AIUB

SOLUTION

Scanned with CamScanner

Data Structure

Algorithm: set of instructions that can be followed to perfo task. sequence of steps that can be followed to solve problem
*we do not follow grammer here.

Variable: Variable is an area of memory that has given a name.
*& x represent the memory area.
*x represent the value stored inside.

Array: An array can hold a series of elements of the same type Placed in contigous memory locations

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

Theory

* 1st dimention is row and 2nd dimention of array is column.

* mimo [5] is index 4.

* A pointer is a variable that stores the location of a memory / variable.

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

Theory

* 1GB → 1024MB → 1024KB → 1024B

B = byte b = bit

* Variable, array, Pointer, linked list.

Array searching: array searching এর জন্য array sorting করতে হবে।

Stack: • Pop → ~~entry~~ exit → উপর

• Push → entry → উপর

LIFO → Last in first out

FILO → First in last out

Top: যেই index এ data push করব তার নিচের index হবে top.

* loop always decrement হবে i এর মান।

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

FIFO → First in First out

LILO → Last in Last out

<u>Queo:</u> যে last ও থাকবে সে হবে Rare.

*always increment ও rear বাড়বে

Enqueue → Entery → শেষে entery

Dequeue → Exit → প্রথম থেকে exit

<u>Data structure:</u> Data structure is a structure where we organize elementary data items in different ways and there exits structural relationship among the items so that it can be used efficiently.

<u>Operations on DS:</u>

① Insertion (addition of a new element)

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

② Deletion (removal of the element)

③ Traversal (accessing data elements)

④ Searching (locating a certain element)

⑤ Sorting (Arranging elements in a specified order)

⑥ Merging (combining elements of 2 similar)

Matrix initialization:

* we can initial matrix is 3 typs.

```
int a[3][5]={1,2,3,4,5,6};
int a[3][5]={{1,2},{3,4},{5,6}};
int a[3][5]={
            {1,2},
            {3,4},
            {5,6}};
```

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

* ভিতরের { } না দিলেও হবে।

* matrix এর কোনো element সংখ্যা থাকলে সেখানে default ভাবে 0 বসবে

* nested loop এর মাধ্যমেও matrix নেয়া যায়।

* Matrix is an 2D array.

* A 2D array is also referred as an array of arrays. An array of which each element is another way.

* getline() function takes the input stream as the first parameter which cin and string object as the 2nd parameter.

* getline() function use করা

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

হয় input ও space নেয়ার জন্য।

<u>Pointer:</u> A pointer is a variable that stores the location of a memory/variable.

<u>Structure:</u> Data structure is a data organization, management, and storage format that enables efficient access and modification.

অর্থাৎ বেশ কয়েকটা data typs যুক্ত variable কে যখন একটি variable এর মাধ্যমে প্রকাশ করা হয় সেটা হল structure.

*A structure is an aggregate data type built using elements of other typs.

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

* strcpy is used to copy the string.

** Operator (->) is used for pointer variable of struct instead of (.).

* The dot(.) or combination of dash -line and greater than sign(->) is used as operator to refer to members of struct.

Operator মাঝে থাকলে → Infix

" শেষে " → Postfix

" শুরুতে " → Prefix

Sorting: (I) Selection

(II) Insertion

(III) Buble

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

Bubble: ২টা করে index ধরে swap করে সবচেয়ে বড় digit শেষে থাকবে ॥ ছোট ॥ প্রথমে থাকবে।

Insertion: সব গুলো index এর সাথে compare করে swap করব। ২টা করে index এর মধ্যে compare করব না।

Final

Linked list: Linked list is a data structure consisting of a group of memory space which together represnt a list or a squence of data. [List আকারে data গুলো memory তে থাকবে এবং একটা data sequence create করবে।]

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

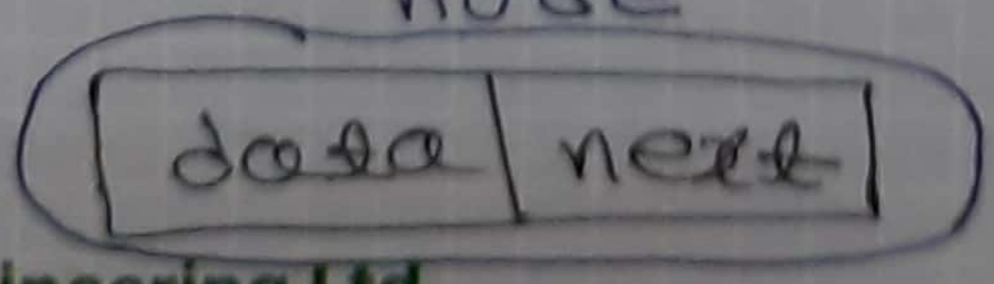
*Linked list ও separate memory space/block থাকে। আর সেই block কে cell /node বলে।

* It's use for matrix calculation and it's also use for image viewer, previous and next page in web browser, music player etc.

<u>Code:</u>

```
struck ListNode
  { int data;
    ListNode *next;
  };
ListNode node;
```

node



AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

* সবার শেষে যে সংখ্যা থাকবে তার memory address null হবে always

* If curr == null → Linked list হবে না।

* If curr ≠ 0 or curr ≠ null linked list হবে এবং next এ যাবে।

* Linked list এর প্রথম part এ data থাকে আর পরের part এ address থাকে।

If curr -> data = item print found and exit

<u>Code:</u>

(1)

1. set New = AV and A Link[a]

2. set ; INFO[New] = ITEAM

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

3. set: LINK [NEW] = START

4. set: START = NEW

5. EXIT

(2)

head = = temp;

Node temp = New node

temp → data = 2

Temp → Next = NULL

temp → Next = head

head = temp

এই পদ্ধতিতে আমরা অসংখ্য node link list এ add করতে পারব।

Tree: Representing hierarcical

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

data.

* Routing algorithoms wifi rout-er এর ভিতর use হয়।

* 1 টি tree তে 1/2 টি Node থাকে সেই Node এর ভিতর একটা করে value থাকবে।

* 1 টি node থাকলে তাকে Root node বলে।

* 1 টার বেশি node থাকলে Child node বলে।

* Level 0 থেকে count করা হয়।

* Binary tree এর প্রতিটি node এ at most 2 টি children থাকে।

* Level index এর মত হিসাব করতে হয়।

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

* Mother node 1 টা থাকবে।

* Operation এর order always left to right যাবে।

* Inorder tree থেকে tree বের করার সময় left গুলো left এ যাবে right গুলো right এ যাবে এবং মাঝের গুলো মাঝেই থাকবে।

* Every node entry has a unique key (no duplication item).

* কোনো সংখ্যা অন্য সংখ্যা / main node এর সংখ্যার চেয়ে বড় হলে ডানে যাবে tree এর।

* কোনো সংখ্যা অন্য সংখ্যা / main

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

node এর সংখ্যার চেয়ে বেশি হলে বাড়ে যাবে tree এর।

Linked list :-

* প্রতিটি memory block পরবর্তী block এর data/location/link/address -s contain করে।

* Data sequence আকারে থাকলেও এর মাঝখানেও প্রকাশ করা হয় তবে অবশ্যই যে data stored হয় consecutively আকারে memory তে। পরপর সাজানো

* Implemenation of stacks and queues.

* Implementation of graphs, adjacency list to store adjacency vertices.

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

* Dynamic memory allocation.
* Maintaining directory of names
* Performing arithmetic operati-
-ons on long integers.
* Manipulation of polynomials
by sorting
* Representing sparse matrix.

Tree: ① Binary tree:

Each node of a binary tree
has at most 2 children.

Complete / Full binary tree:

A complete / full binary tree is a
binary tree which is completely

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

filled with nodes from top to bottom and left to right.

In complete binary tree some of the nodes only for the bottom level might be absent.

In full binary tree the last/bottom level must be filled up.

Nodes at each level $\boxed{L = 2^L}$

If total number of nodes is n

Height of the tree is $\boxed{\log_2 n}$

* Every node entry has a unique key.

Binary search Tree:

Deletion: Leaf node delete

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

করতে চাইলে just delete হবে।

Child node delete করতে চাইলে মাঝের child delete হয়ে যাবে এবং উপরের node এর সাথে যুক্ত হবে। [যদি child only ১টা থাকে]

যদি ২টা child থাকে আর parent কে delete করতে হয় তাহলে সব চেয়ে বড় সংখ্যার সাথে replace হয়ে যাবে। next বড় সংখ্যার সাথে replace হবে। like 31 delete করতে চাইলে 32 replace করবে।

<u>Heap:</u> A heap is a binary tree with some conditions.

* সব level full থাকতে হবে তবে

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

last level always ফাঁকা থাকতে পারে। rightmost level maybe missing

* The key of each node is ≥ keys of its children. [Parent node child node এর চেয়ে বড় হতে হবে।]

Max heaps:

Parent ≥ child

Min heaps:

Parent ≤ child

Array representation of Heaps:-

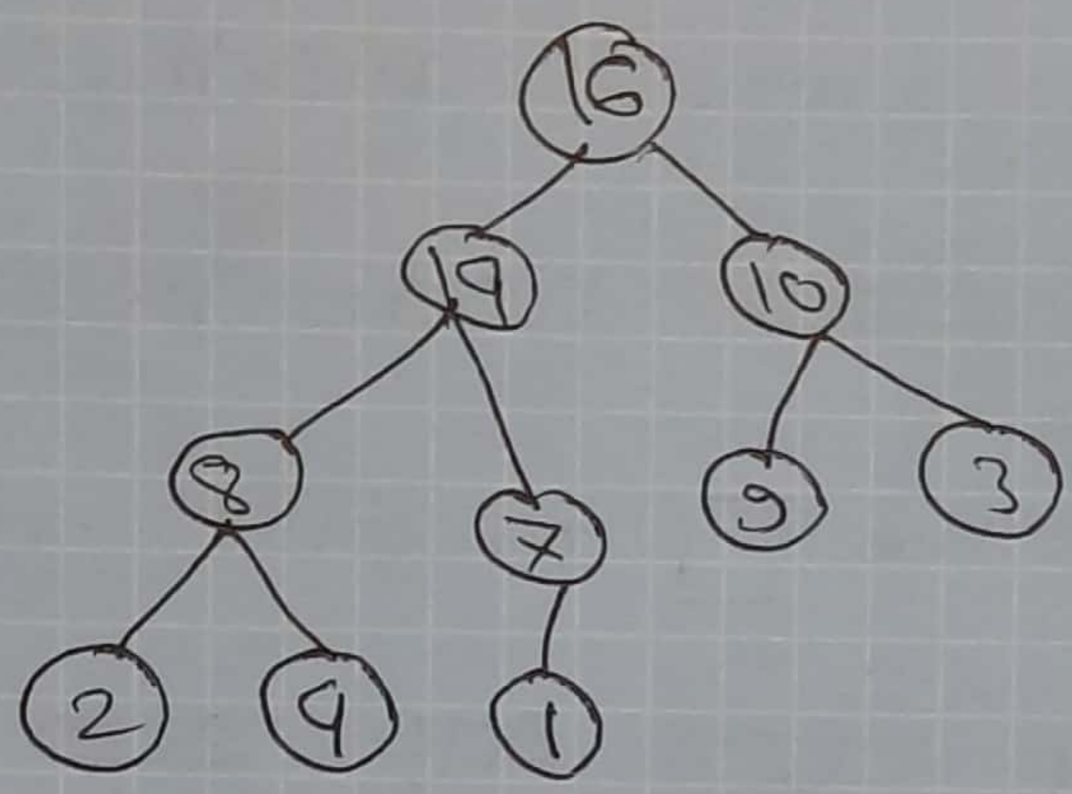
When index i is from 0 to n-1 and number of element length of A[ ] and n=10

* Root of tree is A[0] = 16

AB Power Engineering Ltd.
ISO 9001:2015 Certified
all kinds of power solution

Scanned with CamScanner

*Left child of $A[i] = A[2i+1]$

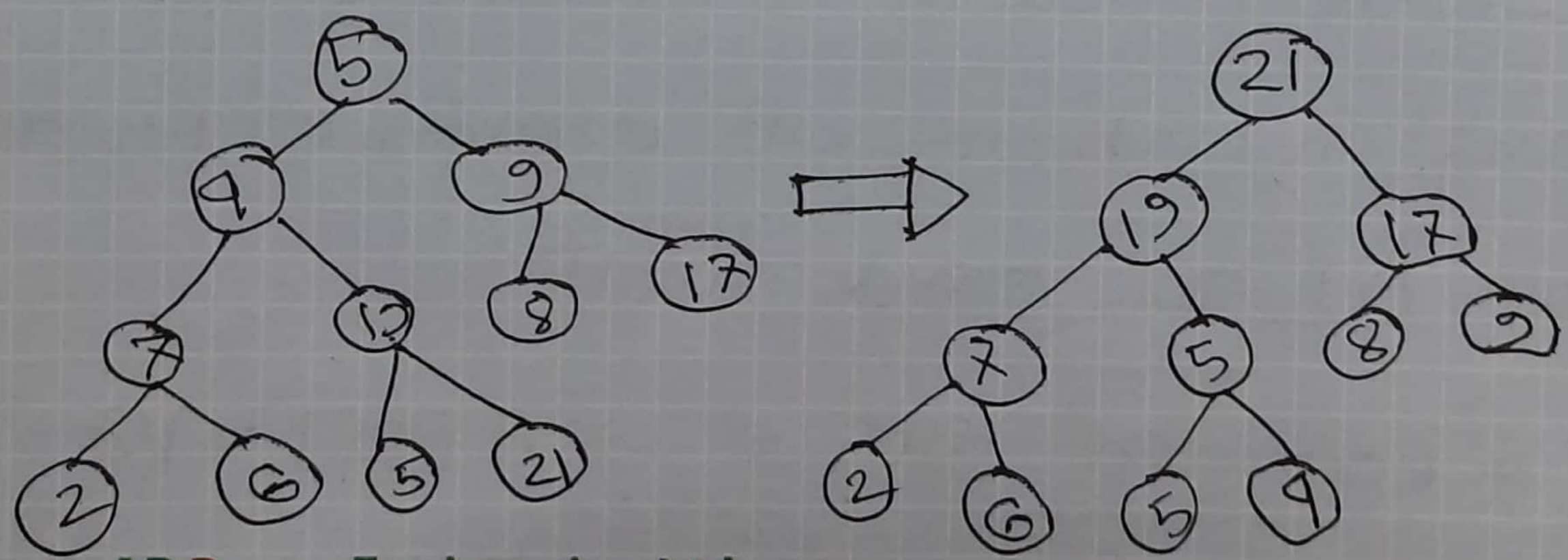


* Right child of $A[i] = A[2i+2]$

* Parent of $A[i] = A[\lfloor (i-1)/2 \rfloor]$

Arrange this array as a heap a tree / Array?

5, 4, 9, 7, 19, 8, 17, 2, 6, 5, 21



AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

আমরা জানি Parent node child node এর চেয়ে বড় হবে। সেক্ষেত্রে Parent node child node এর বড় সংখ্যার সাথে সব সময় replace করবে।

* Restoring the properties is called down heap, also known as heapify-down, cascade-down and extract-min/max.

Delete/Removing Max element:

- Replace/exchange the root of the heap with the last element on the last level.
- Reduce the heap size by one
- perform the max heapify

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

(A, 0, n-1) function for the root

i=0

<u>Heap sort:</u> Sort an array using heap representation.

- Build a max-heap from the array
- swap the root with the last element.
- Discard the last node by decreasing the heap size.
- call max-heapify on the new root.
- Repeat this process until only one node remains

* There are two main uses of heaps.

- The first is as a way

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

of implementing a special kind of queue, called a priority queue.

- The second application is sorting.

* Heaps are the data structure most often used to implement priority queues.

Graph

Nodes = vertex, line = edges,

connected vertex = degrees,

→ = in degree, ← = out degree,

(2) = loop

Complete graph: When every ~~graph is~~ vertex is strictly

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

connected to each other.

Dense Graph: When the number of edges in the graph is close to maximum. (adjacency matrix is used to store info for this)

Sparse Graph: When number of edges in the graph is very few. (adjacency list is used to store info for this)

Weighted Graph: Associates weights with either the edges or the vertices.

Connected: If every vertex of a graph can reach every other vertex.

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

Strongly connected: Every 2 vertices are reachable from each other.

Examples of Graph Aplication: (i) State space search in AI (ii) scene graphs which is use in contents of visual scence (iii) Telecommunications network design.

vertex = city, edge = communication link

communication network

Storage requirements: $O(n^2)$

- Adjecency is more efficient to represent dense graph.
  - store just one bit/edge.
  - Undirected graph only need half of matrix.

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

Spanning Tree: A spanning tree of G is a subgraph which is a tree containing all vertices of G.

* Nodes সংখ্যা হবে same and vertices হবে V-1.

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

~~*e-n+1~~
~~=16-13+1~~
~~= 4~~ ~~=16-14~~

*e-n+1
=16-13+1
= 4

*spanning tree তে কোনো loop থাকতে পারবে না।

Spanning tree: A spanning tree is a sub-graph of a graph that contains or connects all the vertices and has no cycle.

*যেহেতু loop থাকা যাবে না সেহেতু edge বাদ দিয়ে loop বাদ করতে হবে।

MST → Minimum spanning Trees

- Undirected connected graph. weight (w)

On(V,E)

AB Power Engineering Ltd.
ISO 9001:2015 Certified
all kinds of power solution

Scanned with CamScanner

- number of edges = vertex-1

MST: total weight of tree is minimum.

Prim's Algorithm:

(i) vertex based algorithom

(ii) edge can be found with priority queue.

- which one is better?

=> prim's algorithom.

Kruskal's algorithm: (i) edge based algorithm

(ii) edge can be done just by sorting.

(ii) edge can be done just by sorting.

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

way of graph traversing and searc-
-hing : 2

- Depth-first search (DFS)
- Breadth-first search (BFS)

DFS	BFS
• stack (LIFO)	• Queue (FIFO)
• Path wise search	• level wise search
• Tree edges &	• Back edges &
cross edges	forcword edges

which one is better?

=> BFS

Back: child to parent

Forcword: parent to child

cross: all other edges (undiscovered)

Motive: Find shortest path

AB Power Engineering Ltd.
all kinds of power solution
ISO 9001:2015 Certified

Scanned with CamScanner

Stay with us:

Our Facebook Group: https://www.facebook.com/groups/solutionaiub

Our Facebook Page: https://www.facebook.com/AIUBSolution

Scanned with CamScanner