Q1:

* A is an ordered integer array with 10 elements from small to large
* B is an ordered integer array with 10 elements from large to small
* C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11}
* D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'}

Apply the following sorting algorithms for the given arrays.
- Shell Sort
- Merge Sort
- Heap Sort
- Quick Sort

(I compare the elements in the places marked with yellow.)

- SHELL SORT -

➔ **Lets suppose A = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}**

```
N = 10 (number of elements)

N/2 = 5
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

N/4 ~ 2
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

N/8 ~ 1
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

Comparisons  :22
Displacement :0
```

➔ **Lets suppose B = {9, 8, 7, 6, 5, 4, 3, 2, 1, 0}**

```
N = 10 (number of elements)

N/2 = 5
[4, 8, 7, 6, 5, 9, 3, 2, 1, 0]   →  4 < 9 so they replaced each other.
[4, 3, 7, 6, 5, 9, 8, 2, 1, 0]   →  3 < 8 so they replaced each other.
[4, 3, 2, 6, 5, 9, 8, 7, 1, 0]   →  2 < 7 so they replaced each other.
[4, 3, 2, 1, 5, 9, 8, 7, 6, 0]   →  1 < 6 so they replaced each other.
[4, 3, 2, 1, 0, 9, 8, 7, 6, 5]   →  0 < 5 so they replaced each other.

N/4 ~ 2
[2, 3, 4, 1, 0, 9, 8, 7, 6, 5]   →  2 < 4 so they replaced each other.
[2, 1, 4, 3, 0, 9, 8, 7, 6, 5]   →  1 < 3 so they replaced each other.
[2, 1, 0, 3, 4, 9, 8, 7, 6, 5]   →  0 < 4 so they replaced each other.
[0, 1, 2, 3, 4, 9, 8, 7, 6, 5]   →  0 < 2 so they replaced each other.
[0, 1, 2, 3, 4, 9, 8, 7, 6, 5]
[0, 1, 2, 3, 4, 9, 8, 7, 6, 5]
[0, 1, 2, 3, 4, 7, 8, 9, 6, 5]   →  7 < 9 so they replaced each other.
[0, 1, 2, 3, 4, 7, 6, 9, 8, 5]   →  6 < 8 so they replaced each other.
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]   →  7 < 9 so they replaced each other.

N/8 ~ 1
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]


Comparisons  :22
Displacement :12
```

➔ **C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11}**

N = 12 (number of elements)

N/2 = 6

[5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11]
[5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11]
[5, 2, 1, 9, 1, 7, 6, 8, 13, 15, 4, 11] → 1 < 13 so they replaced each other.
[5, 2, 1, 9, 1, 7, 6, 8, 13, 15, 4, 11]
[5, 2, 1, 9, 1, 7, 6, 8, 13, 15, 4, 11]
[5, 2, 1, 9, 1, 7, 6, 8, 13, 15, 4, 11]

N/4 = 3

[5, 2, 1, 9, 1, 7, 6, 8, 13, 15, 4, 11]
[5, 1, 1, 9, 2, 7, 6, 8, 13, 15, 4, 11] → 1 < 2 so they replaced each other.
[5, 1, 1, 9, 2, 7, 6, 8, 13, 15, 4, 11]
[5, 1, 1, 6, 2, 7, 9, 8, 13, 15, 4, 11] → 6 < 9 so they replaced each other.
[5, 1, 1, 6, 2, 7, 9, 8, 13, 15, 4, 11]
[5, 1, 1, 6, 2, 7, 9, 8, 13, 15, 4, 11]
[5, 1, 1, 6, 2, 7, 9, 8, 13, 15, 4, 11]
[5, 1, 1, 6, 2, 7, 9, 4, 13, 15, 8, 11] → 4 < 8 so they replaced each other.
[5, 1, 1, 6, 2, 7, 9, 4, 11, 15, 8, 13] → 11 < 13 so they replaced each other.

N/8 ~ 1

[1, 5, 1, 6, 2, 7, 9, 4, 11, 15, 8, 13] → 1 < 5 so they replaced each other.
[1, 1, 5, 6, 2, 7, 9, 4, 11, 15, 8, 13] → 1 < 5 so they replaced each other.
[1, 1, 5, 6, 2, 7, 9, 4, 11, 15, 8, 13]
[1, 1, 5, 2, 6, 7, 9, 4, 11, 15, 8, 13] → 2 < 6 so they replaced each other.
[1, 1, 2, 5, 6, 7, 9, 4, 11, 15, 8, 13] → 2 < 5 so they replaced each other.
[1, 1, 2, 5, 6, 7, 9, 4, 11, 15, 8, 13]
[1, 1, 2, 5, 6, 7, 9, 4, 11, 15, 8, 13]
[1, 1, 2, 5, 6, 7, 4, 9, 11, 15, 8, 13] → 4 < 9 so they replaced each other.
[1, 1, 2, 5, 6, 4, 7, 9, 11, 15, 8, 13] → 4 < 7 so they replaced each other.
[1, 1, 2, 5, 4, 6, 7, 9, 11, 15, 8, 13] → 4 < 6 so they replaced each other.
[1, 1, 2, 4, 5, 6, 7, 9, 11, 15, 8, 13] → 4 < 5 so they replaced each other.
[1, 1, 2, 4, 5, 6, 7, 9, 11, 15, 8, 13]
[1, 1, 2, 4, 5, 6, 7, 9, 11, 15, 8, 13]
[1, 1, 2, 4, 5, 6, 7, 9, 11, 8, 15, 13] → 8 < 15 so they replaced each other.
[1, 1, 2, 4, 5, 6, 7, 9, 8, 11, 15, 13] → 8 < 11 so they replaced each other.
[1, 1, 2, 4, 5, 6, 7, 8, 9, 11, 15, 13] → 8 < 9 so they replaced each other.
[1, 1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 15] → 13 < 15 so they replaced each other.

Comparisons :32
Displacement :17

➔ **D = {‘S’, ‘B’, ‘I’, ‘M’, ‘H’, ‘Q’, ‘C’, ‘L’, ‘R’, ‘E’, ‘P’, ‘K’}**

N = 12 (number of elements)

N/2 = 6

[‘C’, ‘B’, ‘I’, ‘M’, ‘H’, ‘Q’, ‘S’, ‘L’, ‘R’, ‘E’, ‘P’, ‘K’] → ‘C’ < ‘S’ so they replaced each other.
[‘C’, ‘B’, ‘I’, ‘M’, ‘H’, ‘Q’, ‘S’, ‘L’, ‘R’, ‘E’, ‘P’, ‘K’]
[‘C’, ‘B’, ‘I’, ‘M’, ‘H’, ‘Q’, ‘S’, ‘L’, ‘R’, ‘E’, ‘P’, ‘K’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘Q’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘K’] → ‘E’ < ‘M’ so they replaced each other.
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘Q’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘K’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘Q’] → ‘K’ < ‘Q’ so they replaced each other.

N/4 = 3

[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘Q’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘Q’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘Q’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘Q’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘Q’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘S’, ‘L’, ‘R’, ‘M’, ‘P’, ‘Q’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] → ‘M’ < ‘S’ so they replaced each other.
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’]
[‘C’, ‘B’, ‘I’, ‘E’, ‘H’, ‘K’, ‘M’, ‘L’, ‘Q’, ‘S’, ‘P’, ‘R’] → ‘Q’ < ‘R’ so they replaced each other.

N/8 ~ 1

[‘B’, ‘C’, ‘I’, ‘E’, ‘H’, ‘K’, ‘M’, ‘L’, ‘Q’, ‘S’, ‘P’, ‘R’] → ‘B’ < ‘C’ so they replaced each other.
[‘B’, ‘C’, ‘I’, ‘E’, ‘H’, ‘K’, ‘M’, ‘L’, ‘Q’, ‘S’, ‘P’, ‘R’]
[‘B’, ‘C’, ‘E’, ‘I’, ‘H’, ‘K’, ‘M’, ‘L’, ‘Q’, ‘S’, ‘P’, ‘R’] → ‘E’ < ‘I’ so they replaced each other.
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘Q’, ‘S’, ‘P’, ‘R’] → ‘H’ < ‘I’ so they replaced each other.
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘Q’, ‘S’, ‘P’, ‘R’]
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘Q’, ‘S’, ‘P’, ‘R’]
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘Q’, ‘S’, ‘P’, ‘R’] → ‘L’ < ‘M’ so they replaced each other.
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘Q’, ‘S’, ‘P’, ‘R’]
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘Q’, ‘S’, ‘P’, ‘R’]
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘Q’, ‘P’, ‘S’, ‘R’] → ‘P’ < ‘S’ so they replaced each other.
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘S’, ‘R’] → ‘P’ < ‘Q’ so they replaced each other.
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’] → ‘R’ < ‘S’ so they replaced each other.

Comparisons :27
Displacement :12

- MERGE SORT -

➔ **Lets suppose A = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}**

```
   [0, 1, 2, 3, 4]                [5, 6, 7, 8, 9]     → splitting
  [0, 1, 2]     [3, 4]          [5, 6, 7]     [8, 9]
[0, 1]   [2]   [3]   [4]       [5,6]   [7]   [8]  [9]
[0] [1] [2]   [3]   [4]       [5] [6]  [7]   [8]  [9]

[0, 1]  [2]    [3, 4]          [5, 6]  [7]    [8, 9]    → merging
 [0, 1, 2]     [3, 4]           [5, 6, 7]     [8, 9] combine elements by comparing
   [0, 1, 2, 3, 4]                [5, 6, 7, 8, 9]
         [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]      → result

Comparisons  :9                 Displacement :0
```

➔ **Lets suppose B = {9, 8, 7, 6, 5, 4, 3, 2, 1, 0}**

```
    [9, 8, 7, 6, 5]                [4, 3, 2, 1, 0]     → splitting
  [9, 8, 7]     [6, 5]          [4, 3, 2]     [1, 0]
[9, 8]   [7]   [6]   [5]       [4,3]   [2]   [1]  [0]
[9] [8] [7]   [6]   [5]       [4] [3]  [2]   [1]  [0]

[8, 9]  [7]    [5, 6]          [3, 4]  [2]    [0, 1]    → merging
 [7, 8, 9]     [5, 6]           [2, 3, 4]     [0, 1] combine elements by comparing
   [5, 6, 7, 8, 9]                [0, 1, 2, 3, 4]
         [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]      → result
Comparisons  :9                 Displacement :10
```

➔ **C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11}**

```
     [5, 2, 13, 9, 1, 7]              [6, 8, 1, 15, 4, 11]     → splitting
  [5, 2, 13]     [9, 1, 7]          [6, 8, 1]      [15, 4, 11]
[5, 2]   [13]  [9, 1]   [7]        [6,8]   [1]    [15, 4]  [11]
[5] [2]  [13] [9] [1]   [7]        [6] [8] [1]    [15] [4] [11]

[2, 5]  [13]   [1, 9][7]          [6, 8]  [1]    [4, 15] [11]    → merging
[2, 5, 13]     [1, 7, 9]          [1, 6, 8]     [4, 11, 15]
   [1, 2, 5, 7, 9, 13]              [1, 4, 6, 8, 11, 15]
          [1, 1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 15]      → result
Comparisons  :11          Displacement :9
```

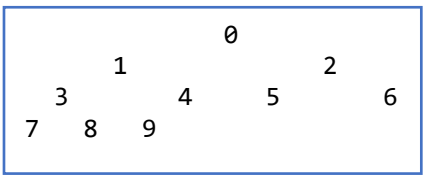
➔ **D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'}**

```
     ['S', 'B', 'I', 'M', 'H', 'Q']          ['C', 'L', 'R', 'E', 'P', 'K']     → splitting
  ['S', 'B', 'I']     ['M', 'H', 'Q']      ['C', 'L', 'R']      ['E', 'P', 'K']
['S', 'B']   ['I']   ['M', 'H']    ['Q']   ['C', 'L']   ['R']   ['E', 'P']   ['K']
['S'] ['B'] ['I'] ['M'] ['H'] ['Q']       ['C'] ['L'] ['R']   ['E'] ['P'] ['K']

['B', 'S']   ['I']    ['H', 'M']['Q']      ['C', 'L']   ['R']    ['E', 'P'] ['K']    → merging
 ['B', 'I', 'S']     ['H', 'M', 'Q']        ['C', 'L', 'R']      ['E', 'K', 'P']
   ['B', 'H', 'I', 'M', 'Q', 'S']            ['C', 'E', 'K', 'L', 'P', 'R']
          ['B', 'C', 'E', 'H', 'I', 'K', 'L', 'M', 'P', 'Q', 'R', 'S']   → result

Comparisons  :11                Displacement :8
```

- HEAP SORT -

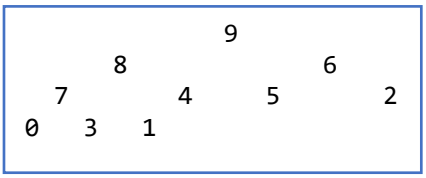
➔ **Lets suppose A = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}**

Heap



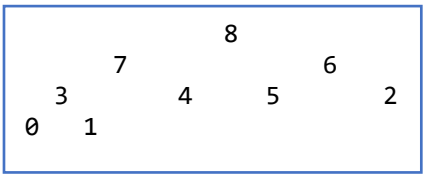
After conversion : [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

Converting to max heap

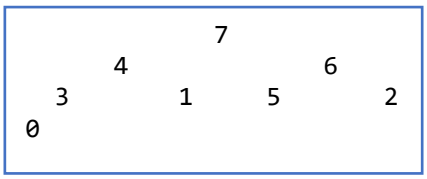


After conversion : [9, 8, 6, 7, 4, 5, 2, 0, 3, 1]

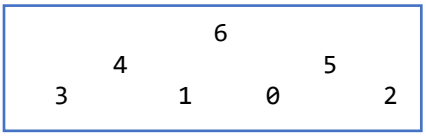
➢ ***In the next steps, I will take the root and convert it to max heap again***



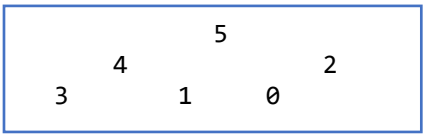
After conversion : [8, 7, 6, 3, 4, 5, 2, 0, 1, 9]



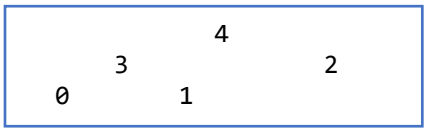
After conversion : [7, 4, 6, 3, 1, 5, 2, 0, 8, 9]



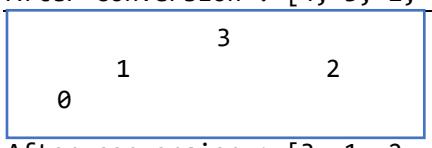
After conversion : [6, 4, 5, 3, 1, 0, 2, 7, 8, 9]



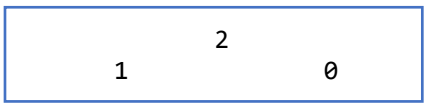
After conversion : [5, 4, 2, 3, 1, 0, 6, 7, 8, 9]



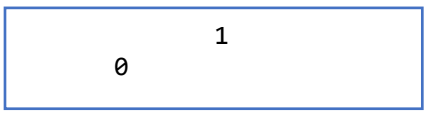
After conversion : [4, 3, 2, 0, 1, 5, 6, 7, 8, 9]



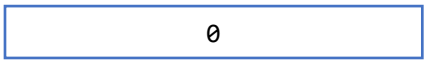
After conversion : [3, 1, 2, 0, 4, 5, 6, 7, 8, 9]



After conversion : [2, 1, 0, 3, 4, 5, 6, 7, 8, 9]



After conversion : [1, 0, 2, 3, 4, 5, 6, 7, 8, 9]

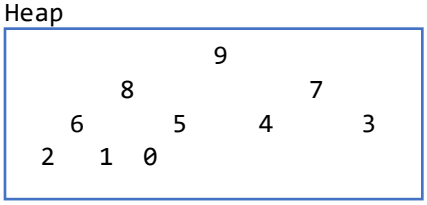


After conversion : [0, 1, 2, 3, 4, 5, 6, 7, 8, 9] → result

Comparisons :23
Displacement :19

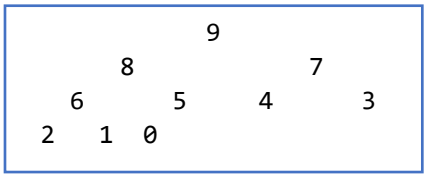
➔ **Lets suppose B = {9, 8, 7, 6, 5, 4, 3, 2, 1, 0}**

Heap



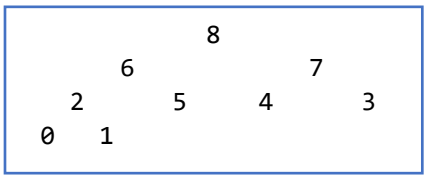
After conversion : [9, 8, 7, 6, 5, 4, 3, 2, 1, 0]

Converting to max heap (it is already max heap)

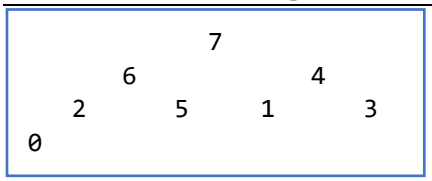


After conversion : [9, 8, 7, 6, 5, 4, 3, 2, 1, 0]

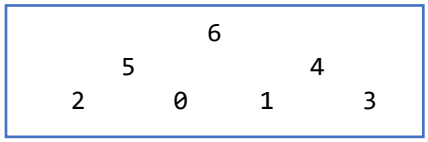
➢ ***In the next steps, I will take the root and convert it to max heap again***



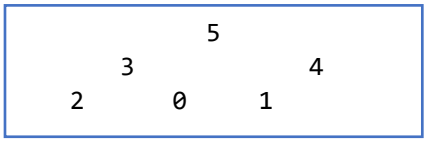
After conversion : [8, 6, 7, 2, 5, 4, 3, 0, 1, 9]



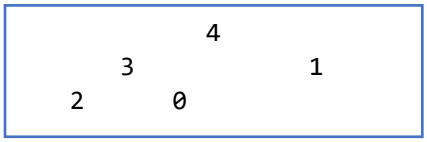
After conversion : [7, 6, 4, 2, 5, 1, 3, 0, 8, 9]



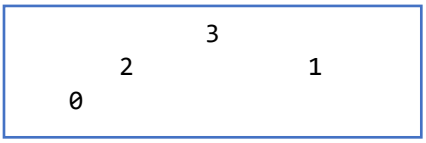
After conversion : [6, 5, 4, 2, 0, 1, 3, 7, 8, 9]



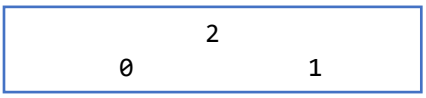
After conversion : [5, 3, 4, 2, 0, 1, 6, 7, 8, 9]



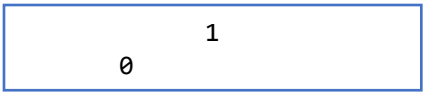
After conversion : [4, 3, 1, 2, 0, 5, 6, 7, 8, 9]



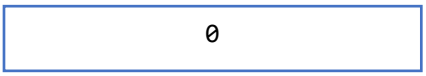
After conversion : [3, 2, 1, 0, 4, 5, 6, 7, 8, 9]



After conversion : [2, 0, 1, 3, 4, 5, 6, 7, 8, 9]



After conversion : [1, 0, 2, 3, 4, 5, 6, 7, 8, 9]

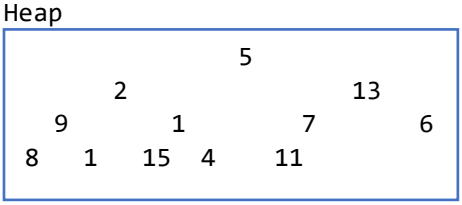


After conversion : [0, 1, 2, 3, 4, 5, 6, 7, 8, 9] → result

Comparisons :14
Displacement :9

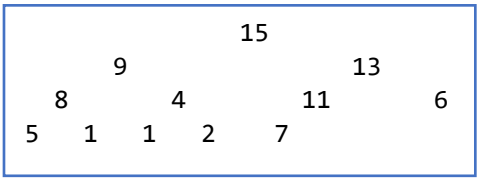
➔ **C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11}**

Heap



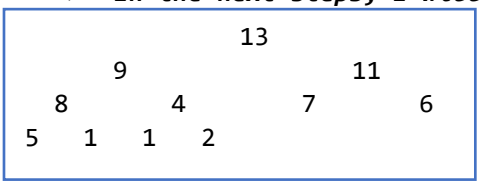
After conversion : [5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11]

Converting to max heap

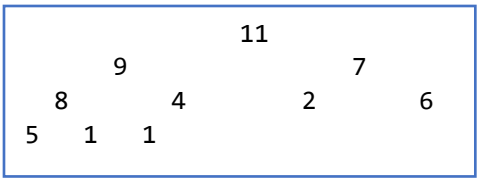


After conversion : [15, 9, 13, 8, 4, 11, 6, 5, 1, 1, 2, 7]

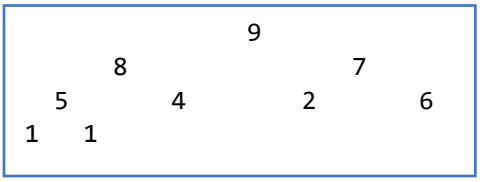
➢ ***In the next steps, I will take the root and convert it to max heap again***



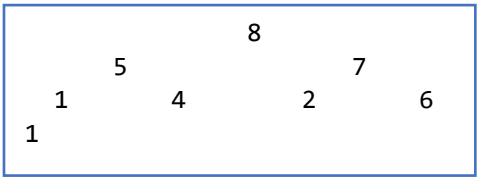
After conversion : [13, 9, 11, 8, 4, 7, 6, 5, 1, 1, 2, 15]



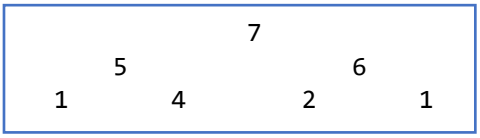
After conversion : [11, 9, 7, 8, 4, 2, 6, 5, 1, 1, 13, 15]



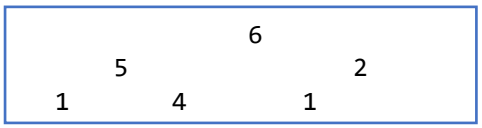
After conversion : [9, 8, 7, 5, 4, 2, 6, 1, 1, 11, 13, 15]



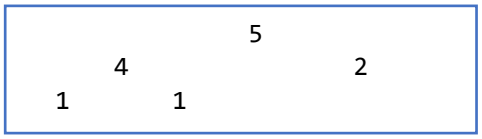
After conversion : [8, 5, 7, 1, 4, 2, 6, 1, 9, 11, 13, 15]



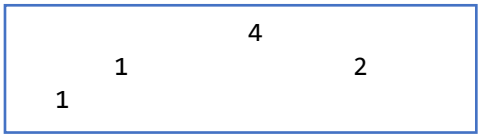
After conversion : [7, 5, 6, 1, 4, 2, 1, 8, 9, 11, 13, 15]



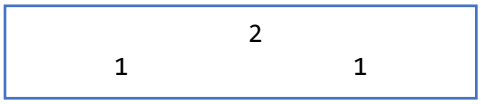
After conversion : [6, 5, 2, 1, 4, 1, 7, 8, 9, 11, 13, 15]



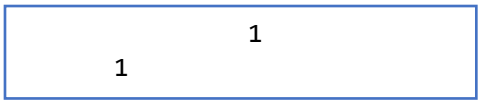
After conversion : [5, 4, 2, 1, 1, 6, 7, 8, 9, 11, 13, 15]



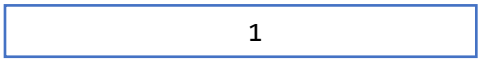
After conversion : [4, 1, 2, 1, 5, 6, 7, 8, 9, 11, 13, 15]



After conversion : [2, 1, 1, 4, 5, 6, 7, 8, 9, 11, 13, 15]



After conversion : [1, 1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 15]

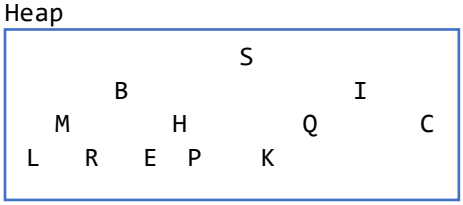


After conversion : [1, 1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 15] → result

Comparisons :37
Displacement :28

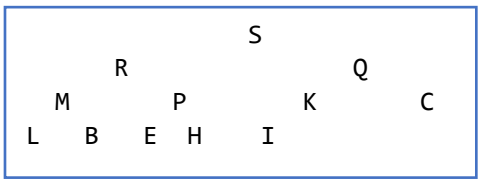
➔ **D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'}**

Heap



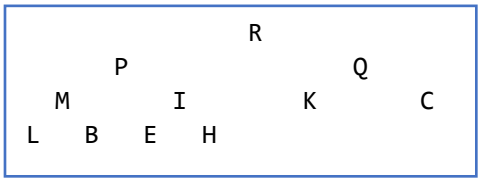
After conversion : ['S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K']

Converting to max heap

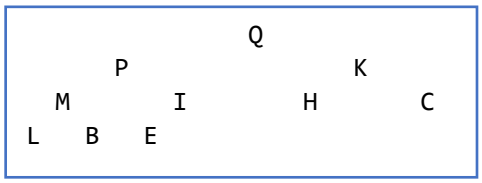


After conversion : ['S', 'R', 'Q', 'M', 'P', 'K', 'C', 'L', 'B', 'E', 'H', 'I']

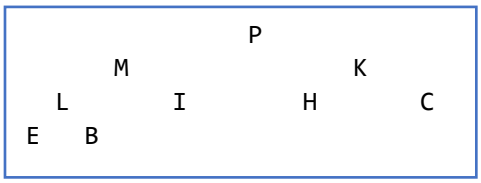
➢ ***In the next steps, I will take the root and convert it to max heap again***



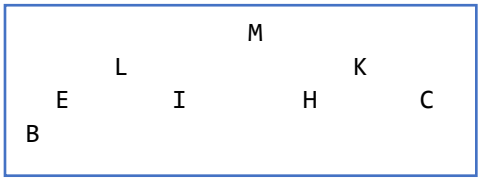
After conversion : ['R', 'P', 'Q', 'M', 'I', 'K', 'C', 'L', 'B', 'E', 'H', 'S']



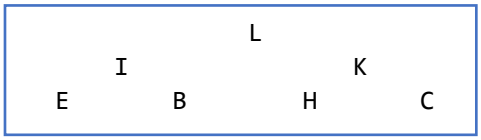
After conversion : ['Q', 'P', 'K', 'M', 'I', 'H', 'C', 'L', 'B', 'E', 'R', 'S']



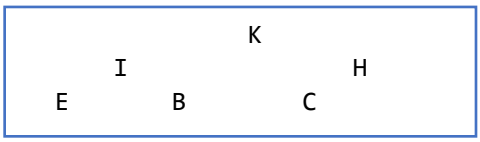
After conversion : ['P', 'M', 'K', 'L', 'I', 'H', 'C', 'E', 'B', 'Q', 'R', 'S']



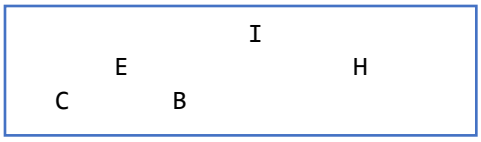
After conversion : ['M', 'L', 'K', 'E', 'I', 'H', 'C', 'B', 'P', 'Q', 'R', 'S']



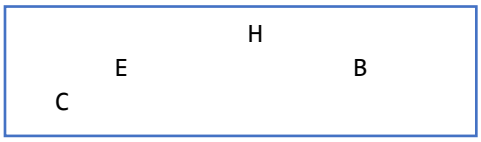
After conversion : ['L', 'I', 'K', 'E', 'B', 'H', 'C', 'M', 'P', 'Q', 'R', 'S']



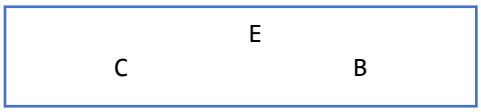
After conversion : [‘K’, ‘I’, ‘H’, ‘E’, ‘B’, ‘C’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’]



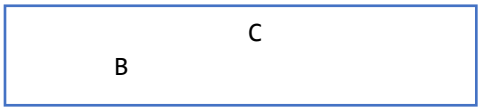
After conversion : [‘I’, ‘E’, ‘H’, ‘C’, ‘B’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’]



After conversion : [‘H’, ‘E’, ‘B’, ‘C’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’]



After conversion : [‘E’, ‘C’, ‘B’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’]



After conversion : [‘C’, ‘B’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’]

After conversion : [‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’] → result

Comparisons :25
Displacement :20

- QUICK SORT -

➔ **Lets suppose A = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}**

Pivot = 9
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →0<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →1<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →2<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →3<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →4<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →5<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →6<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →7<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →8<pivot no change

Pivot = 8
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →0<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →1<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →2<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →3<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →4<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →5<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →6<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →7<pivot no change

Pivot = 7
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →0<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →1<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →2<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →3<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →4<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →5<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →6<pivot no change

Pivot = 6
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →0<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →1<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →2<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →3<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →4<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →5<pivot no change

Pivot = 5
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →0<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →1<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →2<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →3<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →4<pivot no change

Pivot = 4
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →0<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →1<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →2<pivot no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] →3<pivot no change

```
Pivot = 3
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →0<pivot  no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →1<pivot  no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →2<pivot  no change

Pivot = 2
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →0<pivot  no change
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →1<pivot  no change

Pivot = 1
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →RESULT


Comparisons  :45
Displacement :0
```

➔ **Lets suppose B = {9, 8, 7, 6, 5, 4, 3, 2, 1, 0}**

```
Pivot = 0
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →9<pivot , changed

Pivot = 9
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →0<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →8<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →7<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →6<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →5<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →4<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →3<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →2<pivot  no change
[0, 8, 7, 6, 5, 4, 3, 2, 1, 9]          →1<pivot  no change

Pivot = 1
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →8<pivot , changed

Pivot = 8
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →1<pivot  no change
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →7<pivot  no change
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →6<pivot  no change
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →5<pivot  no change
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →4<pivot  no change
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →3<pivot  no change
[0, 1, 7, 6, 5, 4, 3, 2, 8, 9]          →2<pivot  no change
```

```
Pivot = 2
[0, 1, 2, 6, 5, 4, 3, 7, 8, 9]          →7<pivot , changed


Pivot = 7
[0, 1, 2, 6, 5, 4, 3, 7, 8, 9]          →2<pivot  no change
[0, 1, 2, 6, 5, 4, 3, 7, 8, 9]          →6<pivot  no change
[0, 1, 2, 6, 5, 4, 3, 7, 8, 9]          →5<pivot  no change
[0, 1, 2, 6, 5, 4, 3, 7, 8, 9]          →4<pivot  no change
[0, 1, 2, 6, 5, 4, 3, 7, 8, 9]          →3<pivot  no change

Pivot = 3
[0, 1, 2, 3, 5, 4, 6, 7, 8, 9]          →6<pivot , changed

Pivot = 6
[0, 1, 2, 3, 5, 4, 6, 7, 8, 9]          →3<pivot  no change
[0, 1, 2, 3, 5, 4, 6, 7, 8, 9]          →5<pivot  no change
[0, 1, 2, 3, 5, 4, 6, 7, 8, 9]          →4<pivot  no change

Pivot = 4
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →5<pivot , changed
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]          →RESULT



Comparisons  :30
Displacement :5
```

➔ **C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11}**

```
Pivot = 11
[5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11]      →5 <pivot  no change
[5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11]      →2 <pivot  no change
[5, 2, 9, 13, 1, 7, 6, 8, 1, 15, 4, 11]      →13<pivot , 13>9 changed
[5, 2, 9, 1, 13, 7, 6, 8, 1, 15, 4, 11]      →13<pivot , 13>1 changed
[5, 2, 9, 1, 7, 13, 6, 8, 1, 15, 4, 11]      →13<pivot , 13>7 changed
[5, 2, 9, 1, 7, 6, 13, 8, 1, 15, 4, 11]      →13<pivot , 13>6 changed
[5, 2, 9, 1, 7, 6, 8, 13, 1, 15, 4, 11]      →13<pivot , 13>8 changed
[5, 2, 9, 1, 7, 6, 8, 1, 13, 15, 4, 11]      →13<pivot , 13>1 changed
[5, 2, 9, 1, 7, 6, 8, 1, 4, 15, 13, 11]      →13<pivot , 13>15 , 13>4 changed
[5, 2, 9, 1, 7, 6, 8, 1, 4, 11, 13, 15]      →15<pivot , 15>11 changed
```

```
Pivot = 4
[2, 5, 9, 1, 7, 6, 8, 1, 4, 11, 13, 15]      →5<pivot , 5>2 changed
[2, 1, 9, 5, 7, 6, 8, 1, 4, 11, 13, 15]      →5<pivot , 5>1 changed
[2, 1, 1, 5, 7, 6, 8, 9, 4, 11, 13, 15]      →9<pivot , 9>1 changed
[2, 1, 1, 4, 7, 6, 8, 9, 5, 11, 13, 15]      →5<pivot , 5>4 changed

Pivot = 1
[1, 2, 1, 4, 7, 6, 8, 9, 5, 11, 13, 15]      →2<pivot , 2>1 changed
[1, 1, 2, 4, 7, 6, 8, 9, 5, 11, 13, 15]      →2<pivot , 2>1 changed

Pivot = 5
[1, 1, 2, 4, 5, 6, 8, 9, 7, 11, 13, 15]      →7<pivot , 7>5 changed

Pivot = 7
[1, 1, 2, 4, 5, 6, 7, 9, 8, 11, 13, 15]      →8<pivot , 8>7 changed

Pivot = 8
[1, 1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 15]      →9<pivot , 9>8 changed

Pivot = 15
[1, 1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 15]      →RESULT


Comparisons  :20
Displacement :17
```

➔ **D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'}**

['S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K']

[83,66,73,77,72,81,67,76,82,69,80,75]

```
Pivot = 'K'
['B', 'S', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K']      →'S'<pivot , 'S'>'B' changed
['B', 'I', 'S', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K']      →'S'<pivot , 'S'>'I' changed
['B', 'I', 'H', 'M', 'S', 'Q', 'C', 'L', 'R', 'E', 'P', 'K']      →'S'<pivot , 'S'>'H' changed
['B', 'I', 'H', 'C', 'S', 'Q', 'M', 'L', 'R', 'E', 'P', 'K']      →'M'<pivot , 'M'>'C' changed
['B', 'I', 'H', 'C', 'E', 'Q', 'M', 'L', 'R', 'S', 'P', 'K']      →'S'<pivot , 'S'>'E' changed
['B', 'I', 'H', 'C', 'E', 'K', 'M', 'L', 'R', 'S', 'P', 'Q']      →'Q'<pivot , 'Q'>'K' changed
```

Pivot = ‘E’
[‘B’, ‘I’, ‘H’, ‘C’, ‘E’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] → ‘B’<pivot no change
[‘B’, ‘C’, ‘H’, ‘I’, ‘E’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] →‘I’≮pivot , ‘I’>‘C’ changed
[‘B’, ‘C’, ‘E’, ‘I’, ‘H’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] →‘H’≮pivot , ‘H’>‘E’ changed

Pivot = ‘C’
[‘B’, ‘C’, ‘E’, ‘I’, ‘H’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] → ‘B’<pivot no change

Pivot = ‘H’
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] →‘I’≮pivot , ‘I’>‘H’ changed

Pivot = ‘Q’
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] → ‘M’<pivot no change
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘R’, ‘S’, ‘P’, ‘Q’] → ‘L’<pivot no change
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘P’, ‘S’, ‘R’, ‘Q’] → ‘P’<pivot no change
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘P’, ‘Q’, ‘R’, ‘S’] →‘S’≮pivot , ‘S’>‘Q’ changed

Pivot = ‘P’
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘P’, ‘Q’, ‘R’, ‘S’] → ‘K’<pivot no change
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘P’, ‘Q’, ‘R’, ‘S’] → ‘M’<pivot no change
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘M’, ‘L’, ‘P’, ‘Q’, ‘R’, ‘S’] → ‘L’<pivot no change

Pivot = ‘L’
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’] →‘M’≮pivot , ‘M’>‘L’ changed

Pivot = ‘S’
[‘B’, ‘C’, ‘E’, ‘H’, ‘I’, ‘K’, ‘L’, ‘M’, ‘P’, ‘Q’, ‘R’, ‘S’] →RESULT

Comparisons :20
Displacement :11