Artificial Intelligence

Parul® University NAAC A++ ACCREDITED UNIVERSITY

DIGITAL LEARNING CONTENT

Parul® University

Subject Syllabus
Artificial Intelligence

Course: BTech **Semester:** 5

Prerequisite: Data structure, automata, and languages, Mathematics | 203105101 - Fundamentals of Programming

Rationale: This course provides a broad introduction to Artificial Intelligence. AI techniques for search and knowledge representation also Apply knowledge of AI planning and machine learning techniques to real-world problems

Teaching and Examination Scheme

Teaching Scheme					Examination Scheme					
Lecture Hrs/Week	Tutorial Hrs/Week	Lab Hrs/Week	Hrs/Week	Credit	Internal Marks			External Marks		Total
					T	CE	P	T	P	
3	0	0	-	3	20	20	-	60	-	100

SEE - Semester End Examination, CIA - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)

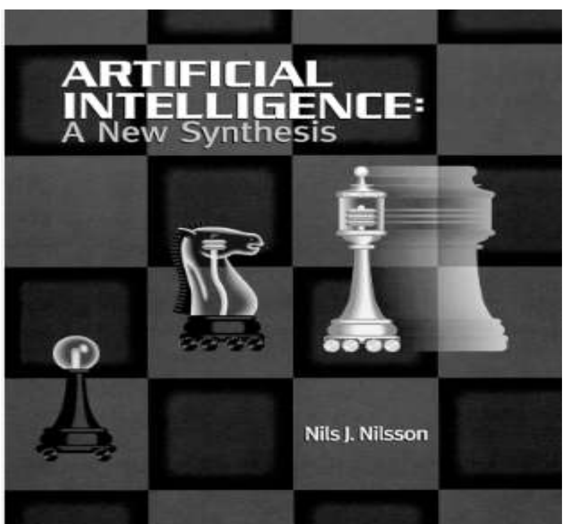
Course Content

W - Weightage (%) , T - Teaching hours

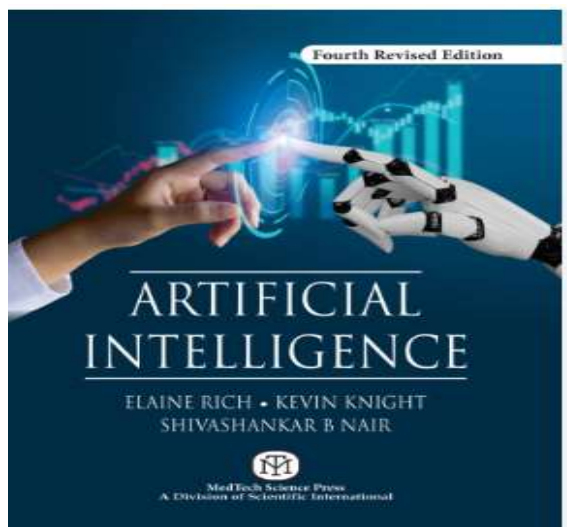
Sr.	Topics	W	T
1	**Introduction:** Definition of an AI, Major Areas of Artificial Intelligence, AI Techniques, History, AI problems, Production Systems, Problem characteristics, Intelligent Agents, Agent Architecture, AI Application (E-Commerce, & Medicine), AI Representation, Properties of internal representation, Future scope of AI, Issues in the design of search algorithms. Introduction to AI Problems and Applications, Defining Problems as a State Space Search, Problem Characteristics, Production Systems.	15	7
2	**Search techniques:** Generate-And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis. Heuristic search, Hill Climbing, Best first search, mean and end analysis, Constraint Satisfaction, A* and AO* Algorithm, Knowledge Representation: Basic concepts, Knowledge representation Paradigms, Propositional Logic, Inference Rules in Propositional Logic, Knowledge representation using Predicate logic, Predicate Calculus, Predicate and arguments, ISA hierarchy, Frame notation, Resolution, Natural Deduction	20	8
3	**Knowledge Representation:** Knowledge Representation – Representation and Mappings, Different Approaches, Issues in knowledge representation. Predicate Logic - Representation Simple Facts in Logic, Representing Instance and Isa Relationships, Computable Functions and Predicates, Resolution. Propositional Logic: Representation, Inference, Reasoning Patterns, Resolution, First-order Logic: Representation, Inference, Reasoning Patterns, Resolution	15	8
4	**Uncertainty:** Non-Monotonic Reasoning, Logics for Non-Monotonic Reasoning, Forward rules, and Backward rules, Justification based Truth Maintenance Systems, Semantic Nets Statistical Reasoning, Probability and Bayes' theorem, Bayesian Network, Markov Networks, Hidden Markov Model, Basis of Utility Theory, Utility Functions.	15	4
5	**Fuzzy Sets and Fuzzy Logic:** Fuzzy Set Operations, Membership Functions, Fuzzy Logic, Hedges, Fuzzy Proposition and Inference Rules, Fuzzy Systems.	10	4
6	**Natural Language Processing:** Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse and Pragmatic Processing, Spell Checking.	10	4
7	**Neural Networks and Expert systems:** Introduction to neural networks and perception-qualitative Analysis, Neural net architecture and applications, Utilization and functionality, the architecture of the expert system, knowledge representation, two case studies on expert systems	15	7

Books

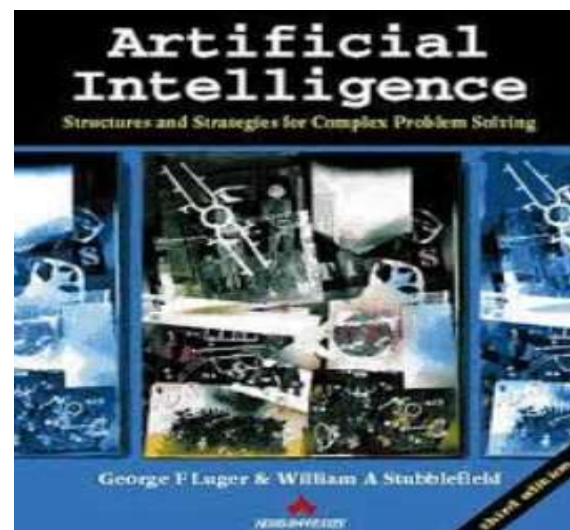
1. Artificial Intelligence: A New Synthesis, Harcourt Publishers (TextBook) By N. J. Nilsson | Harcourt Publishers



2. Artificial Intelligence (TextBook) By Elaine Rich and Kevin Knight | TMH

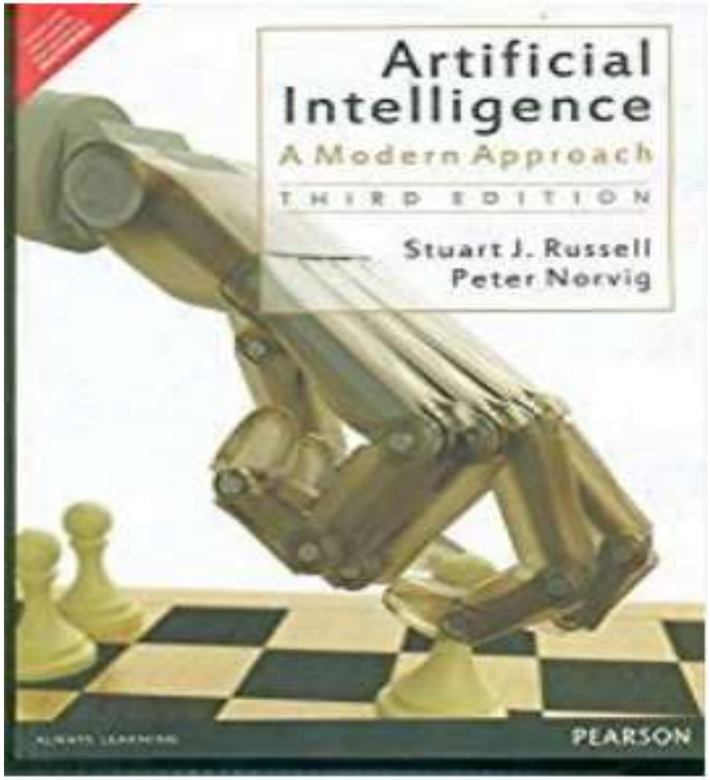


3. Artificial Intelligence- Structures and Strategies For Complex Problem Solving By George F. Luger | Pearson Education / PHI



Books

4. Artificial Intelligence-A Modern Approach By Stewart Russell and Peter Norvig | Pearson Education/ Prentice Hall of India | 2



5. Artificial Intelligence – A Practical Approach By Patterson | Tata McGraw Hill | 3

CHAPTER-1

Introduction of Artificial Intelligence

OutLine

- Definition of an AI
- Major Areas of Artificial Intelligence
- AI Techniques, History
- AI problems, Production Systems
- Problem characteristics
- Intelligent Agents
- Agent Architecture,
- AI Application (E-Commerce, & Medicine)
- AI Representation
- Properties of internal representation
- Future scope of AI
- Issues in the design of search algorithms
- State Space Search

Artificial Intelligence

"Artificial Intelligence (AI) is the field of computer science that aims to create systems that can perform tasks that typically require human intelligence, such as learning, problem-solving, decision-making, and perception. AI systems utilize advanced algorithms and techniques to mimic human cognitive abilities."

Introduction of an AI

- Artificial Intelligence (AI) is the field of computer science that aims to create intelligence machines capable of mimicking human cognitive functions such as learning and problem solving.
- AI systems are designed to process information from the environment, learn from data and take actions that maximize their goals.

What is Intelligence??

- According to dictionary.com, “the capacity, for learning, reasoning, understanding, and similar forms of mental activity.”.
- **Intelligence = Knowledge + Search strategy for exploring KB to draw useful conclusions.**
- Thus, in AI our **objective is to simulate KB and the search strategies in computers** so that they can behave in a way similar to the humans.

Major Areas of Artificial Intelligence

Machine Learning

The ability of AI systems to learn and improve from experience without being explicitly programmed.

Natural Language Processing

The development of AI systems that can understand, interpret, and generate human language.

Computer Vision

The field of AI that enables machines to identify and process digital images and videos.

Robotics

The integration of AI technologies to create autonomous and semi-autonomous robots that can perform tasks.

Major Areas of Artificial Intelligence and Techniques

- Artificial intelligence (AI) is a vast field encompassing various approaches and techniques that enable machines to exhibit intelligent behavior.

- Here are some of the major areas of AI research:

1. **Machine Learning**
2. **Deep Learning**
3. **Natural Language Processing**
4. **Computer Vision**
5. **Robotics**

1.Machine Learning

Machine learning is a subfield of AI where algorithms learn from data without explicit programming. They can identify patterns, make predictions, and improve their performance over time. Machine learning algorithms are trained on large datasets and can be categorized into three main types:

•**Supervised Learning:** Involves learning from labeled data, where each data point has a corresponding label or output value. The algorithm learns the mapping between the input data and the desired output.

•**Unsupervised Learning:** Deals with unlabeled data, where the algorithm must identify patterns and relationships in the data on its own.

•**Reinforcement Learning:** Involves an agent interacting with an environment and learning through trial and error. The agent receives rewards for desired actions and penalties for undesired actions, enabling it to learn optimal behavior over time.

2.Deep Learning

Deep learning is a subset of machine learning that uses artificial neural networks inspired by the structure and function of the human brain. These artificial neural networks consist of interconnected nodes (artificial neurons) arranged in layers.

Deep learning models can learn complex patterns from large amounts of data, achieving high levels of accuracy in tasks like:

Cont.....

- **Image Recognition:** Recognizing objects and scenes in images with high accuracy.
- **Speech Recognition:** Converting spoken language into text.
- **Machine Translation:** Translating text from one language to another.
- **Natural Language Processing:** Enabling machines to understand and respond to natural language more effectively.

3. Natural Language Processing (NLP)

Natural Language Processing (NLP) is a subfield of AI concerned with the interaction between computers and human language. NLP techniques enable machines to understand, generate, and manipulate human language. Some key NLP tasks include:

Machine Translation: Automatically translating text from one language to another.
Text Summarization: Generating a concise summary of a lengthy Piece of text.
Sentiment Analysis: Identifying the emotional tone of a piece of text (positive, negative or neutral).
Chatbots: Creating conversational agents that interact with humans in a natural way.

4. Computer Vision

- Computer vision is a field of AI that deals with the extraction of information from digital images and videos. Computer vision algorithms can:

Object detection: Identifying and locating objects within images or videos.

- **Image classification:** Categorizing images based on their content.
- **Facial recognition:** Identifying people in images or videos.
- **Medical image analysis:** Assisting doctors in analyzing medical images for diagnosis and treatment planning.

5. Robotics

- Robotics is a field of engineering concerned with the design, construction, operation, and application of robots.
- AI plays a crucial role in robotics by enabling robots to: Navigate their environment: Perceiving their surroundings and planning their movements. Interact with objects: Grasping and manipulating objects in a precise way.
- Learn and adapt: Continuously improving their performance based on new experiences.

Artificial Intelligence Techniques

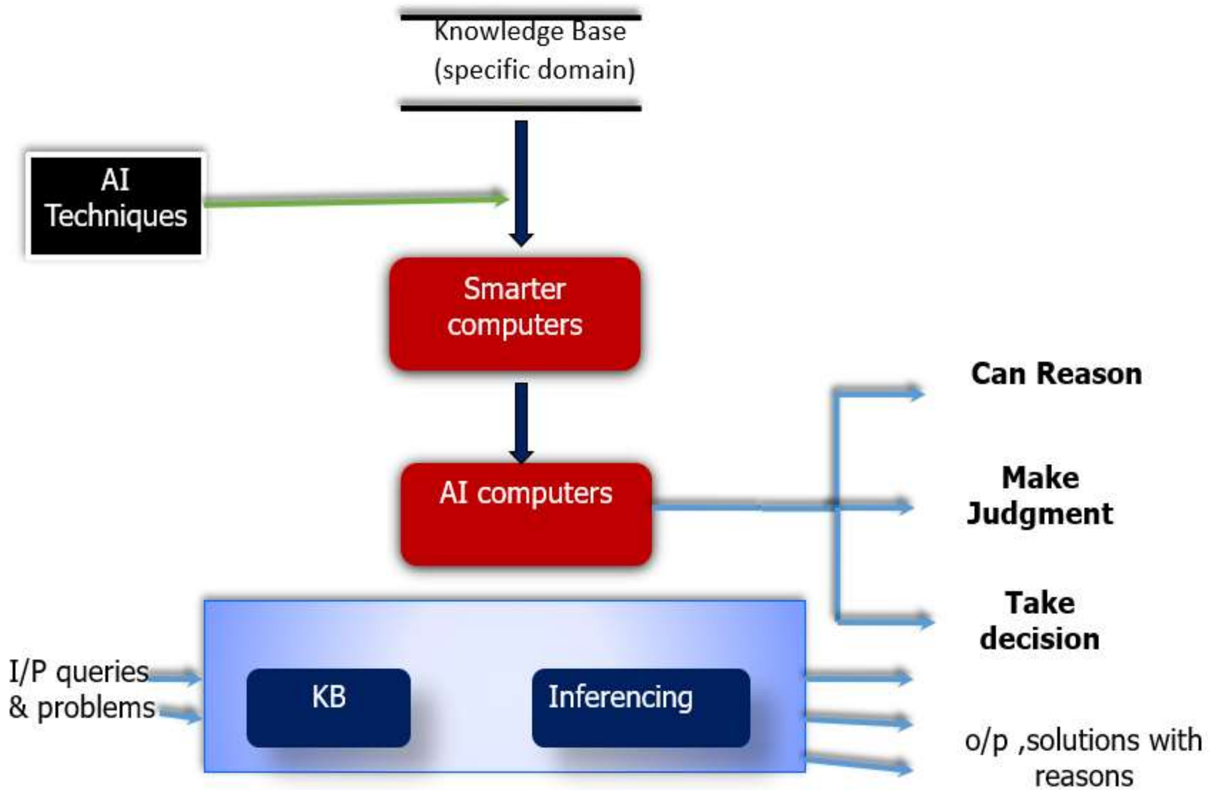
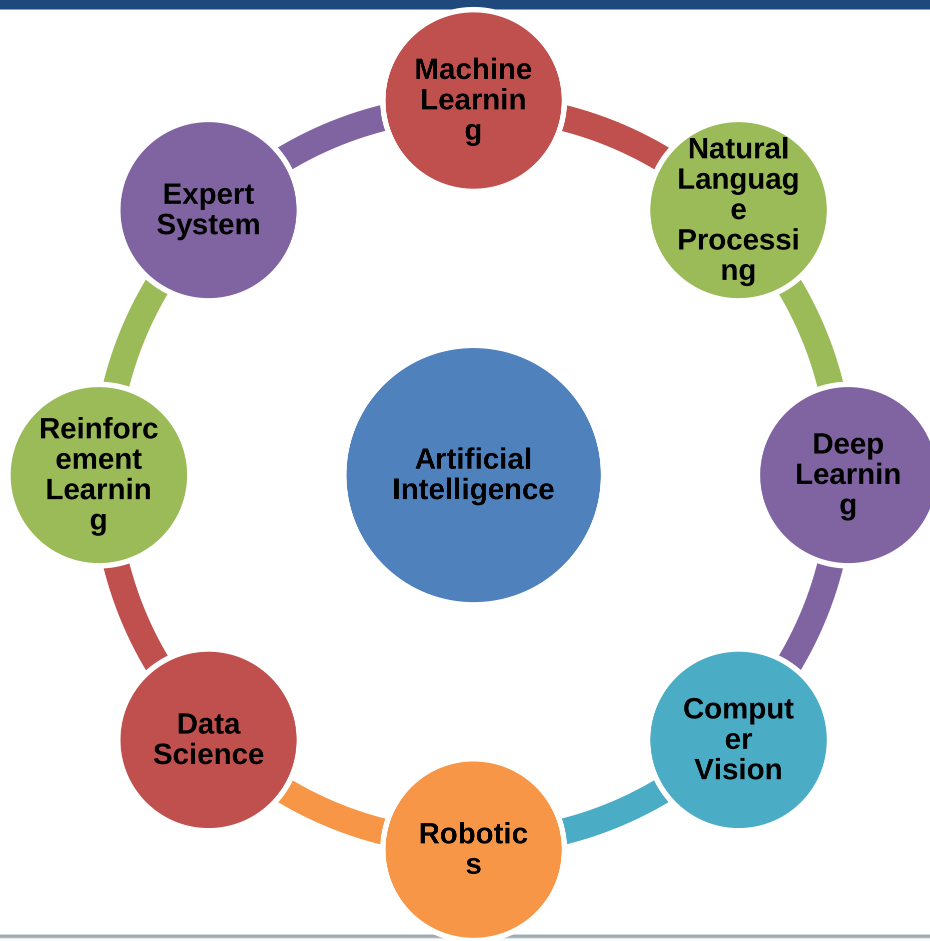


Figure: Flow chart of AI computing

Techniques of Artificial Intelligence



Techniques of Artificial Intelligence

Deep Learning

- **Definition**: A subset of machine learning involving neural networks with many layers.
- **Components**: Neurons, layers, backpropagation.
- **Applications**: Autonomous vehicles, natural language processing, game playing.

Natural Language Processing (NLP)

- **Definition**: The ability of a computer program to understand human language as it is spoken.
- **Key Tasks**:
    - Text analysis
    - Machine translation
    - Sentiment analysis
- **Applications**: Virtual assistants, chatbots, language translation services.

Techniques of Artificial Intelligence

Computer Vision

•**Definition**: The field of AI that trains computers to interpret and understand the visual world.

•**Key Techniques**:

- Image classification
- Object detection
- Image generation

•**Applications**: Facial recognition, medical imaging, autonomous driving.

Robotics

•**Definition**: The branch of AI that involves the design, construction, operation, and use of robots.

•**Components**:

- Sensors
- Actuators
- Control systems

•**Applications**: Manufacturing automation, surgical robots, drone technology.

Techniques of Artificial Intelligence

Expert Systems

- **Definition**: AI systems that use reasoning capabilities to reach a conclusion.
- **Components**:
  - Knowledge base
  - Inference engine
- **Applications**: Diagnostic systems, financial analysis, process control systems.

Machine Learning

- **Definition**: A subset of AI that enables machines to learn from data and improve from experience.
- **Types**:
  - Supervised Learning
  - Unsupervised Learning
  - Reinforcement Learning
- **Applications**: Image recognition, speech recognition, medical diagnosis.

Techniques of Artificial Intelligence

Data Science

•**Definition:** Data Science involves using scientific methods, processes, algorithms, and systems to extract knowledge and insights from structured and unstructured data.

•**Key Features**:

- Data Mining
- Predictive Analytics
- Data Visualization
- Data Cleaning

- **Applications:** Healthcare, Finance, Marketing, Retail, Sports.

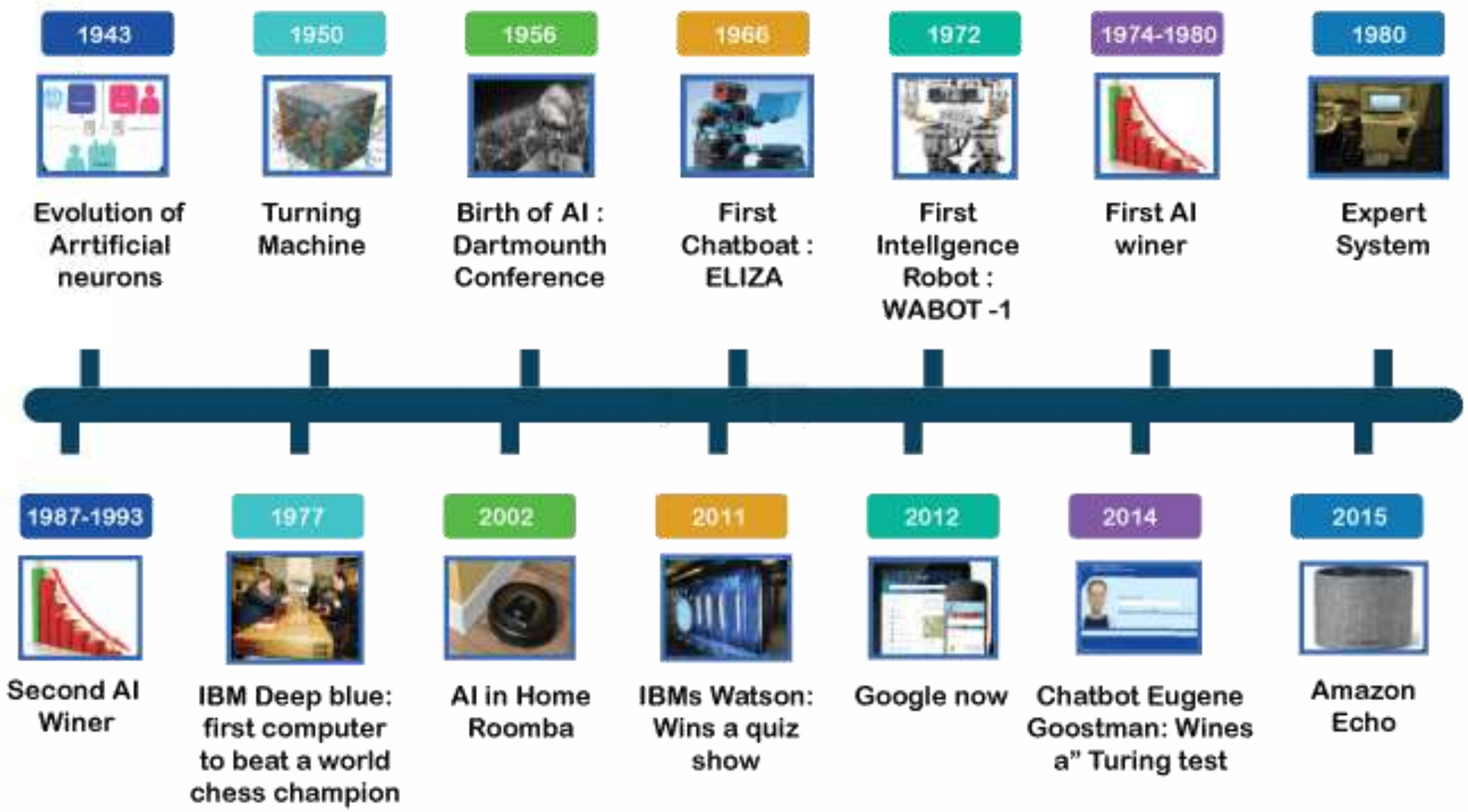
Reinforcement Learning

- **Definition:** Reinforcement Learning (RL) is a type of machine learning where an agent learns to make decisions by performing actions in an environment to maximize cumulative reward. **Components**:
  - Agent
  - Environment
  - Actions
  - Rewards Policy

•**Applications**: Gaming Robotics, Autonomous Vehicle, Health care.

History of AI

History of AI



Artificial Intelligence Problem

Complexity

AI systems must grapple with the inherent complexity of the world, from uncertain and dynamic environments to the nuances of human behavior and language.

Uncertainty

AI models often have to make decisions and predictions based on incomplete or imperfect information, requiring them to handle uncertainty effectively.

Adaptability

AI systems need to be flexible and adaptable, capable of learning and evolving as they encounter new situations and challenges.

Interpretability

As AI becomes more advanced, the need to understand and explain its decision-making processes becomes increasingly important for trust and accountability.

AI Problem

AI problems can be broadly categorized into two main areas: technical challenges and ethical considerations.

1.Lack of transparency and explainability: Complex AI systems can be difficult to understand and interpret, making it challenging to determine how decisions are being made.This can be a problem in areas where accountability is important, such as healthcare or criminal justice.

Cont……

2.Data quality and bias: AI systems are only as good as the data they are trained on. If the data is biased, the AI system will also be biased. This can lead to discrimination against certain groups of people.

Cont……

3.Safety and security: AI systems can be vulnerable hacking and other security threats. Malicious actors cou potentially use AI to cause harm, such as by launchi cyberattacks or spreading misinformation.

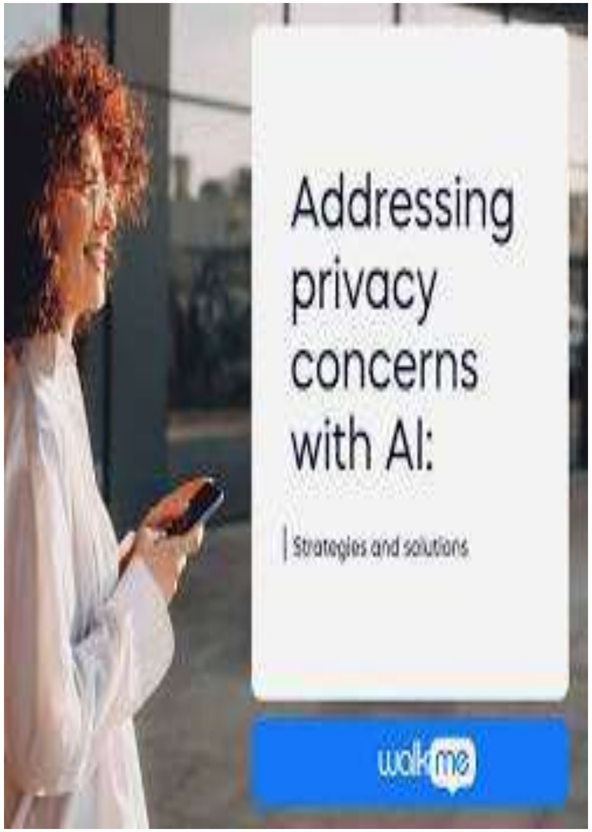
Parul® University NAAC A++ ACCREDITED UNIVERSITY

DIGITAL LEARNING CONTENT

Cont……

4.Job displacement: AI has the potential to automate many jobs, leading to job loss and a need for reskilling.

Cont......



5. Privacy Concerns: AI systems can collect and use a lot of personal data. This raises concerns about privacy and the potential for misuse of this data.

Production Systems

- Production rules in AI are a group of rules that apply to information collected from a global database.
- Each rule has a precondition and a postcondition that the global database must either fulfill or not, depending on the rule.

How its Works

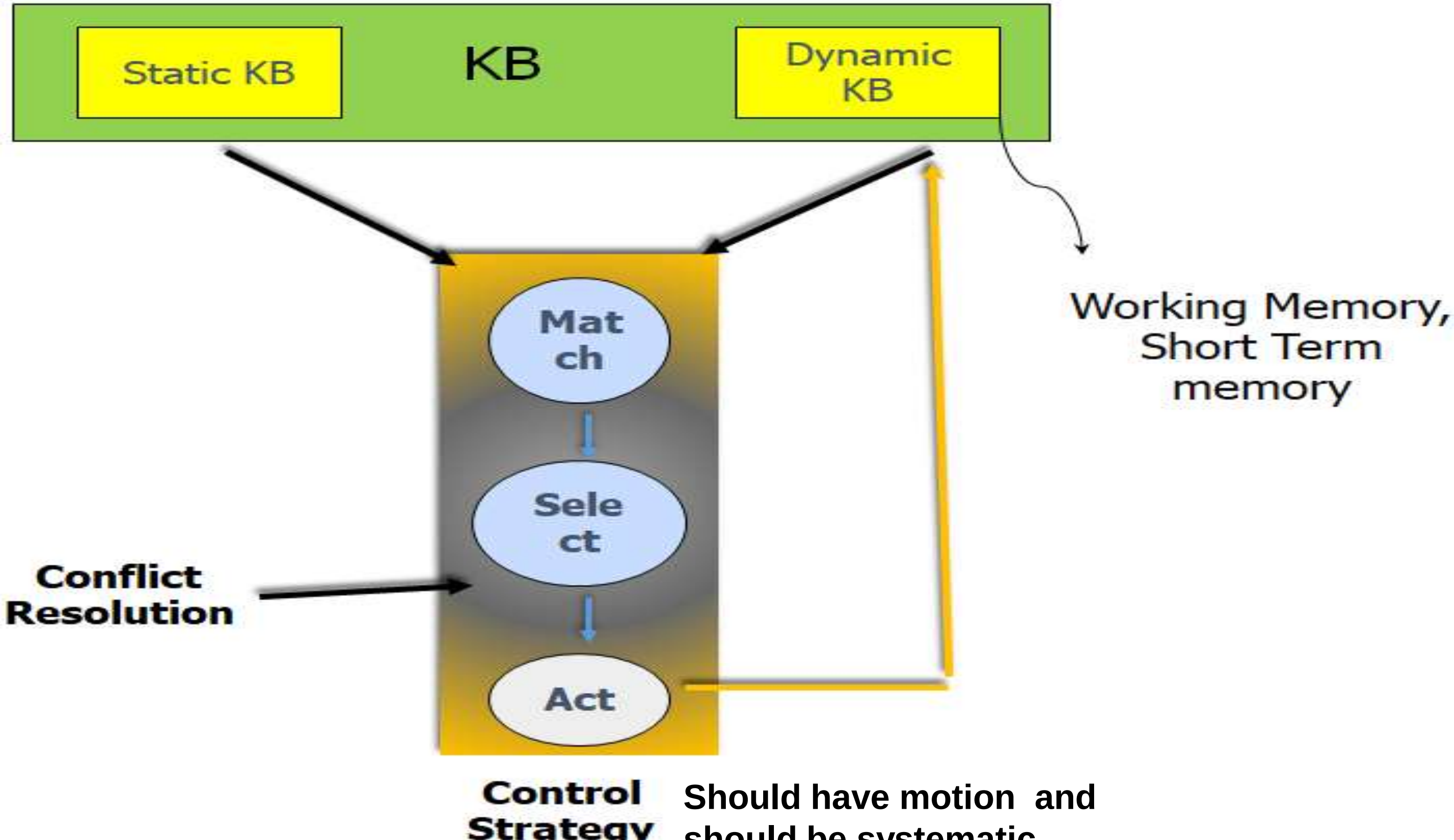
- **Input:** The system receives some input data representing the current situation.
- **Matching:** The inference engine compares the input data to the conditions in the production rules.
- **Firing:** If a rule's condition matches the input data, the rule is fired, and the corresponding action is taken. This action may involve modifying the system's internal state, generating an output, or even firing other rules.
- **Iteration:** The process continues iteratively until no more applicable rules are found or a specific goal is achieved.

Parul® University NAAC A++ ACCREDITED UNIVERSITY

Production System

- Production systems provide appropriate structures for performing and describing search processes.
- A production system has four basic components:
  1. A set of rules each consisting of a left side that determines the applicability of the rule and a right side that describes the operation to be performed if the rule is applied.
  2. A database of current facts established during the process of inference.
  3. A control strategy that specifies the order in which the rules will be compared with facts in the database and also specifies how to resolve conflicts in selection of several rules or selection of more facts.
  4. A rule applier.
- Production systems provide us with good ways of describing the operations that can be performed in a search for a solution to a problem.

Structure of Production System



Should have motion and should be systematic

Advantages of Production System

- Excellent tool for structuring AI problem.
- Separation of **KB and Control.**
- The natural mapping into **state space search – Rules are expressed in natural form.**
- Modularity of production rules:

"The scope of variables of the rules remain confined to an individual rule". This syntactic independence can support addition, deletion or modification of rules.

- Easy to understand.

Types of Production Systems

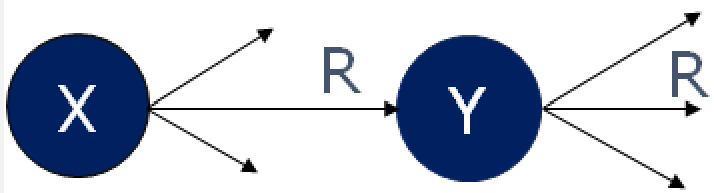
1. A monotonic production system is a production system in which the application of a rule never prevents the later application of another rule that could also have been applied at the time the first rule was selected.
2. A non-monotonic production system is one in which this is not true. This production system increases the problem-solving efficiency of the machine by **not keeping** a record of the changes made in the previous search process.
3. A partially communicative production system is a production system with the property that if the application of a particular sequence of rules transforms state P into state Q, then any combination of those rules that is allowable also transforms state P into state Q.
4. A commutative production system is a production system that is both monotonic and partially commutative. These type of production systems is used when the order of operation is not important, and the changes are reversible.

Parul® University NAAC A++ ACCREDITED UNIVERSITY

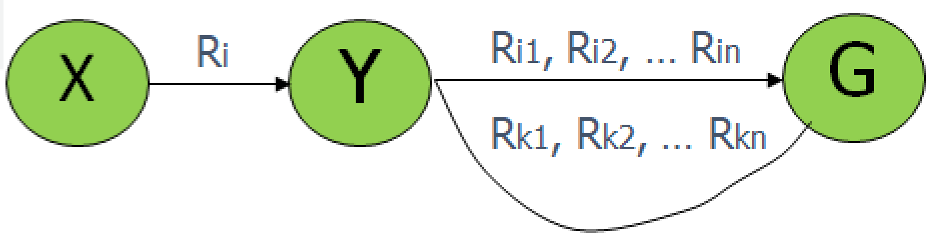
DIGITAL LEARNING CONTENT

Characteristics of Commutative Production System

- Any rule applicable to a state of problem is also applicable to the state resulting from application of that rule at that state of the problem.



- If the goal state can be reached from a state by application of a sequence of rules, then it can also be reached from the state resulting from application of that rule at that state.



Applications

Production systems are used in various AI applications, including:

- **Expert Systems:** These systems capture the knowledge of human experts in a specific domain and use it to solve problems, diagnose diseases advice.
- **Medical Diagnosis:** AI systems can analyze patient data and medical history using production rules to suggest potential diagnoses.
- **Game Playing:** AI players in games like chess or checkers use production rules to evaluate the game state and make optimal moves.
- **Robotics Control:** Robots can use production rules to react to their environment and make decisions about their actions.

Characteristics of Problem

1. Is the problem decomposable into a set of independent smaller or easier sub-problems?
2. Can solution steps be ignored or at least undone if they prove unwise?
3. Is the problem's universe predictable?
4. Is a good solution to the problem obvious without comparison to all other possible solutions?
5. Is the desired solution a state of the world or a path to a state?
6. Is a large amount of knowledge absolutely required to solve the problem or is knowledge important only to constrain the search?
7. Can a computer that is simply given the problem return the solution or will the solution of the problem require interaction between the computer and a person?

Intelligent Agents in AI

- **Intelligent agents** are autonomous entities which observe their environment through sensors and act upon that environment using actuators (effectors) to achieve specific goals.
- They can be simple, like a sensor, complex, a self-driving car. The fundamental aspects of intelligent include:

Autonomy: The ability to operate without human intermediation.

Perception: Using sensors to collect data from the environment.

Influence: Performing actions in the environment.

Goal directed behavior: Taking actions aimed at achieving specific objectives.

Learning: Adjusting based on experiences and new data.

Types of Agents in AI

- **Simple Reflex Agents**: Act only based on the current percept, ignoring the rest of the percept history.
  Example: A vacuum cleaner that cleans when it senses direct.

- **Model-Based Reflex Agents**: Maintain an internal state to track aspects of the world not immediately understandable.
  Example: A self-driving car that keeps track of its environment and past states.

- **Goal Based Agents**: Act to achieve specific goals, taking into account future states resulting from actions.
  Example: A robot navigating a maze to reach the exit.

Cont……

Utility Based agents: choose actions based on a utility function to maximize the expected utility.

Example: A stock trading bot that sells to maximize profit.

Learning Agents: Improve their performance over time based on experience.

Example: A recommendation system that improves its suggestions as it learns user preferences.

Implementation Aspects

Implementing intelligent agents involves several key aspects:

Perception: Utilizing sensors and data processing algorithms to gather and interpret environmental data.

Action Selection: Using decision-making algorithms to choose actions that achieve the agent's goals.

Learning: Employing machine learning techniques to improve performance over time.

Communication: Enabling agents to communicate with other agents or humans.

Ethics and Safety: Ensuring agents operate within ethical guidelines and prioritize safety.

Agent

- What is an agent ?
  - An agent is anything that perceiving its environment through sensors and acting upon that environment through actuators
  - Example:
- Human is an agent
- A robot is also an agent with cameras and motors
- A thermostat detecting room temperature.

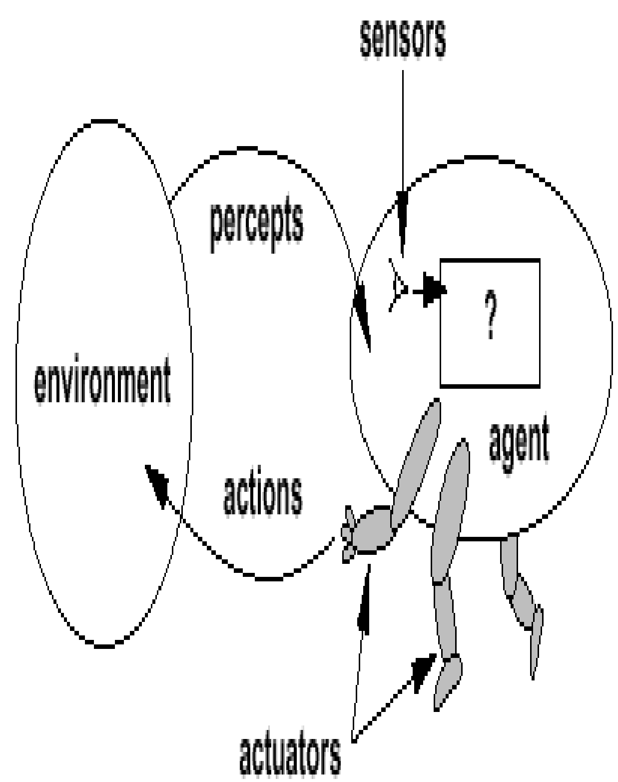
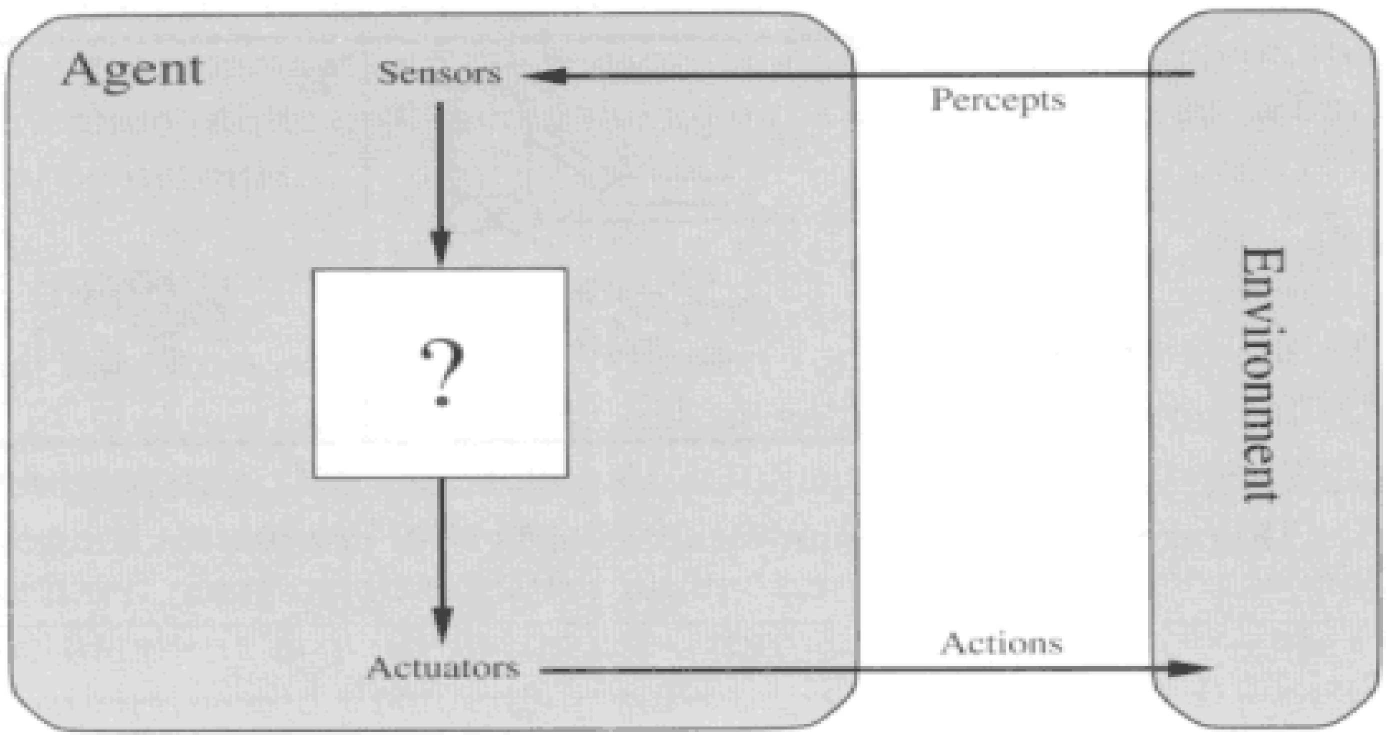


Diagram of Agent



What AI should fill

Structure of agents

- Agent = architecture + program
  - Architecture = some sort of computing device (sensors + actuators)
  - (Agent) Program = some function that implements the agent mapping = “?”
  - Agent Program = Job of AI

Agent Programs

- P = the set of possible percepts
- T= lifetime of the agent
  - The total number of percepts it receives
- Size of the look up table
- Consider playing chess
  - P =10, T=150
  - Will require a table of at least 10^{150} entries

Types of agent programs

- Four types
  - Simple reflex agents
  - Model-based reflex agents
  - Goal-based agents
  - Utility-based agents
  - Learning agents

Simple reflex agents

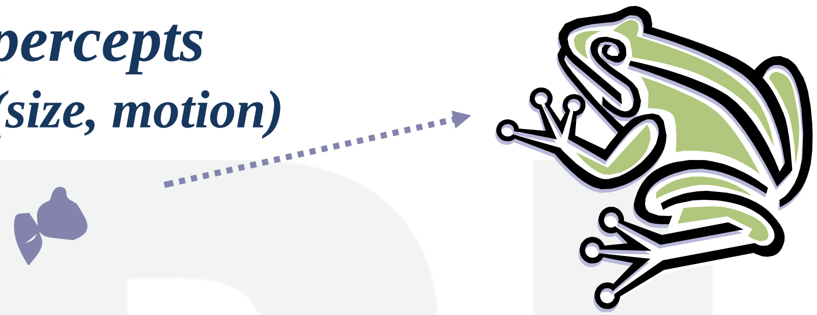
- It uses just ***condition-action rules***
  - The rules are like the form "if … then …"
  - efficient but have narrow range of applicability
  - Because knowledge sometimes cannot be stated explicitly
  - Work only
    - if the environment is fully observable

```
function SIMPLE-REFLEX-AGENT(percept) returns action
  static: rules, a set of condition-action rules

  state ← INTERPRET-INPUT(percept)
  rule ← RULE-MATCH(state, rules)
  action ← RULE-ACTION[rule]
  return action
```

A Simple Reflex Agent in Nature

percepts
(size, motion)



RULES:

(1) If small moving object,
  then activate SNAP

(2) If large moving object,
  then activate AVOID and inhibit SNAP

ELSE (not moving) then NOOP

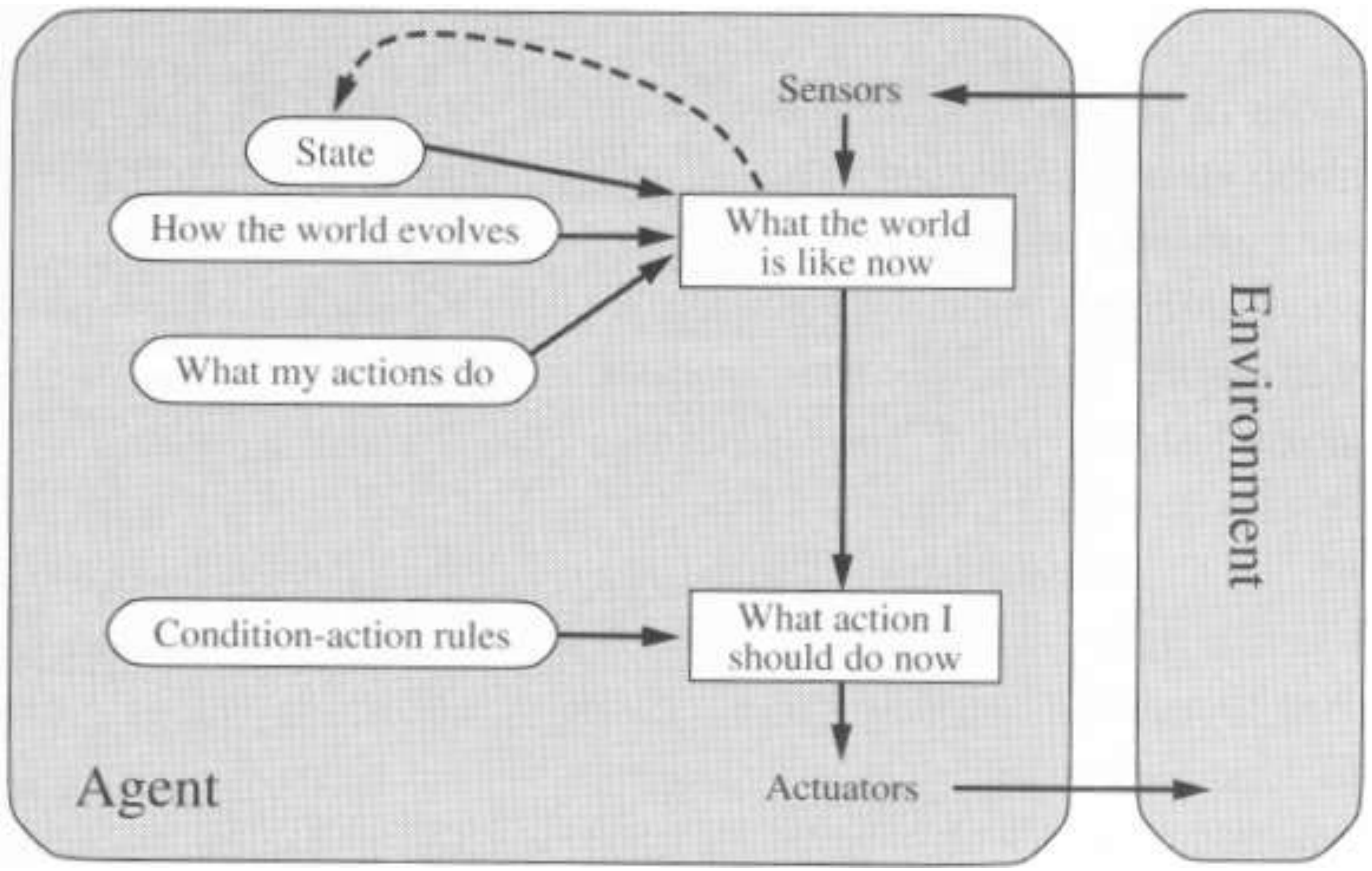
needed for completeness

Action: SNAP or AVOID or NO OP

Model-based Reflex Agents

- For the world that is partially observable
  - the agent has to keep track of an internal state
    - That depends on the percept history
    - Reflecting some of the unobserved aspects
    - E.g., driving a car and changing lane
- Requiring two types of knowledge
  - How the world evolves independently of the agent
  - How the agent's actions affect the world

Model-based Reflex Agents



Model-based Reflex Agents

```
function REFLEX-AGENT-WITH-STATE(percept) returns action
    static: state, a description of the current world state
            rules, a set of condition-action rules

    state ← UPDATE-STATE(state, percept)
    rule ← RULE-MATCH(state, rules)
    action ← RULE-ACTION[rule]
    state ← UPDATE-STATE(state, action)
    return action
```

The agent is with memory

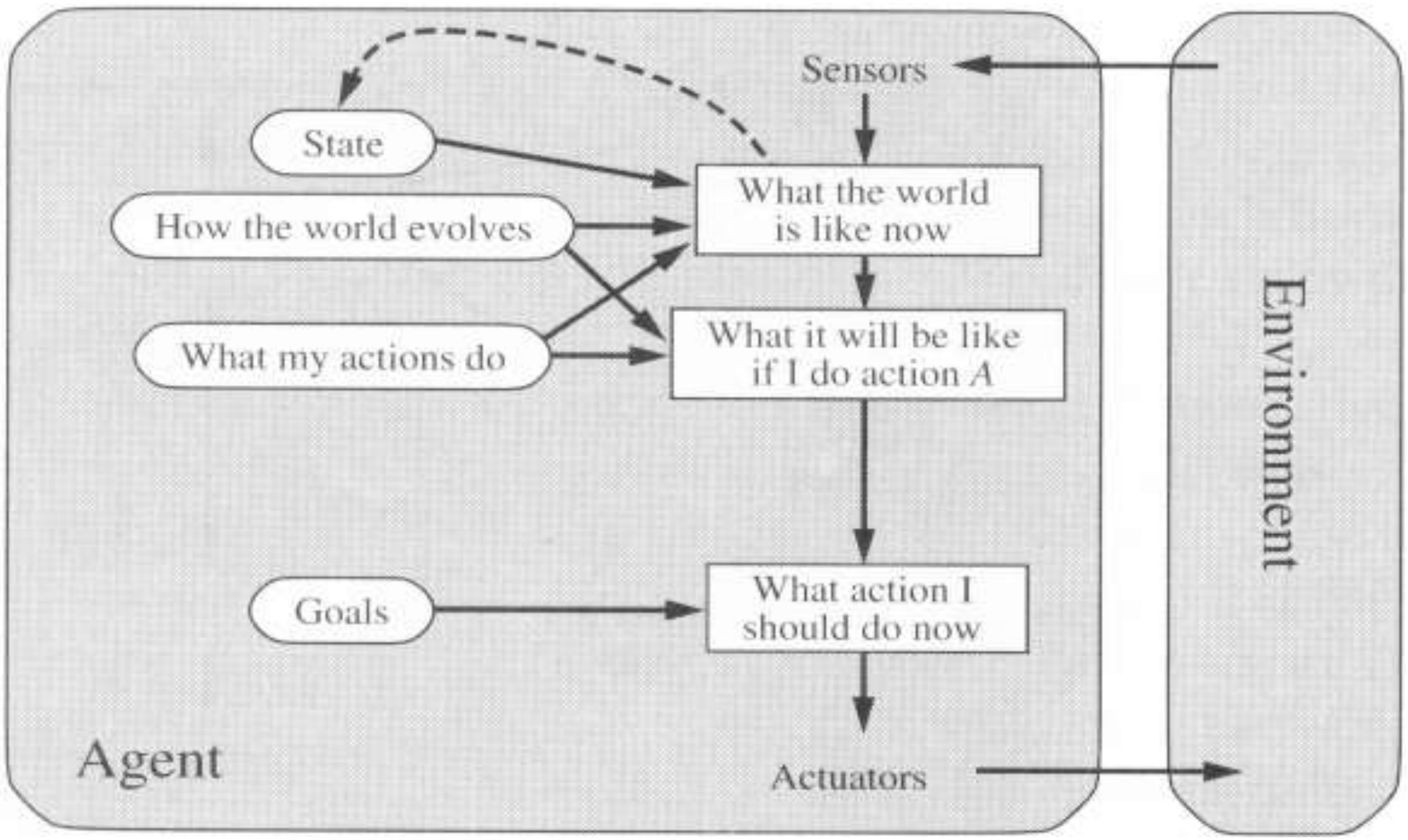
Goal-based agents

- Current state of the environment is always not enough
- The goal is another issue to achieve
  - Judgment of rationality / correctness
- Actions chosen ⍰ goals, based on
  - the current state
  - the current percept

Goal-based agents

- Conclusion
  - Goal-based agents are less efficient
  - but more flexible
    - Agent Different goals different tasks
  - Search and planning
    - two other sub-fields in AI
    - to find out the action sequences to achieve its goal

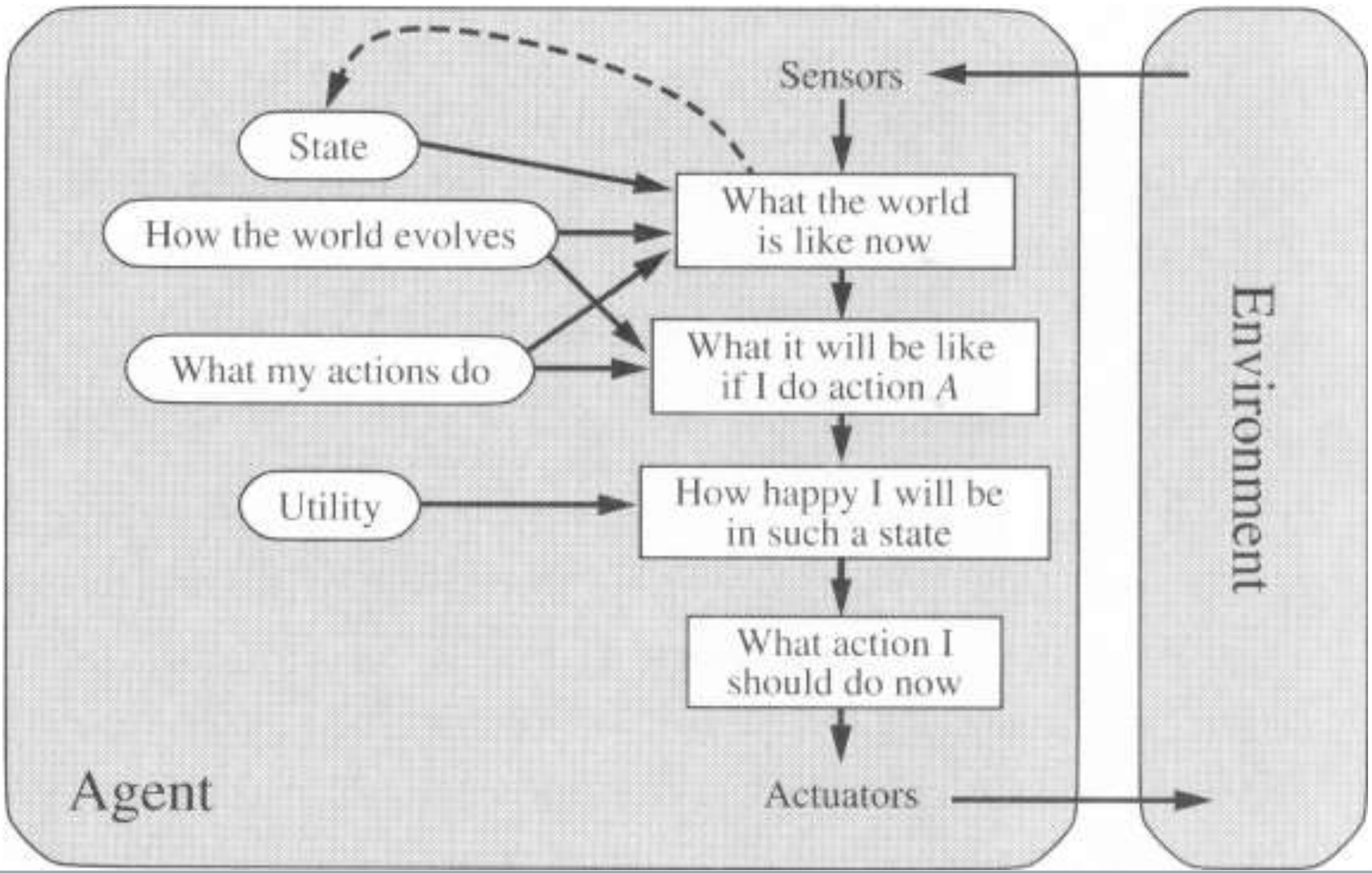
Goal-based agents



Utility-based agents

- it is said state A has higher utility
  - If state A is more preferred than others
- Utility is therefore a function
  - that maps a state onto a real number
  - the degree of success

Utility-based agents



Utility-based agents

- it is said state A has higher utility
  - If state A is more preferred than others
- Utility is therefore a function
  - that maps a state onto a real number
  - the degree of success

Utility-based agents

- Utility has several advantages:
  - When there are conflicting goals,
    - Only some of the goals but not all can be achieved
    - utility describes the appropriate trade-off
  - When there are several goals
    - None of them are achieved **certainly**
    - utility provides a way for the decision-making

Learning Agents

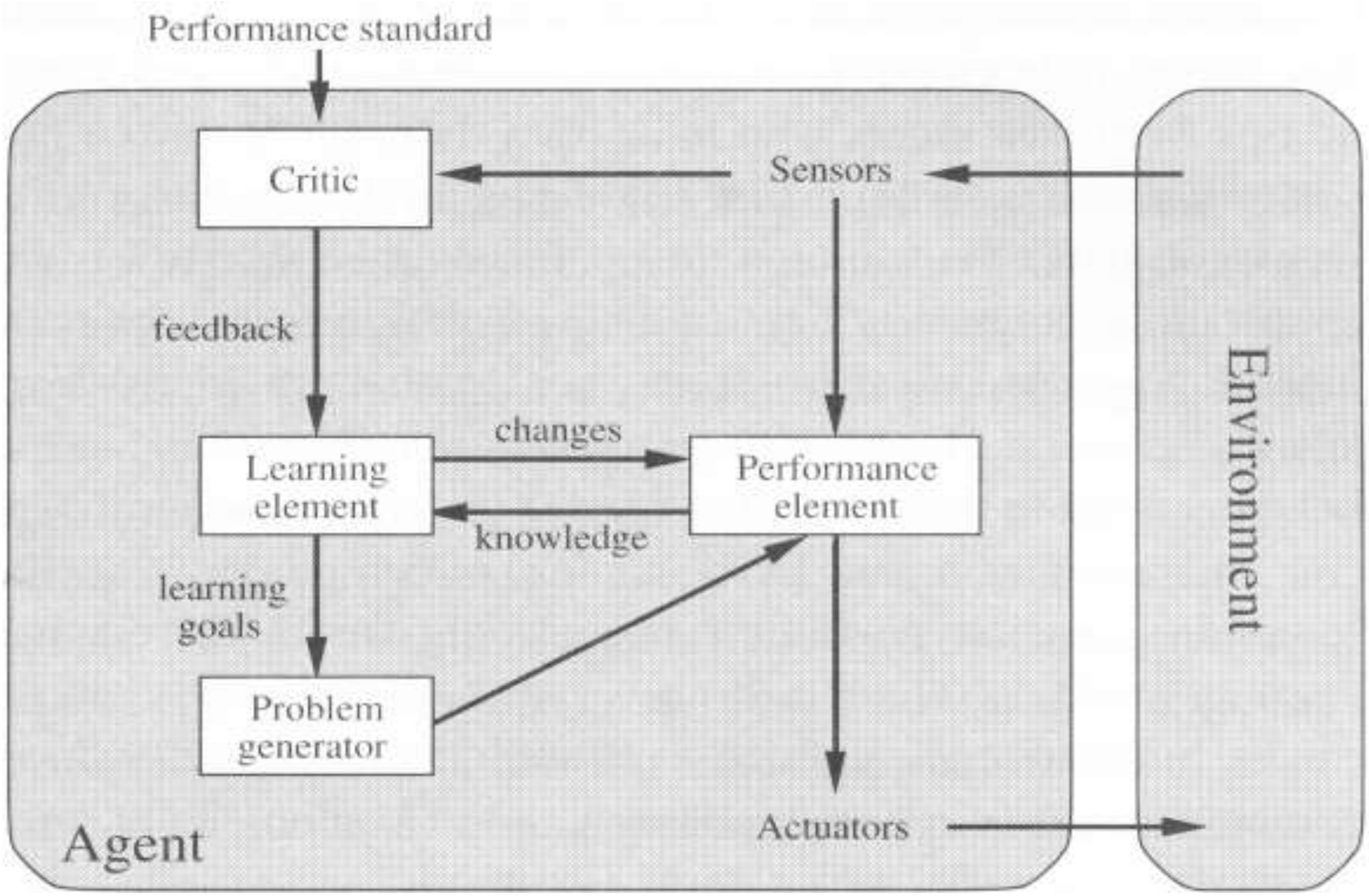
- After an agent is programmed, can it work immediately?
  - No, it still need teaching
- In AI,
  - Once an agent is done
  - We teach it by giving it a set of examples
  - Test it by using another set of examples
- We then say the agent learns
  - A learning agent

Learning Agents

- Four conceptual components
  - Learning element
    - Making improvement
  - Performance element
    - Selecting external actions
  - Critic
    - Tells the Learning element how well the agent is doing with respect to fixed performance standard.

    (Feedback from user or examples, good or not?)
  - Problem generator
    - Suggest actions that will lead to new and informative experiences.

Learning Agents



Applications of Intelligent Agents

Robotics: Autonomous robots in manufacturing, healthcare, and exploration.

Finance: Trading bots that execute transactions in financial markets.

Healthcare: Diagnostic tools and personalized treatment planning.

Gaming: Non-player characters (NPCs) with realistic behaviors.

Smart Homes: Systems that automate and optimize home environments.

Parul® University NAAC A++ ACCREDITED UNIVERSITY

DIGITAL LEARNING CONTENT

AI Applications in Medicine

Diagnostic Assistance

AI-powered systems can analyze medical images, patient data, and symptoms to assist clinicians in making more accurate and timely diagnoses, improving patient outcomes.

Drug Discovery

AI algorithms can accelerate the drug discovery process by identifying promising drug candidates, simulating drug interactions, and optimizing clinical trials.

Personalized Prosthetics

AI-driven design and manufacturing techniques are enabling the creation of highly customized prosthetic limbs that better fit and function for individual patients, enhancing their quality of life.

Remote Patient Monitoring

AI-enabled wearable devices and sensors can continuously monitor patients' vital signs, activity levels, and other health indicators, allowing for earlier intervention and more proactive care.

Application of AI in Medicine

1.Diagnostics:

- **Medical Imaging**: AI algorithms analyze medical images (e.g., X-rays, MRIs, CT scans) to detect abnormalities, such as tumors, fractures, or diseases, with high accuracy.
- **Pathology**: AI can assist in analyzing pathology slides to identify cancerous cells and other pathological conditions.

2.Predictive Analytics:

- **Disease Prediction**: AI models can predict the likelihood of developing certain diseases based on genetic, lifestyle, and environmental factors.
- **Patient Outcomes**: AI can predict patient outcomes and potential complications, helping in early intervention and personalized treatment plans.

Cont…..

3. Personalized Medicine:

- **Genomics**: AI analyzes genetic data to identify mutations and variations linked to specific diseases, aiding in the development of personalized treatment plans.
- **Treatment Optimization**: AI helps in identifying the most effective treatments for individual patients based on their genetic makeup and medical history.

4. Robotics and Automation:

- **Surgical Robots**: AI-powered robots assist surgeons in performing complex procedures with precision and minimal invasiveness.
- **Automated Systems**: AI automates routine tasks, such as dispensing medication, managing patient records, and scheduling appointments.

Cont…...

5. Telemedicine:

- **Remote Monitoring**: AI enables remote monitoring of patients with chronic conditions, providing real-time data to healthcare providers.
- **Virtual Consultations**: AI supports virtual consultations by analyzing patient data and assisting healthcare providers in diagnosis and treatment.

6. Drug Discovery and Development:

- **Molecular Analysis**: AI accelerates drug discovery by analyzing molecular structures and predicting their effects on biological targets.
- **Clinical Trials**: AI optimizes clinical trial design, patient recruitment, and data analysis, reducing the time and cost of bringing new drugs to market.

Cont….

7.Health Management:

- **Wearable Devices**: AI analyzes data from wearable devices to monitor vital signs, activity levels, and other health metrics, providing insights for preventive care.
- **Behavioral Health**: AI applications in mental health analyze patterns in behavior and speech to provide early warnings of conditions like depression and anxiety.

AI Applications in E-Commerce

- **Personalized Product Recommendations**:
  - AI analyzes past customer behavior, browsing history, and purchase history to suggest relevant products.
  - Features like “People also purchased” or “Customers also viewed” enhance the shopping experience[1].
- **Chatbots and Virtual Assistants**:
  - AI-powered chatbots handle customer inquiries, provide support, and assist with order tracking.
  - They improve response time and enhance customer satisfaction.

AI Applications in E-Commerce

- **Fraud Detection and Prevention**:
  - AI algorithms identify suspicious transactions, patterns, and anomalies.
  - This helps prevent fraudulent activities and protects both customers and businesses.

AI Applications in E-Commerce

- **Dynamic Pricing**:
  - AI adjusts prices based on real-time data, competitor pricing, and demand fluctuations.
  - Businesses can maximize revenue while remaining competitive.
- **Customer Churn Prediction**:
  - AI analyzes customer behavior to predict potential churn (when customers stop buying).
  - Businesses can take proactive measures to retain customers.

AI Applications in E-Commerce

- **Inventory Management**:
  - AI optimizes inventory levels by predicting demand and automating restocking.
  - It ensures products are available when needed without overstocking.

- **Generative AI**:
  - AI generates product descriptions, marketing content, and even designs.
  - It enhances creativity and efficiency in content creation.

Application of AI

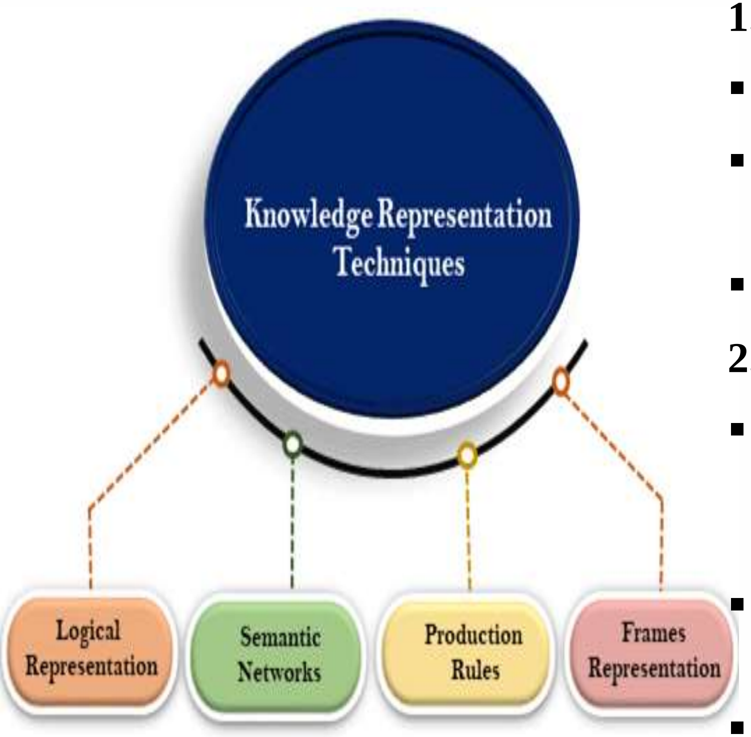
AI is revolutionizing various industries:

- **Self-driving cars:** AI algorithms navigate roads and make decisions in real-time.
- **Fraud detection:** AI identifies suspicious patterns in financial transactions.
- **Medical diagnosis:** AI assists doctors in analyzing medical images and data for accurate diagnoses.
- **Recommendation systems:** AI personalizes product recommendations based on user behavior.
- **Virtual assistants:** AI-powered assistants like Siri and Alexa respond to voice commands and complete tasks.

Representation of AI

- It consists of the objectives that are used to express the knowledge that is required to solve a specific problem.
- The different kinds of knowledge that need to be represented in AI systems. include: Objects: All the information related to the objects present in our world.

Cont….



1.Logical Representation:

- Drawing a conclusion based on various conditions.
- provides machines with the capacity for representing their world and for logical reasoning.
- Statements in propositional logic can be either True or false.

2.Semantic Networks:

- AI are graphical structures designed to represent and organize knowledge, enabling machines to understand and process information in human-readable form.
- words and sentences and using those details to perform tasks or provide information to users.
- For example, a semantic AI system can automatically summarize a news article, answer questions, or translate text from one language to another.

Cont….

3. Production Rules

- Production rules in AI are a group of rules that apply to information collected from a global database.
- Each rule has a precondition and a postcondition that the global database must either fulfill or not, depending on the rule.

4. Frames Representation

- A frame-based expert system is an (AI) program that uses a knowledge representation technique to store and reason with facts about the world.
- It works on the basis of frames, which are structures designed to capture relevant information from a particular domain such as medicine or business.

Properties of internal representation

- Internal representation, also known as knowledge representation in AI, refers to how information is stored and structured within an AI system.
- This structure allows the AI to reason, learn, and solve problems.
- Here are some key properties of a good internal representation in AI:

1. **Representational Capability:** The system should be able to represent all the necessary knowledge for the specific task or domain. It needs to capture the essential elements and relationships between them.
2. **Inferential Capability:** The representation should allow the AI to manipulate existing knowledge to derive new knowledge. This enables reasoning, logic, and making predictions based on the stored information.

Cont….

3. **Inferential Efficiency:** The system should facilitate efficient reasoning and manipulation of knowledge. This means the AI can save and use relevant information quickly to solve problems.

4. **Acquisitional Efficiency:** The knowledge representation scheme should allow for easy acquisition of new knowledge. This makes the system easy going and able to learn from new data.

Cont….

5. Descriptive Power: Ideally, the internal representation should be somewhat understandable by humans. This allows us to explain the AI's reasoning process and identify potential biases or errors in its logic.

These properties are essential for building effective AI systems. The choice of representation method depends on the specific task and the type of knowledge being distributed with. Some common internal representation techniques include logic statements, semantic networks, probabilistic models, and deep learning architectures.

Future Scope of AI

Autonomous Systems

AI-powered autonomous systems, such as self-driving cars and intelligent robots, will become more advanced and widespread.

Natural Language Processing

AI-driven language understanding and generation will revolutionize human-computer interaction and communication.

Healthcare Optimization

AI will play a crucial role in optimizing healthcare delivery, disease diagnosis, and personalized treatment plans.

Ethical AI Frameworks

Developing ethical guidelines and governance frameworks for AI systems will be a key focus.

Future Scope of AI

Machine Learning

Advancements in machine learning algorithms and techniques will drive breakthroughs in AI capabilities.

Neural Networks

Deep neural networks and other advanced architectures will enable more powerful and versatile AI systems.

Artificial General Intelligence

The long-term goal of achieving Artificial General Intelligence (AGI) that matches human-level cognitive abilities.

Ethical AI

Ensuring the development of ethical and socially responsible AI systems will be a critical priority.

Cont…..

Healthcare

- **Personalized Medicine**: AI can analyze genetic information, lifestyle data, and medical records to modify treatments to individual patients.
- **Early Diagnosis**: Machine learning models can detect diseases early by analyzing medical images, genetic data, and other biomarkers.
- **Drug Discovery**: AI speed up the process of discovering new drugs by predicting how different compounds will interact with targets in the body.

Cont…..

Transportation

- **Autonomous Vehicles**: Continued advancements in AI will enhance the safety, efficiency, and occurrence of self-driving cars, buses, and drones.
- **Traffic Management**: AI can optimize traffic flow in cities, reducing overcrowding and productions by managing traffic lights and predicting traffic patterns.

Cont…..

Education

- **Personalized Learning**: AI-driven educational platforms can adapt to the learning styles and paces of individual students, providing customized resources and feedback.
- **Administrative Automation**: AI can handle administrative tasks, such as categorizing and scheduling, liberation educators to focus more on teaching.

Cont…..

Finance

- **Fraud Detection**: AI algorithms can identify unusual patterns and behaviors that may indicate fake activities.
- **Algorithmic Trading**: AI can analyze vast amounts of financial data to make trading decisions at speeds and accuracies beyond human capabilities.
- **Personal Finance Management**: AI-driven applications can provide personalized advice on planning, saving, and investing.

Cont…..

Manufacturing

- **Predictive Maintenance**: AI can predict equipment failures before they occur, reducing downtime and maintenance costs.
- **Quality Control**: Machine learning algorithms can detect defects in products at various stages of the manufacturing process, ensuring higher quality outputs.
- **Supply Chain Optimization**: AI can optimize supply chains by predicting demand, managing list, and identifying the most efficient logistics ways.

Cont…..

Environmental Protection

- **Climate Modeling**: AI can improve climate models by analyzing vast amounts of environmental data, leading to better predictions and strategies for combating climate change.
- **Nature Conservation**: AI-driven tools can monitor nature populations, detect activities, and help in the conservation of common species.
- **Energy Management**: AI can optimize energy consumption in homes and industries, reducing waste and promoting the use of renewable energy sources.

Parul® University NAAC A++ ACCREDITED UNIVERSITY

DIGITAL LEARNING CONTENT

Cont…..

Customer Service

- **Chatbots and Virtual Assistants**: AI-powered chatbots and virtual assistants can handle customer inquiries, provide recommendations, and offer support, improving customer service efficiency.
- **Sentiment Analysis**: AI can analyze customer feedback and social media to instrument public sentiment and improve products and services accordingly.

Cont……

Entertainment

- **Content Creation**: AI can assist in creating song, art, and literature, offering new tools for artists and creators.
- **Personalized Recommendations**: AI algorithms can suggest movies, music, books, and other content personalized to individual preferences.

Cont…...

Smart Cities

- **Infrastructure Management**: AI can optimize the use of resources, manage utilities, and maintain infrastructure efficiently.
- **Public Safety**: AI-driven surveillance systems can enhance public safety by monitoring for and answering to potential threats.

Cont….

AI Ethics and Governance

- **Ethical AI Development**: As AI becomes more integrated into society, ensuring ethical use and avoiding biases in AI systems will be important.
- **Regulation and Policy**: Governments and organizations will need to develop policies and regulations to govern the use of AI, ensuring it benefits society while minimizing risks.

Issues in the design of Search Algorithms

- Definition: Search algorithms are methods for locating specific data within a larger dataset or finding solutions to computational problems.
- Importance: Efficient search algorithms are critical for applications in computer science, AI, data retrieval, and more.
- **Common Issues in Search Algorithm Design**
- **Scalability:**
  - Challenge of maintaining performance with increasing dataset sizes.
  - Example: Algorithms that perform well on small datasets may become inefficient on larger ones.

Issues in the design of Search Algorithms

- **Complexity:**
  - Time Complexity: The algorithm's running time in relation to the input size.
  - Space Complexity: The amount of memory required by the algorithm.
  - Need to balance between time and space efficiency.
- **Accuracy and Precision:**
  - Ensuring the algorithm returns correct and relevant results.
  - Handling false positives and false negatives.
- **Robustness:**
  - Algorithm's ability to handle different types of data and edge cases.
  - Example: Dealing with noisy, incomplete, or corrupted data.

Issues in the design of Search Algorithms

1. The direction in which to conduct the search (forward versus backward reasoning). If the search proceeds from start state towards a goal state, it is a forward search or we can also search from the goal, i.e., backward search.
2. How to select applicable rules (Matching). Production systems typically spend most of their time looking for rules to apply. So, it is critical to have efficient procedures for matching rules against states.
3. How to represent each node of the search process (knowledge representation problem).

Problem And Problem Solving

- The steps that are required to build a system to solve a particular problem are:
  1. Problem Definition that must include precise specifications of what the initial situation will be, as well as what final situations constitute acceptable solutions to the problem.
  2. Problem Analysis, this can have immense impact on the appropriateness of various possible techniques for solving the problem.
  3. Isolate and Represent the task knowledge required to solve the problem.
  4. Selection of the best technique(s) for solving the particular problem.

- Problem solving is a process of generating solutions from the observed data.

Defining State & State Space

- A ***state*** is a representation of problem elements at a given moment.
- ***A State space is the set of all states reachable from the initial state.***

- A state space forms a graph in which the nodes are states and the arcs between nodes are actions.
- In state space, a path is a sequence of states connected by a sequence of actions.
- The solution of a problem is part of the graph formed by the state space.
- ***The state space representation forms the basis of most of the AI methods.***

Contd...

- To provide a formal description of a problem, we need to do the following:
  1. Define a state space that contains all the possible configurations of the relevant objects.
  2. Specify one or more states that describe possible situations, from which the problem solving process may start. These states are called initial states.
  3. 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 (operators) 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'.

Defining Problems as a State Space Search

A Powerful Problem-Solving Technique

- In Artificial Intelligence (AI), state space search is a fundamental approach for solving problems.
- It involves modeling the problem as a collection of possible states, along with the actions that can transition between them.
- The goal is to find a sequence of actions that leads from the starting state (initial state) to a state that satisfies the desired outcome (goal state).

Cont…..

Key Components of a State Space Search

State Space:

- This represents the set of all possible configurations or situations the problem can be in.
- Each state is a snapshot of the problem at a specific point in time.
- Examples: A Rubik's cube in a particular configuration, a game board layout in chess, a city on a map during route planning.

Initial State:

- This defines the starting point of the search, the state from which the solution path begins.
- Examples: The scrambled state of the Rubik's cube, the starting position of the pieces in chess, the starting city in route planning.

Cont…..

Goal State(s):

- This defines the desired outcome(s) of the problem. One or more states that meet the success criteria.
- Examples: The solved state of the Rubik's cube, a checkmate position in chess, the destination city in route planning.

Actions:

- These are the operations or decisions that can be taken to transition from one state to another.
- Examples: Rotating a face of the Rubik's cube, moving a piece in chess, choosing a road to travel on in route planning.

Cont…..

Successor Function:

- This function takes a current state as input and returns all the possible states that can be reached by applying a single action.
- Essentially, it outlines the valid transitions between states.

Cost Function (Optional):

- This function assigns a numerical cost to each action or state transition.
- It allows for finding the most efficient solution path when there are multiple paths to the goal state.
- Examples: Distance traveled in route planning, time taken for a move in chess.

Cont…..

Benefits of State Space Search

Systematic approach:

- It explores the problem space systematically, ensuring all possibilities are considered.

Flexibility:

- Applicable to various AI problems by defining appropriate states, actions, and goals.

Foundation for algorithms:

- Forms the basis for many search algorithms used in AI, like Breadth-First Search, Depth-First Search, and A* Search.

Cont…..

Challenges of State Space Search

Complexity:

- Can be computationally expensive for problems with large state spaces (e.g., complex games like chess).

Heuristic design (informed search):

- Designing effective heuristic functions to guide the search towards the goal is crucial for informed search algorithms.

Overall, defining problems as a state space search provides a powerful framework for solving problems in AI.
By understanding the components and considering the challenges, you can effectively apply this technique to various AI applications.

Define the Problem as State Space Search

- **<u>Ex.1:- Consider the problem of Playing Chess</u>**
  - To build a program that could play chess, we have to specify:
- The starting position of the chess board,
- The rules that define legal moves, and
- The board position that represents a win.
  - The starting position can be described by an 8 X 8 array square in which each element square (x, y), (x varying from 1 to 8 & y varying from 1 to 8) describes the board position of an appropriate piece in the official chess opening position.
  - The goal is any board position in which the opponent does not have a legal move and his or her “king” is under attack.
  - The legal moves provide the way of getting from initial state of final state.

Ex.1:- Consider the problem of Playing Chess

- The legal moves can be described as a set of rules consisting of two parts: A left side that gives the current position and the right side that describes the change to be made to the board position.
- An example is shown in the following figure.

- **Current Position**
- While pawn at square (5 , 2), AND Square (5 , 3) is empty, AND Square (5 , 4) is empty.
- **Changing Board Position**
- Move pawn from Square (5 , 2) to Square (5 , 4) .
  - The current position of a chess coin on the board is **its state** and the set of all possible states is **state space**.
  - One or more states where the problem terminates are goal states.

Ex.1:- Consider the problem of Playing Chess

- Chess has approximately 10^{120} game paths. These positions comprise the problem search space.
- Using above formulation, the problem of playing chess is defined as a problem of moving around in a state space, where each state corresponds to a legal position of the board.
- State space representation seems natural for play chess problem because the set of states, which corresponds to the set of board positions, is well organized.

Define the Problem as State Space Search

Ex.2:- Consider Water Jug problem

- A Water Jug Problem: You are given two jugs, a 4-gallon one and a 3-gallon one, a pump which has unlimited water which you can use to fill the jug, and the ground on which water may be poured. Neither jug has any measuring markings on it. How can you get exactly 2 gallons of water in the 4-gallon jug?
- Here the initial state is (0, 0). The goal state is (2, n) for any value of n.
- **State Space Representation:** we will represent a state of the problem as a tuple (x, y) where x represents the amount of water in the 4-gallon jug and y represents the amount of water in the 3-gallon jug. Note that $0 \le x \le 4$, and $0 \le y \le 3$.

Ex.2:- Water Jug problem

- To solve this we have to make some assumptions not mentioned in the problem. They are:

- We can fill a jug from the pump.
- We can pour water out of a jug to the ground.
- We can pour water from one jug to another.
- There is no measuring device available.
  - Operators – we must define a set of operators that will take us from one state to another.

Ex.2:- Water Jug problem

Sr.	Current state	Next state	Description
1	(x, y) If x<4	(4, y)	fill the 4- gallon jug
2	(x, y) If x<3	(x,3)	fill the 3-gallon jug
3	(x, y) If x>0	(x-d, y)	pour some water out of the 4- gallon jug
4	(x, y) If y>0	(x, y-d)	pour some water out of the 3- gallon jug
5	(x, y) If x>0	(0, y)	empty the 4- gallon jug on the ground
6	(x, y) If y>0	(x, 0)	empty the 3- gallon jug on the ground

Ex.2:- Water Jug problem

Sr.	Current state	Next state	Description
7	(x, y) If x + y >= 4 & y>0	(4,y-(4-x))	pour water from the 3- gallon jug into the 4-gallon jug until the 4-gallon jug is full
8	(x, y) If x + y >= 3 & x>0	(x-(3-y),3))	pour water from the 4- gallon jug into the 3-gallon jug until the 3-gallon jug is full
9	(x, y) If x + y <= 4 & y>0	(x+y,0)	pour all the water from the 3-gallon jug into the 4-gallon jug

Ex.2:- Water Jug problem

Sr.	Current state	Next state	Description
10	(x, y) If x + y <= 3 & x>0	(0,x+y)	pour all the water from the 4 - gallon jug into the 3-gallon jug
11	(0,2)	(2,0)	pour the 2-gallon from the 3 – gallon jug into the 4-gallon jug
12	(2,y)	(0, x)	empty the 2 gallon in the 4 gallon on the ground

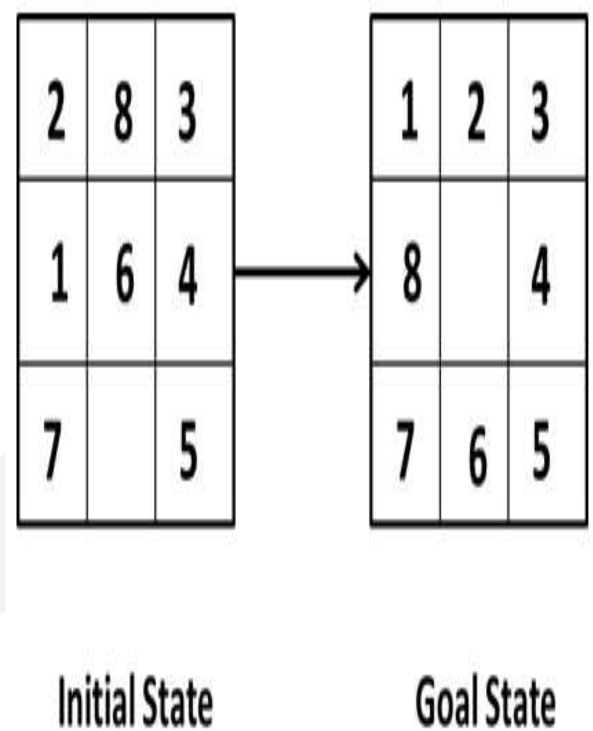
Ex.2:- Water Jug problem - Solution

Gallons in the 4- gallon Jug	Gallons in the 3- gallon	Rule Applied
0	0	
0	3	2
3	0	9
3	3	2
4	2	7
0	2	5 or 12
2	0	9 or 11

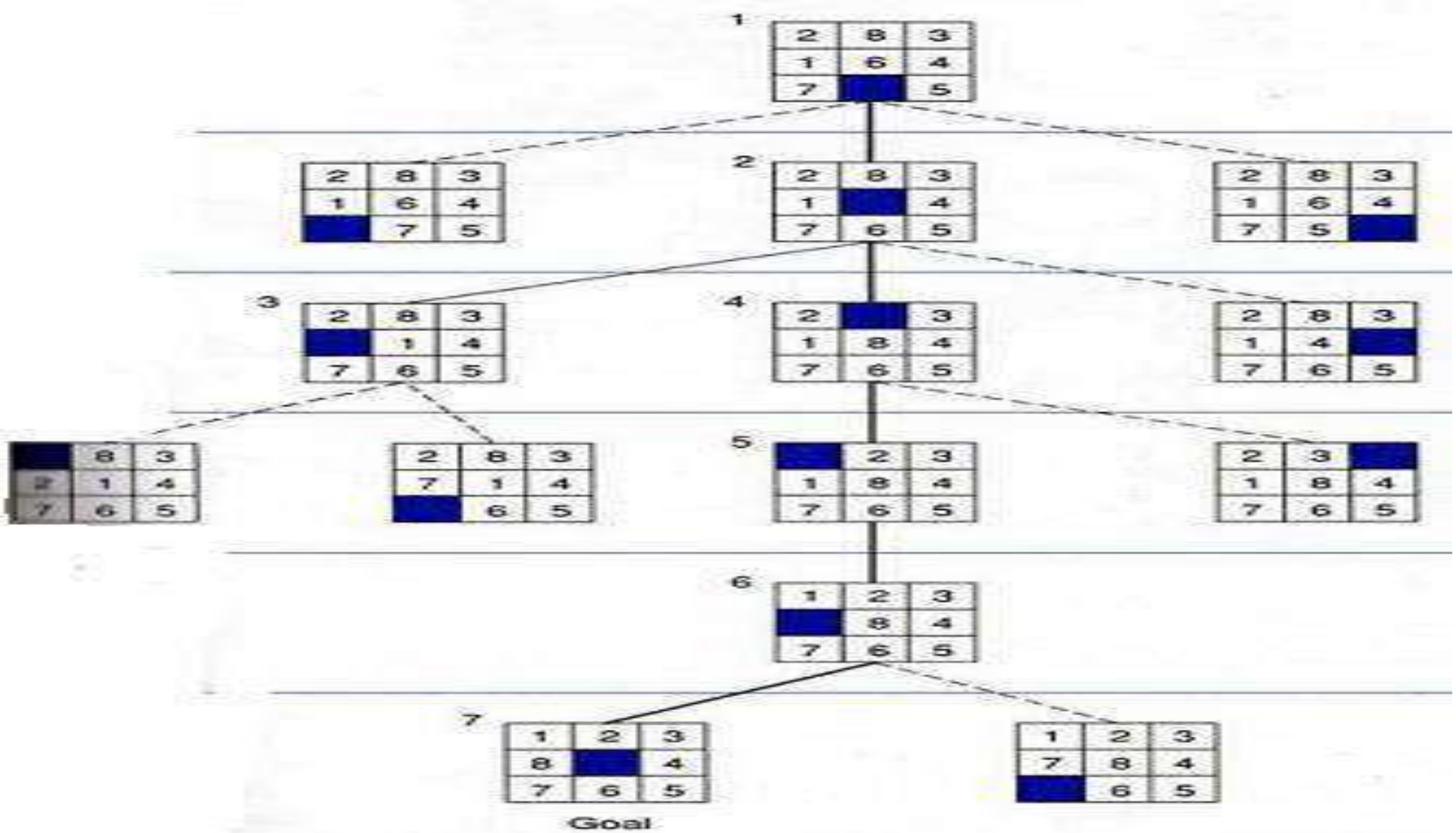
Define the Problem as State Space Search

- **<u>Ex.3:- Consider 8 puzzle problem</u>**
- The 8 puzzle consists of eight numbered, movable tiles set in a 3x3 frame. One cell of the frame is always empty thus making it possible to move an adjacent numbered tile into the empty cell. Such a puzzle is illustrated in following diagram.

- The program is to change the initial configuration into the goal configuration.
- A solution to the problem is an appropriate sequence of moves, such as “move tiles 5 to
- the right, move tile 7 to the left ,move tile 6 to the down” etc…



Ex.3:- Consider 8 puzzle problem



Ex.3:- Consider 8 puzzle problem

- To solve a problem, we must specify the global database, the rules, and the control strategy.
- For the 8 puzzle problem that correspond to three components.
- These elements are the problem states, moves and goal.
- In this problem each tile configuration is a state.
- The set of all possible configuration in the problem space, consists of 3,62,880 different configurations of the 8 tiles and blank space.
- For the 8-puzzle, a straight forward description is a 3X3 array of matrix of numbers. Initial global database is this description of the initial problem state. Virtually any kind of data structure can be used to describe states.

Ex.3:- Consider 8 puzzle problem

- The 8-puzzle is conveniently interpreted as having the following for moves.

- Move empty space (blank) to the left, move blank up, move blank to the right and move blank down.
- These moves are modeled by production rules that operate on the state descriptions in the appropriate manner.
  - The goal condition forms the basis for the termination.
  - The control strategy repeatedly applies rules to state descriptions until a description of a goal state is produced.
  - It also keeps track of rules that have been applied so that it can compose them into sequence representing the problem solution.
  - A solution to the 8-puzzle problem is given in fig. 1.

MCQ:

Which AI technique involves enabling machines to learn from experience and improve over time?

A. Expert systems

B. Natural language processing

C. Machine learning

D. Robotics

What is the Turing Test designed to assess?

A. The speed of an AI system's decision-making

B. The ability of an AI system to understand natural language

C. Whether an AI system can exhibit intelligent behavior indistinguishable from that of a human

D. The accuracy of an AI system's predictions in real-world scenarios

Which of the following is an example of an expert system?

A. Siri (Apple's virtual assistant)

B. IBM's Watson

C. Google Translate

D. Tesla's self-driving cars

MCQ:

What does the term "agent" refer to in the context of AI?

A. A software program that performs tasks autonomously

B. A physical robot designed to mimic human behavior

C. A system that executes instructions without decision-making capability

D. A specialized computer chip used for processing AI algorithms

Which branch of AI focuses on creating systems that mimic human cognitive processes?

A. Expert systems

B. Natural language processing

C. Machine learning

D. Cognitive computing

What is the fundamental difference between strong AI and weak AI?

A. Strong AI aims to replicate human intelligence, while weak AI is task-specific.

B. Weak AI is developed using strong computing hardware, while strong AI is not.

C. Strong AI is a theoretical concept, while weak AI is practical and in use today.

D. Weak AI can pass the Turing Test, while strong AI cannot.

MCQ:

What is the primary goal of Artificial Intelligence (AI)?

A. To replace human intelligence entirely

B. To simulate human intelligence in machines

C. To automate all tasks without human intervention

D. To develop machines capable of self-awareness

Which of the following is a characteristic of intelligent agents?

A. They have no autonomy and require constant human control

B. They possess the ability to learn from experience and adapt

C. They can only perform predefined tasks and cannot learn new ones

D. They are unable to interact with their environment

References

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
3. "Superintelligence: Paths, Dangers, Strategies" by Nick Bostrom
4. "Human Compatible: Artificial Intelligence and the Problem of Control" by Stuart Russell
5. "The Master Algorithm: How the Quest for the Ultimate Learning Machine Will Remake Our World" by Pedro Domingos
6. Artificial Intelligence: A New Synthesis, Harcourt Publishers (Text Book) by N. J. Nilsson / Harcourt Publishers.
7. Artificial Intelligence (Text Book) by Elaine Rich and Kevin Knight / TMH.
8. Artificial Intelligence Structures and Strategies for Complex Problem Solving by George F. Luger / Pearson Education / PHI.
9. Artificial Intelligence A Practical Approach by Patterson / Tata McGraw Hill / 3.

Parul® University ×

DIGITAL LEARNING CONTENT

Parul® University

www.paruluniversity.ac.in