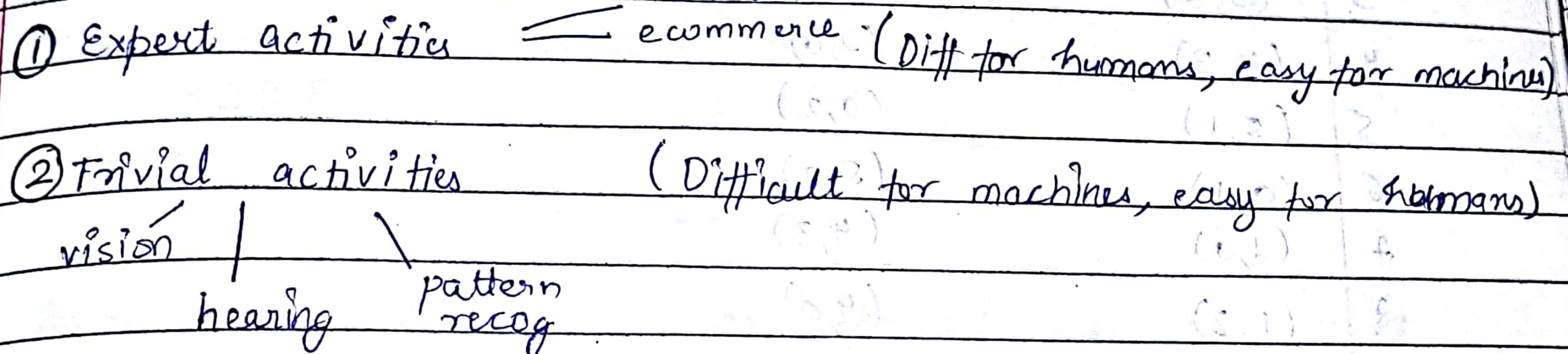
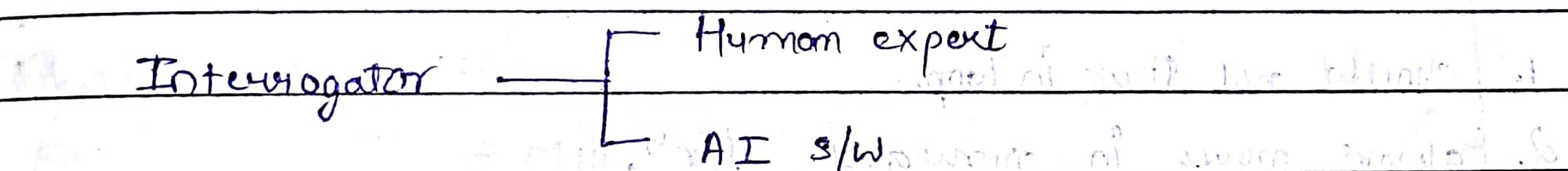


CED16ARTIFICIAL INTELLIGENCE

→ Fuzzy logic - DIY

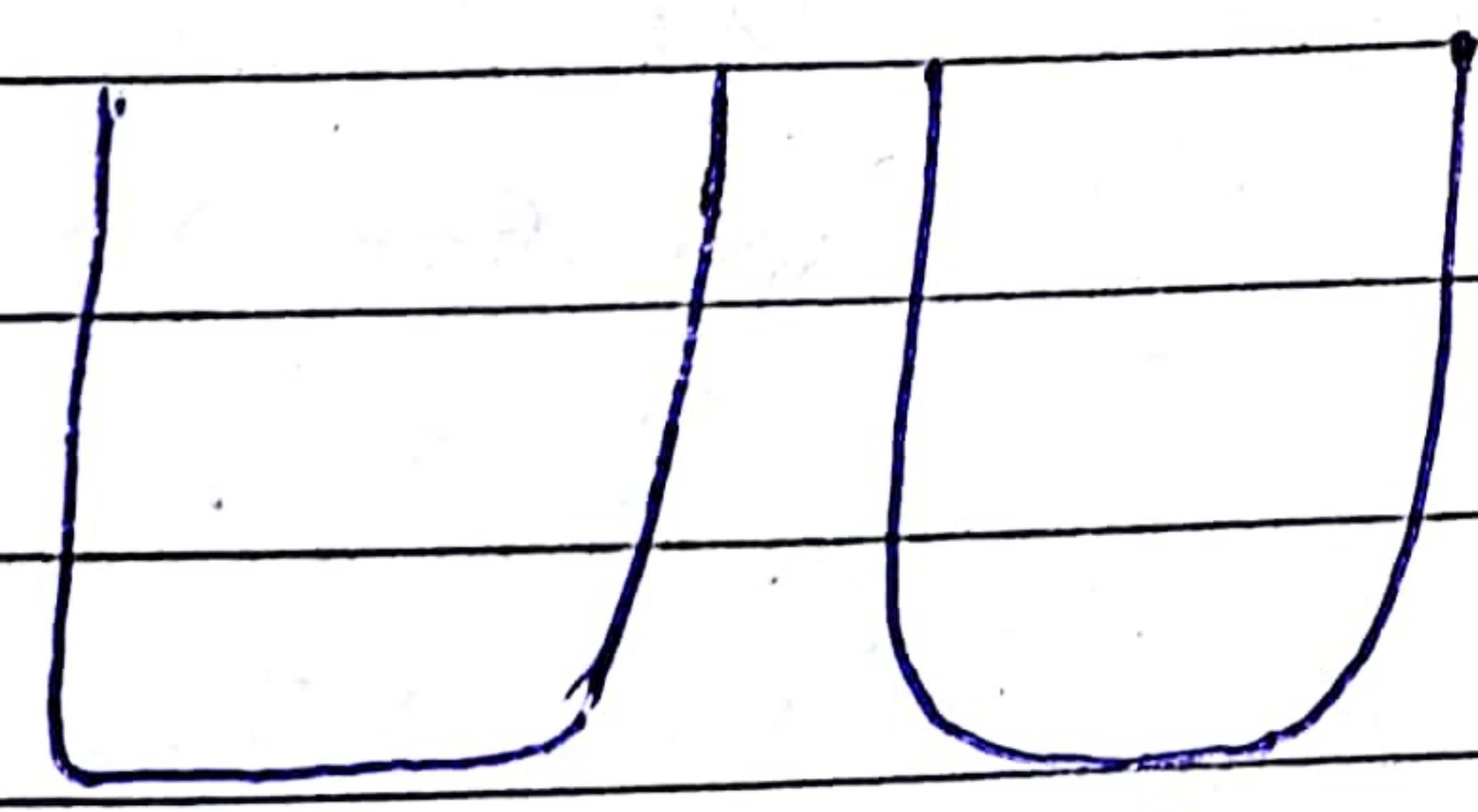


→ Who coined term AI and when. - DTY

→ Turing test helps to judge whether a machine is AI or not.

Some questions are asked from both, if the interrogator cannot distinguish which answer came from whom, then then the machine ~~is indistinguishable~~ exhibits intelligent behaviour.

→ First AI software which cleared Alan Turing test. - DIY

A Water Jugs Problem:

5 litres

3 litres

Measure exactly 4 litres

P E P

H E F +

2 3 H T

(x, y)

- | | | |
|----|----------|----------|
| 1. | $(0, 0)$ | $(0, 0)$ |
| 2. | $(0, 3)$ | $(5, 0)$ |
| 3. | $(3, 0)$ | $(8, 3)$ |
| 4. | $(3, 3)$ | $(2, 0)$ |
| 5. | $(5, 1)$ | $(0, 2)$ |
| 6. | $(0, 1)$ | $(5, 2)$ |
| 7. | $(1, 0)$ | $(4, 3)$ |
| 8. | $(1, 3)$ | $(4, 0)$ |
| 9. | $(4, 0)$ | |

→ State space search

1. should not stuck in loop.
2. always moves in forward direction.

* Crypt arithmetic problems

$$\begin{array}{r}
 \text{TWO} \\
 + \text{TWO} \\
 \hline
 \text{FOUR}
 \end{array}$$

Unique assigned assignment of alphabets to 0-9 to follow

F can't be zero.

$$\begin{array}{r}
 734 \\
 + 734 \\
 \hline
 1468
 \end{array}$$

EAT
+ THAT
APPLE

$$\begin{array}{r} 819 \\ + 9219 \\ \hline 10038 \end{array}$$

SEND
+ MORE
MONEY

$$\begin{array}{r} 9567 \\ + 1085 \\ \hline 10652 \end{array}$$

Ques Amol and Ravi and grandparents have to cross a bridge over river in 1 hr. only 1 umbrella which can be shared by two people. No one wants to get wet. How can they get across in an hour or less.

Fruit - 5 mins

Rani - 10 min

gm - 20 min

gt - 25 min

$$\begin{array}{r} 10 \\ 8 \\ 25 \\ 5 \\ 20 \end{array}$$

$$25, 5 \rightarrow 25$$

$$5, \cancel{25} \rightarrow 5$$

$$5, 20 \rightarrow 20$$

$$5, 10 \rightarrow 10$$

$$25$$

$$5$$

$$20$$

$$5$$

$$10$$

$$25, \cancel{25} \rightarrow 25$$

$$5$$

$$20$$

$$20, 25 \rightarrow 25$$

$$5, \cancel{25} \rightarrow 5$$

$$5, 10 \rightarrow 10$$

$$\underline{60}$$

Ques

P/E/R

R₁ R₂ R₃ R₄ R'

R''

Rabbits Each rabbit can jump over only one other rabbit. How can they avoid a deadlock?

* Deep learning - DIY

* Neural network - DIY

* Deep Blue by IBM - DIY

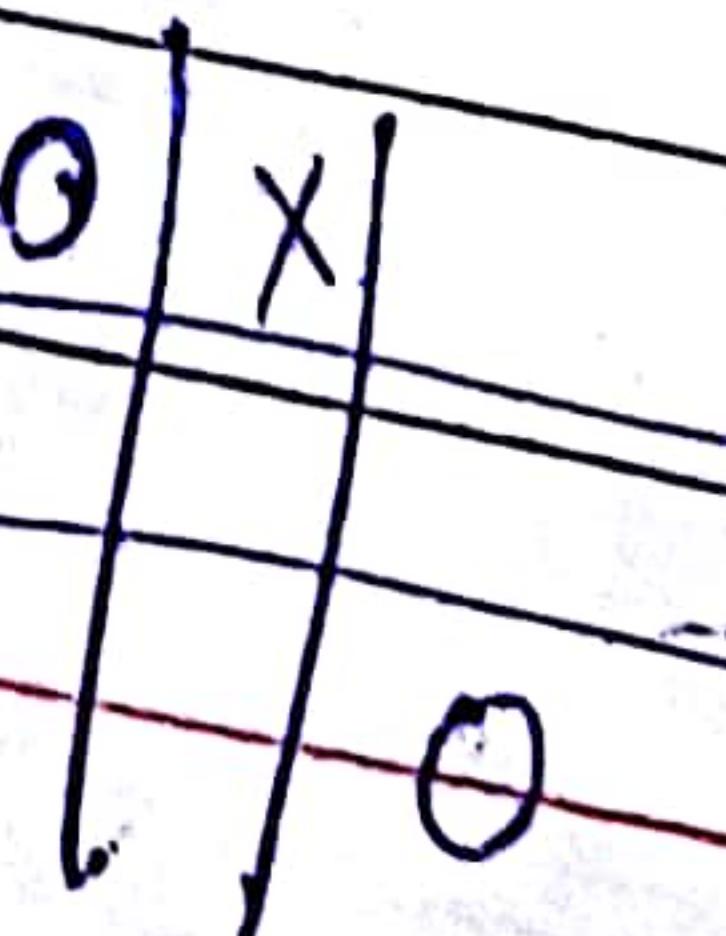
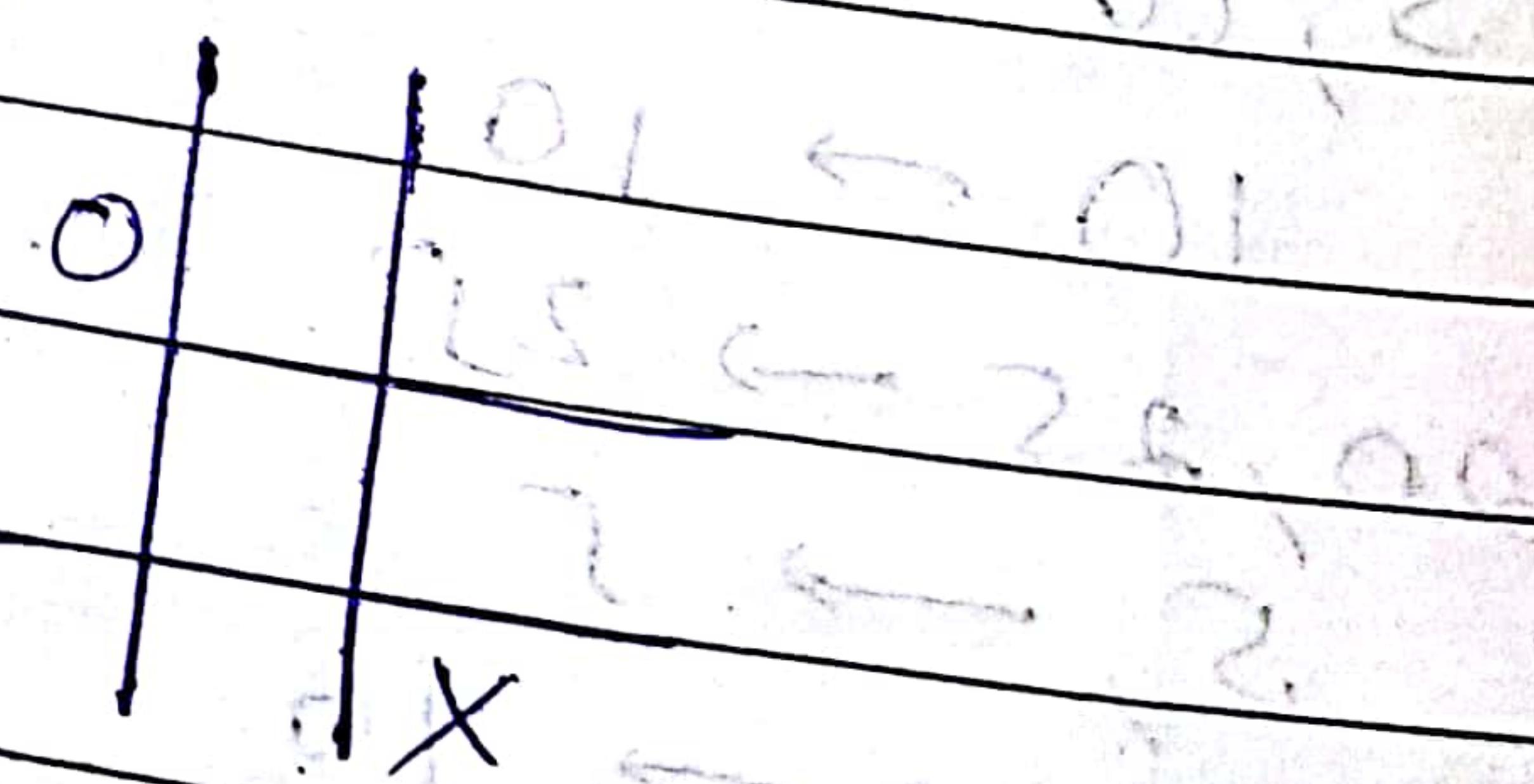
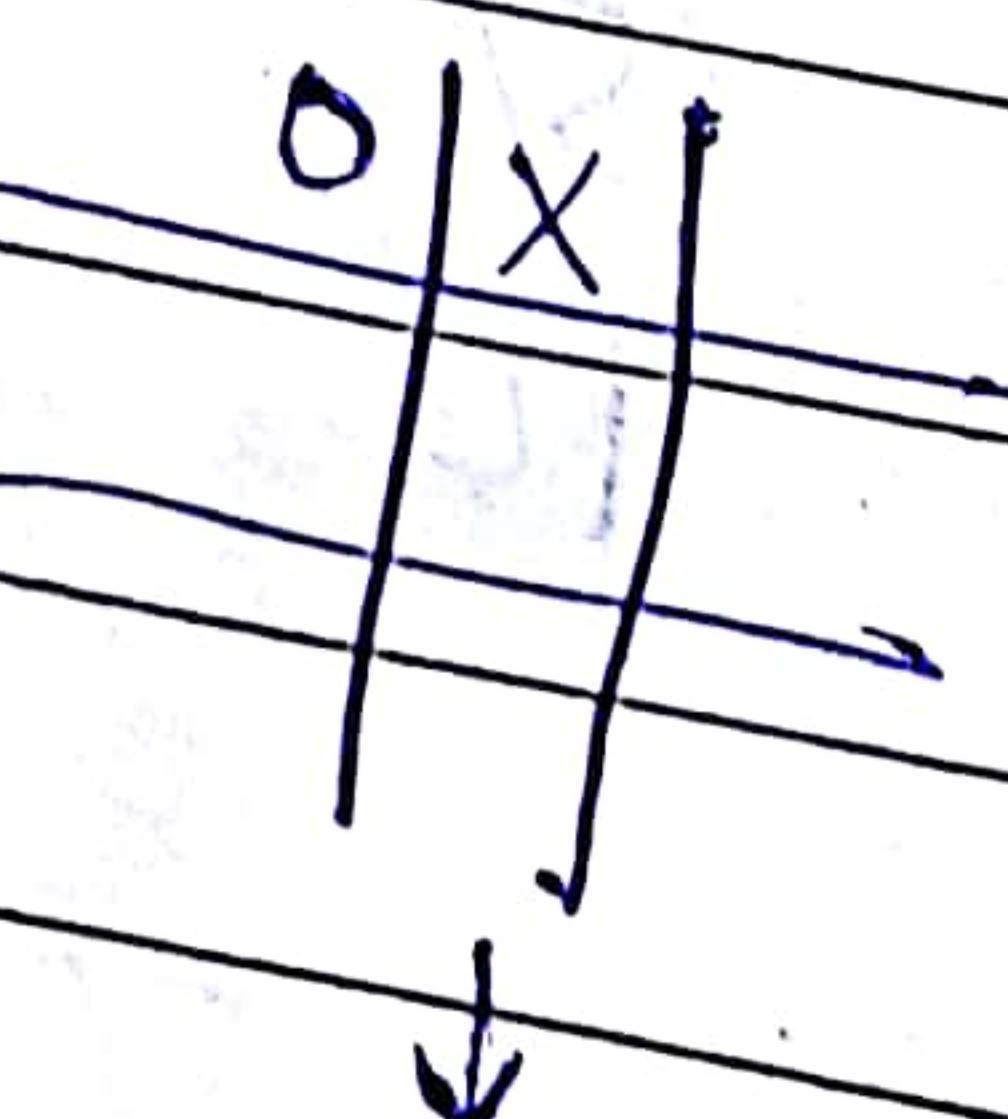
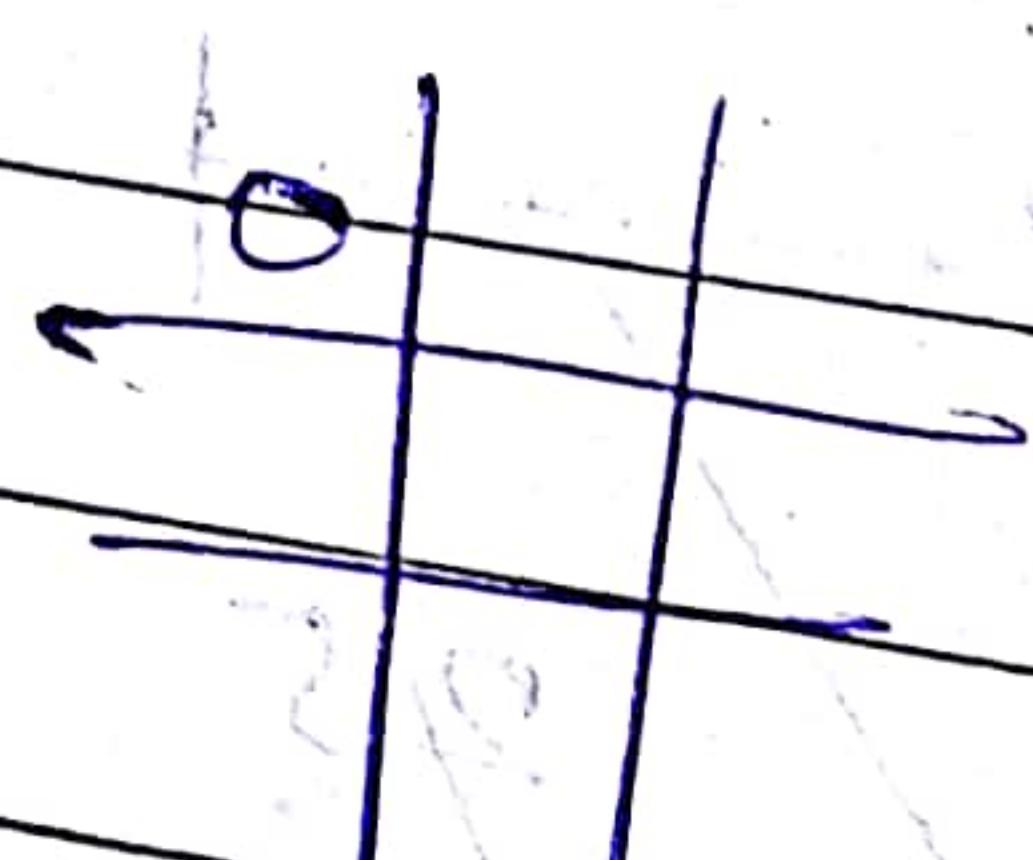
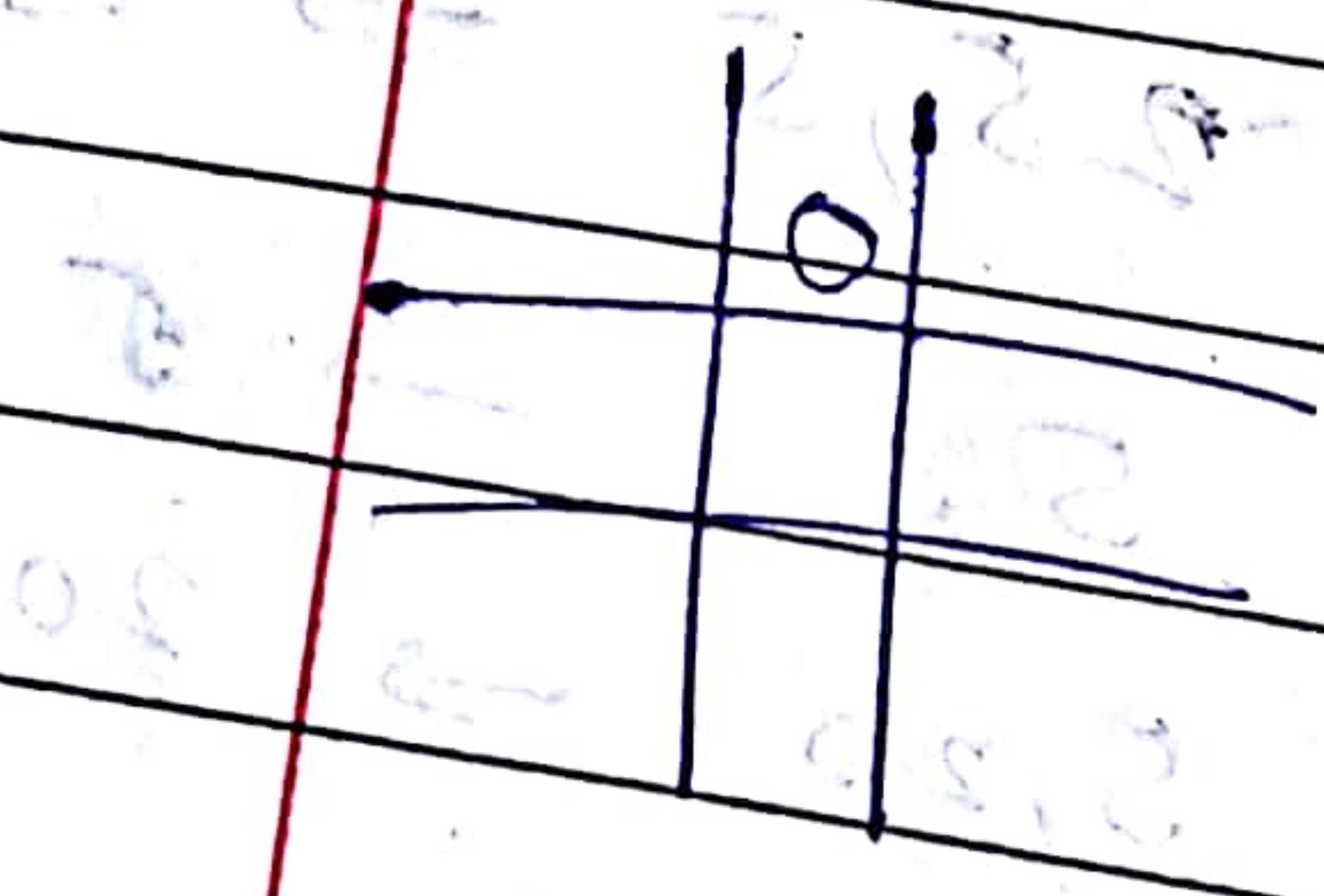
* Fuzzy logic operation on traffic lights - DIY

* Chapter-2

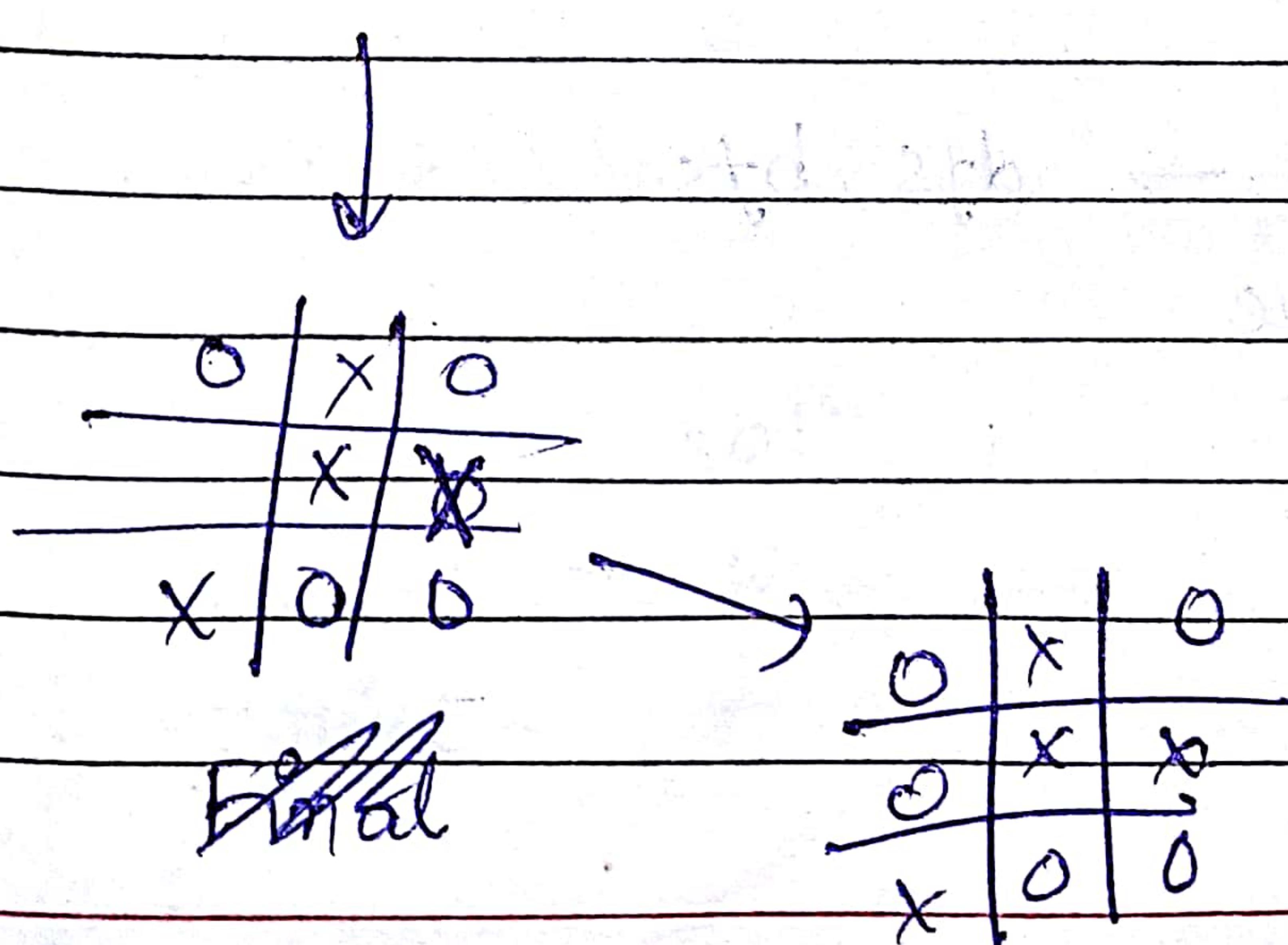
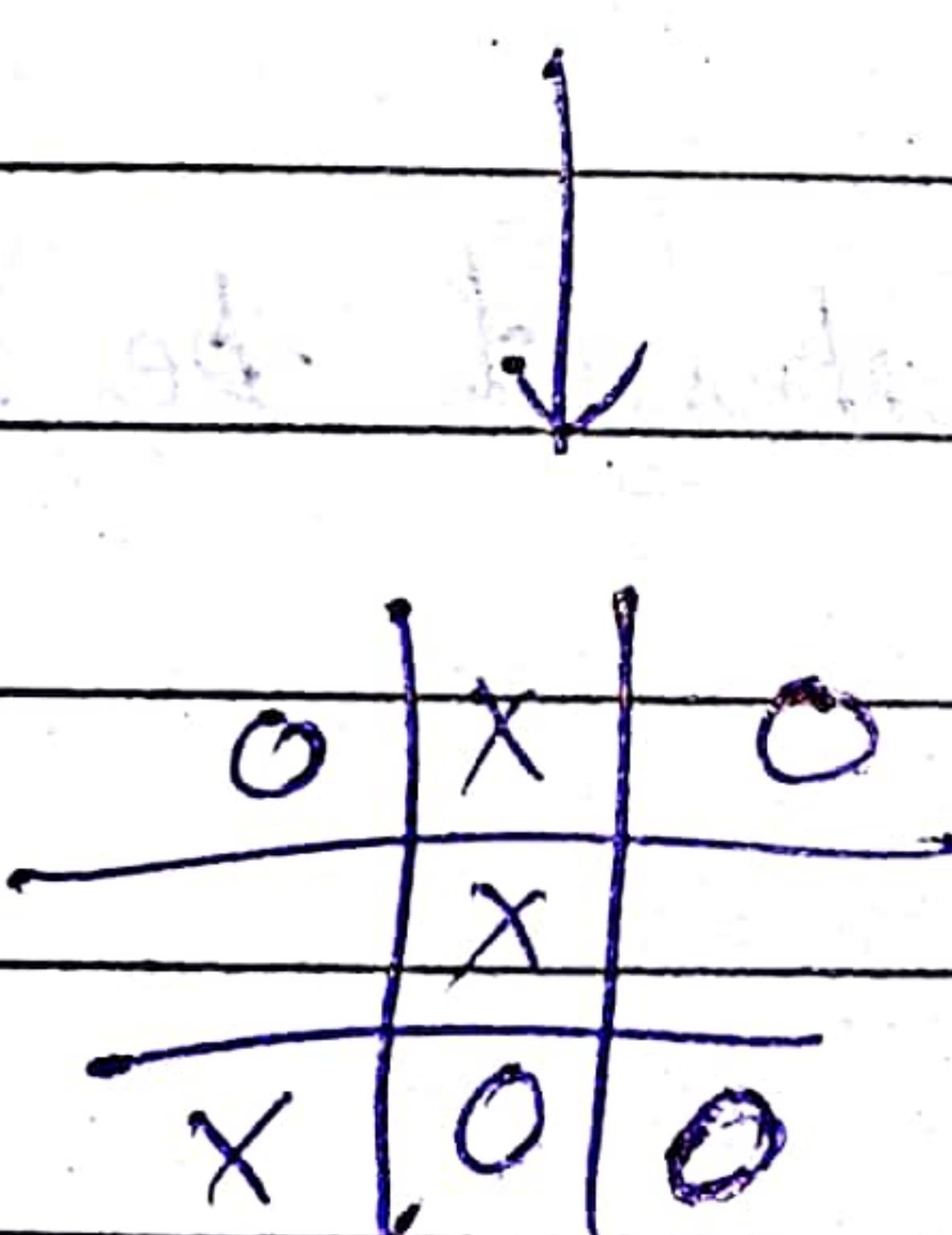
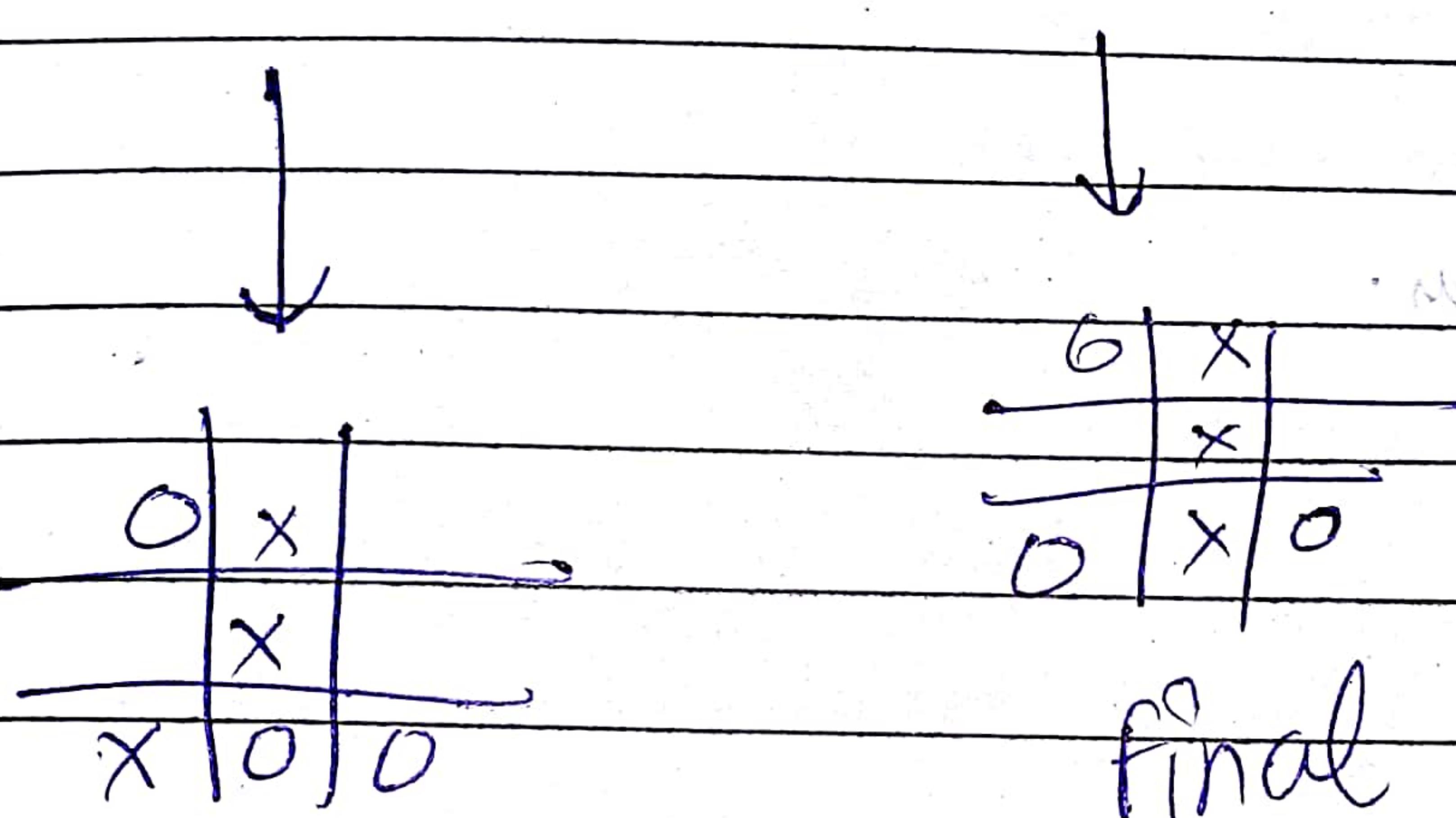
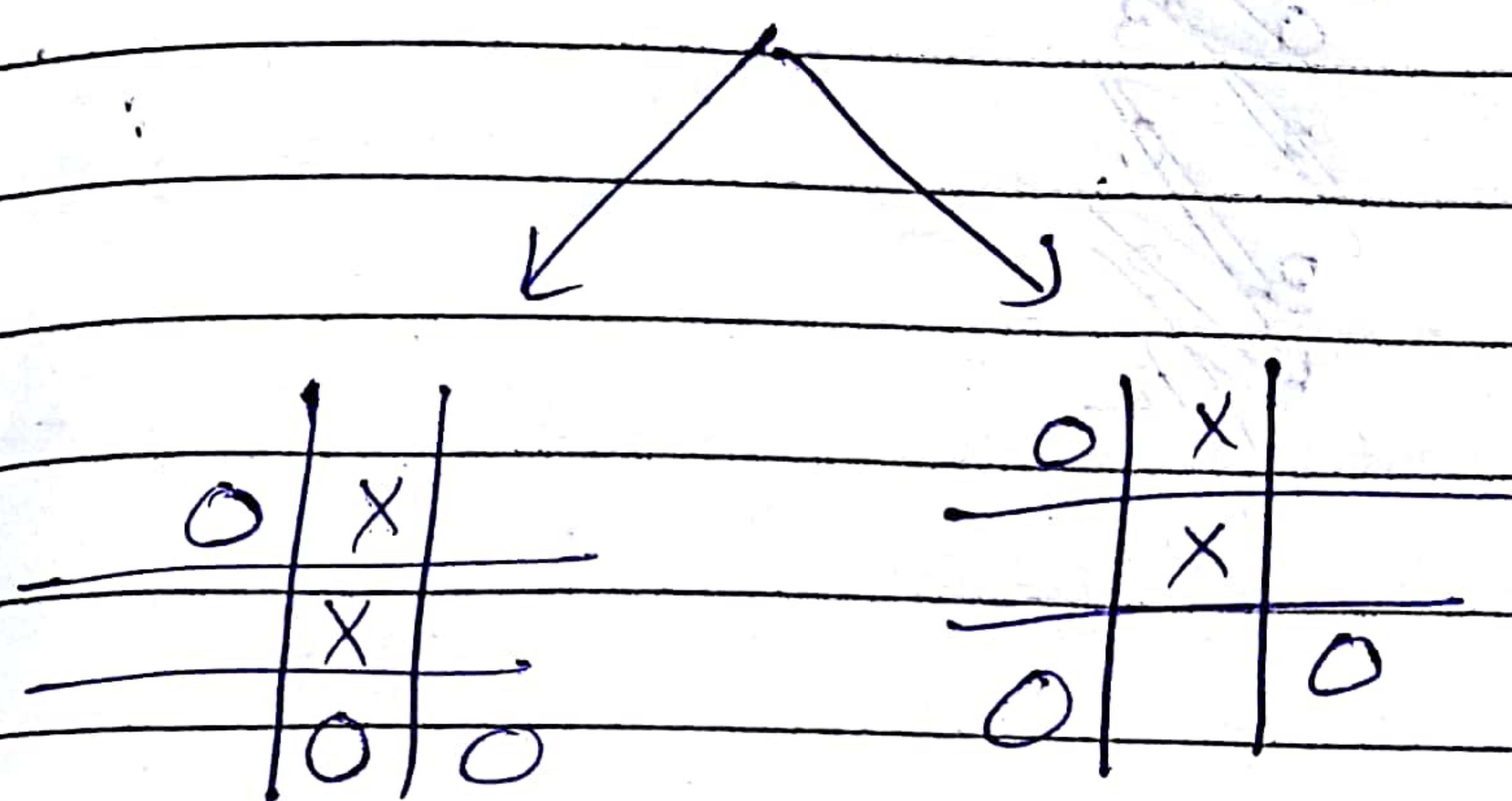
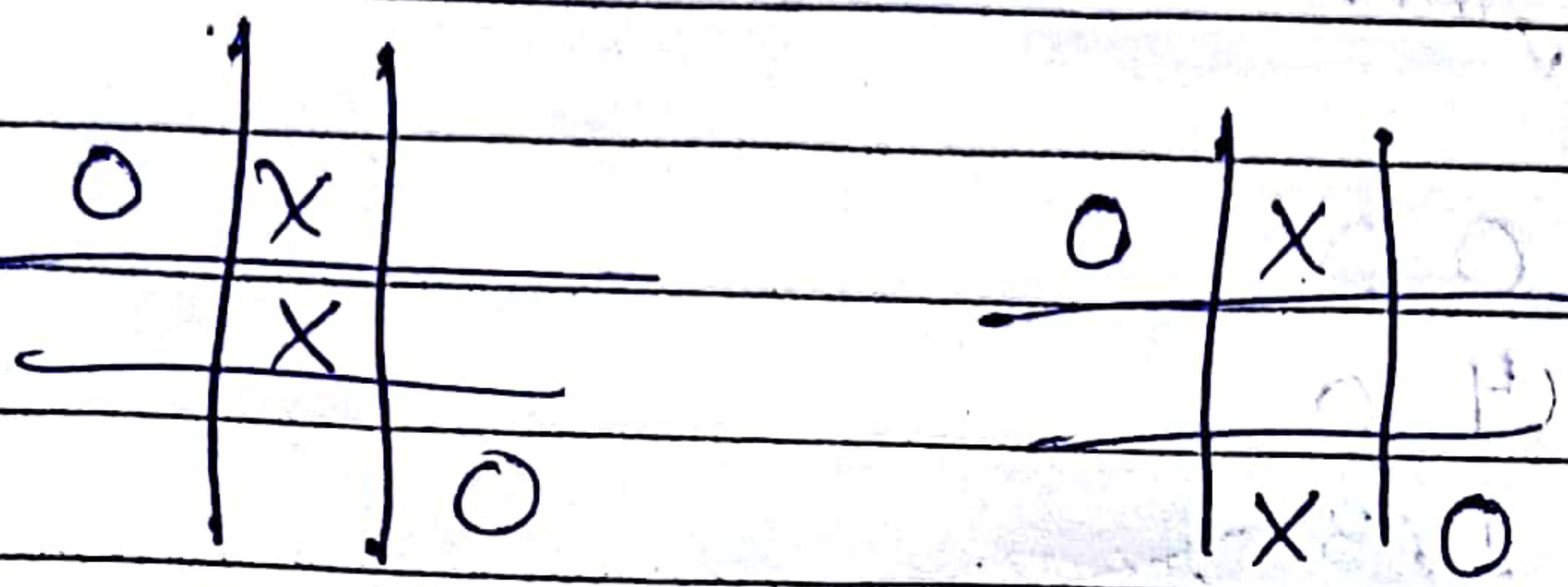
Problem, Prob-space and Search



Initial



22. 3. 2nd condition to get the width of the rectangle.



Q. 4 and 3 litre jug with no markings. Get 2 ltr in 4 ltr jar.

0 0
4 0
~~1 3~~
~~2 0~~ 10
~~0 1~~
4 1
2 3
2 0

→ Define rules for this:

* Production system:

consists of: (i) set of rules.
(ii) knowledge base
(iii) control strategy
(iv) rule applicator

* Control strategies:

Control strategies cause motion and it should be systematic

* Search techniques:

- ① State Space Search
- ② Blind/Uninformed Search → dts, bts
- ③ Heuristic Search technique

Valid rule

R₁. LHS → RHS

When there are multiple rules applicable, the strategy to resolve such conflicts is known as conflict resolution. Choose the best rule applicable on current state.

Problem for which entire state space traversal is needed

* Categorization of Problems :

1. Is the problem decomposable? non-decomposable - tic-tac-toe
e.g., Div 8 cong, $\sqrt{n^2 + \sin^2 n}$.

2. Types? (can moves be undone?)

I. Ignorable → theorem proving

II. Undoable

III. Recoverable → water jug problem, Maze.

IV. Irrecoverable → chess.
(cannot be undone)

3. Is the universe predictable?

resultant (predictable or not)

state

non-predictable - any card game.

predictable - 8 puzzle

4. Is the good solⁿ absolute or relative?

Absolute - Water jug

Relative - TSP. (Seems)

5. Is the solⁿ a state or a path?
state - any config or problem
path - walk up

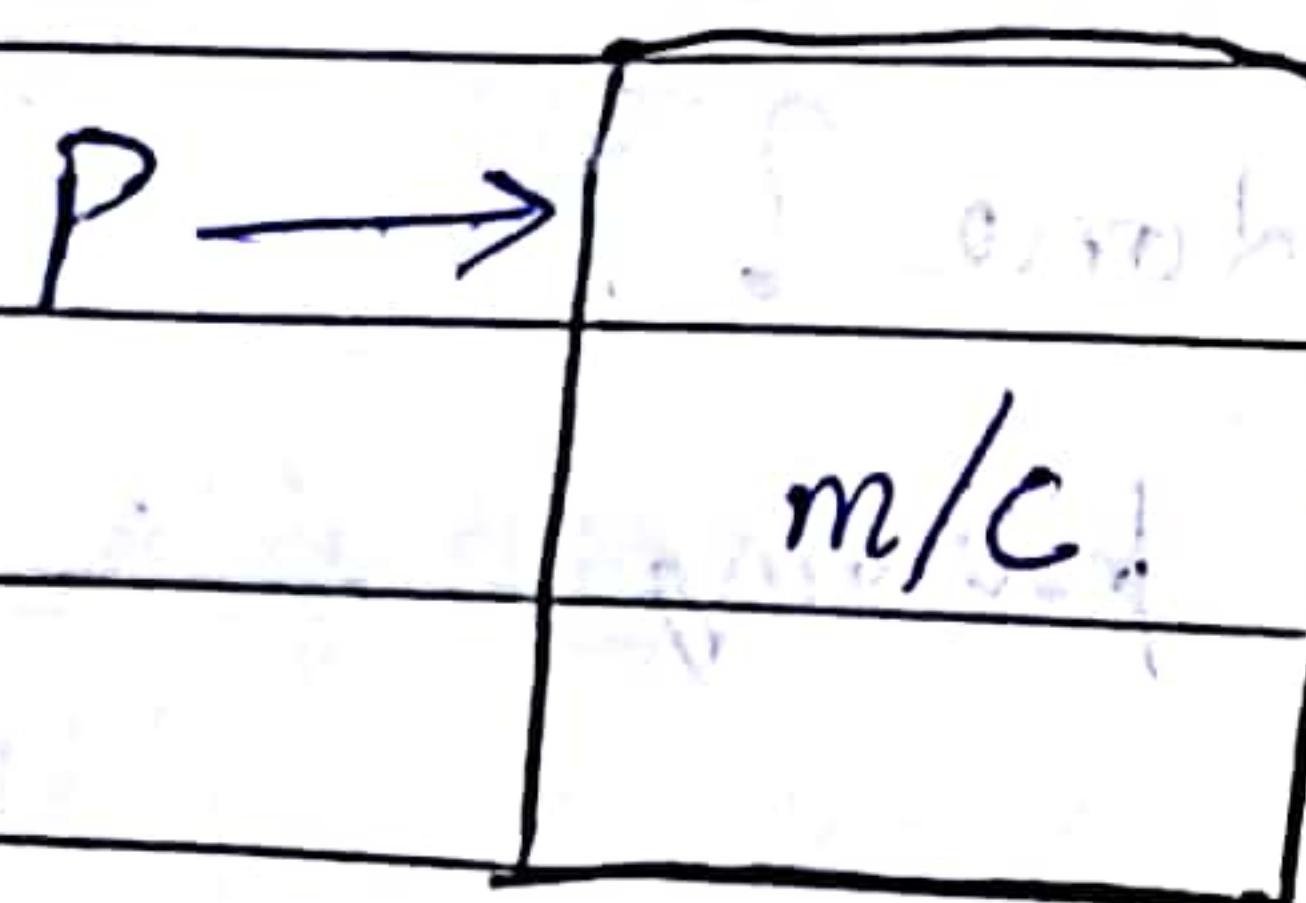
* Chapter-3: Heuristic Search Techniques

→ Expert Systems:

(A) medicine → expert system

↳ MYCIN

↳ first exp sys in field



→ Estimation Techniques

Represented by

$$f'(n) = g + h'(n)$$

I

$$\begin{aligned} f'(2) &= g(2) \\ &\quad + h'(2) \end{aligned}$$

Current cost

2

from this node

E

$$f'(I) = g(I) + h'(I)$$

$\hookrightarrow 0$

For goal nodes,

$$h'(n) = 0$$

For initial node,

$$g(x) = 0$$

I Generate and Test Algos

- Suitable for problems with small state.
- Brute force

II Hill Climbing :

- ①
- ②
- ③

Randomly choose one of the option, then check whether it is better state than current, then move to that state. else, try out with other state while ignoring ~~other~~ previous predicted nodes.

→ Limitations :

1. Not taking best.

2. Stuck at local min/max.

3. Next state same value as current (~~Plateau~~)

4. Multiple next states with same value. (~~Plateau~~)

5. ~~All~~ Ridge (All successors have lesser value)

→ Steepest Hill Climbing

1. Take the next best state instead of any one of better solⁿ

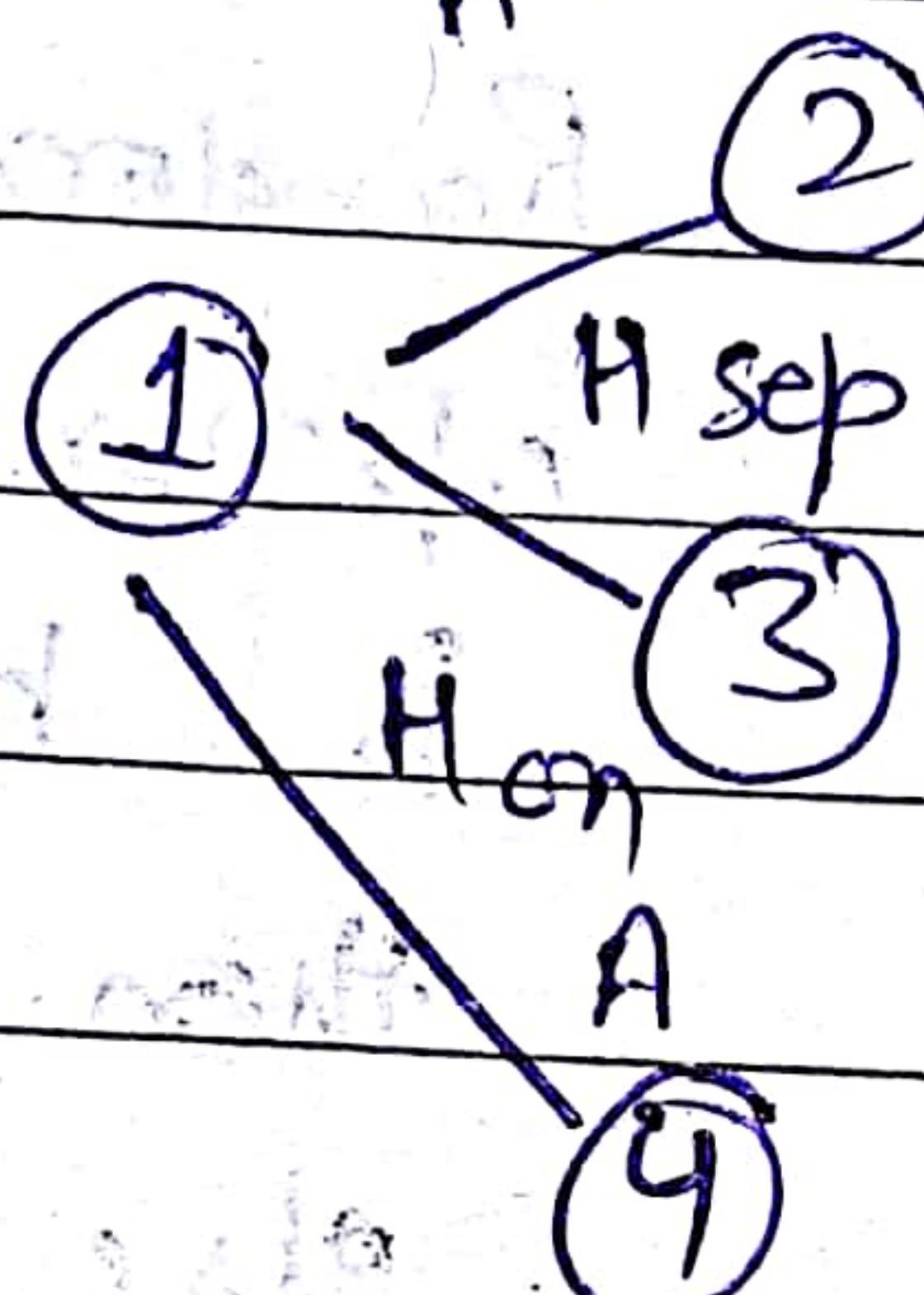
example,

Blocks world problem

Initial	A	E	O	Final
	D		C	
	C		B	
	B		A	

Operations → block can be put on table
put ~~on~~ ~~at~~ top of another.

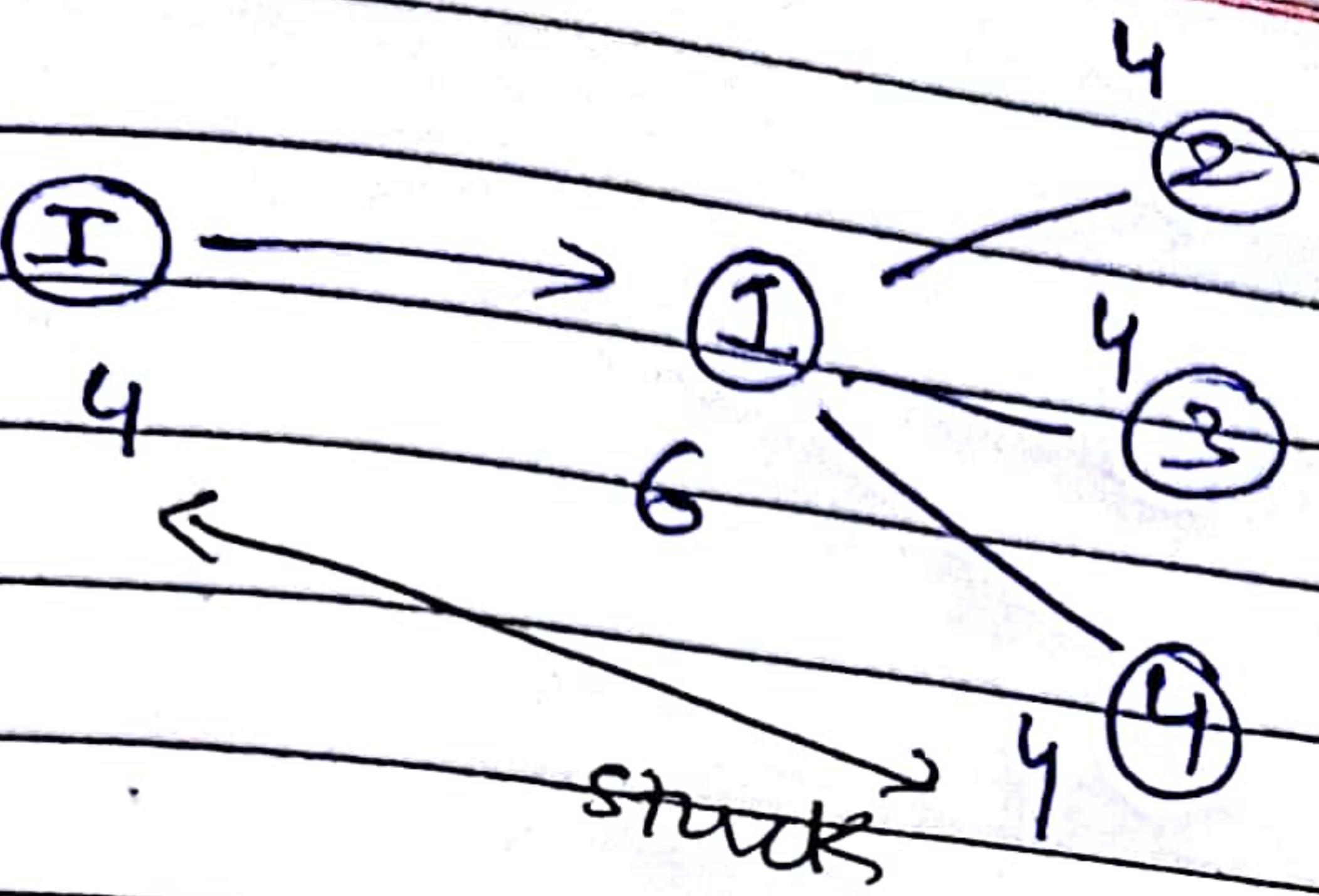
A back



→ Write down a strategy.

1. Add +1 to the block if it is resting on desired block.
2. Add -1 to the block if resting on wrong block.

In	A	H	F	Fin
	-1	+1	-1	
	G	+1	F	
	F	+1	E	
	E	+1	P	
	D	+1	C	
	C	+1	B	
	B	-1	A	



Do not know which
dirm to take

Another Strat:

1. Add $+1$ to entire structure to which it is supposed
 2. Add -1 , rest.

	+ 3	D
<u>Final</u>	+ 2	C
	+ 1	B
	+ 0	A
		28 Total

Initial

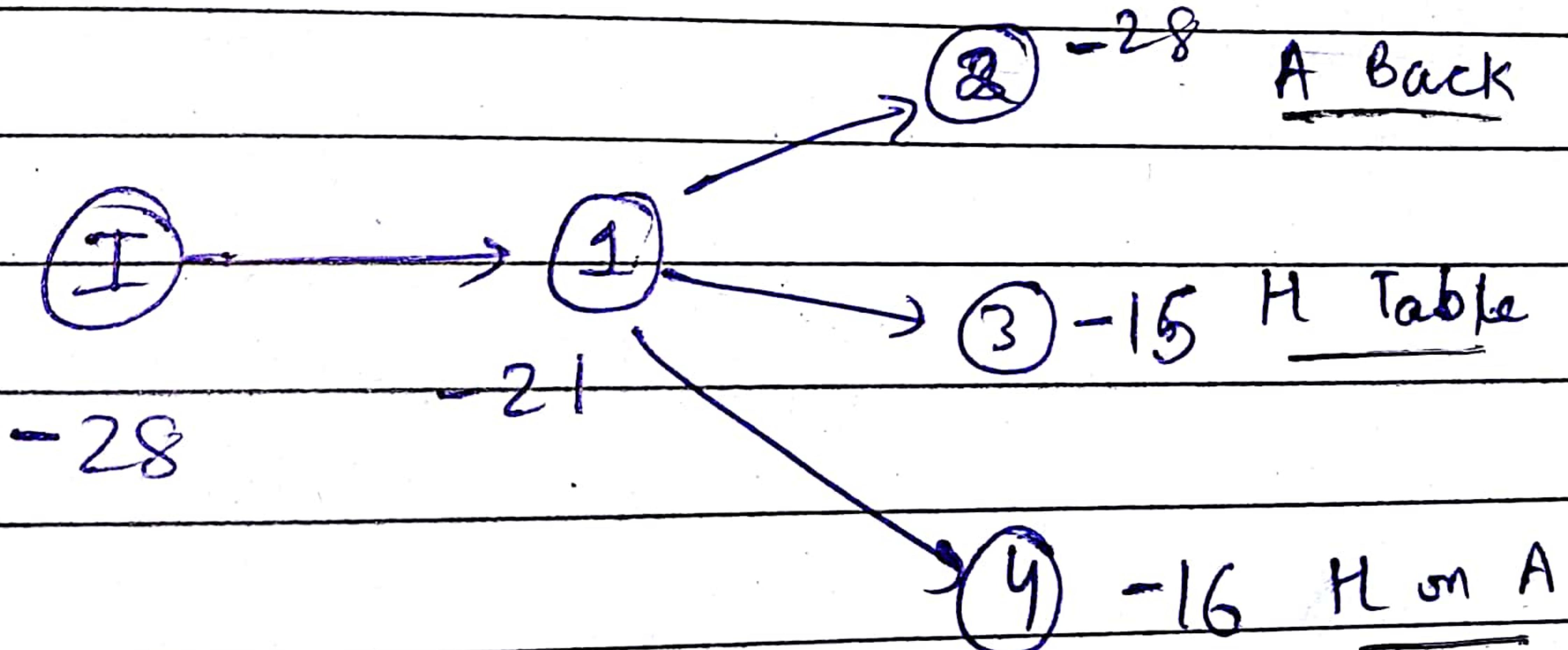
-3 -2 -1 0

D
C
B

-28

-2 -1 0

D
C
B



Here, we can easily choose better option (3)

C. ED16 Tut

* 9-Aug:

Q(1) Water Jug Problem - Measure 4 litre in jug1 using 5 litre and 3 litre jugs.

→ Solⁿ(1)

$$(0,0) \rightarrow (0,3) \rightarrow (3,0) \rightarrow (3,3) \rightarrow (5,1) \rightarrow (0,1) \rightarrow (1,0) \\ \rightarrow (2,3) \rightarrow (4,0)$$

→ Solⁿ(2)

$$(0,0) \rightarrow (5,0) \rightarrow (2,3) \rightarrow (2,0) \rightarrow (0,2) \rightarrow (5,2) \rightarrow (4,3) \rightarrow (4,0)$$

Q(2)

TWO
+ TWO
FOUR

F can't
be zero.

EAT
+ THAT
APPLE

$$\begin{array}{r} 734 \\ + 734 \\ \hline 1468 \end{array}$$

$$\begin{array}{r} 819 \\ + 9219 \\ \hline 10038 \end{array}$$

SEND

+ MORE
MONEY

$$\begin{array}{r} 9567 \\ + 1085 \\ \hline 10652 \end{array}$$

Q(3) Amit, Ravi and grandparents have to cross bridge in 1 hr. Only 1 umbrella which can be shared by max two people. No one wants to get wet. How can they get across in an hour or less.

Amit - 5 mins

Ravi - 10 mins

GM - 20 mins

GF - 25 mins

5, 10 → 10

10 → 10

5 → 5

5, 10 → 10

60 mins

Ques(4) R_0, R_1, R_2 can move only in fwd dirn. R'_0, R'_1, R'_2 can only move in backward dirn. Place R_0, R_1, R_2 after R'_0, R'_1, R'_2 without deadlock.

$R_1 \ R_2 \ R_3 = R' \ R'' \ R'''$

~~$R_1 \ R_2 \ R_3 \ R' = R'' \ R'''$~~

~~$R_1 \ R_2 = R' \ R_3 \ R'' \ R'''$~~

~~$R_1 \ R_2 \ R' = R_3 \ R'' \ R'''$~~

~~$R_1 = R' \ R_2 \ R_3 \ R'' \ R'''$~~

$$\cancel{R} + \cancel{R'} = \cancel{R_2} \cancel{R'_2} \cancel{R''} \cancel{R'''}$$

8/21

$$\cancel{R_1}, \cancel{R_2}, \cancel{R_3} \rightarrow a, b, c$$

$$\cancel{R'}, \cancel{R''}, \cancel{R'''} \rightarrow x, y, z$$

$$\textcircled{1} a b c - x y z$$

$$\textcircled{2} a b c x - y z$$

$$\textcircled{3} a b - x c y z$$

$$\textcircled{4} a - b x c y z$$

$$\textcircled{5} a x b - c y z$$

$$\textcircled{6} a x b y c - z$$

$$\begin{array}{l} \cancel{a x b y} - \cancel{c z} \\ \cancel{a n b y z} - \cancel{c} \\ \cancel{a n b y z} - \cancel{c} \end{array} \quad \textcircled{7} a x b y c z -$$

$$\textcircled{8} a x b y - z c$$

$$\textcircled{9} a n - y b z c$$

$$\textcircled{10} a - n a y b z c$$

$$\textcircled{11} n - a y b z c$$

$$\textcircled{12} a y a - b z c$$

$$\textcircled{13} a y a z b - c$$

$$\textcircled{14} a y a z - b c$$

$$\textcircled{15} a y z - a b c$$

$$\textcircled{16} a y z - a b c$$

16/8

Q(5) For the given problems, analyze them w.r.t various problem characteristics discussed.

	decomposable?	undone?	predictable?	absolute / relative	State / Path
Chess	No	IR No	No	Abs	state path
Water Jug	No	R Yes	Yes	Not Abs	path
8-puzzle	No	R Yes	Yes	Abs	path
TSP	No	IR No	Yes	Abs Rel	path
Crypt	No	IR Yes	Yes	Abs	state
Bridge	No	IR No	No	Abs	state path
Card game		IR			
Move					

Queens Lion Hen L, Goat G, cabbage C across a river. Boat B with capacity of only one of them at a time. L eats Goat, Goat eats cabbage. Give

(i) initial state disc

L, G, C

(ii) final state disc

L → G

(iii) solⁿ

(i)

L → G, C, M → —

(ii)

— → L → G, C, M

(iii)

L, G, C, M → —

L, C ← M, G

L, C, M → G

L ← G, C, M

L, M, G → C

G ← C, M, L

C, M → C, L

C, L, G, M

Ques Consider trying to solve 8-puzzle using Hill Climbing
Can you find a heuristic fn that makes it work. Make
sure it works on foll examples.

(i) 1 2 3

1 2 3

8 5 6

4 5 6

4 7 -

7 8 -

Starting

Goal

1 2 3

8 5 6

4 - 7

①

1 2 3

8 5 -

4 7 6