

25/07/2024
Thursday

Lecture 1. Part 1 Review
काल्पनिक कार्योंका एवं मरणोंका
निश्चयकर कालिक्रम अभियान।

Book : AI on modern approach
• 1956 → Dartmouth workshop

AI is making machines which can think on
which can do that humans can do.
thinking & actions

→ How do we think? How machines can think?

Thinking can be in 2 ways :-

(1) Humanly
(2) Rationally / logically / theoretically

similarly of actions :- (1) Humanly
(2) Rationally

जो वह है उसी को मानेंगे

True is True → machines keeping
false is false → they can't do

humans are not rational.

we don't want
such machines, we want
them as humans.

→ Rational is pure.

→ chatpt. can also think ; so bots can also act.
we want machines which can think as
well as act.

* Turing Test :- If there is machine (say computer)
that is interacting with human
via chat exchange / chatbox, and again
human ko na pta chle. wo machine hal yaa
human, then that machine passes Turing
test in terms of chat only. This is

initial test.
But 3 limitations, can not do any chat,
there is some subset of chat only, which
can fool the machine Human \rightarrow so called
"intelligent" machine.
and this chat is definitely "Voice chat".

\rightarrow Rational thinking is absolute.
different types of logic :-
(i) Binary logic [2 values, 0, 1]

(ii) Conditional logic (something b/w 0 and 1)

\rightarrow membership function :-
fuzzy logic b/w 0 and 1,
then map with membership
function, if " ", then 1 \rightarrow true !

\rightarrow Humans want to go beyond their capacity
but machines not.

\rightarrow DFS \rightarrow we will use to find some solution

\rightarrow same program will give same output, but humans
improve, they give better output, so we are more
intelligent.

\rightarrow "Intelligent program" : jab hm pura program khi
likh rhe, we'll use shortcuts, tyekar &

* Heuristic approach/method

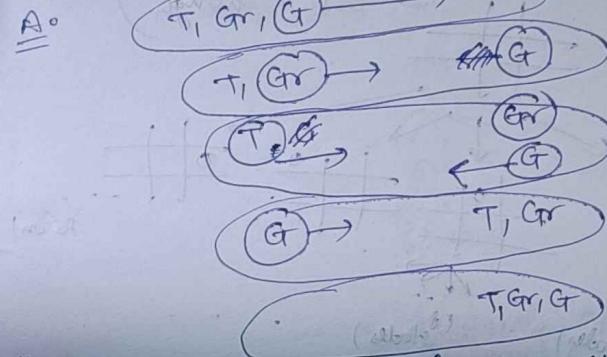
person have grass, goat, tiger to have to
buy boat, person can take only one item with himself
person can of boat. both must result

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Look's simple & easy

one condition is given :-
tiger & goat can't be placed together.
goat & grass



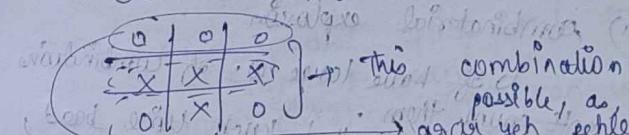
Tic-Tac-Toe :- machine se yeh play krovide
chain to check its intelligence.
Can you write code ??

initially both players are machine or
any player is machine & other is
human.

\rightarrow what is the problem ?

\rightarrow find out combinations (3 consecutive

0's or X's) in minimum steps.



\rightarrow this combination is not
possible, agar yeh keli bna, toh
yeh bon hi rahi payage &
vice-versa.

\rightarrow what is trick in this game?

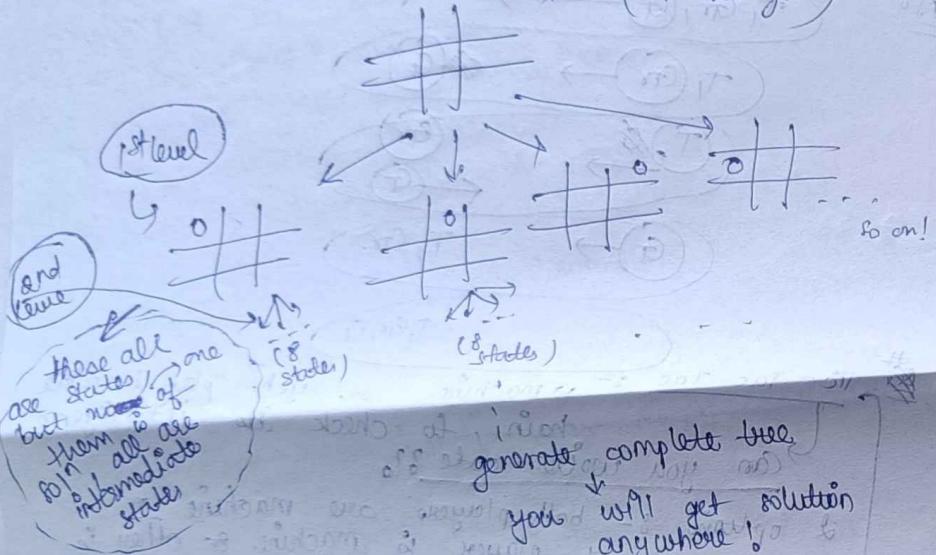
\rightarrow lock the centre \rightarrow agar
khud na jee paaye, opponent
bhi na jee paaye !!

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→ solve this using matrix approach.

"state space search"

(obviously repetition hongi)



problem :- contains multiple repetition as well.

so, "state space search" has certain problems :-
(i) combinatorial explosion

if have large no. of combinations
to count them.
here, so many combinations that each time bad,
can't count no. of nodes.
$$= 9 + 9 \cdot 8 + 9 \cdot 8 \cdot 7 + \dots + 9! \quad (\text{in this question, total no. of nodes})$$

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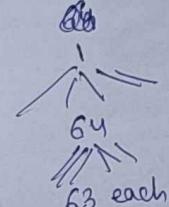
→ but no. is too large b/c other droppings left

e.g.: play chess (8×8) of 8x8

→ solve 8 queens problem

→ agar iska tree bnao

→ "droppings" start now



combinatorial approach
can't count, if anyhow
count kar liya, then can't store them.
node has 64 cells
 $\rightarrow 64 \times 8$ bytes

Hyperbba!!

again pura chess play karne ho, fir
toh aur bhi dikkat hoi!
↑ state hi nahi hoga, toh search
kare karega \rightarrow so count some another trick.

so generate partial space and search.

↑ branch & bound

Square (3×3)

↑ iska horizontal, vertical and diagonal

sum equal ho.

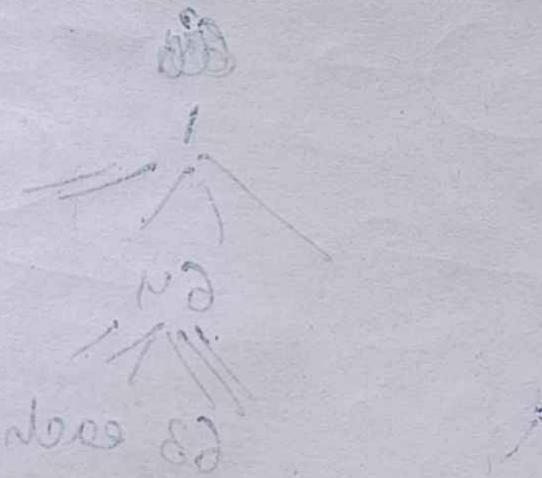
8	1	6
3	5	7
4	9	2

→ what is trick to
generate odd size
magic square
trick?

→ even size magic square ki trick nahi hai!

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min.

- This approach will be used to solve
tic-tac-toe.
- magic square to solve tic-tac-toe is
"Heuristic approach" → will save time.



No wrongs
No wrongs
No wrongs
No wrongs
No wrongs
No wrongs

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Lec-2

AI

WOMK 2 book
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→ Enrich & learnin
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P.R.

- 1) Turing Test → Inspection is textual
- 2) Total Turing test
 - ↳ Inspection is not only textual, but also visual and audio.
- This test requires some skills or fields.
 - (1) NLP (Natural Language Processing)
 - (2) Knowledge Representation
 - (3) Automated Reasoning
 - (4) Machine Learning

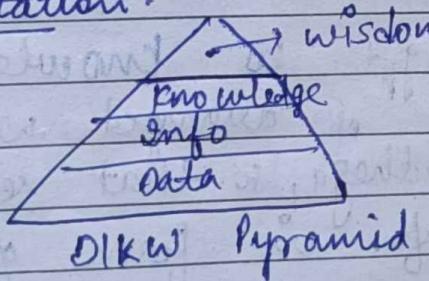
As machine is sharing text with human and machine is interacting with human like a human only.

→ deals with NL like English and will be processed by machine via tokenizing the sentences known as Parsing.
statements are divided into tokens and then these tokens are processed.
we'll learn conversions :-

- text → text
- text → speech
- speech → text
- speech → speech (e.g., Alexa)

NLP deals with these 4 frames/conversions.

knowledge representation:-



knowledge → generated from info.

↳ expected from Data

As we can't know everything!

So we'll talk of domain knowledge!

→ we have knowledge

↳ now have to represent it.

chartpt :-

text → text

↳ info ko represent kisi hai in useful manner

① How to represent data?

↳ can be in form of numeric, alphabets, etc.

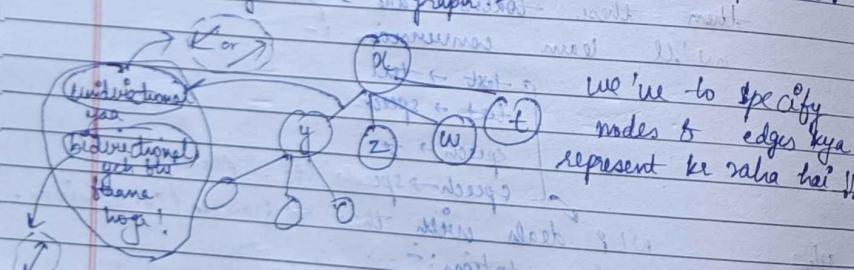
↳ symbols

→ in form of ASCII / unicode

→ info also represented in form of Unicode / text / graphics

→ knowledge :-

↳ may have a graphical representation



chartpt ko - knowledge → ek hierarchical

arranged way mein store kia jaha, so that retrieval easy ho !!

→ to store info. in form of graph or tree.

① Graph based knowledge. store kina → Ontological representation

→ agar foldes ki form main data store hai → toh wo graphical / tree form mein hi hai;

② Automated reasoning :-

↳ is basically logical / rational,

→ This statement is true

↑ is not a statement as it is not direct statement, does not have truth value & which statement is not defined, so ese knowledge represent nahi hogi !! It will deal with only unambiguous statements (domain fix & restrict ho rahi hai)

③ ML

↳ different methods to train machines so that they can learn by themselves / pretend to learn.

↳ like life Algo hote hain;

↳ Tuning algo.

↳ having some parameters.

→ with same input, get different outputs as via ML, they improve themselves

↳ better kise - 2. kyi vaar

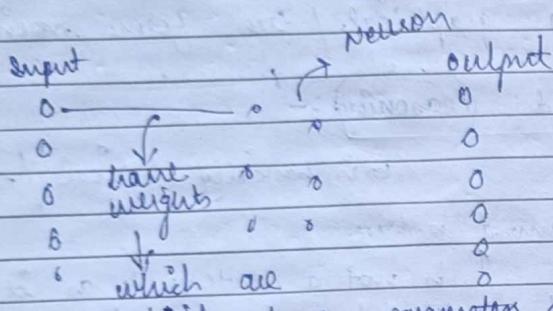
→ certain ho jaati hain machines. apple / orange → identified orange on basis of features / properties which are different for apple & orange.

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→ features are identified and parameters are tuned / changed by neuro learning. (neurons).



modified → hence parameters are tuned!

Did chatgpt passes Turing Test?

Total Turing Test:-

But how?

speech se toh bola skta hai machine hai & use pehle jab radio share hogi tabhi pta chl payega ki yeh machine hai!!

Captcha ?? complete automatic public turing test to tell computers and humans apart.

Reverse Turing Test where machine decide kegi, interacting wala human ya machine hai!!

⑥ AI → not just to copy humans

↳ want work done, from machines like humans w/o copying humans.

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* Acting Humanly
* Thinking Humanly

↳ self introspection (ask ques to ourselves)
↳ psychological querying
↳ brain mapping

→ only thinking?
→ Are we thinking
in real time?

psychological test idea hai
with some set of questions and observe
will focus on how you answer!!

↳ based on that thinking process
brain mapping is observed!

→ device idea hai to capture real-time thinking.

* Cognition

↳ how we recognise or perceive something.

* Thinking Rationally

↳ is based on binary / boolean logic

* Acting Rationally

↳ is implemented with help of
"intelligent agents".

↳ hypothesis

↳ works rationally
↳ nothing but a software / machine
anything that can perceive from its environment

↳ may be machine / hardware / software /
perceive from its environment

code ↳ provided it can perceive from its environment
(observe)
(and thus learn)
is a domain
surrounding of agent

If agent is 'Software'

↳ need to define its environment.

* b, environment bhi phle define kina hoga,
need to define boundaries of surrounding as well.

→ If observe kiya environment too, then learn!
But how agent will learn?
Firstly needs computer vision (\rightarrow it's optional, not necessary)

→ agents has:-

(1) Sensors \rightarrow detect, sense ke liye.

(2) Actuators \rightarrow e.g. rollers, legs (simulated),

↳ used for actions, tyres like our hands / legs etc.

If agent is software \rightarrow wo khudh nahi krega \rightarrow ,
u have to define actions.

e.g. chatbot does not have actuators.

→ e.g. (1) Vision Sensors

(2) Hearing Sensors

e.g. phone does not have actuators but has sensors!!

Environment \rightarrow surrounding which is context dependent.

agent \rightarrow hardware / software / combination of both.

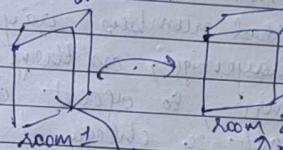
\rightarrow If command not given, actuators will work to learn from the environment.
 \rightarrow How?

\rightarrow jo bhi yeh observe krega,

It will record that?

Now say environment change kiya !!

↳ may be agent wham property kaam na ke! \rightarrow as observation changes behaviour of agent will be different.



\rightarrow yahan se learn kare apply krega

\rightarrow Agent will perceive from 1st environment & will apply on other environments.

\rightarrow done through mapping & modelling.

\rightarrow Agar agent ko room dimension nahi pta, he will roll & will record dimensions.

\rightarrow yeh obstacles augegi bhi map keta hai!!

\rightarrow agar obstacle aya \rightarrow agent acts rationally

\rightarrow initially, agents stop

\rightarrow then factors jaake \rightarrow dura path lega

(one step)

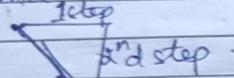
\rightarrow will turn left / right.
 \rightarrow jo defined hai!!

\rightarrow why usually agent diagonally nahi jaata ??

* city block distance
* chess board, distance

shortest distance \rightarrow Euclidean Distance.

- one step is already defined and points are also already marked
- and diagonal distance is more than one step or less than 2 steps and it is real no. in general and not a discrete no., thus calculation mein real numbers aayenge, so diagonally nahi aayenge, as then complex calculations aayengi, so agent "city block distance" ke hisaab se chlega.



- and obstacles bhi hain esse rakhenge jo bits ko follow karen, randomly nahi rakhenge!

- image size \uparrow , resolution \uparrow , space $\uparrow \Rightarrow$ quality \uparrow
agar pixel size \downarrow ikhaange!

* Record the moves

get percept sequence. or actions

- ↳ set of moves \uparrow made by agent, in order to learn environment.
- ↳ in a sequence

- ① Percept sequence, for agent A, which moves down \downarrow and initial pt is given and reaches some position at

These steps will be written in form of sequence,
called percept sequence.

- and that learning will be recorded in form of percept sequence
- ↳ knowledge
- more kya and obstacle mila, it will record that and then will remember that.
- percept sequence as future mein use hogा, so agent must remember it; but as can't remember, so we store it.

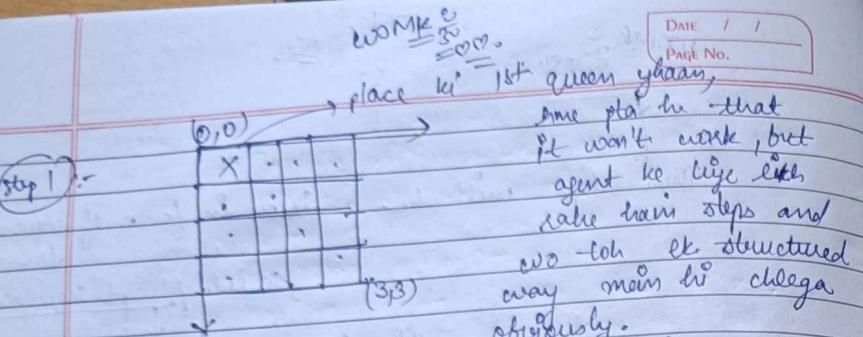
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[lec-3] :- WOMK
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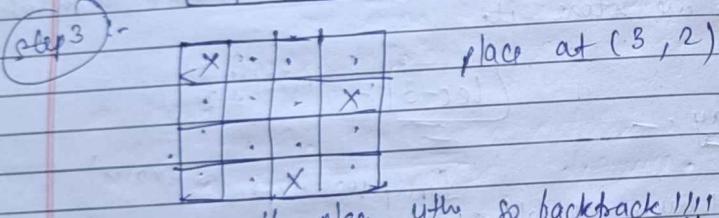
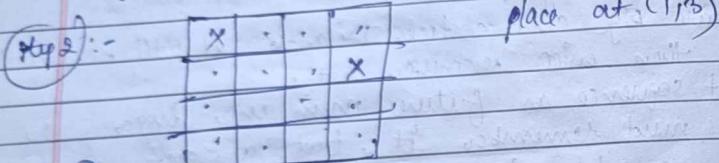
(lec-3) :- (perception steps in exam)

- ① 4 Queens problem
 - ② Water Jug problem $3\text{L}, 5\text{L} \rightarrow 4\text{L}$
- We'll try to solve these problems using some agents.

- ① 4 Queens problem :- 4x4 chess board place 4 Queens on non-attacking places.
- what will be the 1st step to solve this problem??



→ abhi dotted jaah nahi ja aata hai,
yah bhi program mein likha hogा;



can't place 4th, so backback!!!

Now no more positions available!

Naturally you will roll back!!

→ see combination starting from (0,0), yeh dikkat
kega!.. finally you will roll back to
initial position.

① Start from (0,1).

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then place at (1,3)

we'll get answer now!!!. no need to
roll back.

and all solutions will be mirror image of
this solution. isko flip kar ke mil jayenge
same solution. so solution is not unique.

② Different types of agents :-

- 1) Simple reflex Agent → agents which act instantly
- 2) Model based reflex agent
- 3) Goal based reflex agent.
- 4) Utility based reflex agent.

③ reflex → instant behaviour / rxn to a situation.

→ used where needed instant actions.
e.g. human reflex and automatic car,
break maara toh tabhi break lg jaana
chahiye.

④ model based reflex agent:- if env. known agent
will act accordingly, and if something of
environment are not known, agent will
assume some parameters are affecting env.

→ applying model.

⑤ robot will work on basis of some model!
generate model, if agent does not know its
complete environment, then and for some parameters
that are affecting that env.

① goal based:

↳ agent will solve some objective, fixed goal hai!

e.g.: 4 queen prob:-

goal:- get 4 places for queens.

→ boi prob hai, getting its solution is goal.

for eg: reaching to destination (in driving) is a goal. (may be min distance/min time mein jaana hog)

↳ that does not matter to us.

② utility based:

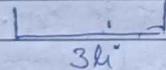
↳ expansion of goal based.

↳ will achieve goal along with some utilities

e.g.: goal: reach destination

utility: shortest distance.

Water Jug Problem:- Jugs are not symmetric

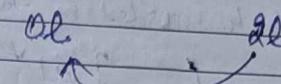


(Step 1):- fill it completely

(Step 2):- pour this into 3L

3L 2L

(Step 3):- pour 3L wala :-



(Step 4):- pour 2L into this 2L 2L

(Step 5):- 5L wala third free.

2L 5L

1L 2L wala mein daalna.

3L 4L

Write code for this 😊

goal:- find steps to solve this problem.

(Step 1):- can fill 3L also.

- 3L 0L
- 0L 3L
- 3L 3L
- 1L 5L
- 1L 0L
- 0L 1L
- 3L 1L
- 0L 4L

↳ sequences/steps for perception.

③ percept sequence of a agent :-

as agents moves on, it records sequences/steps.

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Steps will be recorded in table / any data structure.

[] → 1st step

[] → 2nd step

Q → agent → to switch on/off the lights.

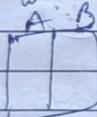
Environment :- 2 rooms. (A, B)

→ agent can move left / right.

→ as it goes from one room to another,
it will on/off.

(cond):-

if light is 'off' → then agent will on it.



VICE VERSA
cond in nth
cell !!

→ write percept sequence for this.

A:

[A, ON] (room A, power to on)

[A, OFF] (room A, power to off)

[B, ON]

[B, OFF]

Now corresponding to each percept, we can have actions.

[A, ON]

actions
do nothing / Move Right

[A, OFF]

switch on

[B, ON]

Move Left

[B, OFF]

switch ON

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No needs to know right likha!

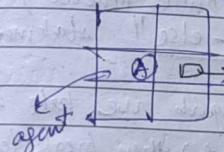
as then [A, ON] → to
jaiyeega & will move right
so on!

one of situation possible:-

[A, ON] [B, OFF] [B, ON] [A, ON] [B, ON]

Q cond: → if light is 'on', then if off it & move ahead,
if light is 'off', on it & move ← ahead.

exp.



→ In every cell there is something (obstacle) to pick, if it's obstacle, then agent will move back.

agent can move up, down, left, right !!

Agent = architecture + program.

Q we learn in a sequence / sareek ek vase mein learn nahe ke skte !!!

Many agents learn in a sequence or is recorded in the table known as "table filling program" (?)

① Form → Table-driven Ag Cp

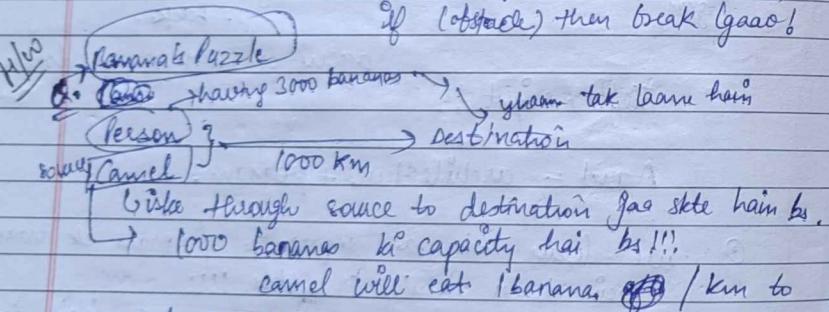
fun TableOfActions (percept). returns action -
 persistent : percept - a seq of percepts,
 initially empty.
 table - a table of actions, indexed
 by percept sequence
 - append percept to the end of percept.
 action \leftarrow look up (percept, table)
 return action

End

(means agar kuch new dekha toh wo end pe
 daal denge table ke).

- for conditions given in environment, we can use "if - then - else" statements.

reflex agents use. teste hain,
 if (obstacle) then break (gao!)



\rightarrow How many ~~bananas~~ bananas at most can reach from source to destination.

there are already known to agent

func SimpleRefAg (percept)
 persistent: rules - a set of if - then state rule
 state \leftarrow Interpret Input (percept)
 rule \leftarrow Rule Match (state rules)
 action \leftarrow Rule Action (find action corresponding to rule),
 return action

End

- Agents learn through certain method :-
- 1) supervised learning (no one will guide, learn itself by data)
 - 2) unsupervised learning
 - 3) reinforcement learning (rewards and punishments are associated here.)

someone guides you & learn.

→ combines both, force kya jaata hai
 learn kene ke liye.
 → agar reward mila, age bollo.
 → punishment, something will loss, and u will record ki age se yeh nahi kina hai!

- 4) semi-supervised learning. more towards combo of ① & ②, but ~~than~~ ②.

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① Problem Solving Techniques:-

- 1) state space search

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we can not solve all problems with same level of thinking.

solving problem requires high level of thinking.

we've different type of agents.

→ Here we'll talk of goal-based agent.

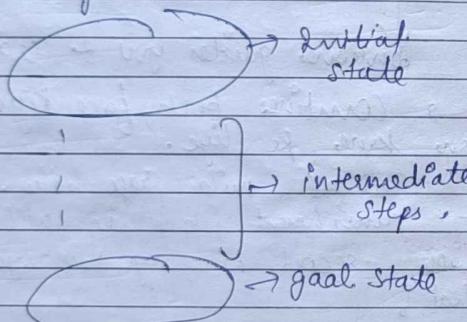
we'll have problem and a goal state.

Our objective is to find goal.

To find path is also important to find goal.

→ For a same problem can have different - 2 solutions.

Eg: Water Jug Problem



→ want goal state and also path.

set of actions to perform (steps applied).

Basically we are interested in solution.

→ we'll create tree → called 'state space tree'
and we'll search 'goal state' in that tree.

→ This is known as "Uniformed Search".

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→ uses :- BFS
DFS

depth limited search

DLS

DBS → depth bounded search.

① Problem solving will be having 4 things :-

- 1) Define the problem
- 2) Analyze problem
- 3) Isolate and represent the knowledge.
- 4) choose the best technology. technique.

② Water Jug problem

① Define problem :- (Usually define input)

② Analyze → get soln, how to solve it

③ which methods to apply

④ apply best method.

⑤ 5 components (of state space search) to define problem properly:

→ initial state

→ description of all possible actions

→ transition model ($f()$)

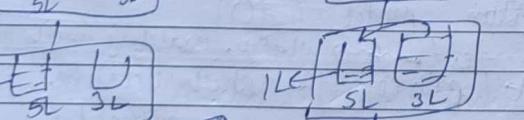
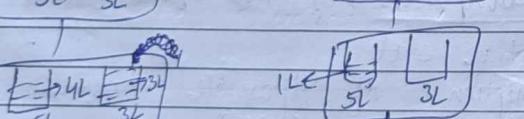
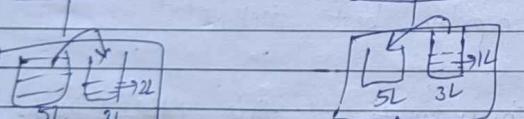
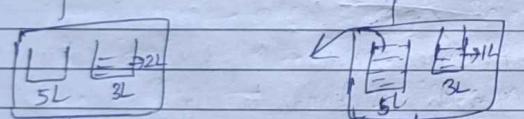
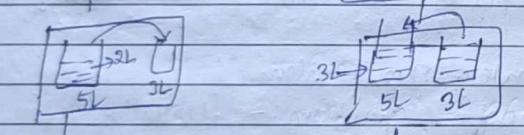
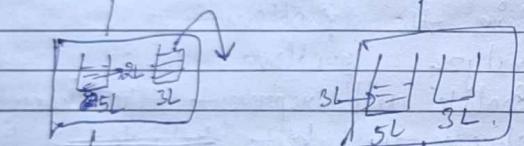
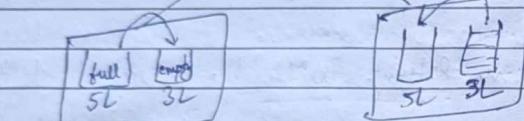
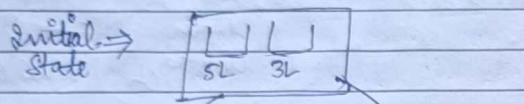
→ goal test (whether matching with goal or not, if yes break)

→ cost / path cost fn which will be evaluated / estimated.

path cost estimation

① Water Jug Problem:-

We'll try to generate tree now:-



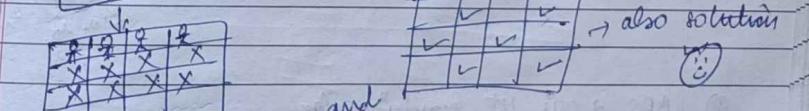
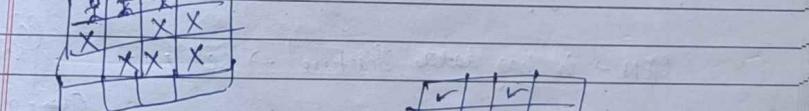
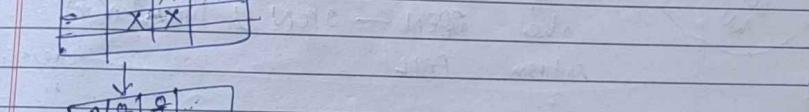
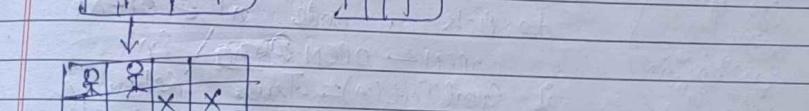
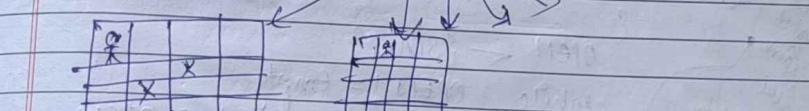
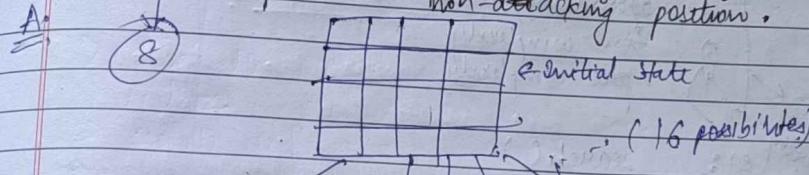
8 steps \Rightarrow goal \Rightarrow stop

Both will give answer,

which is wasting more efficient water??
right one \Rightarrow 5L wastage.
In left one is efficient??

Q: max no. of knights in 4x4 chess board, which can be placed at non-attacking position.

A:



also solution
and
all other solutions will be mirror images of this.

WDMK
= 25%
= 50%A/B \Rightarrow A + BDATE / /
Page No.

Q. Camel Banana Puzzle:-

A: ?

BFS will follow this model.

★ Formulate Search Execute Model :-

- ① 4 points to test performance of algo :-

- 1) completeness \rightarrow given soln or not & perfom.
- 2) optimality \rightarrow soln is optimal or not.
- 3) time complexity
- 4) space complexity

Tree
will
get
rooted
from
left
also
given
bits
kon-kona
left

eg: search()

```

OPEN  $\leftarrow \{\text{START}\}$ 
while OPEN != Empty
    do pick a node 'n'  $\in$  OPEN
        OPEN  $\leftarrow \text{OPEN} \setminus \{n\}$ 
        if GoalTest(n) = True. Return n
        else OPEN  $\leftarrow \text{OPEN} \cup \text{MoreGen}(n)$ 
    return FAIL
}

```

↑ (generally)

OPEN \rightarrow is 'bag data structure' \rightarrow 'set',


Bag generates
Big, if not
goal state,

- ② BFS \rightarrow our 1st searching algo,

↳ it is complete ✓, optimal ✓,
 $TC = O(V+E)$

WDMK
= 50%
= 50%DATE / /
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why we use 'V' and 'E' in TC?

(representing
no. of nodes)(representing no. of
edges)

why '+'? what's role of it!, '+' to
use in $E = \frac{n(n+1)}{2}$ eliminate ho jata hai!!
 $e.g., O(n + log n) = O(n)$

here we're only if both,
then so can compare.

if graph is complete & simple \Rightarrow

$$E = \frac{n(n+1)}{2}$$

if graph is not simple \rightarrow can have parallel edges/
self loops.

as graph may
not be simple

so in general E can be anything
whichever dominates we
 $\Rightarrow TC = O(V+E)$ aa jaayega!

- ③ Branching factor \rightarrow 'b'

depth factor \rightarrow 'd'

TC (to traverse tree
with 'b' branches
(d) depth) $= O(b^d)$

BFS is complete \rightarrow as it will give goal state if it exists.

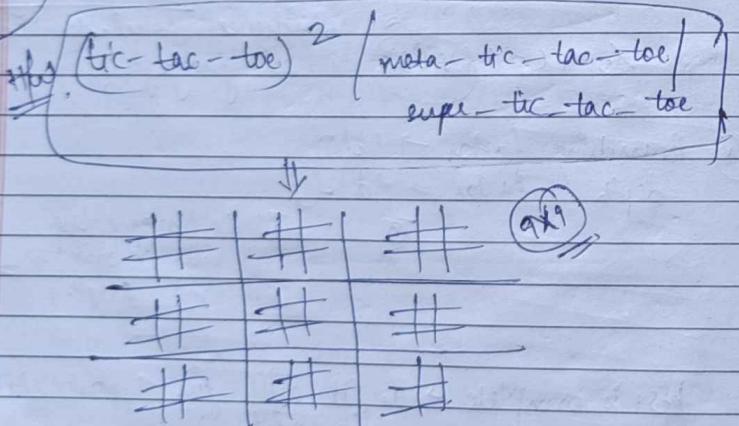
bfs will never skip 'goal node' \rightarrow to complete.
 ↳ check till the depth present to!

If 16' all(d) are 'oo', then can't store/make tree !!
 ↳ how to handle such edge/test cases??
 ↳ it won't store complete tree!

(Use) :- Generate and Test:-

at level generate kro (test lcr), pop
kro, new generate kro ... soon!

if goal
stop
else
generate
more
kro
but code mem from previous tree make hair and then
we search



What are rules?

11/10. done 'X' with value hair !

11/10. reverse tic-tac-toe if you follow it
again 3 times rule ('X' or 'O'), then
you will lose.

① knight's move (version-1) \rightarrow move knight
 ↳ solve for $N \times N$,
 ↳ can't solve for 1×1 , 2×2 .
 ↳ can solve for 3×3 ?
 ↳ we don't know what is sol? ↳

② knight's move (version-2)
 ↳ cover cells \rightarrow non-overlapping lines
 ↳ are to be considered.

Q# Uninformed (Blind) search

↳ no additional info available.

↳ only input & goal statement is available

→ Uninformed cost search

→ Depth first search

→ Depth bounded / Limited search

→ Best fit search

→ find soln till
depth = 5 (eg.)

③ Problem :- Play chess

↳ Not solved till now!

search
TC, SC,
which one is
complete, optimal??

↳ we'll limit our depth

(Loc 5)

2022

→ Informed search, (Heuristic based search):-

① Uniform Cost Search:-

State space search:-

$$BFS \rightarrow TC = O(b^d)$$

↓
not to be considered,

② Similar to Dijkstra:-

- ↳ start from 1st node
- ↳ explore all
- ↓
- take least cost path
- for upto expand two,
- so on!

$$TC = O(b^{(1 + \lceil \log_b c \rceil)})$$

specific case:- ek node ko expand kiya → all are having same cost

koi bhi li se then

Usually we go left to right →
tab left wall li

↳ expand kiya

↳ same cost

↳ left wall li.

→ so if for each part, cost is same → then BFS

↓
then $TC = O(b^{(d+1)})$

③ Goal Test

$$\hookrightarrow O(b^m)$$

max depth

④ Problem :- Infinite loop (in BFS)

↳ e.g.

you are in trap now.

↳ no way to go out of this.

→ If we apply cost theorem:-

If 'b' se min cost 'c' tak jaaye,
& 'c' se min cost 'b' tak
na jaaye → then u r out of loop,
o/w not.

⑤ again goal right pe, then u will visit all
nodes from left to right, ~~tab~~ tab
sake goal milga

↳ Thus similar to BFS.

→ Informed search helps to find goal in min no.
of search.

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(*) Depth Limited search/ Depth Bounded search:-

$$TC = O(b^d)$$

$$SC = O(b \cdot d)$$

b → branching factor

d → restricted depth

↳ say till l^d only.

→ search space is limited

↳ intention is: agar goal within
this space huye, we'll find it easily.
O/w limited depth search will fail.

If $l = \infty$, then it is DFS only.

↳ as depth not
known.

$$\text{DFS} \Rightarrow TC = O(b^m)$$

$$SC = O(b \cdot m)$$

Iterative Deepening :-

↳ Based on DFS / depth limited search.

Initially, $d=0$, search node at level $\rightarrow 0$ (root), if hoi,
then $d=1$,

if hoi, stop,
O/w move
ahead

so on!

↳ Similar to BFS, but not same as BFS mein
and take jaate hain, zubde nahi din, but
here restriction hai, jaam nilar, nuk Jaago!

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worst case, when $d = m \rightarrow$ then (DFS).

max depth

(*) Bidirectional Search:-

↳ will search in both directions

↳ root se leaf node tak jaayi

↳ leaf node se root node tak jaayi

and find

mid pt

where both
meet.

This not for goal test.

which is not exact middle pt., somewhere
b/w root and node, but not root
as well as node.

→ TC will be reduced by half.

① ② if ①, ② done pe DFS

lgaaye,

$$TC = O(b^{d/2}) + O(b^{d/2})$$

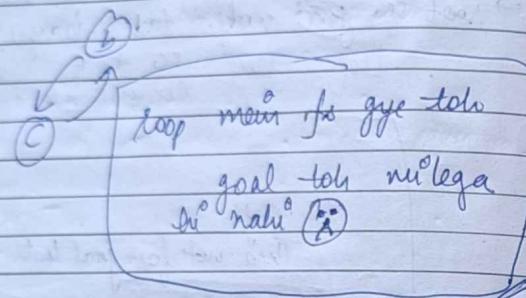
$$= O(b^{d/2})$$

↳ if btm!, → upper kaik jaagein tree
k??

goal

- ① PFS → is not complete
↳ not optimal.

- ② ↳ bcoz of infinite loop



→ Iterative deepening and bidirectional.

↳ complete ✓
optimal ✓

PFS
↳ complete ✓, optimal ✓

- ① Can solution steps be undone?

3 possibilities:

- ① Ignorable
② Recoverable
③ Unrecoverable

e.g. chess

↳undo op'n (ga skte hain, kya?
Met certain times)
↳ not always.

↳ ignore, if sol'n step set not working, do with another.

→ Ignorable:— Theorem proving main idea.

→ Recoverable:— When we have to apply backtracking
↳ if true, affli. take algo ~~other~~ path → all are recoverable.
↳ e.g. — sudoku

→ Unrecoverable:— games played on computer,
as ek maa che gye, wapsi aana not allowed.

- ① Problems related to:-

① Toy world
② Real world.

↳ movement of robot
↳ Travelling salesman problem

like obstacle
wegera aagya
toh kya hoga?

- e.g. where solution steps can be undone!!

- ① sudoku grid:-



→ 9x9

imp

cl

path

select

Adithi

Crypta

$$\begin{array}{|c|c|c|} \hline 1 & 2 & 3 \\ \hline 4 & 5 & 6 \\ \hline 7 & 8 & 9 \\ \hline \end{array} \rightarrow \begin{array}{|c|c|c|} \hline 4 & 5 & 6 \\ \hline 1 & 2 & 2 \\ \hline 7 & 8 & 9 \\ \hline \end{array}$$

↳ same combo can't be used in 2nd cell

$$\begin{array}{|c|c|c|} \hline 4 & 5 & 6 \\ \hline 1 & 2 & 2 \\ \hline 7 & 8 & 9 \\ \hline \end{array}$$

WEEK 3
COM

Combinatorial Expression

Then

3rd cell \rightarrow

7	8	9
1	2	3
4	5	6

so on! \rightarrow logika manki.

then Heuristic approach \rightarrow as

by experience kya.

so beginner nahi ke paayega,

Magic Square :-

8	3	4
1	5	9
6	7	2

→ need to solve problem of tie-tac-toe, and many other problems (By transformation etc.)

Informed Search Algo

↳ some info we'll have.

↳ not a blind search

→ will solve problem additional info & goal.

→ there will be some fn. called Heuristic functions.

↳ kind of guess / help given to us.

Tie-Tac-Toe won't generate tree from scratch \rightarrow of course combinatorial explosion logic!

WEEK 3
COM

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1	2	3
4	5	6
7	8	9

\rightarrow

00	01	02
00	11	12
20	21	22

\rightarrow any combination which is winning position will give sum = 15,

$\Rightarrow a, b \rightarrow$ represents 2 moves,

(Obviously 1st move will never be winning move).

X	0	
		1 move ↳ no winning move

X		
X	0	2nd move is winning decision start kya!!

↓

X	X	
X	0	0

\rightarrow a and b are placed anywhere on magic square grid to find $a+b=?$

↳ 2 moves are played

next move

s.t.
sum = 15.

(WORK C)
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$$15 - (a+b) \leq 0$$

$$15 - (a+b) > 0$$

then a, b are not in straight line.

Thus not a winning position.

$\Rightarrow a, b$ is not in winning position.

dhon doon khe main, and tees ra phin
bech mein hoga yaa

side main.

9, 8	8, 9	1, 2	2, 1
9, 7	7, 9	1, 3	3, 1
9, 6	6, 9	1, 4	4, 1
8, 7	7, 8	2, 3	2, 3

$$15 - (a+b) \leq 0$$

so not
in straight line

e.g.: 9, 8

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

cast wins

$\begin{array}{|c|c|} \hline 0 & 1 \\ \hline 0 & X \\ \hline 0 & \\ \hline \end{array}$ \rightarrow at '0' ~~wal~~ ^{ko} 'ew' chahiye,
leh 'X' isko Rock kega,
agre both are using
same method to play.

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if khud jetha nahi hai,
dene ko bhi ~~denha~~ jisne
dene \rightarrow possible. If both
follow same algo

0	X	0	X
0	X	0	X
0	0	0	0

\rightarrow so this method is having additional info.

5 Sep 2024

Thursday

Lec-6 :-

\rightarrow Informed search Algorithms

\hookrightarrow if some additional info also available along with initial state and goal state

\rightarrow Heuristic ~~fn~~ will (must) be available to us.

\rightarrow Uninformed main self 'initial and goal' state pta hoti thi.

① Best first search \rightarrow find next node based on cost

A*

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

cost $f(n)$ node heuristic $f(n)$.

evaluation fn.

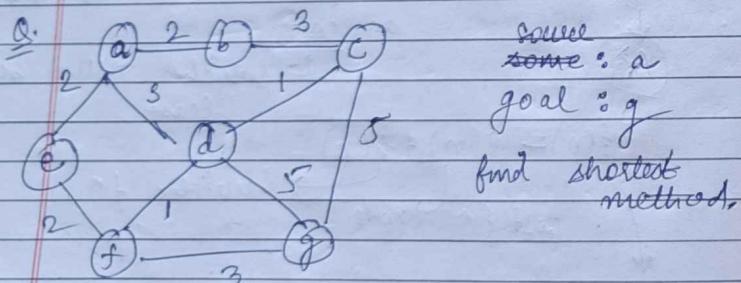
notes

- estimate the distance of goal.
- ↳ want nearest distance
 ↳ can be
 in terms of no. of
 edges/traversed.

* greedy approach to find shortest distance
 (btw 2 nodes are directionless, they
 don't tell direction.
 works in chunks based on distance.)

→ additional info available in informed
 search algo is h' fn (heuristic fn).
 ↳ (direction
 information).

→ these won't search through whole
 state space, it will get reduced,
 will get optimized.



(M1) brute force :-

consider all paths from a to g
and take min cost value path.

$$a \rightarrow b \rightarrow c \rightarrow g = 10$$

$$a \rightarrow b \rightarrow g = 8$$

$$a \rightarrow e \rightarrow f \rightarrow g = 7 \checkmark$$

$$a \rightarrow b \rightarrow c \rightarrow d \rightarrow g = 11$$

$$a \rightarrow b \rightarrow c \rightarrow d \rightarrow f \rightarrow g = 10$$

$$a \rightarrow e \rightarrow f \rightarrow d \rightarrow g = 8$$

$$a \rightarrow d \rightarrow f \rightarrow g = 7 \checkmark$$

⇒ Ab dijkstra konsa lega dono mein se and
kyu 10 ek hi liya ???

↳ Dijkstra will give only one
 answ., others will be ignored and
 overlapped.

(M2) Dijkstra

(M3) All-pair shortest path

↳ will also give only one path ??
 chake multiple path hogi
This soln also will never say " ", hai ??

WOMEN
SCM.

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here $g(n)$ gives cost fn.

$$\begin{aligned} g(d) &= 3 \\ g(b) &= 2 \quad \text{?} \\ g(a) &= 0 \rightarrow \text{obviously} \\ g(c) &= 2 \end{aligned}$$

$h(n) \rightarrow$ not given here !!

(bottom) se mali extract hoga $h(n)$, extra info se hoga and wo given honi chahao.

e.g:- estimated distance of goal!

$$a \rightarrow 7$$

$$b \rightarrow 5$$

$$c \rightarrow 4$$

$$d \rightarrow 4$$

$$e \rightarrow 6$$

$$f \rightarrow 3$$

$$g \rightarrow 0$$

$$\text{obviously}$$

pham & kya estimation?
how?

available with
some kind of hidden
mapping, with help of
directions.

\rightarrow If $h(n)$ is exact, then no guess req.
sddha ans. hoi !!

\rightarrow but $h(n)$ is game of experience.

\rightarrow How to use it here ??

WOMEN
SCM.

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for each node n , $h(n)$ is given.

$$a \rightarrow 7$$

\rightarrow like, a se g agar direct path
hota, toh 7 units ka hota.

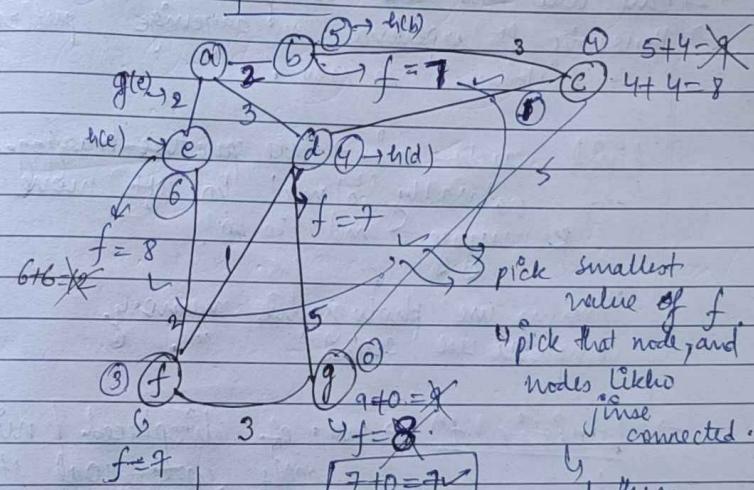
$$b \rightarrow 5$$

\rightarrow b se g, 5 units ka hota.

Now, calculate values of f of each node.

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

\rightarrow start from a \rightarrow nodes likho jisse connected.



pick smallest value of f .
pick that node, and
nodes likho jisse
connected.

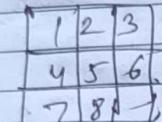
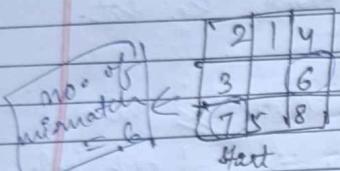
and then

sat leaf nodes jo
is graph mein
hain as kisi

to discarded mali ka hake unmein se min
se hakt ho.

* mini-max Algorithm

* Heuristics for 8-puzzle problem:-



- can move only up, down, left and right.
- can we solve this using heuristic f^n .
- Heuristic f^n experience & arranging, problem statement & natn.

blind search → main → state space tree branching!
naturally (blank) to left moves
reversage and so on!

Humans use photographic memory.
Computer use serial

- heuristic f^n → no. of displaced / mismatched cells w.r.t goal state.
want to minimize this (optimal)
i.e. no. of mismatches.

- $g(n)$ → not given!!
↳ find ??

Bisection method??

Binary search to find sq. root

WJMKE

1041	2.00	00
24	100	
	96	
24	4.00	
	281	

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* How to estimate value of $\sqrt{2}$.

" " " " " cube root of a number,

→ calculator main job f'n how / what is theory behind them.

* How to get roots of quadratic eqn, cubic eqn.

$$\begin{array}{c} f \\ \curvearrowleft x_1 \quad x_2 \curvearrowright \\ \text{if } f(x_1) < 0 \text{ then idhar ans,} \\ \text{o/w dusri side.} \end{array}$$

$\epsilon = 0.000001$
if $|x_2 - x_1| < \epsilon \rightarrow$ stop
use precision ka kisi pta chlega!!!

① find x' s.t. $f(x') = 0$

↳ may be non-zero,

i.e. may find something which is not root.

→ blind search won't help

↳ need to optimize it.

Hill climbing Algo

To optimize $f(x)$, need to find (x)
where $f(x)$ is maximum.

→ climb through hill and find its peak
↳ hill climbing algo.

$$\text{Let } f(x) = x^2 - 2$$

$$f(0) = -2$$

$$f(1) = -1$$

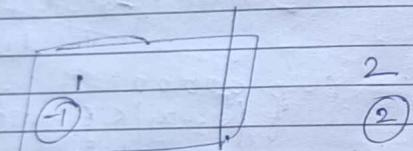
$$f(1.5) = \text{true}$$

$$f(2) = 2$$

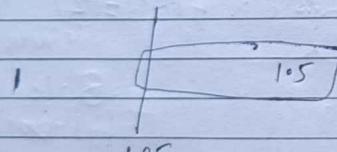
$$f(3) = 7$$

$$f(4) = 14$$

$$f(5) = 23$$



$$1.5 \\ \text{true.}$$



$$1.25$$

$$f(1.25) = \text{0.} - \text{ve.}$$

→ need 2 end points, ek -ve, ek +ve →
yeh dono thik ~~paros~~ train !!.

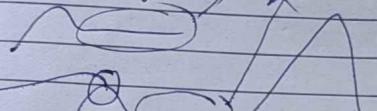
→ finding peak not easy if eqns
are complex.

local maximum problem

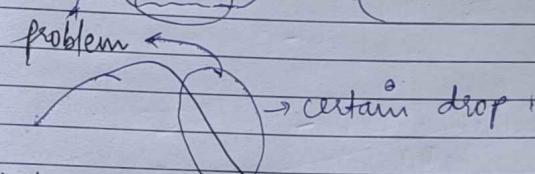
↳ local maximum hi kyi vaar hm
global " maan lenge (2)

* Plateau problem.

↳ same y for different x



* Bridge problem



→ certain drop !

→ what to do to solve these problems?

⇒ local max problem → solved agar
(goal) pta → global max bya
wo pta → agar koi btaade
lelo yeh answer hai yaa nahi'