A class frame has associated with it a collection of template slots that describe own slot values considered to hold for each instance of the class represented by the frame. The values of template slots are said to inherited to the subclass and to the instances of a class.

Ans 29:-

Forward chaining/reasoning :-
It is a strategy of an expert system to answer the question, "What can happen next?" Here the inference engine follows the chain of conditions & derivations and finally deduces the outcome. It considers all the facts and rules and sort them before concluding to a soln. It takes a decision based on data. It is also called data-driven approach. It starts from the initial state, looks at the IF part of the rule and then perform action using the THEN part. It continues until no more rules can be applied or the cycle limit is met.

For eg:- "If it is raining, we will take umbrella", Here, "If it is raining" is the data and "we will take umbrella" is the decision.

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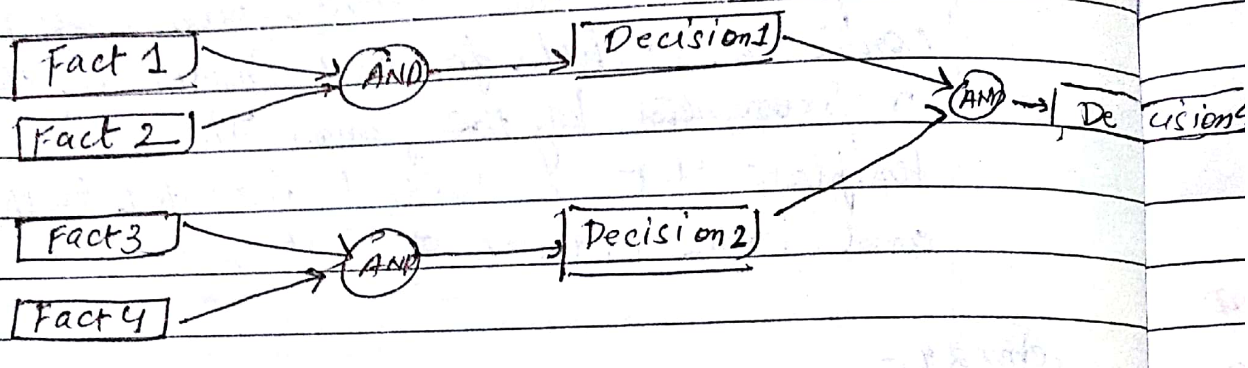
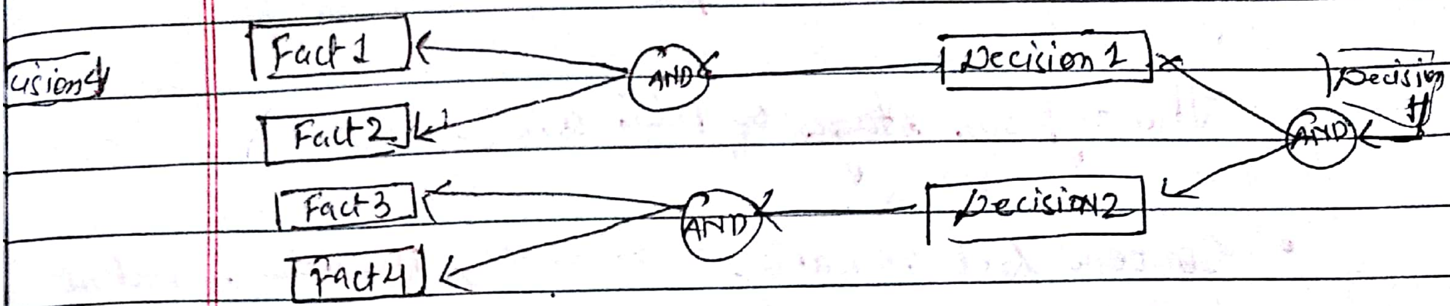
This technique is used by design expert Systems.



Backward chaining / Reasoning :-
With this strategy, an expert system find out the answer to the question, "Why this happened"?
On the basis of what has already happened, the inference Engine tries to find out which conditions could be happened in the past for this result. This strategy is followed for finding out cause or reason.
It is also called goal-driven approach. It starts from goal state, looks at the THEN part to establish sub-goals and reaches IF part.
For eg :- If someone takes umbrella, it is assumed that it is raining.
Here, "takes umbrella" is a decision based on which the data "it is raining" is

assumed. The technique is used by ~~diagon~~ diagonstic expert systems.



Ans 26:- Natural Language Generation :-

Natural Language Generation simply means producing text from computer data. It acts as a translator and converts the computerised data into natural language representation. In this, a conclusion or text is generated on the basis of collected data and input provided by the user. It is the natural language processing task of generating natural language from a machine representation system. ~~Natural Language~~ In Natural language generation the system needs to make decisions about how to put a concepts into words.

Example :- Example of a simple NLG system is the pollen forecast for scotland system that could essentially be a template NLG system takes as input six numbers, which predicts the pollen

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in different parts of scotland. From these nos, a short textual summary of pollen levels is generated by the system as its output.

The typical stages of NLG are :-

- Content Determination :- Deciding the main content to be represented in a sentence or the information to mention in the text.
- Document structuring :- Deciding the structure or organization of the conveyed information.
- Aggregation :- Putting a similar sentences together to improve understanding & readability.
- Lexical choice :- Using appropriate words that convey the meaning clearly.
- Referring expression Generation :- Creating such referral expressions that help in identification of a particular object & region.
- Realisation :- Creating & optimizing the text that should be correct as per the rules of Grammar

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There are 3 basic techniques for evaluating NLG systems:-

i) Task Based evaluation :- It includes human based evaluation, who asses how well it helps him perform a task. For eg:- a system which generates summaries of medical data can be evaluated by giving these summaries to doctors & accessing whether the summaries help doctors make better decisions.

ii) Human Ratings:- It access the generated text on the basis of ratings given by a person on the quality & usefullness of the text.

iii) Metrics :- It compares generated texts to texts written by professionals.

Ans 25:- Expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human Intelligence & Expertise.

Characteristics of expert Systems:-

- High Performance
- Understandable
- Reliable

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- Highly responsive

The expert systems are capable of advising, instructing and assisting human in decision making, demonstrating, Deriving a solution, Diagnosing, interpreting input, predicting results, justifying alternative options to a problem.
They are incapable of substituting human decision makers, possessing human capabilities, producing accurate output for inadequate Knowledge base.

Components of Expert Systems :-
- Knowledge Base
- ~~Interface Engine~~ Inference Engine
- User Interface

→ Knowledge Base :- It contains domain-specific and high-quality knowledge. Knowledge is required to ~~exb~~ exhibit intelligence. The success of any ES majorly depends upon the collection of highly accurate and precise Knowledge.

→ Interface Engine :- use of efficient procedures and rules by the inference engine is essential in deducting a correct, flawless solution.

In case of Knowledge-based ES, the Inference Engine acquires and manipulates the knowledge from the knowledge base to arrive at a particular solution.

- In case of rule based ES, it –
- Applies rules repeatedly to the facts, which are obtained from earlier rule application.
- Add new knowledge into Knowledge Base if required.
- Resolves rules conflict when multiple rules are applicable to a particular case.

User Interface :- It provides interaction b/w user of the ES and the ES itself. It is generally Natural language processing so as to be used by the user who is well-versed in the task domain. The user of ES need not be necessarily an expert in AI.

Requirement of Efficient ES User Interface :-

→ It should help users to ~~am~~ accomplish their goals in the shortest possible way.

→ It should be designed to work for user's existing or desired work practices.

→ Its technology should be adaptable to user's requirements; not the other way round.

→ It should make efficient use of user input.

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Ans 27:- Simple Hill climbing :- Simple hill climbing does not offer the optimal solution but it surely save execution time. It uses the heuristic value for the evaluation of the state. The goodness is decided by the heuristic value of that state. In this algorithm, the first state that is better than the current state is considered for further expansion.

Algorithm :-

i) Evaluate the initial state. If it is the goal state then return and quit, otherwise, make it the current state and go to step (ii)

ii) Loop until the solution is found or there are no new operators left to be applied.

a) select and apply a new operator.

b) Evaluate the new state :-

1. If it is ~~better~~ a goal state, then return & quit.
2. If it is better than the current state, make it the new current state.
3. If it is not better than the current state, continue the loop and go to step (ii)

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Steepest ascent hill climbing :-

This method always finds the steepest path to hilltop. It select the best node among all the child nodes. It also uses the heuristic value for state evaluation. This technique will ~~return~~ require more time than the previous one as this one looks for the best successor for the further expansion which also assures an optimal soln.

Algorithm :-

i) Evaluate the initial state. If it is the goal state then return and quit. Otherwise, make it the current state.

ii) Loop until a solution is found or a complete iteration does not change the current state :

a) SUCC = a state such that any possible successor of the current state will be better than SUCC.

b) For each operator that applies to the current state, evaluate the new state :-

1) If it is a goal, then return & quit.

2) If it is better than SUCC set SUCC to this state.

c) (ii) SUCC is better than the current state the set the current state to SUCC.

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Ans:- Unification algorithm:-

Consider X and Y as literals to be unified. The steps of algorithm will be as follows:-

i) if X and Y are identical then return NIL.
ii) ~~if~~ else, if P is a variable, then if X occurs in Y then return FAIL, else return (Y/X)
iii) if Y is a variable and if Y occurs in X, then return fail else return (X/Y)
iv) else return FAIL.
v) If the initial predicate symbol in X and Y are not identical, the return Fail.
vi) if the X and Y have different number of arguments then return FAIL.
vii) Set Substitution list to nil. (This list contains the Substitution made for performing the unification).
viii) for i = 1 to number of arguments in X :

a) call unify with arguments of X and the ith argument of Y, putting result in S.
b) if S contains FAIL then return (FAIL).
c) if S is not equal to nil then
d) Apply S to remainder of both X and Y
e) Substitution : = APPEND (S, Substitution)

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f) return Substitution.

① eg unify $P(x, f(y)), P(a, f(g(z)))$

Apply substitution
Substitution set = $[a/x , g(z)/y]$
~~Hence X and Y are identical~~

eg ② unify $Q(a, g(x,a), f(y)), Q(a, g(f(b),a), x)$

Substitution set =
$[a/a, f(b)/x , b/y]$

note :- substitution t_i/v_i specifies substitution of term t_i and variable v_i
means Put t_i in place of v_i

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Ans 3 and 13

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~~Ans~~3:- Production rules for water jug problem.

The state space for this problem can be described by set of ~~ordered~~ ordered pairs of 2 variables (x, y) where, Variable x represents the water in 4 liter jug, and y represents the water in the 3 liter jug. Variable x can take the value 0, 1, 2, 3, 4 and Variable y can take the value 0, 1, 2, 3. The start state is (0, 0) and the goal state is (2, 0). The production rules are formulated as follows:

Rule 1 : $(x, y) \rightarrow (4, y)$ (fill the 4 liter jug, applicable if $x < 4$)

Rule 2 : $(x, y) \rightarrow (x, 3)$ (fill the 3-liter jug, if $y < 3$)

Rule 3 : $(x, y) \rightarrow (x - x1, y)$ (pour some water out from 4-liter jug)

Rule 4 : $(x, y) \rightarrow (\cancel{x}, y - x1)$ (pour some water out from 3-liter jug)

Rule 5 : $(x, y) \rightarrow (0, y)$ (Empty the 4 liter jug)

Rule 6 : $(x, y) \rightarrow (x, 0)$ (Empty the 3 liter jug)

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Rule 7: $(x,y) \rightarrow (4, y-(4-x))$ (fill the 4-liter jug by pouring some water from 3 liter jug)

Rule 8: $(x,y) \rightarrow (x-(3-y), 3)$ (fill the 3-liter jug by pouring some water from 4-liter jug)

Rule 9: $(x,y) \rightarrow (x+y, 0)$ (Empty 3 liter jug by pouring all water in to 4-liter jug)

Rule 10: $(x,y) \rightarrow (0, x+y)$ (Empty 4 liter jug by pouring all its water in to 3-liter jug)

Rule 11: $(0,2) \rightarrow (2,0)$ (pour the 2 liters from 3-liter jug into 4-liter jug)

Rule 12: $(2,y) \rightarrow (0,y)$ (empty the 2 liters in the 4-liter jug on the ground)

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Ans 17 :- Different expert Systems are :-

i) Dendral expert system :-

Dendral is the expert system developed for inferring process of structure elucidation of chemical ~~coun~~ compounds. DENDRAL is concerned with the ~~in~~ interpretation of data obtained from a device called "mass spectrometer". In this field of structure elucidation of compounds chemical expertise is needed in 2 major aspects :-

- Domain specific knowledge is needed for reading and interpreting the output of X-Ray crystallography, ultraviolet spectroscopy, infrared spectroscopy, and NMR spectroscopy.
- Extensive domain specific knowledge is essential during assembly ~~process~~. process.

The control process employed by DENDRAL is of the kind, "generate and test".

In generate and test procedure, starting with arbitrary initial state and by employing a generator all possibilities regarding presence of compounds is generated. On these possibilities a series of tests are carried out to eliminate unwanted states.

In DENDRAL instead of generating all possibilities,

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Some planning is done and single feasibility is generated. This procedure is called "plan-generate-test."

2 MYCIN explained in Q 9.

Ans 14 Ans 28:- Alpha-Beta Pruning (Cutoff's)

In MINIMAX search, the no. of game state increases exponentially. To reduce the search, the pruning is done. Alpha-beta is one such pruning technique. It maintains two threshold values one is called alpha (or α) and other beta (β). The threshold values are defined as follows:-

α = Lower bound on maximum value of utility function. It is least acceptable value of utility function in maximizing play.

β = Upper bound on minimum value of utility function. It is the highest acceptable value of utility function in case on minimizing play.

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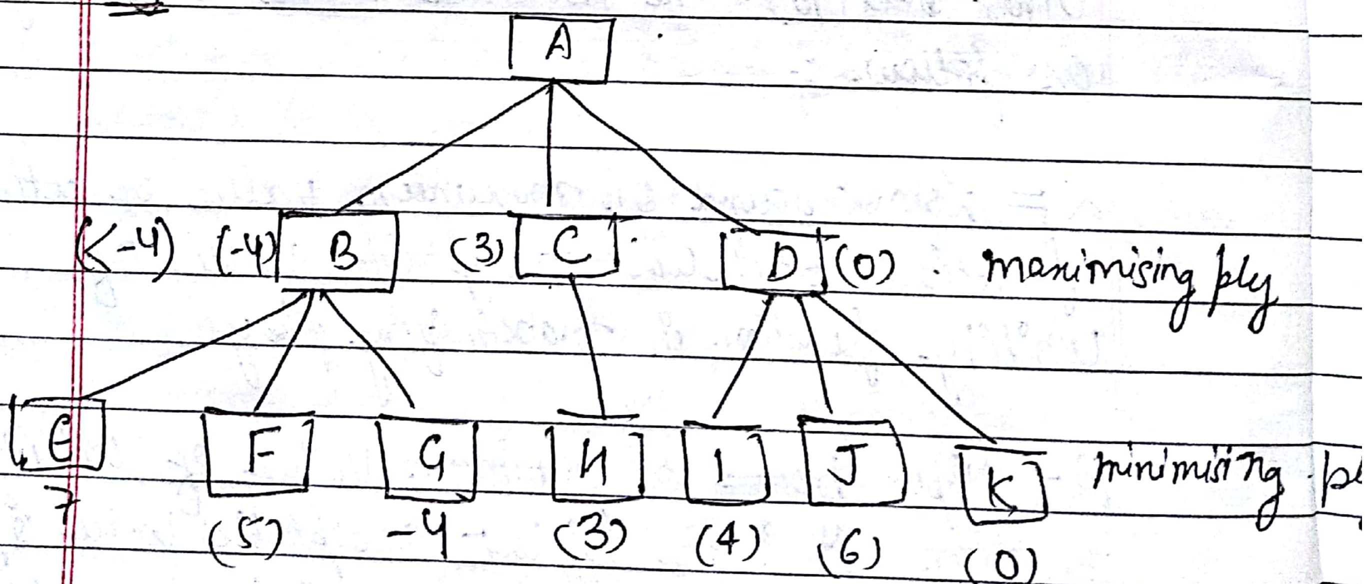
In searching the game tree in mini-Max search, the part of tree having utility value less than α indicates that this particular move will not at all be useful. Hence, part of tree having utility value less than Alpha will be pruned. This means, in future all the node below it will never be explored, similarly, if utility value comes out to be more than beta in case of minimizing ply, it will indicate that this move is at all not useful and that subtree will be pruned on similar ground.

Eg



say $\alpha = 0$, $\beta = 5$

Here the possibilities are considered upto 2 ply. At min ply, the best value from three nodes is $-4, 3, 0$. These will be back propagated towards root and a maximizing move 3 will be taken. Now node E having utility 7 is far more, then accepted. (as it is ~~minimizing~~ minimizing ply) so further node E will not be explored. In this situation when more plies are considered, whole sub tree below E will be pruned. Similarly if alpha $= 0$ and $\beta = 5$, all nodes and related sub trees having value of utility function less than 0 at maximizing ply and more than 5 at minimizing ply will be pruned.

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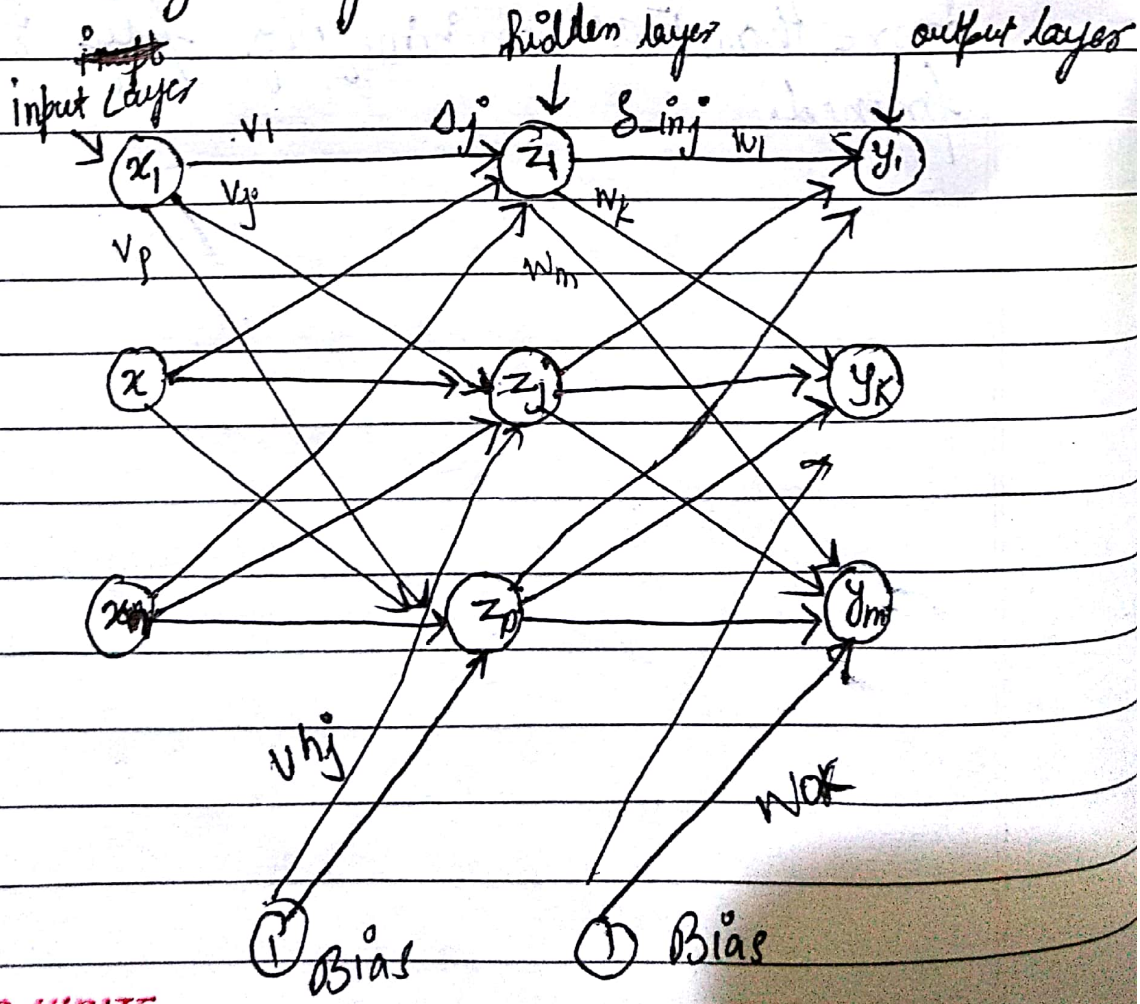
Ans 7:- Back Propagation Algorithm

→ It is used for error detection & correction in neural network.
There are four phases in Back Propagation algorithm

i) Initialization of weight
ii) Feed Forward
iii) Back-propagation of error
iv) updation of weight and bias

i) ~~Int.~~ Initialization of weight.

step 1 :- initialize weight to some random value



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Step 2:- while stopping condition is false, do step 3-10
Step 3:- For every training pair do step 4-9.

ii) Feed Forward

Step 4:- propagate input to upper layers.
Step 5:-

$$z\_in_j = v_{0j} + \sum_{i=1}^{n} x_i v_{ij}$$

$$= v_{0j} + x_1 v_{1j} + x_2 v_{2j} + x_3 v_{3j} \ldots$$

$$z_j = f(z\_in_j)$$

activation function.

Step 6:- $y\_in_k = w_{0k} + \sum_{j=1}^{p} z_j w_{jk}$

$$= w_{0k} + z_1 w_{1k} + z_2 w_{2k} + \ldots$$

$$y_k = f(y\_in_k)$$

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iii) Back-propagation of error

Step 7:- calculate the error to the output layer

$$\delta_K = (t_K - y_K)\, f'(y\text{-}in_K)$$

error for y_K — desired output — calculate output

Step 8:- calculate error input to the hidden layer

$$\delta\_in_j = \sum_{K=1}^{m} \delta_j w_{jK}$$

$$= \delta_j w_{j1} + \delta_j w_{j2}$$

Step Calculate error output from the hidden layer

$$\Delta_j = \delta in_j\, f'(z\,in_j)$$

iv) updation of weight & bias

Step 9: $\Delta w_{jK} = \alpha \delta_K z_j$

α learning rate

update bias to the output layer

$$\Delta W_{0K} = \alpha \delta_K$$

GOOD WRITE $\Delta V_{ij} = \alpha \Delta_j x_i$

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$\Delta V_{hj} = \alpha \Delta_j$

So the new weights will be

$W_{jk}(new) = W_{jk}^{(old)} + \Delta W_{jk}$

$W_{0k}(new) = W_{0k}(old) + \Delta W_{0k}$

$V_{ij}(new) = V_{ij}(old) + \Delta V_{ij}$

$V_{hj}(new) = W_{hj}(old) + \Delta V_{hj}$

Step 10 :- stopping algo.

1) no of iteration (i.e the no of times the iteration performed and stopped)

2) minimum of error.

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