5. Backtracking

Backtracking Techniques

- Provide a solution to the problems.
- Backtracking solve problem recursively step by step or incremently.
- objective is determine all possible solution.

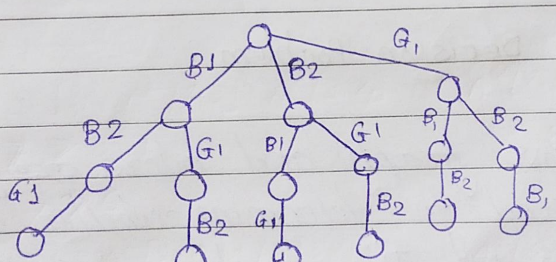
· Backtracking is an algorithmic technique. Use to solve a problem reqursively And trying to build solution incremently, step by step one piece or part a solution at a time and remaining those solution that failed to satisfies the constraints of the problem are removed.

- objective
  - ~~It~~ Is to determine all possible solution.

· In Backtracking problem is solved using state space tree.

Constraint :-
Girl
cond :- should not sit on 2nd chair.

P : B1, B2, G1. chairs: $\square\square\square$



No. of Possible Solution :-
$3! = 6$

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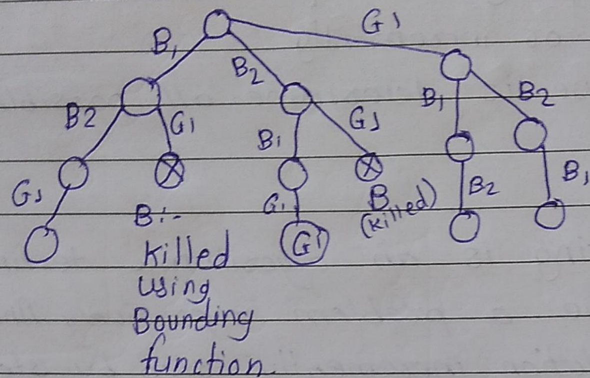
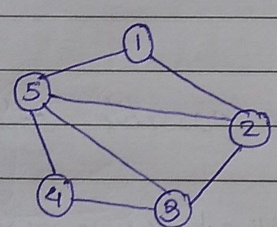
Now check the condition and remove those solution which not satisfies the condition



i) Graph Colouring Problem.

m = indicating no. of colours.



Here adjacent node should not give same colour.

i) M Colouring Decision problem
ii) Mcoloring Optimization problem.

i) MColoring Decision Problem

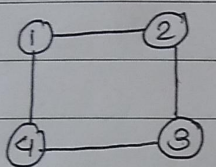
In this graph and colors are given to you and you need to determine whether that graph is Coloured or not, This problem is called as MColoring decision Problem

2) mcoloring optimization Problem

Only graph is given and you need to decide minimum how many colors to required to color the given graph. So this problem is called mcoloring optimization problem.

Example:-

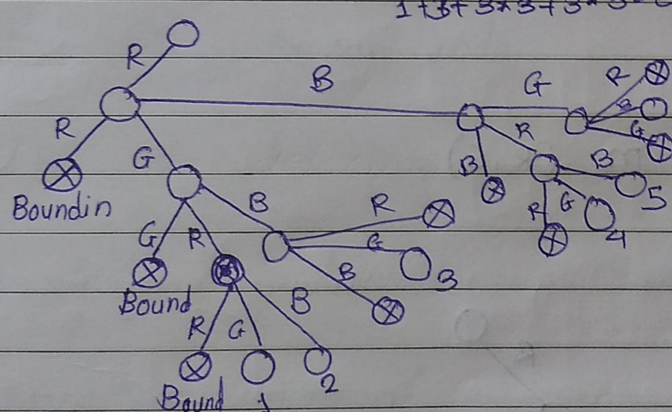
1)



m = 3 (RGB)

start with vertex 1.

$1+3+3*3+3*3*3+3*3*3*3$



1) RGRG
2) RGRB
3) RGBG
4) RBRG
5) RBRB

$1+3+3*3+3*3*3+3*3*3*3$

$1+3^1+3^2+3^3+3^4 = \frac{3^{4+1}-1}{3}$

$\therefore O(3^{n+1}) = \boxed{c^{n+1}}$.

when we killed it using Bounding function.

$\therefore O(3^n)$

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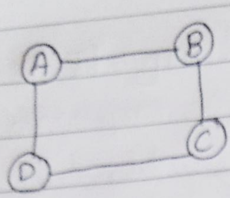
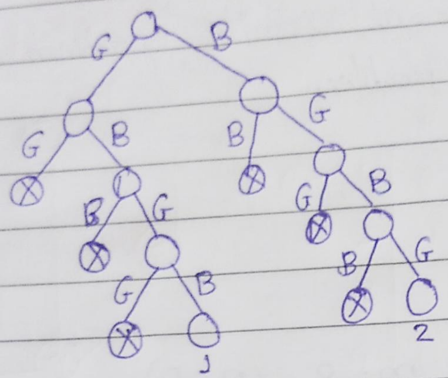
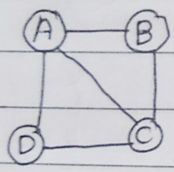
2) 

m: (G, B).

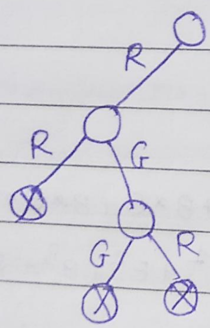


- Feasible Solution:-

1) G, B, G, B
2) B, G, B, G

3) 

m: (R, G)



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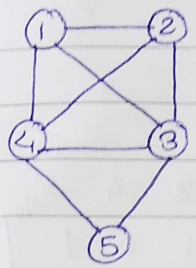
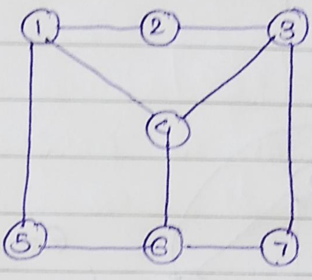
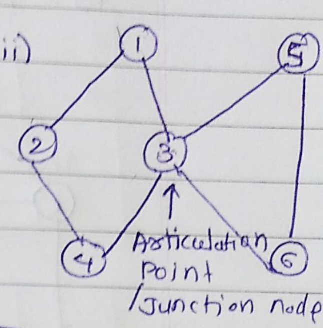
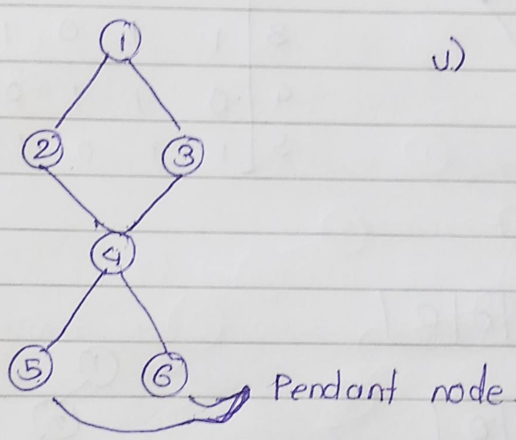
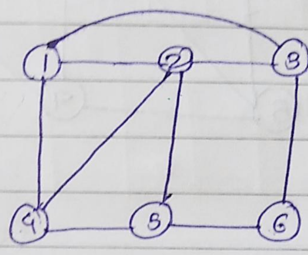
Hamiltonian Cycle.

i) 

ii) 

iii) 

iv) 

v) 

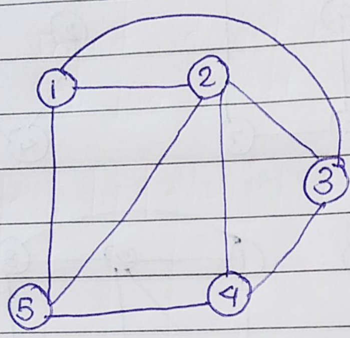
i) A graph may be directed or undirected but it must be connected, in disconnected graph there is no possibility of hamiltonian cycle.

ii) Start from any vertex of a graph and visit all remaining nodes or vertices exactly once and return back to starting vertex.

Possible cycles are present in the (v) graph.

v) 1 - 1, 2, 3, 7, 5, 6, 1
1, 2, 6, 5, 7, 3, 1
1, 6, 5, 7, 3, 2, 1.
2, 3, 7, 5, 6, 1, 2 ← This cycle is same as

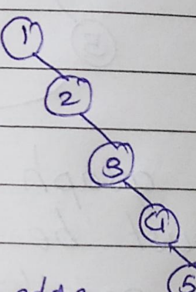
If graph is given and there Articulation point or pendant nodes are present then there is not possible of Hamitonian cycle.



$$
\begin{array}{c|c}
 & \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\
G = \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} & \begin{bmatrix} 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 \\ 1 & 1 & 0 & 1 & 0 \end{bmatrix}
\end{array}
$$

take all 0's. $x = $ | 0 | 0 | 0 | 0 | 0 |

first vertex (1) $x = $ | 1 | 0 | 0 | 0 | 0 |



add all Vertex

$x = $ | 1 | 2 | 0 | 0 | 0 |

$x = $ | 1 | 2 | 3 | 0 | 0 |

$x = $ | 1 | 2 | 3 | 4 | 0 |

$x = $ | 1 | 2 | 3 | 4 | 5 |

~~Now~~, after 5 there no any vertex so place 0 of 5.

$x = $ | 1 | 2 | 3 | 4 | 0 |

We got 0 to go one ~~step~~ back, and check ~~there~~ any edge is present

$x = $ | 1 | 2 | 3 | 5 | 0 |

$x = $ | 1 | 2 | 3 | 0 | 0 |

5 to 3 there no edge so place 0 to 5

~~Now check~~ any edge present in 3 to 2 yes -

$x = $ | 1 | 2 | 4 | 0 | 0 |

$x = $ | 1 | 2 | 4 | 3 | 0 |

$x = $ | 1 | 2 | 4 | 3 | 5 |

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|1|2|4|3|5|

3 to 5 no direct edge so place 0.

x: |1|2|4|3|0| -

x: |1|2|4|5|0|

x: |1|2|4|5|3|

x = |1|2|4|5|0|

~~to~~ place 0 to 5 bcz no edges to present over 5.

x = |1|2|4|0|0|

Now get 0 so go one step back. and change the 4 in 5 bcz we already use 3

~~x~~=

x = |1|2|5|0|0|

Now check there any edge 5 to 2. if yes go next step.

x: |1|2|5|3|0|

Here no edge betn 5 to 3 so place 0.

x: |1|2|5|0|0|

Now go one step back bcz we got 0.

There is present edge in 5 to 2 so go next step

x: |1|2|5|3|0|

No edge betn 5 to 3

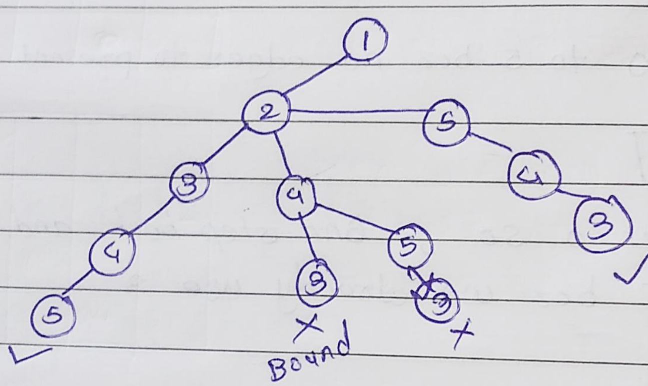
x = |1|2|5|0|0|

* 3 to 2 there edge is present so replace 4 to 0. ~~bcz~~ we can't replace with 3 bcz ~~w~~ putting we can't got cycle.

x = | 1 | 2 | 5 | 4 | 0 |

There edge is present between 5 to 4. so go Next step.

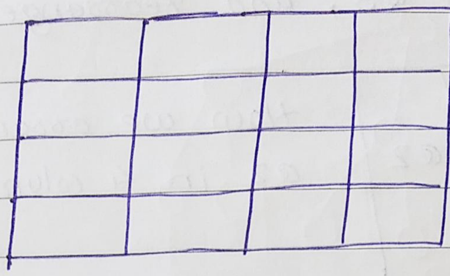
x = | 1 | 2 | 5 | 4 | 3 |



~~N Queen~~ Process of Hamilton cycle

i) When there no next vertex present put 0.
ii) When 0 is come then using backtracking go back one step and change it.
iii) check ~~that~~ if there edge is present then go next step and change it.

N - Queen Problem 8/4.

chessboard - 

4 - Queen Problem.

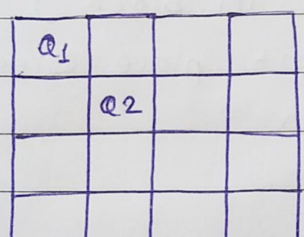
4x4

In this we will have 4 Queens from Q1 to Q4 and we need to place the Queens on chessboard such that no two queens ~~are~~ under attack.

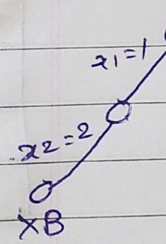
- When Queens are under attack ?

  When then are in same row, same column and same diagonal.

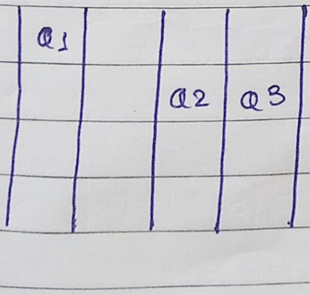
No of possible : $^{16}C_4$ - It is time consuming so we apply row, column, and diagonal.



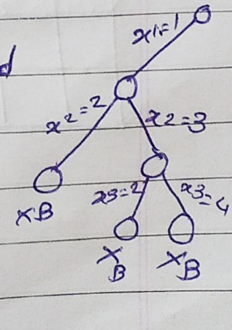
- First placed Q1 in 1 row, column.
- Now place Q2



- Here Q1 and Q2 are in diagonal so killed it.



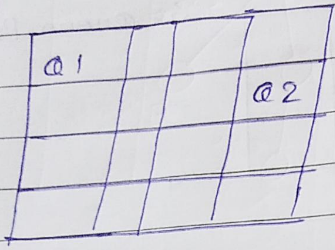
- Now we place Q2 in ~~second~~ row and third column. using backtracking.



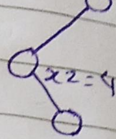
- Place Q3.

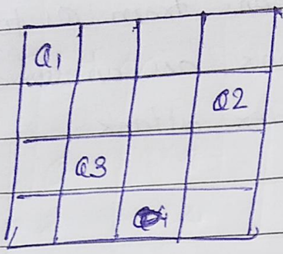
But here we can't place Q3. ~~bcz of Q3 is~~

So Remove Q3, and rearrange Q2.

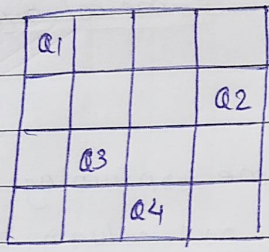


Now we arrange Q2 in 4 column

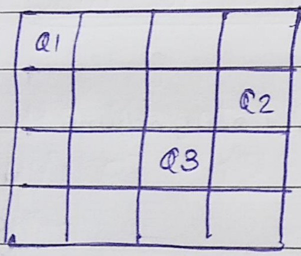




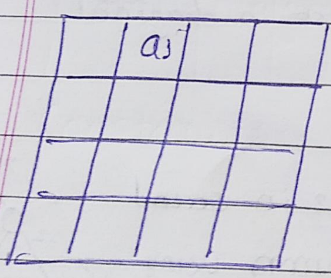
Put Q3 in 2nd block.



Here we put Q4 in 3rd block but Q3 and Q4 are in under attack.



When Q1 is in block 1, Then we can't place Queens without attack.



So, we put Q1 in 2nd block.

	Q1		
Q2			

diagonal that comes in under attack.

	Q1		
		Q2	

That also diagonal inunder attack.

	Q1		
			Q2

So there that two Queens are not in under attack.

Now place Q3.

	Q1		
			Q2
Q3			

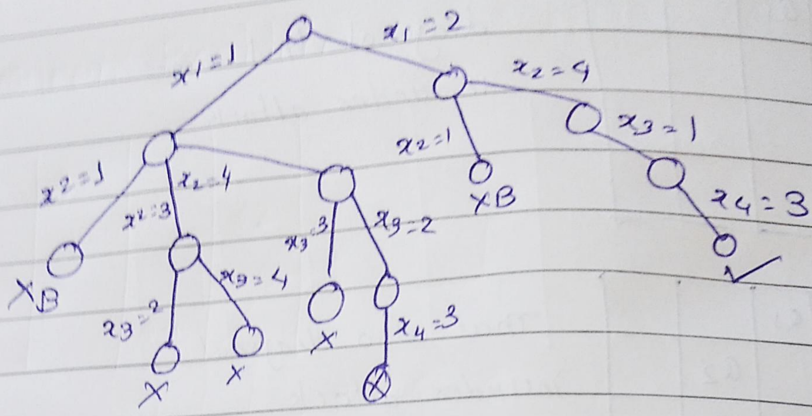
Place Q3 in first column so therefore they are not in attack.

Now place Q4

	Q1		
			Q2
Q3			
		Q4	

This is perfect solution

Here first check the all possible solutions and then place the Queens.



Solution

Q1	Q2	Q3	Q4
2	4	1	3

← column

13-May-2023
Saturday.

▸ Sum of Subsets :-

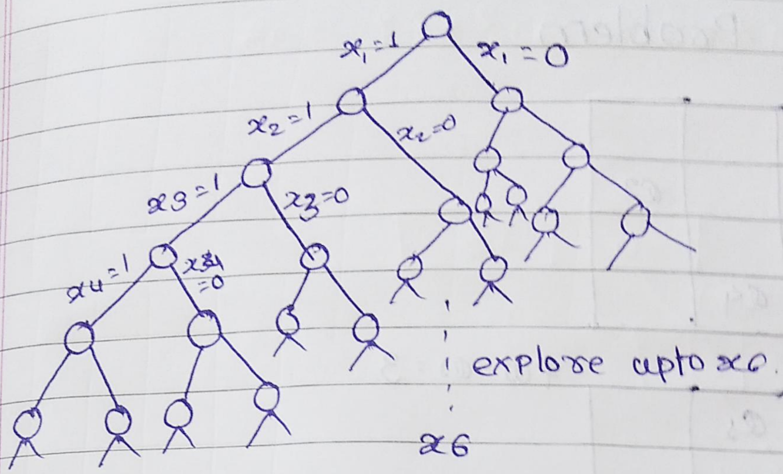
w = Weight

w[1:6] = {5, 10, 12, 13, 15, 18}

Total weight is = 73.

Constraints : Get only or exactly ~~the~~ 80 weight from set.

	1	2	3	4	5	6
x = 1/0	1	1	0	0	1	0



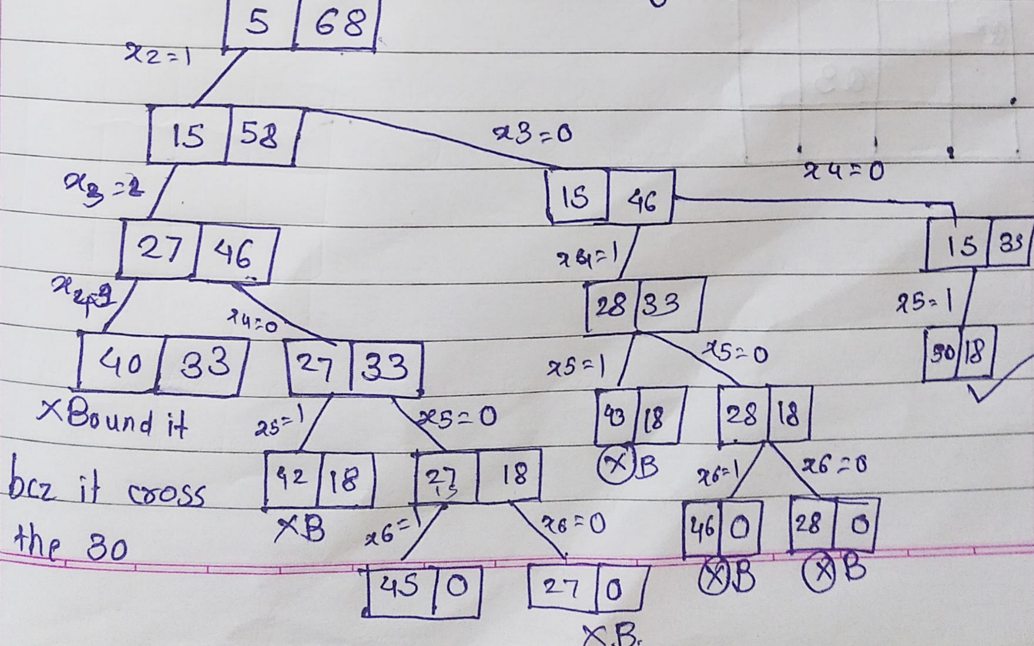
Total no of level/ height = 7.

Possible solutions = 2^6

$\therefore 6 =$ level - 1.

It value is more large and therfore it is time consuming so we apply backtracking.

when $x_n = 0$ then first get Previous block ~~nex~~ then get next block.



N - Queen Problem

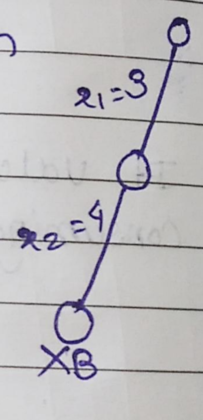
	Q1		
			Q2
Q3			
		Q4	

put $Q_1 = 3$

		Q1	
Q2			
			Q3
	Q4		

		Q1	
			Q2

It is diagonal so in under attack



put $Q_1 = 4$

			Q1
Q2			
		Q3	

Here we can't put Q1 in 4 block

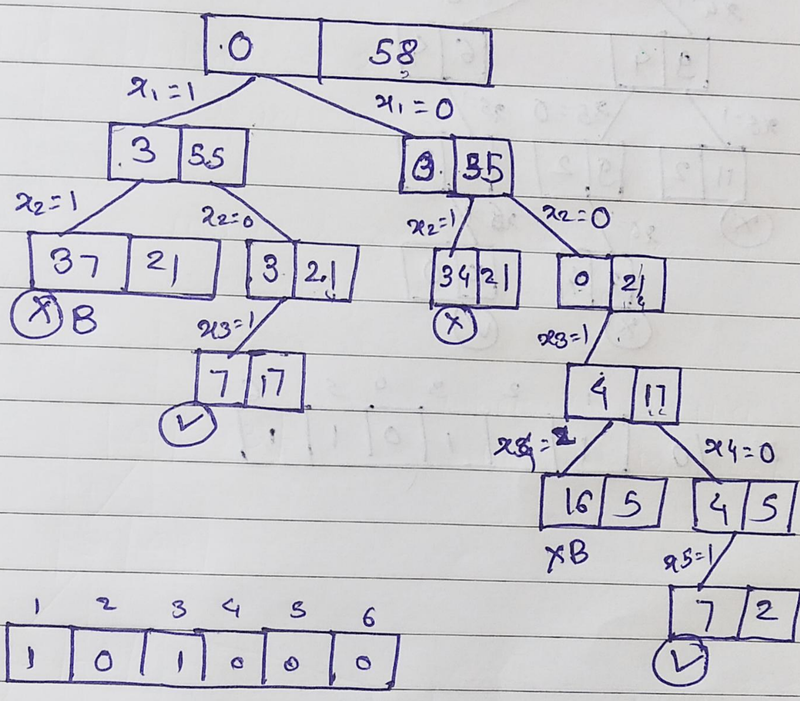
Sum of subset - Example.

$w[1:6] = \{3, 34, 4, 12, 3, 2\}$.

Total weight = 58

Sum or condition or constraint = 7.

1	2	3	4	5	6



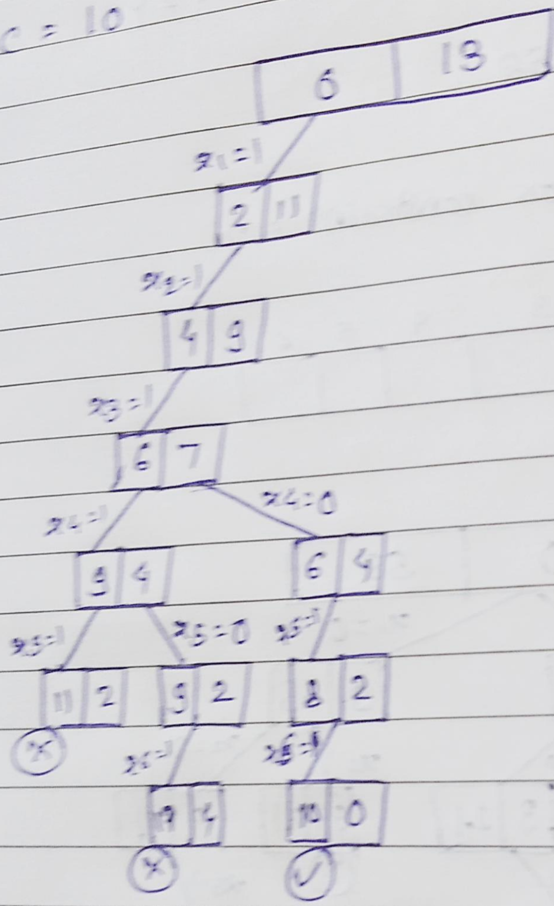
	1	2	3	4	5	6
x_1 =	1	0	1	0	0	0

	1	2	3	4	5	6
x_2 =	0	0	1	0	1	0

1 2 3 4 5 6

arr[1:6] = {2, 2, 2, 3, 2, 2} = 13

C = 10



x = 1/0

1	2	3	4	5	6
1	1	1	0	1	1

$arr[1:7] = \{7, 3, 8, 5, 4, 6, 2\} = 35$

Sum = 18