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HQ17
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- a// x[1.n] is an away of bits, met will be used to
 - (i) def Init (n):

 | for i = 1 to n
 | x[i] = 0
 - (i) def Set(i); if(i>1 2 2 i(= n-1) *CiJ=1
 - iii) det Isset(i):

 setur XIII

 setur XIII
 - (iv) dog Newtonsel-(i): for k = i to nif (x[h] == 0)suhun h

time complexity of me above operations -

- (1) $\Theta(n)$ / given n, the for loop will son for all the n bits and set it to value O
- (ii) (1) // constant operation
- (iii) B(1) // constant operation
- (i) O(n) // we will return he as soon as we find xivio and me for loop will parinate

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(b) de f Init (i):

| for (int i = 1 ton) |
| maluset (i) |
| i val = 0 |
| i ptx = i
```

DE BERRESE WE

In the disjoint set, each element will correspond to The index of the away of bits X[1...n] . Each disjoint set element is on object which has a beilds named val and ptt which stores me value of the dement comes ponding to the array and . pth me / points to me next element which stores a value of 0; induding itself ie which has element has a value . pt will point to it self.

The inhuition behind the approach is, epts will always point to me dement which has a value of O including itself i.e if is on element out value o then its opto will point to itself and of not men its opta will point to some greater index than i sit its value that index's value is 0° Now when ever we are performing a union() when an element's value is set to I and i i ee all are doing it, with the next element of i i ee one alonerys do a union 86 ; 2 :+1, trus ensuring (i+1)'s leader. pH will always give me the greater trans
indus of element with value on So were acherency a new element is combined in a set we make use of the above info & fact and store that element with value or in the leader ptr of the newly formed set. So all me dement with value set as I are combined together with an element of value the element asim value of this set that he points to

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go with first war this say were the say of the say

First when Int(i) is called an make singleton sets and also we store me value of such elements as a company me definition of Init()) and point me pts pointer to itself cause as per me pts pointer definition where, we are marking/pointing pts to the next element which has a value including it self. There operations we do in (b) (i) as written above.

Now woo when Set (i) is called, after chebing me array bour size bounds, we first store me (i+1)'s leader . et in a variable. We do so become it1>i & and even if (i+1) element is in a set o singleton set as not its leader ie bird (i+1). will pte will always point to me next element having value o including itself. Now we do a union of it1 and i element. Thus ensuring configuous bits of I are combined in one set. But again in his newly formed set, the leader might must point to me next element, with righer index leader might must point to me next element, with value = 0

Thus we take find (i) · pt = which is timed leader (i) · pts 2 store temp in This. temp will always ensure that on index of highes value is stored as temp itself was st = final (i+1) · pts where · pts can point to cloment itself or any about 86 a greater index · we do there operations in (b) (i)

In (b(iii) ables chacking the away size bounds,
Is sot() simply subsure the value stored in
the im element, where i is the passed parameter

when Next Unset (i) is called, we simply which the array, bounds and suturn find (i) opts. 2/2 i is a gingle ton set je joval=0 tran · pts will point to itself and true it will return Phoedle , which is the as per the definition of me NewtInit(). now it i is not a singleton set i'e it is a part of some other bigger set men 948 vol must be equal to 1 as one perform a uni on only when we set value of element to i. So, find (i) i.e leader of i's opt value will point to me element It greater man equal to ender whose volve is 0. Thus we return fend (i) of and so it matches the return definition of Nasturett as

© Italy 1849	2 2 37	weath			
Onit (9)				196 146 147 146.	
1)2 oval=0	22 .val=0	1 to 30	4	92 92	
o pH = 1	o pH = a			pH = 9	
where when	arrow.	supres ento	12 wared		1 .0 8
T8 Xet (3)					
will setur	3. ral	which is	as sign whos		musto u
Set(4) temp = b	and (141) find (5)	· pt.	- 60	li soundo	b with
2 d 13 = 1/g	5 · PH	and all	5's leader	and pt	1 are both
foral = 1	11	Dai G	updated to	P) (y	=1-6
union (it),		(5) on 2	g one o	am bired	
		leader is	implemento	tion dep	endant
bind(1) · pH =>	temp gets		1	01000	

pinel (i) return find (i) opti as per 6 (i) so, i) finel (i) opti i) leader (4) opti i) so (as mantioned in the last step of be set(4)). Thus 5 is suturned. Set(5) temp = find (i+1) opti — (b) (i) (i) = find (6) opti = 6	New t Unset (4)
	et will return find (i) opts as per 6 (iv) so,
Set (5) Set (5) Lemp = Gind (i+1) · pts. — (5) (i) (i) = Gind (6) · pts = 6 · pts = 6 · pts = 6 · pts = 5 · val = 1 // 5 · val is updated to 1 (5) which (i+1, i) & — (6) (i) (i) which (i+1, i) & — (6) (i) (i) which (5) // 5 and 6 are now combined to parm one set ine £4,5,6,4 we now combined into a single set wach 2 · pts in this step sumains wachayed for each eternate.	=) final (1) · pts
Set (5) Set (5) Lemp = Gind (i+1) · pts. — (5) (i) (i) = Gind (6) · pts = 6 · pts = 6 · pts = 6 · pts = 5 · val = 1 // 5 · val is updated to 1 (5) which (i+1, i) & — (6) (i) (i) which (i+1, i) & — (6) (i) (i) which (5) // 5 and 6 are now combined to parm one set ine £4,5,6,4 we now combined into a single set wach 2 · pts in this step sumains wachayed for each eternate.	=) leader (Y) ·pH
Net(5) Let(5) Lemp = find(6) · pk = find(6) · pk = 6 · pti 6 · pti 7 · pti	2) 5 (as mentioned in the last step 8/9
Set (5) temp = bind (i+1) · pts ·	
Set (5) temp = find (i+1) · pk · — (b) (ii) (c) = find (6) · pk = 6 · pk (15 codes and ph are bohn italy sold = 1 — (b) (ii) (b) sold = 1 sold is updated to 1 (5) vod = 1 sold is updated to 1 (5) vod = 1 ord = 5 vnien (i+1, i) = — (b) (ii) (c) vnien (6, 5) 5 ond 6 one now combined to form are set ine Ey, 5, 6y val 2 · pk in this step sumains vnchuyed for each element.	
temp = pind (i+1) \cdot pk \\ = pind (6) \cdot pk \\ = 6 \c	
= \\\\ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Set (5)
ival = 1 — 6 ii) b som itself soul = 1 — 6 ii) b soul = 1 // 5. val is updated to 1 5 l oval = 1 union (i+1, i) = — 6 ii) c union (6, 5) // 5 and 6 are now combined to form one set. i.e £4,5,6y are now combined into a single set oval 2 opts in this step surrains unchanged for each element.	
(ival = 1 — 6 (i) b 5.val = 1 // 5.val is updated to 1 (5) wion (i+1, i) = — (b) (i) (c) wion (6, 5) // 5 and 6 are now can bined to from one set. i.e £4,5,67 one now combined into a single set oval 2 epts in this step sumains wacherged for each element.	
5.val = 1 / 5.val is updated to 1 (5) 2 5.val = 1 // 5.val is updated to 1 (5) 2 wien (i+1, i) = - (6) (i) (c) wien (6, 5) / 5 and 6 are now can bived to form one set. i.e E4.5164 we now combined into a single set oval 2 opts in this step sumains which and 2 opts in this step sumains which and 2 opts in the second of the second	= 6° pts // 6's leader and ptr are
5.val = 1 // 5.val is updated to oval = 1 - Union (i+1, i) = - (b) (i) (c) union (6, 5) // 5 and 6 are now can bired to form one set. i.e (24, 5, 6, y) one now combined into a single set oval 2 opts in this step sumains uncharged for each element.	
union (i+1, i) = - (b) (i) (c) union (6, 5) / 5 and 6 are now combined to form one set. i.e {4,5,6} one now combined into a single set uncharged for each element.	5-val = 1 // 5-val is updated 10
union (i+1, 1) = - (b) (1) (c) union (6, 5) / 5 and 6 are now combined to form one set. i.e £4,5,64 one now combined into a single set oral 2 opts in mis step waring uncharged for each element.	of perely 1 series
wion (6, 5) / 5 and 6 are now combined to form one set. i.e E4,5,67 we now combined into a single set oval 2 opts in twis step surrains uncharged for each element.	(mida (it) i) = - (b) (ii) (c)
form and set. 1.e 29,5,69 oue now combined into a single set oual 2 opts in this step surrains uncharged for each element.	union (4 5) 11 5 and 6 are now com bired to
oval 2 opts in this step surrains uncharged for each element.	form one set. i.e E4,5,67
unchayed for each element.	to a simple sett
	eval 2 opts in twis step surrains
find (1) = ptr = temp. (cader.ptr ow'll now have value of temp = 6	
	find (1) = pt = temp (ader.pt out 1 now have value of temp = 6

Next Unself (9)
it will suturn find (i). pt or per 6 (v) 180,
2) bind (4) . ptq
now y belongs to the set £4,5,69
This sets leader. pts has a value of 6 as marking
in me last are step of me last aperation.
Thus & will be geturned. beneated
Set (7)
temp = bind (i+1) opti - 0000 (i+1)
= find (B) · pt
= 8
ibely.
(oval=31 - 6 10 6
7-val =1 // 7-val is appliated to 1
d = thg w
union (i41,i) — 6 (ii) C
union (8,7) // now 7 28 are won since in
a implementation
dependent ie can be either of the from . val 2 . pt of each element namewing unchanged in his interpretation of the production of the prod
element remains unchanged in his to
find(i) - pt = temp - (6) (i) (1) find(i) - pt = temp - (6) (i) (1) find(i) - pt = temp - (6) (i) (1) find(i) - pt = temp - (6) (i) (1) find(i) - pt = temp - (6) (i) (1) find(i) - pt = temp - (6) (i) (1)
Gind (+). Pt 2) value temp = 8.

Set (8)

4emp = Gind (i+1) · PH — (5) (1) (2)

2 Gind (9) · pH

- 9 // 9's · pH and wat leader are

9+self.

9. val = 1 - 6 6 6 6 8. val is set to 2 now.

union (1+1, i) — (b) (ii) (c)

union (9, 8) // now 9 2 8 are combined into

one set: ise {7, 8,94 are combined

into one det as 7 2 8 arele

aloredy a part of one set. and

2 opt of each alonest somains unchanged

9 n tris step.

find (8) · pt = temp - 6 (i) (d)

find (8) · pt => leader & 8's set · pt will now

point to temp ie temp = 9.

deader is implementation dependent 2 trus can be

any one of mp 3 above elements.

15 Set (4)

aill seturn youal which is 1., updated in sety

temp = find (i+i) · pk - 6 (i) @

=) final (7) . pts

2) 9 // 7 belongs to set {7,8,99 who se leader. pts contains value of 9 as dir mentioned in last step of set (8) call.

6.val=1 - 6.val is set to 2.

UNION CITY) - (1) (1) (C)

union (7,6) // 7 2 6 are combined into and

set ie 7 belonged to set [7,8,9]

and 6 belonged to set [4,5,67 thus

mere 2 sets are journed / combined into

£ \$4,576,7,8,9] where reader 18

implements tien dependant. val and

. Mr. of each element sumain unaburyed

in this step.

find (i) - pt/2 temp — (b) (i) (d)

find (c) bt =) 6's set's leader which can be any one

or the above element, to pt rollie

ie reader pt rollie will be temp which

Nept Unset (4)	
it will return bird (i).	pts as per 6 (i) 180
2) find (4) . pts.	
now 4 hickorys to me	set { 4,6,6,7,8,94 whose
leader. pH has value of.	9 (as montioned in me
last step of last June tion	
This of will seturn !	
Time complexity.	
Direct (as in (1)	
already men tioned in	
Reversed true.	Remose tree + union by depth
Init (i): 0(n)	Frit (i): OCn)
Set (i): O(n)	Set(i): O(logn)
Isset (i): P(1)	Islet (i): 0(1)
Nept Under (i): B(n).	(orga)o: (i)topaltagen
shallow tale + threading	Shallow tue + threeoding + union by
Trit(i): O(n) Set(i): O(n) on amongle Is Set(i): O(1) NextUrect(i): O(1)	Thit(i): O(n) Set(i): O(logn) Thit(i): O(logn) Whent Unset(i): O(1)