Merge Two Sorted Arrays

- Problem: Merge two sorted arrays so that the resulted array is still sorted.

Example: $A = \{1, 4, 6\}$
$B = \{2, 5\}$

The merged result will be:
$\{1, 2, 4, 5, 6\}$
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Merge $A[i .. j]$ and $B[m .. n]$ and put the result in $C[0 .. ]$
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Merge $A[i..j]$ and $B[m..n]$ and put the result in $C[0..]$

```plaintext
{ I: A[i] p and B[m] q have been processed and the result has been put in C[0] k in sorted order,
  if p is in [i,j], A[p] >= C[0] k,
  if q is in [m,n], B[q] >= C[0] k,
} {!B: p == j+1 and q == n+1}
```
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Merge $A[i .. j]$ and $B[m .. n]$ and put the result in $C[0 ..]$.

- $I$: $A[i ..]$ and $B[m ..]$ have been processed and the result has been put in $C[0 ..]k$ in sorted order.
- $B!$: $p == j+1$ and $q == n+1$

$p = i; q = m; k = 0;
while (p != j+1 || q != n+1)
{
    if (p == j+1) { C[k] = B[q]; k++; q++;}
    else if (q == n+1) {C[k] = A[p]; k++; p++;}
    else { if (A[p] < B[q]) { C[k] = A[p]; k++; p++;}
        else {C[k] = B[q]; k++; q++;}}
}
Dutch Flag Problem

- Partition an array A into 3 segments, the left has the negative numbers, zero in the middle and positive numbers are on the right.

- Example: \( A = \{-1, 2, -3, 4, 0, 6, -7, 0\} \)
  
  The result will be
  
  \( \{-1, -3, -7, 0, 0, 2, 4, 6\} \)
<table>
<thead>
<tr>
<th>&lt;0</th>
<th>=0</th>
<th>?</th>
<th>&gt;0</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>i</td>
<td>j</td>
<td>k</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b</td>
</tr>
</tbody>
</table>

[a ]i has the negative elements.
[i ]j has the zero elements.
[j k] is not processed yet.
k[ b] has the positive elements.
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</tr>
</tbody>
</table>

\{ I: \text{Elements in } [a]i < 0, \text{elements in } [i]j == 0, \text{elements in } k[ b] > 0 \}

\{ !B: k < j \}
$\begin{array}{|c|c|c|c|c|}
\hline
<0 & =0 & ? & >0 \\
\hline
a & i & j & k & b \\
\hline
\end{array}$

{ I: Elements in $[a]i < 0$, elements in $[i]j == 0$, elements in $k[b] > 0$ }

{ !B: $k < j$ }

\begin{verbatim}
   i=a; j = a; k = b;
   while (k >= j)
   {
      if (A[j] == 0) j++;
      else if (A[j] < 0) { swap(A[i], A[j]); i++; j++; }
      else { swap(A[j], A[k]); k--; }
   }
\end{verbatim}