1. A set of objects whose state must satisfy a number of constrains / limitations are defined as constraint satisfaction problems (CSPs). CSPs consist of

   i. A set of variables
   ii. A domain for each Variable
   iii. A set of constraints.

A finite CSP has a finite set of variables and a finite domain for each variable.

$$
\begin{array}{ccccc}
C_4 & C_3 & C_2 & C_1 & \\
F & O & R & T & Y \\
 & & T & E & N \\
+ & & T & E & N \\
\hline
S & I & X & T & Y
\end{array}
$$

Here,

$Y + 2N = Y + 10C_1$ —— (i)

$C_1 + T + 2E = T + 10C_2$ —— (ii)

$C_2 + R + 2T = X + 10C_3$ —— (iii)

$C_3 + O = I + 10C_4$ —— (iv)

$C_4 + F = S$ —— (v)

From (i);

To get $Y+2N = Y + 10C_1$, 'N' should be either 5 or 0.

Also from (ii)

$C_1 + T + 2E = T + 10C_2$. Here, E should be either 5 or 0

so,

Let's assume;

$N = 0$ & $E = 5$ with $c_1 = 0$

$$\begin{array}{ccccc} c_4 & c_3 & c_2 & 0 & \\ F & O & R & T & Y \\ & & T & 5 & 0 \\ & & T & 5 & 0 \\ \hline S & I & X & T & Y \end{array}$$

From (V) $c_4 + F = S$. This gives $c_4 = 1$ since $F \neq S$.

To get $c_4 = 1$;

$c_3 + O = I + c_4 * 10$ should yield;

$(I + 10 c_4) \geq 10$.

If $O = 8$ & $c_3 = 2$; $I = 0$ which is invalid.

so, $O = 9$ & $c_3 = 2$.

$$\begin{array}{ccccc} 1 & 2 & c_2 & 0 & \\ F & 9 & R & T & Y \\ & & T & 5 & 0 \\ & + & T & 5 & 0 \\ \hline S & 1 & X & T & Y \end{array}$$

Now,

$c_2 + R + 2T$ must be greater or equal to 22 to make the previous asumption right.

$(R, T) = (6,8), (7,8), (8,7)$ are the possible conditions.

If $(R, T) = (6,8)$ then 2, 4 & 7 will be the remaining numbers.

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We have,

$1 + F = S$. so, F & S are consicutive numbers.

so, $(R,T) \neq (6,8)$

Again,

if $(R,T) = (8,7)$ then remaining numbers are 2, 4, 6, still invalid.

If $(R,T) = (7,8)$ then remaining numbers are 2, 3, 6.

Hence,

$F = 2$

$S = 3$

$R = 7$

$T = 8$.

	1	2	1	0	
	2	9	7	8	Y
			8	5	0
		+	8	5	0
	3	1	4	8	Y

Remaining number is 6. so, $Y = 6$

Thus;

2	9	7	8	6
		8	5	0
	+	8	5	0
3	1	4	8	6

2. Let us model the problem by defining each state by 4 bits. Each bit represents boat, cabbage, goat && wolf.

1 = west bank

0 = East bank.

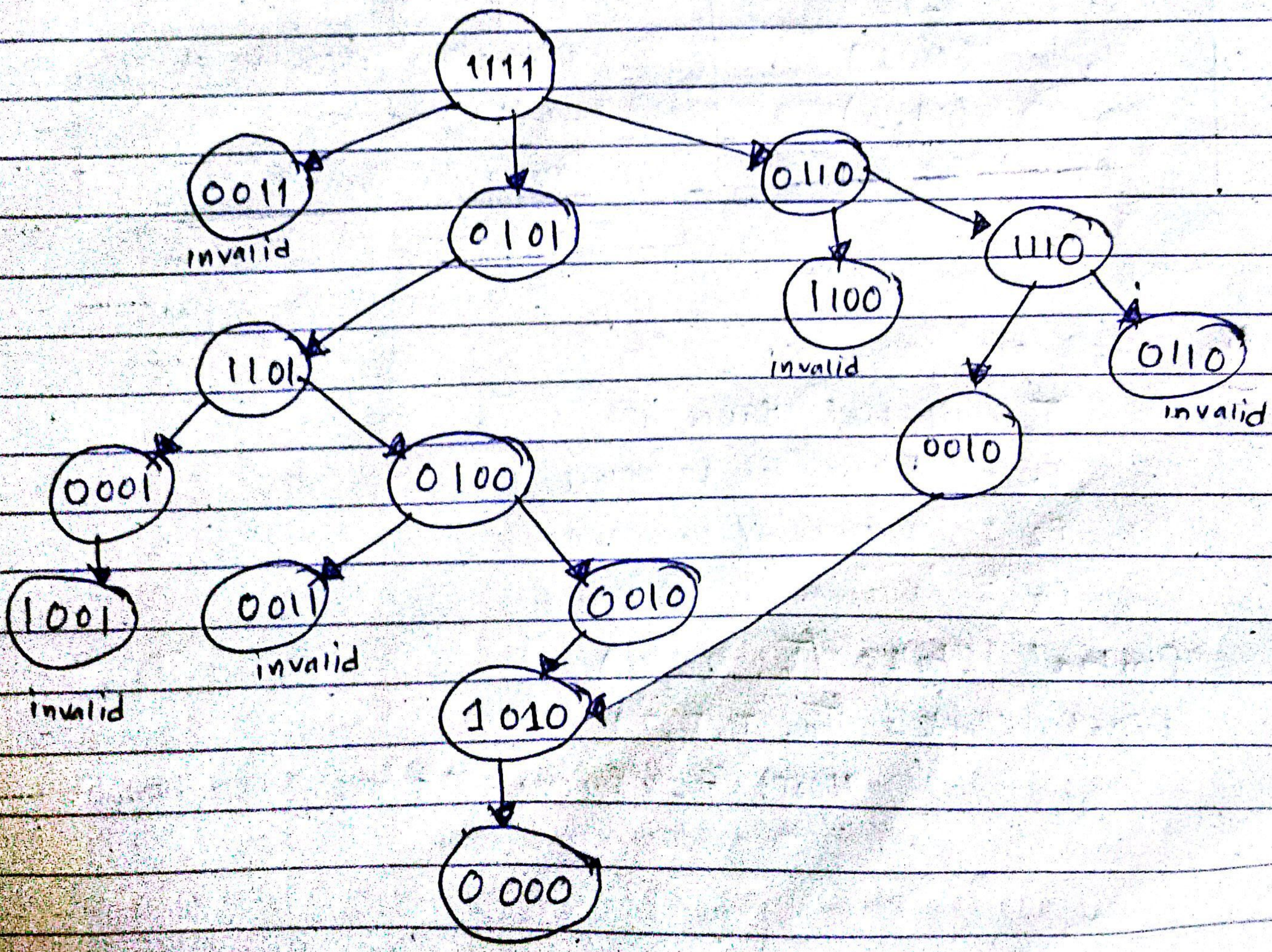
Now;

The initial state is: 1111

Final state is : 0000

Invalid states : (0011) (1100) (0110) (1001)

Now, the search tree is obtained as follows:



3. let us assume:

$x \rightarrow$ 4 gallon jug

$y \rightarrow$ 3 gallon jug

we have, initial state $(x, y) = (0,0)$

Final state $(x, y) = (2, y)$

step	state	Remark
0	(0,0)	Intial
1	(4,0)	fill x
2.	(1, 3)	Transfer from x to y.
3.	(1, 0)	Empty y
4.	(0, 1)	Transfer from x to y
5.	(4, 1)	Fill x
6.	(2, 3)	Transfer from x to y.

4. let us assume;

T_0 = initial flowers

T_1 = Flowers at temple 1

T_2 = Flower at temple 2

T_3 = Flower at Temple 3

Initial state = $(T_0, 0, 0, 0)$

Final state = (T_0, T, T, T)

Here, T = flowers at each temple.

Step	State	Remark
0.	$(T_0, 0, 0, 0)$	Initial
1.	$(2T_0 - T, T, 0, 0)$	1st temple
2.	$(4T_0 - 3T, T, T, 0)$	2nd temple
3.	$(8T_0 - 7T, T, T, T)$	3rd temple.

we have;

$$8T_0 - 7T = 0$$

$$\Rightarrow 8T_0 = 7T$$

$$\therefore \frac{8}{7} = \frac{T}{T_0}$$

Thus, the person has initially 7 flowers & he presented 8 flower per temple.

6. Here,

pegs = {A, B, C}

Disks = {1, 2, 3}

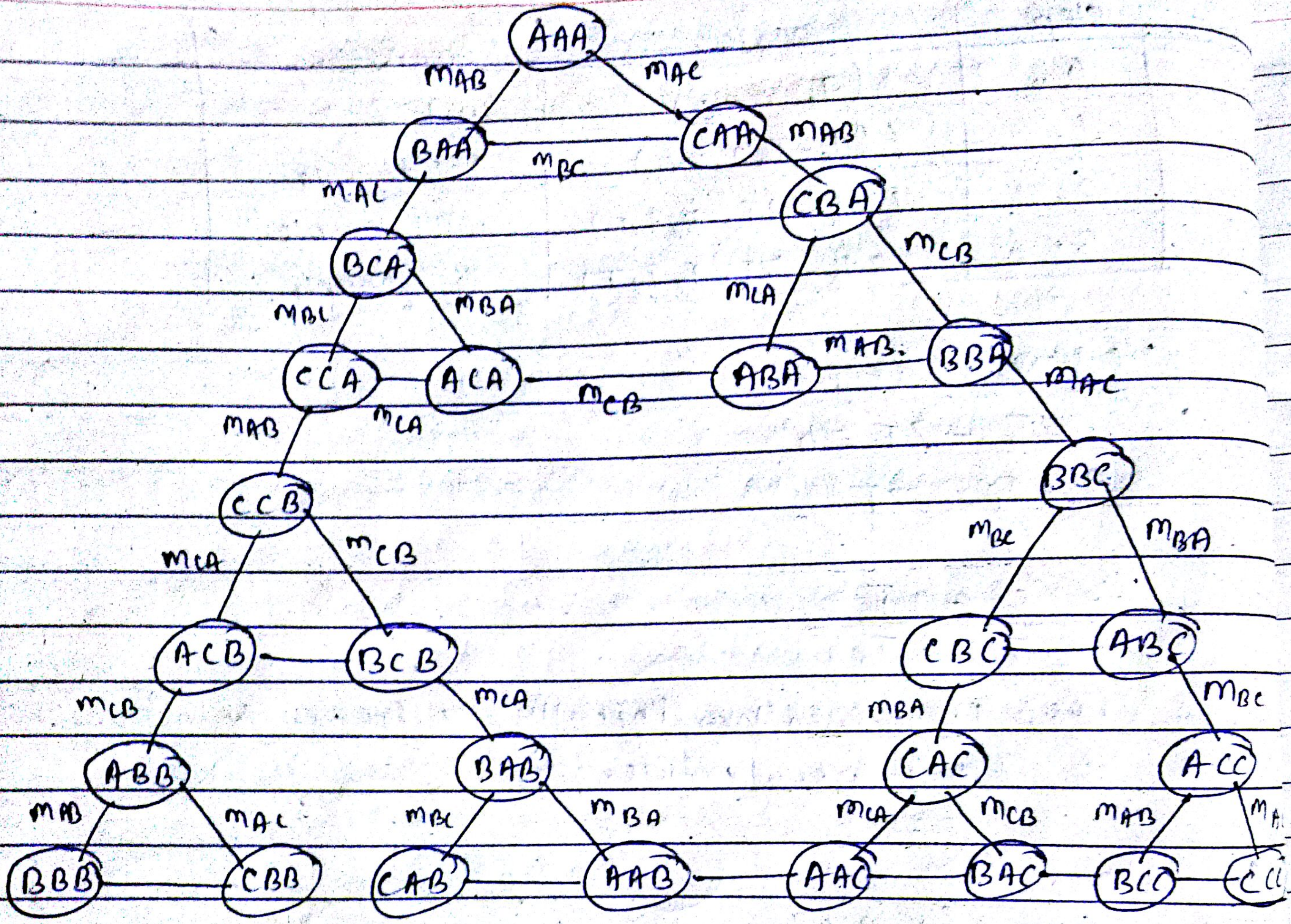
let us represent the problem by a tuple ⟨x, y, z⟩ where x, y, z represent the position of disks 1, 2, 3 in A, B or C.

Initially = ⟨A, A, A⟩

Final state = ⟨C, C, C⟩

we can apply more operation in this problem. It is permitted to move a top disk from one peg to top of another peg. It can be represented by

$m_{ij}: S \to S$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BCC

8 a) Turing Test and Total Turing Test:

The Turing test is a test which was developed by Alan Turing. This test is used to test the machine's ability to exhibit intelligent behavior equivalent to that of human. This test is carried out by the help of conversation between a machine & human in text-only channel. If the evaluator can't reliably tell the machine from human, then the machine is said to have passed the Turing Test. This test doesn't necessarily focuses on right or wrong answer but checks how closely those answers resembles the answer given by human.

The Total turing test is the variation of Turing test, proposed by cognitive scientist Stevan Harnad. This adds further requirements to the traditional Turing test. The interrogator can also test the perceptual abilities of the subject and the subject's ability to manipulate objects.

b) State-space problem:

State-state search is a process, used in computer science including artificial intelligence, in which successive states of an instance are considered while trying to find the goal state. The problems are modeled as a set of states that the problem can be in. The set forms a graph where nodes are the states and edges connect two nodes if there is an operation that can transform the first state into second.

c) Constraint satisfaction problem (CSP):

A set of objects whose state must satisfy a numbers of constraints or limitations are defined as constraints satisfaction problem (CSP). The CSPs consists of:

- A set of variables
- A domain for each variable.
- A set of constraints.

For example: crypto-arithmetic problem, automated scheduling, 8 queens problem.

we also can write CSP as:

$CSP = \langle X, D, C \rangle$

Where,

$X = \{x_1, \dots x_n\}$: set of variables

$D = \{D_1, \dots D_n\}$: set of domains.

$C = \{C_1, \dots C_n\}$: set of constraints.

d) Min-Max search:

The min max algorithm computes the min-max decision from the current state. It uses a simple recursive computation of the min-max values of each successor state, directly implementing the defining equations. This technique implements the philosophy of maximizing the possibility of winning & minimizing the possibility of loss if seen under game Theory.

e. Alpha-Beta Pruning:

Alpha-beta pruning is the improvement over minmax algorithm. When applied to a standard minmax tree, Alpha-Beta pruning returns the same move as minmax would, but prunes away branches that can't possibly influence the final decision.

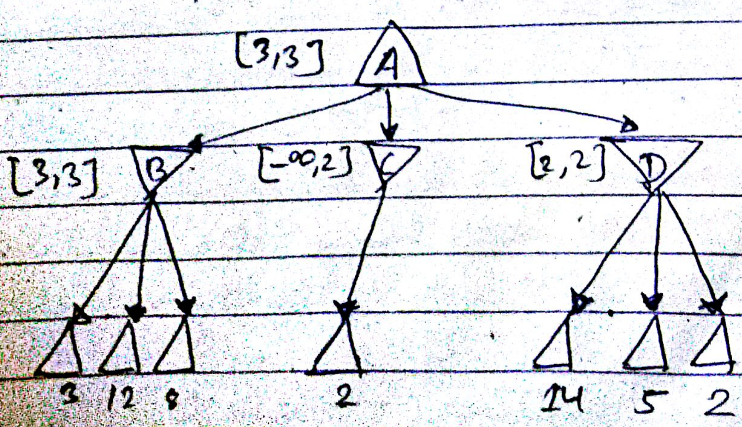
It can be applied to trees of any depth, and is often possible to prune entire subtree rather than just leaves.

This algorithm utilizes two more variables (α, β) within interval $(-\infty, +\infty)$.

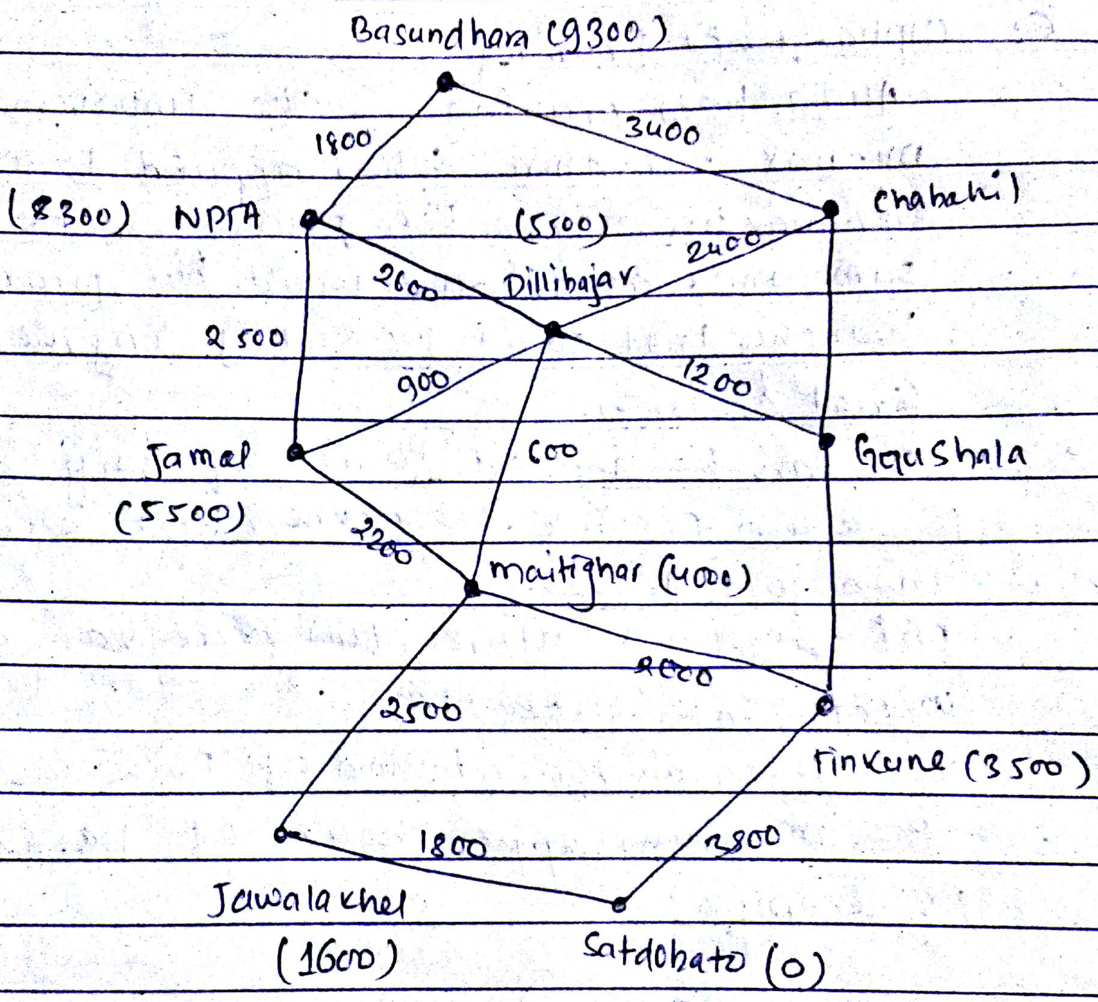
α = maximum lower bound of possible solutions.

β = minimum upper bound of possible solutions

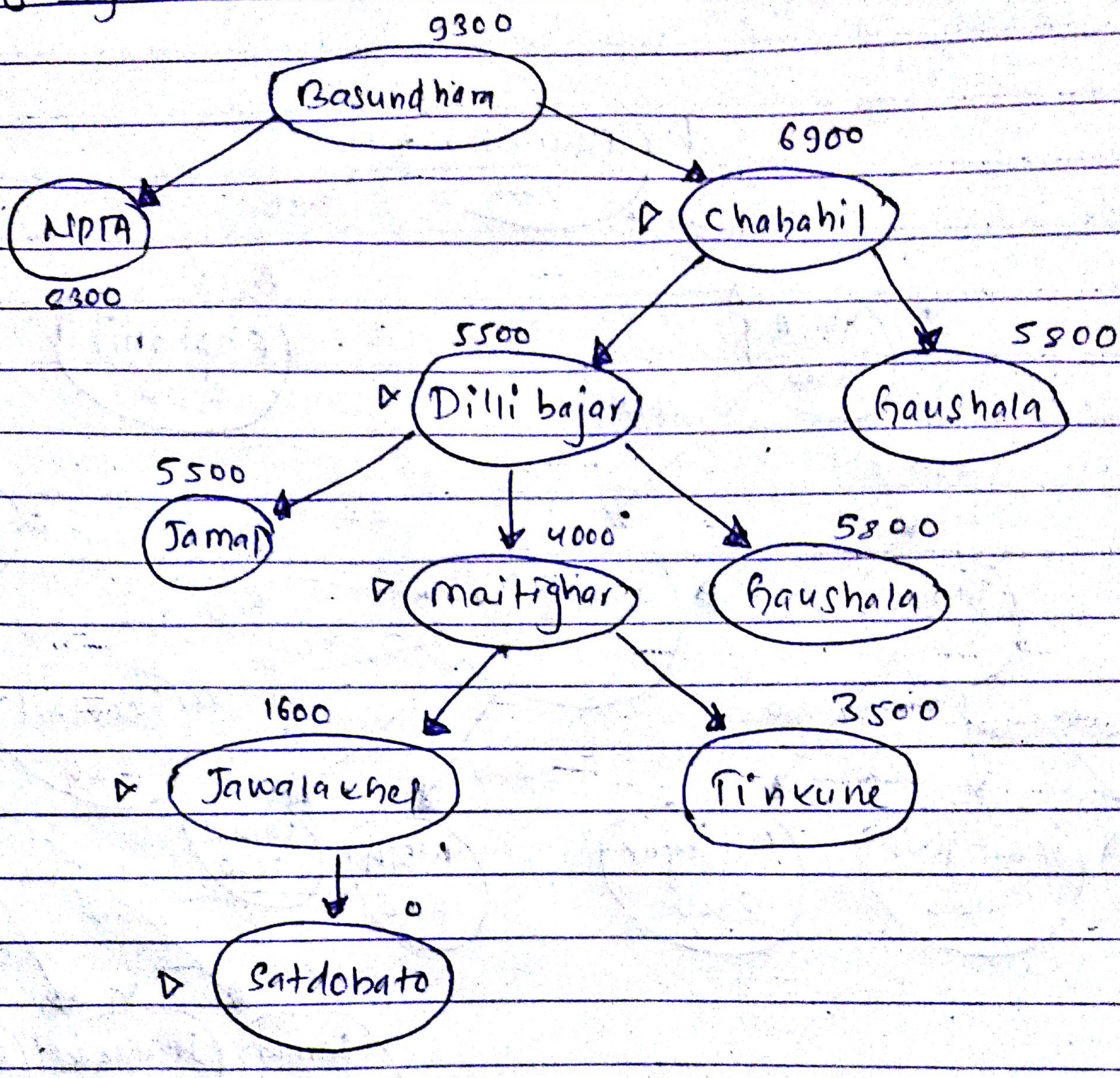
For example:



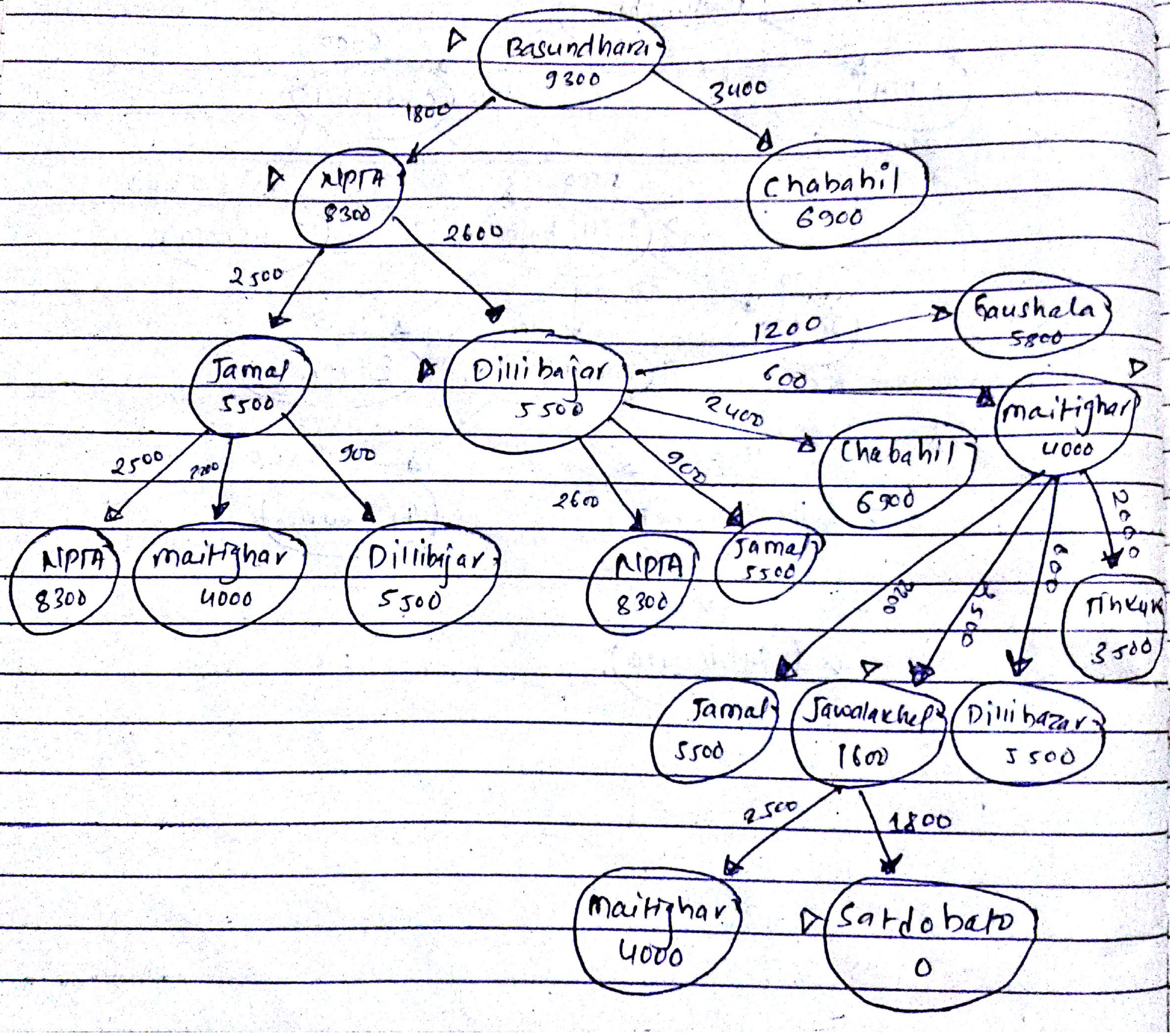
7. Let us assume a graph as shown below:



Greedy Algorithm :



A* Algorithm:



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Gaushala
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600
2400
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4000
Chabahil
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