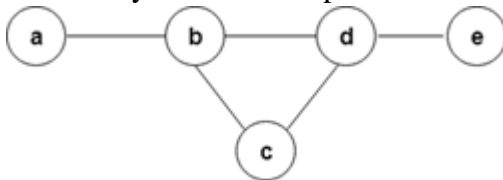


Part - A

1. Backtracking algorithm is implemented by constructing a tree of choices called as?
a) **State-space tree**
b) State-chart tree
c) Node tree
d) Backtracking tree
2. Of the following given options, which one of the following is a correct option that provides an optimal solution for 4-queens problem?
a) **(3,1,4,2)**
b) (2,3,1,4)
c) (4,3,2,1)
d) (4,2,3,1)

3. How many Hamiltonian paths does the following graph have?



- a) 4
b) 2
c) **1**
d) 3
4. Which of the following is not a branch and bound strategy to generate branches?
a) LIFO branch and bound
b) FIFO branch and bound
c) Lowest cost branch and bound
d) **Highest cost branch and bound**
5. The Data structure used in standard implementation of Breadth First Search is?
a) Stack
b) **Queue**
c) Tree
d) Linked List
6. What is a randomized Quick Sort?
a) The leftmost element is chosen as the pivot
b) The rightmost element is chosen as the pivot
c) **Any element in the array is chosen as the pivot**
d) Pivot element can not be chosen
7. What is the purpose of using randomized quick sort over standard quick sort?
a) so as to avoid worst case space complexity
b) **so as to avoid worst case time complexity**
c) to improve accuracy of output

d) to improve average case time complexity

8. _____ is the class of decision problems that can be solved by non-deterministic polynomial algorithms.

a) **NP**

b) P

c) Hard

d) Complete

9. What is the basic principle in Rabin Karp algorithm?

a) **Hashing**

b) Sorting

c) Augmenting

d) Dynamic Programming

10. Hamiltonian path problem is _____

a) NP class problem

b) P class problem

c) **NP complete problem**

d) None of the above

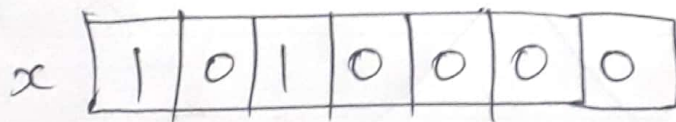
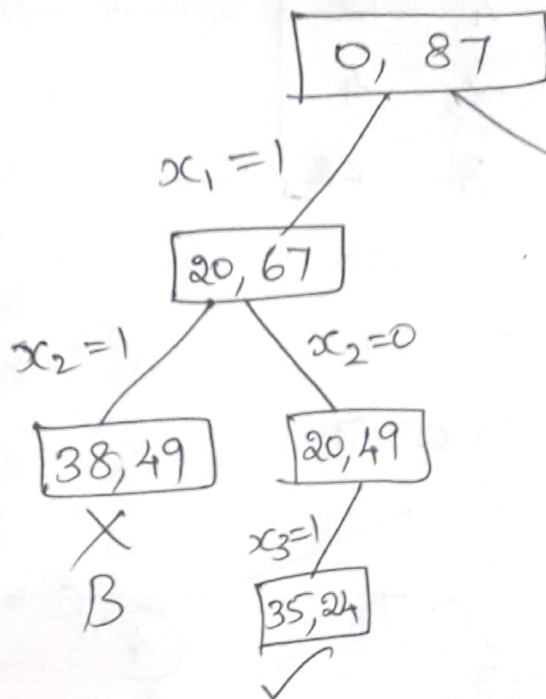
Part-B

Sum of subsets

11.

$$W = \{20, 18, 15, 12, 10, 7, 5\}$$

$$m = 35.$$



$$20 + 15 = 35$$

Other solutions

$$0, 1, 0, 1, 0, 0, 1$$

$$18 + 12 + 5 = 35$$

$$1, 0, 0, 0, 1, 0, 1$$

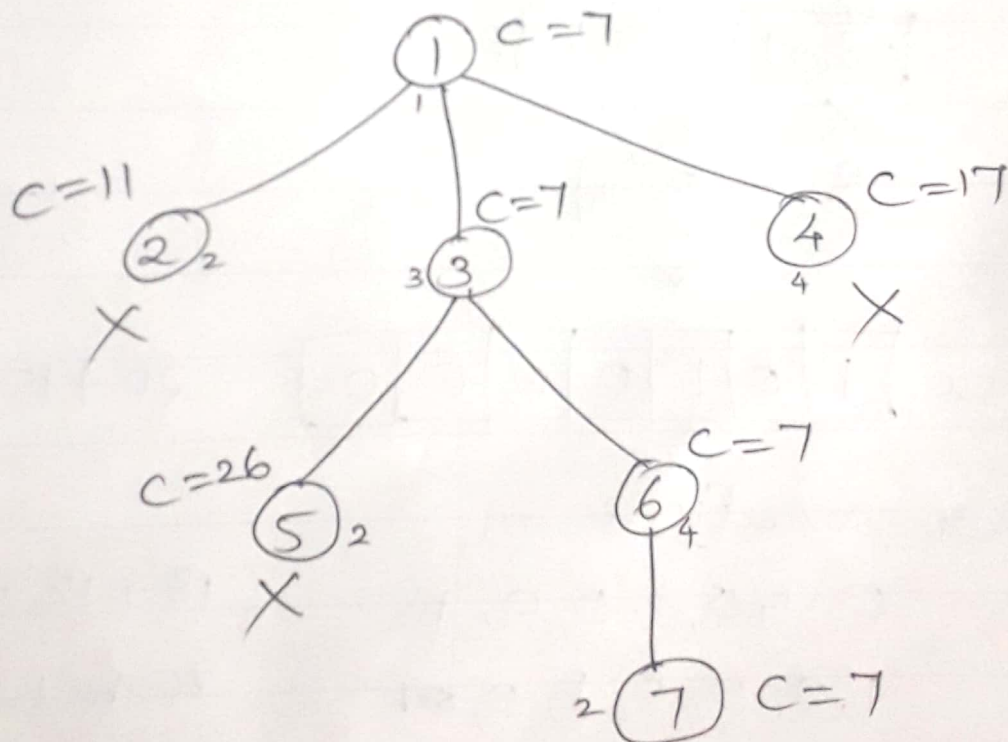
$$20 + 10 + 5 = 35$$

⋮

12. Travelling sales person Problem - LCBB procedure

	1	2	3	4
1	∞	5	1	10
2	1	∞	4	12
3	3	6	∞	4
4	7	1	3	∞

State-space Tree



Node 1

	1	2	3	4	
1	∞	5	1	10	1
2	1	∞	4	12	1
3	3	6	∞	4	3
4	7	1	3	∞	1
					<u>6</u>

\Rightarrow

	1	2	3	4
1	∞	4	0	9
2	0	∞	3	11
3	0	3	∞	1
4	6	0	2	∞
				0 0 0 1 = 1

	1	2	3	4
1	∞	4	0	8
2	0	∞	3	10
3	0	3	∞	0
4	6	0	2	∞

Reduced cost = 6 + 1 = 7

Node 2

	1	2	3	4
1	∞	∞	∞	∞
2	∞	∞	0	7
3	0	∞	∞	0
4	4	∞	0	∞

$$\text{Cost}(1,2) + r + \hat{y} = 4 + 7 + 0 = 11$$

node 3

	1	2	3	4
1	∞	∞	∞	∞
2	0	∞	∞	10
3	∞	3	∞	0
4	6	0	∞	∞

$$\text{cost}(1,3) + r + \hat{r} = 0 + 7 + 0 = 7$$

node 4

	1	2	3	4
1	∞	∞	∞	∞
2	0	∞	3	∞
3	0	3	∞	∞
4	∞	0	2	∞

	1	2	3	4
1	∞	∞	∞	∞
2	0	∞	1	∞
3	0	3	∞	∞
4	∞	0	0	∞

$$0 \quad 0 \quad 2 \quad = 2$$

$$\text{Cost}(1,4) + r + \hat{r} = 8 + 7 + 2 = 17$$

node 5

	1	2	3	4
1	∞	∞	∞	∞
2	∞	∞	∞	10
3	∞	∞	∞	∞
4	6	∞	∞	∞

	1	2	3	4
1	∞	∞	∞	∞
2	∞	∞	∞	0
3	∞	∞	∞	∞
4	0	∞	∞	∞

$$\text{Cost}(3,2) + C(3) + \hat{r} = 3 + 7 + 16 = 26$$

Node 6

	1	2	3	4
1	∞	∞	∞	∞
2	0	∞	∞	∞
3	∞	∞	∞	∞
4	∞	0	∞	∞

$$\text{Cost}(3,4) + \text{cost}(3) + \hat{r} = 0 + 7 + 0 = 7$$

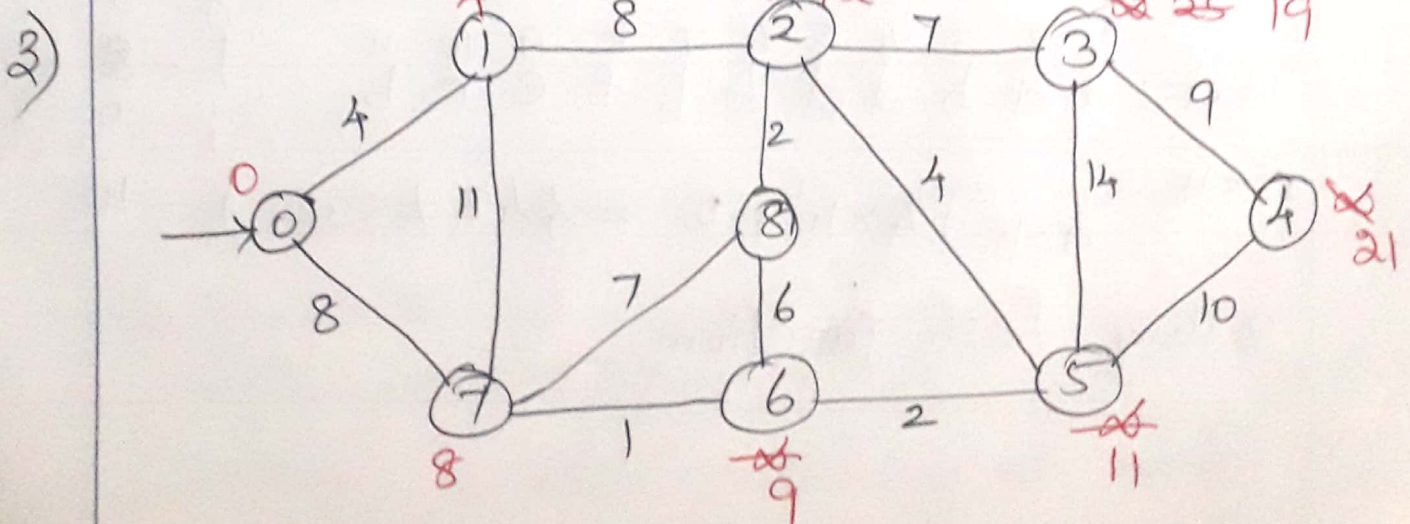
Node 7

	1	2	3	4
1	∞	∞	∞	∞
2	∞	∞	∞	∞
3	∞	∞	∞	∞
4	∞	∞	∞	∞

$$\text{Cost}(4,2) + c(6) + \hat{r} = 0 + 7 + 0 = 7$$

cost of the tower = 7

Tower is 1-3-4-2-1



Shortest paths

0-1 is 4

0-2 is 12

0-3 is 19

0-4 is 21

0-5 is 11

0-6 is 9

0-7 is 8

0-8 is 14

14. Rabin Karp string Matching Algorithm.

Text: d d b d d b b f e c b

Pattern: e c b

Pattern: ¹e ²c ³b

m=3 $5 \times 10^2 + 3 \times 10^1 + 2 \times 10^0$

$$500 + 30 + 2 = \boxed{532}$$

Text: ¹d ²d ³b ⁴d ⁵d ⁶b ⁷b ⁸f ⁹e ¹⁰c ¹¹b

n=11

$$4 \times 10^2 + 4 \times 10^1 + 2 = 442 \neq 532$$

Rolling hash function

a-1

b-2

c-3

d-4

e-5

f-6

g-7

h-8

i-9

j-10

$\Rightarrow d b d$

$$442 - 400 = 42 \times 10 = 420 + 4 = 424$$

$$424 \neq 532$$

$\Rightarrow b d d$

$$424 - 400 = 24 \times 10 = 240 + 4 = 244 \neq 532$$

$\Rightarrow d d b$

$$244 - 200 = 44 \times 10 = 440 + 2 = 442 \neq 532$$

$\Rightarrow d b b$

$$442 - 400 = 42 \times 10 = 420 + 2 = 422 \neq 532$$

$\Rightarrow b b f$

$$422 - 400 = 22 \times 10 = 220 + 6 = 226 \neq 532$$

$\Rightarrow b f e$

$$226 - 200 = 26 \times 10 = 260 + 5 = 265 \neq 532$$

$\Rightarrow f e c$

$$265 - 200 = 65 \times 10 = 650 + 3 = 653 \neq 532$$

$\Rightarrow e c b$

$$653 - 600 = 53 \times 10 = 530 + 2 = 532 = 532$$

Pattern is also matching at indices 9, 10, 11.

class P

- set of deterministic algorithms ~~#~~ which are taking polynomial time.

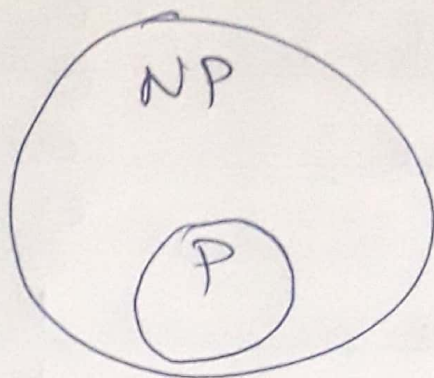
Ex: Linear search, Binary search, MST, Huffman coding, etc.

class NP

- set of non-deterministic algs taking polynomial time.

Ex: (~~Exponential~~ ^{time} algs)

For exponential time algs, we try to make polynomial. But we don't know how to make, so we can leave the stmts as ~~#~~ non-deterministic. (Ex. Previous one). So alg. becomes non-deterministic.



P is a subset of NP.

The deterministic alg. today were the part of non-deter. alg.

Ex: Merge sort found recently. It becomes deterministic. Previously it was non-deterministic.

non-deter (yesterday) - deter (Today)

non-determ (Today) - determ (Tomorrow)

CNF - Satisfiability.

$$x_i = \{x_1, x_2, x_3\}$$

$$CNF = (\underbrace{x_1 \vee \bar{x}_2 \vee x_3}_{C_1}) \wedge (\underbrace{\bar{x}_1 \vee x_2 \vee \bar{x}_3}_{C_2})$$

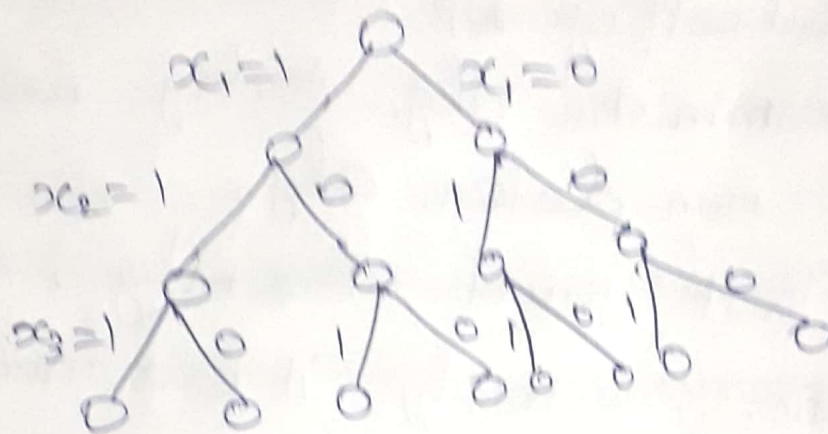
Satisf

problem is to find, for what values of x_i this formula is true.

$$\text{Time} = 2^3 \Rightarrow 2^n$$

Exponential Time.

State space Tree



x_1	x_2	x_3
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Parse from Root to leaves give solution

Ex:

0/1 Knapsack

$$P = \{10, 8, 12\} \quad n=3$$

$$W = \{5, 4, 3\} \quad m=8$$

$$x_i = \{0, 1, 0, 1\}$$

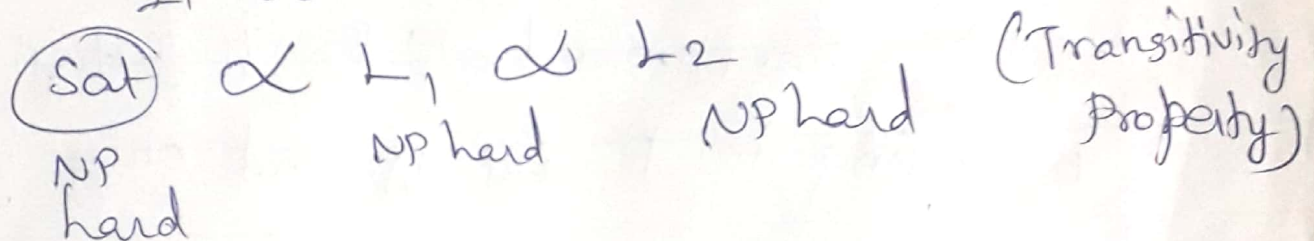
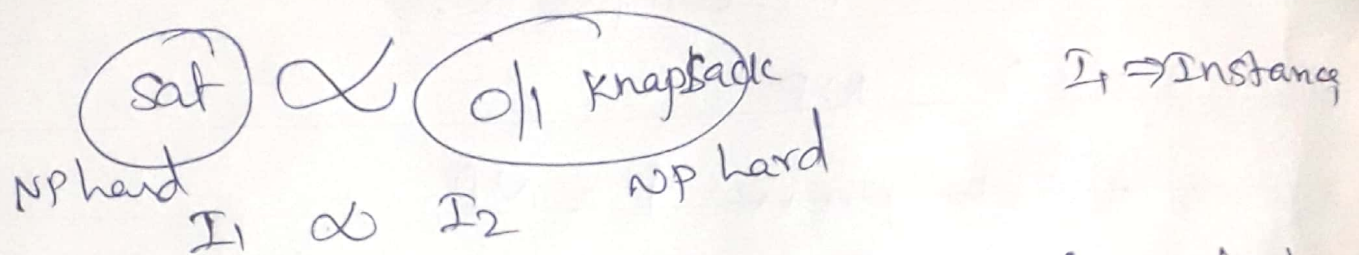
x_1	x_2	x_3
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

This is similar to the satisfiability problem. So if we get soln for this, we get for that also.

NP hard

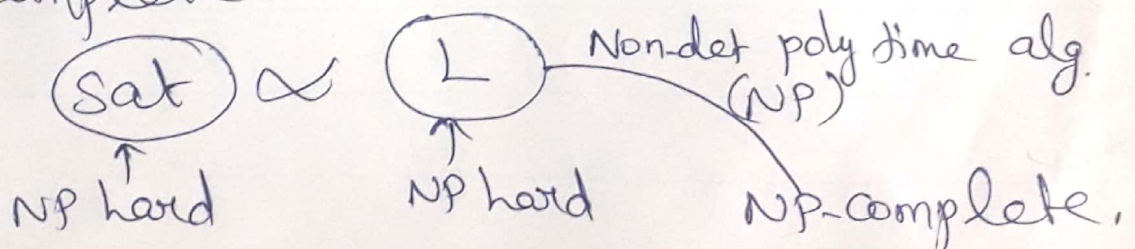
Satisfiability is a base pblm for converting exp \rightarrow poly time.

It is NP hard. If sat is reduced to 0/1 knapsack, then 0/1 knap is also NP hard



NP complete

~~we~~ we have a non-deterministic polynomial time alg for satisfiability pblm. So it is NP-complete.

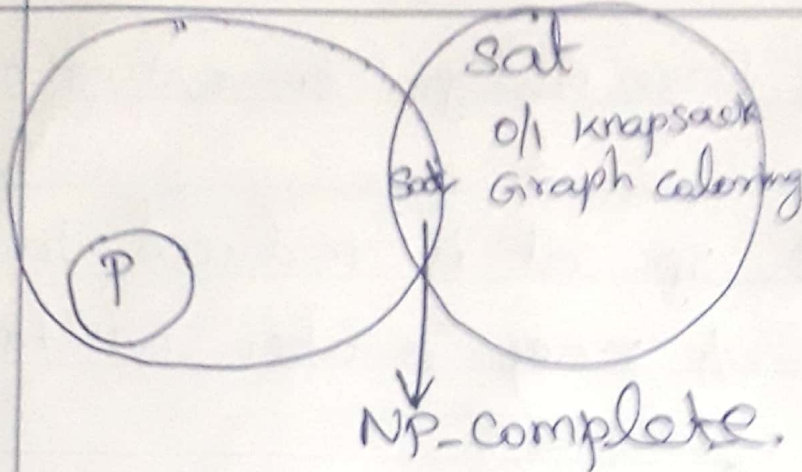


On any problem L we need to show that it is directly/indirectly related to sat, & write non-deter poly time alg.

NP (write non-deter alg)

NP-Hard

NP-~~NP~~ deter alg.



$$P \subseteq NP$$

Able to prove $P = NP$

Cook's has proved that, - if satisfiability is lying in P, ~~iff~~ if and only if $P = NP$