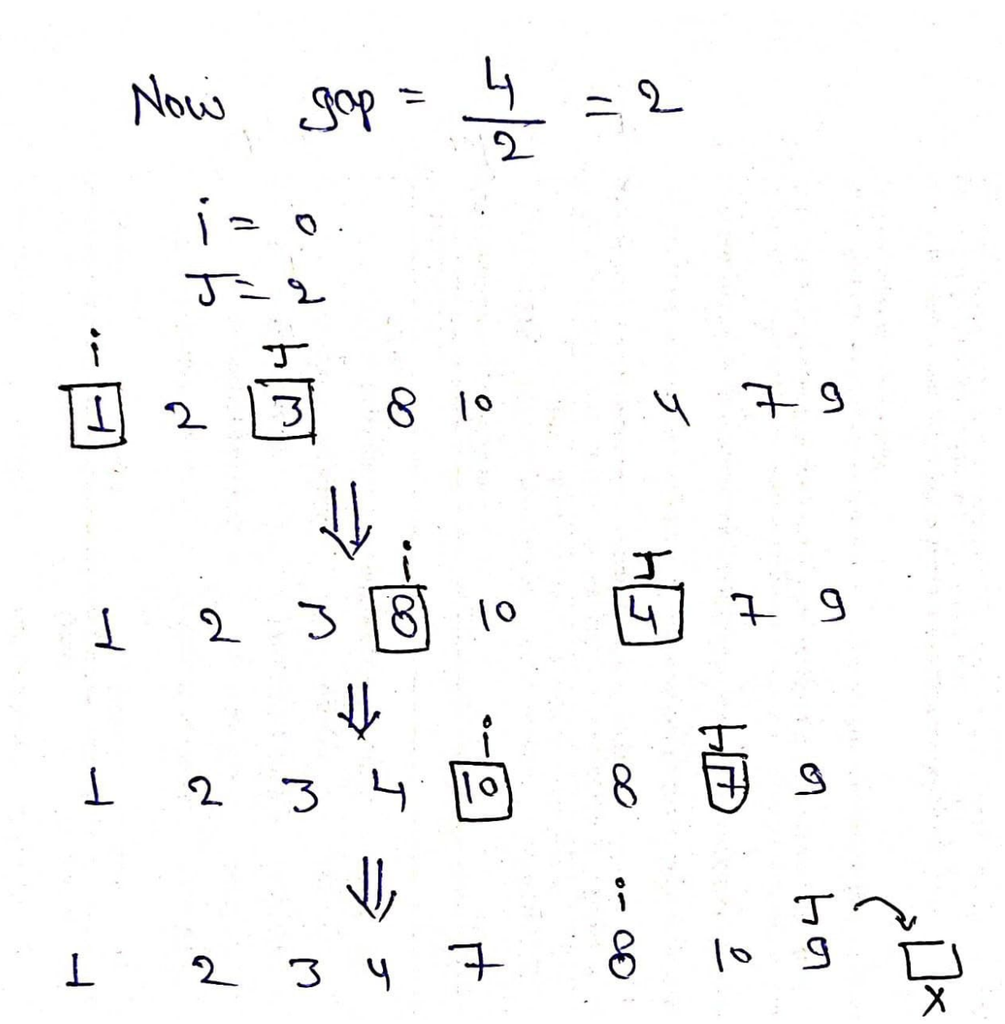
Time complexity: O(n*m)

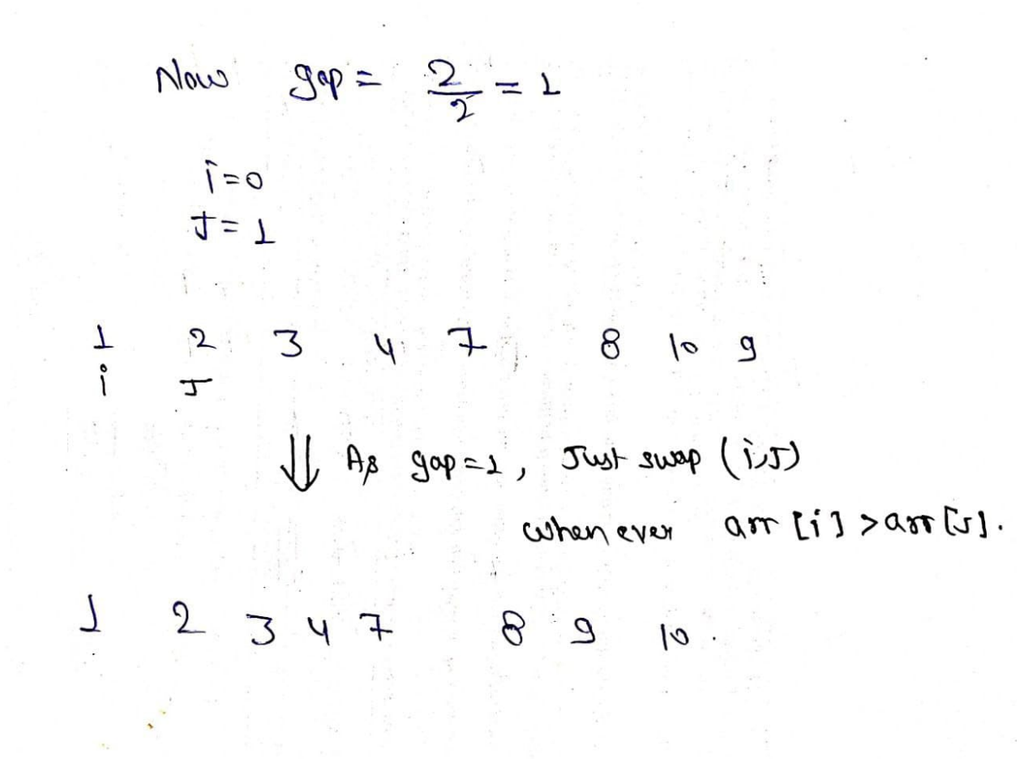
Space Complexity: O(1)

Solution 3: Gap method-

Approach:

- Initially take the gap as (m+n)/2;
- Take as a pointer1 = 0 and pointer2 = gap.
- Run a loop from pointer1 & pointer2 to m+n and whenever arr[pointer2]<arr[pointer1], just swap those.
- After completion of the loop reduce the gap as gap=gap/2.
- Repeat the process until the gap>0.





Code:

C++ Code

```
#include<bits/stdc++.h>
using namespace std;
void merge(int ar1[], int ar2[], int n, int m) {
  // code here
  int gap = ceil((float)(n + m) / 2);
  while (gap > 0) {
    int i = 0;
    int j = gap;
    while (j < (n + m)) {
      if (j < n && ar1[i] > ar1[j]) {
        swap(ar1[i], ar1[j]);
      } else if (j >= n && i < n && ar1[i] > ar2[j - n]) {
        swap(ar1[i], ar2[j - n]);
      } else if (j >= n && i >= n && ar2[i - n] > ar2[j - n]) {
        swap(ar2[i - n], ar2[j - n]);
      }
      j++;
      i++;
    }
    if (gap == 1) {
      gap = 0;
    } else {
      gap = ceil((float) gap / 2);
    }
  }
}
int main() {
  int arr1[] = {1,4,7,8,10};
  int arr2[] = {2,3,9};
  cout << "Before merge:" << endl;
  for (int i = 0; i < 5; i++) {
    cout << arr1[i] << " ";
  }
  cout << endl;
  for (int i = 0; i < 3; i++) {
    cout << arr2[i] << " ";
  }
  cout << endl;
  merge(arr1, arr2, 5, 3);
  cout << "After merge:" << endl;
  for (int i = 0; i < 5; i++) {
    cout << arr1[i] << " ";
  }
  cout << endl;
  for (int i = 0; i < 3; i++) {
    cout << arr2[i] << " ";
  }

}
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n+m)

Space Complexity: O(1)

Java Code

```java
import java.util.*;
class TUF{
    static void swap(int a,int b)
    {
        int temp=a;
        a=b;
        b=temp;
    }
   static void merge(int ar1[], int ar2[], int n, int m) {
  // code here
  int gap =(int) Math.ceil((double)(n + m) / 2.0);
  while (gap > 0) {
    int i = 0;
    int j = gap;
    while (j < (n + m)) {
      if (j < n && ar1[i] > ar1[j]) {
        swap(ar1[i], ar1[j]);
      } else if (j >= n && i < n && ar1[i] > ar2[j - n]) {
        swap(ar1[i], ar2[j - n]);
      } else if (j >= n && i >= n && ar2[i - n] > ar2[j - n]) {
        swap(ar2[i - n], ar2[j - n]);
      }
      j++;
      i++;
    }
    if (gap == 1) {
      gap = 0;
    } else {
      gap =(int) Math.ceil((double) gap / 2.0);
    }
  }
}
public static void main(String[] args) {
    int arr1[] = {1,4,7,8,10};
    int arr2[] = {2,3,9};
    System.out.println("Before merge:");
    for (int i = 0; i < arr1.length; i++) {
      System.out.print(arr1[i] + " ");
    }
    System.out.println();
    for (int i = 0; i < arr2.length; i++) {
      System.out.print(arr2[i] + " ");
    }
    System.out.println();
    merge(arr1, arr2, arr1.length, arr2.length);
    System.out.println("After merge:");
    for (int i = 0; i < arr1.length; i++) {
      System.out.print(arr1[i] + " ");
    }
    System.out.println();
    for (int i = 0; i < arr2.length; i++) {
      System.out.print(arr2[i] + " ");
    }

  }
}
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n+m)

Space Complexity: O(1)

Python Code

```python
from typing import List
def merge(arr1: List[int], arr2: List[int], n: int, m: int) -> None:
    gap = (n + m + 1) // 2
    while gap > 0:
        i = 0
        j = gap
        while j < (n + m):
            if j < n and arr1[i] > arr1[j]:
                arr1[i], arr1[j] = arr1[j], arr1[i]
            elif j >= n and i < n and arr1[i] > arr2[j - n]:
                arr1[i], arr2[j - n] = arr2[j - n], arr1[i]
            elif j >= n and i >= n and arr2[i - n] > arr2[j - n]:
                arr2[i - n], arr2[j - n] = arr2[j - n], arr2[i - n]
            j += 1
            i += 1
        if gap == 1:
            gap = 0
        else:
            gap = (gap + 1) // 2
```

```
if __name__ == "__main__":
    arr1 = [1, 4, 7, 8, 10]
    arr2 = [2, 3, 9]
    print("Before merge:")
    print(*arr1)
    print(*arr2)
    merge(arr1, arr2, 5, 3)
    print("After merge:")
    print(*arr1)
    print(*arr2)
```

Output:

Before merge:

1 4 7 8 10

2 3 9

After merge:

1 2 3 4 7

8 9 10

Time complexity: O(n+m)

Space Complexity: O(1)

> Special thanks to **Prashant Sahu** for contributing to this article on takeUforward. If you also wish to share your knowledge with the takeUforward fam, please check out this article

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