Algorithm

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Book

Lecture Video for the Book

Recursion :

Recursion is the process of defining a problem (or the solution to a problem) in terms of (a simpler version) itself.

Law of Recursive:

- A recursive algorithm must have a base case (when to stop)
- A recursive algorithm must move toward the base case
- A recursive algorithm must call itself recursively

Code:

Example 1:

```
def count_down(n):
  print(n,end='')
  if n>0:
    count_down(n-1)
```

Example 2:

```
def sum_list(list):
  if len(list)==0:
    return 0
  return list[0]+sum_list(list[1:])
```

Example 3:

```
def tostr(n,base):
  digit='0123456789ABCDEF'
  if n<base:
    return digits[n]
  return tostr(n // base,base) + digits[n % base]
```

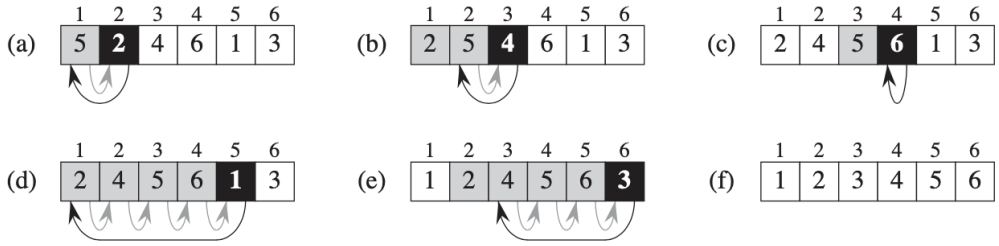

Figure 1: Insertion Sort

Insertion Sort

Code:

```
def insertion_sort(A):
    for j in range(2,len(A)):
        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
        return A
```

The $\theta(n)$ steps. Each steps have $\theta(n)$ swaps.

Merge Sort:

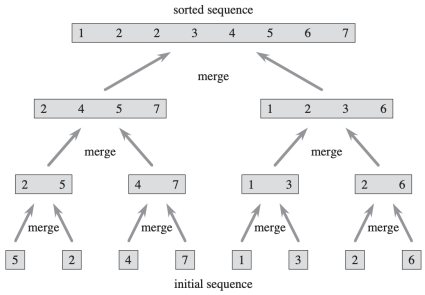

Figure 2: Merge Sort

Code:

```
def mergeSort(myList):
    if len(myList) > 1:
        mid = len(myList) // 2
        left = myList[:mid]
        right = myList[mid:]

        # Recursive call on each half
```

```
        mergeSort(left)
        mergeSort(right)

        # Two iterators for traversing the two halves
        i = 0
        j = 0

        # Iterator for the main list
        k = 0

        while i < len(left) and j < len(right):
            if left[i] < right[j]:
              # The value from the left half has been used
              myList[k] = left[i]
              # Move the iterator forward
              i += 1
            else:
                myList[k] = right[j]
                j += 1
            # Move to the next slot
            k += 1

        # For all the remaining values
        while i < len(left):
            myList[k] = left[i]
            i += 1
            k += 1

        while j < len(right):
            myList[k]=right[j]
            j += 1
            k += 1

myList = [54,26,93,17,77,31,44,55,20]
mergeSort(myList)
print(myList)
```

The complexity $\theta(n)$.

$T(n) = c_1 + 2T(\frac{n}{2}) + c.n$

Selection Sort:

Code:

```
def selection_sort(A):
    # Traverse through all array elements
    for i in range(len(A)):

        # Find the minimum element in remaining
        # unsorted array
        min_idx = i
        for j in range(i+1, len(A)):
            if A[min_idx] > A[j]:
                min_idx = j
```

```
        # Swap the found minimum element with
        # the first element
        A[i], A[min_idx] = A[min_idx], A[i]
    return A
```