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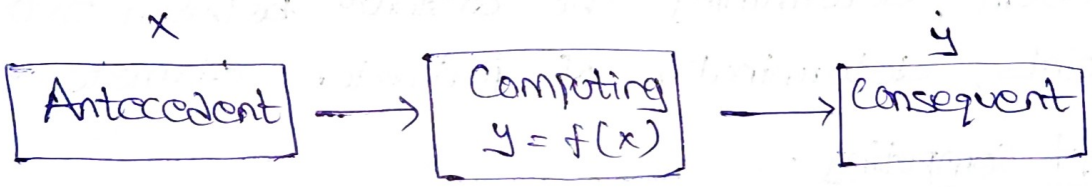
Unit-I

Introduction to Soft Computing and A.I techniques:

1) Introduction to soft Computing
2) Hard computing vs soft computing
3) Types of soft Computing techniques
4) Applications of soft computing
5) Search algorithms of AI
6) Predicate Calculus
7) Semantic Network representation
8) Hybrid models

Computing:

Computing means mapping of inputs to the outputs with the help of algorithm (or) mathematical model.
In the context of computing, the input is also called as Antecedent and the output is called as Consequent.
The basic computing model is as given in the below figure:



As given in the above example, when the input x is given function f will be evaluated and output y will be know (or) to find output y which is the basic example of Computing.
The method of computing must be unambiguous, accurate and provides precise solution.

Computing is suitable for Problems that are easy to model mathematically.

Hard Computing :-

A scientist called Lotfi A Zadeh introduced the term hard Computing in the year 1996. According to him, A computing is said to be hard computing if

1) It Provides precise results. The
2) The control action is formally defined by either mathematical model or algorithm.
3) Algorithm used to solve a problem is unambiguous.

Examples of hard Computing:

1) Determination of differentiation, integration, finding the roots of an equation.
2) All sorting and searching techniques Comes under hard Computing.
3) All geographical Problems such as traveling Salesman Problem, determining the distance between two points, determination of Perimeter, diameter etc.

Soft Computing : What is soft Computing, Explain in brief

Some of the real world Problems like handwriting recognisation, image classification, image processing, audio processing etc donot have an algorithm or mathematical model for computation. To handle this type of Problems soft computing techniques

will be used. The term softcomputing is also introduced by Lotfi A zadeh.

- Soft computing is collection of methodologies that aim to exploit (or) provide tolerance of imprecision and uncertainity to achieve the tractability, robustness and low computing cost.

In the above definition, the following is the few terms to be understand:

1) Tolerance of imprecision : The result obtained is not precise or fixed.
2) uncertainity : The soft computing algorithm may give different results everytime for the same problem.
3) Robustness : Soft computing technique can handle any kind of noise signal.
4) Low solution cost : The soft computing can solve the problems at less computational cost compared to Hard computing.

2. Differentiate the Soft Computing vs. Hard Computing

2/8 Hard Computing vs Soft Computing:

Hard computing	Soft Computing
1. It requires exact mathema-tical model.	1. It requires approximate mathematical model.
2. The response is precise.	2. The response is approximate.
3. Data is Processed sequentially.	3. Data is Processed Parallely.
4. The logic used is Binary logic.	4. fuzzy, Propositional and Predicate logics are used.

Hard Computing	Soft Computing
5. Time required is more.	5. Time required is less.
6. The computation cost is more.	6. The computation cost is less.
7. Examples :- All the conventional methods used in our Personal Computers.	7. Example :- Neural Networks fuzzy logic Genetic algorithms and Hybrid models.

3. Explain the various types of Soft Computing Techniques

Various types of soft Computing techniques:

The following are the various types of soft Computing techniques:

1. Artificial Neural Networks
2. fuzzy logic Controllers
3. Genetic Algorithms

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Artificial Neural Networks (ANN):-

1) Artificial Neural Networks are simplified models of biological neural network.
2) These are designed to mimic the characteristics of human brain.
3) The fundamental element of the ANN is artificial neuron.
4) Different scientists tried in different manner to represent the artificial neuron based on the functioning of biological neuron.

The popular representations (or) models are given as

1. MC-Culloch and pitts model
2. Perceptron model
3. ADALINE model - Adaptive linear element

→ Practically Perceptron model is mostly used because this model can be used in complex problems also.

→ The different architectures of artificial neural networks are

1. Single layer feed forward Neural Network
2. Multi layer feed forward neural network
3. Multi Layer feedBack Neural Network (or) Recurrent Neural Networks

→ To train the artificial neural networks, three basic learning methods are there as given below

1. Supervised learning
2. Unsupervised learning
3. Reinforced learning

Some of the popular artificial neural networks are as follows based on the algorithm used to train the neural network

1. Back Propagation neural network (BPNN)
2. Radial basis function neural network (RBFNN)
3. ~~Coherence~~ Kohenen's Neural Network
4. Hop field Neural Network
5. ADALINE Neural Network
6. MADALINE Neural Network

- Most of the applications (60%) uses Back Propagation. Most of them are stuck up with local, global minima.

Applications of ANN

1) Pattern recognisation
2) Image classification
3) Image Processing
4) Data compression
5) forecasting and optimization etc

5)a)

Fuzzy logic

1) fuzzy logic is developed by a scientist Lofti A Zadeh in the year 1965.

- fuzzy means "uncertain" (or) "vagueness" (or) "incompleteness".
- fuzzy logic is used to provide solution to the problems where there is uncertainity. This uncertainity maybe in the problem definition, in the data given, in the mathematical model (or) in the algorithm.
- fuzzy logic is the extension of classical set theory. Classical set theory make use of Boolean logic (Binary logic).
  fuzzy set theory is implemented using fuzzy logic.
- In a Boolean logic 0.7 can be round off to 1, 0.3 can be round off to 0, But 0.5 maynot be roundoff to either 0 (or) 1, means for this type of problems that are uncertain, boolean logic is unable to provide the solution.
  But fuzzy logic can provide solution.
- In classical set theory, a set is defined as collection of elements.

Ex: $A = \{1, 2, 3, 4\}$ Is $1 \in A \rightarrow$ True (or) 1

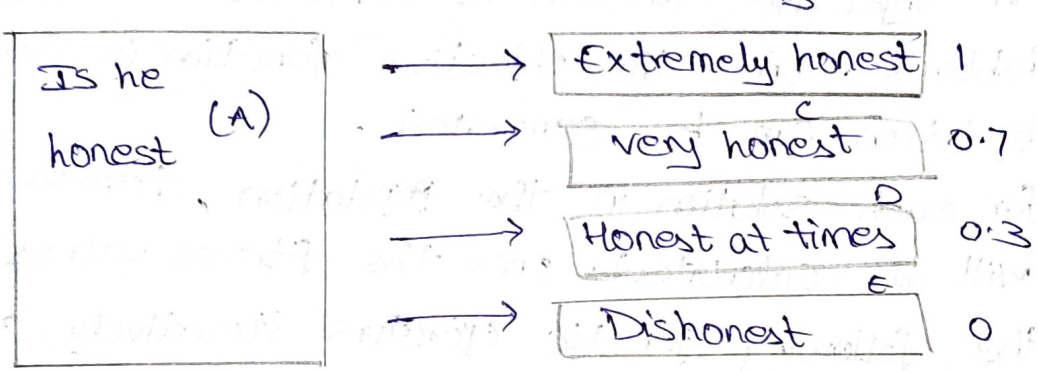
$B = \{a, b, c, d\}$ Is $a \in A \rightarrow$ FALSE (or) 0

- A fuzzy set also defined as collection of elements but each element is represented with "degree of Truth" (or) "membership value".

A Degree of Truth or membership value defines how much strongly the element is belongs to the set.

Let us Consider an example :- Is he honest? Question will have different answers like extremely honest, very honest, honest at times and Dishonest. for every question in fuzzy logic will have multiple answers.

- The Degree of Truth (or) membership values are represented in below:



$$\hat{A} = \{(B, 1), (C, 0.7), (D, 0.3), (E, 0)\}$$

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Fuzzy logic controller is designed using three steps:

1. fuzzification
2. fuzzy Inference
3. Defuzzification

- fuzzification is nothing but conversion of crisp (or) linguistic variables into fuzzy variables.
- fuzzy inferencing is nothing but mapping of inputs to the outputs by rules from rulebase.

- Defuzzification is nothing but again conversion of fuzzy variables into crisp (or) linguistic variables

Genectic algorithms :- (GA)

- Genetic algorithms are developed by a scientist called John Holland in the year 1970.
- These are used to optimize the given problem which follows natural evaluation.
- The basic Principle of genetic algorithms is Darwinian's theory of "survival of fittest".
- The basic thing required for the genetic algorithm to find the optimal solution is 'objective function' (or) 'fitness function'.
- The objective function is different for different Problems. Once the objective function is designed, Population can be generated.
- for each solution in the Population, fitness values will be calculated. once the fitness values calculated the following genetic operators iteratively applied to get the optimum solution:

1) Selection / Reproduction operator
   i) Roulette-wheel selection
   ii) Rank ordering
   iii) Boltzmen selection
   iv) Tournment selection
   v) Steady state selection
2) Cross over
   i) Single site crossover
   ii) Two site crossover

iii) Multi site Crossover
iv) Uniform Crossover
v) Matrix Crossover

3) Mutation :

Applications of Genetic algorithm :

1) optimization
2) Scheduling
3) Machine Learning

Applications of soft Computing : 4. Explain the various Applications of Soft Computing

ANN
1) Pattern recognition
2) Image recognition
3) Image Processing
4) Data Compression
5) forecasting (or) prediction
6) optimization

fuzzy
1) Control system
2) Decision Making

Genetic algorithm
1) Scheduling
2) Machine learning

AI searching techniques 5. Discuss various Search algorithms of AI Techniques

AI searching algorithms are the most commonly used techniques of Problem solving. Different real world problems are travelling salesman problem, scheduling of tasks, designing of self driving cars, designing of Pseudo Sudoko games, N-Queens Problem in ~~class~~ chess, Tower Hanoi Problem, water and jug Problem etc..

The Process of Problem solving having following five steps: 6. What is searching Algorithm give steps involved in problem solving in AI searching Algorithms

1) Defining the Problem
2) Analysis (or) Exploring the Problem
3) Identifying the solutions
4) Choosing Best solution

5) Implementation of solution

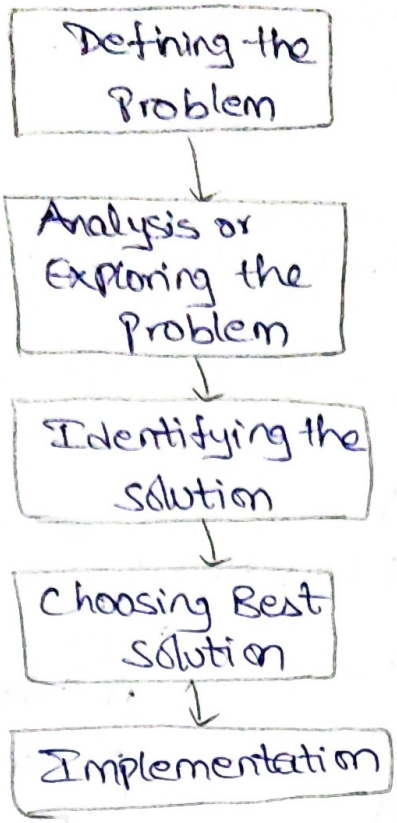


fig: Basic steps in Problem solving

Based on the searching problem, AI search algorithms are classified into

i) UnInformed search algorithm / Blind search

ii) Informed search algorithm / Heuristic search

Uninformed / Blind Search :-

The uninformed search doesnot contain any domain knowledge and information regarding Problem.

It operates on a brute force way as it only includes information about how to traverse the tree to identify b goal / target node.

It examines each node until it acheives the goal node, so it is called as blind search.

Informed search:

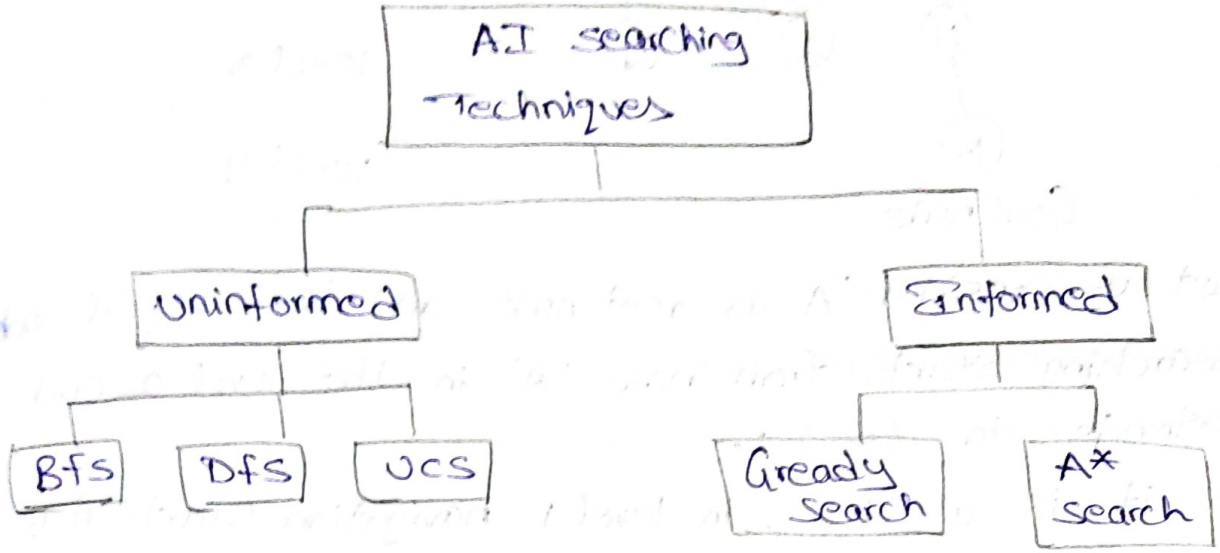
It uses domain knowledge, the problem information is available (which) to guide the search.

Informed search strategies can find a solution more efficient than an uninformed search.

Informed search is also called as heuristic search.

A heuristic search is a way to find good solution in reasonable time.

It can solve much complex problems which could not be solved by uninformed search.



Bfs - Breadth first search
Dfs - Depth first search
UCS - Uniform cost search

7. Discuss the following Search Algorithms[7].
i. Breadth first Search Algorithm
ii. Depth first search Algorithm
iii. Uniform search Algorithm

Breadth first search:

It is the most common search strategy for traversing a graph. This algorithm searches in a breadth wise in a tree of graph.

So it is called as Breadth first search (Bfs) (left to right).

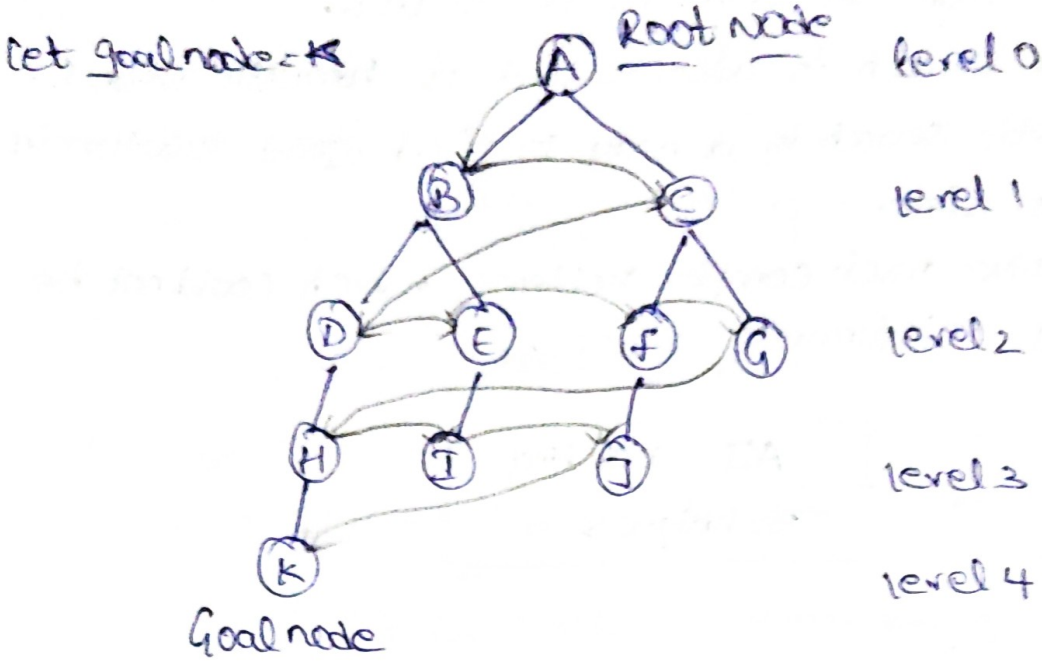
Breadth first search starts searching root node of the tree and navigate all the nodes in that level for

goal node before going to next level.

Bfs is an example of general graph searching algorithm

Bfs is implemented using fifo Queue data structure

Let us consider the following example:



Let us consider 'A' as root node and 'K' as goal node searching starts from node 'A' in the level 0 and extends to level 1.

As it is a Bfs, in level 1 navigation starts at B and move towards C. As there is no goal node in level 1 search expands to level 2.

In level 2, search starts at D and reads remaining nodes (E, F, G). As the goal node is not there in level 2, search expands to level 3.

In level 3 navigation starts & moves to I, J in sequence then search expands to level 4 and moves to node k which is the goal node so the searching terminates here.

Advantages:

1) Bfs provides the solution if any solution exists. If there is more than one solution for a given Problem., Bfs will provide minimal solution which requires least no of steps.

Disadvantages

1) Bfs needs lot of time if the solution is far away from the root node.
2) It requires lot of memory since each level of the tree must be saved into the memory.

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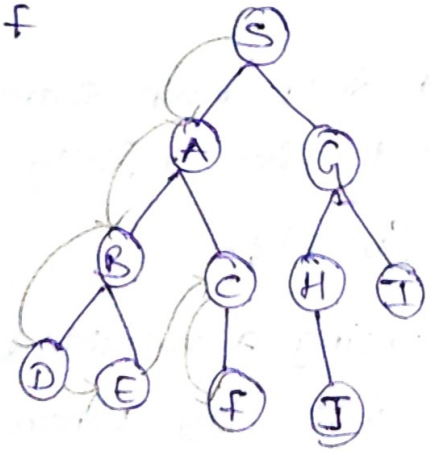
Depth first search

It is a recursive algorithm for traversing a tree or graph. It is called depth first search algorithm because it starts from the root and follows each path to its greatest depth node before moving to the next.

Depth first search uses stack datastructures for implementation.

Goal Node = f



Level 0

Level 1

level 2

level 3

Let us Consider 'f' as a goal node the searching Starts from root node 's' and traverses to 'A'. Then it goes to 'B' and then to 'D' finally. After 'D', there is no successor nodes and it is the greatest depth node. So the searching moves to node 'E' as already node 'B' is navigated. Then the searching ~~brack~~ backtracks [navigates to node 'c' as it is also not a goal node it moves to 'f'.

The searching will be terminated here as 'f' is the goal node.

Advantages:

1) It requires very less memory as it only needs to store a stack of the nodes on the path from root node.
2) It takes less time to reach the goal node compared to Bfs algorithm.

Disadvantages

1) Dfs algorithm goes for deep down searching and sometimes it may go to the infinite loop.

Uniform cost searching (ucs):-

It is used for traversing a weighted tree of a graph. It comes into play when a different cost is available for each edge.

The goal of ucs is to find a path to the goal node which has the lowest cummulative

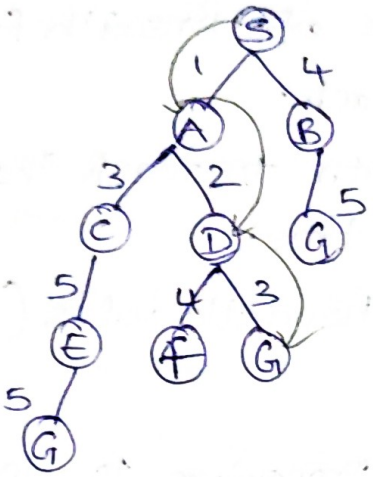
cost. It expands to the nodes with lowest cost from the root.

It gives maximum priority to the lowest cummulative cost.

It is implemented by the Priority Queue.

It is equivalent to Bfs, if the path cost is same.

Ex:



target = G

The navigation starts at rootnode 'S' as 4 is greater than 1, searching moves to node 'A'.

As 3 is greater than 2, it navigates to node 'D' as the node 'D' is not the goal node, searching moves to node 'G'.

As 'G' is the goal node, searching will be terminated here.

The low cost path is $S \rightarrow A \rightarrow D \rightarrow G$

The cummulative cost in the path is $1+2+3=6$

Advantages:-

1) Uniform Cost search is provides the path with optimum cost

Disadvantage:

1) It doesnot care about no. of steps involved in searching and only concentrates about path cost.

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Greedy Search algorithm :-

1) It is a informed search algorithm.
2) It is also called as Best first search (Bfs)
3) It is the combination of Breadth first search and Depth first search.
4) This gives the best path to reach the goal node at that moment of time.
5) It ~~may~~ make use of heuristic value (h(n)) to find the goal node.

The following is the procedure to find the shortest Path using Best first / Greedy search :-

Step 1 : Let us consider 's' as root node and 'G' as the goal node.

Root node is placed in openlist

openlist = [Root node] = [S]

Step 2 :

As without Root node 's', we cannot form any path and successors of root node 's' is 'A' and 'B'.

The root node 's' is moved to closed list and the successors A, B moves to open list

openlist = [A, B], closed list = [S]

- The heuristic value of B is less Compared to A so B is removed from openlist and placed in closed list.

openlist = [A] , Closedlist = [S,B]

step3 :

The successors of node 'B' are placed in openlist

openlist = [A, E, f] , closed list = [S, B]

As the heuristic value of 'f' is less when compared to 'E', 'f' is removed from openlist and placed in closed list.

openlist = [A, E] , Closedlist = [S, B, f]

step4 :

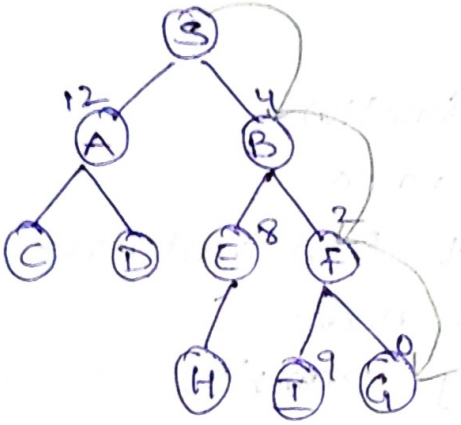
The successors of node 'f' is I and G which are placed in open list

openlist = [A, E, I, G] , Closedlist = [S, B, f]

Heuristic value of 'G' is less compared to I so it is placed in closed list.

openlist = [A, E, I], closed list = [S, B, f, G]

Since the 'G' is goal node, searching will be terminated here.



Path :- S → B → f → G

Node	h(n)
S	13
A	12
B	4
C	7
D	3
E	8
f	2
G	0
H	4
I	9

Advantages :

1) Since it is the combination of Bfs, Dfs it gains advantages of both
2) This algorithm is more efficient than Bfs, Dfs algorithms

Disadvantages

1) As it follows depth first search also, the searching may struck in infinite loop.

- A* Searching Technique :-

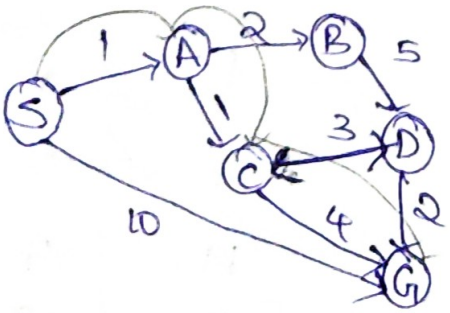
1) It is an informed search technique, it finds out the shortest path based on heuristic function ($f(n)$).
2) The heuristic function is the sum of the heuristic value ($h(n)$) and the path cost from root node to current node ($g(n)$)

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

Where,

$f(n)$ = Heuristic function
$h(n)$ = Heuristic value
$g(n)$ = Path Cost from root node to current node

Let us consider following example;



State	h(n)
S	5
A	3
B	4
C	2
D	6
G	0

Step 1 :

Let us consider 's' as root node and 'G' as target node.

Step 1 : Successors of root node (s) are A, G

$S \rightarrow A$

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

$= 3 + 1 = 4$

$S \rightarrow G$

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

$= 0 + 10 = 10$

As $S \rightarrow A$ is having less path cost, this path is considered for next step.

Step 2 :- Successors of $A \rightarrow B, C$

$S \rightarrow A \rightarrow B$

$f(n) = 4 + 3 = 7$

$S \rightarrow A \rightarrow C$

$f(n) = 2 + 2 = 4$

As the heuristic function value of path $S \rightarrow A \rightarrow C$ is less the same path is considered in the next step.

Step 3 :-

$S \rightarrow A \rightarrow C \rightarrow G$

$f(n) = 0 + 6$

$= 6$

$S \rightarrow A \rightarrow C \rightarrow D$

$f(n) = 6 + 5 = 11$

As per A* searching technique the shortest path to reach the target (or) goal node is

$S \rightarrow A \rightarrow C \rightarrow G$

where, heuristic function value is 6

Advantages

1) It is the best algorithm than any research algorithm.
2) It is optimal and complete.
3) It can solve very complex problems.

Disadvantages

1) As it is finding the path based on heuristic function value always it. may not give shortest Path.

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Knowledge Representation:

knowledge is the well organized data and procedure to do a useful task.

Ex: Doctor and Patient

A Physician treating a patient uses both knowledge and data to diagnonise the patient health Problem.

The data consists of symptoms, blood test reports, X-Ray and scanning reports etc.

The doctor based on his knowledge analyze symptoms and all reports, finally comesup with correct diagonise.

The main objective of artificial intelligence is designing expert or intelligent systems.

In order to design intelligent (or) expert system large amount of data to be imparted to the machine

Before large amount of the data feeding to the machine, it should be arranged in well defined format which is called as knowledge representation.

Two important methods of knowledge representation are:

1. Predicate calculus
2. Semantic network representation.

Predicate calculus : 8. Discuss the Predicate Calculus and rules of inference

1. It is also called as first order logic (FOL).
2. It is extension of Propositional logic.

for example, Let us consider two statements in Propositional logic which are called as propositions.

P: All humans are mortal :- True

Q: Sunil is a human - True

The main drawback of Propositional logic is

i) By applying logic (or) reasoning we on the second statement we cannot produce new statement like 'Sunil is mortal'.

ii) Quantifying is not possible in predicate logic.

iii) The predicate logic is a powerful language that develops information about the objects in a more easy way and can also express the relation -ship b/w the objects.

Terms used in Predicate logic :

Constant : Names of animals, Humans, colors, Numbers (1,2,3....), Alphabets etc. (A,B,C..).

Variable : a, b, c ... , x, y, z

Predicate / relation : ≥, ≤, Inbetween, father of, mother of, sister of etc...

function : Addition, Deletion, sqrt etc.

Connectives : ¬, ∧, ∨, ⇒, ⟺ etc

Equality : "="

Quantifier : ∀ (for all), ∃ (each (or) there exists)

In Predicate logic, each statement can be represented in two parts :

1. Subject (or) object :

It is the main part of the statement usually names of different objects.

2. Predicate :

Predicate gives the relation between objects.

Any statement in the predicate logic can be represented as follows :

Predicate (Term1, Term2, ..., Termn)

Ex: Ramu is intelligent

Predicate logic : Intelligent (Ramu)

Ex: x is an Integer.

Predicate logic : Integer (x)

Ex: Gopi and Ramu are friends.

Predicate logic : friends (Gopi, Ramu)

Ex: All humans are Mortal.

Predicate logic : ∀x humans(x) ⇒ Mortal(x)

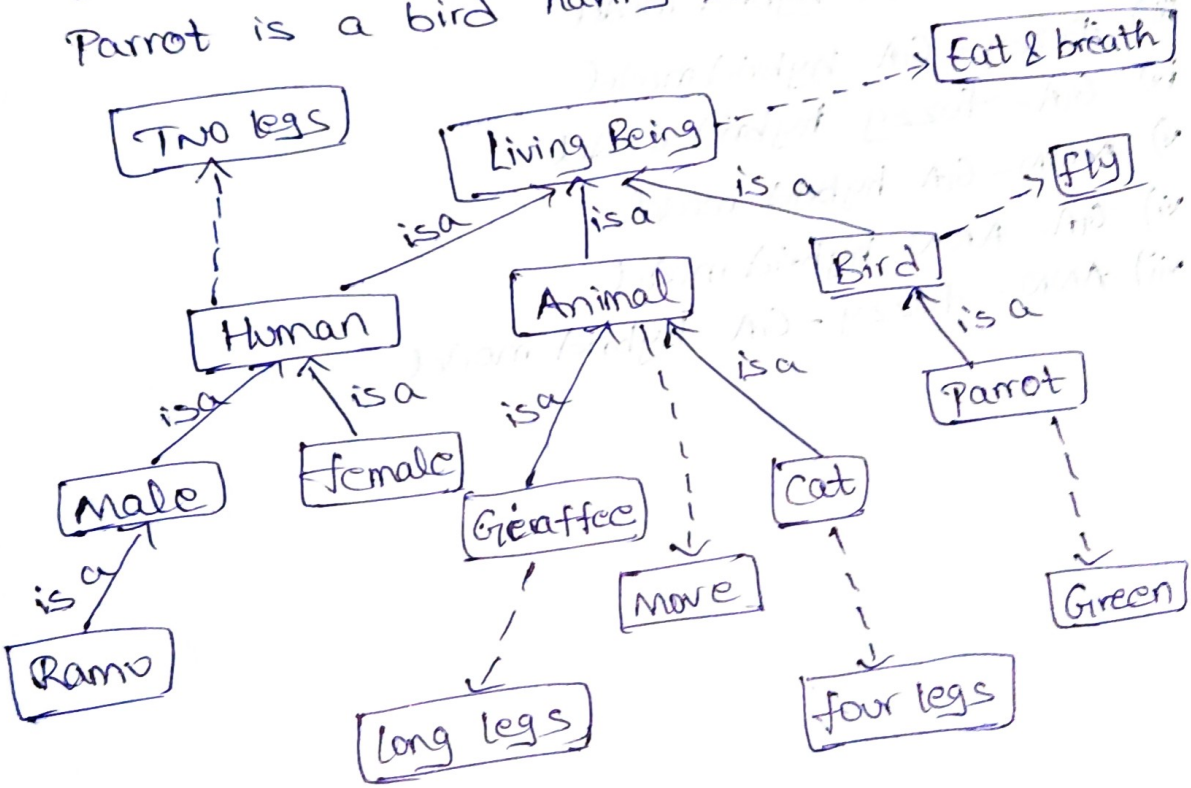
Semantic network representation:

1. It is a directed graph representation of objects and lines joining the objects.
2. Objects Presents the names (or) facts, lines joining the objects represents relation b/w objects.

for example,

9. How knowledge is represented in terms of Semantic Networks, discuss in detail using neat diagrams.[

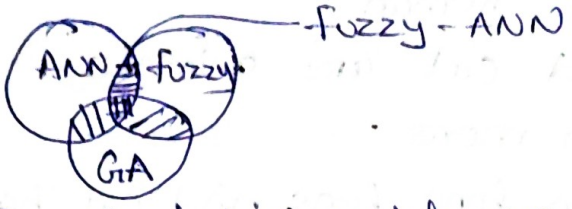
Human, animal, bird are living beings.
All living beings can eat and breath.
Humans are classified into male and female.
Humans have two legs.
Ramu is a human.
Giraffee and cat are animals.
Animals can move.
Giraffee has long legs and cat has four legs.
Birds can fly.
Parrot is a bird having green colour.



Hybrid Models

10. Briefly discuss the different Hybrid Models of the Soft Computing

1. Soft computing techniques are used to solve the real world problems.
2. Different soft computing techniques are
   i) ANN
   ii) fuzzy logic controllers
   iii) Genetic algorithms
3. Hybrid models are developed by combining two or more above set of soft computing techniques which is explained with the help of following venn diagram.



4. Different types of hybrid models are:
   i) ANN - fuzzy hybrid model
   ii) fuzzy - ANN hybrid model
   iii) Fuzzy - GA hybrid model
   iv) GA - fuzzy hybrid model
   v) ANN - GA hybrid model
   vi) GA - ANN hybrid model
   vii) ANN - fuzzy - GA hybrid model