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Definations

① What is data:- Data is raw, unprocessed i/p given to a system.

② What is atomic data:- Atomic data is a single, elementary piece of data which cannot be further decompose.
for e.g : character 'a', number 10 are atomic.

③ What is composite data:- composite data is a grouped of data item consist of subfield each of which is atomic.
for e.g. date consist of day, month, year.

④ What is Data structure:-
A data structure cosist of data object (like, 0, ±1, ±2, ---), their properties (like +, −, *, ÷, /, %, <, >), & the set of legal operation (arithematic rules which apply to the operation.

or

A data structure is a set of Domain D, a designated domain d ∈ D, a set of function F, & a set of axioms A.
The triple (D,F,A) denoks the Data structure.

↕ ← Very IMP.

What is abstract Data type?
The ADT is a mathematical of concep-tual defⁿ of data structure
The datastructure i.e the triple {D, F, A} is called the ADT

very IMP # What is data object:- Data object refer to a set of element (D) of a specific data type. These set may be finite or de-finite.
e.g A set of integer is infinite
A set of Alphabets is finite

What is logical DS:-
→ An ADT is a logical DS because if Specifies the "logical property" of the Datatype.

what is physicle DS?
→ A physical DS is the implemented ADT which can be used to store element & perform operation

Space complexity:- The space complexity of an algorithm is the amount of memory a program needs to be execute.
The space complexity S(P) of an Algorithm is is written as
$S(P) = C + S_p$

Time complexity:- The time complexity of an program is the amount of time the program require to execute however, it is very difficult to calculate the exact running time.
Also the exact running time is depend of S/w or hardware.

Best Case :- The best case performance is the minimum no. of steps that can be executed for the given i/p values

worst case:- The worst case step count is the maximum number of that can be execute for the given parameter

Average case:- Avg case running time assume that all i/p of a given size are equally likely
Usually the avg case & worst case step count is nearly same.

Big Oh notation. (O) :-
This notation is used to denote upper bounds
It is expressed as O(Frequency count(n))
means O(f(n))

Omega notation (Ω) :-
This notation is used to denote lower bound
It is written as $T(n) = \Omega(f(n))$

θ notation (θ) :-
This notation denotes both upper & lower bound of f(n) & written as $T(n) = \theta(f(n))$

Advantages of linear / sequential search:-
- It is very simple method.
- It doesnot require the data to be ordered.
- It does not required any additional DS.
- It is very easy to implement

Disadvantage of linear / sequential search:-
- If n is very large, this method is inefficient & slow.
- Its worst case complexity is O(n)

Sentinal search :-

Binary search :-
It is very efficient searching method used for linear/sequential data (files, array or linklist).
~~This is a very efficient searching~~
This method is based on the Divide & conquer algorithmic stategy.
In this strategy the problem is solved by dividing the set of element & performing operation on each part.

Precondition:-
Data must be organized in linear way.
Data has to be in the sorted order in either ascending or descending.

Trees are the kindest

Internal sorting:- Sorting is done on data which is stored in main memory

External sorting:- Sorting is done on data which stored in auxillary storage devices.

Inplace sorting:- Inplace sorting is said to be inplace if it does not use a lot of additional memory for soring.
e.g. Bubble sort, insertion, selection sort are inplace sort
& Merge sort, Count sort is not inplace sort because we need addition array for them.

comparison base sort:- A comparison base sort method sorts the element by performing the comparison operation
e.g Bubble sort, insertion, selection, merge, Quick, etc.

Non comparison based sort:- These sorting method sort element without comparing them with each other but use integer arithematic on key.
e.g. Count sort, Radix sort, Bucket sort.

Efficiency of Bubble sort:-

There are n-1 comparisons in the 1st pass, n-2 comparison in 2nd pass & 1 comparison in n-1th i.e last pass.

∴ total no of comparison is $= (n-1)+(n-2)+\dots+1 = \frac{n(n-1)}{2}$

The same no of passes is required in best case (i.e already sorted) & worst case (elements in reverse order).

Hence the Best case & worst case time complexity is $O(n^2)$

Advantage:-
- It is simple sorting Method.
- It is inplace & stable sorting method.
- No additional data structure is required.

Disadvantage:-
- It is very inefficient Method - $O(n^2)$
- Even the elements are already sorted but all passes are will be done.

Advantages of insertion sort:-
- Write all Advantages of Bubble sort
- Best case time complexity is $\Omega(n)$
- This method gives best efficiency, if the elements are almost sorted.
- Disadvantage:- Worst case efficiency is $O(n^2)$

Advantages of selection sort:-
=> write all advantages of Bubble sort.

Disadvantages:-
=> Best & worst case efficiency is $O(n^2)$

Complexity analysis of merge sort:-

The total no. of iteration in Merge sort are $\log_2 N$.

In each iteration, n elements are merged.

Hence time complexity of Merge sort is $O(n \log_2 n)$

Advantage:-
- Best & worst case efficiency is $O(n \log_2 n)$ Hence it is very efficient.
- It is stable sorting processs.

Disadvantage:-
- Additional array (Memory) require for these merging process.
- It is "not" in place sort method.
- It use divide & conqure technique which bit difficult to implement.

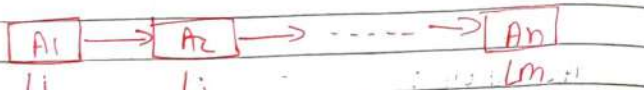
What is divide & conqure techique:-

The divide & conqure technique involves taking a large scale problem & dividing it into similar sub problem of a smaller scale & recursively solving each of these sub problems.

Defⁿ of linklist:-

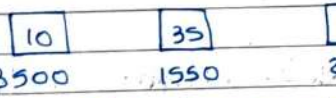
A linklist is an ordered collection of data element which are stored at random memory location & linked to one another.

The order among element is given by means of links i.e each item is "linked" to an another item.



In above diagram A1 to An are n element which are stored at locations Li, Lj, etc & they are linked to one another.

In the Dynamic implementation, each element is stored independently by allocating memory dynamically. The memory are linked to each other using pointer



Here 3 element are stored at three different locations.

We will need three pointer to store their addresses

Hence the no. of pointer needed = number of element in the list.

Clearly this is inefficient.

Node Structure of Singly linklist:-

```
struct node {
    int info;
    struct node *next;
};
```

```
typedef struct node {
    int info;
    struct node *next;
} NODE;
```

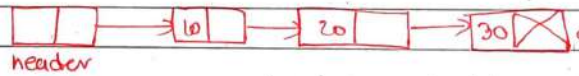
This is a "self referential" structure since it contain a pointer to the same structure.

Operation of linklist:-

① create ② Traverse ③ Length ④ insert (All insert operation) ⑤ Delete (All Delete operation) ⑥ Search ⑦ Reverse ⑧ concatnate ⑨ Merge

Header node:-

A header node is an extranode that is added at begining of the list. This node doesnot store any data but can be used to store some control information like elements.



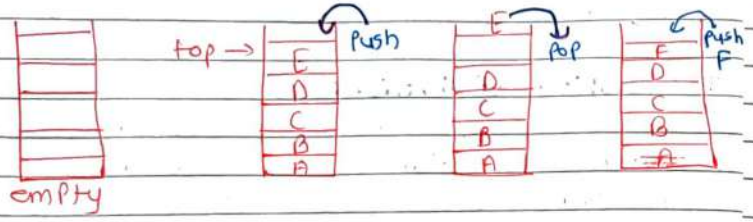
Application of linklist:-

① Multivariable poly representation.

Def" of Stack:-

A stack is an ordered collection of data item which are arrange in LIFO manner.

It has one open end called "top" & element can be added (PUSH) & removed (POP) from the same end.



Stack can be implemented using static as well as dynamic.

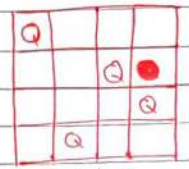
Application of stack:-

① Handelling function call
② Compiler & operating system
③ Expression conversion & evaluation (infix, postfix & prefix)
④ Games.
⑤ String reversal & palindrome check.

N Queen problem:-

In this problem, we have to place N queen on a N×N chess board, such that no queen can attack any other queen.

The chess queen can attack if they are in the same row, same column or same diagonal. There are many variants of this problem namely 8-Queen (92 solution) & 4-Queen (2 solution) problem.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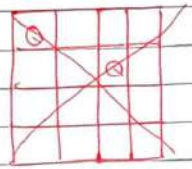

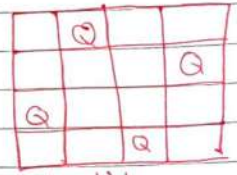
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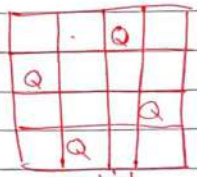
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