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Recursive Insertion Sort

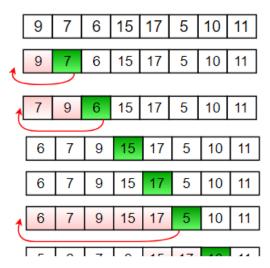
Insertion sort is a simple sorting algorithm that works the way we sort playing cards in our hands.

Below is an iterative algorithm for insertion sort

Algorithm

```
// Sort an arr[] of size n
insertionSort(arr, n)
  Loop from i = 1 to n-1.
  a) Pick element arr[i] and insert
    it into sorted sequence arr[0..i-1]
```

Example:



Refer Insertion Sort for more details.

How to implement it recursively?

Recursive Insertion Sort has no performance/implementation advantages, but can be a good question to check one's understanding of Insertion Sort and recursion.

If we take a closer look at Insertion Sort algorithm, we keep processed elements sorted and insert new elements one by one in the inserted array.

Recursion Idea.

- 1. Base Case: If array size is 1 or smaller, return.
- 2. Recursively sort first n-1 elements.
- 3. Insert last element at its correct position in sorted array.

Below is implementation of above idea.

C/C++

```
// Recursive C++ program for insertion sort
#include <iostream>
using namespace std;
// Recursive function to sort an array using
// insertion sort
void insertionSortRecursive(int arr[], int n)
    // Base case
    if (n <= 1)
        return;
    // Sort first n-1 elements
    insertionSortRecursive( arr, n-1 );
    // Insert last element at its correct position
    // in sorted array.
    int last = arr[n-1];
    int j = n-2;
    /* Move elements of arr[0..i-1], that are
      greater than key, to one position ahead
      of their current position */
    while (j \ge 0 \&\& arr[j] > last)
        arr[j+1] = arr[j];
        j--;
    arr[j+1] = last;
}
```

```
// A utility function to print an array of size n
void printArray(int arr[], int n)
{
    for (int i=0; i < n; i++)
        cout << arr[i] <<" ";
}

/* Driver program to test insertion sort */
int main()
{
    int arr[] = {12, 11, 13, 5, 6};
    int n = sizeof(arr)/sizeof(arr[0]);

    insertionSortRecursive(arr, n);
    printArray(arr, n);

    return 0;
}</pre>
```

Java

```
// Recursive Java program for insertion sort
import java.util.Arrays;
public class GFG
{
    // Recursive function to sort an array using
    // insertion sort
    static void insertionSortRecursive(int arr[], int n)
        // Base case
        if (n <= 1)
            return;
        // Sort first n-1 elements
        insertionSortRecursive( arr, n-1 );
        // Insert last element at its correct position
        // in sorted array.
        int last = arr[n-1];
        int j = n-2;
        /* Move elements of arr[0..i-1], that are
          greater than key, to one position ahead
          of their current position */
        while (j \ge 0 \&\& arr[j] > last)
            arr[j+1] = arr[j];
            j--;
        arr[j+1] = last;
```

```
// Driver Method
public static void main(String[] args)
{
    int arr[] = {12, 11, 13, 5, 6};

    insertionSortRecursive(arr, arr.length);

    System.out.println(Arrays.toString(arr));
}
```

Python

```
# Recursive Python program for insertion sort
# Recursive function to sort an array using insertion sort
def insertionSortRecursive(arr,n):
    # base case
    if n<=1:
        return
    # Sort first n-1 elements
    insertionSortRecursive(arr,n-1)
    '''Insert last element at its correct position
        in sorted array.'''
    last = arr[n-1]
    j = n-2
      # Move elements of arr[0..i-1], that are
      # greater than key, to one position ahead
      # of their current position
    while (j>=0 and arr[j]>last):
        arr[j+1] = arr[j]
        j = j-1
    arr[j+1]=last
# A utility function to print an array of size n
def printArray(arr,n):
    for i in range(n):
        print arr[i],
# Driver program to test insertion sort
arr = [12,11,13,5,6]
n = len(arr)
insertionSortRecursive(arr, n)
printArray(arr, n)
# Contributed by Harsh Valecha
```

Output:

5 6 11 12 13





This article is contributed by Sahil Chhabra (akku). If you like GeeksforGeeks and would like to contribute, you can also write an article using contribute.geeksforgeeks.org or mail your article to contribute@geeksforgeeks.org. See your article appearing on the GeeksforGeeks main page and help other Geeks.

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