Artificial Intelligence Notes

Q.1 Explain component of AI program.
Following are the components of AI :-

1. Learning
2. Reasoning
3. Problem – solving
4. Perception understanding

1. Learning :-
   - Similar to humans, computer programs also learn in different manners.
   - One of the essential components of AI learning for AI includes the trial-and-error method.
   - The learning component of AI includes memorizing individual items like different solutions to problems. Vocabulary, foreign languages. Etc. also known as rote learning.

2. Reasoning :-
   - The art of reasoning was something that was only limited to humans until five decades ago.
   - The ability to differentiate makes reasoning one of the essential components of AI.

3. Problem – solving :-
   - In its general form, the AI's problem solving ability comprises data, where the solution needs to find
   - The different methods of `problem-solving` count for essential AI components that divide the queries into special and general purposes.

Q. 2 Intelligent agent ? characteristic ?

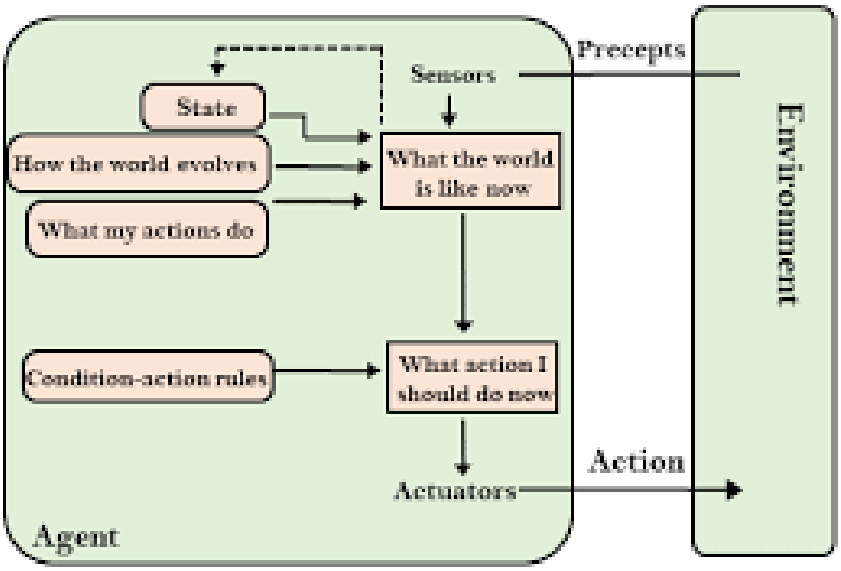
1. An intelligent agent is an autonomous entity which act upon an environment using sensors and actuators for achieving their goals.
2. An intelligent agent may learn from the environment to achieve their goals.
3. It uses actuators to initiate action in that environment.
4. Two main functions :
   i. Perception
   ii. action
5. Perception is alone through sensors.
   Actions are initiated through actuators.
6. A thermostat is an example of intelligent agent.

Characteristics :

1. Goal oriented
2. Independent : *Self –dependent *makes decision on its own & initiates.
3. Intelligent : intelligent agents can collect data more intelligently.
4. Reduce net traffic : Agent communicate & co-operate with other agents quickly.
5. Multiple tasks : Can perform more than one or multiple task at same time.
6. Mobility

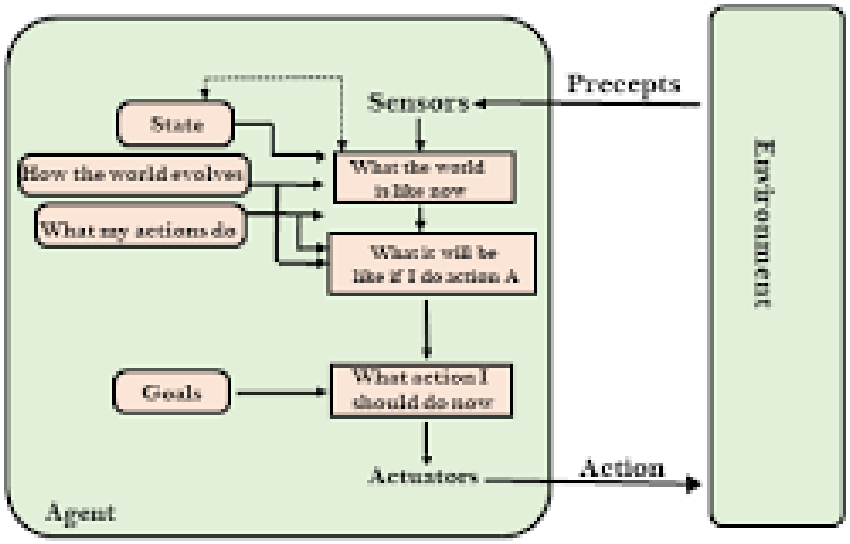
Q. 3 Model base reflex agents

1. A model based reflex agent needs memory for storing the percept history.
2. Model based reflex agents are mode to deal with partial accessibility.
3. Model based agent has two important factors :
   a) Model : It is knowledge about “how things happen in world” so it is called as model based agent.
   b) Internal state : It is representation of current state based on percept history.
4. These agent have the model which is “knowledge of the world” and based on model they perform actions.
5. Updating agent state requires information about
   a) How the world evolves.
   b) How agents action affects the world.



Q. 4 Goal based agent

1. The knowledge of current state environment is not always sufficient to decide for an agent to what to do.
2. It needs to know its goal which describes solutions.
3. Goal based agents expand the capabilities of model based agent by having “goal” information.
4. They chose an action so that they can achieve goal.
5. A goal based algorithm uses searching and planning for solution to achieve goal.



Q. 5 Utility based agent

1. These agents are similar to goal based agent but provide an extra component of utility **measurement**.
2. Utility based agent act based not only goals but also best way to achieve goal.
3. The utility based agent is useful when there are multiple possible solutions and agent has to choose best action to perform.
4. The utility function maps each state to real number to check show efficiently each action achieves goal.

Q. 6 Model based vs goal based

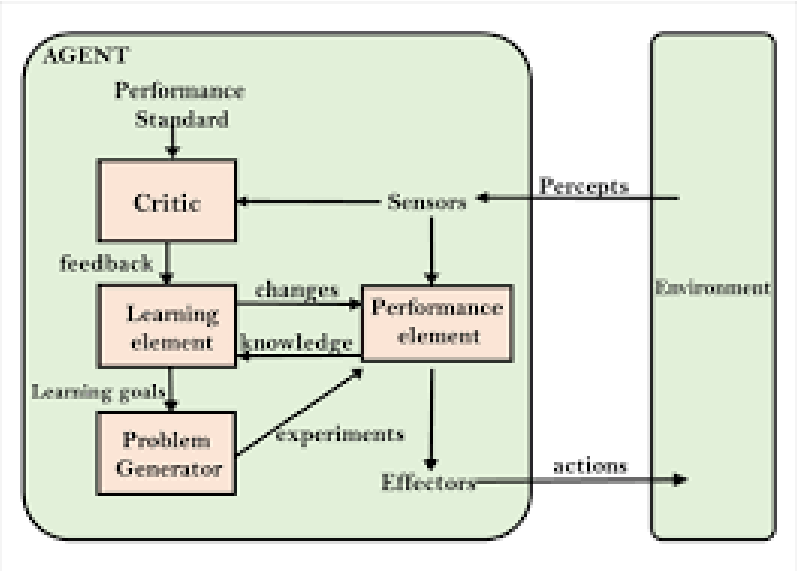
a) Model based :
   1. Model based reflex agents are mode to deal with partial accessibility.
   2. They do this by keeping track of part of world it can see.
   3. It keeps an internal state that depends on what it has seen before.
   4. So it holds information on the unobserved aspects of current state.

b) Goal based :
   1. A goal based agent has an agenda. It operates on goal based in front of it and makes decisions based on how best to reach that goal.
   2. A goal based agent is capable of thinking beyond the present moment to decide best actions to achieve goal.
   3. A goal based agent operates as search & planning function.
   4. If targets goal ahead and finds right action in order to reach it.

Q.7 Learning agent :

1. A learning agent is an agent capable of learning from experience.
2. A learning agent in AI is type of gent that can learn from its past experiences or its has learning capabilities.
3. The learning algorithm gain feedback from critic on how agent is doing.
4. Building block of learning agent **are :**
   i. Critic

ii. Learning agent
iii. Performance element
iv. Problem generator



i. Critic :
Critic determines outcome of action & gives feedback to learning element.
ii. Learning agent :
- It takes feedback from critic and figures out how to make action better next time.
- Responsible for making improvements.

iii. Performance element :
As per figures.
iv. Problem generator :
As per figures.

Q. 8 Heuristic function :

1. The process of searching can be drastically reduced by use of heuristics. Heuristics are approximations used to minimize the searching process.
2. It is function that maps from problem state description to measures of desirability usually represented as number.
3. The heuristic function is an estimate of how close we are to a goal based on domain-specific information.
4. Well designed heuristic function can play important role in efficiently guiding search process towards a solution.
5. Two categories of problem use heuristics.
   i. Problems for which no exact algorithms are known and needs to find solution.
   Ex. Speech recognition.
   ii. Problems for which exact solutions are known but infeasible.
   Ex. Rubik's cube.
6. Following algorithm make used of heuristic functions :
   i. Hill climbing algo
   ii. Best-first search
   iii. A* algo
   iv. AO* algo
   v. Beam search

7. Types of problems :
   i. Ignorable problems :
      Ex. Theorem proving
      In this solution steps can be ignored.
   ii. Recoverable problems :
      Ex. 8 puzzle
      In this solution steps can be undone.
   iii. Irrecoverable problems :
      Ex. Chess
      In this solution steps can't be undone.

Q. 9 Uninformed search :

They have no additional information about states other than those provided in problem definition. They can only generate successors and distinguish between goal state & non-goal state.

Search techniques :

1. Depth first search
2. Breadth first search
3. Uniform cost search
4. Depth limited search
5. Bidirectional search

1. Depth first search (DFS) :
   - DFS search is distributive file system. The distributive file function provides the ability to logically group shares on multiple servers and to transparently link shares into single namespace.
   - DFS is file system with data stored on a server the data is accessed and processed.
   - DFS is an algorithm for traversing or searching tree or graph data structure.
   - Advantages :
     i. Memory requirement is linear with respect to nodes.
     ii. Less time & space complexity.

   - Disadvantages :
     i. Not guarantee that it will give you sol^n .
     ii. Determination of depth until the search proceeds.
   - Applications :
     i. Finding connected components.
     ii. Finding bridges of graph.

2. Breadth first search :
   - BFS stands for breadth first search is a vertex based technique for finding shortest path in graph.
   - BFS is core of many graph analysis algorithms and it is used in many problems, such as social network, computer network analysis and data organization.
   - BFS uses Queue-data structure for finding the shortest path. BFS can be used do find single source shortest path in an un-weighted graph.
   - Advantages :
     i. Sol^n will be definitely found out by BFS if there is.
     ii. BFS will never get trapped in blind valley, meems unwanted nodes.
   - Applications :
     i. Unweighted graphs

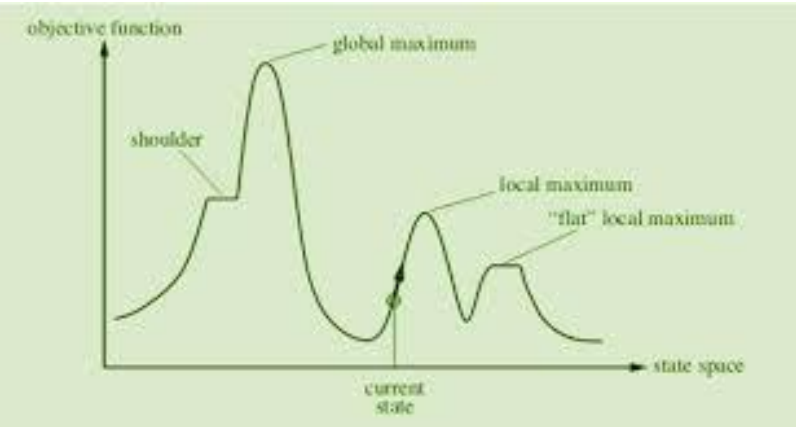
ii. P2P networks
iii. Web crawlers

Q. 10 Local search algorithms :

1. In computer science local search is **heuristic** method for solving computationally hard optimization problems.
2. Local search starts from an initial solution and evolves single solution that is mostly better solution.
3. Local search uses a single search path and moves facts around to find good feasible solution. Hence it is natural to implement.
4. Local search algorithms are widely applied to numerous hard computational problems, including problems from artificial intelligence, mathematics, operations research, engineering.
5. Some problems where local search algorithms are applied are :
   i. The vertex cover problem :
      In this, solution is vertex cover and target is to find solution with minimal no. of nodes.
   ii. The travelling salesman problem :
      In this, solution is cycle containing all nodes of graph and target is to minimize the total length of cycle.
   iii. The Hopfield neural networks problem :
      In this, finding stable configuration in hop-field network.

Q. 11 Hill climbing :

1. Hill climbing is local search algorithm which continuously moves in direction of increasing value to find peak of mountain or best solution to problem.
2. One of most widely discussed examples of hill climbing is travelling-salesman problem in which **we** need to minimize distance travelled by salesman.
3. Hill climbing algorithm is also called as discrete optimization algorithm. Also called as greedy local search.
4. Hill climbing algorithm makes use of simple heuristic function.
5. Feathers of hill climbing
   i. Generate and test variant
   ii. Greedy approach
   iii. Bi backtracking
6. State space diagram :



7. Types of hill climbing also
   i. Simple hill climbing
   ii. Steepest-Ascent hill climbing
   iii. Stochastic hill climbing
8. Problems in hill climbing
   i. Local maximum
   ii. Plateau
   iii. Ride
9. Algorithm
   - Step 1 : Put initial node on list START
   - Step 2 : If (START is empty) or (START is GOAL) then terminate search.
   - Step 3 : Remove first node from START call this as node a.
   - Step 4 : If (a = GOAL) then terminate search with success.
   - Step 5 : Else if node a has successors, generate all of them. Sort them by remaining distance from goal and add them at beginning of START.
   - Step 6 : Go to sept 2.

Q. 12 A* with example :

Algorithm :

- Sept 1 : Put initial node on list START
- Step 2 : If (START is empty) or (START = GOAL) then terminate search
- Step 3 : Remove first node from START call it as node a
- Step 4 : If (a = GOAL) then terminate search with success
- Step 5 : Else if node has successors generate all of them. Sort list by fitness number.
- Step 6 : Name this new list as START 1
- Step 7 : Replace START with START 1
- Step 8 : Go to step 2.

Q. 13 Limitations of steepest-ascent hill climbing :

1. A local maximum is a state that is better than all its neighbors but is not better than some other states farther away. At a local maximum all moves appear to make things worse. In this case they are called foothills.
2. A plateau is flat area of search space in which a whole set of neighboring states have same value. On a plateau, it is not possible to determine the best direction in which to move by making local comparisons.
3. A ridge is special kind of local maximum. If is an area of search space that is higher than surrounding areas and that itself has a slope but the orientation of high region compared to set of available moves and directions in which they move makes it impossible to traverse a ridge by single moves.

Q. 14 What is FOPL ?

1. The first order predicate logic (FOPL) is a method of formal representation of natural language text.
2. The prolog language for AI programming has its foundation in FOPL.
3. It demonstrates how to translate NL to FOPL in form of facts and rules and conversion of predicate expression to clause forms.
4. This is followed with unification of predicate expression using instantiations and substitutions, compositions of substitutions.
   i. x : x (Ramesh) – at least friends (y ^ z)

ii. $x \wedge y$ (friends) – $(\neg x) \wedge (\neg y)$ (enemies)

Q. 15 Uniformed vs informed search :

	Uniformed search	Informed search
Known as	It is also known as blind search.	It is also known as heuristic search.
Knowledge usage	It doesn't use knowledge for searching process.	It uses knowledge for searching process.
Performance	It is slower.	It is faster.
Completion	It is always complete.	It may or may not complete.
Cost	Cost is high.	Cost is low.
Implementation	It is more lengthy.	It is less lengthy.
Efficiently	It is less efficient.	It is more efficient.
Examples	DFS BFS Branch & bound	A* search AO* search Hill climbing

Q. 16 BFS vs DFS

	BFS	DFS
Stands for	Breadth first search.	Depth first search.
Data structure	BFS uses queue data structure for finding shortest path.	DFS uses stock data structure for finding shortest path.
Speed	It is slower	It is faster.
Approach	BFS work on FIFO.	DFS works on LIFO.
Back tracking	In BFS there is no concept of back tracking.	DFS uses back tracking concept.
Memory	BFS requires more memory.	DFS requires less memory.
Distance from source	BFS works better when target is closer to source.	DFS works better when target is further from source.

Q. 17 Forward chaining and backward chaining :

1. forward chaining employs the system starts from that a set of facts and set of rules and tries to find a way of using those rules and facts to deduce a conclusion or come up with suitable course of action.
2. This is known as data-driven reasoning because the reasoning starts from set of data and ends up at goal, which is conclusion.
3. Ex. Rule 1 : If on first floor and button is pressed on first floor
   THEN open door.

   Rule 2 : If on first floor
   AND button is pressed on second floor
   THEN go to second floor

   Rule 3 : If on first floor
   AND button is pressed on third floor
   THEN go to third floor

Rule 4 : If on second floor
AND button is pressed on first floor
AND already going to third floor
THEN remember to go to first floor later.

4. In backward chaining, we start from a conclusion which is the hypothesis. We wish to prove and we aim to show how that conclusion can be reached from the rules & facts in database.

5. The conclusion we are aiming to prove is called a goal and so reasoning in this way is known as goal-driven reasoning.
For example, if goal state involves a block being on table then one possible action would be to place that block on table.
This action might not be possible from start state and so further actions need to be added before this action in order to reach it from the start state.

Q. 18 Knowledge representation & types :

- In AI systems knowledge is represented in the following manner,
  i. Events
  ii. Object
  iii. Meta-knowledge
  iv. Knowledge-base
  v. Performance

- Categories of knowledge :
  i. Tacit knowledge
  ii. Explicit knowledge

- Types of knowledge representation :
  i. Declarative knowledge : Includes concept, facts, objects
  Also called as descriptive knowledge

  ii. Procedural knowledge : Also called as imperative knowledge
  Includes rules, strategies, procedures

  iii. Meta knowledge : Knowledge about other knowledge

  iv. Heuristic knowledge : Knowledge of some expert in subject

  v. Structural knowledge : Basic problem solving knowledge
  kind of, part of, grouping of

Q. 19 Planning ? types planning ? Partial planning :

- Planning :
  1. Artificial intelligence is critical technology whether it is intelligent robots or self-driving cars or smart cities, then will use all different aspects of AI.
  2. But to create any such AI project planning is very important.
  3. Planning is considered as logical side of acting.
- Types of planning :
  1. Forward state space planning (FSSP)
  Advantage : The algorithm is sound (consistent)
  Disadvantage : Large branching factor
  2. Backward state space planning (BSSP) :
  Advantage : Small branching factor

Disadvantage : not sound algorithm (inconsistent)

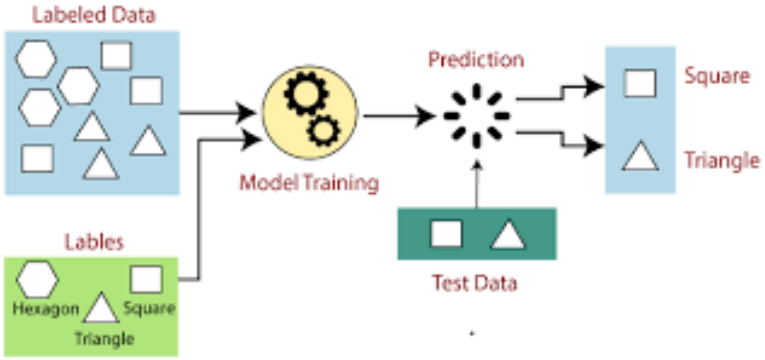
- Partial order planning :
  1. In partial order planning ordering of actions in partial.
  2. Also partial ordered planning don't specify which action will come first out of two actions which placed.
  3. With POP problem can be decomposed, so it can work well in case environment is non cooperative.
  4. Partial order planning sometimes also called as non **linear** planner.
  5. Partial order planner components :
     i. A set of actions
     ii. A partial order
     iii. A set of casual links
     iv. A set of open preconditions
     v. Casual links
     vi. Partial order plan
  6. Example,
     Plan for backing cake might start :
     i. Go to the store
     ii. Get eggs, get flour, get milk
     iii. Pay for all goods
     iv. Go to kitchen

     This is partial plan because order of milk, eggs, flour is not specified.

Q. 20 Supervised and unsupervised learning ?

- Types of learning algorithms :
  i. Supervised learning
  ii. Unsupervised learning
  iii. Reinforcement learning

- Supervised learning :
  i. In supervised learning the training data provided to machines work as supervisor that teaches machines to predict output correctly.
  ii. In real world supervised learning can be used for risk assessment, image classification fraud detection, spam filtering, etc.
  iii. Diagram :



  iv. Dataset of different types of shapes which includes hexagon, square, triangle, rectangle
     a) If given shape has four sides& all sides are equal then it will be labelled as square.
     b) If given shape has 3 sides, then it will be labelled as triangle
     c) If given shape has 6 sides, then it will be labelled as hexagon.
  v. Types of supervised learning :

a) Regression
b) Classification

i. Regression
   - Linear regression
   - Non-linear regression
   - Bayesian linear regression
   - Polynomial regression

ii. Classification
   - Random forest
   - Logistic regression
   - Decision trees
   - Support vector machines

- Unsupervised learning :

1. Unsupervised learning refers to the learning from unlabeled data.
2. Unsupervised learning does not take any feedback.
3. Why use unsupervised learning :
   i. Helpful for finding useful insights
   ii. Closer to real AI
   iii. Works on uncategorized data
4. Types of unsupervised learning :
   i. Clustering
   ii. Association
5. List of unsupervised learning algo
   i. K-means clustering
   ii. KNN
   iii. Hierarchical clustering
   iv. Neural networks
   v. Principle component analysis
   vi. Independent component analysis
   vii. Apriori algo
6. Advantages :
   i. Used for complex tasks
   ii. Easy to get unlabeled data
7. Disadvantages :
   i. Difficult
   ii. May be less accurate

Q. 21 NLP (natural language processing)

Different levels of NLP 1 steps :

1. Morphology :
   - It is analysis of individual world that consist of morphemes the smallest grammatical unit.
   - This analysis becomes necessary
2. Syntax :
   - Syntax is concerned with rules
   - It includes legal formulation of sentence to check structures.
   - Ex. “Hari is good not to” = structure is invalid.

3. Semantic :
   - During this phase, meaning check is carried out and way in which meaning is conveyed is analyzed.
   - Ex. “The table is on ceiling” = syntactically correct, semantically wrong.
4. Discourse integration :
   - Discourse analysis deals with identification of discourse structure.
5. Pragmatic :
   - In this phase, the analysis of response from user is handled.
   - Ex. “Do you know how long it will take to complete the job”, expected answer is number rather than yes or no.
6. Prosody :
   - It is an analysis phase that handles rhythm.
7. Phonology :
   - This involves analysis of different kinds of sounds that are combined.

Basic steps :

1. Lexical analysis
2. Syntax
3. Semantic
4. Discourse integration
5. Pragmatic analysis

Applications of NLP :

1. Spelling & grammar checking
2. Screen readers for blind users
3. Document classification
4. Document clustering
5. Question answering
6. Exam marking
7. Report generation

Types of NLP language models :

1. Statistical language models
2. Neural language models

Q. 22 Belief network / conditional probability

1. Bayesian belief network is key computer technology for dealing with probabilistic events and to solve problem which has uncertainty.
2. It is also called as Bayes network, belief network, decision network or Bayesian model.
3. Bayesian network used in various tasks including prediction, anomaly detection making.
4. Bayesian network consist of two parts :
   i. Directed acyclic graph
   ii. Table of conditional probabilities
5. Bayesian network has mainly two components :
   i. Casual component
   ii. Actual numbers
6. Purpose of belief network :
   i. Specifies joint probability distribution
   ii. Network can be queried by asking for conditional probability
7. Belief networks are popular tools for encoding uncertainty in expert systems

8. Probability propagation in trees of clusters (PPTC) algorithm is method for exact inference on belief networks.
9. Ex.
   i. Has lung cancer (C)
   ii. Smokes (S)
   iii. Has a reduced life expectancy (RLE)
   iv. Exposed to secondhand smoke (SHS)
   v. At least one parent smokes (PS)

Q. 23 Generic algorithm (chromosomes, mutation, cross over)

1. Generic algorithm is problem solving technique that uses genetics as its model of problem solving.
2. Terminologies :

i. Population :
Population is subset of all possible solutions, which can solve given problem.

ii. Chromosomes :
Chromosome is one of the solutions in population for given problem and collection of Gene generate a chromosome.

iii. Gene :
A chromosome is divided into different gene, it is an element of chromosome.

iv. Allele :
Allele is value provided to gene within particular chromosome.

v. Fitness function :
The fitness function is used to determine the individuals fitness level in population.

Crossover operator :

i. This represents mating between individuals.
ii. Two individuals are selected using selection operator and crossover sites are chosen randomly.

Mutation operator : The key idea is to insert random geners in offspring to maintain diversity in the population to avoid premature convergence.

Q. 24 FOL to CNF

Step 1 : Eliminate implication = $\alpha \rightarrow \beta = \neg \alpha \vee \beta$

(remove $\rightarrow$ or $\leftrightarrow$) $\alpha \leftrightarrow \beta = (\alpha \rightarrow \beta) \wedge (\beta \rightarrow \alpha)$

Step 2 : Standardize variable = (use different variable at different sentence)

Step 3 : Move negation inwards = (remove negation $\neg$)

Step 4 : Skolemization

Step 5 : Drop universal quantifier

Q. 25 Resolution :

All people who are graduating are happy

All happy people smile

Some one is graduating

i. Convert to FOL
ii. FOL to CNF
iii. Prove “Is someone smiling?”
iv. Resolution tree

i. Convert to FOL
   a) ∀x (Graduating (x) → happy(x))
   b) ∀x happy(x) → smile(x))
   c) x (Graduating (x)))
   d) ⅂ x smile (x)

ii. FOL to CNF
   a) ∀x (⅂ graduating (x) v happy(x))
      ∀x (⅂ happy (x) v smile(x))
      x Graduating (x)
      ⅂ x smile G
   b) ∀x (⅂ Graduating (x) v happy(x))
      ∀y (⅂ happy (y) v smile(y))
      Z Graduating (z)
      ⅂ x smile (w)
   c) ∀w ⅂ smile (w)
   d) Graduating (A)
   e) ⅂ Graduating (x) v happy(x)
      ⅂ Graduating (y) v happy(y)
      Graduating (A)
      ⅂ smile (w)

Q. 26 Expert system architecture

- AI tools
- Expert system is a computer system that emulates the decision-making ability of human expert.
- It is designed to solve complex problems by reasoning.

Components :

1. Knowledge base :
   - db of rules
   - contains domain-specific & high quality knowledge
2. interface engine :
   - takes & manipulates knowledge from knowledge base.
   - Uses forward & backward chaining techniques.
3. User interface :
   - Provides interaction between expert system & user.