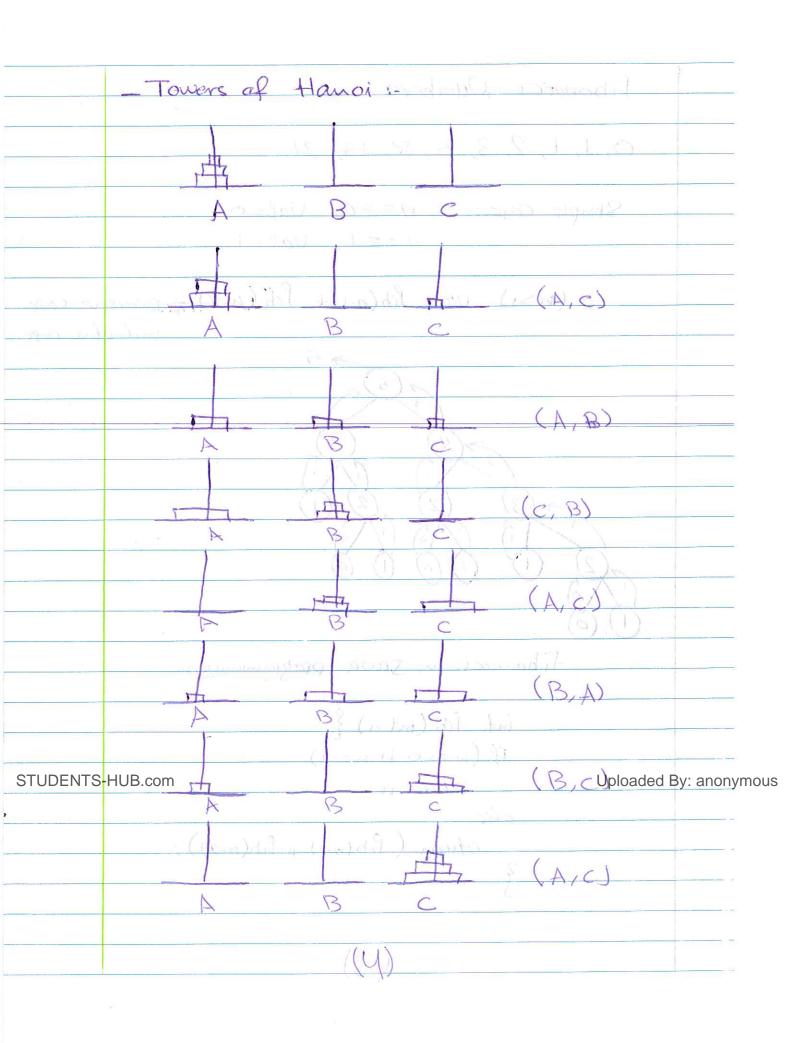
Chapter 1 30 Data Structure :- an organization or structing for acollection of data items in the main memory (RAM) a solution is said to be efficient if it solves the problem with it's constraints (space and time). abstract Data Type (ADT) and Data Structures:-* Type :- is a collection of values. 1) Single types :- "integer/boolean. 2) Composite / aggregate: Circle object. Ex:- boolean -> true byte -> -1281-1127 101 101 a data type :- is a type together with a collection of operations to mainpulate the type. (integer / Double) Del-Wallack ... an abstract Data type (ADt) :: is the realization of adata type as a software component. Uploaded By: anonymous STUDENTS-HUB.com A Data Structure :- is the implementation of the ADT. Ex:- ADT : list; stack / Tree, ... add (), remove (), clear (),...

* Recursion: - inether that directly as indirectly called Hself (5) P P2 P3 P = 17.0 Factorial problem :find 51 2. auta 5 24 P, => 5×4! 4 P2 > 4 + 3! P3 => 3 + 2! 3 Py => 2×11 2 hea 2 int fact (int a) } => simple case / base case int Vali 1 If(n=1)Val = 1; else Val = nx fact(n-1); return val; (1) and and STUDENTS-HUB.com Uploaded By: anonymous * Fibonacci number * a call of the class.

Fibonacci Numbers:-0, 1, 1, 2, 3, 5, 8, 13, 21, ... Simple case: - N==0, Val=01 n==1, Val=1. => (n>1) val= fib(n)+ fib (4-2) => recursive case inductive case 5 5 3 -Fibonacci in Java programming:int fib (int n) { If (n==011 n==1) STUDENTS-HUB.com Uploaded By: anonymous veturn n: else return (fib(n-1) + fib(n-2));



in _ 18

* # of moves = 21 - 1 " Offeringen" 24_1 = 15 move Ex :-* ٢ أَوَرُصِ * problem :- moving 4 disks from A to c vig B :-(problem) B (A, B) R (1.8) (A, c)(B) C (B, C) C B STUDENTS-HUB.com Uploaded By: anonymous (A,B)1 they B S.A.) , iffer -- (c,A) DOB PEC 5 •

(C,B)1 1th (A,B)do its (A,c) Ľ. (B,c) 11 -(B,A) <u>
</u>
-1 (c,A),中, • (B, c) 14 (A,B)F ----STUDENTS-HUB.com Uploaded By: anonymous 19. (A,c) 1 (B, C) (\mathcal{C})

* Code in Tava :-Static Void H(int 1, char start, char goal, char temp) } if(n=0)veturn; else } H (n-1, start, temp, goal); Move (start, goal); H (N-1, temp, goal, start); } } * Example so H(4, A, C, B) $H(3,A,B,c) \longrightarrow \{H(2,A,c,B) \longrightarrow \{H(1,A,B,c) \longrightarrow \{H(0,A,c,B) \longrightarrow {$ move (A,c) move (A,B) | move (A,c) / move (A,B) H(3, B, C, A) [H(2, C, B, A), [H(1, B, C, A)](H(O,C,B,A) 14 - 5170 al and a > H(2, B, A, C) -> H(1, B, C, A). > SH(0, B, A, C) Move (B,c) L>(H (1, C, A, B) move (B,A) move(B, c) H(2,A,GB)-H(O, A, C, B) H(1, C, A, B)move (C,B) H(I,A,B,C). SH(O, B, A, C) >SH(I, A, B, C) > H(O, C, B, A) move (A,c) move(B,C) move (C, A) H(1, B, C, A). (H(O,A,GB) (H(O, B, A, C) H(O,C,B,A) H (o, A, c, B) Uploaded By: anonymous move (A(B) STUDENTS-HUB COM move (C, A) move(B,c) H(O, B, A, C)_ H(O, C, B, A) H(O, A, C, B)

* Analysis of algorithmse Critical resources >time (*) & Spale The theoritical study of a computer program performance and resource usage officience Asymptotic analysis mesures the eff of an algorithm, its or its implementation as aprogram, as the input size become Lange. - problem Size: the number of inputs to be processed Ex: Size of array, number of elements in a sequence Basic operation: adding or comparing two integers. * for agiven input size n we often express the time I to run the algorithm as alunction of n = T(n) where T(n) > 0. STUDENTS-HUB.com . Uploaded By: anonymous

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5.

Example:for (int i=0; (i<=n; i++)=1 mi) for (int j=0; jZ=N; j++) Sum ++; $T(n) = Cn^2 [p] o [s] p] o [8] T$ where c is the amount of time required To complete one basic operation. * Groth Rate: is the rate at which the cost of the algorithm grows as the size of its inputs grows et aloret, and any a time Corgent walke Using seatheringsis cn > linear groth rate n2 > quadratic (10_pid) or buind sogner + 13 => cubic STUDENTS HUB.com Uploaded By: anonymous n1 => exponential groth rate Logn > n > nlogn > n2 > n3 > 2 > nl

-5

* sequential search: for(int i=0; ikn; i++) if(key = AEiJ)return i; 781592093 - search for 7 => Best Case search for 9 => average case => n/2 search for 3 or 13 => Warst case =>n " آخر ه في المصفى أوعن عوعد " * Best, worst, and average cases:factorial (n) => only one case largest value using sequential search > One case ((Array A) (3.200 - mas)) * upper Bound: 0 (big-oh) STUDENTS-HUB.com Uploaded By: anonymous R

* Asymptotic Analysis:it refers to the study of an algorithm as the input size gets big or reaches alimit * Upper_Bound :- "Big-Oh":- $T(n) = C_1 n^2 + C_2 n (n-1)$ $C_1 h^2 + C_2 h \leq C_1 h^2 + C_2 h^2$ $\leq (c_1 + c_2) h^2$ CINZTOZNIK (CONZ) where col= CI+CZ \rightarrow T(n) is in O(n²) "it indicates the upper or heighest groth rate that the algorithm can have ... * Lower Bound: (sc)"Omega":then in the colorest and they -T(n) = c, n2 (+ c2 n = + ((~), p) () ~ CIANO (a) p) summer STUDENTS-HUB.com, $n^2 + c_2 n \ge C, n^2$ Uploaded By: anonymous $\Rightarrow T(n)$ is (in $\mathcal{P}(n^2)$ (i)) .

* O notestion: when the upper Bound and the lower Bound are the same with a constant factor, we indecate this by O (Big-Theta) notation. Bund "Big Big 1 * an algorith is said to be in \$0(h(n)) if it is in O (hens) and is in R (hen) * Simplifying Rules :-Liff(n) is in O(g(w)) and g(n) is in O(h(n)), then f(n) is in O(h(n)). 2 if f(n) is in O(kg(n)) for any constant kjo, then flus is in O (glus). 1 ignore Constants" 3 if film is in O(g(m)) and film is in C(g2(n)) then f(n) + f2(n) is in 0(max (g, (n), g, (n)) Uploaded By: anonymous STUDENTS-HUB.com 4 if film) is in O(g(m)) and fz is in $O(g_2(n))$, then $f_1(n) f_2(n)$ is in $O(g(n) f_2(n))$

* classifying functions:him f(n) noo g(n) = 00, f(w) is in 2 (g(w) // f(w) faster = 0, f(n) is in O(g(w) // g(w) is faster + O, f(n) is @ (g(n)) // Both grows at the Same rate * Calculating the Running time for aprogram :-The core of algorithm analysis is to find out the number of Basic operation, depende the size of the input. * Rules to count the operations:-Rule 1 : for loop:for(i=0; i < n; i++) Sum == 1; STUDENTS-HUB.com i=0 executed once O(1) Uploaded By: anonymous i=n n+1 times O(n) êtt n times O(n) heading + loop Body = O(n) + O(n) sum += i = O(n)

 $for(0 \rightarrow n) \frac{3}{2}n \frac{2}{2}o(2 + n^2) = 2 o(n^2).$ Rule 2: - Nested Loops !-1) Sum = 0; (1) for (i=0; i<n; i++) }n 20(n+n) for (j=0; j<n; j++) }n J=0(n2) Sumazi Sum=0; for(i=o; i<n; i++) for(j=i ; j<n; j++) Sum ++; i=0 the inner loop will execute 11 times n-1 times 1-1 n-2 times i-2 Once (-m-1 $\frac{1}{2} = n(n+1) = 0(n^2)$ STUDENTS-HUB.com Uploaded By: anonymous (12)

3) SUM=0; for(i=o; i<n; i++) for(j=0; jKn; j++) (n2 log n) sum=sum + function (sum); * function (sum) is in O (logn) \$ \$ pote :- not all nested loops run in O(n2) EX:- Sum=0; for (k=1; k k=n; k+=2) & log n -> 1, 2, 4=2# for(j=1; j<=n; j++) Zn Sum tti $= O(n \log_2 n)$ => login 4) Sum 2 = 0 ; for (K=1; KZ=n; KX=2) => logy for (j=1; j<=k; j++) SUM2++; logn+1 2n-1 = O(n)STUDENTS-HUB.com Uploaded By: anonymous 2. 1

Rule 3 :- If statement if (condition) 51; else 52; The Running time is the makimum of the running times of SI and S2 Example:-2 int max Sum = 0: for(1=0; (< N; i++) for(j=i; j<n; j++) 3 int sum=0; for (K=i; k<=ji k++) Sum == a[k]; if (sums maxsum) max Sum = Sum; 3 return max Sum; Uploaded By: anonymous STUDENTS-HUB.com $\frac{1}{2}$ j-i+1 $\frac{n-1}{2}$ (n-i+1) = (n-i+1)(n-1) $(n-i+i)(n-i) = n^3 + 3n^2 + 2n = O(n^3)$ $(|\mathbf{y})$

Example :-That - } d 14=1 2T(1/2)+n MSI T(n) = 2T(n/2) + nT(n/2) = 4T(n/4) + 2nT(n/4) = 8 T(n/8) + 3 n (N) + T(n/8) = 16T(n/16)+ 4n $= 2^{k} T(n/2^{k}) + kn$ T(1)=1, 1/2"=1 OR $N = 2^k$ => k = logm $T(N) = 2^{\log n} T(1) + (\log n) n$ = n + n log 4 Uploaded By: anonymous STUDENTS-HUB.com T(n)= O(nlogn) (16) .

T(n) = T(n/2) + O(1) Binary search O(logn) T(n)= T(n-U + O(1) sequential sort O(n) T(n) = T(n-1) + O(w) selection Sort O(n2) T(n) = 2T(n/2) + O(n) merge Sort O(nlogn) M(N+1) 2 Example:-(n) - S 1 (2T (n/2)+10 , n>1 2 [2T (n/4) +107+10 has =) = 4T (n/4) + 20+10 10 10 11 X = 4[2T(n/8)+10]+20+10 (= 8T(n/8)+40+20+10 =16T(n/16)+80+40+20+10 Uploaded By: anonymous STUDENTS-HUB.com $= 2^{4} + (n/2^{4}) + 2^{k-1} + 10^{k-2} + 10 + 2^{k-2}$

chapter 3: - lists stacks and gueues :-Linked list :-* list operations :-14/14) 14 insert , remove, read, creat new list clear , get Next element (Data) A iext head tail * List implementation (Arrays vs linked lists) operation Array linked list 1) search o(n) (R) (n) (n) "for an element" STUDENTS-HUB.confind with element Constant O(in.) Uploaded By: anonymous "index " 0(n) 3) print list O(n) 4 Anstatistes 74) jusert the end O(n) Oustant "at the Beginning" O(n) constant 3) insert to the end constant constant 5) (18)

ANA ANT OF MAR 25 public class Dode } Node Next; object data; public Node (object - data) next = null; data = - data; 3 / end loop public vode (Object - data , Node next) Next = next data = - docta; S. Langert M. James al 18 get Darte () set Deuta () get lext () to have been a Set Next () public class Linked List } him private Node head: STUDENTS-HUB.comprivate ind list Counter: Uploaded By: anonymous public Linkcellist () head = new Node (null); list counter = 0, 100 nuu

Il add to the end "tail" public void and object data) } Node temp = new Node (data); Node current - head i While (Current. get Next () (= null) } Current - Current get Next (); 3/lend loop current. Set. Next (temp); Ust Count ++' "null as the ci as head is and " "List 1,51 _ 5 54 & Node Finlip !" public word add (object data, int index) } Mode temp = new Node (date); Node current = head; for (int i=1; it index & & Current. get Next () != null; it+) [current = current getrex(); } Uploaded By: anonymous STUDENTS-HUB.com temp. setNext (current. getNext ()). Current Set Vekt (temp). list Count ++; "List jes d'é à d'a cla ciel?"

Public object get (ind index) } if (index = 0) return hall; Node current = head. get Next (); for lint i=1; iz index; i++) if (current. get Next () == 1/411) veturn null; Stetum current.get Deta (); Public boolean remove (int index) 2 if (index 21 11 index > size()) return false; Nocle current = head; STUDENTS-HUB.comfor (int i=1; i Lindex; i++) { Uploaded By: anonymous if (current get Next() == null veturn Salse; // "jees) 35 30 list joi jes Current = Current. getNext(); } Current. setNext (Current.gotNext().getNext()); return true; ?

public boolean remove (object data) } look current head (a washed) While (current. getNext () 1= null if (((current, getlex+ (), get Data ()), equals(data)) curvent. SetNext (Couvent. getNext(). getNext(); list court ___; veturn true; Current = Current. get Next (). return Salge; public int sizel) return list count; public string to String () { ----Uploaded By: anonymous STUDENTS-HUB.com public class Test } linkeellist list = new Linkeellist (); List add ("comp332").

1) Single Linkeel List :-÷. tail head 2) Doubly linked lists :-3) circular Linkeel lists :-4) Doubly circular linked lists :-* application :=>(polynomial) $p(M) = \chi^{100} + 14 \chi^{30} + 5 \chi^{10} +$ STUDENTS-HUB.com 3X + 1X° Uploaded By: anonymous P=30 C=1 P=100 head C=5 P=10 C=3

=> (Bycket sort) 1, 7, 0, 9, 4, 6, 5, 10 L 2 3 4 5 6 7 8 9 10 0, 1, 4, 5, 6, 7, 9, 10 " لطع النرقاع المحرف نكون العتين عناها O(n)-(Radix Sort) . Vleast MOST Example: 64, 8, 216, 512, 27, 727, 0, 1, 343, , 512, 343, 64, 125, 216, 27, 8, 729 sue ano " and and a langer lied of STUDENTS-HUB.com Uploaded By: anonymous 0, 1, 8, 5\$2, 216, 125, 729, 343, 64 and and a constants

60 27 8 + 125 343 729 216 512 0 9 6 7 3 4 5 8 2 G 0, 1, 8, 27, 64, 125, 216, 343, 512, 729 الترتيق عسب المنزلة المالكة " (10g n) Classon implementation of bother lists : $j = \langle j \rangle$ for (int i=0; i<=9; i++) current = ALIJ. next; While (A Eijonext t- Muy) AEij. nekt = convent, next; aligit = ((current clement / pow (10, j)) × 10; insert (BEoligit], Current). Current = ALIJ. MERT; it+, in STUDENTS-HUB.com Uploaded By: anonymous

(25)

	1 4 60		1. 01	ementation of Linkeellist:-
	ACC	plement	Next	
	header of	-	VX	34 BX 7 B int Ly - Curser Alloc ().
	1	4 header	2\$	$\frac{1}{2} \text{insert} (l_1, l_0);$
	2		3	int Lz = cursorAlloc();
	3		4	$insert(L_1, Z);$
	4		5	iusert (12,15);
	e N			$iuser + (L_2 + 17);$
	1.			insert(4, 20);
	4-1		0	>null
				in cifio pointer is all
		free (ist	12 set index are pointer 11
	el			next C'3
	0		+2	342
	14	head !	202	Cursor Alloc => free sprie) i co is
1 204		10 :	of the local division in which the local division in which the local division in the loc	1 delete(L,10)
	3 (zheadi	40	in the second procession in the second secon
	4	;	3	L => linkcellist
	5		6	- la => linkcellist
	M-1	!	ò	CS- (insert) Falipulie
				(inheallist and a uis
STUDENT	ITS-HUB.com Uploaded By: anonymous			
	4			
				100
				(26)

JavaCode for cursor Allocation: int cursor Alloc () 3 P p= CursorSpace [0]. Next, Cursor Space [0]. Next = Cursor Space [D]. Next; return Di Vaid Cursorfree (intp)} CursorSpace[p]. Next = CursorSpace[0]. Next; Cursor Space[a] - P; Boolean isEmpty (List L) } return (cursos Space [L]. Next == null); shead boolean islast (intp, List L) } veturn (CursorSpace[p], Next == null); () head int find (object X, list L) 3 STUDENTS-HUB.com int p: Uploaded By: anonymous p= cursor Space [L]. Next; While ((p!=null) fif cursor Space [p]. dement != x) } p= Cursor Space [P]. Next; ? return p;

Stacks:addl first add last OR delete first delete Last push: add pop: delete top :- point to the first freespace > first in Last out - lost - O(1) Shirst -> O(n amery Based Stack. Linkeel list Based application of stacks:-Infix aperand Operanel STUDENTS-HUB.com Uploaded By: anonymous Operater In-Fix to post-fix compresion: Infix: a + b * c + (d * e + f) * g Postfix: abc * + de * + 9 * + 28

POP >* Y × × * + + + (+ /×) P(*, '+) P(+) U P(+)+) -+ P(1 F * abo + + at. 4) 14) + P × T + P(+) +) P(4,5) + t + t F Rules: (+', (+') op,' P 0 2 (+', '+') rior 1+ 11 FX +b) G+b-C () op) P(GP, (')ŗ, Uploaded By: anonymous STUDENTS-HUB.com

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Stack implementation Using array:-Public class stack } private int marstack; private int emptistack; private int top; private char EJ items; public Stock (int size)} max Stack = Size; emptyStack = -1; top = cmptyStack; items = new char[maxStack]; } Public void push (chare) { if (I full ()) items [++ top] = C; else public char pop () { if (! is Empty) STUDENTS-HUB.com voturn items [tep -]: Uploaded By: anonymous

public bodean full () } return tep+1 == maxstack; Z public boolean fait Empty () } veturn top == emptyStack; { Stack Linkellist implementation = Lat the beginning: public void push (object new Item) } list. add (1. new Item); } public object pop () } object temp = list. get(1); * list remove (1); veturn temp; STUDENTS-HUB.com Uploaded By: anonymous 21

adding and deleting from the end:public void push (Object new Item) list. add (list. Size() + 19 new Item); public object pop() Object tup = list get (list Size()); List. remove (list. Size()); temp to veturn + mp; STUDENTS-HUB.com Uploaded By: anonymous

Array Based Queine ... class queue } int [] items; int front, rear; boolean is Empty (queue q) } veturn q. front == q. vear; int vernove (queue q) } if (listimpty(q))int tup = front; q. front = (q. front+1) %. Size, return q. items [tmp]; else cupty list STUDENTS-HUB.com Uploaded By: anonymous 22)

void insert (quare q, int x) } temp= (q. rear +1) % size; if (temp == q. front) full else q. vear =temp; q. items[q. vear]=x; Trees & I Tree 2 Binary Tree 3 Binary search tree (BST) 4 AVL Tree (BST) Nith Balance 5 splay Tree (BST without Balance) delete, find, usert Uploaded By: anonymous STUDENTS-HUB.com

Trees :node => root edge lever o sinternal nocle Path B level parent => internal node (0) level 2 G Subtree leaf (4) I child level 3 1) A Tree is made up of a finteset of dements called Nodes 2) The tree is either empty or consists of a node called root together with Zero or more [Subtrees] Ti, Tz, ..., The each of whose roots are connected by a direct edge to the root. T STUDENTS-HUBICOM is an (edge) between each uploaded By: anonymous its children, and a node is said to be apavent of its children (35)

depth :- is number of edges The depth of [1] is the length of the unique path from the root to n. - if there is aposth from a nocle RI to a node M, then R is an ancestor of M. and M is a descendant of R R m The height of MI is the longest path from Inj to the Teap Teaf nocle is any nocle that has cimpty the children An internal node is a node that has at least one non-empty children STUDENTS-HUB.com Uploaded By: anonymous (3.2

voort B G E D H I T M K P a height (E) = 2 A -> E -> J -> (height (F)=1 "unique path" Uploaded By: anonymous STUDENTS-HUB.com

class Tree Pode } Tree Dode object element: plement Tree Node firstchild; TreeNode nextsibling; nextsibiling firstchild * Tree Traversal with application :any process of visiting all nodes a in a tree in some order is called five traversal 1 pre-order :-Usit any given node befor visiting its children (root -> leff -> right)) 3 4 5 STUDENTS-HUB.com Uploaded By: anonymous 8 9 pre_order:-1, 2, 5, 8, 9, 6, 7, 3, 4 1. right most root 38

2 post order:-Visit each node only after visiting each children (including its subtrace) (1 left > right > root)) 8,9,5,6,7,2,3,4,1 L Promonate First 8 and magnet 3 Inorder :first visit the left child (including all its subtrees) then visit the node, and finally visit the right child (including its subtrees) ((left -> root -> right)) 8,5,9,2,6,7,1,3,4 STUDENTS-HUB.com Uploaded By: anonymous (29)

÷ * Binary tree :-Full Binary tree: 1) A A B B C C E D D full & complete Full & Not complete 2) Complete Binary tree complete & not full not full of the Complete STUDENTS-HUB.com Uploaded By: anonymous 40

* Binary tree implementation:- philophilanon* public class BSTAbele } Comparable data; BSTNORK left; BST Nocle right; public BSTNOOLe (comparable d) } data = d, left = right = hull; * Expression Tree:di Ki + * 9 9 b × d e 1 inorder: - "left -> regt -> right" (a+b*c) + (d*e+f)*g 2 postarder :- "left -> right -> robt" JB.com STUDENTS-HUB.com Uploaded By: anonymous (abc * + dex f+ g * + 3 precorder 1 - "root - left, - right " + qxbexele ++ q x bc x+ x defq

* constructing an expression trees. I convert the expression from infix to postfix 2 Scan the expression when encounter an operand pushit on the stack, when you encounter an operation pop Last to suptree. Example: - ab+ cde + * * Dab, b 9 9 + b 0 3, Cidie d C Q + b e) e × + 4 d X d + c Ь + C Ь 9 q Uploaded By: anonymous STUDENTS-HUB.com 0 6 * ď × ¥ C a b. a

Mr. steel marke * Binary search type :-O(n)n: number of nodes (17 in BST, every node X in the tree, the value of all Keys in the left subtree are smaller than the key value of X, and the value of all the keys in the right subtrees are greater than or equal to the key value inx => left < root <= right Example: - 37, 24, 42, 7, 2, 40, 42, 32, 120 42 Example 1-8 Uploaded By: anonymous STUDENTS-HUB.com Jot BST Example: 120, 42, 42, 7, 2, 32, 37, 24, 40

class tree node object element; tree-node left; tree_node right; (1) (1) 3 * find operation in BST :-11 to find any node in BST :tree-node find (object x, tree-node t) } if (+== null) /1 wo nodes 1 wo doite yeturn hull; if (X< 1. element) return (find (object X, tileff)); else (1) (1) (1) if (x) f. element) return (find (x, t. right)). plac. returns +; ?? X-final min max STUDENTS-HUB.come node find min (tree node t) JUploaded By: anonymous if (t==null) Peturin mill , March else if (l. left == null) vetur ti else return find min (+. left); } (44)

-tree_node insert (tree_node t, object x)} if(t==nu(n)) (1) t=new tree_node(); () + element = X; t. left = t. right = null; } else 3 (23) (23) (23) int compare Result = X. Compare TO (t. element) if (compare Result < 0) Eleff = insert (t. leff, x); else if (compare Result >0) tight = insert (tiright, X); a vada dideda (tra vada L abuat X) else (internet)) return ti 11 do nothing int (and Res - V Compane To (bride * find max:- company and his tree-node find-max (tree-node t)} if (t=+way) stangeros) is set Creturn hall all a tal and STUDENTS-HUB.com Uploaded By: anonymous if (t.right = = null) (Lupp 1 yeturn b), alastala a hisia) else return find_max (2. right).

50 20 70 10 30 90 3 55 60 52 58 65 63 67 64) tree node delete (tree node t, object X) } if (t == nall) error: 11,00 nodes in the BST jut compRes = X. compare To (f. element). if (compare Res <0) t.leff = delete (t.leff, X); else if (compare Res >0) 6 right = delete (tright, X); else if (t. left != null f t. right != Uplaaded By: anonymous STUDENTS-HUB.com t. element = find min Lt-right). Mement; tright = delete (t. element, t. right); ? else t= (t.left != null)? t.leff : t. right; veture t; 146

Example: delete (T, 60) delete (70,60) >T. left = delete (t. left, 60) \Rightarrow delete (bo, 60) 69 > temp = find-min (60, right) find min (69) => 83 -> delete (69,63) left > delete (65, 63) left \Rightarrow elelete (63, 63) t= tright () STUDENTS-HUB.com Uploaded By: anonymous

AVL Tree =- () a halale an AVL tree is identical to a BST, except that for every node in the tree, the height of the left and right subtrees can differ by at most one. 5 8 AUL tree 4 7 right = 2 left = 4 $4-2 = 2 \Rightarrow Not Balan$ 8 Not AUL Tree B Uploaded By: anonymous STUDENTS-HUB.com

when inserting a new node, we have four options 1-I An insertion into left subtree of the left child 1+4 => outside => single rotation 2 An insertion into right subtree of the left child 3,2 = sinside = olouble votation 3 an insertion into left subtree of the right child I an insertion into right subtree of the right child Example: Start with an empty AUL tree, and insert the following items in asequential order 3, 2, 1, 4, 5, 6, 7 77 5 STUDENTS-HUB.com Uploaded By: anonymous not AVL

; Not AUL STUDENTS-HUB.com Uploaded By: anonymous

Example: meent the following items into an empty AUL tree, 1,2,3,4,5,6,7,15,14 1) NOF AVL (2) JUATOC 4) not AUL G STUDENTS-HUB.com 4) Uploaded By: anonymous T

Ŷ ÷ left WA toes Kright Ź (14) AUL tree Uploaded By: anonymous STUDENTS-HUB.com Z

* Double rotention: - "MIT BCW !! left V Example 1:-5 10 Kright 5 2 1 5 10 10 Example 2:-K3 ist. h. 0 STUDENTS-HUB.com Uploaded By: anonymous h2 Δ C 2 (53)

* AUL Tree Implementation:public class AVL - Marche } element object dement; AUL mode left; AVL right, 1 else right int beight; int height (AULT) if (T == MULL) return -1; else return (max (heigt(T. left), height (T. right))+U; AUL State to right (AVL K2) AUL KI k = kz. left. ky left = ky right: STUDENTS-HUB.com Uploaded By: anonymous // update height k2. height = max (height (k2. left), height (k2. ngud) +1) h1. height = max (height (k1. left), height (k1. right)) +1), return k1;

AVL State to Fight (AUL K2) } AVL KI; k1 = k2. right, k2. right = k1. left ... k1. left = 102; ki height \$ = k2. height = & return hez; Zalant) alson AVL D_rotate_R (AVL k3) } hz. left = S_ rotate to_ left (ks. left)); veture (S-rotate to right (k3)), K, 3 (K3) 62 AUL Drobate - L (AUL 203) & ks. left = S-rotete-to-right (ks. teft). Uploaded By: anonymous STUDENTS-HUB.com (R)

Tree traversal :-1) print in order :-Voiel inOrder (AVLT) if (7 1= null) inorder(T.left); print (T. element); inorder (+ right); print pre order:-2) Void preceder (AVL-T) if (T 1= null) print (T. element); pre Order (T. left); preosoler (T.right); Uploaded By: anonymous STUDENTS-HUB.com (56

3) past order: Void postoroler(AULT) if (TI=null) postorder (t.1ef4); postaveler (T.right); print (I. element); 23 is a binary search tree without the * splay Trees :-Balance condition 1) left_left P G X G X STUDENTS HUB.com Uploaded By: anonymous "Zig-Zig" D (57)

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Examp	ple :-	
Find	7?	
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	(4) (7) (6) (8)	
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	(3) (5)	
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ý ý	4 2 3
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	10,20 35, 15, 13,
	5 57 X \$
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Tenston tog 1.	g set and get a set of the set of the
11.01	•
(4	59)

Hashing:-1) separate chaining 101 70 20 0 L 2 13 3 4 15 35 5 7 8 9 10, 20, 35, 15, 13, 70 10% 10 =0 207.10 =0 35%10=5 15% 10=5 13% 10= 3 70% 10=0 STUDENTS-HUB.com Uploaded By: anonymous "increase the number of pointers" (P3)

2) open addressing may at both (if
a) linear polying mail (i)

$$h(x) = (x x size + f(i))/size - i > 0$$

 $fxample : 89, 18, 49, 58, 69$

 $0 49$
 $1 58$
 $2 69$
 $3 4$
 $4 5$
 $6 7$
 $8 18$
 $9 89$
 $8 18$
 $9 89$
 $18/10 + 0 = 8$
 $49 x10 + 0 = 8$
 $49 x10 + 0 = 8$
 $12/10 + 0 = 8$
 $49 x10 + 0 = 8$
 $49 x10 + 0 = 8$
 $41 = 10/10 = 0$
Uploaded By: anonymous
 $58 x10 + 0 = 8$
 $4 x = 10 x10 = 0$
 $58 x10 + 0 = 8$
 $4 x = 10 x10 = 0$
 $58 x10 + 0 = 8$
 $4 x = 10 x10 = 0$
 $58 x10 + 0 = 8$
 $4 x = 10 x10 = 0$

b) Quad	cliratic probing - alling (
h(x) = (X / size + i) / size , izo	
	$\frac{1}{2} = \frac{1}{2} \left(\frac{1}{2} \right) + \frac{1}{2} \left(\frac{1}{2}$	
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STUDENTS-HUB.com	Uploaded By: anony	/mous
	and the second s	
	p _ / ,	
,	(61)	

C) Double hashing :h(x) = (h, (x) + i. h2(x)) #Size Example: - 89, 18, 49, 58, 69 4,(X) = X Y. Size $h_2(x) = Size_(XY, Size)$ Size = O 89%0 + 0() = 918/10 0 ()=8 0 49 1 69 $49/10 + 0() = 9 \times 258$ 9+1(10-9)=10/10=0 3 4 58/10+0()=8x 5 8 + 1 (10-8) = 10/10=0 × 6 8 + 2(10-8) = 12/10=2 7 818 $69710 \pm 0() = 9x$ 9 89 9 + 1(10-a) = 10×10=0× STUDENTS-HUB.com 2(10-9) = (11/10-1)Uploaded By: anonymous (82)

30, 75, 47, 53, 98, 15, 6, 96, 27, 50, 82 1) Double hashing 2) Quadraotic Hashing h, (x) = X / Size h2(x) = Size (x y. size) Size = ? Size = 2×4 = 2×11=22 => 23 Lo Aros 00910 AY / ICH - CO Uploaded By: anonymous STUDENTS-HUB.com (83)

* String Hashing: 1 h(St) = (ZASCII St. charAt(i)) / size h(st) = (ZASCII steharAt(i) + 27") / size 2 $\frac{3}{1}$ h(st) = $\left(\frac{3}{1}\right) + \frac{3}{1} + \frac{3}{1} + \frac{3}{1}\right) \times \frac{3}{1}$ STUDENTS-HUB.com Uploaded By: anonymous (34)

* Heaps:-Example: 10, 14, 10, 8, 7, 9, 3, 2, 4, 1 6.0 (2) G 1.1 heap 6 a (G)-(10) = leff = 1+2=2 0-1 right = 1×2+1=3 => left= 4x2=8 i = Uright = 4x2+1=9 Example: 10, 15, 7, 5 => min heap chitch Root si a element B 5 7 10 STUDENTS-HUB.com Uploaded By: anonymous 15 - max heap = child < Root a element of

Basic Heap operation :- "min-heap" insert 14 Q 32:14: 24: STUDENTS-HUB com 19 Uploaded By: anonymous 19 68 24 21 65 26 32 31 32 3 (26

insert code: - for min-heap Void insert (element-type X, PRIORITY QUEUE, H) int i if (isfull (H)) System. and. printle (full heap"); else 1= ++ H. Size: While (H. element [i/2] >X) H. element [i]= H. clement [i/2]; i=i/2; 21 H. element [i] = X; 11 isfull > if size = capacity STUDENTS-HUB.com Uploaded By: anonymous

Delete Min :- "for min heap" At- 1 13 14 19 141 26 68 19 19 68 65 32 31 31 26 32 31 element type delete-min (PRIORITY_QUEUE H) O(logn) unsignedint i, child, element type min element, last element. if (is Empty (H)) System and print ("empty Heap"). return H. element Fo]; min_element - Helement[0]; Last_element = H. element [size --]; for (i=1; i+2 <= H.size; i=child) child = ix2: if ((child 1= H.Size) for (H. dement [child +1]) Uploaded By: anonymous STUDENTS-HUB.com H. element [child]) child ++: if (last_element> H. element [child]) H. elementEi] = H. elementEchile]; elee break;

H. element [i] = Last element; veturn min-element. Sorting Using heap:heap-sort (A)} Build max heap(A) for (i = Size(A); i==2; i== 0 (rilogn Swap (A(1), A(i)), heap-size (A) - heap-size (A) - 1; ment-heap-prop(A, 1); => procedure ment-heap-prop(A,i)} l = left(i)R = Right(i) If L <= heap-size and A[i]>A[i] then Langest = L STUDENTS-HUB.com Uploaded By: anonymous else langest = i if R<= heap-size and AERJ> AElangest]) they Largest = R;

if largest <> i then	
exchange (AEi3, AElargest J)	
men heap-prob (A, largest)	1
Build a heap tice 1. d. P. S. 2	
heap size arrenz size	
for(i-heap-size/2; in>=1; i)	
ment-heap prop(A,i);	
28.5 \$ \$ \$ 11 3 2 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	
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156 28 2 4 5 1 2 1 2 1 3 2 2 5 6 5 6 5 C	1
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STUDENTS-HUB.com Upload	ed By: anonymous
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31- 7

Sorting :merge sert. 35,2,4,6,1,3,2,6? 35, 2, 4, 6 3 1, 3, 2, 6 3 15,22 34,03 11,33 2,62 253 223 243 263 212 33 3 323 263 \$2, 4, 5, 6} <u>21, 2, 3, 6</u> midel right leli A 4 6 3 5 2 2 6 left mid micht right B 8 Uploaded By: anonymous STUDENTS-HUB.com 21-1

procedure menge Sort (A, left, night) Begin if (left Lright) Begin Monson mich= (leff+right)/2 menge-sort (A, left, mich) merge-sort (A, Emol, nglit) merge sort (A, left, miel right) end if pallance end pro sogle procedure merge (A, left, mid, night) Begin 1=left and and soll j= (eff. k= miel +1 while ((12=mid) & (K2=nght)) Begin or if (AEij < AEij) B[i+t] = A[i+t] = 0else stushi o mound BlittJ=Alk++J. STUDENTS-HUB.com end while Uploaded By: anonymous

if (jk=miel) for(k=s; k<=mel;k++) B[i++] = A[k];ale for (j=k; jk=right; j++) BEI++J=AEJ] end if Mol All (left); il= right; it+) AEI] = BEIJ end for endprec time (dulling here Mat A) and T(n)= i cl = n=1 2T(yz) + cn > 1 (DIT(n)= C)(hlogn))) => disadvantages in Huge darta Because we need extra space since we make anow arraing B STUDENTS-HUB.com Uploaded By: anonymous

& Quick sort :-Divide and conquire recursive algorithm:-The basic algorithm to sort an array s consists of the following four steps. 1 if the number of elements in S is O Or I then return 2 pick any element V in S. This is called pivot 3 partition S. 2UZ (The remaining elements ins) into two disjoint groups. 4 Return Quick Sort (SI) followed by V followed by Quick Sort (S2) ? STUDENTS-HUB.com Uploaded By: anonymous (ZU)

8.1, 4,9, 6, 3, 5, 2, 7,0 0,1, 4,9, 6, 3, 5, 2, 7,8 0, 1, 4, 9, 7, 3, 5, 2, 6, 8 12 1; 0,1; 4, 2, 7, 3, 5, 9, 6, 8 , 4, 2, 5, 3, 7, 9, 6, 8 M. T. 3,1 0,1,4,2,5,3 6 9,718 Repaired a Uploaded By: anonymous STUDENTS-HUB.com

Void Quick sort (A, left, right) & int i, j, pivot: if (left< right) pivot = get pivot (A, left, vight); i= left; J = right_L. while (i<j) While (A[++i] < pivot) while (AE-j] >= pruot) if (i<j> exchange (ACiJ, AEJ) exchange (AEi], A Evight -13). QuickSort (A, left, i-1); Quick sout (Arit 1, vight) 2 int getPivot (A, left, vight) } STUDENTS-HUB.com Uploaded By: anonymous

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