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1a-

⇒ Bayes Theorem:

The probability of an event based on prior knowledge of condition that might be related to event.

↳ In probability ~~test~~ theory it relates conditional probability and marginal probabilities of two random events.

Formula:

$$P(B|A) = \frac{P(A|B) \cdot P(B)}{P(A)}$$

Derivation:

$$P(A \cap B) = P(A|B) \cdot P(B) \quad \longleftarrow (i)$$

Also $$P(A \cap B) = P(B|A) \cdot P(A) \quad \longleftarrow (2)$$

from (1) and (2):

$$P(A|B) \cdot P(B) = P(B|A) \cdot P(A)$$

$$\rightarrow P(B|A) = \frac{P(A|B) \cdot P(B)}{P(A)}$$

where $P(A|B)$ = probability of event A when B is already occured.

$P(B|A)$ = probability of event B when A is already occured

$P(A)$ = probability of event A

$P(B)$ = " " B.

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Importance of Bayes theorem
1] Robot Automatic machine (next step is calculated.
2] Forecasting (weather forecast.
3] Monty Hall Problem can be solved.

→ Conditional Probability :

It is defined as chances that some outcome occurs given that another event has also occured.

- It is often stated as probability of B given A and is written as P(B|A), where probability of B depends on that of A happening.
- It can be contrasted with unconditional probability.
- Baye's theorem is a mathematical formula used in calculating conditional probability

→ Posterior Probability :

It is revised or updated probility of an event occuring after taking into consideration new information. The posterior probability is calculated by updating prior probality in Bayes theorem.

- The posterior probality is probability of event A occuring given that event B has occured.

→ Prior Probability :

It is probability of an event before new data is called.

- This is best rational assessment of probability of an outcome based on current knowledge before an experiment is performed.
- The prior probability is basis for posterior probabilities.

1.b

Monotonic reasoning System	Non-Monotonic Reasoning System
• It is process which doesn't change its direction as can say that it moves in one direction.	• It is process which changes its direction as value as knowledge base increases.
• It deals with very specific type of models, which has valid proofs	• Non monotonic reasoning deals with incomplete as not known facts.
• The addition in knowledge won't change result.	• The addition in knowledge will invalidate previous conclusions and change result.
• In monotonic Reasoning, results are always true, therefore, set of preposition will only increase.	• In Non-Monotonic reasoning results and set of prepositions will increase and decrease based on condition of added knowledge.
• It is based on true facts.	• It is based on assumptions
• Deductive reasoning is type of monotonic reasoning.	• Abductive Reasoning and Human Reasoning is a non-monotonic type of reasoning.

2.a.

i) Every mail carrier → was bitten by → dog

ii) Radha → gave a book → Sita

iii) Every dog → in city bites → Constable.

2.b.

Script : Restaurant

Tract : Coffee shop

Props : Table
Menu

F = Food
Check
Money

Roles : S = Customers
W = Waiters
M = Cashiers
O = Owners
C = Cooks

Entry conditions :
S is hungry
S has money.

Results :
S is not hungry
or S is pleased
or S has less money

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Scene 1: Entering
S PTRANS S into restaurant
S ATTEND eyes to tables
S MBUILD where to sit
S PTRANS S to table
S MOVE S to sitting position

Scene 2: Ordering
(W brings menu) (menu on table)
S ATRANS menu to S
S MTRANS W to table
S MBUILD choice of F
S MTRANS signal to W
W PTRANS W to table
S MTRANS 'I want F' to W
W PTRANS W to C
W MTRANS to C

(Do to Scene 3)

Scene 3: Eating
C ATRANS F to W
W ATRANS F to S
S INGEST F

(option: Return to Scene 2 to order something new otherwise go to Scene 4)

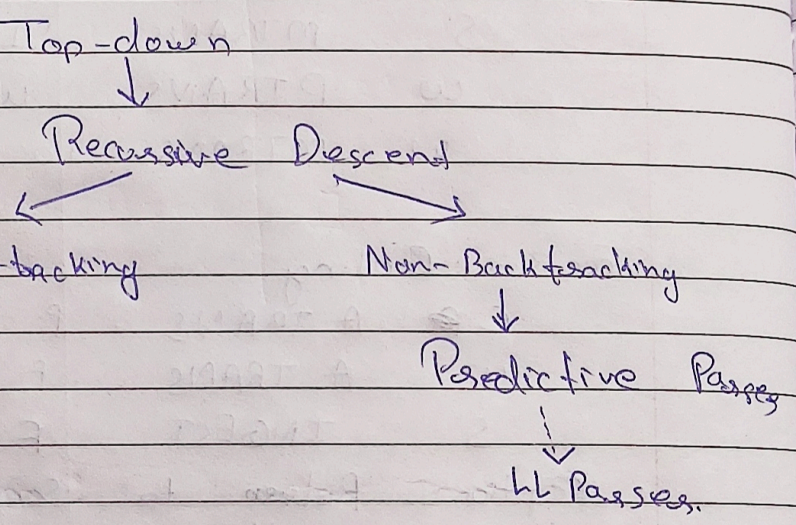
Scene 4: Existing
S MTRANS to W (optional)
W PTRANS W to S
W ATRANS check to S
S PTRANS S to M
S ATRANS money to M
S PTRANS S out of restaurant.

3a, 3b.

4.a.

Two basic passing techniques in AI are:
1] Top-down passing
2] Bottom-up passing

→ Top-down Passing:
- It is also known as recursive passing or predictive passing
- In top-down passing, passing starts from start symbol and transform it into input symbol.



Recursive Descent Parsing: is topdown parsing technique that constructs parse tree from top and input is read from left to right. It uses procedure for every terminal and non-terminal entity. The parsing technique recursively parses, the input to make a parse tree, which may or may not require back-tracking.

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Predictive Parser: is a recursive descent parser, which has capability to predict which production is to be used to replace input string. The predictive parser doesnot suffer from backtracking.

→ Botton-up passing:

- It is also known as shift reduce passing
- It is used to construct a parse tree for an input string
- In bottom-up passing, the passing starts with input symbol and construct parse tree up to start symbol by tracking out rightmost derivations of string in reverse.
- It starts from leaf nodes of a tree and works in upward direction till it reaches root node.
- Here, we start from a sent. and then apply production rules in reverse manner in order to reach start symbol.

Top-down Passing	Bottom-up Passing
• It is passing strategy that first looks at highest level of parse tree and works down parse tree by using rules of grammer	• It is passing strategy, that first looks at lowest level of parse tree and works up parse tree by using rules of grammer.

• Top-down passing attempts to find left most derivations for input string.	• Bottom-up passing can be defined as an attempt to reduce input string to start symbol of grammar.
• In this, we start passing from top to bottom. ~~left rule of pase~~	• In this, we start passing from bottom to up-
• This passing technique uses left most derivation	• It uses right most derivation.
• This main leftmost decision is to select what production rule to use in order to construct string.	• The main decision is to select when to use production rule to reduce string to get starting symbol
• example: Recursive Descent passes.	eg]: Its shift Reduce passes.

4. b.

Expert System:

An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like human expert. It performs this by extracting knowledge from its knowledge base using reasoning and inference rule acc^n to queries.

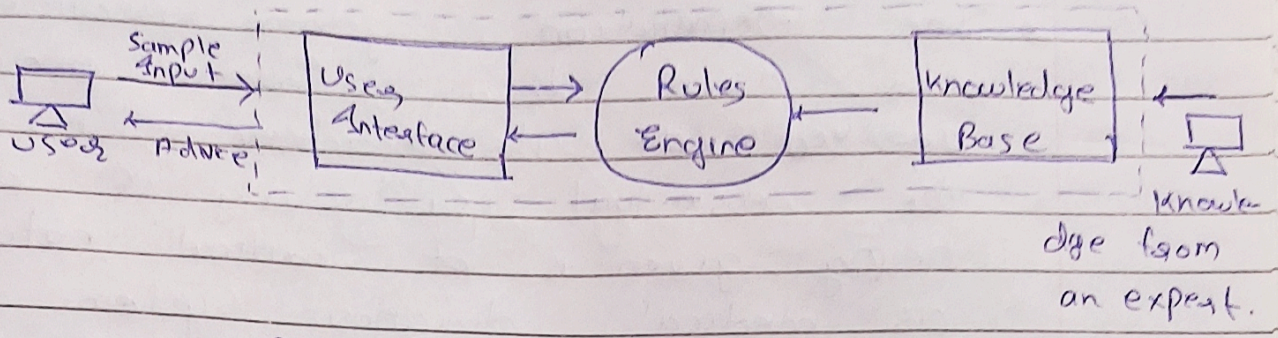


Fig: block dig. of expert system.

→ Architecture of an Expert System.

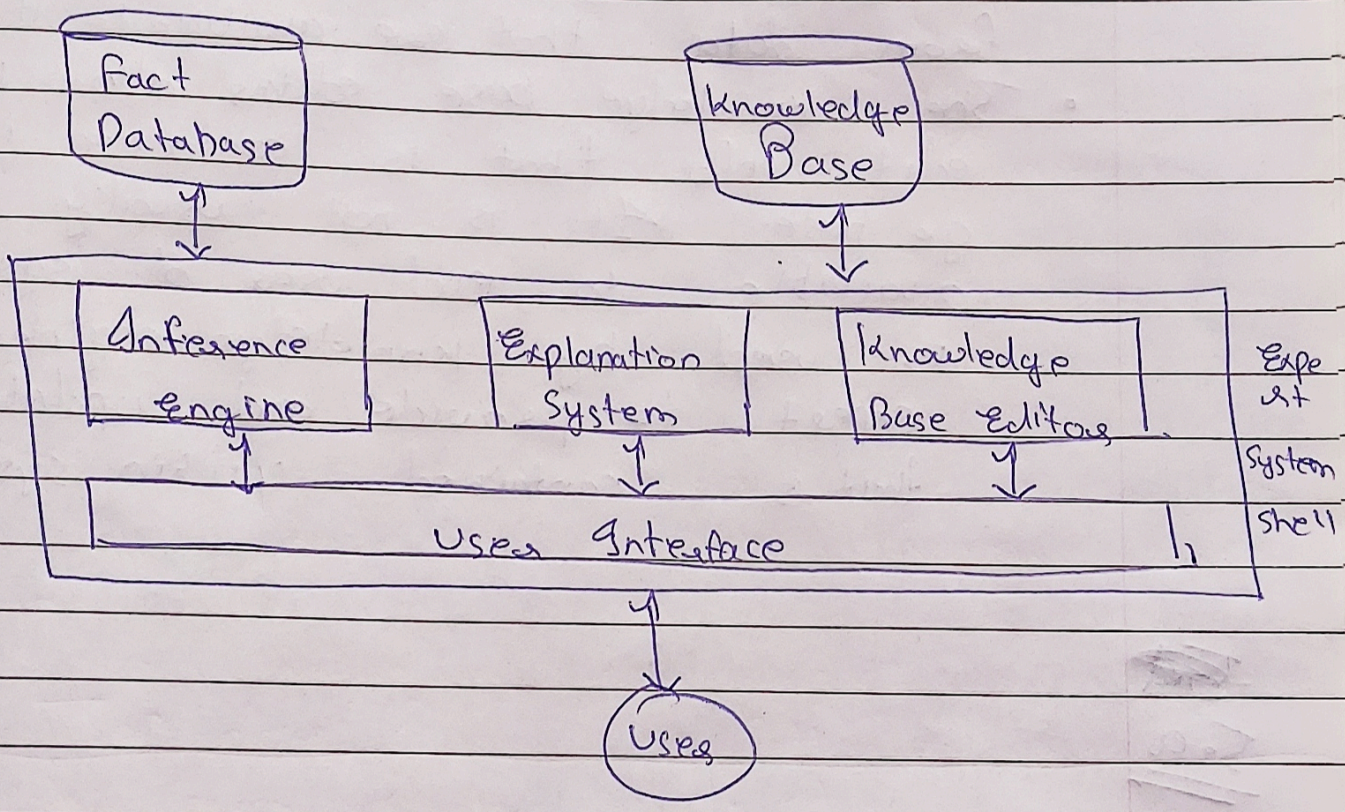


fig: Expert system Architecture.

- The knowledge base contains spefic domain knowledge that is used by an expert to derive conclusions from fact.

- The explanation system provide info to user about how inference engine arrived at its conclusion. This can often be essential, particularly if advice being given is of critical nature, such as medical diagnosis system.
- The inference engine is part of system that uses rules and facts to derive conclusions. The inference engine will use forward chaining, backward chaining or combination of two to make inferences from data that are available to it.
- The knowledge base editor allows user to edit info that is contained in knowledge base. It is not usually made available to end user of system but is used by knowledge engineer or expert to provide and update knowledge that is contained within system.

~~3rd~~

5. a

- Game playing is imp domain in A.I. Game doesn't require much knowledge; the only knowledge we need to provide is rules, legal moves and conditions of winning or losing game
- Both players try to win game. So both of them try to make best move possible at each turn.
- Searching techniques like BFS (Breadth first search) are

not accurate for this as branching factor is very high, so searching will take bt of time. So, we need another search procedure that improve

- Generate procedure so that only good moves are generated
- Test procedure so that best move can be explored first.

- The most common search technique in game playing is minimax search Procedure. It is depth-first, depth-limited search procedure. It is used for games like chess and tic-tac-toe.

→ minimax algo uses two func:

MOVEGEN

STATICVALUATION.

- AI ~~is used~~ can make game more realistic, ~~transforming~~ skills of developers, make game smarter, enhancing overall gaming experience, ~~it is used~~ catch cheaters in game.

This algo is of two players (Player 1, Player 2). The value of each node is backed-up from its children. For Player 1 backed-up value is max value of child. and for Player 2 min value of child. It provide most promising move to Player 1, assuming player 2 have best move.

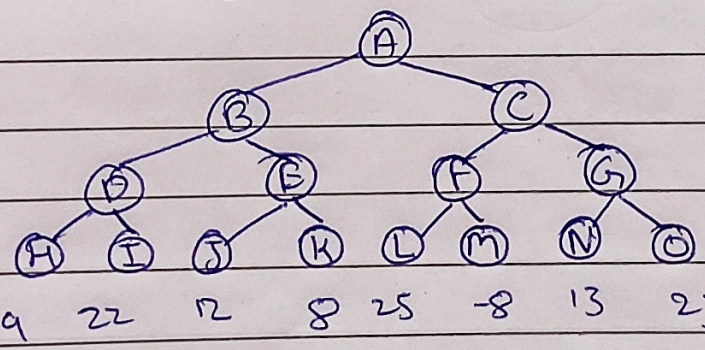


fig: Before Baking-up of values

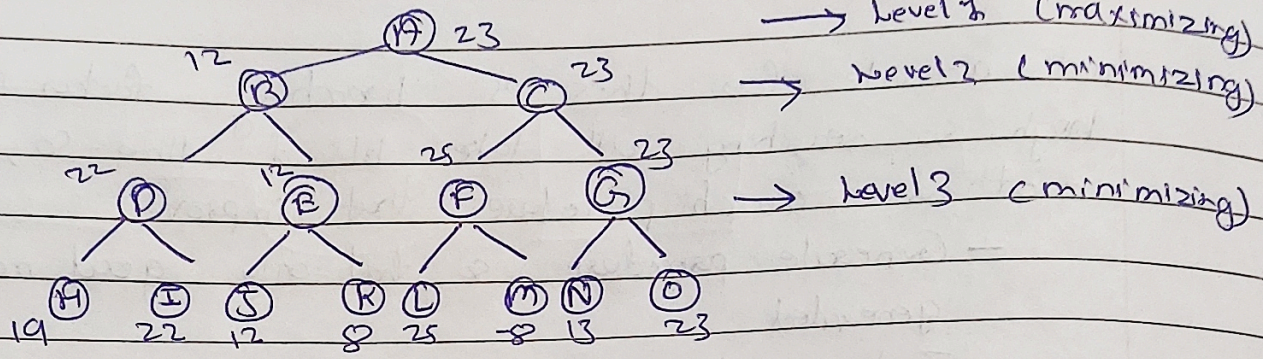


Fig: 2. After backing-up of values.

~~We~~

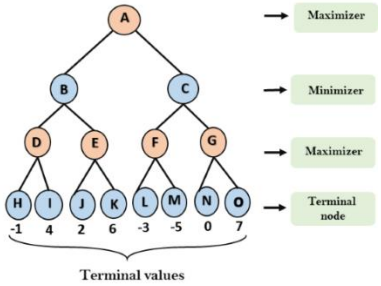
5.b Explain the following (any one) i) Mini Max search procedure ii) Alpha - beta pruning

Ans:

- Mini-max algorithm is a recursive or backtracking algorithm which is used in decision-making and game theory. It provides an optimal move for the player assuming that opponent is also playing optimally**.**
- Mini-Max algorithm uses recursion to search through the game-tree.
- Min-Max algorithm is mostly used for game playing in AI. Such as Chess, Checkers, tic-tac-toe, go, and various tow-players game. This Algorithm computes the minimax decision for the current state.
- In this algorithm two players play the game, one is called MAX and other is called MIN.
- Both the players fight it as the opponent player gets the minimum benefit while they get the maximum benefit.
- Both Players of the game are opponent of each other, where MAX will select the maximized value and MIN will select the minimized value.
- The minimax algorithm performs a depth-first search algorithm for the exploration of the complete game tree.
- The minimax algorithm proceeds all the way down to the terminal node of the tree, then backtrack the tree as the recursion

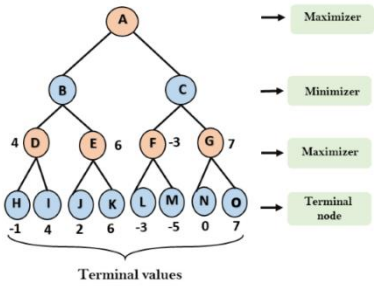
Working of Min-Max Algorithm:

Step-1: In the first step, the algorithm generates the entire game-tree and apply the utility function to get the utility values for the terminal states. In the below tree diagram, let's take A is the initial state of the tree. Suppose maximizer takes first turn which has worst-case initial value =- infinity, and minimizer will take next turn which has worst-case initial value = +infinity.



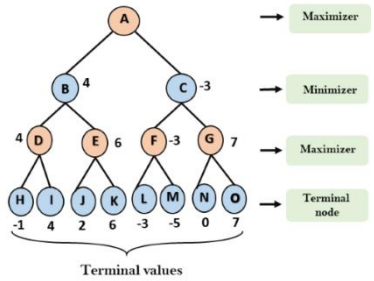
Step 2: Now, first we find the utilities value for the Maximizer, its initial value is -∞, so we will compare each value in terminal state with initial value of Maximizer and determines the higher nodes values. It will find the maximum among the all.

- For node D max(-1,- -∞) => max(-1,4)= 4
- For Node E max(2, -∞) => max(2, 6)= 6
- For Node F max(-3, -∞) => max(-3,-5) = -3
- For node G max(0, -∞) = max(0, 7) = 7



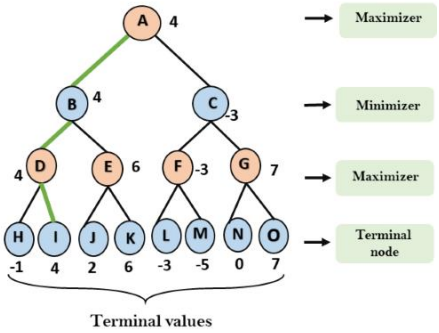
Step 3: In the next step, it's a turn for minimizer, so it will compare all nodes value with +∞, and will find the 3rd layer node values.

- For node B= min(4,6) = 4
- For node C= min (-3, 7) = -3



Step 4: Now it's a turn for Maximizer, and it will again choose the maximum of all nodes value and find the maximum value for the root node. In this game tree, there are only 4 layers, hence we reach immediately to the root node, but in real games, there will be more than 4 layers.

- For node A max(4, -3)= 4



That was the complete workflow of the minimax two player game.

6.a)Define NLP. Explain the following components of NLP.
i) NLU (Natural Language Understanding)
ii)NLG (Natural Language Generation).

Ans: NLP: Natural Language Processing (NLP) refers to AI method of communicating with an intelligent systems using a natural language such as English.
Processing of Natural Language is required when you want an intelligent system like robot to perform as per your instructions, when you want to hear decision from a dialogue based clinical expert system, etc.
The field of NLP involves making computers to perform useful tasks with the natural languages humans use.
The input and output of an NLP system can be −

- Speech
- Written Text

Components of NLU :

- NLU
- NLG

NLG: NLG is a method of creating meaningful phrases and sentences (natural language) from data. It comprises three stages: text planning, sentence planning, and text realization.

- Text planning: Retrieving applicable content.
- Sentence planning: Forming meaningful phrases and setting the sentence tone.
- Text realization: Mapping sentence plans to sentence structures.
  Chatbots, machine translation tools, analytics platforms, voice assistants, sentiment analysis platforms, and AI-powered transcription tools are some applications of NLG.

NLU: NLU enables machines to understand and interpret human language by extracting metadata from content. It performs the following tasks:

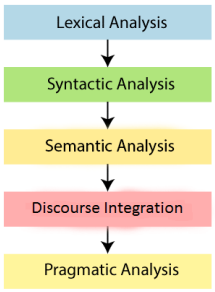
- Helps analyze different aspects of language.
- Helps map the input in natural language into valid representations.

NLU is more difficult than NLG tasks owing to referential, lexical, and syntactic ambiguity.

- Lexical ambiguity: This means that one word holds several meanings. For example, "The man is looking for the match." The sentence is ambiguous as 'match' could mean different things such as a partner or a competition.
- Syntactic ambiguity: This refers to a sequence of words with more than one meaning. For example, "The fish is ready to eat." The ambiguity here is whether the fish is ready to eat its food or whether the fish is ready for someone else to eat. This ambiguity can be resolved with the help of the part-of-speech tagging technique.
- Referential ambiguity: This involves a word or a phrase that could refer to two or more properties. For example, Tom met Jerry and John. They went to the movies. Here, the pronoun 'they' causes ambiguity as it isn't clear who it refers to.

6.b. List the levels of NLP and explain each with suitable example.

ANS: There are the following five Levels of NLP:



1. Lexical Analysis and Morphological

The first phase of NLP is the Lexical Analysis. This phase scans the source code as a stream of characters and converts it into meaningful lexemes. It divides the whole text into paragraphs, sentences, and words.

2. Syntactic Analysis (Parsing)

Syntactic Analysis is used to check grammar, word arrangements, and shows the relationship among the words.

Example: Agra goes to the Poonam

In the real world, Agra goes to the Poonam, does not make any sense, so this sentence is rejected by the Syntactic analyzer.

3. Semantic Analysis

Semantic analysis is concerned with the meaning representation. It mainly focuses on the literal meaning of words, phrases, and sentences.

4. Discourse Integration

Discourse Integration depends upon the sentences that proceeds it and also invokes the meaning of the sentences that follow it.

5. Pragmatic Analysis

Pragmatic is the fifth and last phase of NLP. It helps you to discover the intended effect by applying a set of rules that characterize cooperative dialogues.

For Example: "Open the door" is interpreted as a request instead of an order.

Q7 a Explain the knowledge representation in artificial neural networks?

Ans: Knowledge representation and reasoning (KR, KRR) is the part of Artificial intelligence which concerned with AI agents thinking and how thinking contributes to intelligent behavior of agents.It is responsible for representing information about the real world so that a computer can understand and can utilize this knowledge to solve the complex real world problems such as diagnosis a medical condition or communicating with humans in natural language.

- It is also a way which describes how we can represent knowledge in artificial intelligence. Knowledge representation is not just storing data into some database, but it also enables an intelligent machine to learn from that knowledge and experiences so that it can behave intelligently like a human.

What to Represent:

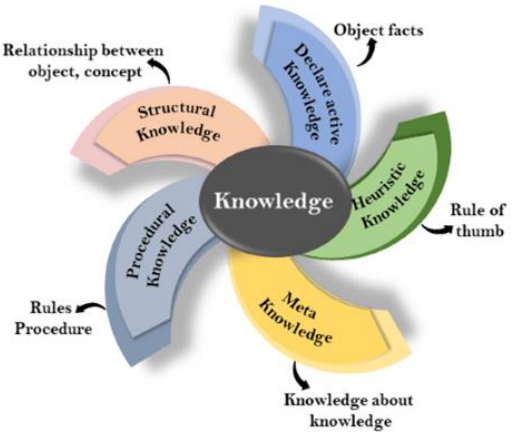
Following are the kind of knowledge which needs to be represented in AI systems:

- **Object**
- **Events**
- **Performance**
- **Meta-knowledge**
- **Facts**
- **Knowledge-Base**

Knowledge: Knowledge is awareness or familiarity gained by experiences of facts, data, and situations. Following are the types of knowledge in artificial intelligence:

Types of knowledge

Following are the various types of knowledge:



1. Declarative Knowledge:

- Declarative knowledge is to know about something.
- It includes concepts, facts, and objects.
- It is also called descriptive knowledge and expressed in declarativesentences.
- It is simpler than procedural language.

2. Procedural Knowledge

- It is also known as imperative knowledge.
- Procedural knowledge is a type of knowledge which is responsible for knowing how to do something.
- It can be directly applied to any task.
- It includes rules, strategies, procedures, agendas, etc.
- Procedural knowledge depends on the task on which it can be applied.

3. Meta-knowledge:

- Knowledge about the other types of knowledge is called Meta-knowledge.

4. Heuristic knowledge:

- Heuristic knowledge is representing knowledge of some experts in a filed or subject.
- Heuristic knowledge is rules of thumb based on previous experiences, awareness of approaches, and which are good to work but not guaranteed.

5. Structural knowledge:

- Structural knowledge is basic knowledge to problem-solving.
- It describes relationships between various concepts such as kind of, part of, and grouping of something.
- It describes the relationship that exists between concepts or objects.

Q.7.b. Explain the life cycle of genetic algorithm.

ANS: A genetic algorithm is used to solve complicated problems with a greater number of variables & possible outcomes/solutions. The combinations of different solutions are passed through the Darwinian based algorithm to find the best solutions. The poorer solutions are then replaced with the offspring of good solutions.

- The components of the population, i.e., elements, are termed as genes in genetic algorithms in AI. These genes form an individual in the population (also termed as a chromosome).
- A search space is created in which all the individuals are accumulated. All the individuals are coded within a finite length in the search space.
- Each individual in the search space (population) is given a fitness score, which tells its ability to compete with other individuals.

- All the individuals with their respective fitness scores are sought & maintained by the genetic algorithm & the individuals with high fitness scores are given a chance to reproduce.
- The new offspring are having better 'partial solutions' as compared to their parents. Genetic algorithms also keep the space of the search space dynamic for accumulating the new solutions (offspring).
- This process is repeated until the offsprings do not have any new attributes/features than their parents (convergence). The population converges at the end, and only the fittest solutions remain along with their offspring (better solutions). The fitness score of new individuals in the population (offspring) are also calculated.

The general lifecycle of a genetic algorithm is as follows:

- **Creation of a population**: This involves creating a random population of potential solutions.
- **Measuring fitness of individuals in the population**: This involves determining the efficacy of a specific solution. This is accomplished by using a fitness function which scores solutions to determine their worth.
- **Selecting parents based on their fitness**: This involves selecting a number of pairs of parents who will reproduce offspring.
- **Reproducing individuals from parents**: This involves creating offspring from their respective parents by mixing genetic information and applying slight mutations to the offspring.
- **Populating the next generation**: This involves selecting individuals and offspring from the population who will survive to the next generation.

Q8 a List the genetic operators and explain each of them with suitable example.
b Explain the following terms:-
i) Genes
ii) Chromosomes

Q9.a. Describe different applications of neural networks.
Ans: Following are some important ANN Applications –

- **Speech Recognition:** Speech recognition relies heavily on artificial neural networks (ANNs). Earlier speech recognition models used statistical models such as Hidden Markov Models. With the introduction of deep learning, several forms of neural networks have become the only way to acquire a precise classification.
- **Handwritten Character Recognition:** ANNs are used to recognize handwritten characters. Handwritten characters can be in the form of letters or digits, and neural networks have been trained to recognize them.
- **Signature Classification:** We employ artificial neural networks to recognize signatures and categorize them according to the person's class when developing these authentication systems. Furthermore, neural networks can determine whether or not a signature is genuine.
- **Medical:** It can be used to detect cancer cells and analyze MRI pictures in order to provide detailed results.

9.b Define :
i) Artificial Neural Network
ii Genetic Algorithm.

Ans: i) Artificial Neural Network
Artificial Neural Networks contain artificial neurons which are called **units**. These units are arranged in a series of layers that together constitute the whole Artificial Neural Networks in a system. A layer can have only a dozen units or millions of units as this depends on the complexity of the system. Commonly, Artificial Neural Network has an input layer, output layer as well as hidden layers. The input layer receives data from the outside world which the neural network needs to analyze or learn about. Then this data passes through one or multiple hidden layers that transform the input into data that is valuable for the output layer. Finally, the output layer provides an output in the form of a response of the Artificial Neural Networks to input data provided.
In the majority of neural networks, units are interconnected from one layer to another. Each of these connections has weights that determine the influence of one unit on another unit. As the data transfers from one unit to another, the neural network learns more and more about the data which eventually results in an output from the output layer.

ii Genetic Algorithm.

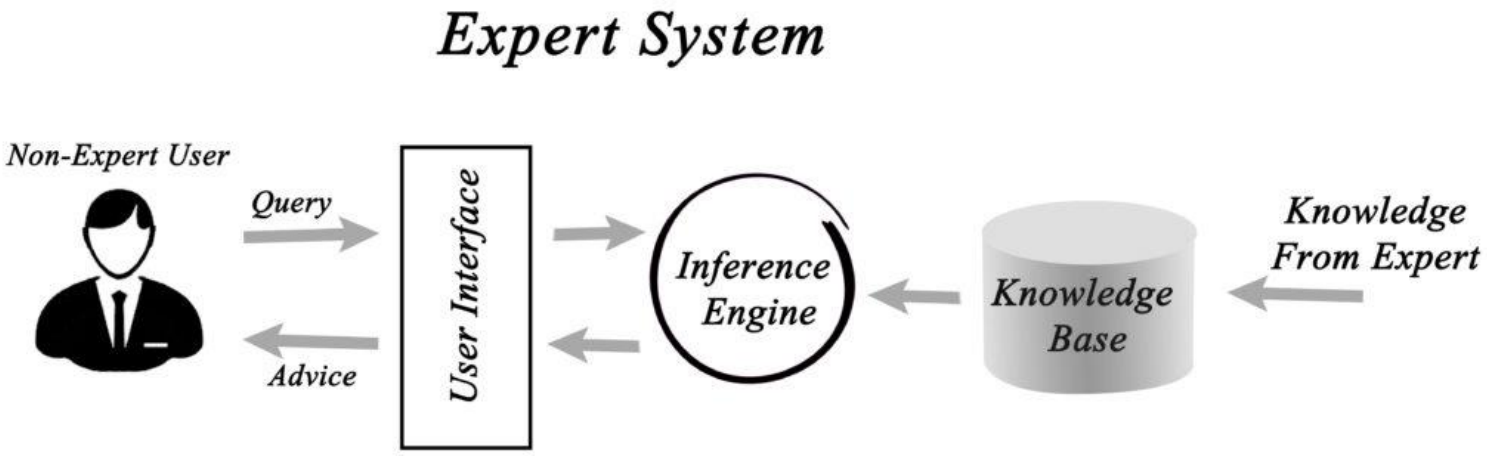
A genetic algorithm is used to solve complicated problems with a greater number of variables & possible outcomes/solutions. The combinations of different solutions are passed through the Darwinian based algorithm to find the best solutions. The poorer solutions are then replaced with the offspring of good solutions.

Genetic Algorithms(GAs) are adaptive heuristic search algorithms that belong to the larger part of evolutionary algorithms. Genetic algorithms are based on the ideas of natural selection and genetics. These are intelligent exploitation of random search provided with historical data to direct the search into the region of better performance in solution space. They are commonly used to generate high-quality solutions for optimization problems and search problems.
Genetic algorithms simulate the process of natural selection which means those species who can adapt to changes in their environment are able to survive and reproduce and go to next generation. In simple words, they simulate "survival of the fittest" among individual of consecutive generation for solving a problem. Each generation consist of a population of individuals and each individual represents a point in search space and possible solution. Each individual is represented as a string of character/integer/float/bits. This string is analogous to the Chromosome.

Q10.a. Explain with neat diagram various components of a typical expert system

Ans: There are 5 Components of expert systems:

1. Knowledge Base
2. Inference Engine
3. Knowledge acquisition and learning module
4. User Interface
5. Explanation module



- **Knowledge base:** The knowledge base in an expert system represents facts and rules. It contains knowledge in specific domains along with rules in order to solve problems and form procedures that are relevant to the domain.
- **Inference engine:** The most basic function of the inference engine is to acquire relevant data from the knowledge base, interpret it, and find a solution to the user's problem. Inference engines also have explanatory and debugging abilities.
- **Knowledge acquisition and learning module:** This component functions to allow the expert systems to acquire more data from various sources and store it in the knowledge base.
- **User interface:** This component is essential for a non-expert user to interact with the expert system and find solutions.
- **Explanation module:** As the name suggests, this module helps in providing the user with an explanation of the achieved conclusion.

Q10.b. Explain GA based machine learning.

Ans: A genetic algorithm is used to solve complicated problems with a greater number of variables & possible outcomes/solutions. The combinations of different solutions are passed through the Darwinian based algorithm to find the best solutions. The poorer solutions are then replaced with the offspring of good solutions.

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How Genetic Algorithm Work?

The genetic algorithm works on the evolutionary generational cycle to generate high-quality solutions. These algorithms use different operations that either enhance or replace the population to give an improved fit solution. It basically involves five phases to solve the complex optimization problems, which are given as below:

- **Initialization**
- **Fitness Assignment**
- **Selection**
- **Reproduction**
- **Termination**

Advantages of Genetic Algorithm

- The parallel capabilities of genetic algorithms are best.
- It helps in optimizing various problems such as discrete functions, multi-objective problems, and continuous functions.
- It provides a solution for a problem that improves over time.
- A genetic algorithm does not need derivative information.

Limitations of Genetic Algorithms

- Genetic algorithms are not efficient algorithms for solving simple problems.
- It does not guarantee the quality of the final solution to a problem.
- Repetitive calculation of fitness values may generate some computational challenges.