Parul® University

ARTIFICIAL INTELLIGENCE

(203105322)

Dr. Pooja Sapra, Associate Professor
Information Technology

Parul®
University

COURSE OUTCOMES

After Learning the course, the students shall be able to:

CO1. Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents.

CO2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game-based techniques to solve them.

CO3. Develop intelligent algorithms for constraint satisfaction problems and design intelligent systems for Game Playing.

CO4. Attain the capability to represent various real-life problem domains using logic-based techniques and use this to perform inference or planning.

CO5. Formulate and solve problems with uncertain information using Bayesian approaches.

CO6. Apply concept Natural Language processing to problems leading to understanding of cognitive computing

Parul®
University

DIGITAL LEARNING CONTENT

TEACHING & EXAMINATION SCHEME

Teaching and Examination Scheme:

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

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Parul® University

DIGITAL LEARNING CONTENT

EVALUATION RUBRICS

Marking Scheme	
Component	Marks
External	60
Internal	40
Total	100

Internal	40
Weekly Test	20
Continuous Evaluation	20

Continuous Evaluation	20
Assignments [4]	10
Quiz [2]	6
Presentation along with Report	4

Parul®
University

DIGITAL LEARNING CONTENT

SYLLABUS

Contents:

Sr.	Topic	Weightage	Teaching Hrs.
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

Parul®
University

DIGITAL LEARNING CONTENT

SYLLABUS

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

Parul®
University

DIGITAL LEARNING CONTENT

SYLLABUS

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

Parul®
University

DIGITAL LEARNING CONTENT

REFERENCE BOOKS

Reference Books:

1. Artificial Intelligence: A New Synthesis, Harcourt Publishers (TextBook)
   N. J. Nilsson; Harcourt Publishers
2. Artificial Intelligence (TextBook)
   Elaine Rich and Kevin Knight; TMH
3. Artificial Intelligence-Structures and Strategies For Complex Problem Solving
   George F. Luger; Pearson Education / PHI
4. Artificial Intelligence-A Modern Approach
   Stewart Russell and Peter Norvig; Pearson Education/ Prentice Hall of India; 2
5. Artificial Intelligence – A Practical Approach
   Patterson; Tata McGraw Hill; 3

Big Players in Market

facebook

Microsoft

amazon

Google

IBM

NVIDIA

Baidu 百度

Start Ups


vicarious
deepinstinct
Numenta
clarifai
MaluubA
SKYMIND
SIGNALSENSE
nnaisense
cortica
In Every Image
deep genomics
enlitic
OpenAI
sentient
nervana
turi
VIV
PredictionIO
MetaMind
DEEPMIND
AlchemyAPI
An IBM Company
wit.ai
DNNresearch
Acquired

What is Intelligence?

- Intelligence means ability to reason, trigger new thoughts to perceive and learn.

- Intelligence requires knowledge but knowledge possesses less desirable properties such as
  - - It is voluminous
  - - it is constantly changing

Parul®
University

DIGITAL LEARNING CONTENT

What is Artificial Intelligence?

Artificial Intelligence (AI) is a branch of Science which deals with helping machines finding solutions to complex problems in a more human-like fashion.

OR

Artificial intelligence is the study of how to make computers do things which at the moment people do better.

eg: SOPHIA, Alibaba, GreyOrange

Parul® University

DIGITAL LEARNING CONTENT

History

- 1943: early beginnings
  - McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing
  - Turing's "Computing Machinery
- 1956: birth of AI
  - Dartmouth meeting: "Artificial Intelligence— name adopted
- 1966—73: Reality dawns
  - Realization that many AI problems are intractable
  - Limitations of existing neural network methods identified
    - Neural network research almost disappears
  - Integration of learning, reasoning, knowledge representation
  - AI methods used in vision, language, data mining, etc
- 1969—85: Adding domain knowledge
  - Development of knowledge-based systems
  - Success of rule-based expert systems,
    - E.g., DENDRAL, MYCIN
    - But were brittle and did not scale well in practice
- 1986-- Rise of machine learning
  - Neural networks return to popularity
  - Major advances in machine learning algorithms and applications
- 1990-- Role of uncertainty
  - Bayesian networks as a knowledge representation framework
- 1995-- AI as Science

Parul® University

How to Achieve AI

Machine Learning

Deep Learning

Image source : http://python-nitol.blogspot.com/

Machine Learning

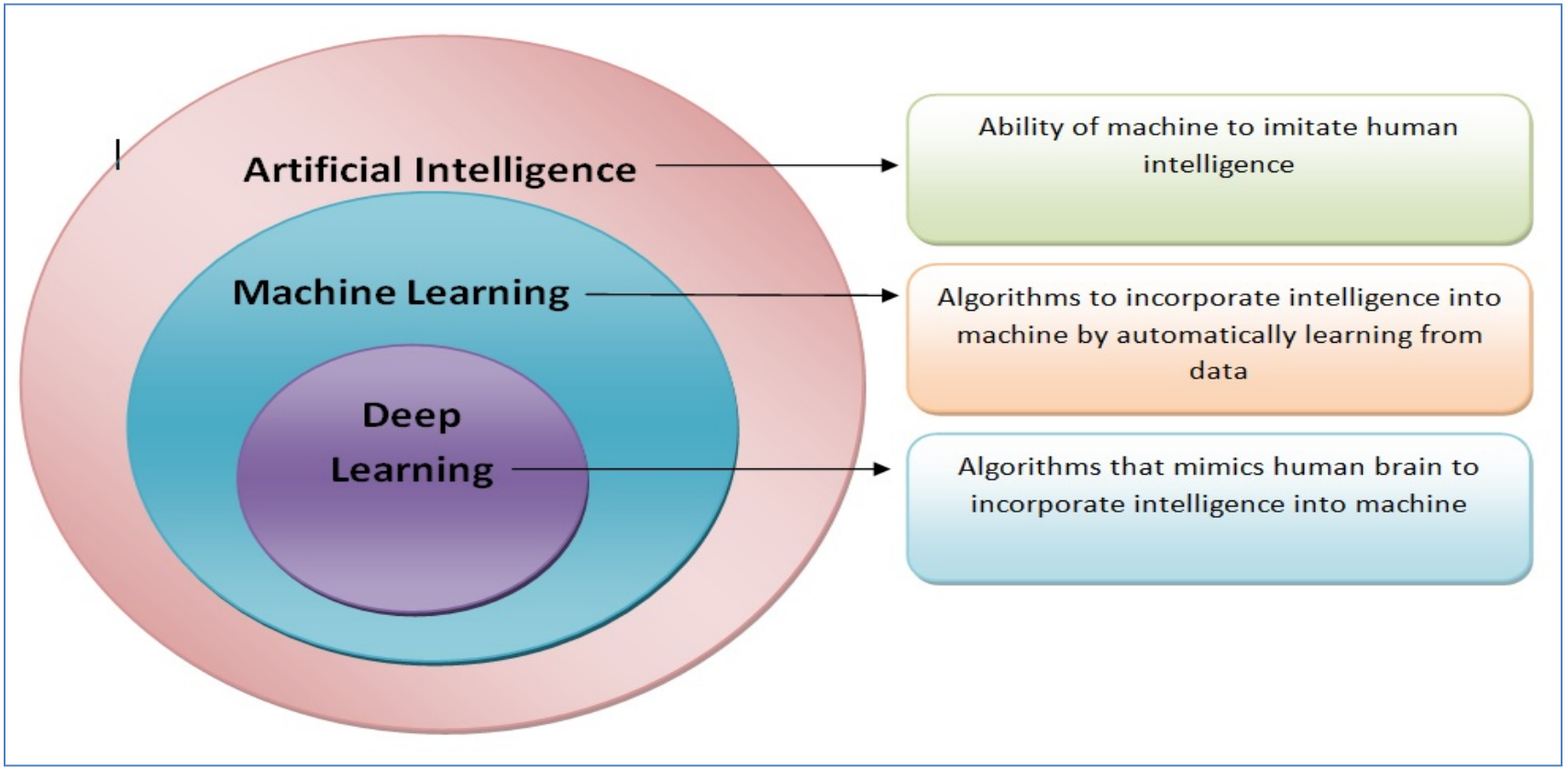
Machine Learning refers to a type of learning in which a machine becomes capable of learning on its own (despite no one programming it to behave that certain way).

Machine learning is basically an application of artificial intelligence, and it provides any system with the ability to improve on its own by learning automatically.

Deep Learning

Deep learning is a subfield of machine learning where concerned algorithms are inspired by the structure and function of the brain called artificial neural networks.

Relation Between AI, ML and DL



Knowledge Pyramid

Types of Knowledge

DOMAIN SPECIFIC [deals with all kinds of knowledge about particular domain]

COMMON SENSE [helps in reasoning]

Human Intelligence VS Artificial Intelligence

Pros

Human Intelligence

- Intuition, Common sense, Judgment, Creativity, Beliefs etc
- The ability to demonstrate their intelligence by communicating effectively
- **Believable** Reasoning and Critical thinking

Artificial Intelligence

- Ability to simulate human behavior and cognitive processes
- Capture and preserve human expertise
- Fast Response. The ability to comprehend large amounts of data quickly.

Human Intelligence VS Artificial Intelligence

Cons

Human Intelligence

- Humans are imperfect
- They have limited knowledge bases
- Information processing of serial nature proceed very slowly in the brain as compared to computers
- Humans are unable to retain large amounts of data in memory.

Artificial Intelligence

- No ―common sense‖
- Cannot readily deal with ―mixed‖ knowledge
- May have high development costs
- Raise legal and ethical concerns

Parul® University

Difference between AI and Conventional Program

FEATURES	AI PROGRAM	CONVENTIONAL SOFTWARE
PROCESSING TYPE	Symbolic	Numeric
TECHNIQUE USED	Heuristic Search	Algorithmic
ANSWERS	Satisfactory	Optimal
KNOWLEDGE	Imprecise	Precise
MODIFICATION	Frequent	Rare
DATABASE REQUIRED	Large Knowledge base	Large Database

AI PROBLEMS AND TECHNIQUES

Building a system to solve a problem requires the following steps –

1. Define the problem precisely including detailed specifications and what constitutes an acceptable solution;

2. Analyze the problem

3. Choose the best problem solving techniques in the solution.

4. Isolate and represent the background knowledge needed in the solution of the problem;

1. Defining the Problem

1. Define a state space that contains all possible configurations of the relevant objects, without enumerating all the states in it. A state space represents a problem in terms of states and operators that change states

2. Define some of these states as possible initial states;

3. Specify one or more as acceptable solutions, these are goal states;

4. Specify a set of rules as the possible actions allowed.

Parul®
University

Water Jug Problem

- There are two jugs called four and three ;
- four holds a maximum of four gallons and three a maximum of three gallons.
- How can we get 2 gallons in the jug four

PROBLEM DESCRIPTION

- The state space is a set of ordered pairs giving the number of gallons in the pair of jugs at any time i.e. (four, three) where four = 0, 1, 2, 3, 4 and three = 0, 1, 2, 3.
- The start state is (0,0) and
- The goal state is (2,n) where n is a don't care but is limited to three holding from 0 to 3 gallons.

PRODUCTION RULES

Initial	condition	goal	comment
1 (four,three)	if four < 4	(4,three)	fill four from tap
2 (four,three)	if three< 3	(four,3)	fill three from tap
3 (four,three)	If four > 0	(0,three)	empty four into drain
4 (four,three)	if three > 0	(four,0)	empty three into drain
5 (four,three)	if four+three<4	(four+three,0)	empty three into four
6 (four,three)	if four+three<3	(0,four+three)	empty four into three
7 (0,three)	If three>0	(three,0)	empty three into four
8 (four,0)	if four>0	(0,four)	empty four into three
9 (0,2)		(2,0)	empty three into four
10 (2,0)		(0,2)	empty four into three
11 (four,three)	if four<4	(4,three-diff)	pour diff, 4-four, into four from three

Solution

Gallons in Four Jug	Gallons in Three Jug	Rules Applied
0	0	-
0	3	2
3	0	7
3	3	2
4	2	11
0	2	3
2	0	10

2. Analysing the Problem

1. Decomposability of the problem into a set of independent smaller subproblems
Example: [Decomposable(Integration) and Non decomposable(Block solving)]

2. Possibility of undoing solution steps, if they are found to be unwise
Example: [Ignorable(Theorem Proving), Recoverable(8 Puzzle), Irrecoverable(Chess)]

3. Predictability of the problem universe
Example: [Predictable(Playing game), Unpredictable(Natural Language Processing)]

4. Possibility of obtaining an obvious solution to a problem without comparison of all other possible solutions
Example: [Absolute(Standard result), Relative(results are different and acceptable)]

5. Type of the solution: whether it is a state or a path to the goal state
Example: [State(Water jug problem), Path(Travelling Sales man)]

6. Role of knowledge in problem solving
Example: [Less Knowledge(Playing Game), Huge Knowledgebase(Natural Language Processing)]

7. Nature of solution process: with or without interacting with the user
Example: [Solitary(Theorem Proving), Conversational(Playing two user game)]

3. Problem Solving Techniques

Parul®
University

DIGITAL LEARNING CONTENT

4. Knowledge Representation Schemes

- Propositional Logic
- Predicate Logic
- Semantic Network
- Frames

Parul®
University

Intelligent Agent

An AI system can be defined as the study of the rational agent and its environment.

The agents sense the environment through sensors and act on their environment through actuators.

An AI agent can have mental properties such as knowledge, belief, intention, etc.

Parul® University

Types of Intelligent Agent

An agent can be anything that perceive its environment through sensors and act upon that environment through actuators. An Agent runs in the cycle of **perceiving**, **thinking**, and **acting**.

An agent can be:

- **Human-Agent:** A human agent has eyes, ears, and other organs which work for sensors and hand, legs, vocal tract work for actuators.
- **Robotic Agent:** A robotic agent can have cameras, infrared range finder, NLP for sensors and various motors for actuators.
- **Software Agent:** Software agent can have keystrokes, file contents as sensory input and act on those inputs and display output on the screen.

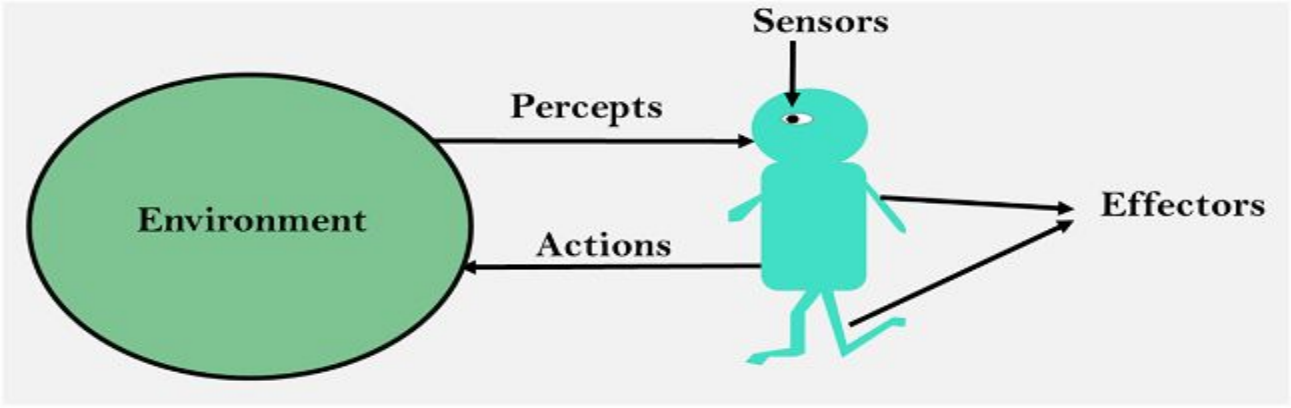
Hence the world around us is full of agents such as thermostat, cellphone, camera, and even we are also agents.

Components of Intelligent Agent

Sensor: Sensor is a device which detects the change in the environment and sends the information to other electronic devices. An agent observes its environment through sensors.

Actuators: Actuators are the component of machines that converts energy into motion. The actuators are only responsible for moving and controlling a system. An actuator can be an electric motor, gears, rails, etc.

Effectors: Effectors are the devices which affect the environment. Effectors can be legs, wheels, arms, fingers, wings, fins, and display screen.



Parul® University

Rules of Intelligent Agent

Following are the main four rules for an AI agent:

- **Rule 1:** An AI agent must have the ability to perceive the environment.
- **Rule 2:** The observation must be used to make decisions.
- **Rule 3:** Decision should result in an action.
- **Rule 4:** The action taken by an AI agent must be a rational action.

Parul® University

Rationality of Intelligent Agent

The rationality of an agent is measured by its performance measure. Rationality can be judged on the basis of following points:

- Performance measure which defines the success criterion.
- Agent prior knowledge of its environment.
- Best possible actions that an agent can perform.
- The sequence of percepts.

Parul® University

Structure of Intelligent Agent

The task of AI is to design an agent program which implements the agent function. The structure of an intelligent agent is a combination of architecture and agent program. It can be viewed as:

Agent = Architecture + Agent program

Architecture: Architecture is machinery that an AI agent executes on.
Agent Function: Agent function is used to map a percept to an action.

Parul® University

PEAS

PEAS is a type of model on which an AI agent works upon.

When we define an AI agent or rational agent, then we can group its properties under PEAS representation model. It is made up of four words:

- **P:** Performance measure
- **E:** Environment
- **A:** Actuators
- **S:** Sensors

Parul® University

PEAS for Self-Driving Car

Let's suppose a self-driving car then PEAS representation will be:

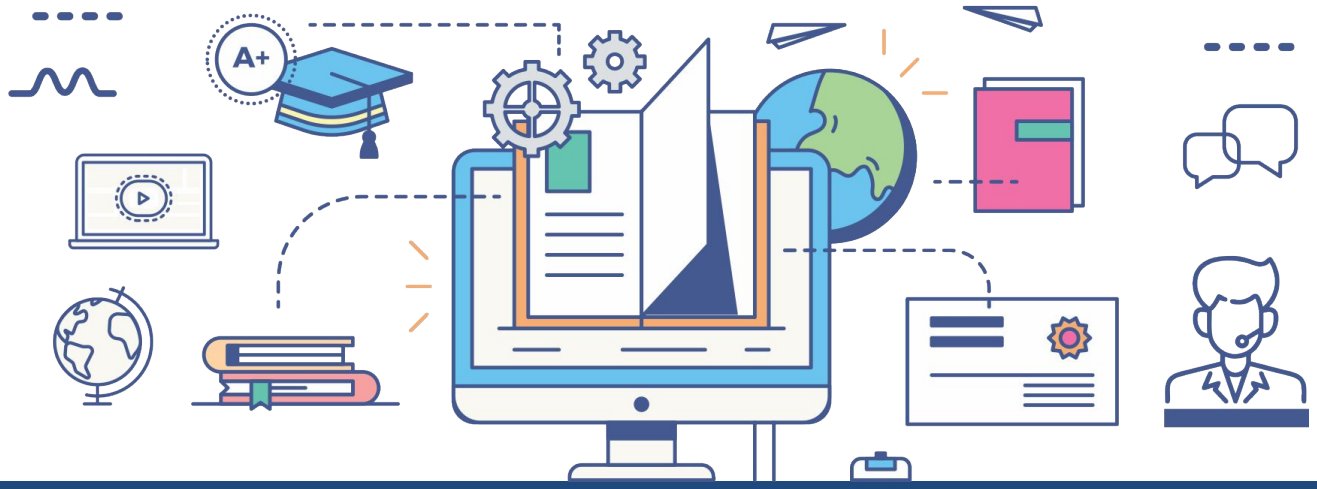
Performance: Safety, time, legal drive, comfort

Environment: Roads, other vehicles, road signs, pedestrian

Actuators: Steering, accelerator, brake, signal, horn

Sensors: Camera, GPS, speedometer, odometer, accelerometer, sonar.

DIGITAL LEARNING CONTENT



Parul® University

www.paruluniversity.ac.in