Recursive Insertion Sort

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

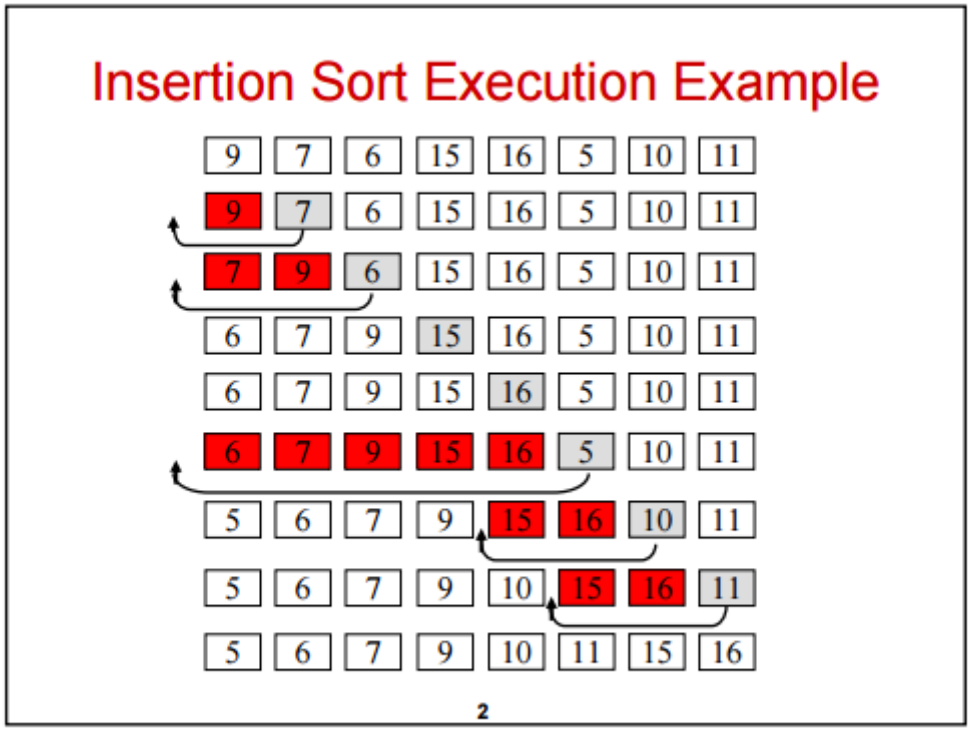
2.4

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 >= 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;
}
```

Run on IDE

```
// 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 >= 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));
    }
}
```

Run on IDE

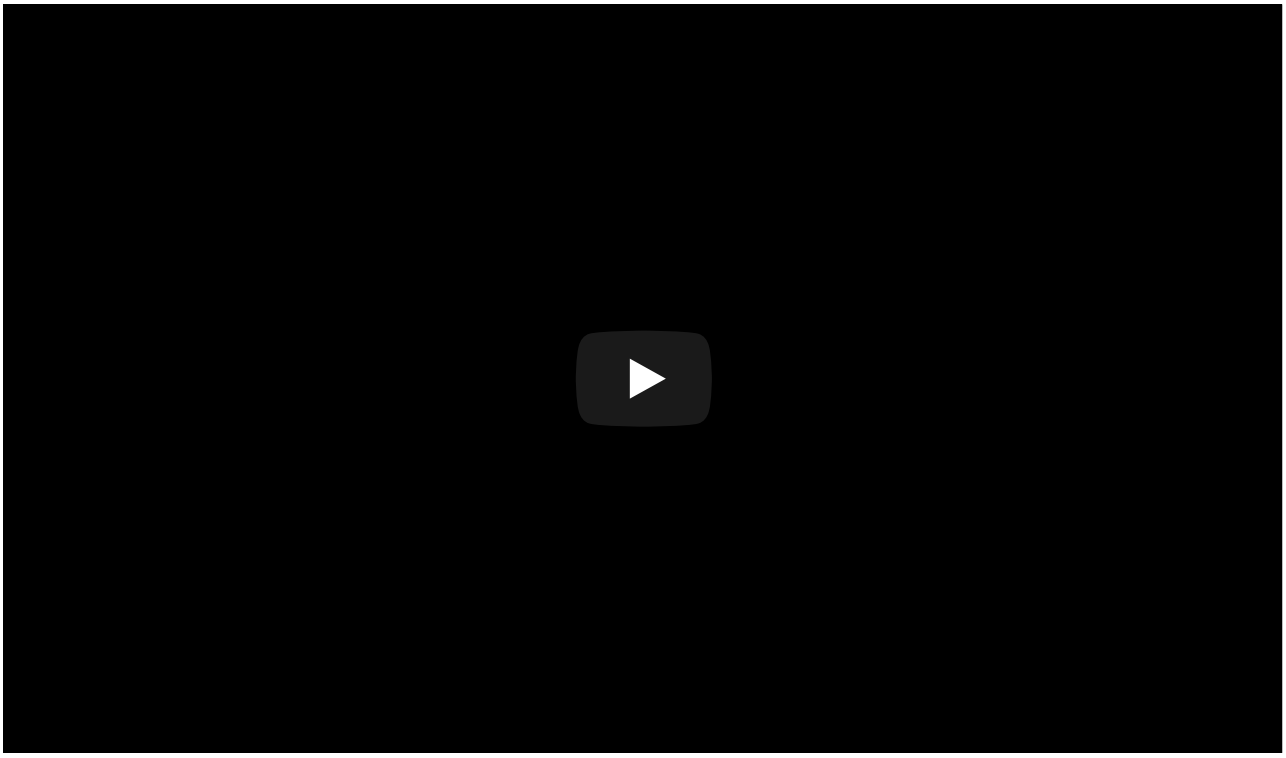
Python

```
# 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
```

Run on IDE

Output :

```
5 6 11 12 13
```



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