Chapter -2: Problem Solving

- Problem solving is a agent based system that finds sequence of actions that lead to desirable states from the initial state.
- Four steps of problem solving are:
  i. Goal Formulation: Helps to organize behavior by isolating and representing the task knowledge necessary to solve problem.
  ii. Problem Formulation: Define the problem precisely with initial states, final state and acceptable solutions.
  iii. Searching: Find the most appropriate techniques o sequence among all possible techniques.
  iv. Execution: Once the search algorithm returns a solution to the problem, the solution is then executed by the agent.

Techniques

State Space Representation

- A state space essentially consists of a set of nodes representing each state of the problem, arcs between nodes representing the legal moves from one state to another, an initial state and a goal state.
- A problem can be defined by
  . Initial state
  . Actions (Using successor function)
  . Goal test (to determine the goal state)
  . Path cost
- A problem is when defined with these components is called ***well defined problem***.
- The actions and rules should be defined in as general way as possible. If the specific rules are made, the rule set becomes very large.
  Eg; Chess world.

8								
7			H		H			
6		H				H		
5				**H**				
4		H				H		
3			H		H			
2								
1								
	1	2	3	4	5	6	7	8

Let Current Position of Horse: (4,4)
Rules for next possible position can be as: (2,4),(2,6), (3,3),(3,7),(5,3)(5,7),(6,4) and (6,6)

- When the current position of the horse chances from (4,4) to any other location, we have to define another rule to find next possible position. By doing so the rule set becomes very large.

- There for specific pattern should be described such as for above case the pattern rule can be as:
  Next possible Position: Current Position +/- ((2 vertical + 1 Horizontal) or (1 vertical + 2 Horizontal)) position.
- When a problem is defined with all its states, it is said to be in ***complete state space***.

Examples:

1. **Vacuum World**
2. **Water Jug Problem**
3. **Tower of Hanoi**
   Etc.

(Refer class note for solution)

Production System

- A production system consists of a set of rules, each consisting of a left hand side (pattern) that determines the applicability of rules and a right side that describes the operation to be performed if the rule is applied.
  Eg. [A, clean] => move right
  Pattern Action (Operation)
  [A, dirt] => clean
- A production system may have one or more knowledgebase that contain whatever information is appropriate for the particular task.
- A control strategy that specifies the order in which the rules will be selected and a way of resolving the conflicts that arise when several rules matched at once i.e. it must have a **Rule Applier** for conflict resolution.
- The first requirement of a good control strategy is that it must cause motion.
- The second requirement of a good control strategy is that it should have systematic.

Evolution Function

- Evaluation function evaluates any state or node that gives a number to indicate how far we are from the goal.
- Every move should reduce this number or if not never increase.
- When this number becomes zero, the problem is solved.
- **Eg. 8-Puzzle game**
  (Refer class note)

Problem Classification

i. **Ignorable:** Intermediate actions can be ignored. Eg. Water-jug problem.
ii. **Recoverable:** The actions can be implemented to go the initial state. Eg. 8-puzzle game.
iii. **Irrecoverable:** The actions cannot help to reach the precious state. Eg. Tic-tac-toe.
iv. **Decomposable:** The problem can be broken into similar ones. Eg. Multiplayer game.

Constraints Satisfaction Problem

- A search procedure that operates in a space of constraints.
- Constraints are discovered and propagated as far as possible throughout the system.
- A guess about something is made and added as a new constraint.
- The problem can be described as a set of variables (X1,X2,……) and Constraints (C1, C2,…….)
- Constraint propagation terminates for one of two reasons.
  - **i.** Contradiction detected i.e. no solution consistent with known constraints.
  - **ii.** Propagation has run off stream and there are no further changes that can be made on the basis of current knowledge.

Eg. Crypto-arithmetic

i. **S E N D + M O R E = M O N E Y**
ii. **R I G H T + R I G H T = W R O N G**
iii. **W R O N G + W R O N G = R I G H T**
iv. **L O G I C + L O G I C = P R O LO O G**
v. **C R O S S + R O A D S = D A N G E R**
vi. **B A S E + B A L L = G A M E S**
vii. **O N E + O N E = T W O**
viii. **O N E + O N E + T W O = F O U R**
ix. **K Y O T O + O S A K A = T O K Y O**
x. **A P P L E + G R A P E = C H E R R Y**