

Syllabus of A.I.

- (1) ~~Approaches~~ ^{A* AO*} ^{first best} ^{constant saturation}, DFS, BFS, Hill climbing
Approaches of AI (Heuristic search, Game Playing)
- (2) ~~Approaches~~ ^{V, A, -} fuzzy set (crisp, fuzzy set, α -cut, operation)
- (3) ~~Approaches~~ Artificial Neural Networks and genetic Algo. (single, multilayer
Feed forward, Recurrent,
Machine learning)
(Supervised, Unsupervised)
- (4) ~~Approaches~~ Multiagent system (types, Properties)
- (5) ^{* Approaches} Knowledge Representation (Approaches, Predicate logic, Reasoning)
- (6) ~~Approaches~~ NLP (syntactic, semantic) Theoretical Path lena
- (7) ~~Approaches~~ Planning (overview, Hierarchical, goal stack) } Theory Path lena

Unit 1 (Artificial intelligence)

①

Definition → Artificial intelligence is the branch of C.S. that is used to study and creation of computer which are more intelligent than human.

- (1) A.I. gained interest during 1956 by Dartmouth Conference
- (2) The term A.I. was coined by John McCarthy in 1956
↓
artificial
or
sifted test

Applications of A.I.

- (1) Game Playing
- (2) Expert systems
- (3) Computer Vision
- (4) Problem solving
- (5) Understanding natural language

Branches of A.I.

- (1) Robotics
- (2) Vision system
- (3) Natural language processing
- (4) Learning system
- (5) Neural Networks
- (6) Expert system

Agents / intelligent agents

(2)

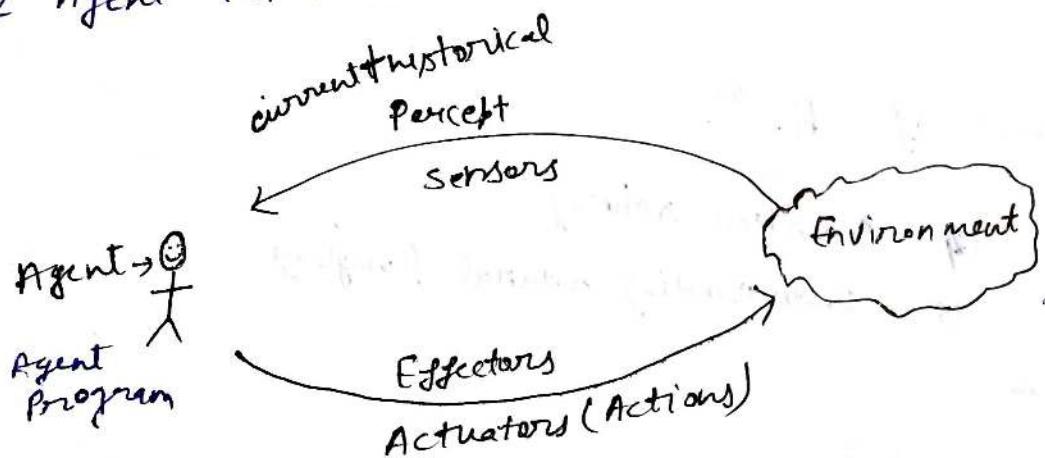
A.I. ka main aim hai how to build intelligent agent.

If we talk about Agent →

Agent is anything like human being, machine, roboats, or any program is called agents.

Agent kon kon se operation perform karta hai

Agent koi b ho skta jaise roboat, human, machine etc.



Agent operations perform

Agent → Percepts (sense) → Decision → Action

For e.g. → Let's say hum school / college jaae hai or hum environment sense karte hai ki monsoon barsa hai kahi barish to hi aagi then ydi hum igta hai ki barish aagi to hum decision lete hai or action perform karte yani umbrella lete hai.
 Aisa hi work hum roboat or machine se karane chahte hai.

Goals of Agents (mean agents k through hum kya hoga achieve karne chahte hai)

(1) High Performance

Mean hum jo agent banana chahte nai vo high performance
(Robot)

(2) Optimized Result

(mean jo Robot Decision le Raha hai uska result
optimized (Right) correct aana chahiye)

(3) Rational actions

(right)
Agent (Robot)
or machine
vo Action Right hona chahiye (correct hona chahiye)

Four important factors of Agents / Robot / machine
to bhi agent hum design karne chahte hai uske
peeche koi design to hogा nii

① P performance

② E Environment

③ A Actions

④ S Sensors

koi bhi agent hum banate hai use hum PEAS system
barks on hi design karne ki kashish karto hai.

Types of Agents

(5)

(1) Simple reflex agent →

meaning (immediately)
जैसे

* Act only on the basis of current perception.

(²) Act current situation पर कार्ते हैं. for e.g. → यदि एक वाहन की संहारणीयता की calculation थोड़ी कार्ते हैं ये तो immediately होता है।

* ignore the rest of percept history

(²) ignore कार्ते हैं past ki situation को, क्योंकि यदि ये past me same calculation करेगा to is time लगा नहीं ये immediately work करते हैं।

* Based on if-Then Rules.

(²) condition के अपर depend होते हैं. यदि ये हैं to ये नहीं तो ये हैं to नहीं।

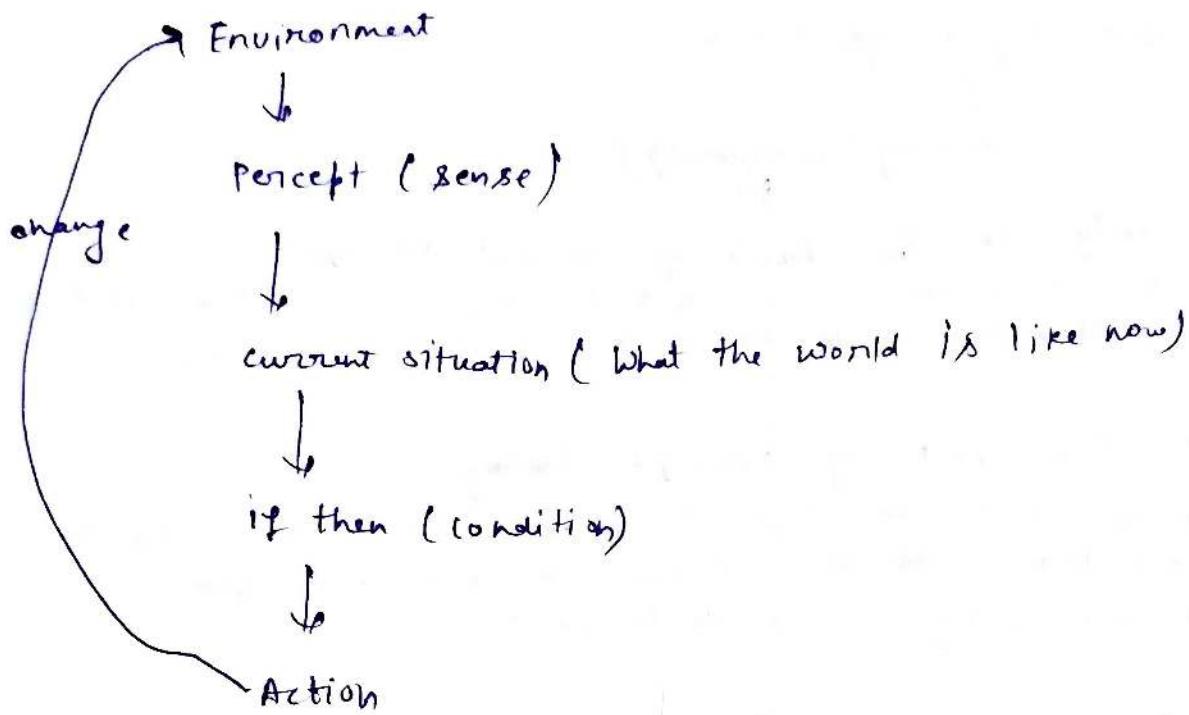
* environment should be fully observable.

(जैसे environment ki poori knowledge etc.)

like → यदि ~~an~~ automatic car ko road break वगे कि fully knowledge ni hoga to accident ho Jayega।

Diagram of simple reflex agent

(6)

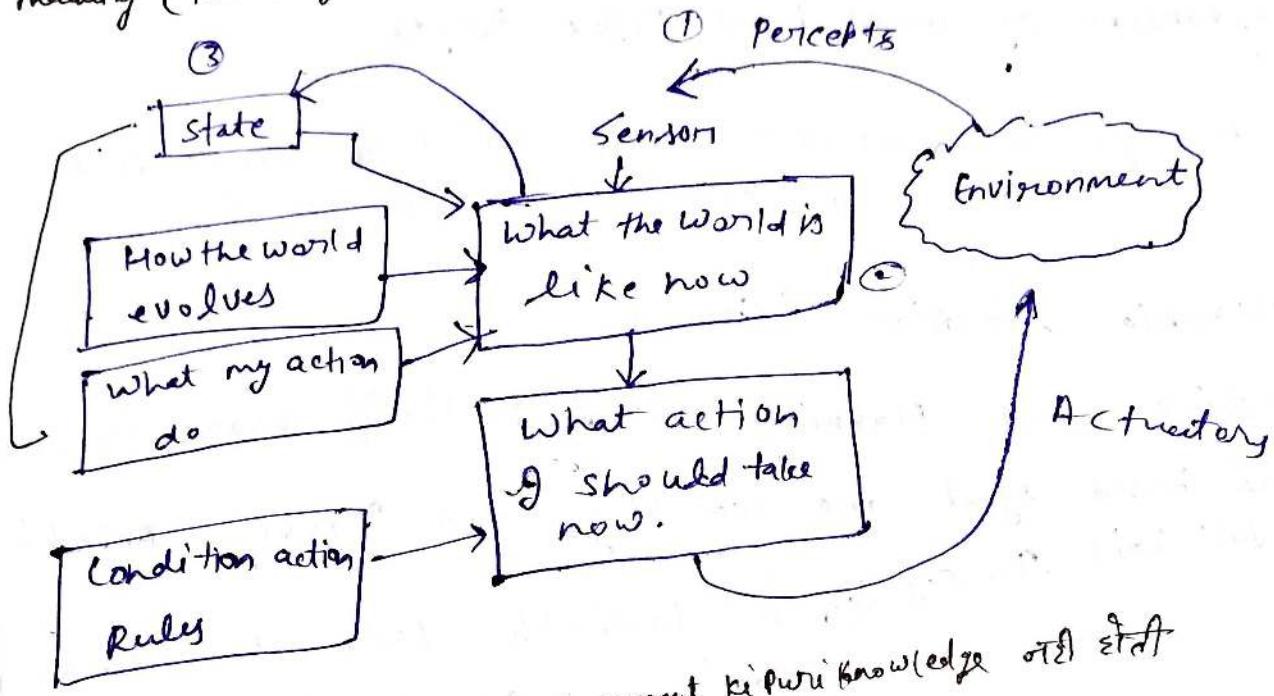


Some important Point about Simple reflex agent →

MEG knowledge ↴

- ① ~~Simple~~ simple reflex agent (if-then rule) ke upar work karta hai.
- ② ~~Simple~~ simple reflex agent (full observable) work karta hai.
- ③ Ques → kon na agent current ke upar kaun karta hai?
Ans → simple reflex agent
- ④ ~~Simple~~ simple reflex agent "percept history" ke work ki koi foreign human being me reflex agent kya ho skta hai
Jst hame kisi ne thappad mera to home gussa
agayga or hum tohaut ye manage bila
bat jana ki usne kya mera home hota
so ye simple reflex agent hata

(2) Model based Reflex agent meaning (knowledge based)



↗ environment ki puri knowledge or self

- * Partially observable environment
- * store percept history (Internal model)

Difference b/w simple Reflex agent and model based Ref. agent

Simple Reflex Agent

- ① Fully observable
- ② ignore percept history

model based R. a.

- ① partially observable
- ② store percept history

3) Goal based Agents

→ 1) Expansion of model based Reflex Agents

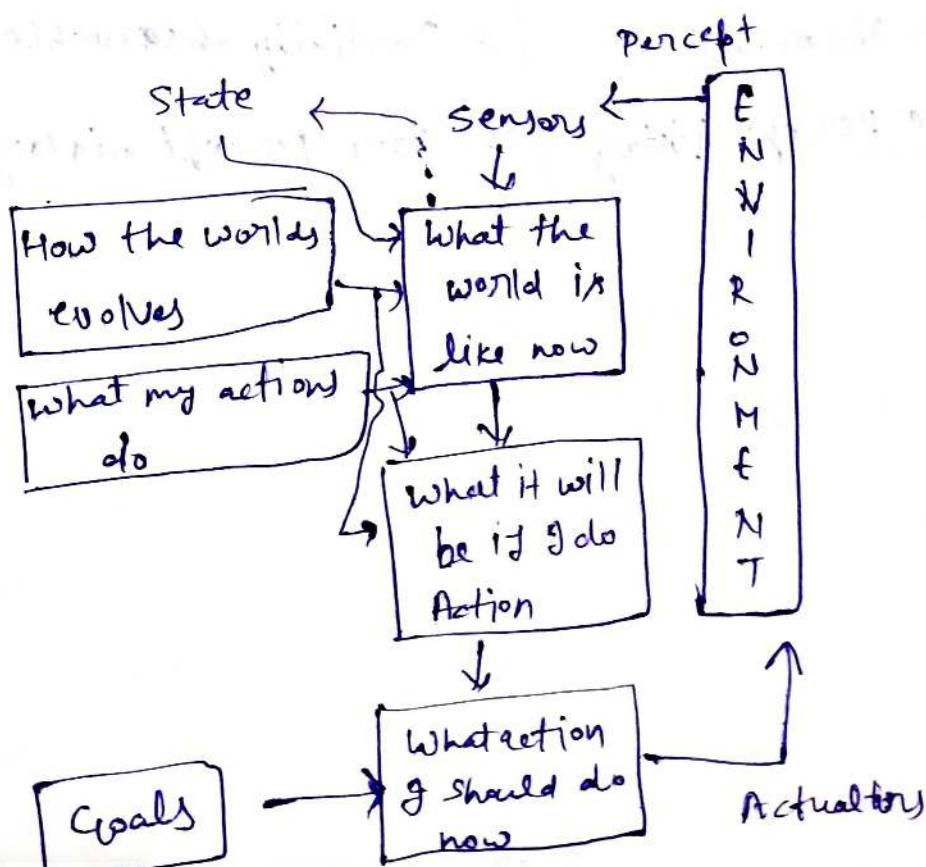
Meaning → If needed agent model based to work at first time
मैंने न किया कि extra charge क्या होता है

2) Desirable situation (Goal)

3) Searching and Planning (4) ~~if~~ Partially observable environment

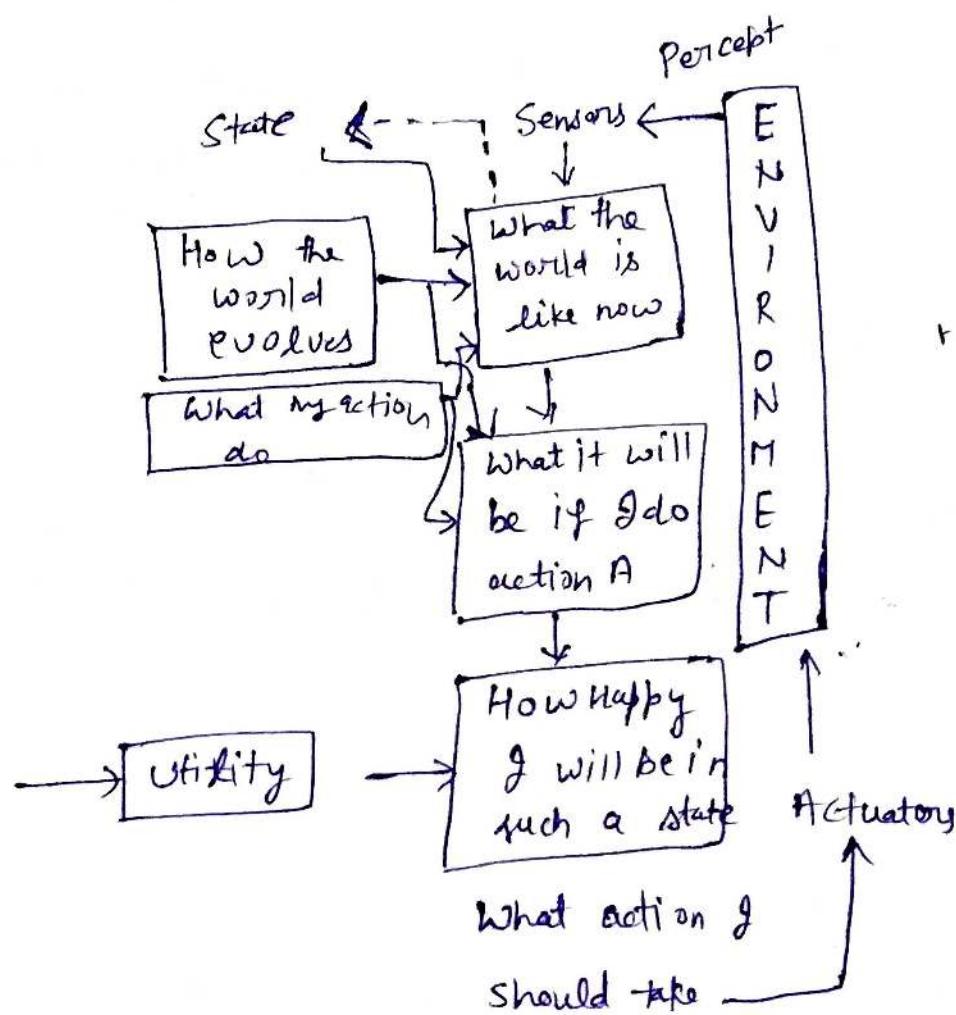
(Goal based agent me searching and planning phle hi
होता है) For e.g. ~~जैसे~~ Iadhakh Jana hai to hum
Phle से एवं search keege Path and
Planning करते हैं.

② China me Ali baba company hai to use
Robot banya hai Jo delivery me work
it is the best e.g. of Goal based agent.



(4) Utility based agents (utility means happy)
beneficial or useful

- focus on utility not goal
 - utility function (Utility function se measure karte hai happy or unhappy state)
 - Deals with happy and unhappy state.
 - Utility based agent work on partially observable environment.



⇒ Agent utility ke upar focus karta hai mean ye
goal tk ait यहाँ तक की है but happily Destination
(destination)

NLP (Natural language Processing)

(11)

- How human communicate with each other they use Natural language.
- Computer should replicate the same thing.

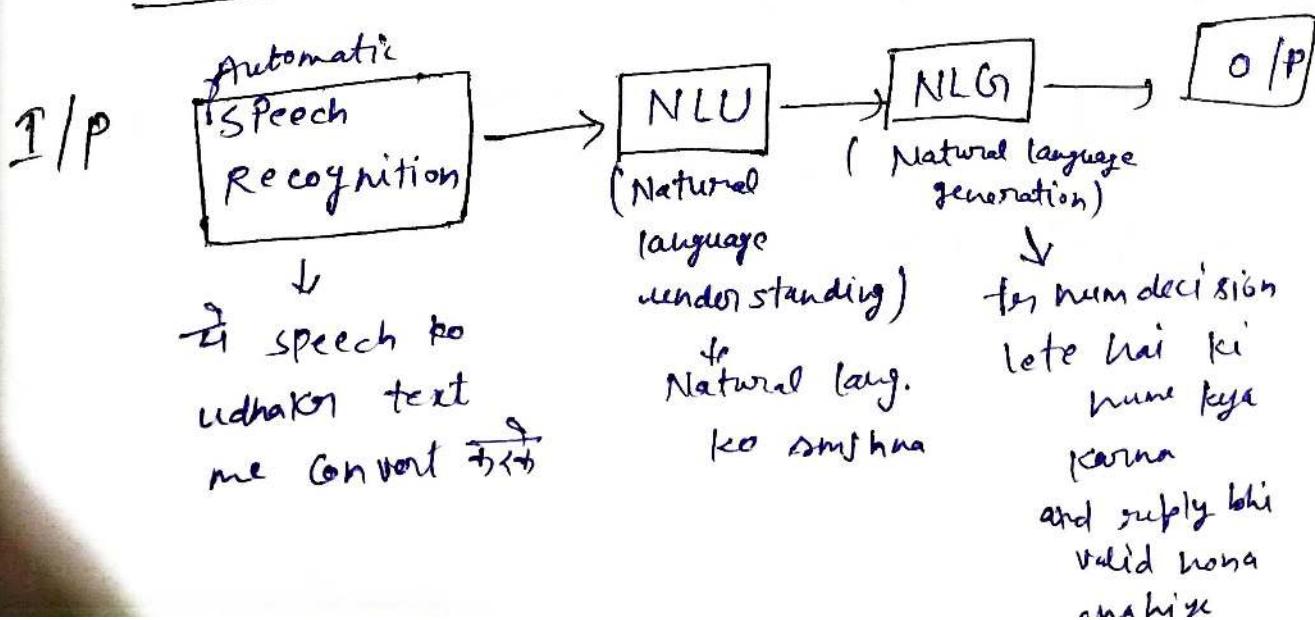
* It actual me human behaviour ko bhut hi intelligent batae hai ki hum kaise natural language ke through Communicate karate hai.

* Et hi chalte ki computer same thing ko replicate kar le.

Application of NLP

- * Speech recognition (e.g. Google Assistant, SIRI)
- * Sentimental Analysis
- * Machine translations (e.g. Google translator)
- * chatbots etc. (for e.g. spell checks)

Simple example for understanding, what is NLP



NLU → Natural language understanding

(12)

ee What do the users say? their intent?

challenges for NLU

① Lexical ambiguity

for e.g. The bank was full of water

② Syntactic Ambiguity (structure)

old men and women were taken to safe place. (Collision ki
only men hi)

③ Semantic Ambiguity (Meaning)

The car hit the pole while it was moving.

④ Pragmatic Ambiguity

The police are coming.

Next Phase

NLG (Natural language generation)

What should we say to user?

→ It should be intelligent and conversation

→ deal with structure data

→ Text of sentence planning.

ee NLG meaning ki ydi hum Google se kuch Puchte
hai to vo answer bilkul shi hona chahiye.
mtlb intelligent hona chahiye.

State Space Search

(13)

~~AA~~ In Problem solving area, state space searching is very important.

Meaning of state space "number of states in which the problem can go".

for e.g. → Jaise hum research start karite hai kisi bhi topic ke upar to obviously aisa nhi hai ki hum ek bar me hi seri jagah par phuch jayge hume kisi na kisi state se to start karne hi hogा.
Humara pass 2 states hai start and goal states and start and goal states tk phuchne ke liye ho skta hai there are many intermediate states matlab hum level by level par karte hue goal state tk jayge.

~~AA~~ Ydi hum problem ko sare set of states me represent karne chahte hai to then we use the state space search. ~~AA~~

Tuple use in State Space Search

$S : \{ S, A, \text{Action}(S), \text{Result}(S,a), \text{cost}(S,a) \}$

\downarrow Total no. of states
 \downarrow (start, intermediate, goal)
 Set of actions
 all possible actions

Benefits of state space search

(14)

- ① Firstly to hum Precisely define kai main hum
 - ② Jo agent vproperly analyse kai skte ki kaise kai,
hum move kai sake nai

~~AS~~ Searching hum Karte Mai two types se

- (a) Uninformed
(b) Informed

Difference b/w informed and Informed Searching

Uninformed Searching

Search without information

(2) No knowledge

(3) Time consuming

(4) More complexity (Time, Space)

(s) DFS, BFS

Q8 Uniformed searching, we generally called Breadth first search method or Blind search.

- searching
uninformed search me hone domain or problem ki mtno koi knowledge hi hji bp hme ya hla hai ye start state ha or ye goal state.
NO guidance in uninformed

* informed searching

(1) Search with information

(2) Use knowledge to find steps to solve

(3) Quick Solution

(4) Less complexity (Time, Space)

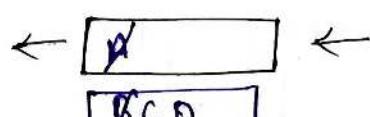
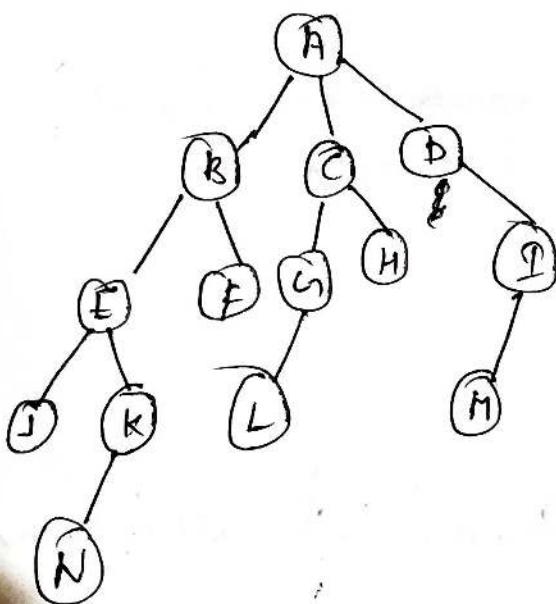
(S) A*, Heuristic DFS, BFS

~~But~~ But ϵ -informed searching
uses ϵ -informed heuristics

BFS (Breadth first Search) / level search technique

- 1) Uninformed search technique or Blind search
(mean BFS uninformed search technique ke wa under strat 2)
- 2) FIFO (Queue) "BFS use FIFO"
- 3) Shallowest Node → 4) Optimal
- 4) Complete → 5) Time Complexity

→ time complexity $O(V+E)$ → space complexity $O(b^d)$
→ T.C. A.P. \rightarrow worst case



ADEF
BEGHI
FGHIJ
GHIJK
HIJKL
IJKL
JKL
KLM
KMN
MN
N

mean total search depth
at each first et A + B + C + D

FIFO
order visiti visiti visiti visiti

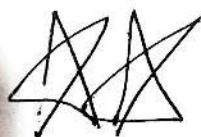
When breadth-first search is optimal?
When all the cost are equal

DFS (Depth first Search)

(16)

- 1) Uninformed search technique [$\frac{1}{2}$ st (DFS) $\frac{1}{2}$ Uninformed work karta hai]
- 2) Stack (LIFO) [mean last in first out (last value phle use hoga)]
- 3) Deepest Node
- 4) Incomplete [mean isme surety ni hoti ki result $\frac{1}{2}$ khatam ho jata hai]
- 5) Non optimal [mean $\frac{1}{2}$ optimal soln $\frac{1}{2}$ koi surety ni hoti ki optimal dega ya nonoptimal]
- 6) Time Complexity

$O[V+E]$	$O[b^d]$	$b = \text{branching factor}$
+ ↓ ↓ ↓	↓ ↓ ↓	$d = \text{depth}$
Data Structure	AI + & etc.	
$\frac{1}{2}$ T.Comp. & etc.	Complex	



DFS & BFS

Do no

Uninforme

Search technique ke upar work karte hai

$\frac{1}{2}$ present knowledge ke upar
work karte hai

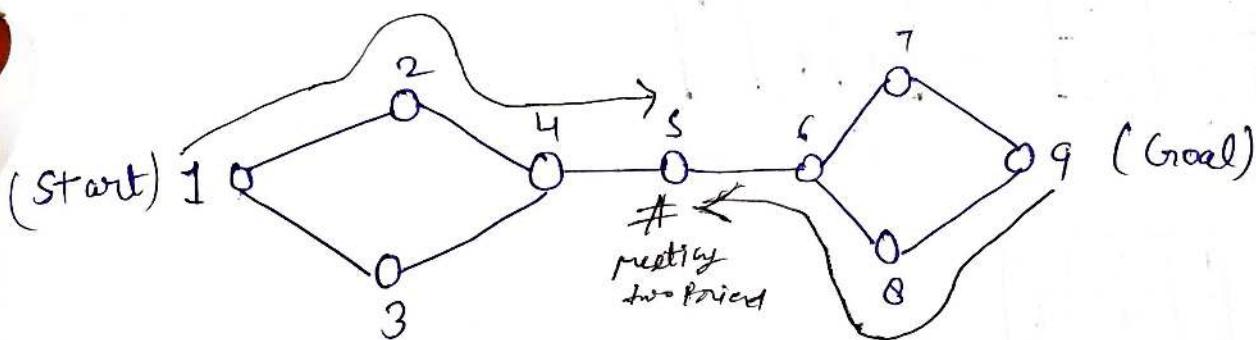
$\frac{1}{2}$ heuristic or estimated estimation value

ke upar work ni karta. leorta

Bidirectional Search

(17)

- Two simultaneous search form on initial node to goal and backward from goal to initial, stopping when two meet.
- Time Complexity : $2(b^{d/2})$
- Complete in breath first search but Not complete in depth first search.



★ ★ ★ Bidirectional search is the extension of BFS & DFS

Example of Bidirectional search

- ① for e.g. → Jaise two friends milne ka plan bharake hai to dono ne ek darsa karo bol de ki is place par milna hai
so same time par dono nikal raha hai and then mid place par dono mil raha hai
so it is called Bidirectional search.
(coz dono taraf hi search kar raha hai)

② Bidirectional Complete solution deta hai BFS & but DFS
one Xe Complete solution n't deta.

- ③ "if koi hmse puchta hai ki why we use Bidirectional or what is the advantage of Bidirectional"
Time complexity reduce ho jati hai as compare to DFS or BFS

8-Puzzle Problem without Heuristic

(18)

- Blind search (uninformed)
- BFS
- $O(b^d)$
- 4 moves (up, down, left, right)

1	2	3
---	---	---

1	2	3
---	---	---

Heuristic in A.I. (rule of thumb)

(19)

[what, why, How]

→ It is the technique designed to solve a problem quickly.

→ (In AI, hum problem ko quickly solve karne ke liye Heuristic ka use karte hai)

→ Heuristic function, hme guarantee deete hai ki hum take good solution denge lekin optimal soln ki guarantee nahi hai.
Optimal soln dekhi state hai or nahi bhi.

→ Jaha par bhi hum Non polynomial → Polynomial time me solve karne chahे mtlb quick solve karna chahiye vha par hum use karte hai heuristic function ko or value ko.

How to Calculate Heuristic Value

Methods

- 1) Euclidean distance → that is called state line distance
manhattan (3) No. of misplaced tiles
- 2) Heuristic me two points hai main []
Ye "good" solution dega but optimal soln ki guarantee nahi hai

How to solve 8-Puzzle problem with Heuristic (2)

(Informed search)

With Solve No. of misPlaced Tiles Method

Question

1	2	3
4	6	
7	5	8

1	2	3
4	5	6
7	8	

2367

12367

458

firstly find heuristic value (h) = 3

$h=3$ up

	2	3
1	4	6
7	5	8

$h=4$

down

1	2	3
7	4	6
5	8	

$h=2$ right

1	2	3
4	6	
7	5	8

$h=3$ up

1	3
4	2
7	5

$h=3$

down

left

$h=3$

right

$h=1$

1	2	3
4	5	6
7	8	

L

R

up

1	2	3
4	5	6
7	8	

1	2	2
4	5	6
7	8	

1	2	3
4	5	6
7	8	

✓

Generate and Test

(21)

(Heuristic technique , DFS with backtracking)

- (1) Generate a possible solution.
- (2) Test to see if this is a actual solution.
- (3) If a soluⁿ is found , quit . otherwise Go to step 1.

Properties of Good generators

- (1) Complete
- (2) Non Redundant
- (3) Informed

Best first Search (Informed, Heuristic)

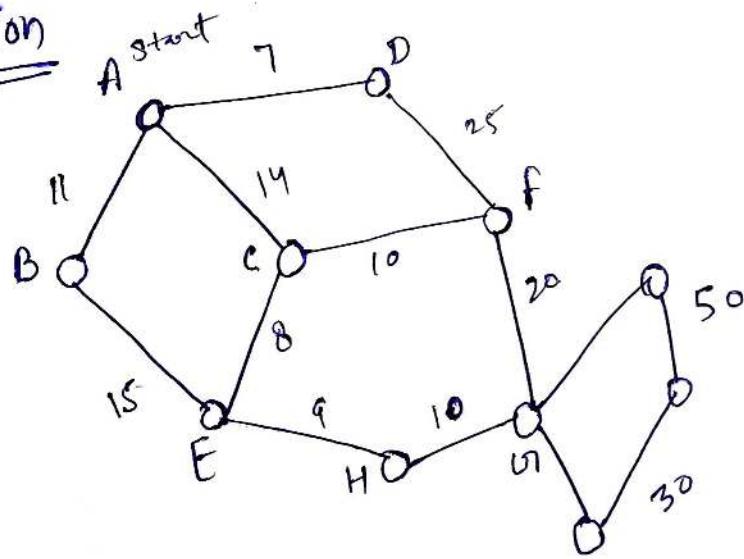
(23)

Algorithm : [★★ BFS heuristic value ke upar hi concentrate karta hai.
jab tak heuristic ke with BFS use karte hai ye "good soln" data hai but "optimal soln" ki guarantee nahi]

→ Let 'open' be a priority queue containing initial state.

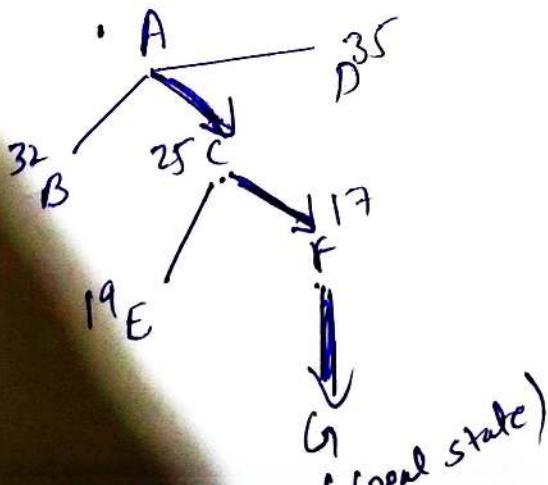
Loop
 if OPEN is empty return failure Node \leftarrow Remove first (OPEN)
 if Node is a Goal then return the path from initial to Node
 else generate all successors of newly generated Node int OPEN
 f values
 Node and put the according to their

Question



straight line distance

$$\begin{aligned} A \rightarrow G &= 40 \\ B \rightarrow G &= 32 \\ C \rightarrow G &= 25 \\ D \rightarrow G &= 35 \\ E \rightarrow G &= 19 \\ F \rightarrow G &= 17 \\ H \rightarrow G &= 10 \\ G \rightarrow G &= 0 \end{aligned}$$



[★★ same heuristic value per concentration nota hai or heuristic value small nota hai.]

$$[A \rightarrow C \rightarrow F \rightarrow G]$$

Beam Search Algorithm

- * Take care of space complexity. (constant)
- * Beam width (B) is given.
- * Beam Search algo or Best first search algo. done hi heuristic ke upar based hai.
- * Best first search is a complete algo. while Beam first search is not a complete Algo.
- * Ye guarantee ni deta ki ye optimal soln' algo but ye good soln' deta hai
- ~~If B value is 1 in Beam Search Algo. So it is called Hill climbing Algo.~~

Simple Hill climbing Algorithm

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(Local search Algo, greedy Approach, No backtracking)

- 1- Evaluate the initial state.
- 2- Loop until a solⁿ is found or
there are no operators left
 - Select and Apply a new operator.
 - Evaluate the new state:
 - if goal then quit.
 - if better than current state then } ^{max point}
it is now current state.

~~1~~ (Local search) Algo. ko is ke local domain ki knowledge hoti hai
Na ki Global domain ki knowledge hoti.

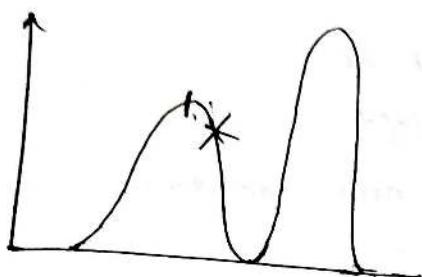
~~2~~ (Greedy Approach) Job tk is e best move milta hai ye uska chalta hai Job ise
best move milne bnd ho jatt hai to ye ruk jata hai.
~~3~~ (No backtracking) Job is e best move mil Jayga to ye back me nahi Jayga.

Example of Hill Climbing Algo. in Traveling Salesman Problem

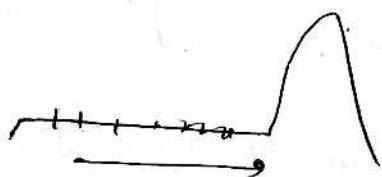
Problems in Hill climbing

2.6

- (1) Local maximum \rightarrow यहाँ ek bar best value par aksar vapas small value par hi jata.

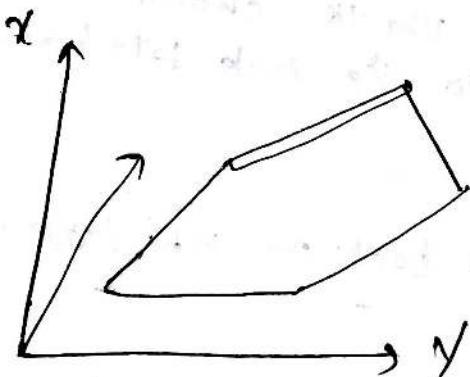


- (2) Plateau / flat maximum



if ine ydi sari values same milti hai to ye kisi sujekt ki aage ni jata.

- (3) Ridge



2. Direction change nikaalta.

A* Algorithm \rightarrow Informed Searching (27)

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

↓ ↓
 Actual Cost Estimation Cost
 from start node from n to goal node
 to n

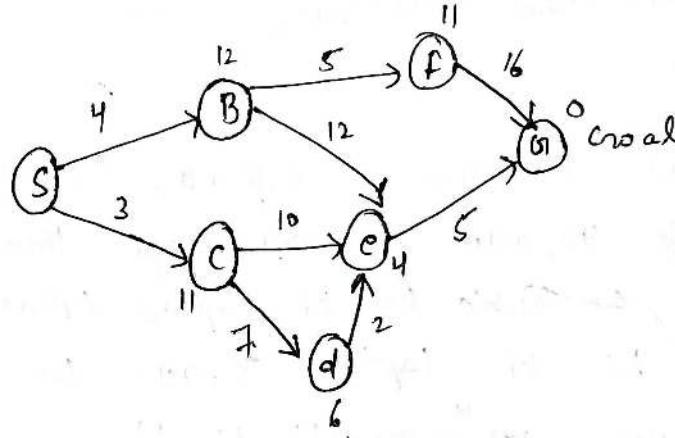
Time complexity $\rightarrow O(b^d)$

Space complexity $\rightarrow O(b^d)$

~~b → branch factor~~ worse case
~~d → depth~~ time comp. = $O(d)$

~~required auxiliary space in worse case~~
 $= O(V)$

Question



firstly S ja raha hai

$$S \rightarrow B \quad | \quad S \rightarrow C$$

$$f(S) = g(N) + h(N)$$

$$f(S) = 4 + 12 = 16$$

$$f(S) = g(N) + h(N)$$

$$f(S) = 3 + 11 = 14$$

Small $S \rightarrow C$

$$SC \rightarrow C$$

~~$E = (3+7)+4$~~

~~$= 44$~~

$$= (10+3)+4$$

$$= 17$$

$$SC \rightarrow d$$

$$= 7+3+6$$

$$= 16$$

Small

$$sc \rightarrow d$$

$$scd \rightarrow e$$

$$= 3+7+2+4$$

$$= 16$$

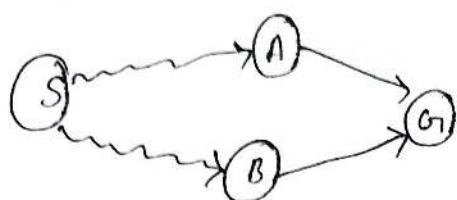
$$scde \rightarrow c$$

$$3+7+2+5+0$$

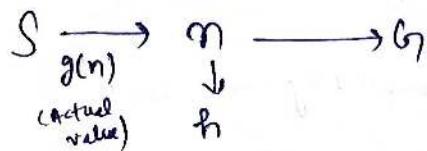
$$= 17 \quad \checkmark$$

How to make A* admissible

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admissible optimal
 or
 Actual value
 estimated value $\leftarrow h(n) \leq f^*(n)$ - Underestimation (if it's Under. because
 or $s(n)$ optimal sol'n of $f^*(n)$)
 $h(n) \geq f^*(n)$ - overestimation
 or
 $s(n)$ (in case we have been
 why he is optimal sol'n
 & $f^*(n)$)



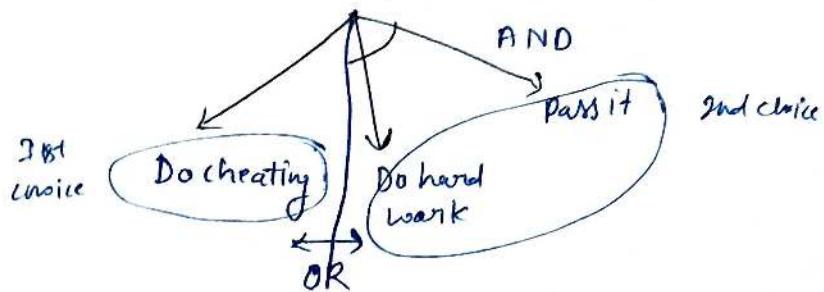
Some important points about Underestimation and Overestimation (Estimated value)

~~* * *~~ if we want purchase a laptop, or hum sochte
hai ki laptop 40,000 ka aa Jayga then hum shop
par jate hai or puchte hai ki laptop kitne ka hai
or shopkeeper bolo ki laptop 39000 ka hai so ise
bolte hai hum ~~so~~ "over estimation"

and ydi hum soche ki laptop 2000 ka hai
or shopkeeper bole ki laptop 3000 ka hai
to ise bolte hai "underestimation".

AO* Algorithm (AND/OR) → Problem Decomposition (Breakdown into smaller pieces)

Want to pass in exam



- AO* is not explore all the solution paths Once it got a solution
- suitable for complex problems to small problem modifiable



Difference b/w AO* and A*

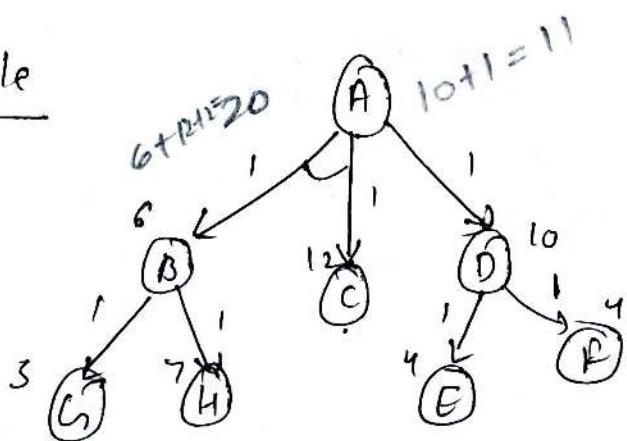
A^* → admissible.

A^* always gives the optimal solution if we work underestimation

AO^* → admissible

But AO^* does not give the optimal solution.

for example



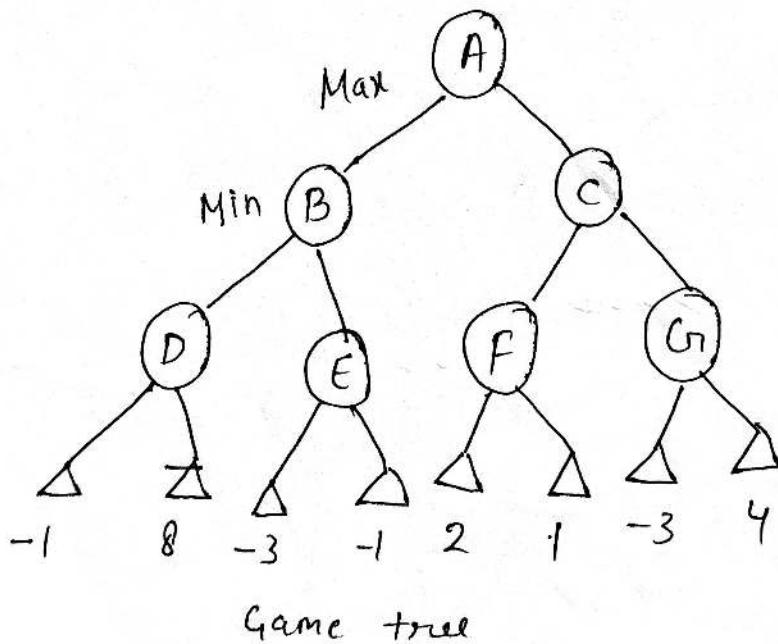
Introduction to Game Playing

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- Minimax Algo.
- Alpha-Beta ($\alpha-\beta$) Pruning

(1) Minimax Algo.

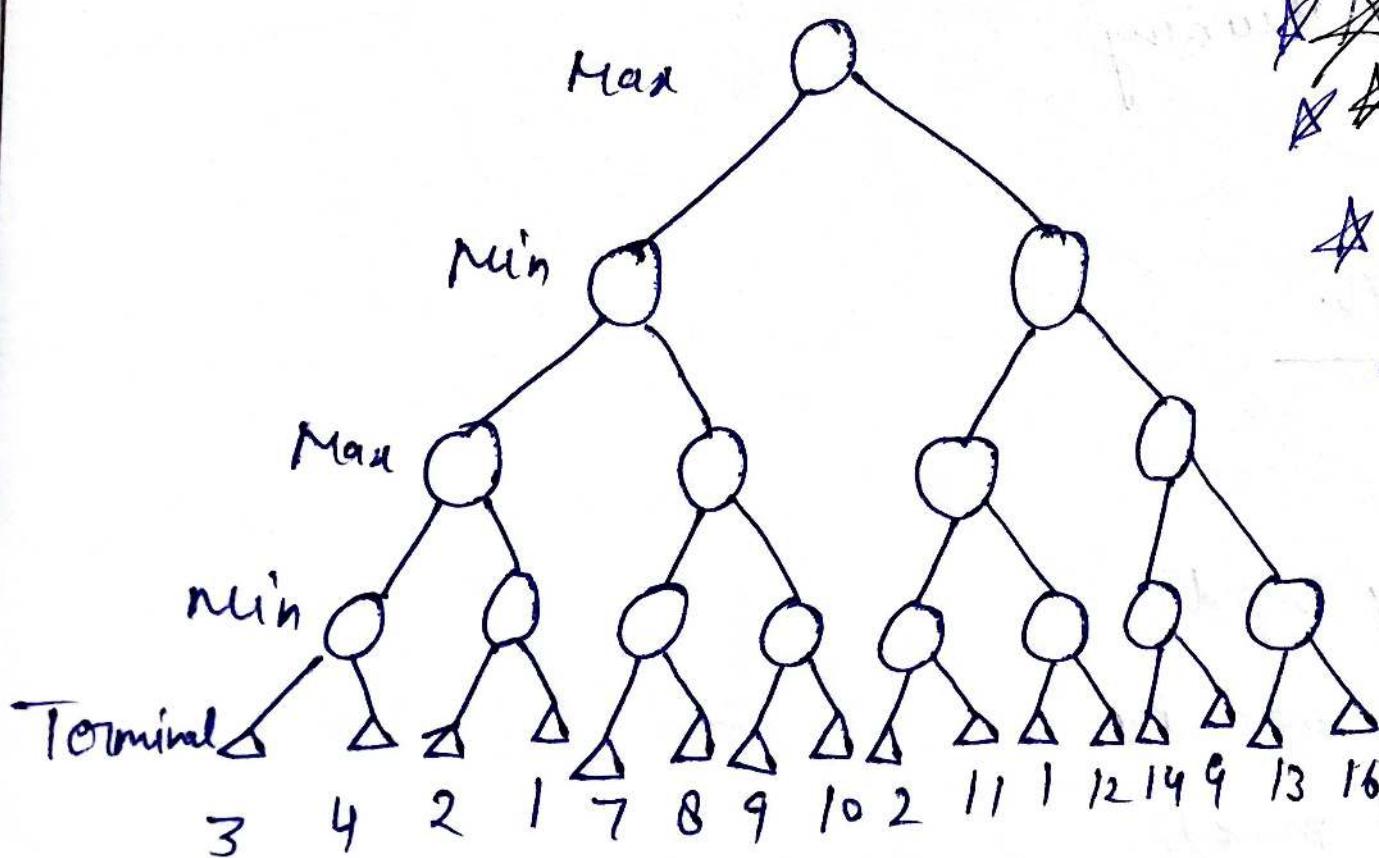
- Backtracking Algo.
- Best move strategy used
- Max will try to maximize its utility (Best move)
- Min will try to minimize utility (Worst move)
- Time complexity $O(b^d)$



Alpha - Beta Pruning (α - β)

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→ Cut off search by exploring less no. of nodes



- * The alpha initial value = α
- * The alpha best highest value choice
- * The beta initial value = β
- * The beta best lowest value choice

knowledge Representation and Reasoning

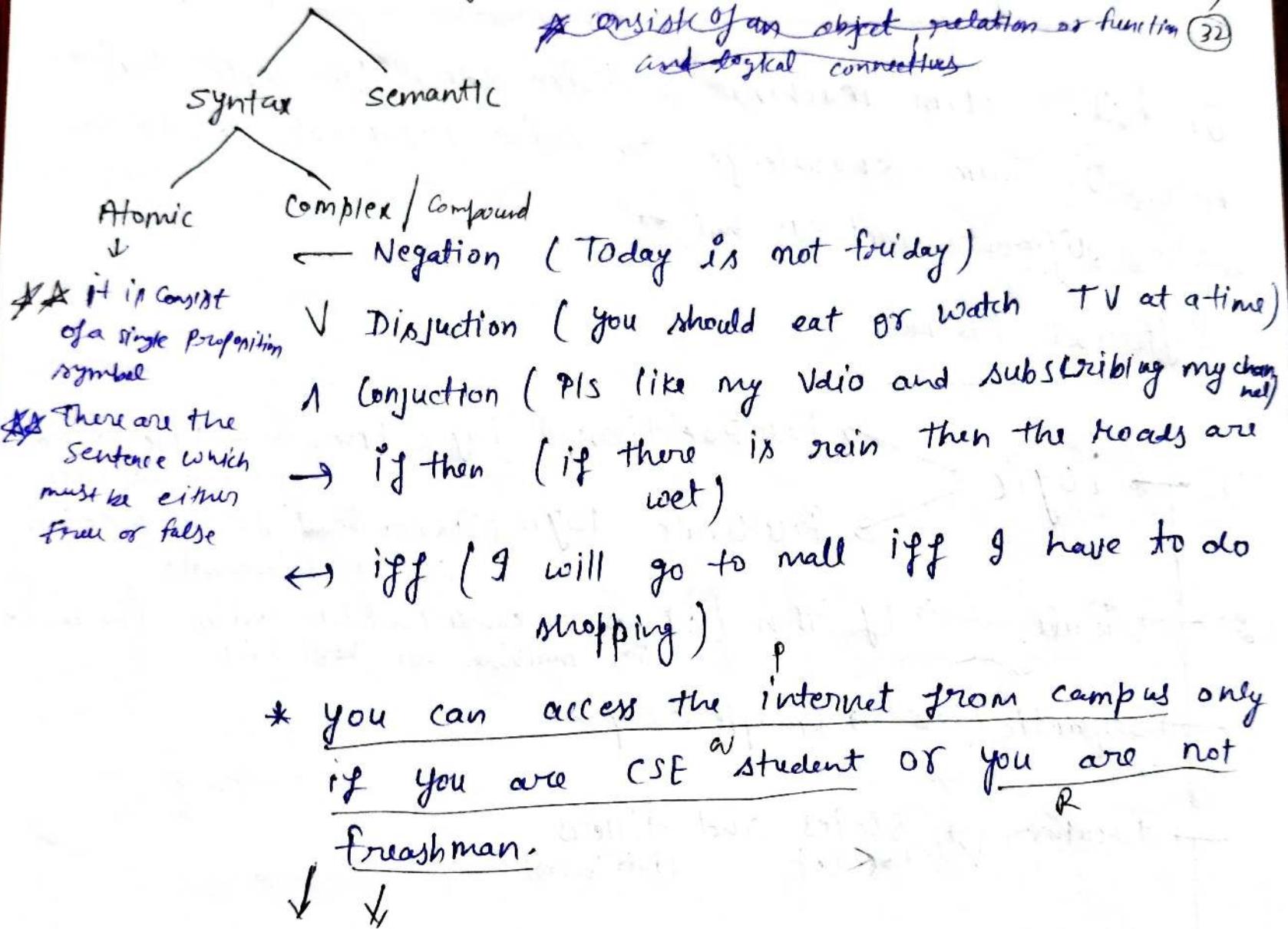
③

In A.I., Hum Machine ko kaise knowledge dete hai
A.I. ~~hi~~ hum knowledge ko kaise represent karte hai
use ke different methods hai ↴

Different Methods

- (1) → Logic
 - Propositional logic (Mean true/false ki term me hum use karte hai)
 - Predicate logic (Yha hum Quantifiers use karte hai
for all, there exists)
- (2) → Rules → if then (if then ki condition dete hai or use ke basis
par machine act kerti hai)
- Semantic Net → Google Graph
 - (meaning) (graph)
- frame → Slots and fillers
 - (objects) (Attributes)
- script

(1) Propositional Logic (Either True or False , Not Both)

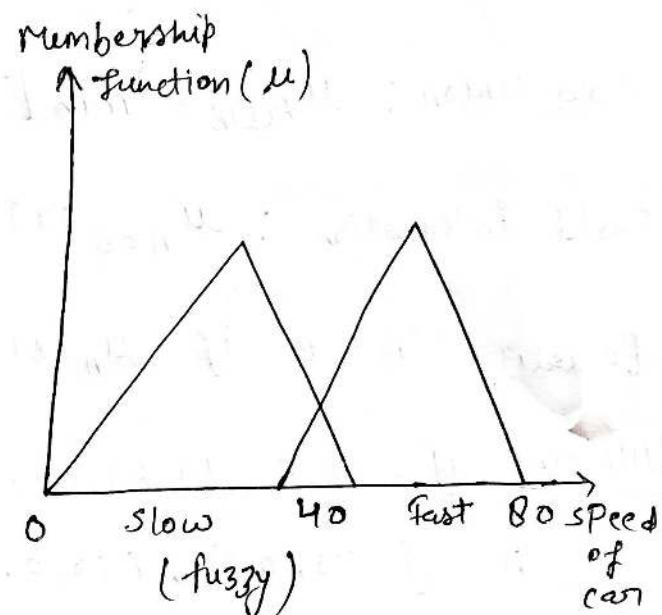
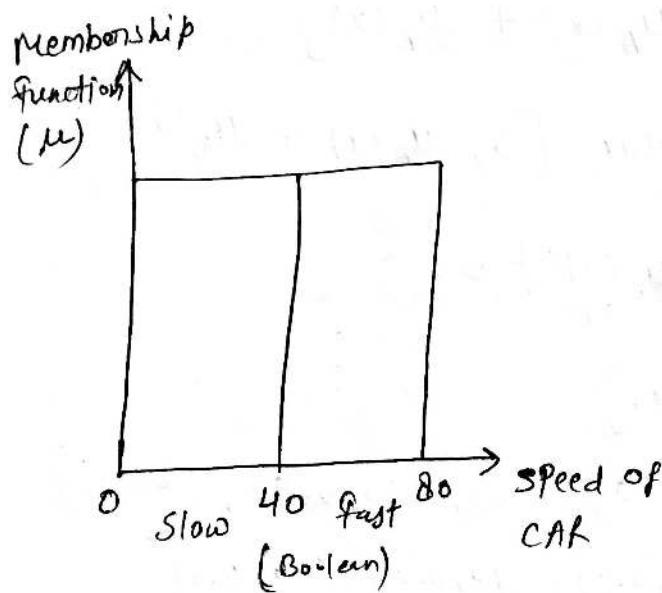


$$p \rightarrow q \vee \neg r$$

Fuzzy Logic (Lotfi Zadeh)

father of fuzzy logic (33)

- Represent uncertainty
- Represent with degree
- Represent the belongingness of a member of a crisp set to fuzzy set.



'check the degree of fastness'

$$\left\{ \begin{array}{l} 0, \text{ if } \text{speed}(x) \leq 40 \\ \frac{\text{speed}(x) - 40}{10}, \text{ if } 40 < \text{speed}(x) < 50 \\ 1, \text{ if } \text{speed}(x) \geq 50 \end{array} \right.$$

* fuzzy logic is a superset of boolean logic [0,1] No. 110

* fuzzy logic is usually represented as if-then rules.

Operations In Fuzzy logic

(34)

→ Union : $\text{Max } \{\mu_A(x), \mu_B(x)\}, x \in U$

→ Intersection : $\text{Min } \{\mu_A(x), \mu_B(x)\}, x \in U$

→ Complement : $\mu_{\bar{A}}(x) = [1 - \mu_A(x)], x \in U$.

→ Bold union : $\mu_{A \oplus B} = \min [1, \mu_A(x) + \mu_B(x)]$

→ Bold intersection : $\mu_{A \ominus B}(x) = \text{Max } [0, \mu_A(x) + \mu_B(x) - 1]$

→ Equality $A = B$ if $\mu_A(x) = \mu_B(x) \forall x \in S$

Questions $U = \{5, 10, 20, 25, 30, 40\}$

$A = \{(10, 0.2), (20, 0.4), (25, 0.7), (30, 0.9), (40, 1)\}$

$B = \{(10, 0.4), (20, 0.1), (25, 0.9), (30, 0.2), (40, 0.6)\}$

1st operation

$$\mu_{A \cup B} = \{(10, 0.4), (20, 0.4), (25, 0.9), (30, 0.9), (40, 1)\}$$

↓ some maximum value likha hai

$$2^{\text{nd}} \text{ oper. } \mu_{A \cap B} = \{(10, 0.2), (20, 0.1), (25, 0.7), (30, 0.2), (40, 0.6)\}$$

↓ some min. dekha

$$3^{\text{rd}} \text{ oper. } \mu_{\bar{A}}(x) = \{(10, 0.8), (20, 0.6), (25, 0.3), (30, 0.1), (40, 0)\}$$

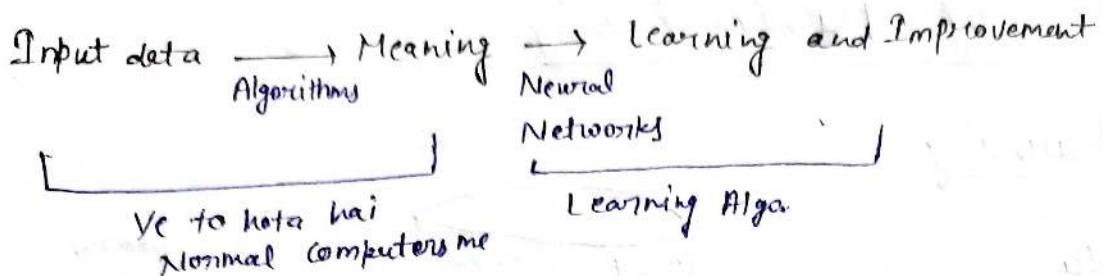
$$4^{\text{th}} \text{ oper. } \mu_{A \oplus B} = \{(10, 0.6), (20, 0.5), (25, 1), (30, 0.3), (40, 0.6)\}$$

$$5^{\text{th}} \text{ oper. } \mu_{A \ominus B} = \{(10, 0), (20, 0), (25, 0.6), (30, 0.1), (40, 0)\}$$

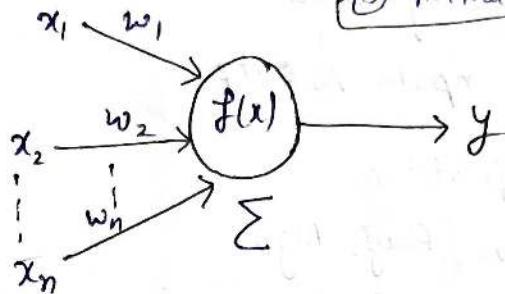
6th ope.

1.0
0.7
0.8

Neural Networks → Artificial Neural Networks (33)



- ★ Processing of ANN
- ① Network Topology
- ② Adjustment of weights of learning
- ③ Activation function



Brain → Machines

Abhi Mere ke liye ek chali aayi abhi kee se Artificial Neural Networks ke andar hum aisi machines banana chahte hai vo machine ke andar ~~bilkih~~ bilkih asitt se jaise human neuron kee jaise human brain system kam machines ke andar or us cheez ko hum bolte hain "Artificial Neural Networks".

Basic Aim of a Neural Network →

Iska main Aim hai ki jaise human brain hai usko home asitts dalna hai machine ke andar or vo learn kare cheezo ko copne experience se.

Power of Neural Network is "Learning Algo".

ANN Consist of three layers → Input layer, Hidden layer, Output layer

" " Applications → ① Sales forecasting ② Data validation
③ Risk management

calculation work
going on

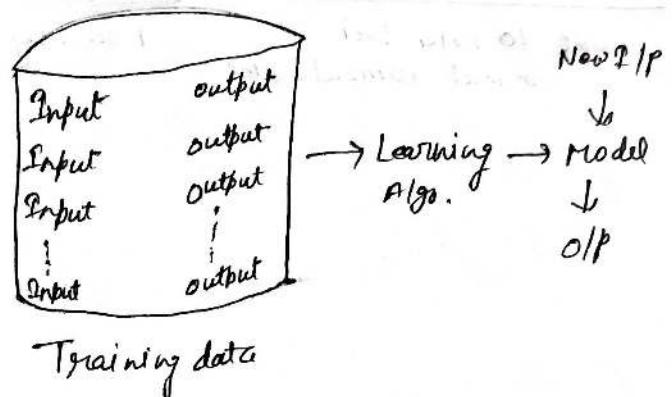
Learning / Machine Learning

Various types of Machine Learning

Supervised Learning

- Training data
- Both inputs & outputs
- Classification
- Naive Bayes Algo.

★ Under the supervision of teacher

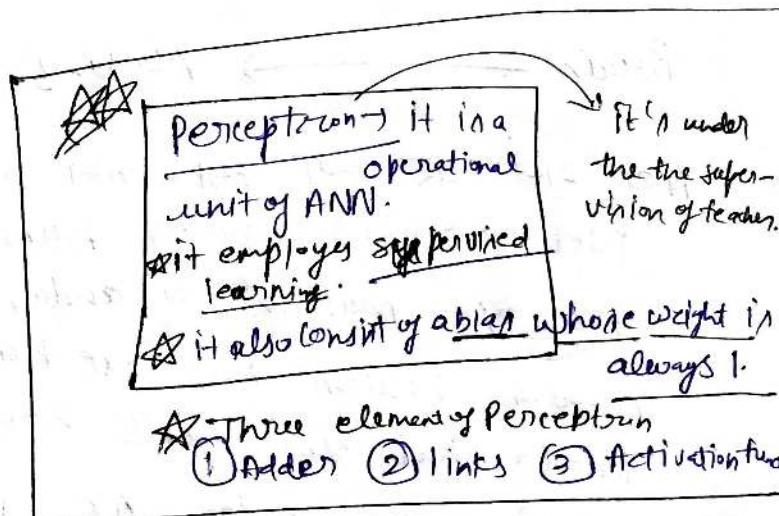
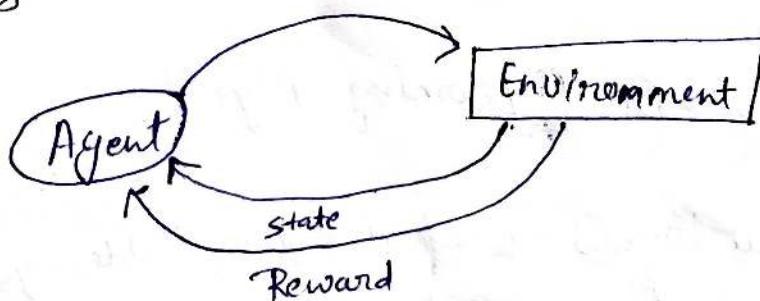


Unsupervised learning

- only Inputs
- clustering
- K-Means
- ★ without the supervision of teacher
- ★ This learning process is independent
- ★ it is called exploratory learning

Reinforcement learning

- Reward / Penalty
- Q-Learning
- ★ it is similar to supervised learning but there is not a supervision of teacher



(Constraint Satisfaction Problem (CSP)) (37)

- CSP consists of three components V, D, C
- V is set of variables $\{v_1, v_2, \dots, v_n\}$
- D is set of Domains $\{D_1, D_2, D_3, \dots, D_n\}$ one for each variable.
- C is set of constraints that specify allowable combination of values. mean different kinds of rules $\{c_1, c_2, c_3\}$
 $c_i = (\text{scope}, \text{rel})$
 - where scope is set of variables that participate in constraints
 - Rel is relation that define the values that variable can take.

~~★~~ Constraints me V hota hai variable
 " " D " " Domain
 Domain mean Variable jo hai vo natural no. Rakhta
 hai ya whole no. mean hai ki vo kis type ki
 value Rakhta hai use hi domain kahte hai.

And Constraints me C hota Constraints

How to Represent the Constraints ?

for e.g. v_1, v_2 \nexists Domain Rakhte hai A, B

so now

v_1 v_2
 A B

(1,2) (2,4)

$$c_1 = ((v_1, v_2), (v_1 \neq v_2))$$

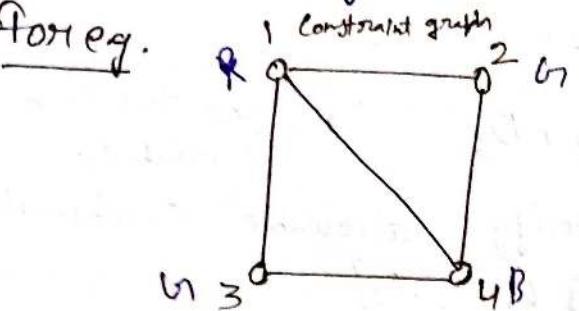
$$c_1 = \{(v_1, v_2), (A, B)\}$$

$$c_1 = \{(v_1, v_2), (1, 2), (1, 4), (2, 4)\}$$

How CSP (Constraint Satisfaction Problem) are solved (38)

* CSP ko solve karne ke liye hum method use karte hai "Backtracking" or "Intelligent Backtracking".

For eg.



$$V = \{1, 2, 3, 4\}$$

$$D = \{\text{Red, Green, Blue}\}$$

$$C = \{1 \neq 2, 1 \neq 3, 1 \neq 4, 2 \neq 4, 3 \neq 4\}$$

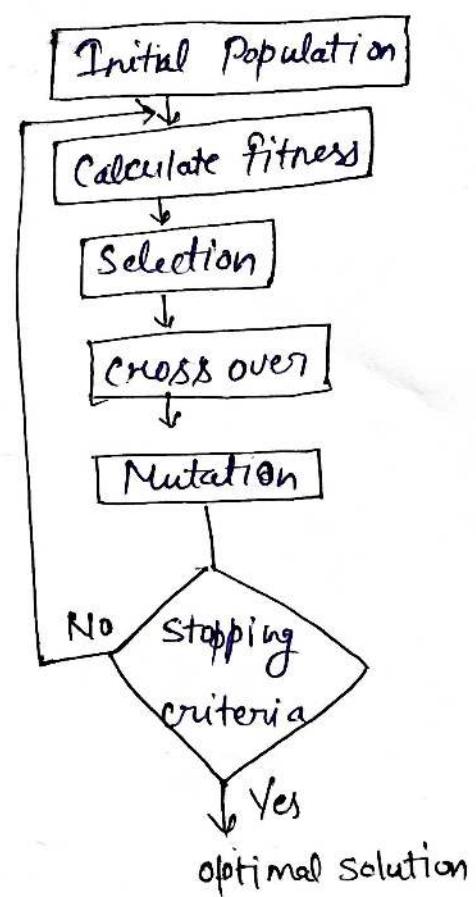
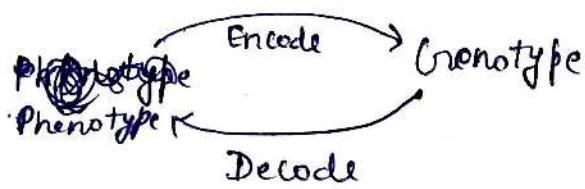
	1	2	3	4
Initial Dom.	R, G, B	R, G, B	R, G, B	R, G, B
1=R	R	G, B	G, B	G, B
2=G	R	G	G, B	B
3=B	R	G	G	B

- * CSP modeled as following problem?
 - * 8-puzzle problem
 - * 8-Queen problem
 - * Map coloring problem
- * Which algo is used in CSP?
 - * Backtracking
 - * Constraint propagation and local search

Genetic Algorithm (John Holland)

(39)

- Abstraction of Real Biological Evolution.
- Solve Complex Problems (like NP hard)
- Focus on optimization
- Population of Possible Solutions for a given Problem.
- From a group of individuals, the best will survive
-



LISP (List processing)

Features of LISP

- * Machine independent
- * user iterative design methodology
- * easy extensibility
- * updating the programs dynamically
- * provides high level debugging
- * provides advanced OOPS.
- * provides a convenient macro system
- * provides wide-ranging data types like, object, array, adjustable, list, symbols, vectors.
- * expression based
- * provides a object oriented condition
- * provides extensive control structure
- * provides extensive I/O Library
- * provides a complete LISP

Application built in LISP

- * Email
- * G2
- * Auto cad
- * igor engraver
- * yahoo store

Q In Lisp, the following function (`(minusp (- 20 4 8))`) returns?

- (A) T ✓
- (B) F
- (C) NIL
- (D) -20

- * Cos set return parma hai
to True stick
- * off return Nthikam
hota to false acha
or false ko represent karte hai NIL

* false = NIL

SRPs (Single Revision Page)

On A.P.

A.I.

single Revision Page on Agents

Simple Reflex agent	Model based reflex agent	Goal based agents	Utility based agent	Learning based Agent
based on current history	* Store percept history	* Expansion of Model based R.A.	* based on utility not goal	a) Critic
# ignore the history		# Searching & Planning	a) deals with happy and unhappy state	b) Problem generator
# Based on If-then Rule		# Store percept history		c) Performance element
# Environment should be fully observable	a) Environment should be Partial object table	# Main focus on final Partial obser Variable	a) Partially observable	d) Learning element

NLP	NLU	NLG
# How human communicate with each other. e.g., Google assistant	# What do the users say? their intent Meaning?	# What should we say to user?

DFS	BFS	Bidirectional search	Generate and Test
# Depth first search	# Breath first search	# Timelomp. $\rightarrow 2(b^{d/2})$	# Complete
# deepest	# shallowest n	# Complete in BFS	# Informed Search
# Non-optimal	# optimal	# Not complete in DFS	
# incomplete	# incomplete		
# LIFO (stack)	# FIFO (Queue)		
# $O(b^d)$	# $O(b^d) \rightarrow$ Time Comp.		
# Uninformed	# Uninformed	# Uninformed Search	

What reason A.I. based approaches to A.I.

It can't reason & it based on work by others

Strong A.I. has C/H

Aims to build machines that can truly reason and solve problems.

Automated chess engine

Weak A.I. C/H

Deals with the creation of some form of computer-based A.I. that cannot truly reason and solve problems but can act as if it were intelligent.

About the robot

Applied A.I.

Aims to produce commercially viable "smart" systems.

In this face recognition system app. we use

 ^{overthinking} Cognitive A.I. Approach → A computer is used to test theories about how the human mind works.

Main Applications of A.I. and

Application of A.I.

- (1) customer support using chatbots
- (2) expert system
- (3) online game playing
- (4) intelligent humanoid robot
- (5) Siri

Machine Learning

App. of Machine Learning

- (1) online recommender system
- (2) Google search algo.
- (3) facebook auto friend tagging suggestions.

* LISP = List processing (A programming lang. designed for easy manipulation of data strings.)

* LISP provides wide-ranging data types like, objects structures, lists, vectors, adjustable, array, hash-tables, and symbols.

* Correct order of precedence in ascending order regarding operators or connectives?

1 2 3 4 5 6

Parenthesis Negation Conjunction Disjunction Implication Biconditional

* Perceptron can solve AND, OR, NOT, NOR, NAND

* Perceptron can not solve XOR and XNOR

* By default value of threshold is $\theta = 0$

* if activities greater than θ $act > \theta$ (neuron fires $Output = 1$)

* if " " less than θ $act < \theta$ (neuron not fires $Output = 0$)

* In LISP the addition of $3+4$ is entered as $\Rightarrow +34$ (first operator then operands)

* How can you evaluate $1.25 + \sqrt{144}$ in LISP $\Rightarrow +1.25\sqrt{144}$ (operator then operands)

③

~~X~~ Given expression belongs to which normal form?

CNF DNF

↑ ↓
Conjunction Disjunction

P \wedge V r

None

(Coz Normal form me ek hi operation use hota hai yeho V & \wedge)

P \wedge V \wedge r

CNF

$\neg P \vee Q \vee R$

DNF

Top five language used by A.I.

① Python

② R

③ LISP

④ Prolog

⑤ Java

Application of Artificial Neural Network

- ① Speech recognition ② Character Recog. ③ Human face Recog.
- ④ Signature verification ⑤ Medical Research ⑥ Employee hiring
- ⑦ fraud detection regarding credit cards

[~~X~~ crisp set = either 0 or 1]

[fuzzy set = mid 0 and 1] for e.g., $\rightarrow \{0.1, 0.2, 0.3, \dots\}$