



Submitted To:

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An Assignment On  
Insertion Sort and Merge Sort

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## Insertion Sort Solution

Algorithm - (A)

for  $j = 2$  to  $A.length$

key =  $A[j]$

$i = j - 1$

while  $i > 0$  and  $A[i] > key$

$A[i+1] = A[i]$

$i = i - 1$

$A[i+1] = key$

$A[1] = 10$

$O1 = [S]A$

$A[10 | 9 | 2 | 1 | 8 | 7]$

Step - 1, for  $j = 2$  to  $A.length$

key =  $A[j] = 9$

$i = j - 1 = 1$

while  $i > 0$  and  $A[i] = 10 > 9$

$A[i+1] = A[i]$

$\Rightarrow A[2] = 10$

$i = i - 1 = 0$

A	10	10	2	1	8	7
---	----	----	---	---	---	---

$$A[i+1] = \text{key}$$

$$\rightarrow A[1] = 9$$

A	9	10	2	1	8	7
---	---	----	---	---	---	---

Step-2

for  $j=3$  to  $A.length$

$$[\text{key} = A[j-1] = 2]$$

$$i = j-1 = 2$$

while  $i > 0$  and  $A[i] = 10 > 2$

$$\begin{aligned} & A[i+1] = A[i] \\ & \Rightarrow A[3] = 10 \\ & i = i - 1 = 1 \end{aligned}$$

A	9	10	10	1	8	7
---	---	----	----	---	---	---

while  $i > 0$  and  $A[i] = 9 > 2$

$$A[i+1] = A[i]$$

$$\Rightarrow A[2] = 9$$

$i = i - 1 = 0$

A	9	9	10	1	8	7
---	---	---	----	---	---	---

$$i = 1 - i = i$$

$A[i+1] = \text{key}$

$A[1] = 2$

$A [2 | 9 | 10 | 1 | 8 | 7]$

Step - 3

for  $j = 4$  to  $A.length - 1$

$\text{key} = A[j] = 1$

$i = j - 1 = 3$

while  $i > 0$  and  $A[i] = 10 > 1$

$A[i+1] = A[i]$

$\Rightarrow A[4] = 10$

$i = 2$

$A [2 | 9 | 10 | 10 | 8 | 7]$

while  $i > 0$  and  $A[i] = 9 > 1$

$A[i+1] = A[i]$

$A[3] = 9$

$i = 1$

$A [2 | 9 | 9 | 10 | 8 | 7]$

while  $i > 0$  and  $A[i] = 2 > 1$

$$A[i+1] = A[i]$$

$$\Rightarrow A[2] = 2.$$

$$i = 0$$

A	[	2	2	9	10	8	7	]
---	---	---	---	---	----	---	---	---

$$A[i+1] = \text{key}$$

$$A[1] = 1$$

A	[	1	2	9	10	8	7	]
---	---	---	---	---	----	---	---	---

Step-4 for  $j = 5$  to  $A.length$

$$\text{key} = A[j] = 8$$

while  $i > 0$  and  $A[i] = 10 > 8$

$$A[i+1] = A[i]$$

$$\Rightarrow A[5] = 10$$

$$i = 3$$

A	[	1	2	9	10	10	7	]
---	---	---	---	---	----	----	---	---

while  $i > 0$  and  $A[i] = 9 > 8$  ;  $i \leftarrow i - 1$

$$A[i+1] = A[i]$$

$$\Rightarrow A[4] = 9 - [8] \leftarrow$$

$$i = 2$$

0	A	1	2	9	1	9	10	7
---	---	---	---	---	---	---	----	---

$$A[i+1] = \text{key}$$

$$A[3] = 8$$

0	A	1	2	8	9	1	0	7
---	---	---	---	---	---	---	---	---

### Step - 5

for  $j = 6$  to  $A.length$

$$\text{key} = A[j] = 7$$

$$i = 5$$

while  $i > 0$  and  $A[i] = 10 > 7$

$$A[i+1] = A[i]$$

$$\Rightarrow A[6] = 10$$

$$i = 4$$

0	A	1	2	8	9	1	0	10
---	---	---	---	---	---	---	---	----

while  $i > 0$  and  $A[i] = 9 > 7$

$$A[i+1] = A[i]$$

$$\Rightarrow A[5] = 9 \quad \leftarrow$$

$$i = 3$$

A	1	2	8	9	9	10
---	---	---	---	---	---	----

while  $i > 0$  and  $A[i] = 8 > 7$

$$A[i+1] = A[i]$$

$$\Rightarrow A[4] = 8 \quad \leftarrow$$

$$i = 2$$

A	1	2	8	8	9	10
---	---	---	---	---	---	----

$$A[i+1] = \text{key}$$

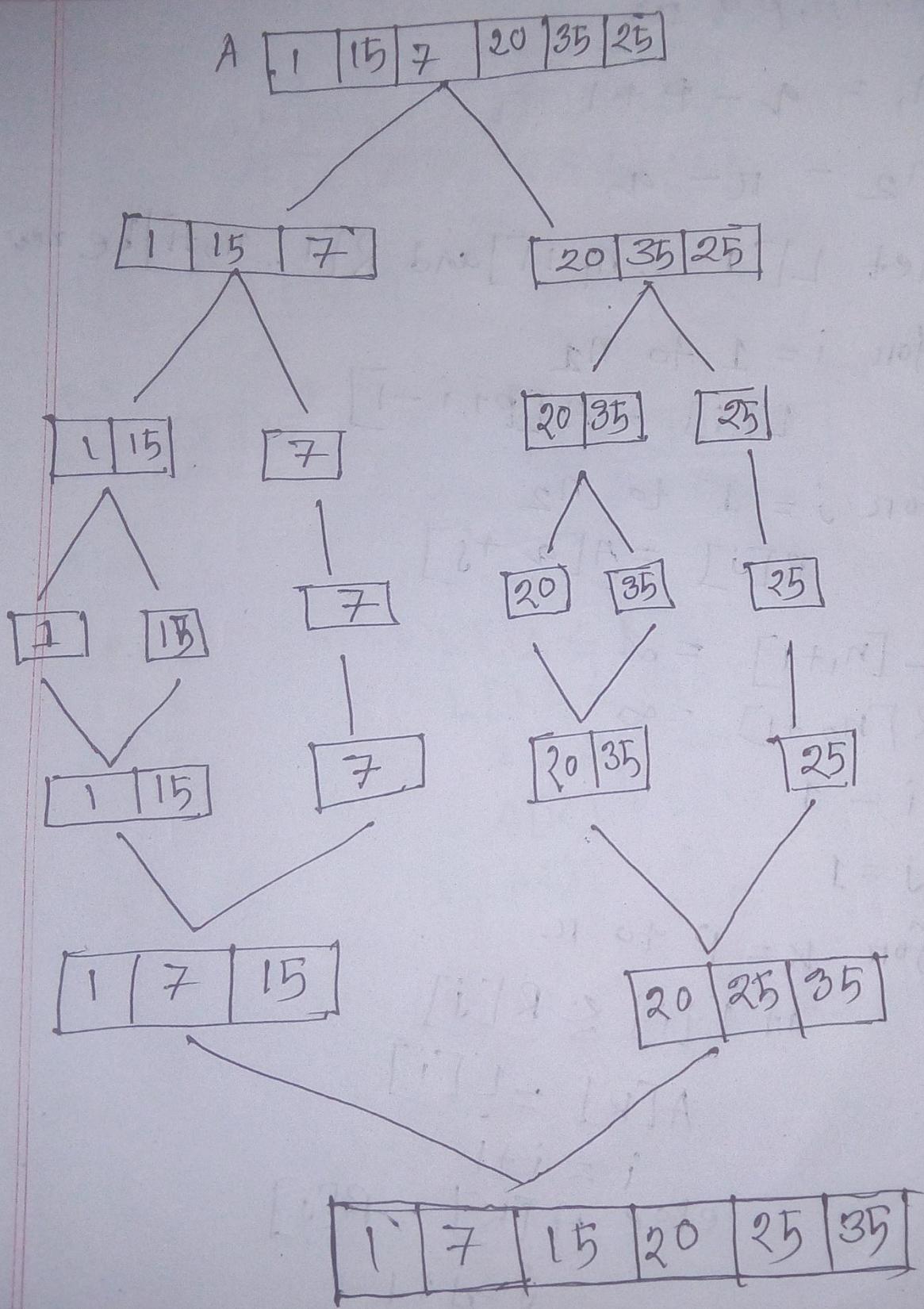
$$\Rightarrow A[3] = 7$$

A	1	2	7	8	9	10
---	---	---	---	---	---	----

(sorted)

### Merge ( $A, p, q, r$ )

1.  $n_1 = q - p + 1$
2.  $n_2 = r - q$
3. let  $L[1 \dots n_1 + 1]$  and  $R[1 \dots n_2 + 1]$  be new
4. for  $i = 1$  to  $n_1$
5.      $L[i] = A[p+i-1]$
6. for  $j = 1$  to  $n_2$
7.      $R[j] = A[q+j]$
8.  $L[n_1 + 1] = \infty$
9.  $R[n_2 + 1] = \infty$
10.  $i = 1$
11.  $j = 1$
12. for  $k = p$  to  $r$ 
  - 13.     if  $L[i] \leq R[j]$
  - 14.          $A[k] = L[i]$
  - 15.          $i = i + 1$
  - 16.     else  $A[k] = R[j]$
  - 17.          $j = j + 1$



## Step - 1

A	$P=1$	$T=6$
	1   7   15   20   25   35	

$$q = \frac{p+r}{2} = \frac{1+6}{2} = \frac{7}{2} = 3.5 = 3$$

$$n_1 = q - p + 1 = 3$$

$$n_2 = r - q = 3$$

$$L \begin{array}{|c|c|c|} \hline P=1 & & q=3 \\ \hline 1 & 7 & 15 \\ \hline n_1 & & \\ \hline \end{array}$$

$$R \begin{array}{|c|c|c|} \hline & 20 & 25 & 35 \\ \hline n_2 & & & \\ \hline \end{array}$$

P = 1  
i = 1  
j = 1  
P = k

if,  $L[i] \leq R[j]$

$$L[1] \leq R[1]$$

$$1 \leq 20, \text{ true}$$

$$A[k] = L[i]$$

$$A[1] = 1$$

$$i = i + 1 = 2$$

$$A. \boxed{1} \boxed{7} \boxed{15} \boxed{20} \boxed{25} \boxed{35}$$

### Step-2

$p=2$

$i=2$

$j=1$

$p=k$

if  $L[i] \leq R[j]$   
 $L[2] \leq R[1]$   
 $7 \leq 20$ , [true]  
 $A[k] = L[i]$   
 $A[2] = 7$

$A \boxed{1} \boxed{7} \boxed{15} \boxed{20} \boxed{25} \boxed{35}$   
 $i = i+1 = 3$

### Step-3

$p=3$

$i=3$

$j=1$

$p=k$

if  $L[i] \leq R[j]$   
 $L[3] \leq R[1]$   
 $15 \leq 20$ , [true]  
 $A[k] = L[i]$   
 $A[3] = 15$

$A \boxed{1} \boxed{7} \boxed{15} \boxed{20} \boxed{25} \boxed{35}$   
 $i = i+1 = 4$

### Step - 4

$p = 4$   
 $i = 4$   
 $j = 1$   
 $P = K$

if  $L[i] \leq R[j]$   
 $L[4] \leq R[1]$   
 $\infty \leq 20$  [false]  
else  
 $A[K] = R[j]$   
 $A[4] = 20$

$A [1 | 7 | 15 | 20 | 25 | 35]$

$$j = j+1 = 2$$

### Step - 5

$p = 5$   
 $i = 4$   
 $j = 2$   
 $P = K$

if  $L[i] \leq R[j]$   
 $L[4] \leq R[2]$   
 $\infty \leq 25$  [false]  
else  
 $A[K] = R[j]$   
 $A[5] = 25$

$A [1 | 7 | 15 | 20 | 25 | 35]$

$$j = j+1 = 3$$

Step - 6

P = 6

i = 4

j = 3

P = K

if  $A[i] \leq R[j]$

$L[4] \leq R[3]$

$\infty \leq 35$  - [false]

else  $A[K] = R[j]$

$A[6] = 35$

A 

1	7	15	20	25	35
---	---	----	----	----	----

$j = j + 1 = 4$

A 

1	7	15	20	25	35
---	---	----	----	----	----

(Sorted)