Tutorial - 3

1) Psudo code for linear Search

```
for (i=0 to n)
{ if (arr [i] == key)
      print " Element found"
}
```

2) recursive

```
void insertion (int arr[ ], int n)
  { if (n<=1)
      return ;
    insertion (arr , n-1);
    int num = arr [n-1];
    int j=n-2;
    while (j>=0 && arr [j] >num)
      { arr [j++] = arr [j];
          j-- ;
      }
    arr [j+1] = num;
  }
```

iterative

```
for (i=1 to n)
    key = A [i]
    j = i-1
    while (j>=0 & A[j] > key)
        { A [j+1] = A [j]
          j = j-1;
        }
```

$A[j+1] = key;$

Insertion sort is online sorting because it doesn't know the whole input, more input can be inserted while the insertion sorting is running.

3) complexity of different sorting algorithms.

Name	Best case	worst case	Average.
Selection Sorting	$O(n^2)$	$O(n^2)$	$O(n^2)$
Bubble Sorting	$O(n)$	$O(n^2)$	$O(n^2)$
Insertion Sorting	$O(\cancel{nlo}\,n)$	$O(n^2)$	$O(n^2)$
Heap	$O(n\log n)$	$O(n\log n)$	$O(n\log n)$
quick	$O(n\log n)$	$O(n^2)$	$O(n\log n)$
merge	$O(n\log n)$	$O(n\log n)$	$O(n\log n)$

4) Inplace sorting	stable Sorting	online sorting
Bubble	Merge	Insertion
Selection	Bubble	
Insertion	Insertion	
quick		
heap		

Iterative

```
int b_search (int arr[], int l, int r, int key)
{
  while (l <= r) {
    int m = ((l+r) /2);
    if (arr [m ]== key)
      return m;
    else if (key < arr [m ])
      r = m-1;
    else
      l = m+1;
  }
  return -1;
}
```

Time complexity = O(n)

Recursive:

```
int b_search (int arr[], int l, int r, int key)
{ while (l< =r) {
    int m = ((l +r) /2);
    if (key == arr [m])
      return m;
    else if (key < arr [m])
      return b_search (arr, l, mid-1, key);
    else
      return b_search (arr, mid+1, r, key);
  }
  return -1;
}
```

Time complexity = O(logn)

6) $T(n) = T(n/2) + 1$ —(1)

$T(n/2) = T(n/4) + 1$ —(2)

$T(n/4) = T(n/8) + 1$ —(3)

$$T(n) = T(n/2) + 1$$
$$= T(n/4) + 2$$
$$= T(n/8) + 3$$
$$= T\left(\frac{4}{2^k}\right) + k$$

let $2^k = n$

$k = \log n$

$$T(n) = T\left(\frac{n}{n}\right) + \log n$$

$T(n) = T(1) + \log n$

$T(n) = O(\log n)$

7)
```
for { i=0 ; i<n ; i++)
{
    for(int j=0 ; j<n ;j++)
    {  if (ar[i]+ ar[j] == k)
          printf( "%d %d", i},j]);
    }
}
```

Quick sort is fastest general-purpose sort. In most practical situations quicksort is the method of choice as stability is important & space is available, merge sort might be best.

9) Inversions in array:

A pair ~~is said~~ (A[i], A[j]) is said to be inversion if

- $A[i] > A[j]$
- $i < j$
- Total no. of inversions in given array are 31 using merge sort.

10) Worst case ($O(n^2)$):- When the pivot element is an extreme (smallest / Largest) element. This happens when input array is sorted or reverse sorted & either first or last element is selected as pivot.

Best case ($O(n \log n)$):- The best case occurs when we will select pivot element as a mean element

11) Merge sort →

Best case - $T(n) = 2T(n/2) + O(n)$
Worst case - $T(n) = 2T(n/2) + O(n)$
$\Big\}$ $O(n \log n)$

Quick sort:

Best case - $T(n) = 2T(n/2) + O(n) \rightarrow O(n \log n)$

Worst case - $T(n) = T(n-1) + O(n) \rightarrow O(n^2)$

In quick sort, array of elements are divided into 2 parts repeatedly until it is not possible to divide further

In merge sort - the elements are split int 2 subarray (n/2 again & again until only 1 element is left.

12)

```
for (int i = 0; i<n-1) ; i++)
{
  int min = 1;
  for(int j = i+1 ; j<n , j++)
  { if (a[min] > a[j]))
        min = j ;
  }
  int key = a[min];
  while (min >i)
  {
    a[min] = a [min-j];
    min --;
  }
  a[i] = key;
}
```

2) A better version of bubble sort, known as modified bubble sort, includes a flag that is set if a exchange is made after an entire pass over. If no exchange is made then it should be called the array is already order because no 2 elements need to be switched

```
void bubble (int arr [], int n)
{
 for (int i=0 ; i<n ; i++)
 {
  swaps =0
  for (int j=0 ; j<n-i-j ; j++)
  {
   if arr [j] > arr [j+1])
    {int t= arr [j] ;
     arr [j] = arr [j+1];
     arr [j+1] =t;
      swap++;
    }
  }
  if (swap ==0)
   break;
 }
}
```