Module-1 Test

Date: 17/01/2023

Q1. What is Intelligence ? 2 Marks

Q2. Describe the four categories under which AI is classified with examples. 5 Marks

Q3. Define Artificial Intelligence. 2 Marks

Q4. what are Components of AI program 2 Marks

Q5. Describe main historical milestones in the field of AI 3 Marks

Q6. List out foundation of AI and describe any two in detail 3 Marks

Q7. What are the applications of AI? describe current trends in AI. 3 Marks

Module Test 2

All questions Carrying 4 Marks Q7. Compulsory question.

Q1. Define intelligent agent and list out it's different types

Q2. What is a PEAS description.Give peas description for a robot meant for cleaning the house?

Q.3 What are the types of task environment.explain any two in detail?

Q4. Describe in detail a problem solving agent with a diagram.

Q 5. Explain four ways to measure performance of an AI algorithm.

Q6. Describe problem formulation steps and formulate 8 queens problem

Q.7 water jug problem:

You are given 2 jugs, a four gallon and 3 gallon and a pump which has unlimited water which you can use to fill a jug and the ground on which the water may be poured. Neither jug has measuring marking on it. how can you get exactly 2 gallons of water in the 4 gallon jug.

1.1 Introduction to Artificial Intelligence

- John McCarthy who has coined the word "Artificial Intelligence" in 1956, has defined AI as **"the science and engineering of making intelligent machines"**, especially intelligent computer programs.
- **Artificial Intelligence (AI)** is relevant to any intellectual task where the machine needs to take some decision or choose the next action based on the current state of the system, in short act intelligently or rationally. As it has a very wide range of applications, it is truly a universal field.
- In simple words, Artificial Intelligent System works like a Human Brain, where a machine or software shows intelligence while performing given tasks; such systems are called **intelligent systems** or **expert systems**. You can say that these systems can "think" while generating output!!!
- AI is one of the newest fields in science and engineering and has a wide variety of application fields. AI applications range from the general fields like learning, perception and prediction to the specific field, such as writing stories, proving mathematical theorems, driving a bus on a crowded street, diagnosing diseases, and playing chess.
- AI is the study of how to make machines do thing which at the moment people do better. Following are the four approaches to define AI.

1.3 Categorization of Intelligent Systems

As AI is a very broad concept, there are different types or forms of AI. The critical categories of AI can be based on the capacity of intelligent program or what the program is able to do. Under this consideration there are three main categories:

1. **Artificial Narrow Intelligence/ Weak AI**

   Weak AI is AI that specializes in one area. It is not a general purpose intelligence. An intelligent agent is built to solve a particular problem or to perform a specific task is termed as narrow intelligence or weak AI. For example, it took years of AI development to be able to beat the chess grandmaster, and since then we have not been able to beat the machines at chess. But that is all it can do, which is does extremely well.

2. **Artificial General Intelligence / Strong AI**

   Strong AI or general AI refers to intelligence demonstrated by machines in performing any intellectual task that human can perform. Developing strong AI is much harder than developing weak AI. Using artificial general intelligence machines can demonstrate human abilities like reasoning, planning, problem solving, comprehending complex ideas, learning from self experiences, etc. Many companies, corporations' are working on developing a general intelligence but they are yet to complete it.

3. **Artificial Super Intelligence**

   As defined by a leading AI thinker Nick Bostrom, "Super intelligence is an intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills." Super intelligence ranges from a machine which is just a little smarter than a human to a machine that is trillion times smarter. Artificial super intelligence is the ultimate power of AI.

1.4 Components of AI Program

AI is a vast field for research and it has got applications in almost all possible domains. By keeping this in mind, components of AI can be identified as follows : (refer Fig. 1.4.1).

1. Perception
2. Knowledge representation
3. Learning
4. Reasoning
5. Problem Solving
6. Natural Language Processing (language-understanding).

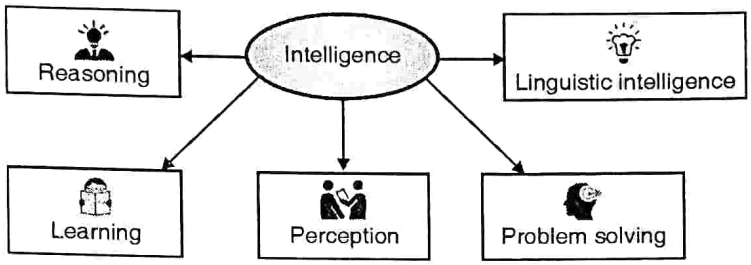


Fig. 1.4.1 : Components of AI

1. Perception

In order to work in the environment, intelligent agents need to scan the environment and the various objects in it. Agent scans the environment using various sense organs like camera, temperature sensor, etc. This is called as perception. After capturing various scenes, perceiver analyses the different objects in it and extracts their features and relationships among them.

2. Knowledge representation

The information obtained from environment through sensors may not be in the format required by the system. Hence, it need to be represented in standard formats for further processing like learning various patterns, deducing inference, comparing with past objects, etc. There are various knowledge representation techniques like Prepositional logic and first order logic.

3. Learning

Learning is a very essential part of AI and it happens in various forms. The simplest form of learning is by trial and error. In this form the program remembers the action that has given desired output and discards the other trial actions and learns by itself. It is also called as unsupervised learning. In case of rote learning, the program simply remembers the problem solution pairs or individual items. In other case, solution to few of the problems is given as input to the system, basis on which the system or program needs to generate solutions for new problems. This is known as supervised learning.

4. Reasoning

Reasoning is also called as logic or generating inferences form the given set of facts. Reasoning is carried out based on strict rule of validity to perform a specified task. Reasoning can be of two types, deductive or inductive. The deductive reasoning is in which the truth of the premises guarantees the truth of the conclusion while, in case of inductive reasoning, the truth of the premises supports the conclusion, but it cannot be fully dependent on the premises. In programming logic generally deductive inferences are used. Reasoning involves drawing inferences that are relevant to the given problem or situation.

5. Problem-solving

AI addresses huge variety of problems. For example, finding out winning moves on the board games, planning actions in order to achieve the defined task, identifying various objects from given images, etc. As per the types of problem, there is variety of problem solving strategies in AI. Problem solving methods are mainly divided into general purpose methods and special purpose methods. General purpose methods are applicable to wide range of problems while, special purpose methods are customized to solve particular type of problems.

6. Natural Language Processing

Natural Language Processing, involves machines or robots to understand and process the language that human speak, and infer knowledge from the speech input. It also involves the active participation from machine in the form of dialog i.e. NLP aims at the text or verbal output from the machine or robot. The input and output of an NLP system can be speech and written text respectively.

1.2 Foundations of AI

- In general, artificial intelligence is the study of how to make machines do things which at the moment human do better. Following are the four approaches to define AI.
- Historically, all four approaches have been followed by different group of people with different methods.

1.2.1 Acting Humanly : The Turing Test Approach

University Questions

Q. Explain Turing test designed for satisfactory operational definition of AI. **MU - May 16**

Q. Explain different definitions of artificial intelligence according to different categories. **MU - Dec. 19**

Definition 1 : *"The art of creating machines that perform functions that requires intelligence when performed by people." (Kurzweil, 1990).*

Definition 2 : *"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991).*

- To judge whether the system can act like a human, Sir Alan Turing had designed a test known as **Turing test**.
- As shown in Fig. 1.2.1, in Turing test, a computer needs to interact with a human interrogator by answering his questions in written format. Computer passes the test if a human interrogator, cannot identify whether the written responses are from a person or a computer. Turing test is valid even after 60 year of research.

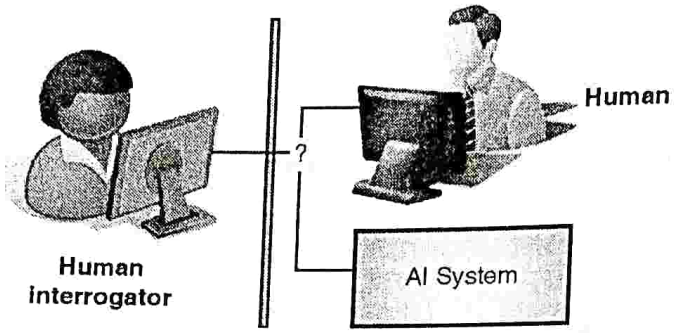


Fig. 1.2.1 : Turing Test Environment

- For this test, the computer would need to possess the following capabilities :
  1. **Natural Language Processing (NLP) :** This unit enables computer to interpret the English language and communicate successfully.
  2. **Knowledge Representation :** This unit is used to store knowledge gathered by the system through input devices.
  3. **Automated Reasoning :** This unit enables to analyze the knowledge stored in the system and makes new inferences to answer questions.
  4. **Machine Learning :** This unit learns new knowledge by taking current input from the environment and adapts to new circumstances, thereby enhancing the knowledge base of the system.
- To pass total Turing test, the computer will also need to have **computer vision,** which is required to perceive objects from the environment and **Robotics,** to manipulate those objects.

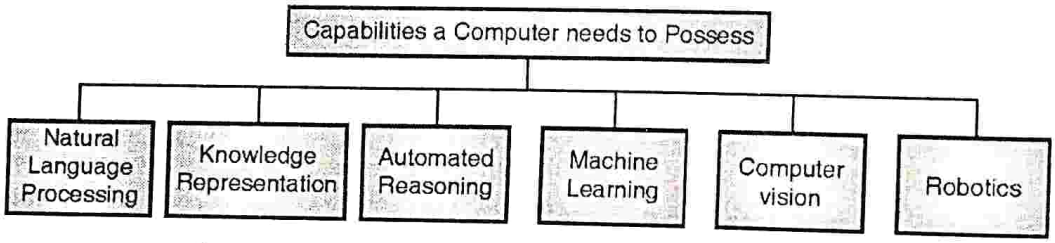


Fig. 1.2.2 : Capabilities a Computer needs to possess

- Fig. 1.2.2 lists all the capabilities a computer needs to have in order to exhibit artificial intelligence. Mentioned above are the six disciplines which implement most of the artificial intelligence.

1.2.2 Thinking Humanly : The Cognitive Modelling Approach

University Question

Q. Explain different definitions of artificial intelligence according to different categories. **MU - Dec. 19**

Definition 1 : *"The exciting new effort to make computers think ... machines with minds, in the full and literal sense". (Haugeland, 1985)*

Definition 2 : *"The automation of activities that we associate with human thinking, activities such as decision making, problem solving, learning ..." (Hellman, 1978)*

- **Cognitive science :** It is inter disciplinary field which combines computer models from Artificial Intelligence with the techniques from psychology in order to construct precise and testable theories for working of human mind.
- In order to make machines think like human, we need to first understand how human think. Research showed that there are three ways using which human's thinking pattern can be caught.
  1. **Introspection** through which human can catch their own thoughts as they go by.
  2. **Psychological experiments** can be carried out by observing a person in action.
  3. **Brain imaging** can be done by observing the brain in action.
- By catching the human thinking pattern, it can be implemented in computer system as a program and if the program's input output matches with that of human, then it can be claimed that the system can operate like humans.

1.2.3 Thinking Rationally : The "Laws of Thought" Approach

University Question

Q. Explain different definitions of artificial intelligence according to different categories. **MU - Dec. 19**

Definition 1 : *"The study of mental faculties through the use of computational models". (Charniak and McDermott, 1985)*

Definition 2 : *"The study of the computations that make it possible to perceive, reason, and act".*

- The laws of thought are supposed to implement the operation of the mind and their study initiated the field called logic. It provides precise notations to express facts of the real world.
- It also includes reasoning and "right thinking" that is irrefutable thinking process. Also computer programs based on those logic notations were developed to create intelligent systems.

There are two problems in this approach :

1. This approach is not suitable to use when 100% knowledge is not available for any problem.
2. As vast number of computations was required even to implement a simple human reasoning process; practically, all problems were not solvable because even problems with just a few hundred facts can exhaust the computational resources of any computer.

1.6 Applications of Artificial Intelligence

- You must have seen use of Artificial Intelligence in many SCI-FI movies. To name a few we have I Robot, Wall-E, The Matrix Trilogy, Star Wars, etc. movies. Many a times these movies show positive potential of using AI and sometimes also emphasize the dangers of using AI. Also there are games based on such movies, which show us many probable applications of AI.
- Artificial Intelligence is commonly used for problem solving by analyzing or/and predicting output for a system. AI can provide solutions for constraint satisfaction problems. It is used in wide range of fields for example in diagnosing diseases, in business, in education, in controlling a robots, in entertainment field, etc.

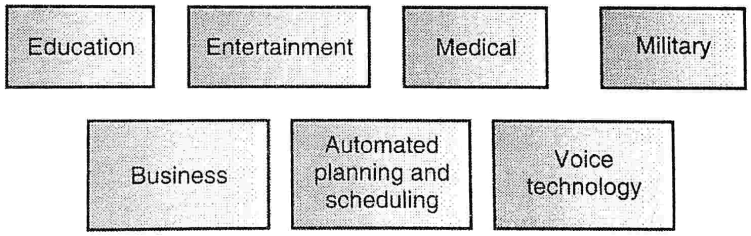


Fig. 1.6.1 : Fields of AI Application

- Fig. 1.6.1 shows few fields in which we have applications of artificial intelligence. There can be many fields in which Artificially Intelligent Systems can be used.

1. **Education**

Training simulators can be built using artificial intelligence techniques. Software for pre-school children are developed to enable learning with fun games. Automated grading, Interactive tutoring, instructional theory are the current areas of application.

2. **Entertainment**

Many movies, games, robots are designed to play as a character. In games they can play as an opponent when human player is not available or not desirable.

3. **Medical**

AI has applications in the field of cardiology (CRG), Neurology (MRI), Embryology (Sonography), complex operations of internal organs, etc. It can be also used in organizing bed schedules, managing staff rotations, store and retrieve information of patient. Many expert systems are enabled to predict the decease and can provide with medical prescriptions.

4. **Military**

Training simulators can be used in military applications. Also areas where human cannot reach or in life stacking conditions, robots can be very well used to do the required jobs. When decisions have to be made quickly taking into account an enormous amount of information, and when lives are at stake, artificial intelligence can provide crucial assistance. From developing intricate flight plans to implementing complex supply systems or creating training simulation exercises, AI is a natural partner in the modern military.

5. **Business and Manufacturing**

Latest generation of robots are equipped well with the performance advances, growing integration of vision and an enlarging capability to transform manufacturing.

6. **Automated planning and scheduling**

Intelligent planners are available with AI systems, which can process large datasets and can consider all the constraints to design plans satisfying all of them.

7. **Voice Technology**

Voice recognition is improved a lot with AI. Systems are designed to take voice inputs which are very much applicable in case of handicaps. Also scientists are developing an intelligent machine to emulate activities of a skillful musician. Composition, performance, sound processing, music theory are some of the major areas of research.

8. **Heavy Industry**

Huge machines involve risk in operating and maintaining them. Human robots are better replacing human operators. These robots are safe and efficient. Robot are proven to be effective as compare to human in the jobs of repetitive nature, human may fail due to lack of continuous attention or laziness.

AI MODULE 2

Q1. Define intelligent agent and list out its different types

In artificial intelligence an intelligent agent (IA) is an autonomous entity which observes through sensors and acts upon an environment and it directs its activity towards achieving goals.

An intelligent agent is a program that can make decisions or perform a service based on its environment, user input and experiences. An intelligent agent is an autonomous system that can perceive, reason, and act on behalf of an individual or a group.

Types of intelligent agents are defined by their range of capabilities and degree of intelligence:

- **Reflex agents:** These agents function in a current state, ignoring past history. Responses are based on the event-condition-action rule (ECA rule) where a user initiates an event and the agent refers to a list of pre-set rules and pre-programmed outcomes.
- **Model-based agents:** These agents choose an action in the same way as a reflex agent, but they have a more comprehensive view of the environment.
- **Goal-based agents:** These agents expand upon the information that model-based agents store by also including 'goal' information, or information about desirable situations.
- **Utility-based agents:** These agents are similar to goal-based agents but provide an extra utility measurement which rates each possible scenario on its desired result and chooses the action that maximizes the outcome.
- **Learning agents:** These agents have the ability to gradually improve and become more knowledgeable about an environment over time through an additional learning element. The learning element will use feedback to determine how performance elements should be changed to improve gradually.

Q2. What is a PEAS description? Give peas description for a robot meant for cleaning the house?

PEAS stands for **Performance measure, Environment, Actuators, and Sensors**, which are the components of an intelligent agent. A PEAS description is a formal way to describe the behaviour of an agent, including its goals, environment, actions, and sensors.

Here is a sample PEAS description for a robot meant for cleaning the house:

- **Performance measure:** The robot is designed to clean the house effectively and efficiently. Its performance is measured by the amount of dirt and debris it removes, the time it takes to complete a cleaning task, and the level of satisfaction of the user.
- **Environment:** The robot operates in a residential environment, which includes various rooms, furniture, and surfaces. The environment may be cluttered, and there may be obstacles that the robot needs to avoid. The robot needs to navigate through the environment to clean various surfaces and return to its charging station when necessary.
- **Actuators:** The robot uses a variety of actuators to perform its cleaning tasks, including a vacuum, brushes, and other cleaning tools. It may also use sensors to detect and avoid obstacles in its environment. Additionally, the robot may have a robotic arm to pick up and move objects.
- **Sensors:** The robot has a range of sensors to perceive its environment, including cameras, sonar, infrared, and bump sensors. These sensors allow the robot to detect dirt, debris, and obstacles, and to navigate through the environment safely.

Overall, the robot's goal is to effectively and efficiently clean the house, while avoiding obstacles and ensuring the safety of the user and the robot itself.

Q3. What are the types of task environment? Explain any two in detail?

There are several types of environments:

- Fully Observable vs Partially Observable
- Deterministic vs Stochastic
- Competitive vs Collaborative
- Single-agent vs Multi-agent
- Static vs Dynamic
- Discrete vs Continuous
- Episodic vs Sequential
- Known vs Unknown

1. Fully Observable vs Partially Observable

- When an agent sensor is capable to sense or access the complete state of an agent at each point in time, it is said to be a fully observable environment else it is partially observable.
- Maintaining a fully observable environment is easy as there is no need to keep track of the history of the surrounding.
- An environment is called unobservable when the agent has no sensors in all environments.
- Examples:
  - Chess – the board is fully observable, and so are the opponent's moves.

2. Deterministic vs Stochastic

- When a uniqueness in the agent's current state completely determines the next state of the agent, the environment is said to be deterministic.
- The stochastic environment is random in nature which is not unique and cannot be completely determined by the agent.
- Examples:
  - Chess – there would be only a few possible moves for a coin at the current state and these moves can be determined.
  - Self-Driving Cars- the actions of a self-driving car are not unique, it varies time to time.

Q4. Describe in detail a problem solving agent with a diagram.

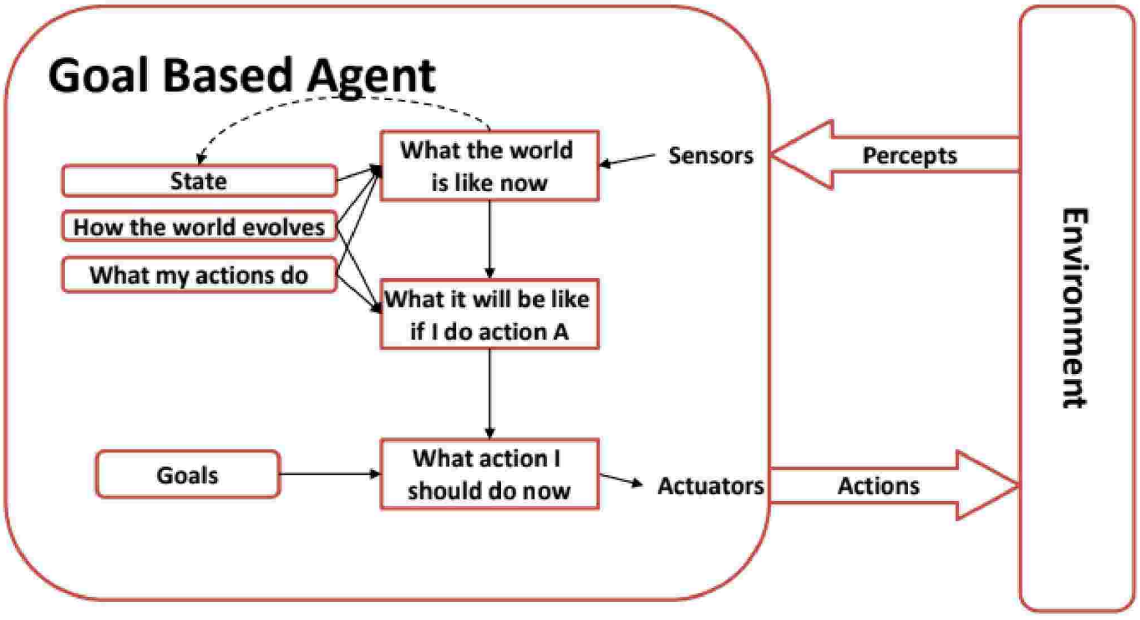
- The problem solving agent performs by defining problems and several solutions. Problem solving agent employees a number of techniques, such as a tree, heuristic algorithms to solve a problem.
- Problem formulation is one of the most important steps of problem solving. Agent has to decide what action to be taken to achieve the role.

Components to formulate The Associated Problem:

(i) **Initial State:** in this state, new methods also initialise problem solving by a specific class.
(ii) **Action:** Here the agent performs all possible actions with a specific class taken from initial state.
(iii) **Transition:** here the agent integrated the actual action by the previous action stage and collects the final stage to forward to next stage.
(iv) **Goal test:** when the goal is achieved, action steps and then forwards into the next stage to determine the cost to achieve the goal.
(v) **Path cost:** here the agent calculates all working cost.

**according to sir ke notes problem solving agent is kind of 'Goal based agent'*

*So uska diagram dala hai ab ye draw karna hai ya nahi tumhare upar**



Q 5. Explain four ways to measure performance of an AI algorithm.

We can evaluate an algorithm's performance in four ways:

– **Completeness:** Is the algorithm guaranteed to find a solution when there is one?

– **Optimality:** Does the strategy find the optimal solution.

– **Time complexity:** How long does it take to find a solution?

– **Space complexity:** How much memory is needed to perform the search?

answer chota lage toh apne words chipka do

Q.7 water jug problem:
You are given 2 jugs, a 4 gallon and 3 gallon and a pump which has unlimited water which you can use to fill a jug and the ground on which the water may be poured. Neither jug has measuring marking on it. How can you get exactly 2 gallons of water in the 4 gallon jug?

Consider x = water level in 3 gallon jug and

y = water level in 4 gallon jug

Let us represent the water levels in each jugs as (x, y)

Step 1: first we fill 4 gallon jug

$(0, 0) \rightarrow (0, 4)$

Step 2: we transfer the water in 4 gallon jug into 3 gallon jug

$(0, 4) \rightarrow (3, 1)$

Step 3: now we throw away the water in 3 gallon jug

$(3, 1) \rightarrow (0, 1)$

Step 4: we transfer 1 gallon water present in 4 gallon jug into 3 gallon jug

$(0, 1) \rightarrow (1, 0)$

Step 5: now we fill 4 gallon jug again

$(1, 0) \rightarrow (1, 4)$

Step 6: now we transfer water from 4 gallon jug into 3 gallon jug

$(1, 4) \rightarrow (3, 2)$

Now we have exactly 2 gallons of water in 4 gallon jug

Q6. Describe problem formulation steps and formulate 8 queens problem

2.8.3 8-Queens Problem

The goal of 8-Queens Problem is to place eight queens on a chessboard such that no queen attacks any other. A queen can attack any piece in the same row, column or diagonal.

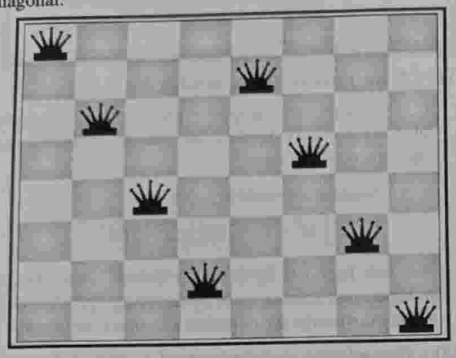


Fig. 2.8.4

In Fig. 2.8.4 the queen in the rightmost column is attacked by the queen at the top left.
(This attempted solution is a failure.)
Here there are two main kinds of formulations.

(1) **An incremental formulations**

This involves operators that **augment** -the state description, beginning with an empty state ; for this problem, it means that each action adds a queen to the state.

(2) **A complete state formulation**

This starts with all 8 queens on the board and moves them around. In either case, the path cost is of no interest because only the final state counts. We form the first incremental formulation as follows :

(i) **States :** Any arrangement of 0 to 8 queens on the board is a state.

(ii) **Initial state :** No queens on the board.

(iii) **Actions :** Add a queen to any empty square.

(iv) **Transition model :** Returns the board with a queen added to the specified square.

(v) **Goal test :** 8 Queens are on the board, no one is attacked.

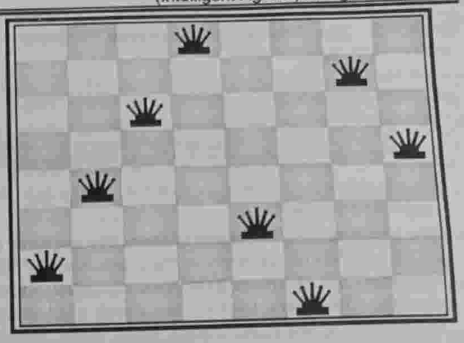


Fig. 2.8.5

In this formulation, there are 64 · 63 57 = 1.8×10^{14} possible sequences. Here the Queens are safe; no queen can attack the other.

Module 2

2.9 EXAMPLES OF REAL WORLD PROBLEM

2.9.1 Route-Finding Problem

Route-finding problem is defined in terms of specified locations and transitions along links between them. In a variety of applications, route finding algorithms are used.

It is used in Web-sites and in car systems that provide driving directions. Also in routing video-streams in computer networks, military operations planning etc.

We consider the airline travel problem that can be solved by a travel - planning web sites.

(i) **States :** Each state includes a location i.e. an airport and the current time. The state has to record extra information such as domestic or international flight, their fare bases etc.

(ii) **Initial state :** This depends upon users's query.

(iii) **Actions :** Take any flight from the current location, leaving after the current time, leaving enough time for within airport transfer if needed.

(iv) **Transition Model :** Taking a flight will have the flight's destination as the current location and the flights arrival time as the current time.

(v) **Goal Test :** Final destination mentioned by the users.

(vi) **Path cost :** This depends upon monetary cost, waiting time, flight time, customs and immigration procedures, seat quality, time of day, type of airplane and so on.

agar formulation stpes alag se explain akrna ho toh ur choice