ARTIFICIAL INTELLIGENCE

UNIT I

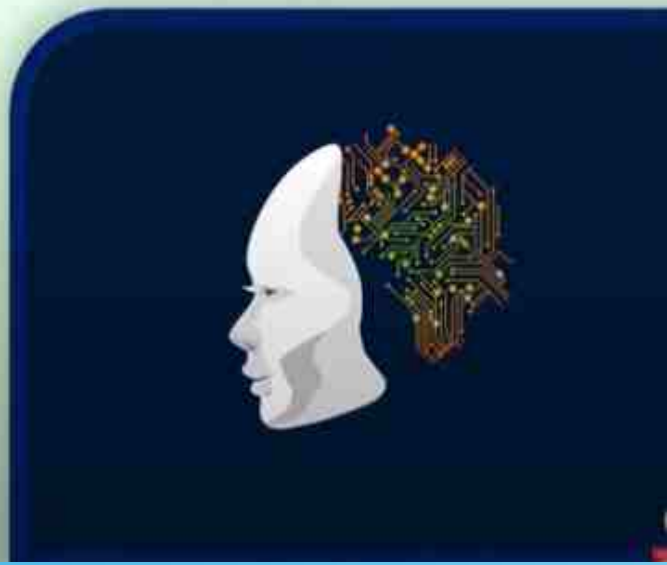
INTRODUCTION TO ARTIFICIAL INTELLIGENCE

- Concept and Definition
- History of AI
- Concepts about AI
- Practical system based on AI
- The Development of Logic
- Components of AI

WHAT IS AI?

AI is the ability of the machines or computer programs to carry out tasks that require human beings to use their intelligence.

The study of computer systems attempt to model and apply the intelligence of the human mind.



WHAT IS AI?

- One of the booming technologies of computer science is Artificial Intelligence which is ready to create a new revolution in the world by making intelligent machines.
- Artificial Intelligence is composed of two words Artificial and Intelligence, where Artificial defines "man-made," and intelligence defines "thinking power", hence AI means "a man-made thinking power."
- Artificial Intelligence exists when a machine can have human based skills such as learning, reasoning, and solving problems
- With Artificial Intelligence you do not need to preprogram a machine to do some work and that is the awesomeness of AI.

DEFINITIONS:-INTELLIGENCE

- Intelligence is a state grasping the truth, involving reason, concerned with action about what is good or bad for human being.
- The ability to learn or understand from experience, the ability to acquire retain knowledge and the ability to respond quickly and successfully to a new situation, use of the faculty of reason in solving problems, directing the conduct effectively.
- The test of a first rate intelligence is the ability to hold two opposite ideas in the mind at the same time and still retain ability to function.

DEFINITIONS

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

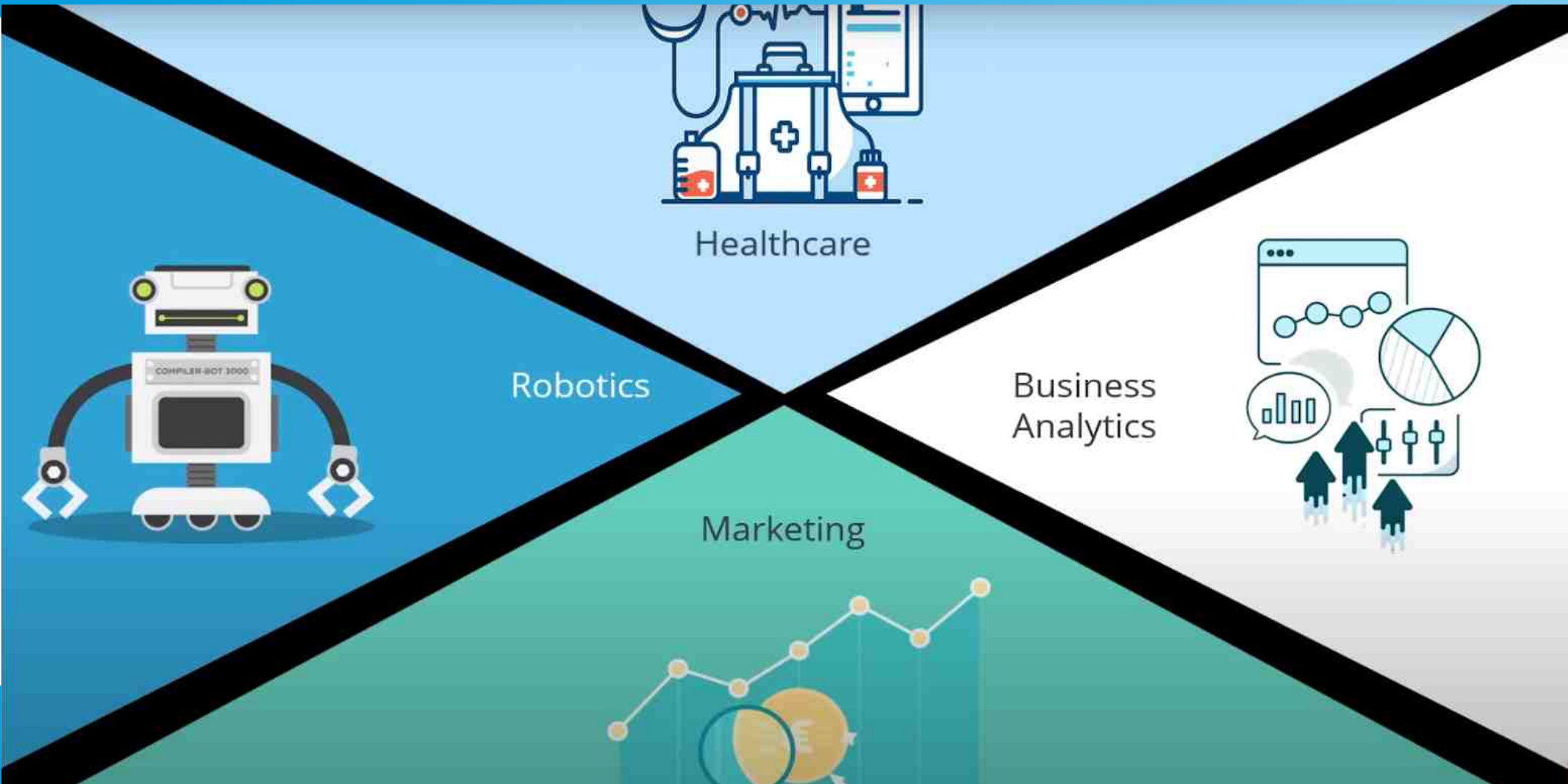
WHY AI?

- With the help of AI, you can create such software or devices which can solve real-world problems very easily and with accuracy such as health issues, marketing, traffic issues, etc.
- With the help of AI, you can create your personal virtual Assistant, such as Cortana, Google Assistant, Siri, etc.
- With the help of AI, you can build such Robots which can work in an environment where survival of humans can be at risk.
- AI opens a path for other new technologies, new devices, and new Opportunities.

GOALS OF AI

- Replicate human intelligence
- Solve Knowledge-intensive tasks
- An intelligent connection of perception and action
- Building a machine which can perform tasks that requires human intelligence such as:
  - Proving a theorem
  - Playing chess
  - Plan some surgical operation
  - Driving a car in traffic

FIELDS OF AI



History of AI

1943

Evolution of Artificial neurons

1950

Turing Machine

1956

Birth of AI: Dartmouth Conference

1966

First Chatboat : ELIZA

1972

First Intelligence Robot : WABOT -1

1974-1980

First AI winer

1980

Expert Ststem

1987-1993

Second AI Winer

1997

IBM Deep blue : first computer to beat a world chess champion

2002

AI in Home: Roomba

2011

IBM s Watson : Wins a quiz show

2012

Google now

2014

Chatbot Eugene Goostman:Wines a "Turing test

2015

Amazon Echo

Maturation of Artificial Intelligence (1943-1952)

- **Year 1943:** The first work which is now recognized as AI was done by Warren McCulloch and Walter pits in 1943. They proposed a model of artificial neurons.
- **Year 1950:** The Alan Turing who was an English mathematician and pioneered Machine learning in 1950. Alan Turing publishes "Computing Machinery and Intelligence" in which he proposed a test. The test can check the machine's ability to exhibit intelligent behavior equivalent to human intelligence, called a Turing test.

The birth of Artificial Intelligence (1952-1956)

- Year 1955: An Allen Newell and Herbert A. Simon created the first artificial intelligence program, Which was named as "Logic Theorist". This program had proved 38 of 52 Mathematics theorems, and find new and more elegant proofs for some theorems.
- **Year 1956:** The word "Artificial Intelligence" first adopted by American Computer scientist **John McCarthy** at the **Dartmouth Conference**. For the first time, AI coined as an academic field.
- At that time high-level computer languages such as FORTRAN, LISP, or COBOL were invented. And the enthusiasm for AI was very high at that time.

The golden years-Early enthusiasm (1956-1974)

- Year 1966: The researchers emphasized developing algorithms which can solve mathematical problems. **Joseph Weizenbaum** created the first chatbot in 1966, which was named as **ELIZA**.
- Year 1972: The first intelligent humanoid robot was built in Japan which was named as **WABOT-1**.

The first AI winter (1974-1980)

- The duration between years 1974 to 1980 was the first AI winter duration. AI winter refers to the time period where computer scientist dealt with a severe shortage of funding from government for AI researches.
- During AI winters, an interest of publicity on artificial intelligence was decreased.

A boom of AI (1980-1987)

- Year 1980: After AI winter duration, AI came back with "Expert System". Expert systems were programmed that emulate the decision-making ability of a human expert.
- In the Year 1980, the first national conference of the American Association of Artificial Intelligence was held at Stanford University.

The second AI winter (1987-1993)

- The duration between the years 1987 to 1993 was the second AI Winter duration.
- Again Investors and government stopped in funding for AI research as due to high cost but not efficient result. The expert system such as XCON was very cost effective.

The emergence of intelligent agents (1993-2011)

- Year 1997: In the year 1997, IBM Deep Blue beats world chess champion, Gary Kasparov, and became the first computer to beat a world chess champion.
- Year 2002: for the first time, AI entered the home in the form of Roomba, a vacuum cleaner.
- Year 2006: AI came in the Business world. Companies like Facebook, Twitter, and Netflix also started using AI.

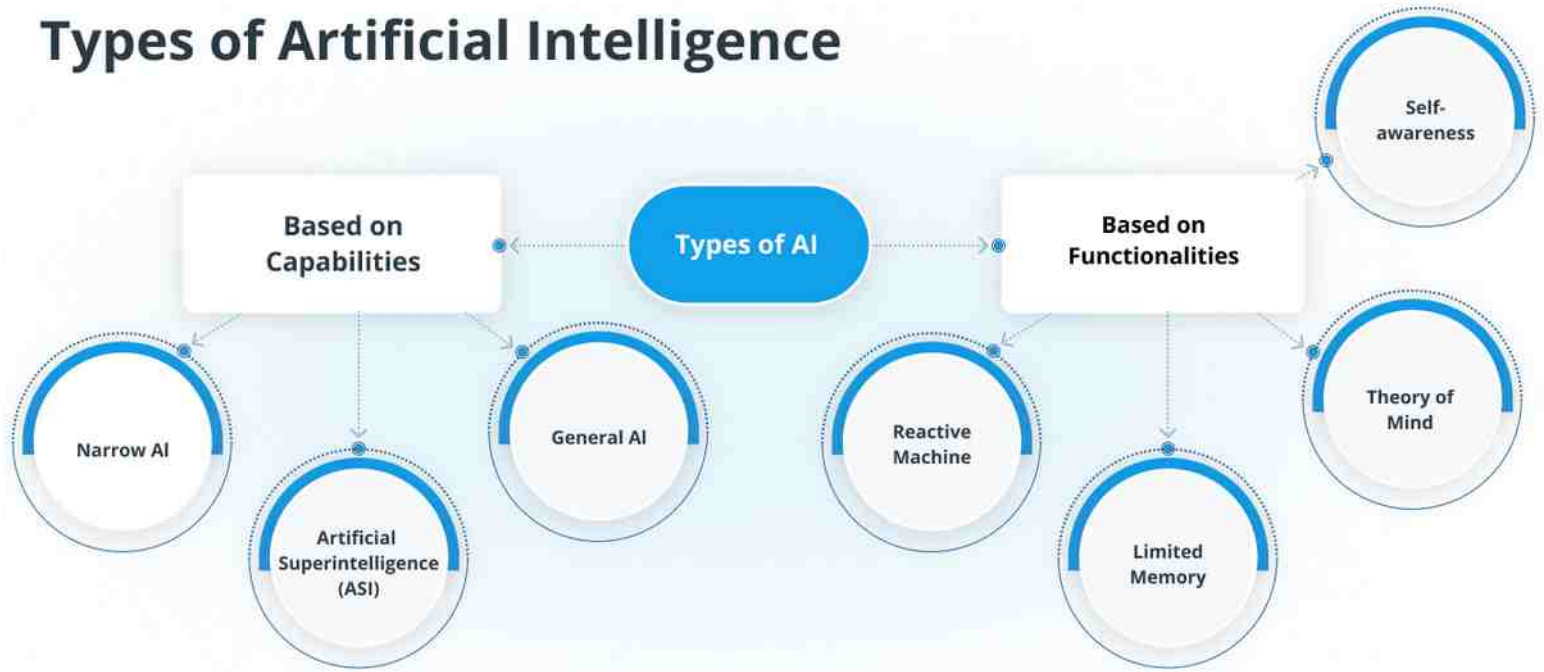
Deep learning, big data and artificial general intelligence (2011-present)

- Year 2011: In the year 2011, IBM's Watson won jeopardy, a quiz show, where it had to solve the complex questions as well as riddles. Watson had proved that it could understand natural language and can solve tricky questions quickly.
- Year 2012: Google has launched an Android app feature "Google now", which was able to provide information to the user as a prediction.
- Year 2014: In the year 2014, Chatbot "Eugene Goostman" won a competition in the infamous "Turing test."

Deep learning, big data and artificial general intelligence (2011-present)

- Year 2018: The "Project Debater" from IBM debated on complex topics with two master debaters and also performed extremely well.
- Google has demonstrated an AI program "Duplex" which was a virtual assistant and which had taken hairdresser appointment on call, and lady on other side didn't notice that she was talking with the machine.
- Year 2020: GPT 3 tool for automated conversations is introduced.
- Year 2022: ChatGPT is available for public.

Types of AI

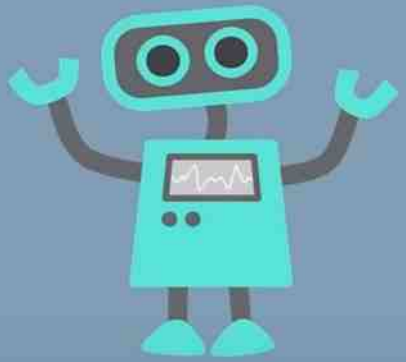

Types of Artificial Intelligence
Types of AI
Based on Capabilities
Based on Functionalities
Narrow AI
Artificial Superintelligence (ASI)
General AI
Reactive Machine
Limited Memory
Self-awareness
Theory of Mind

Types of AI – Based on Capabilities

	Artificial Narrow Intelligence (ANI)	Stage-1	Machine Learning	Specialises in one area and solves one problem
	Artificial General Intelligence (AGI)	Stage-2	Machine Intelligence	Refers to a computer that is as smart as a human across the board
	Artificial Super Intelligence (ASI)	Stage-3	Machine Consciousness	An intellect that is much smarter than the best human brains in pratically every field

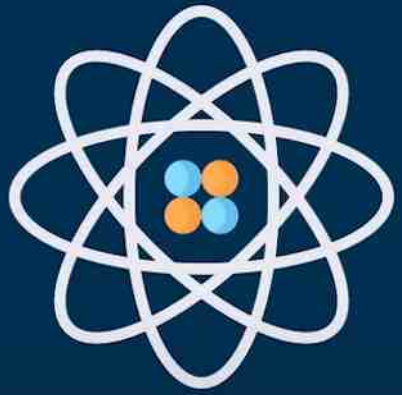
TYPES OF AI

Artificial Narrow Intelligence



Artificial General Intelligence

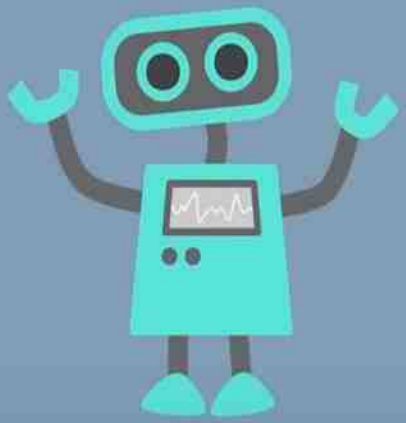
Artificial Super Intelligence



Narrow AI (Weak AI)

- Narrow AI refers to AI systems that are designed to handle a specific task or a narrow set of tasks. These AI systems do not possess general intelligence and are limited to the problem they were programmed to solve.
- Capabilities:
  - Task-specific, focused on a single function
  - Operates within defined parameters
  - Cannot generalize knowledge across different domains
- Examples:
  - Chatbots like me (ChatGPT) – language understanding and generation
  - Image recognition systems – identifying objects or faces in images
  - Voice assistants like Siri or Alexa – answering queries or performing simple tasks

Artificial Narrow Intelligence



Artificial Narrow Intelligence (ANI) also known as weak AI involves applying AI only to specific tasks.

iPhone

Face verification at Apple

TESLA

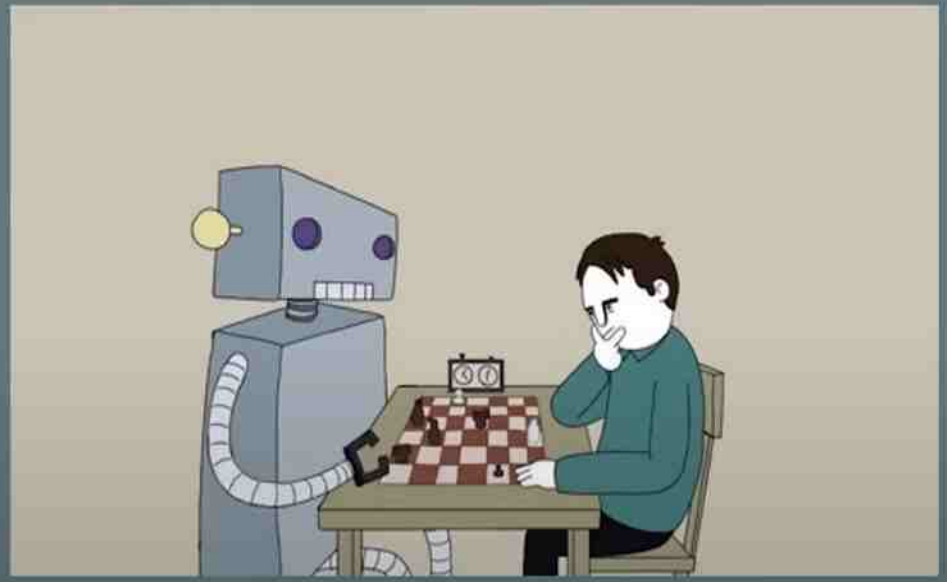
Autopilot feature at Tesla

General AI (Strong AI)

- General AI, also called Strong AI or Artificial General Intelligence (AGI), refers to AI that can understand, learn, and apply intelligence across a broad range of tasks, just like a human. This type of AI would have the capability to reason, solve problems, think abstractly, comprehend complex ideas, and learn from experience in a more generalized manner.
- Capabilities -
  - Can perform any intellectual task that a human can do
  - Able to learn across different domains
  - Possesses a form of consciousness and self-awareness (theoretical at this stage)
- Examples:
- As of now, General AI is still theoretical. No AI system today has achieved true AGI.

Artificial General Intelligence

Artificial General Intelligence (AGI) also known as strong AI, involves machines that possess the ability to perform any intellectual task that a human being can.



"Strong AI would take off on its own, and re-design itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, couldn't compete, and would be superseded."

Superintelligent AI

- Superintelligent AI refers to AI that surpasses human intelligence across all fields: creative, social, general wisdom, and problem-solving. It would have the ability to outperform the best human minds in every area, including scientific creativity, general wisdom, and social interactions.
- Capabilities:
  - Exceeds human intelligence
  - Can innovate, solve complex global issues, and evolve autonomously
  - Would theoretically revolutionize every aspect of society, including science, healthcare, and ethics
- Examples:
  - This type of AI is purely speculative at the moment and doesn't exist yet. It represents a future stage of AI development.

Artificial Super Intelligence

Artificial Super Intelligence (ASI) is a term referring to the time when the capability of computers will surpass humans.

Types of AI – Based on Functionalities

Reactive AI	Limited memory	Theory of mind	Self-aware
Good for simple classification and pattern recognition tasks	Can handle complex classification tasks	Able to understand human motives and reasoning; can deliver personal experience to everyone based on their motives and needs	Human-level intelligence that can bypass our intelligence, too
Great for scenarios where all parameters are known; can beat humans because it can make calculations much faster	Able to use historical data to make predictions	Able to learn with fewer examples because it understands motive and intent	Considered a long-shot goal
Incapable of dealing with scenarios including imperfect information or requiring historical understanding	Capable of complex tasks such as self-driving cars, but still vulnerable to outliers or adversarial examples	Considered the next mile-stone for AI's evolution	
	This is the current state of AI, and some say we have hit a wall		




Reactive AI

- Reactive Machines are the simplest type of AI. They do not store memories or past experiences and can only react to specific stimuli. These AI systems are task-specific and are not capable of learning from experience or adapting to new situations.
- Capabilities:
  - Responds to specific inputs with predefined outputs
  - No memory of past interactions or experiences
  - Limited to the tasks for which they were designed
- Examples:
  - IBM's Deep Blue – A chess-playing AI that analyzes the current board and makes decisions based on the present state of the game.

Limited Memory AI

- Limited Memory AI systems can learn from past experiences or data, but only within a specific timeframe or context. They retain information for a limited period and use that to make decisions, improving performance based on past data.
- Capabilities:
  - Can learn from historical data
  - Retains information for short-term use
  - Enhances decision-making over time with new data
- Examples:
  - Self-driving cars – Use real-time data like traffic conditions, road signs, and previous driving experiences to navigate.
  - Chatbots – May use past conversation history to improve responses in ongoing chats, but with limitations.

Theory of Mind

- AI with a Theory of Mind refers to systems that can understand and simulate human emotions, beliefs, intentions, and other mental processes. While this level of AI does not currently exist, it is an area of active research, aimed at enabling AI to better understand the human experience and interact more naturally with people.
- Capabilities:
  - Understands and processes human emotions, thoughts, and behavior
  - Can engage in complex social interactions
  - Aims to predict human actions based on internal states
- Examples:
  - Currently theoretical – No AI systems yet have a true "Theory of Mind," but research is ongoing in areas like emotional AI and affective computing.

Self-Aware AI

- Self-Aware AI represents the most advanced type of AI, which has its own consciousness, awareness of its own state, and an understanding of its actions and impact. This type of AI would be capable of understanding its environment and making decisions based on self-reflection.
- Capabilities:
  - Has awareness of itself and its surroundings
  - Makes decisions based on self-awareness and internal motivations
  - Can set goals and reason about its actions and their consequences
- Examples:
  - Currently theoretical – No AI system exists with full self-awareness. This remains a long-term vision for AI research, and any form of self-awareness is speculative at this point.

APPLICATIONS OF AI

DIGITAL ASSISTANTS

AI-driven tools like Siri, Alexa, or Google Assistant help manage daily tasks, provide answers to queries, and control smart home devices, making everyday life more convenient.

SOCIAL MEDIA

AI curates personalized content feeds, moderates user-generated content, and suggests friends or interest groups based on behavior, enhancing social connectivity.

DRIVING

AI powered self-driving cars and real-time traffic predictions improves road safety and enables efficient transportation.

FACIAL RECOGNITION

AI secures devices, verifies identities, and enables seamless user access through face-based authentication.

FRAUD DETECTION

AI detects suspicious transactions and patterns in real-time, protecting users from financial fraud and cyber threats.

SPAM DETECTION

AI filters out unwanted emails or messages, ensuring a cleaner inbox and protecting against phishing scams.

RECOMMEDATION SYSTEMS

AI suggests products, shows, or music tailored to individual preferences, enhancing user engagement.

CONTENT STREAMING

AI optimizes streaming quality, recommends content, and personalizes viewing experiences on platforms like Netflix.

SMART KEYBOARDS

AI predicts and autocorrects text as users type, improving typing speed, accuracy, and overall communication efficiency on smartphones and computers.

SEARCH ENGINES

AI enhances search engines by ranking and delivering the most relevant search results quickly, making it easier to find accurate information online.

PRACTICAL SYSTEMS BASED ON AI

- Autonomous vehicles: DARPA (Defense Advanced Research Projects Agency) funded onboard computer system from Carnegie Mellon University drove a van all but 52 of the 2849 miles from Washington, DC to San Diego, averaging 63 miles per hour day and night, rain or shine.
- Computer Chess: Deep Blue, a chess computer built by IBM Researchers defeated world champion Gary Kasparov.
- Mathematical theorem proving: A computer system at Argonne National Laboratories proved a long-standing mathematical conjecture about algebra using a method that would be considered creative if done by humans.
- Advanced User Interfaces: PEGASUS is a spoken language interface connected to the American Airlines EAASY SABRE reservation system, which allows subscribers to obtain flight information and make flight reservations via a large, on-line, dynamic database, accessed through their personal computer over the telephone.

APPLICATIONS OF AI

- Gaming − 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.
- Natural Language Processing − It is possible to interact with the computer that understands natural language spoken by humans.
- Expert Systems − There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.
- Vision Systems − These systems understand, interpret, and comprehend visual input on the computer. For example, A spying aeroplane takes photographs, which are used to figure out spatial information or map of the areas.

APPLICATIONS OF AI

- Doctors use clinical expert system to diagnose the patient.
- Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.
- 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.

APPLICATIONS OF AI

- Handwriting Recognition − The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.
- Intelligent Robots − Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, emperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.

APPLICATIONS OF AI- FINANCE SECTOR

J.P.Morgan

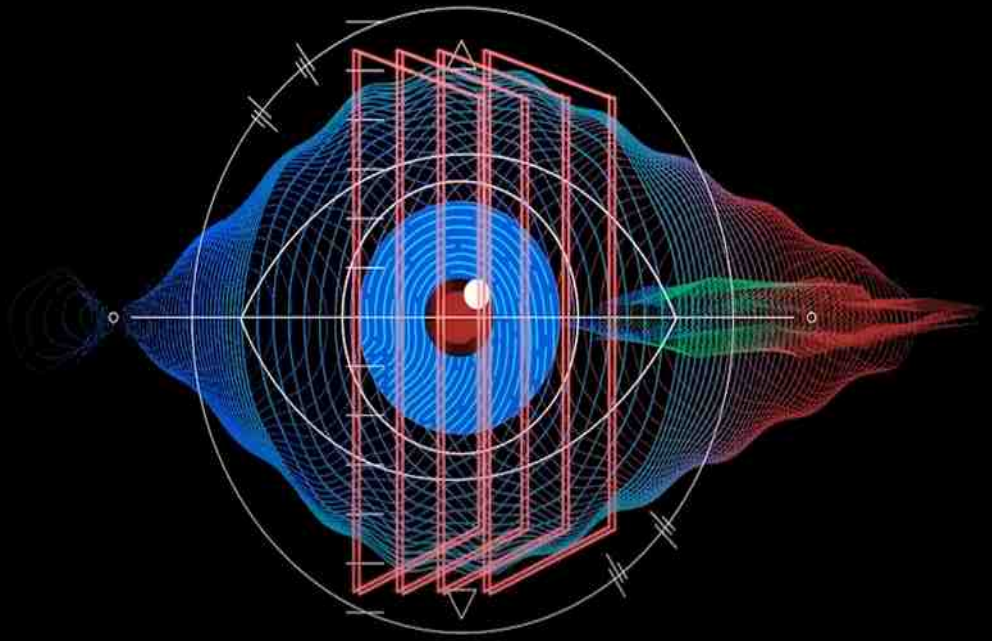
JPMorgan Chase's Contract Intelligence (COiN) platform uses AI, machine learning and image recognition software to analyze legal documents.

APPLICATIONS OF AI- MEDICAL SECTOR

Millions of Healthcare organizations use IBM AI (Watson) technology for medical diagnosis.

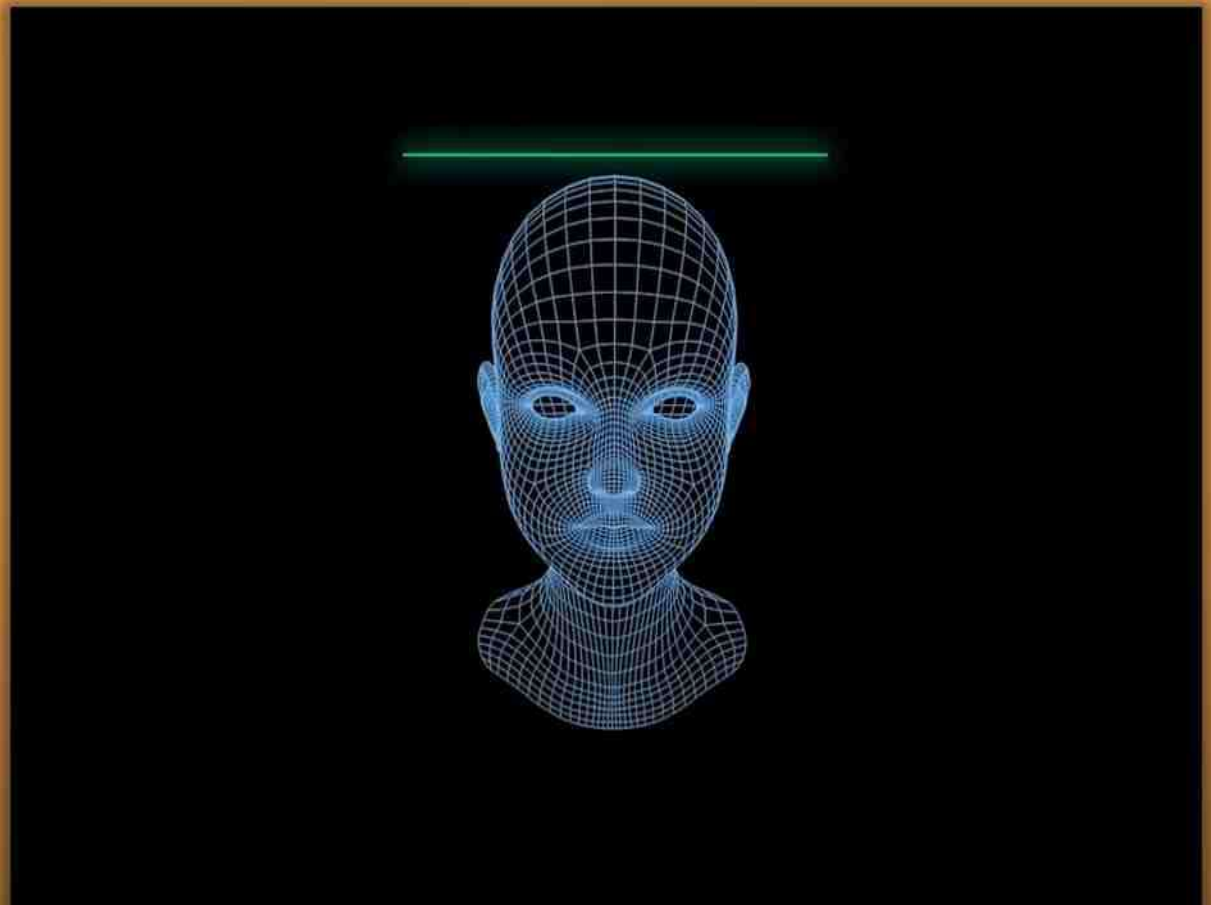
IBM Watson™

Google's AI Eye Doctor can examine retina scans and identify a condition called diabetic retinopathy.



Google

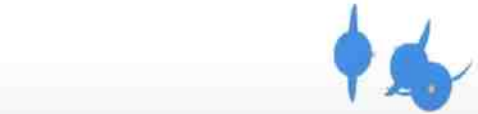
Facebook uses Machine Learning & Deep Learning to detect facial features and tag your friends



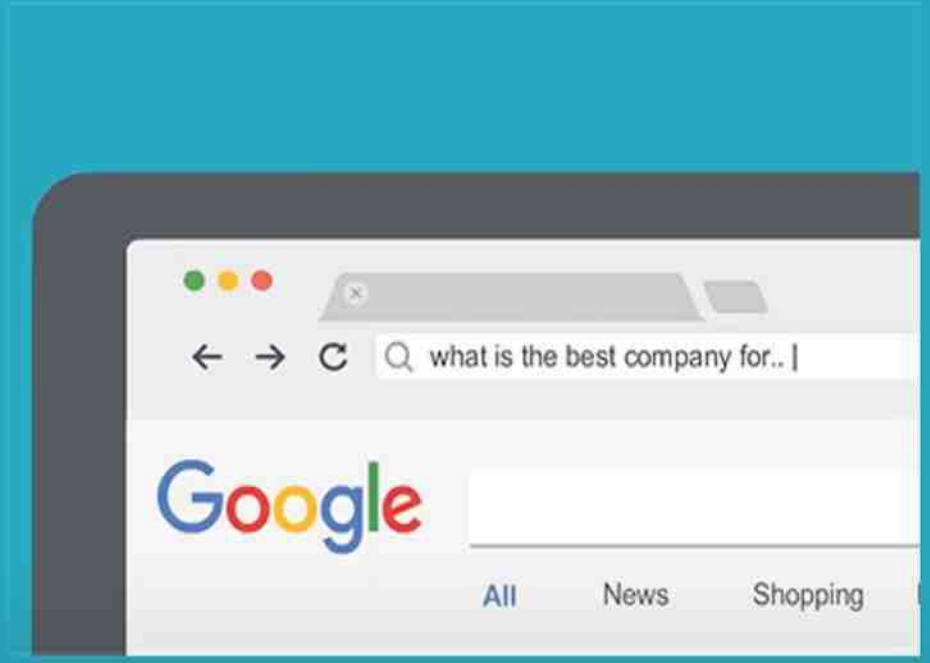
facebook

Twitter's is using AI to identify hate speech and terroristic language in tweets.

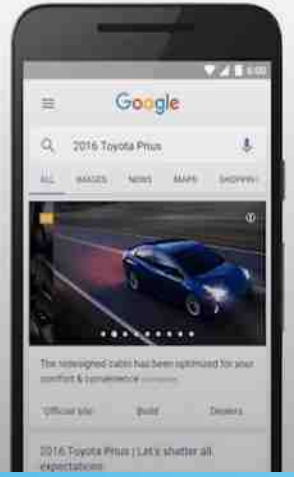
twitter



The company discovered and banned 300,000 terrorist-linked accounts, 95% of which were found by non-human, artificially intelligent machines.



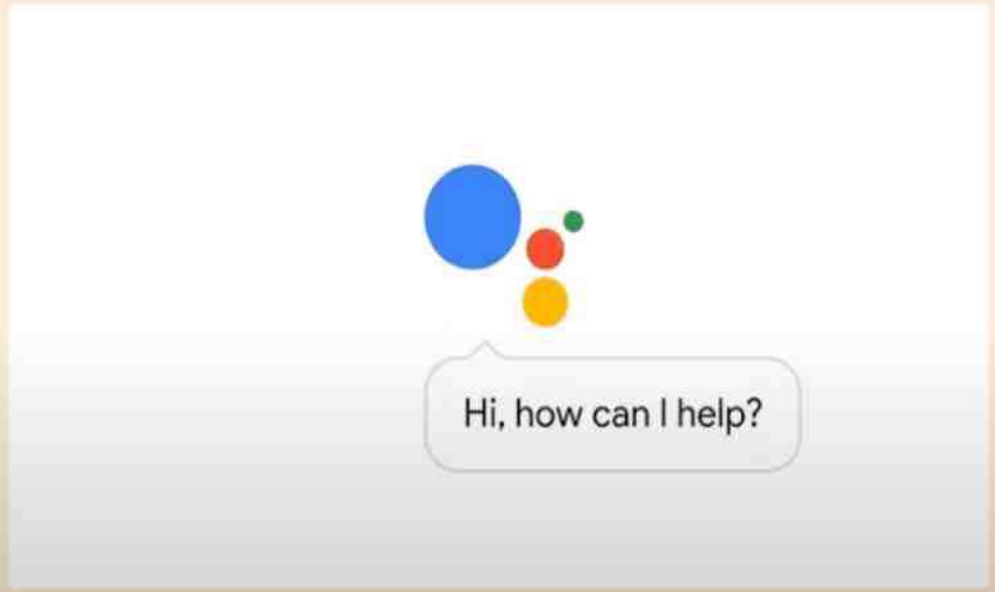
Google



Predictive searches are based on data that Google collects about you, such as your location, age, and other personal details.

Google Assistant

The Google Duplex can not only respond to calls and book appointments for you, it adds a human touch



Intelligent Agent

- An intelligent agent is a computer system or program that can observe its surroundings, make decisions, and take actions to achieve a specific goal.
- It works independently, adapts to changes, and can improve its performance over time by learning from its experiences.
- Examples include virtual assistants like Siri, self-driving cars, and recommendation systems on Netflix or Amazon.

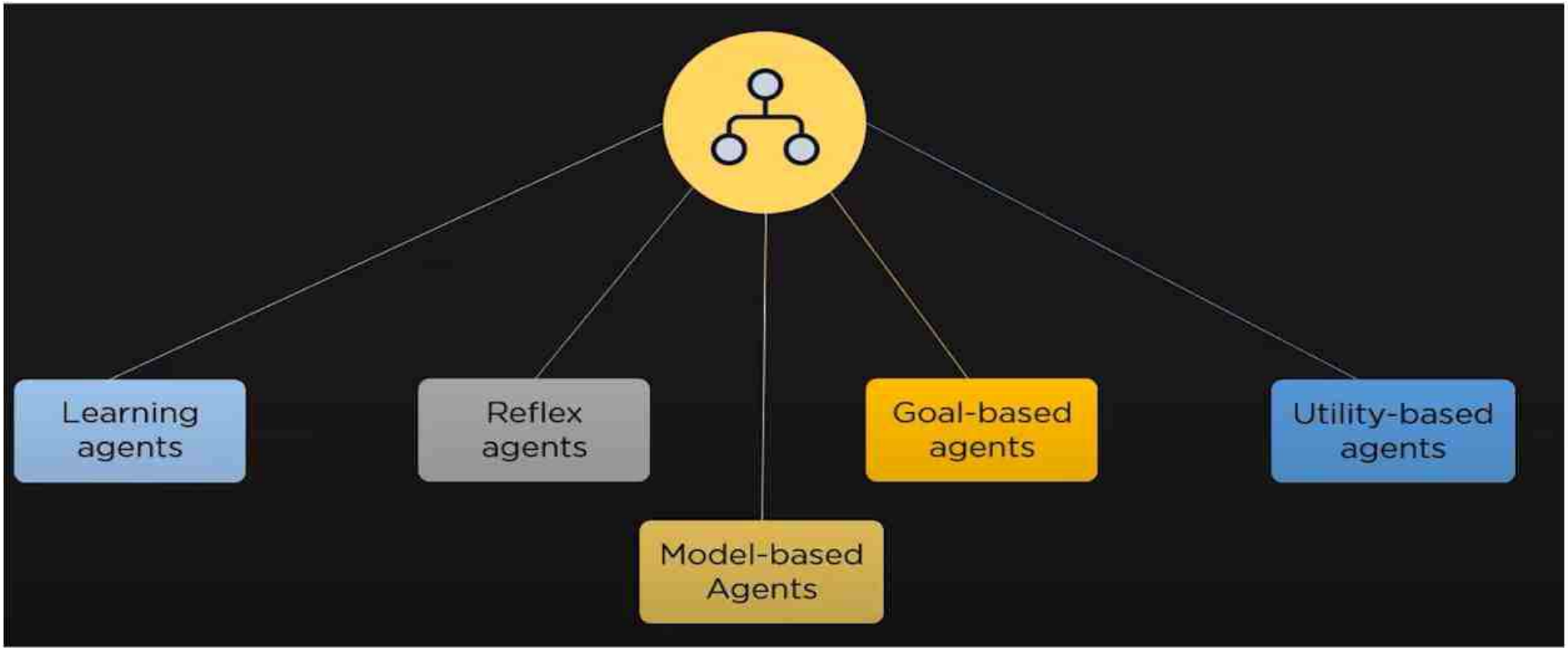
Key Features of Intelligent Agent

- Operates without direct human intervention and can make decisions independently.
- Uses sensors or other means to perceive and understand its environment.
- Works toward achieving specific goals or objectives, often optimizing for efficiency or utility.
- Learns from past experiences or data to improve performance and adapt to changing environments.
- Takes actions that are expected to maximize its success in achieving the desired outcome.

Components of an Intelligent Agent

- **Sensors:**
  - Gather information from the environment.
  - Example: Cameras, microphones, APIs for data input.
- **Actuators:**
  - Perform actions to interact with or affect the environment.
  - Example: Moving a robotic arm, sending an alert, or updating a database.
- **Reasoning Module:**
  - Processes input, makes decisions, and selects the best course of action.
  - Example: AI algorithms, decision trees, neural networks.
- **Learning Mechanism (Optional):**
  - Uses techniques like machine learning to improve its performance over time.

Types of Intelligent Agents

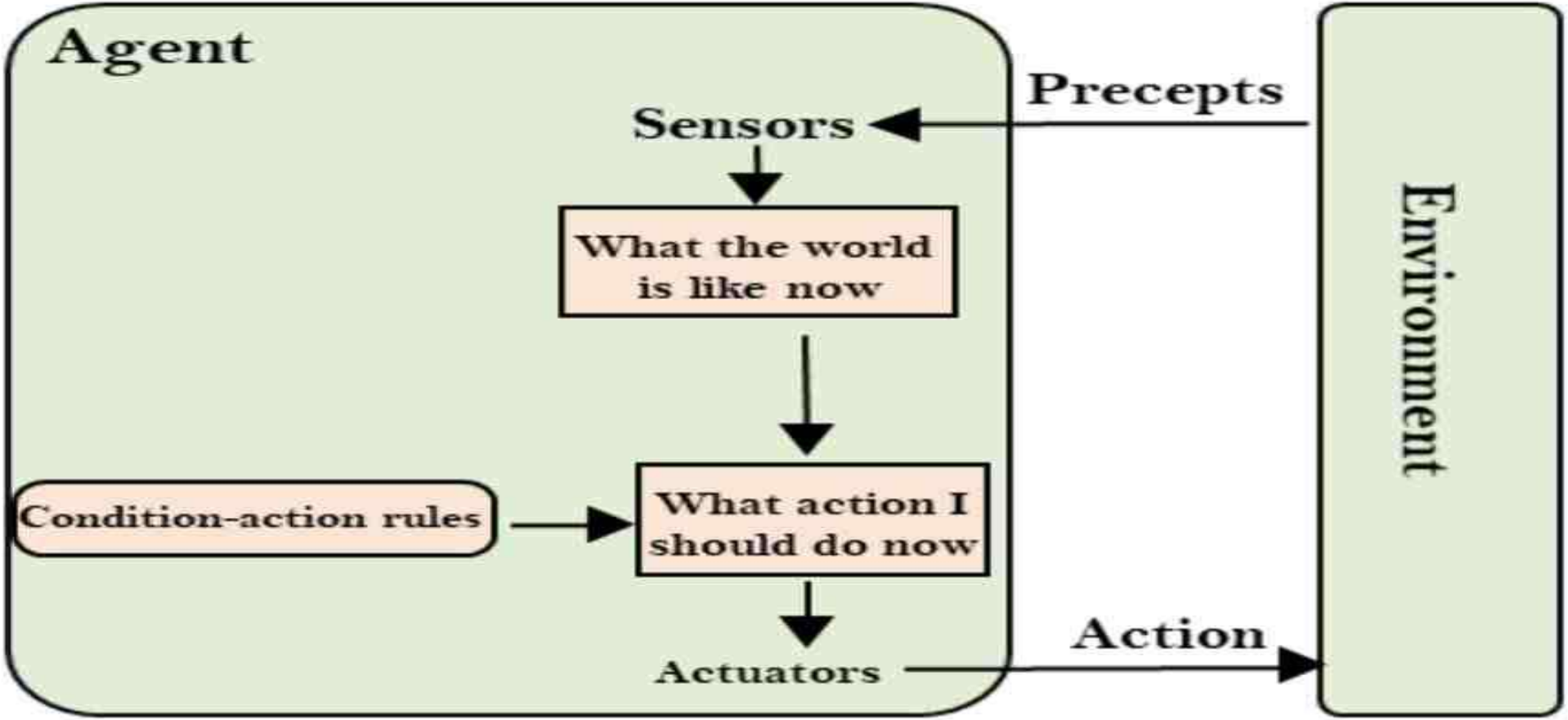


Simple Reflex Agents

Simple Reflex Agents:

- The Simple reflex agents are the simplest agents. These agents take decisions on the basis of the current percepts and ignore the rest of the percept history.
- These agents only succeed in the fully observable environment.
- The Simple reflex agent works on Condition-action rule, which means it maps the current state to action. Such as a Room Cleaner agent, it works only if there is dirt in the room.

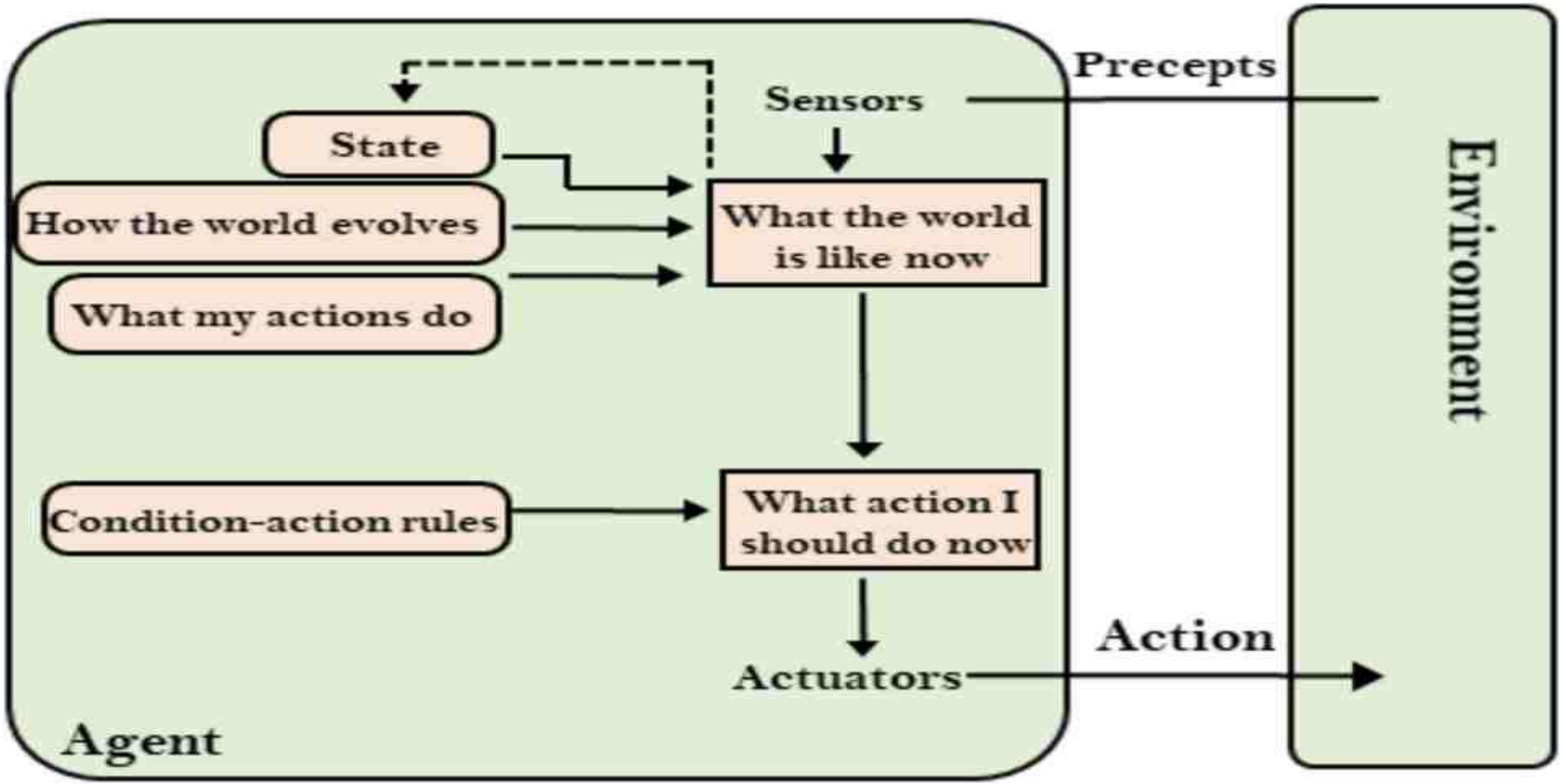
Simple Reflex Agents



Model-based reflex agent

- The Model-based agent can work in a partially observable environment, and track the situation.
- A model-based agent has two important factors:
  - Model: It is knowledge about "how things happen in the world," so it is called a Model-based agent.
  - Internal State:It is a representation of the current state based on percept history.
- These agents have the model, "which is knowledge of the world" and based on the model they perform actions.
- Updating the agent state requires information about:
  - How the world evolves.
  - How the agent's action affects the world. Example: Weather prediction systems.

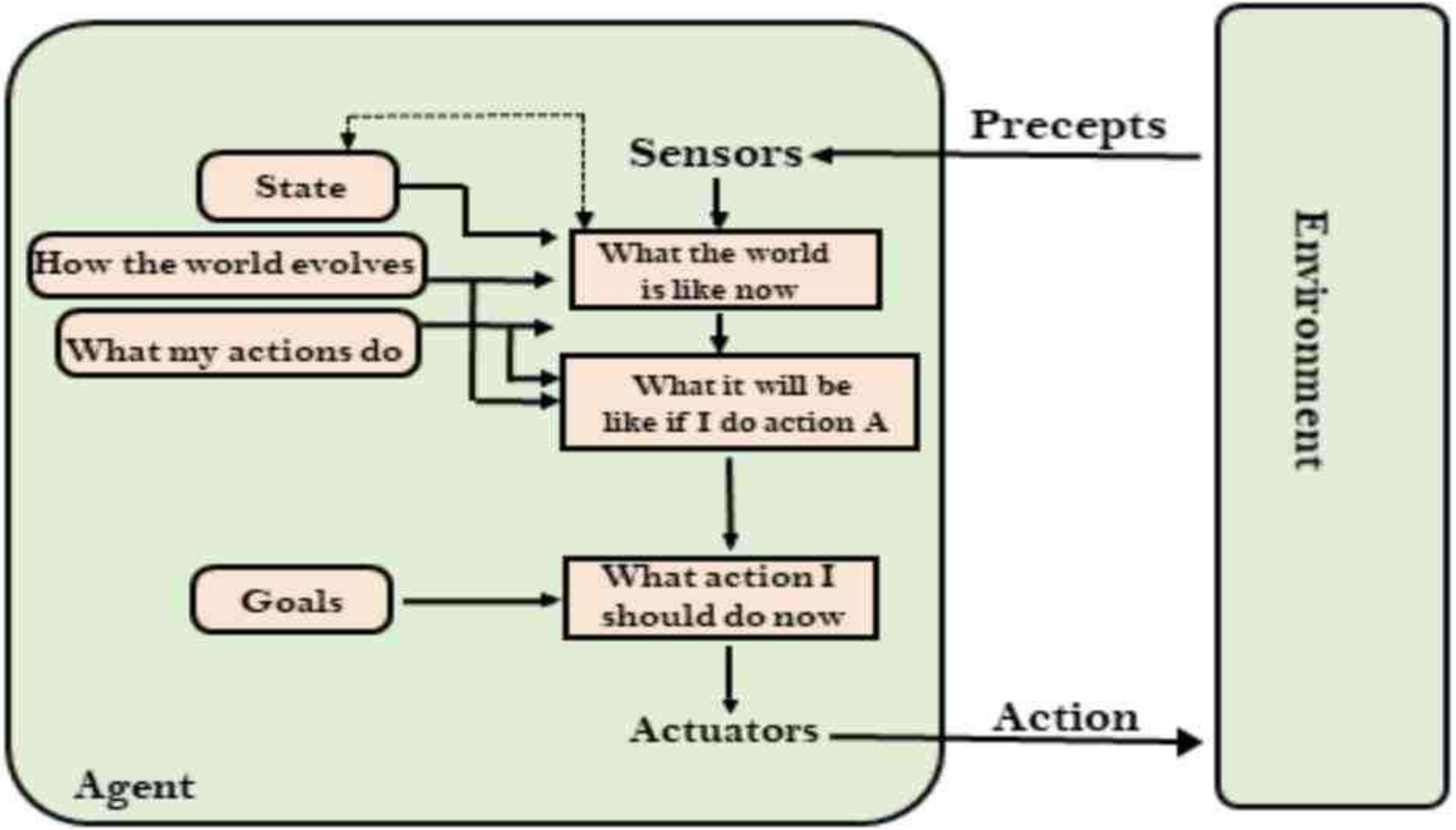
Model-based reflex agent



Goal-based agents

- The knowledge of the current state environment is not always sufficient to decide for an agent to what to do.
- The agent needs to know its goal which describes desirable situations.
- Goal-based agents expand the capabilities of the model-based agent by having the "goal" information.
- They choose an action, so that they can achieve the goal.
- These agents may have to consider a long sequence of possible actions before deciding whether the goal is achieved or not. Such considerations of different scenario are called searching and planning, which makes an agent proactive. Example: Autonomous navigation systems.

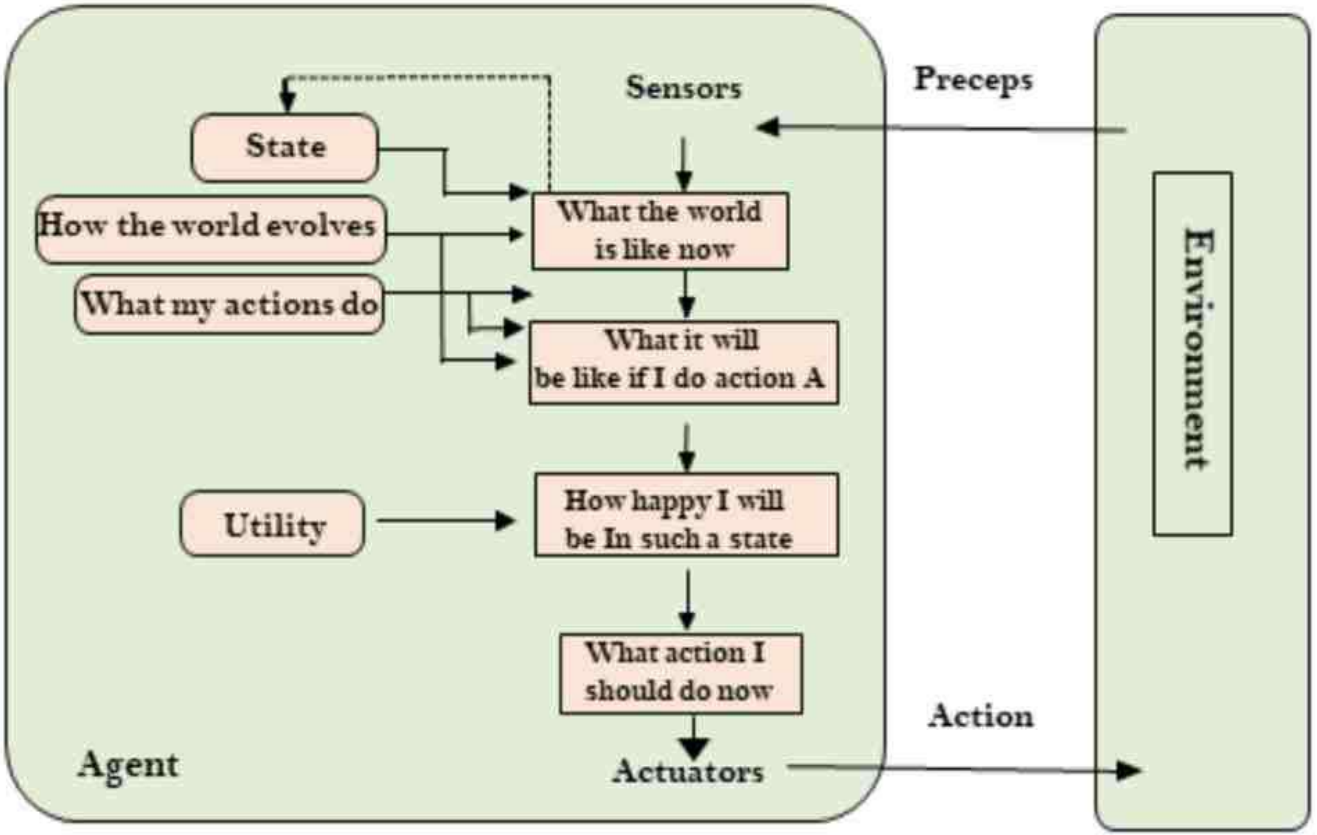
Goal-based agents



Utility-based agents

- These agents are similar to the goal-based agent but provide an extra component of utility measurement which makes them different by providing a measure of success at a given state.
- Utility-based agent act based not only on goals but also the best way to achieve the goal.
- The Utility-based agent is useful when there are multiple possible alternatives, and an agent has to choose in order to perform the best action.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals. Example: Recommendation engines.

Utility-based agents



Learning Agents

- A learning agent in AI is the type of agent which can learn from its past experiences, or it has learning capabilities.
- It starts to act with basic knowledge and then able to act and adapt automatically through learning.
- A learning agent has mainly four conceptual components, which are:

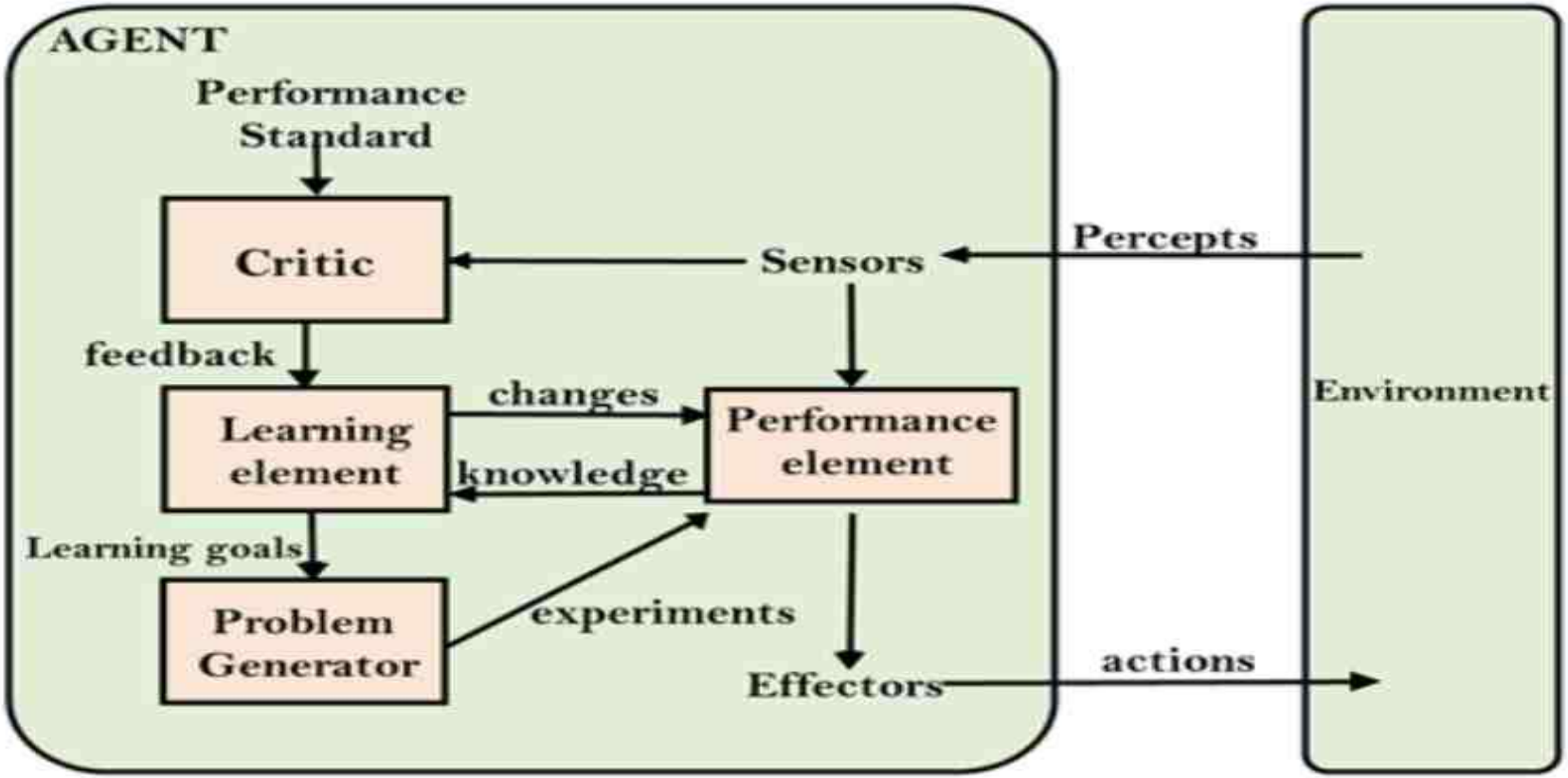
  a. Learning element:It is responsible for making improvements by learning from environment

  b. Critic:Learning element takes feedback from critic which describes that how well the agent is doing with respect to a fixed performance standard.

  c. Performance element : It is responsible for selecting external action.

  d. Problem generator:This component is responsible for suggesting actions that will lead to new and informative experiences.
- Hence, learning agents are able to learn, analyze performance, and look for new ways to improve the performance. Example: AI chatbots like ChatGPT.

Learning Agents



DEVELOPMENT OF LOGIC

- 17th Century- Gottfried Wilhelm von Leibniz with his Calculus Philosophicus introduced the first system of formal logic.
- 18th Century- Euler with his analysis for the correctedness of the bridges joining the river bank and islands of the city of Konigsberg.
  - The formalization of graph theory also afforded the possibility of state space search.

DEVELOPMENT OF LOGIC

- 19th Century- Charles Babbage, originator of science of Operation Research, also contributed a lot in AI. Babbage's Difference Engine, Analytical Engine made to compute value of polynomial functions.
- 19th Century- George Boole developed formal languages. Later, these logic based languages were used for the implementation of AI. Boole' best work was in the formulation of the laws of the logic.
- Boole's work devised 3 operations "AND, OR, NOT" which formed the centrepoints of his logical calculus.

DEVELOPMENT OF LOGIC

- Gottlob Freg in his ‘foundations of Arithmetic’ created a mathematical specification language for describing the basis of arithmetic in a clear and precise fashion.
- With this language he formalized many issues addressed by Aristotle’s logic. His language now called First Order predicate calculus.
- Russel’s and Whitehead in 1950 developed the mathematics through formal operations. He created it as a collection of axioms. Every step of proof is followed from strict application of formal syntactic rules to either axioms or previously proven algorithms.

DEVELOPMENT OF LOGIC

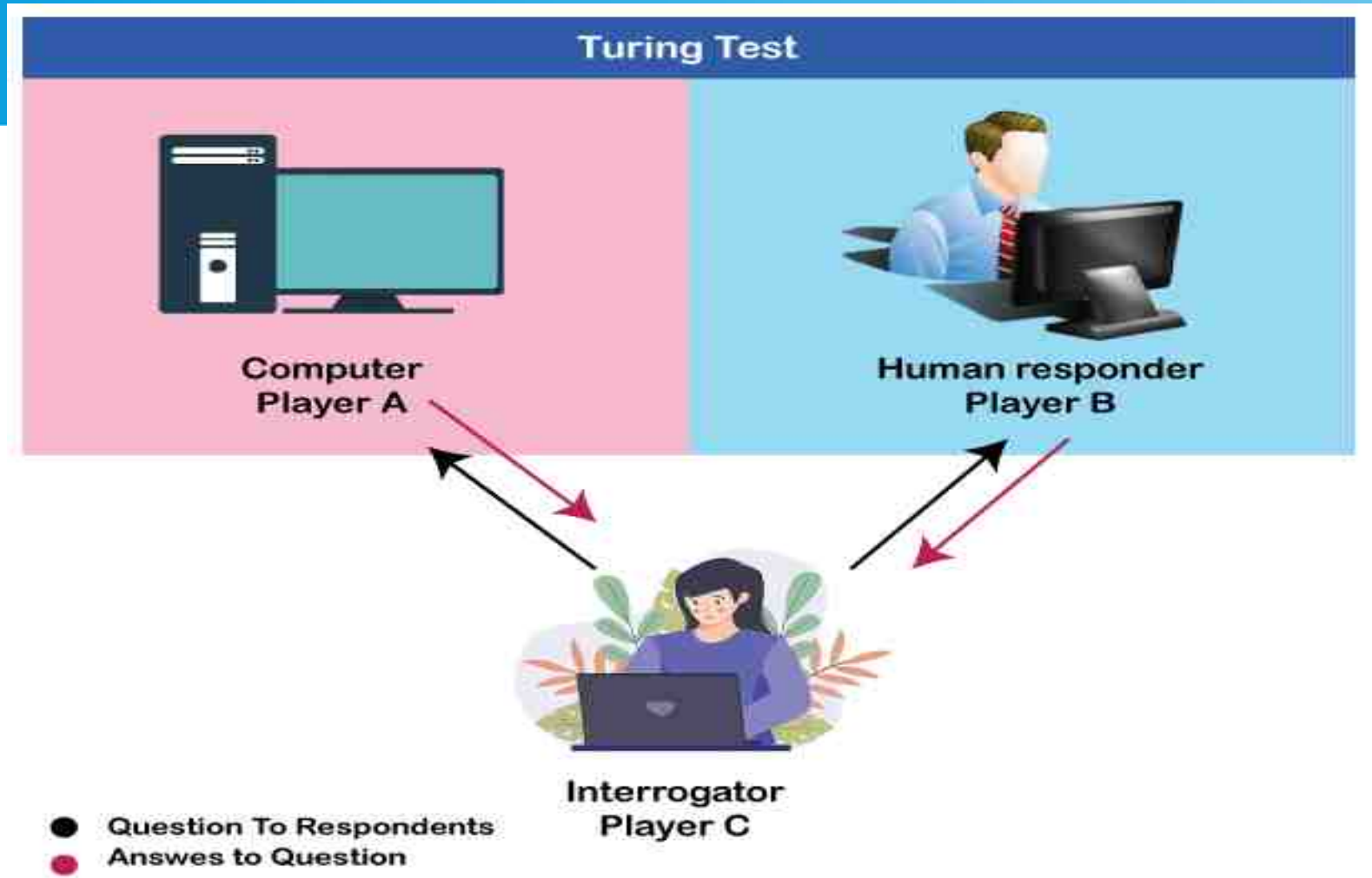
- Russell and whitehead’s work was modified by Alfred Tarski to include the semantics component into it. By this inclusion the formal logics are related with the real world events.
- Though in the eighteenth, Nineteenth and twentieth century the development of logic was done, it was not until in twentieth century the introduction of digital computers, AI became the viable scientific field.
- With this development it became possible to implement formal reasoning system on a computer and to emperically test their ability for exhibiting intelligence.

Turing Test

- The Turing Test, proposed by Alan Turing in 1950, is a method to determine whether a machine can exhibit intelligent behavior indistinguishable from that of a human.
- Turing introduced this concept in his paper "Computing Machinery and Intelligence" and posed the question, "Can machines think?"

The Turing Test Setup

- The test involves three participants.
  - A human interrogator.
  - A human responder.
  - A machine responder (the AI being tested).
- These participants communicate via a text-based interface to eliminate any bias based on physical appearance or voice. The interrogator's task is to determine which responder is the human and which is the machine by asking a series of questions.
- If the machine can respond in a way that convinces the interrogator it is human as often as the actual human can, the machine is said to have passed the test.


Turing Test
Computer
Player A
Human responder
Player B
Interrogator
Player C
Question To Respondents
Answes to Question