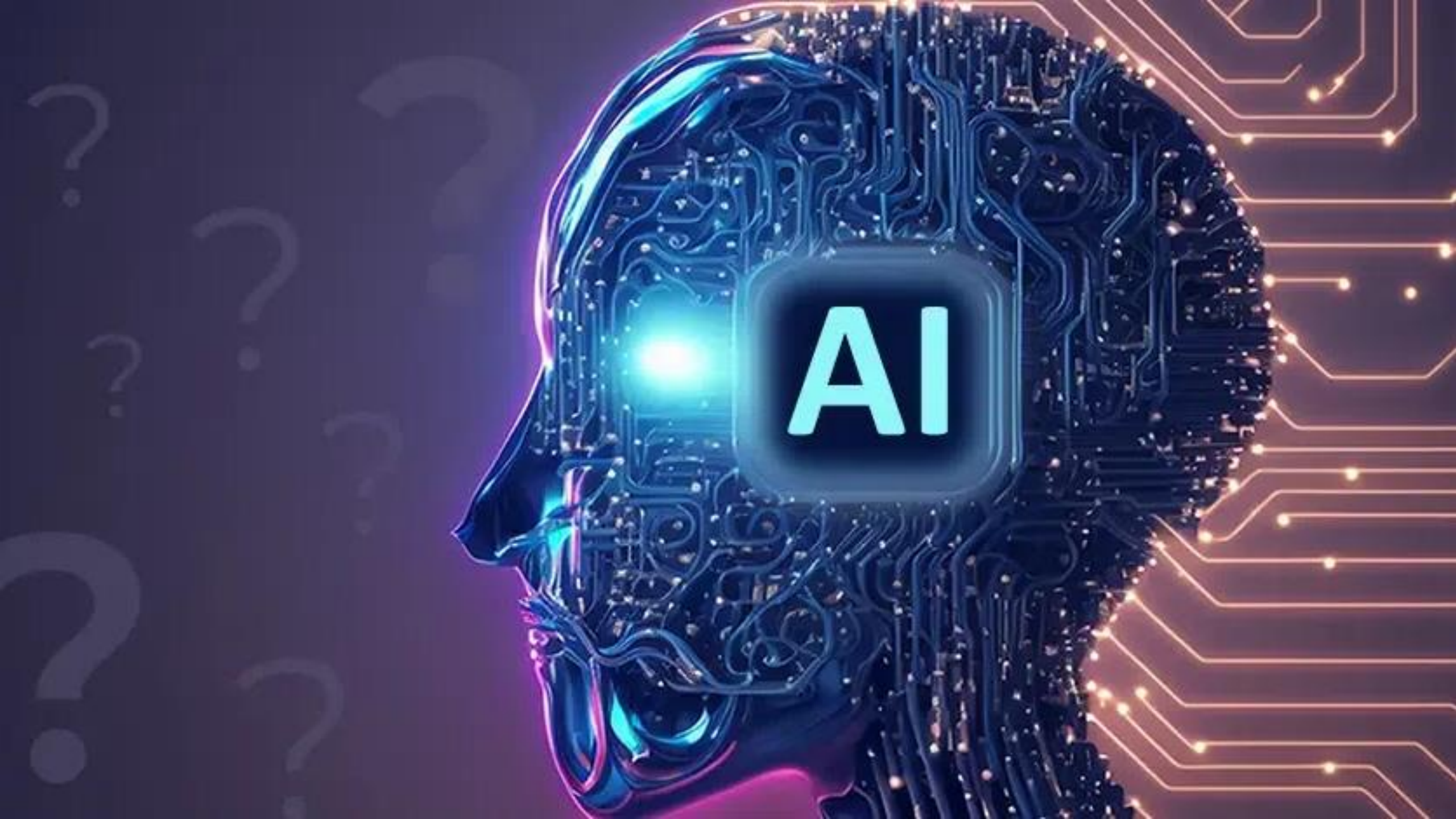

AI

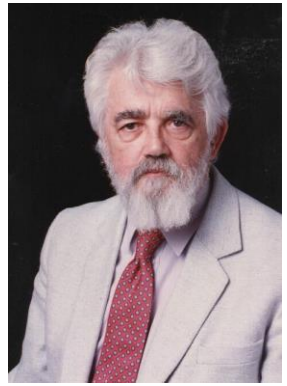
Unit 13:Artificial Intelligence

- INTRODUCTION TO Al AND PRODUCTION SYSTEMS: Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized productions system- Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.
- REPRESENTATION OF KNOWLEDGE: Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.
- KNOWLEDGE INFERENCE: Knowledge representation -Production based system, Frame based system. Inference – Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory.
- PLANNING AND MACHINE LEARNING: Basic plan generation systems – Strips -Advanced plan generation systems – K strips - Strategic explanations - Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.
- EXPERT SYSTEMS: Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Artificial Intelligence

- Definition. The science of developing methods to solve problems usually associated with human intelligence.
- Alternate definitions:
  - building intelligent entities or agents;
  - making computers think or behave like humans
  - studying the human thinking through computational models;
  - generating intelligent behavior, reasoning, learning.

What is Artificial Intelligence (John McCarthy , Basic Questions)



- **What is artificial intelligence?**
- It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

- **Yes, but what is intelligence?**
- Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

- **Isn't there a solid definition of intelligence that doesn't depend on relating it to human intelligence?**
- Not yet. The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others.

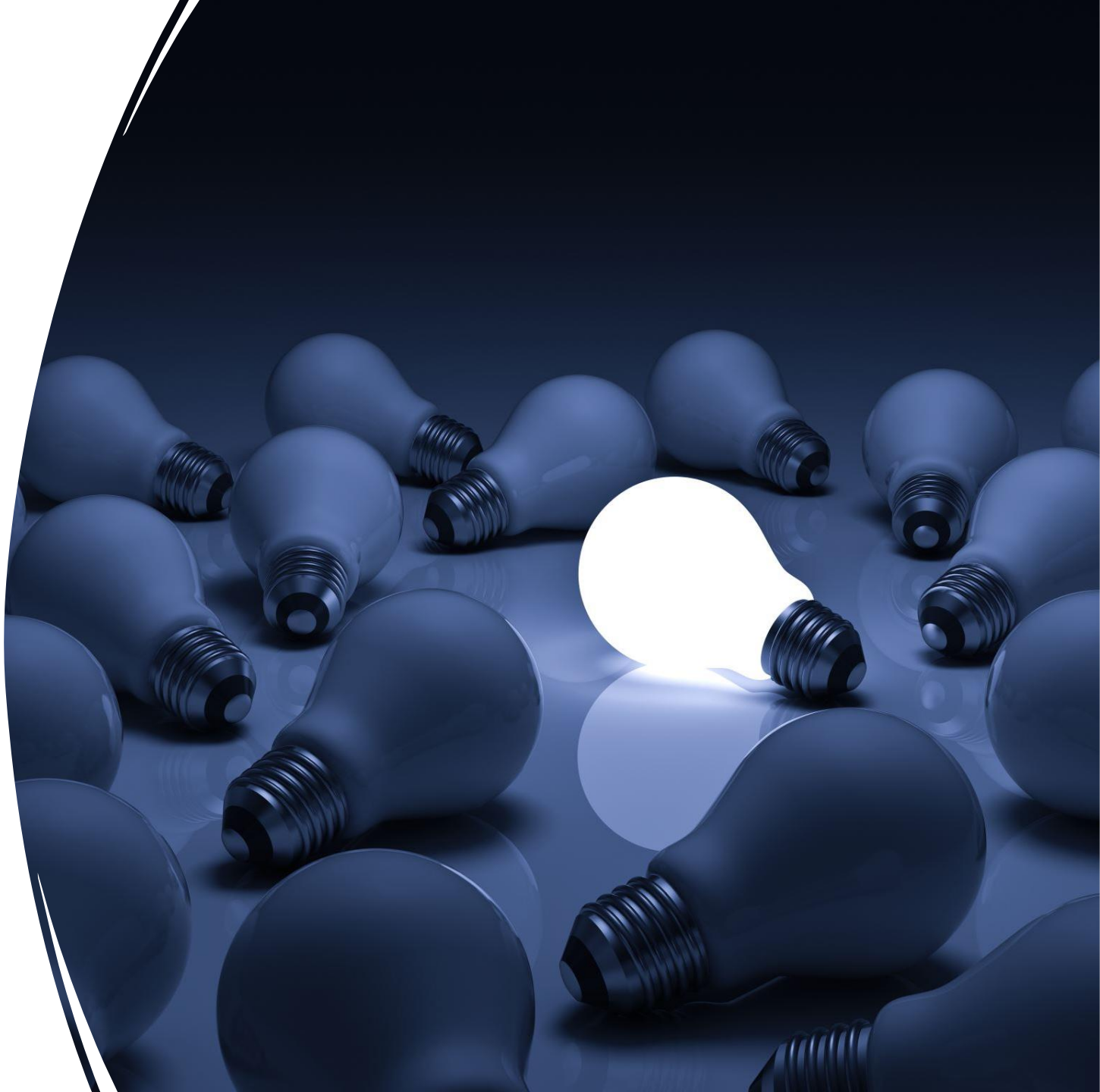
Natural Intelligence

- Definition. *Intelligence –* inter ligare (Latin) – the capacity of creating connections between notions.
- Wikipedia: the ability to solve problems.
- WordNet: the ability to comprehend; to understand and profit from experience.
- Complex use of creativity, talent, imagination.
- Biology - Intelligence is the ability to adapt to new conditions and to successfully cope with life situations.
- Psychology - a general term encompassing various mental abilities, including the ability to remember and use what one has learned, in order to solve problems, adapt to new situations, and understand and manipulate one's reality.
- Nonlinear, non-predictable behavior.

Visions of AI

- Systems that think like humans.
- Systems that act like humans.
- Systems that think rationally.
- Systems that act rationally.

- A distinction between being intelligent and acting intelligently, and being like a human, or solving similar problems (not necessarily the same way).



	Humanly	Rationally
Thinking	Systems should solve problems as humans do	Use of Logic Patterns for arguments structures that yields correct conclusion
Acting	Acting like humans- Natural language processing Automated reasoning Knowledge representation	Study of rational agents Expected to act so as to achieve best expected outcome

Thinking Humanly

- Cognitive science: modeling the processes of human thought.
- Through a set of experiments and computational models, trying to build good explanations of what we do when we solve a particular task.
- Relevance to AI: to solve a problem that humans (or other living being) are capable of, it's good to know how we go about solving it.
- Early approaches tried to solve any problem exactly the way a human would do. Now we know that it's not the best approach.

Acting Humanly

- How do you distinguish intelligent behavior from intelligence?
- *Turing test,* by A. Turing, 1950: determining if a program qualifies as artificially intelligent by subjecting it to an interrogation along with a human counterpart.
- The program passes the test if a human judge cannot distinguish between the answers of the program and the answers of the human subject.

Acting Humanly

- ELIZA: A program that simulated a psychotherapist interacting with a patient and successfully passed the Turing Test. It was coded at MIT during 1964-1966 by Joel Weizenbaum.

Thinking Rationally

- Systems capable of reasoning, capable of making logical deductions from a knowledge base.
- This requires some capacity to make logical inferences, like "*All humans are mortal; Socrates is a human; thus Socrates is mortal*".

Acting Rationally

- Many AI applications adopt the intelligent *agent* approach.
- An *agent* is an entity capable of generating action.
- In AI a rational agent must be autonomous, capable of perceiving its environment, adaptable, with a given goal.
- Most often the agents are small pieces of code with a specific proficiency. The problem is solved by combining the skills of several agents.

History of AI

- 1943 – W. McCulloch and W. Pitts designed the first neural network. M. Minsky and D. Edmonds built the first one in 1951 at Princeton.
- 1950 – A. Turing, "Computing Machinery and Intelligence".
- 1956 – J. McCarthy organized a workshop at Darmouth where the name of AI was officially adopted for the field.
- Early successes: the General Problem Solver (puzzles), Geometry Theorem Prover, Samuel's checkers player.
- 1958 – McCarthy invented Lisp.

History of AI

- The early systems were successful on small problems but failed on larger ones.
- 1958 – Friedberg's machine evolution (now better known as hill-climbing) using mutations; failed to find good solutions.
- 1966 – a commission reports on the failing of machine translation and all funding to such projects is ceased.
- 1969 – Minsky and Papert, Perceptrons, proved that they could learn anything they could represent, but there was not much they could represent.

History of AI

- Knowledge-based systems – that contain domain-specific knowledge giving them more problem-solving power – *Expert Systems*. The industry adopted them on a relatively large scale, but many such projects failed.
- More recent developments combine AI methods with strategies from other fields.
- Although the initial ambition of AI seems a distant goal at most, many methods have been developed that are used in most areas of CS.

Successes in AI

- 1975 – Meta-Dendral learning program finds new rules in spectral chemistry.
- 1978 – Herb Simon wins the Nobel Prize in Economics for his theory of bounded rationality.
- 1979 - The Stanford Cart, built by Hans Moravec, the first computer-controlled autonomous vehicle.
- 80s – neural networks with backpropagation algorithm become popular, evolutionary computation
- 1997 – Deep Blue beats G. Kasparov, first Robo-Cup.
- 2000 – Interactive robots commercially available, Kismet (MIT), robots used for real applications.

Related Fields

- Philosophy – knowledge, mind, logic
- Mathematics - formal rules, logic, probability, algorithms
- Economics – decision making, maximizing the outcome, game theory
- Neuroscience – understanding how the brain works
- Psychology – How do animals and humans think and act?
- Cybernetics – control theory
- Linguistics – understanding the natural language

Main Areas of AI

- Autonomous planning and scheduling
- Decision making
- Machine learning, adaptive methods
- Biologically inspired algorithms
- Game playing
- Autonomous control, robotics
- Natural language processing

• Problem solving, planning, and search --- generic problem solving architecture based on ideas from cognitive science (game playing, robotics).

• Knowledge Representation – to store and manipulate information (logical and probabilistic representations)

• Automated reasoning / Inference – to use the stored information to answer questions and draw new conclusions

• Machine Learning – intelligence from data; to adapt to new circumstances and to detect and extrapolate patterns

• Natural Language Processing – to communicate with the machine

• Computer Vision --- processing visual information

• Robotics --- Autonomy, manipulation, full integration of AI capabilities

- ✓ Game Playing : AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.

- ✓ Speech Recognition Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.

- ✓ Understanding Natural Language: The computer can now understand natural languages and hence human can now interact using natural spoken languages. The computer has to be provided with an understanding of the domain the text is about, and this is presently possible only for very limited domains.

- ✓ Computer Vision: The computer vision leads the computer to understand the signals and act accordingly. There are some systems as:
- ✓ - Face detection system installed at airport.
- ✓ - Medical diagnosis

- ✓ Heuristic Classification: One of the most feasible kinds of expert system given the present knowledge of AI is to put some information in one of a fixed set of categories using several sources of information.

- ✓ An example is advising whether to accept a proposed credit card purchase. Information is available about the owner of the credit card, his record of payment and also about the item he is buying and about the establishment from which he is buying it.

MULTIPLE INTELLIGENCES

SPACIAL INTELLIGENCE

Strengths
Visual and spacial judgment

Characteristics
-Draws for fun
-Good at puzzles
-Recognizes patterns
-Interprets visuals well

BODILY-KINESTHETIC INTELLIGENCE

Strengths
Physical movement, motor control

Characteristics
-Skilled at sports
-Excellent physical coordination
-Remembers by doing, instead of hearing or seeing

MUSICAL INTELLIGENCE

Strengths
Rhythm and music

Characteristics
-Appreciation for music
-Thinks in sounds and patterns
-Rich understanding of musical structure, notes

LINGUISTIC INTELLIGENCE

Strengths
Words, language, writing

Characteristics
-Enjoys writing, reading
-Good at public speaking
-Very persuasive
-Can explain things well

LOGICAL-MATHEMATICAL SKILLS

Strengths
Analyzing problems, mathematical operations

Characteristics
-Fast problem-solver
-Understands complex computations
-Likes thinking about abstract ideas

INTERPERSONAL INTELLIGENCE

Strengths
Understanding and relating to others

Characteristics
-Strong emotional intelligence skills
-Creates healthy relationships
-Good at solving conflicts

INTRAPERSONAL INTELLIGENCE

Strengths
Introspection and self-reflection

Characteristics
-Understands one's own strengths, weaknesses
-Highly self-aware
-Sensitive to one's own feelings

NATURALISTIC INTELLIGENCE

Strengths
Seeing patterns and relationships to nature

Characteristics
-Interested in areas like botany, biology, zoology
-Appreciation for nature
-Enjoys activities like camping, gardening, hiking

- ✓ From SIRI and Alexa, to self-driving cars, artificial intelligence (AI) is progressing rapidly.
- ✓ While science fiction often portrays AI as robots with human-like characteristics, AI can encompass anything from Google's search algorithms, to IBM's Watson, to autonomous weapons.
- ✓ Artificial intelligence today is properly known as narrow AI (or weak AI), in that it is designed to perform a narrow task such as only facial recognition, or only internet searches, or only driving a car).
- ✓ However, the long-term goal of many researchers is to create general AI (AGI or strong AI).
- ✓ While narrow AI may outperform humans at whatever its specific task is, like playing chess or solving equations, AI would outperform humans at nearly every thinking task.

✓ Agent and Environment

✓ An agent is anything that perceive its environment through sensors and acts upon that environment through effectors.

• A human agent has sensory organs such as eyes, ears, nose, tongue and skin parallel to the sensors, and other organs such as hands, legs, mouth, for effectors.
• A robotic agent replaces cameras and infrared range finders for the sensors, and various motors and actuators for effectors.
• A software agent has encoded bit strings as its programs and actions.

✓ Agent Terminology

• Performance Measure of Agent − It is the criteria, which determines how successful an agent is.
• Behavior of Agent − It is the action that agent performs after any given sequence of percepts.
• Percept − It is agent's perceptual inputs at a given instance.
• Percept Sequence − It is the history of all that an agent has perceived till date.
• Agent Function − It is a map from the precept sequence to an action.

(a) Simple Reflex Agents

- They choose actions only based on the current percept.
- They are rational only if a correct decision is made only based on the current precept.
- Their environment is completely observable.

Condition-Action Rule – It is a rule that maps a state (condition) to an action.

(b) Model Based Reflex Agents

They use a model of the world to choose their actions. They maintain an internal state.

Model – knowledge about "how the things happen in the world".

Internal State – It is a representation of unobserved aspects of current state depending on percept history.

Updating the state requires the information about –

- How the world evolves.
- How the agent's actions affect the world.

(c) Goal Based Agents

They choose their actions in order to achieve goals. Goal-based approach is more flexible than reflex agent since the knowledge supporting a decision is explicitly modeled, thereby allowing for modifications.

Goal − It is the description of desirable situations.

(d) Utility Based Agents

They choose actions based on a preference (utility) for each state.
Goals are inadequate when −

- There are conflicting goals, out of which only few can be achieved.
- Goals have some uncertainty of being achieved and you need to weigh likelihood of success against the importance of a goal.