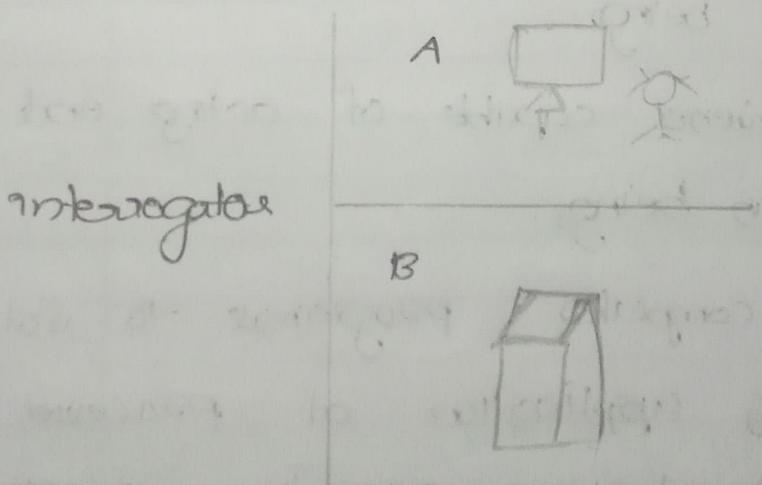
ARTIFICIAL INTELLIGENCE

* AI is a branch of computer science concerned with the study and creation of computer systems and exibit some form of intelligence.
* Intelligence is the ability to reason, to trigger new thoughts, to perceive and learn.
* It is an ability to learn, to deal with different situations, to acquire understand and apply knowledge and to analyse and reason.
* It is concerned with the design of intelligence in an artifical device.
* creating the computer or machines as intelligent as human beings.
* build machines capable of acting and thinking like human beings.
* developing computer programs to solve complex problems by application of process that are analogous to human reasoning process.
* the term was coined by John mccarthy in 1956.
* AI is the art of creating machines that perform functions that require inteligence.

when performed by people.

Turing Test

* Turing in 1950 published an article in the mind magazine.
* turing proposed that if the human interrogator in room C is not able to identify who is in room A or in room B, then the machine possess intelligence. turing considered as a sufficient test for attributing thinking capacity to a machine.
* As of today, turing test is the ultimate test a machine must pass in order to be called as intelligent



Applications of AI

* Healthcare
* Surveillence
* Social Media
* Robotics

* e-commerce * Gaming
* space-exploration * agriculture.

Type of problems

* Problem solving is fundamental to many AI based applications.

There are 2 type of problems.

1) problem like, computation of the sine of an angle or the square root of a value. these can be solved through the use of deterministic procedure and the success is guaranteed.

2) In the real world very few problems lend themselves to straightforward solutions

Problem formulation

* Problem space is an abstract space.

⇒ a problem space encompasses all valid states that can be generated by the application of any combination of operators on any combination of objects.

⇒ the problem may contain one or more solutions.

* solution is a combination of operations and objects that achieve the goals.

* search refers to the search for a solution in a problem space. search proceeds with different types of search control strategies. the dfs and bfs search are the 2 common search strategies

* Problem solving is a process of generating solutions. from observed or given data.

* Problem solving often needed to use informed or model-based methods.

⇒ define the problem precisely - find input situations aswell as final situations for acceptable solution to the program problem.

⇒ analyse the problem - Find few important features that may have impact on the appropriateness of various possible techniques for solving the problem.

⇒ isolate and represent task knowledge necessary to solve the problem.

⇒ choose the best problem solving techniques. and apply to the particular problem.

Problem definition

* Problem is defined by its elements and their relations

⇒ define a state space that contains all the possible configurations of the relevant objects, including some impossible ones.

⇒ specify one or more states that describe possible situations from which the problem solving process may start. these states are called initial states.

⇒ specify one or more states that would be acceptable solution to the problem. these states are called goal states.

⇒ specify a set of rules that describe the actions available

* The problem can then be solved by using the rules in combination with an appropriate control strategy to move through the problem space until a path from an initial state to a goal state is found. this process is known as search.

⇒ search is the fundamental to the problem solving process.

⇒ search is generated mechanism that can be used when more direct method is not known.

⇒ search provides the framework into which more direct methods for solving subparts of a problem can be embedded.

Problem characteristic

* Problem solving is a process of generating solutions from observed data.
  - ⇒ a problem is characterised by set of goals
  - ⇒ a set of objects
  - ⇒ a set of operations.

* a problem may have different aspect of representation and explanation. In order to choose the most appropriate method for a particular problem it is necessary to analyze the problem along several key dimensions. some of the main key features.

1) Is the problem decomposable into set of sub problems.

2) can the solution step be ignored or undone.
3) is the problem universally predictable.
4) is a good solution to the problem obvious without comparison to all the possible solutions.
5) Is the desire solution a state of world or path to a state.
6) Is a large amount of knowledge absolutely required to solve the problem.
7) will the solution of the problem required interaction between the computer and the person.

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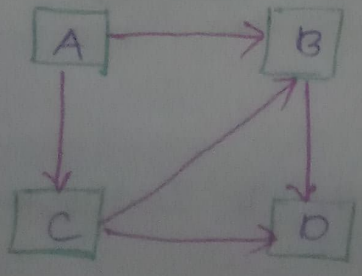
Production Systems

Space

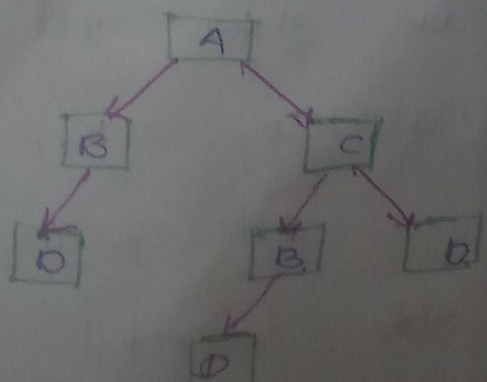
Problem space

- A problem space is represented by directed graph where node represent search state and paths represent the operator applied to change the state.

graph



Tree



Problem solving methods

Problem - solving methods are categorized as special purpose

special purpose method

is tailor-made for a particular problem, often exploits very specific features of the situation in which the problem is embedded.

General-purpose method.

is applicable to a wide variety of problems. one general purpose technique used in AI is "mean-end analysis". It is step by step or incremental reduction of the difference between current state and final goal.

State space

- state space A state space is the set of all states reachable from the intial state.
- a state space forms a graph in which the nodes are states and the arcs between the nodes are action
- In state space a path is sequence of states connected by a sequence of actions.

- the solution of a problem is part of the map formed by the state space.
- the structure of state space are tree and graphs:

⇒ tree is hierarchical structure in graphical form and graph is non-hierarchical structure

⇒ tree has only one path to given node,

⇒ graph consists of set of nodes and a set of edges. arcs establish relationship between the nodes.

- search process explore the statespace. In the worst case the search explore all possible path between the initial state and the goal state
- state space is defined explicitly or implicitly.
- initial state is start state.
- goal state is the conditions it has to fulfill
- a description of a desired state of the world the description may be complete or partial.

operators are to change state. operator do action that can transform one state to another

Production Systems

- (x, y) x-4 to jug. y-3 to jug
- If y > 0 then → (x, 0)
- (0,0) --(0,3) -(3,0) -(3,3) -(4,2)-(0,2)-(2,0)
- (0,0) initial stage goal stage -(2,0)
- the term production system refers to many things.

  ⇒ It may refer to a computer program which is used to provide a solution for a problem using set of rules

  ⇒ It may also refer to programming language for writting such programs.

  ⇒ further it can be also be thought of as a model of computation that can be applied to implement search algorithms or as a model of human problem solving.

- a knowledge representation formalism consists of collections of condition - action rules. a database which is modified in accordance with the rule, and a production system interpreter which controls the operation of the rule

- the control mechanism of production system determining the order in which production rules are fired.
- a system that use this form of knowledge representation is called a production system
- a production system consist of rules and facts. knowledge is encoded in a declarative form which comprises of a set of rules.
- production system consist of

  set of rules
  knowledge database
  control strategies
  interpreter

Advantages of production System

- production system provide an excellent tool for starting AI programs.
- Production system are highly modular because the individual rule can be added removed or modified independently.
- there is a separation of knowledge and control.
- the system use pattern directed control which is more flexible than algorithmic control

- provide opportunities for heuristic control of the search.
- Helpful in a real-time environment and applications.

Disadvantage.

- one important disadvantage is the fact that it may be very difficult analyze the flow of control within a production system because individual rules doesn't call each other.
- Production System describe the operations that can be performed in a search for a solution the problem.
- there is a lot of inefficiency in production system. for example these maybe situations where multiple rules get activated during execution and each of these rules may trigger exhaustive search.
- there is an absence of learning due to a rule-based production system that doesn't store the result of the problem for future use.
- the rules in the production system should have any type of control operations. when

a recorale is a added to the database it should ensure that it doesn't have any conflict with any existing rule

knight movement in chessboard

- knight move in an "L-shape" that is, they can move 2 square in any direction vertical followed by one horizontally, or 2 square in any direction horizontally followed by in vertically.

1	2	3
4	5	6
7	8	9

3x3 chessboard

application of production rule

Rule No	condition	Action
1	knight on square 1 →	knight on square 8.
2	knight on squa 1 →	knight on square 6
3	knigh on squar 2 →	knight on square 9
4	knight on squar 2 →	knight on square 7
5	knight on square 3 →	knight on square 4
6	knight on squar 3 →	knight on square 8
7	knight on squar 4 →	knight on square 9

8	knight on square 4 →	knight on square 3
9	knight on square 6 →	knight on square 1
10	knight on square 6 →	knight on square 7
11	knight on square 7 →	knight on square 2
12	knight on square 7 →	knight on square 6
13	knight on square 8 →	knight on square 3
14	knight on square 8 →	knight on square 1
15	knight on square 9 →	knight on square 2
16	knight on square 9 →	knight on square 4

Step No	working memory	current square	conflict set	fire rule	Remarks
0	{1, 2}	1	-	-	initialstate
1	{1, 2}	1	1, 2	1	-
2	{8, 2}	8	13, 14	13	-
3	{3, 2}	4	9, 6	5	-
4	{4, 2}	4	7, 8	7	-
5	{9, 2}	9	15, 16	15	-
6	{?, 2}	2	-	-	Hell

classes of production system.

four classes of production system.

1. A monotonic production system.
2. A non monotonic production system.
3. A partially commutative production system.
4. A commutative production system.

Production system characteristics

1) monotonic and nonmonotonic production system.

It is in which the application of a rule never prevents the later application of another rule that could also have been applied at the time the first rule was selected. A production system which is not monotonic is called a nonmonotonic production system.

2) partially commutative production systems

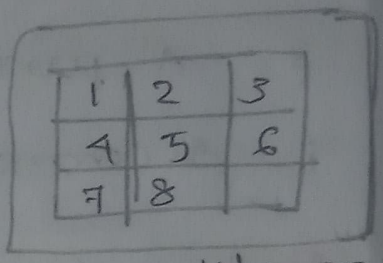
a partially commutative production system is a production system with the property that if the application of a particular sequence of rule transforms state x to state y then any allowable permutation of those rule also transforms state x into state y.

3) commutative production systems

- A production system that is both monotonic

and partially commutative is called a commutative production system.

Example of AI problems.



1) 8 puzzle

- state space - configuration of 8 tiles on the board.
- initial state - any configuration.
- goal state - tiles in a specific order.
- action - 'blank moves'
- condition - the move is within the board.
- transformation - blank move left, right, up, down.
- solution - optimal sequence of operators.

2) Missionaries and cannibals problem

description

three missionaries and 3 cannibals are on one side of a river, along with a boat that can hold one or two people. find a way to get everyone to the other side without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place

standard formulation

ignore all irrelevant parts of the problem.

state

each state is represented by an ordered sequence of 3 numbers. (x, y, z) where.

x - number of missionaries on initial river bank

y - number of cannibals on initial river bank

z - number of boats on initial river bank.

3) cryptarithmetic problem

1) T W O +
   T W O

   F O U R

```
  7 3 4 +
  7 3 4
  -----
1 4 6 8
```

T = 7, O = 4, R = 8, W = 3, U = 6

2) S E N D
   M O R E

   M O N E Y

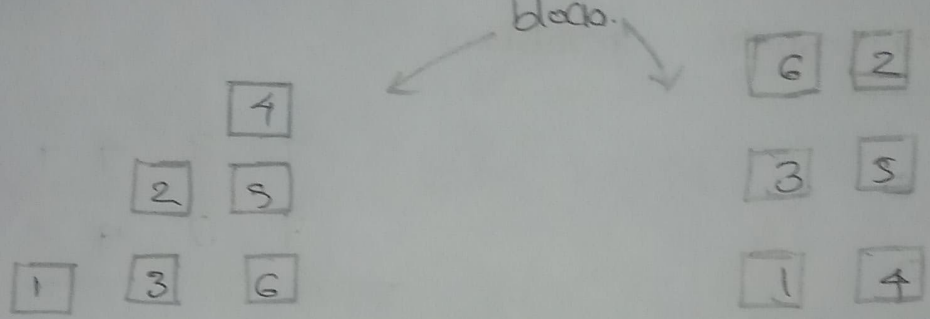
```
    1 1
  9 5 6 7
    1 0 8 5
  -------
1 0 6 5 2
```

S = 9, E = 5, M = 1, N = 6, O = 0, R = 8

Y = 2

4) Block world problem

block world is a model domain used in artificial intelligence to explore different approaches to automated reasoning. this model is used to illustrate that a given algorithm can perform planning. so that it is efficient in terms of the number of calculation required to find a solution so in terms of the length of that solution.



A block of world pblm.

Solution

unstack (2, 3)
putdown (2)
unstack (4, 5)
put down (4)
unstack (5, 6)
stack (5, 4)
pickup (2)
stack (2, 3)
pickup (5)

stack (5, 1)
pickup (6)
stack (6, 3)

Another problems

5) water jug problem.

Problem Statement

we have 2 jugs of capacity 4 lts and 3 lts, and a tap with an endless supply of water. the objective is to obtain 2 lts of water exactly in the 4 lts jug with the minimum steps possible.

Formulation

x denote the number of lts of water in the 4 lts jug.

y number of lts of water in the 3 lts jug.

now, $x = 0, 1, 2, 3$ or 4, $y = 0, 1, 2$ or 3.

the order pair (x, y) represent a state

- initial state - the order pair $(0, 0)$
- actions - (x, y) represent the state before the application of the action

(u, v) represent the state after the application of the action.

SINO	State before action	State after action	description of operation
1	(x,y) if $x < 4$	$(4, y)$	Fill 4 - lts Jug.
2	(x,y) if $y < 3$	$(x, 3)$	Fill 3 lts Jug
3	(x,y) if $x > 0$	$(0, y)$	empty 4 lts Jug on the ground
4	(x,y) if $x > 0$	$(x, 0)$	empty 3 lts Jug on the ground
5	(x,y) if $x+y \geq 4$ and $y > 0$	~~$(4,y)$~~ $(4, y-(4-x))$	pour water from 3 lts Jug into 4 lts Jug until 4 lts Jug is full
6	(x,y) if $x+y \geq 3$ and $x > 0$	$(x-(3-y), 3)$	pour water from 4- lts Jug into 3 lts Jug until 3 lts Jug is full.
7	(x,y) if $x+y \leq 4$ and $y > 0$	$(x+y, 0)$	pour all water from 3 lts into 4 lts Jug.
8	(x,y) if $(x+y \leq 3$ and $x > 0$	$(0, x+y)$	pour all water from 4 lts Jug into 3 lts Jug

Solution

One solution to the water jug problem is given below.

$(0,0) \xrightarrow{\text{Rule 2}} (0,3) \xrightarrow{\text{Rule 7}} (3,0) \xrightarrow{\text{Rule 2}} (3,3) \xrightarrow{\text{Rule 5}} (4,2) \xrightarrow{\text{Rule 3}}$

$(0,2) \xrightarrow{\text{Rule 7}} (2,0)$

6) Towers of Hanoi puzzle

- For a Robot this might consist of pickup, putdown, moveforward, moveback, moveleft and moveright. until the goal is reached.
- This puzzle may involve a set of rings of different sizes that can be placed on three different pegs.
  - The puzzle starts with the rings arranged as shown in Fig (a)
  - the goal of this puzzle is to move them all as to Fig (b).
  - Condition - only the top ring on a peg can be moved and it may only be placed

on a larger ring or on an empty peg.

* In this cases of Hanoi puzzle : the set of all possible configurations of ring on the peg is called problem space