Artificial Intelligence-Introduction

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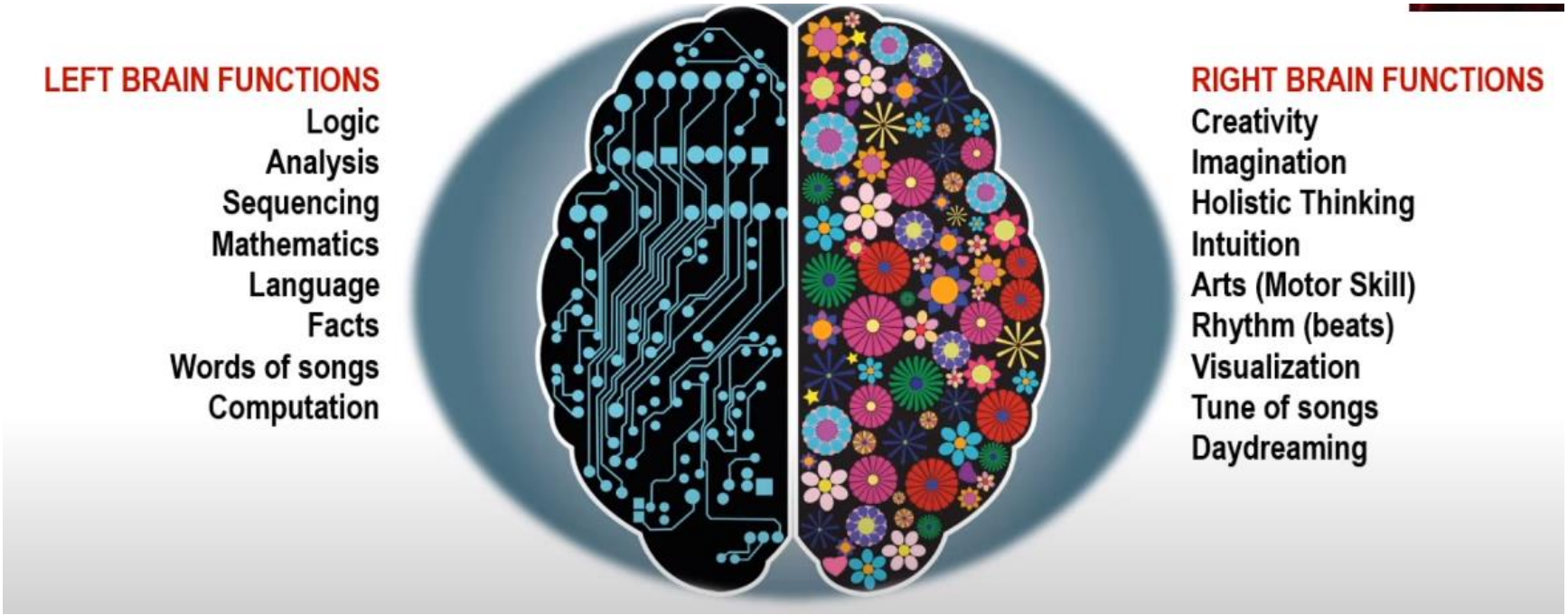
Cognitive System of Human



Classical AI

Modern AI: Convergence of these two

Statistical Methods, Machine Learning

Stuart Russell, Peter Norvig, *Artificial intelligence : A Modern Approach*, Prentice Hall, Fourth edition, 2020.

Motivations

- AI is not just a technical subject, but it has relation with Philosophy.
- AI subject consisting of many sub-fields.
- AI based problems have many solutions.
- Breadth wise course not depth (Something of Everything)
- Tradeoff between Broad and Shallow vs. Deep and Narrow.
- Searching, heuristic search, planning, decision making, Reinforcement Learning.
- Theory $\rightarrow$ Modeling $\rightarrow$ Algorithm $\rightarrow$ Applications

History

- Take a real life problem, convert it into a computational problem, i.e. Modeling
- For finding solution, apply suitable algorithms for the problem.
- ENIAC is the first computer (1946) following principle of Turing Machine, used for US defense purposes.
- Lot of progress of AI has done due to Defense
- Question: “Can a machine think?” – Alan Turing in 1950
- Not known if the machine cannot communicate with us by any way.
- Brain is meaningless in absence of communicators.

Turing Test

- The Turing Test is a method of inquiry in artificial intelligence (AI) for determining whether or not a computer is capable of thinking like a human being.
- The test is named after Alan Turing, the founder of the Turing Test.
- The phrase “The Turing Test” is most properly used to refer to a proposal made by Turing (1950) as a way of dealing with the question whether machines can think.
- According to Turing, the question whether machines can think is itself “too meaningless” to deserve discussion.
- To pass a well-designed Turing test, the machine must use natural language, reason, have knowledge and learn.

- 1950: Turing Test for Machine Intelligence

- 1956: AI born at Dartmouth College Wrkshop

McDermott

- 1964: Eliza – the chatbot psychotherapist

1966: Shakey – general purpose mobile robot

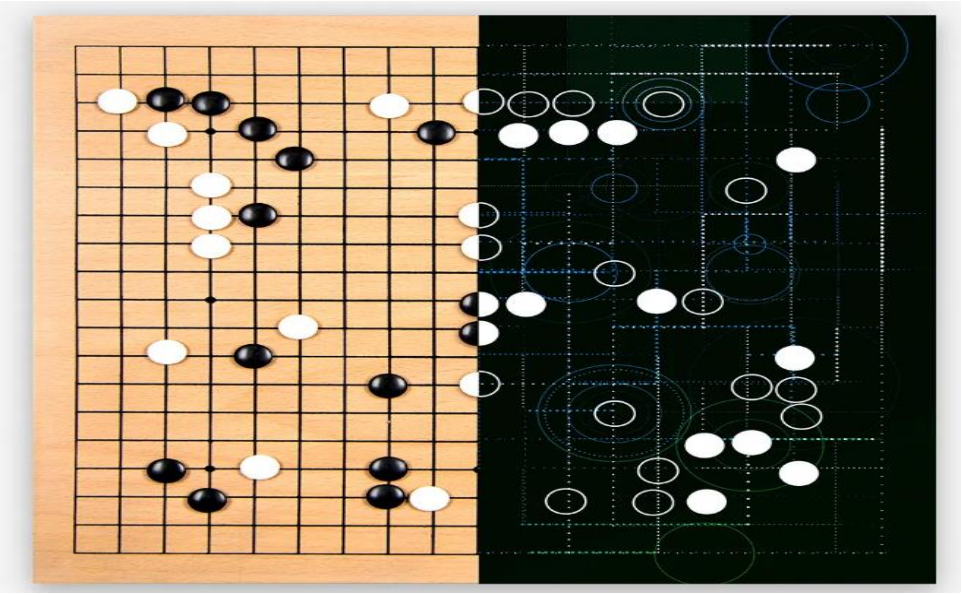
1974-1980 no development on AI

Next Expert systems were developed but not sustained.

1997 – AI ends human supremacy in Chess

Phase of AI

- First Phase – Logic based AI
- Second Phase – Probabilistic AI
- Third phase – Neural Network based AI
- AlphaGo competition
  - **Go** (game) is an abstract strategy board game for two **players** in which the aim is to surround more territory than the opponent.



• Go---a 2,500-year-old game that's exponentially more complex than chess.

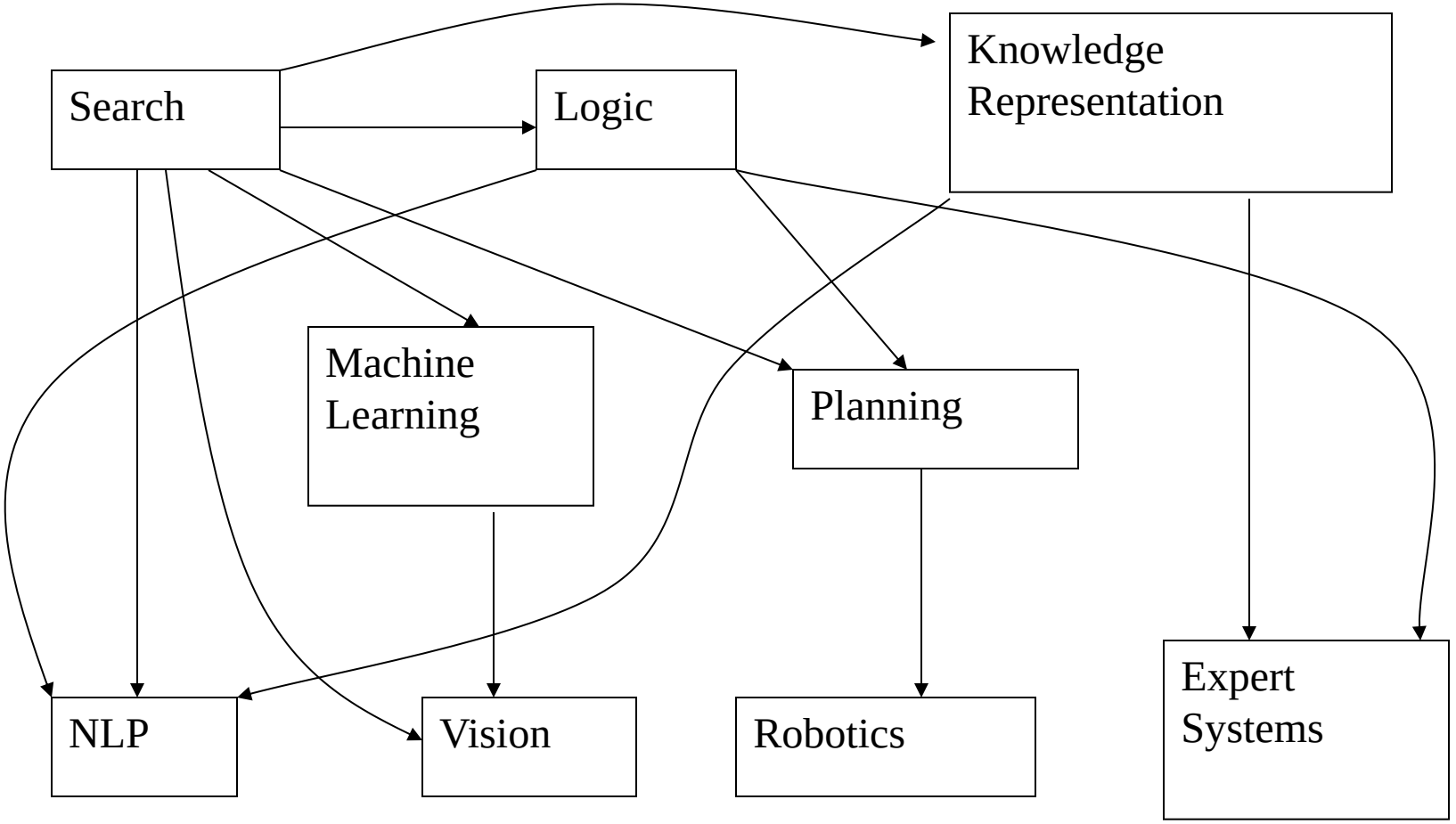
• Researchers at DeepMind---a self-professed "Apollo program for AI" that Google acquired in 2014---staged this machine-versus-man contest in October, in London.

• IN A MAJOR breakthrough for artificial intelligence, a computing system developed by Google researchers in Great Britain has beaten a top human player at the game of Go.

Introduction

- Artificial intelligence is the simulation of human intelligence processes by developing computing systems that have the ability to perform tasks like human.
- AI is the study of ideas that enable computers to be intelligent.
- Applications of AI include Expert System, Natural Language Processing, Speech Recognition, Robotics and Machine Vision.
- AI can process large amounts of data much faster and make predictions more accurately than humanly possible.
- AI is expensive to process the large amounts of data.

Areas of AI and Some Dependencies



What is *artificial* intelligence?

human-like *vs.* rational

thought *vs.* behavior		
	Systems that think like humans	Systems that think rationally
	Systems that act like humans	Systems that act rationally

- Cognitive Science
  - Very hard to understand how humans think

We don't do cost benefit analysis, rather decision is intuitive

- Thinking like humans important in Cognitive Science applications
  - Intelligent tutoring
  - Expressing emotions in interfaces… HCI

Systems that think ‘rationally’

- Humans are not always ‘rational’
- How to define *Rationale* - Rationale means doing the right thing
- *The right thing* is expected to maximize goal achievement, given the available information
- Is it in terms of *logic*?
- Logic can’t express everything (e.g. uncertainty)
- At that time, some *specific (in domain) human knowledge* or information is used, thus covers more generally different situations of problems.
- AI is the study of mental facilities through the use of computational models (Charniak and McDermott).
- “The study of the computations that make it possible to perceive, reason, and act” (Winston)

Systems that act Rationally

- Study AI as *rational* ***agent*** –

2 advantages:

  - It is more general than using logic only
    - Because: LOGIC + Domain knowledge
  - It allows extension of the approach with more scientific methodologies

AI has two major roles:

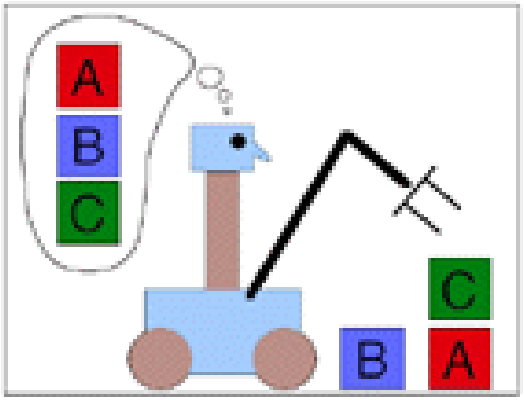
  - Study the intelligent part concerned with humans.
  - Represent those actions using computers.

Systems that act like humans

- *Natural language processing*
  - for communication with human
  - *Knowledge representation*
    - to store information effectively & efficiently
  - *Automated reasoning*
    - to retrieve & answer questions using the stored information
  - *Machine learning*
    - to adapt to new circumstances

Goals of AI

- To make computers more useful by letting them take over dangerous or tedious tasks from human.
- Understand principles of human intelligence



The Foundation of AI

- Mathematics formalizes the three main area of AI: *computation*, *logic*, and *probability*
  - Computation leads to analysis of the problems that can be computed
    - *complexity theory*
  - Probability contributes the *"degree of belief"* to handle *uncertainty* in AI
  - *Decision theory* combines *probability theory* and *utility theory* (bias)
- *Psychology*
  - How do humans think and act?
  - The study of human reasoning and acting
  - Provides reasoning models for AI
  - Strengthen the ideas
    - humans and other animals can be considered as information processing machines

The Foundation of AI

- Computer Engineering
  - The power of computer makes computation of large and difficult problems more easily
  - AI has also contributed its own work to computer science, including: time-sharing, the linked list data type, OOP, etc.
- Linguistics
  - For understanding natural languages
    - different approaches has been adopted from the linguistic work
  - Formal languages
  - Syntactic and semantic analysis
  - Knowledge representation

The main topics in AI

Artificial intelligence can be considered under a number of headings:

- Search (includes Game Playing).
- Representing Knowledge and Reasoning with it.
- Planning.
- Learning.
- Expert Systems.
- Natural language processing.
- Interacting with the Environment
  (e.g. Vision, Speech recognition, Robotics)

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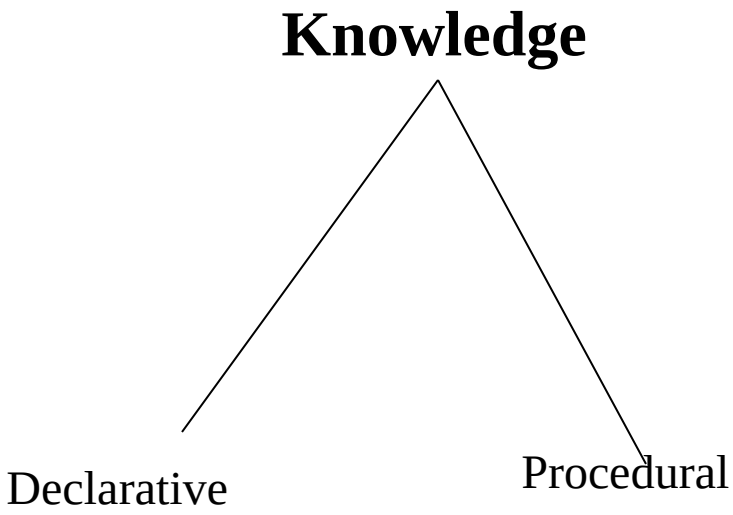
Search

- *Search* is the fundamental technique of AI.
  - Possible answers, decisions or courses of action are structured into an abstract space, which we then search.
- Search is "blind" and “informed":
  - blind
    - we move through the space without worrying about what is coming next, but recognising the answer if we see it
  - informed
    - we guess what is ahead, and use that information to decide where to look next.
- We may want to search for the first answer that satisfies our goal, or we may want to keep searching until we find the best answer.



• Declarative knowledge deals with factoid questions (what is the capital of India? Etc.)

• Procedural knowledge deals with “How”

• Procedural knowledge can be embedded in declarative knowledge

Planning

Given a set of goals, construct a sequence of actions that achieves those goals:

- often very large search space
- but most parts of the world are independent of most other parts
- often start with goals and connect them to actions
- no necessary connection between order of planning and order of execution
- what happens if the world changes as we execute the plan and/or our actions don’t produce the expected results?

AI Planning

Elements of a Planning Problem

- A set of states (worlds) described in terms of predicates
- A set of actions which transforms some parts of one world to take us to another world
- An initial world
- A goal in terms of the predicates that must hold in the final world

Planning is widely used in robotics and automated control

Modern AI explores techniques that combine planning with machine learning

Learning

- If a system is going to act truly appropriately, then it must be able to change its actions in the light of experience:
  - how do we generate new facts from old ?
  - how do we generate new concepts ?
  - how do we learn to distinguish different situations in new environments ?

Interacting with the Environment

- In order to enable intelligent behaviour, we will have to interact with our environment.
- Properly intelligent systems may be expected to:
  - accept sensory input
    - vision, sound, …
  - interact with humans
    - understand language, recognise speech, generate text, speech and graphics, …
  - modify the environment
    - robotics

Knowledge and Inferences

- Several ways to know:
  - **Empiricism:** Involves acquiring knowledge through observations or experiences.
  - The **Scientific** method: A process of systematically collecting and evaluating evidence to test ideas and answer questions.
  - **Intuition**s: Rather than examining facts or using rational thoughts, intuition involves believing what feels true.
  - **Authority**: Accepting ideas because some authority figure says that they are true.
  - **Rationalism**: Using Logic and Reasoning to acquire knowledge

Reasoning = Making Inference

Logical Reasoning

- What is known to reason about something that is not known explicitly.
- **Deductio**n : From a given set of facts infer another fact that is *necessaril*y true – *cause to effect* (disease to symptoms)
- **Abduction**: From a given set of facts infer another fact that is *possibly* true – *Effect to cause* (symptoms to disease).
  - Abduction needs to be consistent.
  - Abduction is the guess work.
- **Induction**: From a given set of facts infer a new fact.
  - Known as generalization.
  - Recognizing that a number of entities in the domain share some common property, and assert as a general statement.

Automated Reasoning

- **Deduction**
  - Rule: *All the marbles in this bag are blue*
  - Case: *These marbles are from this bag*
  - Inference: *These marbles are blue*
- **Abduction**
  - Rule: *All the marbles in this bag are blue*
  - Observation: *These marbles are blue*
  - Case: *These marbles are from this bag*
- **Induction**
  - Case: *These marbles are from this bag*
  - Observation: *These marbles are blue*
  - **Rule: All the marbles in this bag are blue**

Logical Reasoning

father(x, z), father(z, y)
⇒ grandfather(x, y)

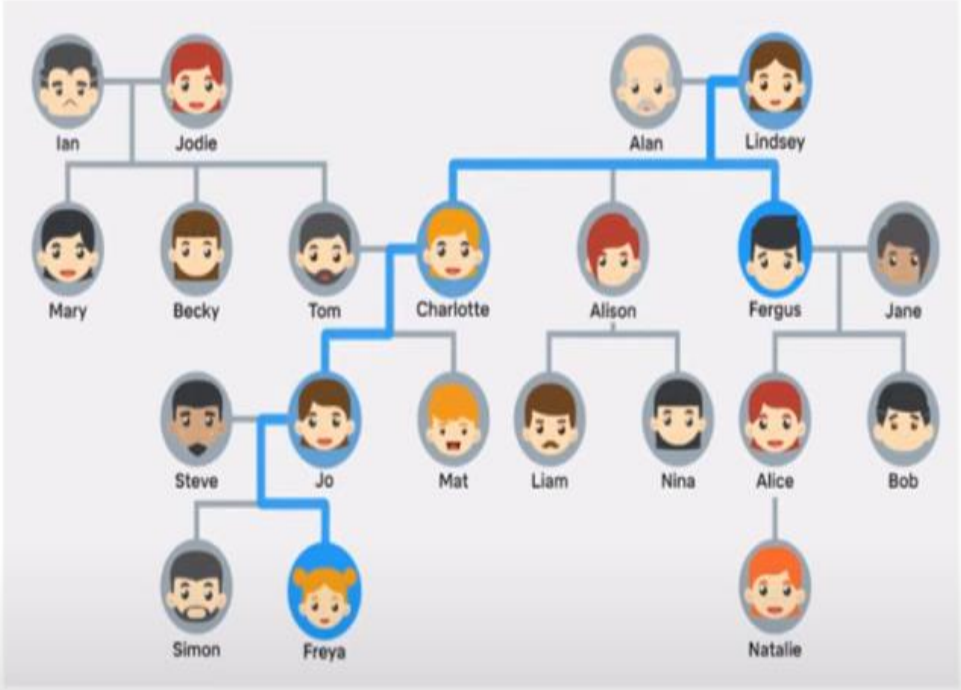
mother(x, z), father(z, y)
⇒ maternalgrandfather(x, y)

mother(x, z), mother(z, y)
⇒ maternalgrandmother(x, y)

father(x, z), mother(z, y)
⇒ grandmother(x, y)

maternalgrandmother(x, z),
mother(z, p), son(p, y)
⇒ maternalgreatuncle(x, y)

Who is the maternal great uncle of Freya?



maternalgrandmother(Freya, Charlotte),
mother(Charlotte, Lindsey), son(Lindsey, Fergus)
⇒ maternalgreatuncle(Freya, Fergus)

Problem Solving

- An autonomous agent has a goal to achieve by choosing a set of actions.
- Abductive inference suggests what action is best.
- Background knowledge make some strategies and tactics where knowledge comes through training.
- Abductive inferences generate **expectations**.
- Scientific progress begins with **Abductio**n (looking for causes) and **Induction** (making informed Generalization).
- Gets validated by Deduction
- Gets experimental Validation
- Only Induction adds New Knowledge.

Constraint optimization problem

When the size and complexity becomes too big we use "heuristic functions" to cut out unnecessary parts.

In the lack of domain knowledge, we can statistically learn the best way (reinforcement learning) by exploration.

Modern AI aims to combine learning from data with structured use of domain knowledge.

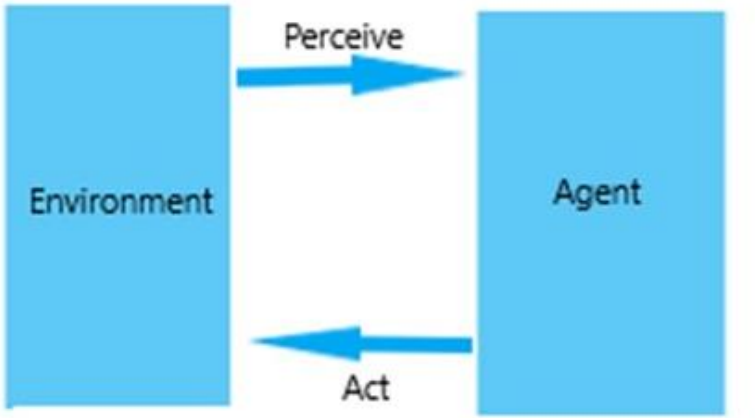
Agent and Environment

- **Artificial intelligence** studies the whole system by dividing it into two components:

  Agent

  Environment

- An agent can either perceive information from the environment or can perform some actions on the environment.



Agent

- The system which is responsible for acting on the environment and causing any changes to it is called an agent.
- It first perceives the information by observing the environment and then acts according to the particular scenario.
- An agent is the one which should be designed in such a way that it may interact from its surroundings by itself, i.e. it should not require any user input to feed information into it.
- It should be able to understand the situation, find the best decision that could be taken, and then act according to it.

The objective of AI is to explore the ways onto a machine that can:

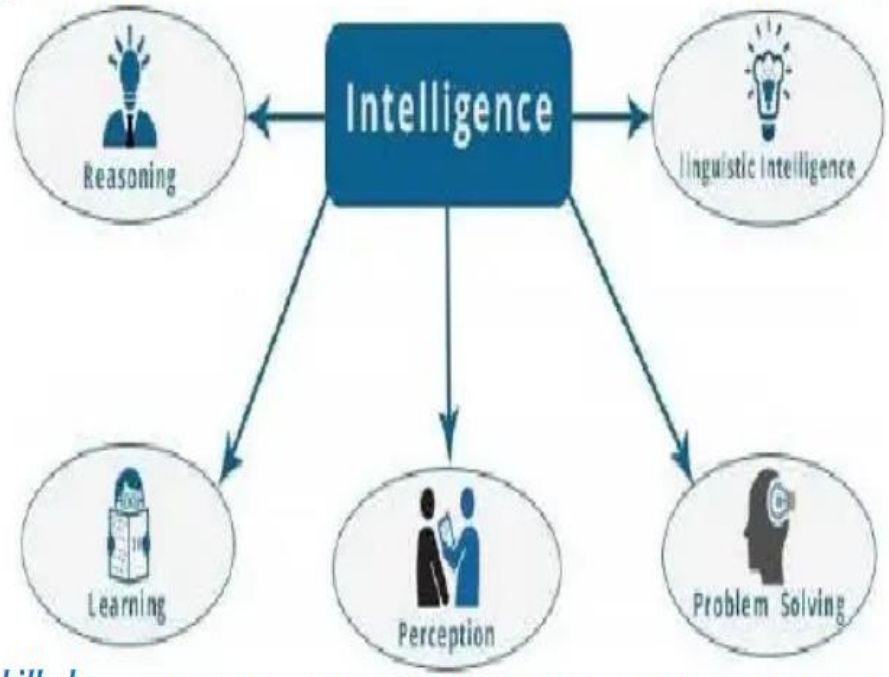
- **Reason like a human**,
- **Think like a human**
- **Act like a human**.

- Its approach is to train a machine (i.e., a computer or a robot) with the **same capabilities as of a human brain.**

- The intelligence is **intangible.**

Set of processes for judgement, making decisions, and prediction

Ability to use, comprehend, speak, and write the verbal and written language



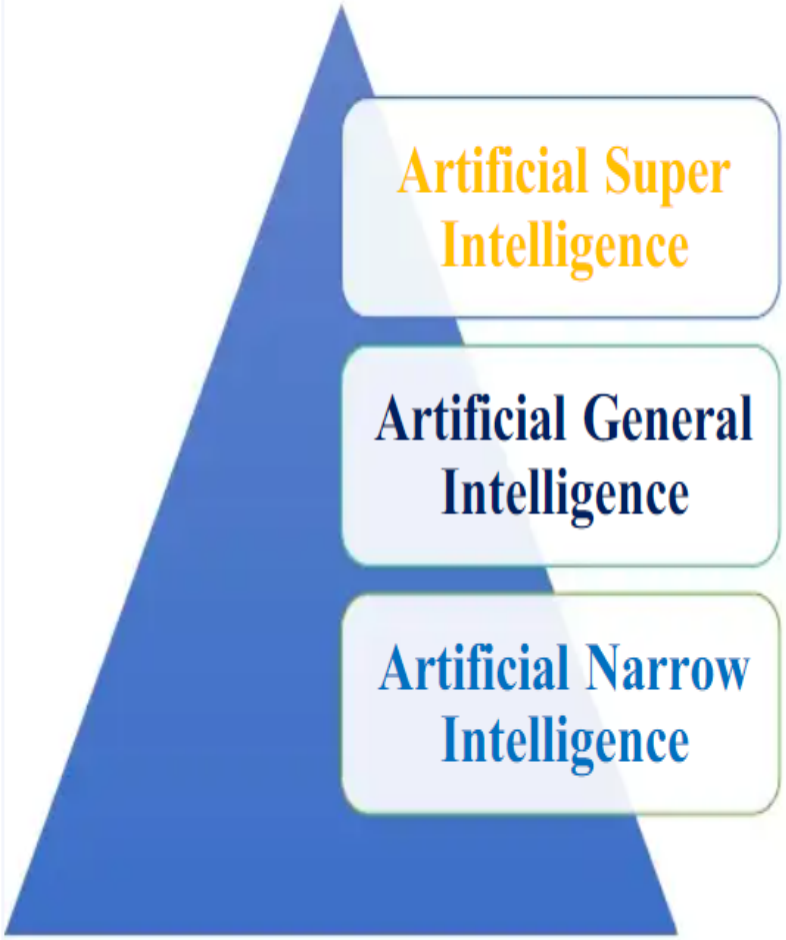
Gaining knowledge or skill by studying, practicing, being taught.

Process of acquiring, interpreting, selecting, and organizing sensory information.

Process in which one perceives and tries to arrive at a desired solution

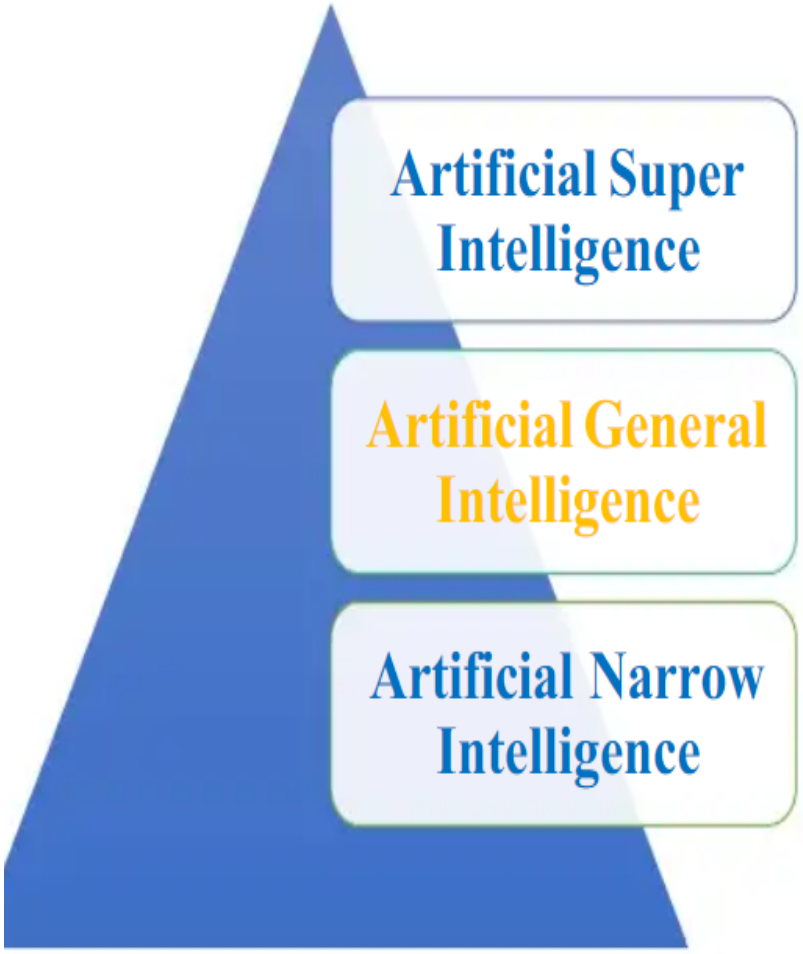
- Consider a scenario where a **human brain may fail** to take **an intelligent decision** and **need someone** who can make a **wise and intelligent decision** for him.
- AI can create such **software or devices** which can solve **real-world problems** very easily and with accuracy such as **health issues**, **marketing**, **traffic issues**, etc.
- AI can create your personal **VA's**, such as **Cortana**, **Google Assistant**, **Siri**, etc.
- AI can build such Robots which can work in an environment where **survival of humans** can be at **risk.**

Stages Of Artificial Intelligence



Artificial Narrow Intelligence (ANI)

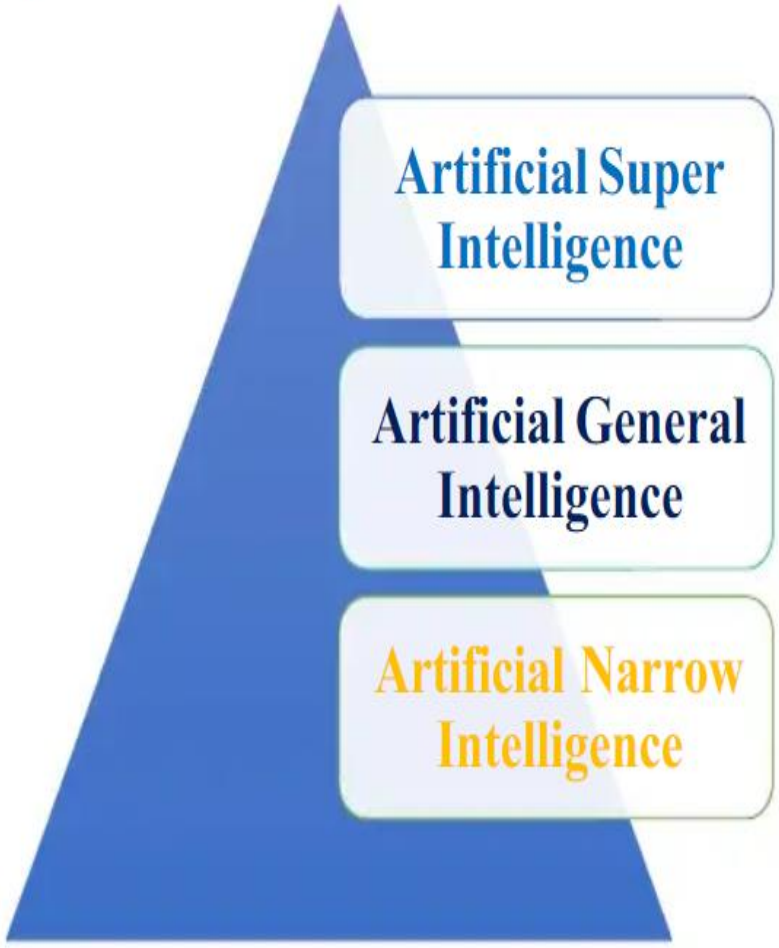
- Also known as **Weak AI,** involve machines that can **perform only narrowly** defined **set of specific tasks**.
- The machine **does not possess any thinking ability**, just performs **a set of pre-defined functions.**
- ***Siri, Alexa, Self-driving cars, Alpha-Go*** based on Weak AI.



Artificial General Intelligence (AGI)

- Also known as **Strong AI**, AGI is the stage of **evolution** of Artificial Intelligence.
- These machines **will possess** the **ability to think and make decisions** just like us humans.
- There are currently no existing examples of **Strong AI**, however, it is believed that we will soon be able to create machines that are **as smart as humans.**

Stages Of Artificial Intelligence



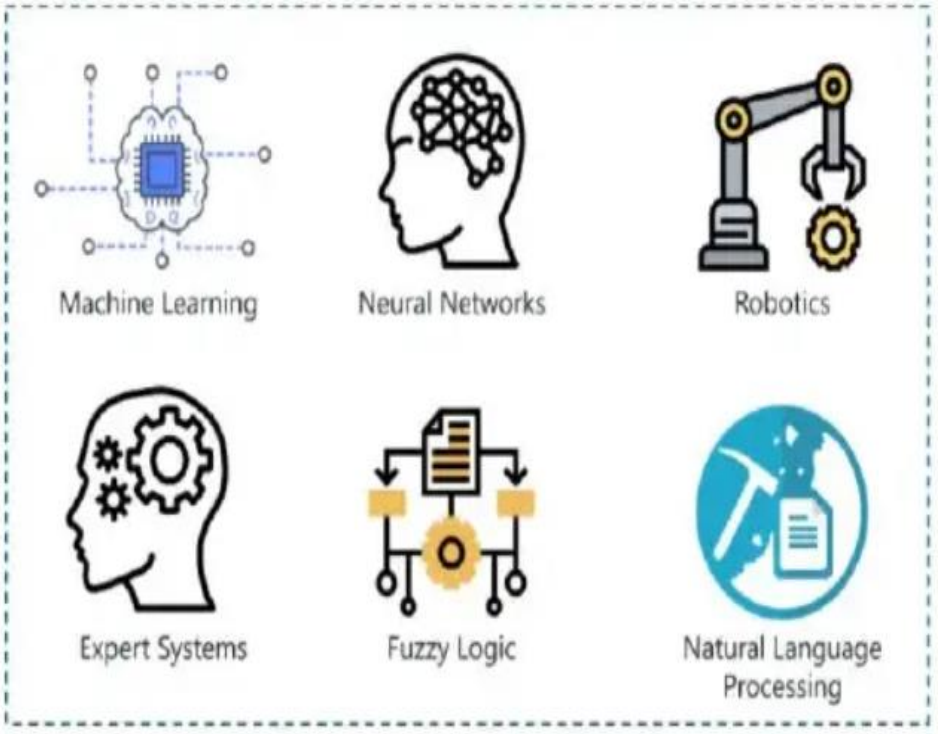
Artificial Super Intelligence (ASI)

- Artificial Super Intelligence is the **stage of Artificial Intelligence** when **the capability of computers** will ***surpass human beings***.
- ASI is currently a **hypothetical situation** as **depicted in movies** and science fiction books, where ***machines have taken over the world***.

Branches Of Artificial Intelligence

Artificial Intelligence can be used to **solve real-world problems** by **implementing the following processes/ techniques:**

- **Machine Learning**
- **Deep Learning**
- **Natural Language Processing**
- **Robotics**
- **Expert Systems**
- **Fuzzy Logic**



Major Use Cases Of Artificial Intelligence

- **Artificial Intelligence In Sports**

Deep Blue was a chess-playing computer developed by IBM. It is the **first computer chess-playing system** to win both a chess game and a chess match against a leading **world champion**.

- **Artificial Intelligence For Rescue Missions**

The use of Artificial Intelligence and technology to ensure the **help arrives faster**. Developing systems which help **first responders** find **victims of earthquakes, floods**, and any **other natural disasters** like **Covid-19.**

- **Artificial Intelligence For Smart Agriculture**

Complete monitoring of the soil and crop yield to providing **predictive analytic models** to track and predict various factors and variables that could **affect future yields**.

The Berlin-based agricultural tech startup **PEAT** has developed a **deep learning algorithm-based application** called **Plantix** which can identify **defects and nutrient deficiencies in the soil.**

- **Artificial Intelligence In Healthcare**

These machines **enable shortening the patients' hospital stay**, positively affecting the surgical experience and reducing medical costs all at once.

Similarly, **mind-controlled robotic** arms and brain chip implants have begun helping **paralyzed patients regain mobility and sensations of touch**.

- **Artificial Intelligence Tracking Wildlife Populations**

Applications like **iNaturalist** and **eBirds** collect data on the **species encountered**. This helps keep **track of species populations,** ecosystems **and** migration patterns.

As a result, these applications also have an **important role** in the better identification and protection of marine and freshwater **ecosystems** as well.