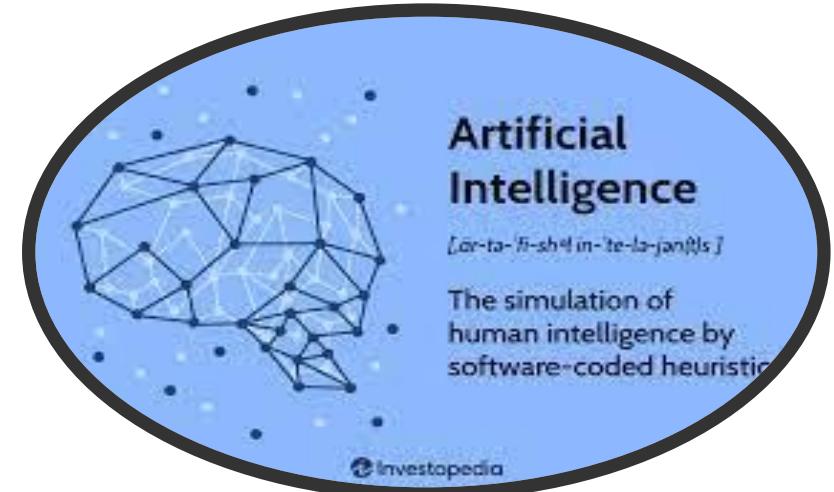
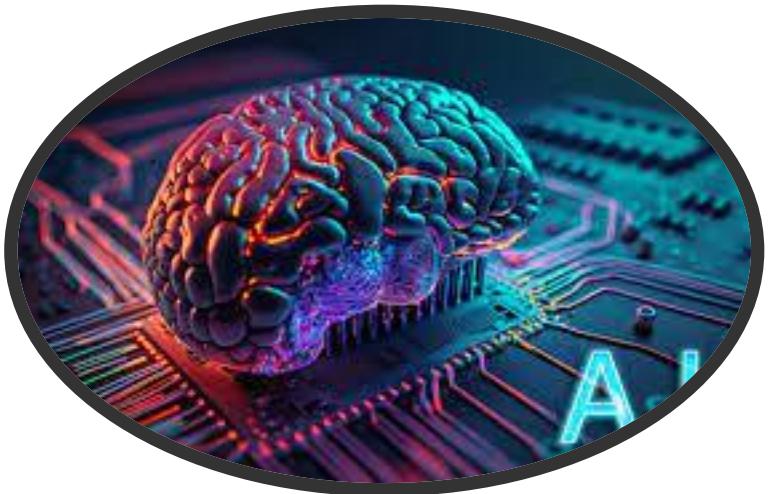


Artificial Intelligence

An Introduction



Course Information

Course Code: CS340

Course Title: Introduction to Artificial Intelligence

Pre-requisite: Data Structures

Category: Core Course in BS-CS Normally Studied in 6th Semester

Class timings:

Thursday 12:00 to 12:50 PM (Room CYS-201)

Friday 9:20 AM – 10:10 PM (Room CYS-201)

Instructor Information

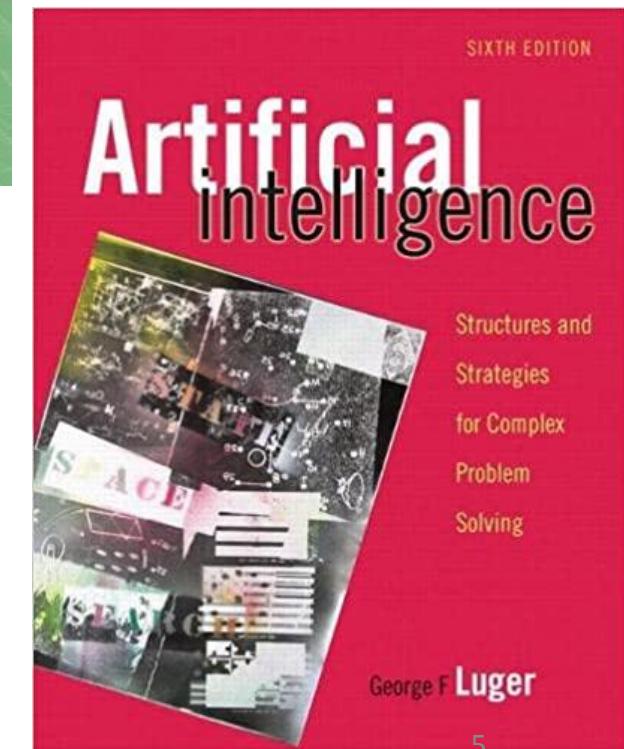
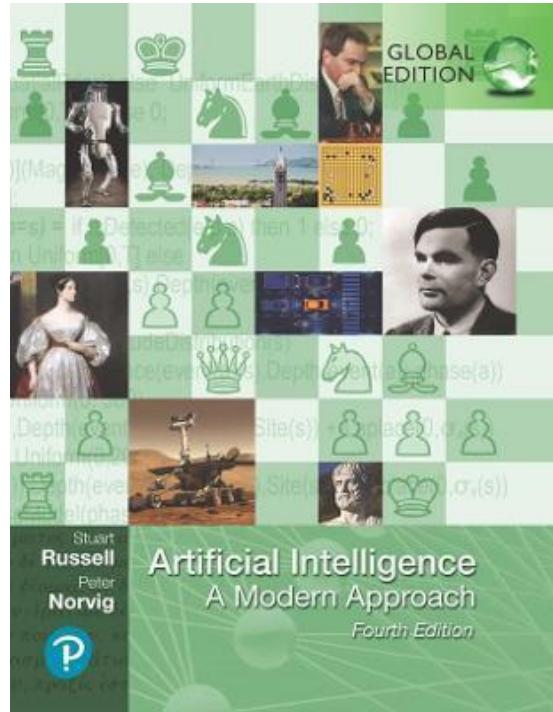
- Ms. Sara Ibrahim
- sara.ibrahim@au.edu.pk
- Office – 5th Floor C Block
- Office Hours:
Mon **12:30 pm to 4:00 pm**
Wed **11:30 am to 4:00 pm**

Evaluation

- Quizzes 15%
- Assignments 15%
- Midterm Exam 25%
- Final Exam 45%
- **Total 100%**

Books

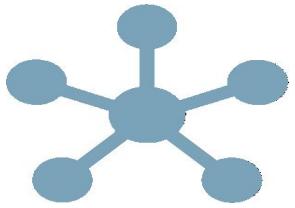
- Artificial Intelligence: A Modern Approach (4th Edition) By: Stuart J. Russell and Peter Norvig
- Artificial Intelligence: Structures and Strategies for Complex Problem Solving (6th Edition) By: George F. Luger



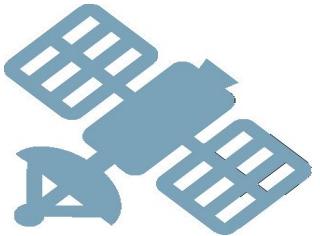
COURSE LEARNING OUTCOMES

1. Understand key components in the field of artificial intelligence(**C2-understand**)
2. Implement classical artificial intelligence techniques (**C3-apply**)
3. Analyze artificial intelligence techniques for practical problem solving (**C4-analysis**)

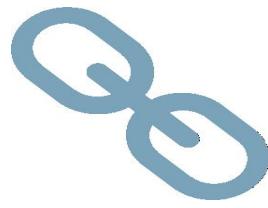
THIS LECTURE



Overview of Artificial
Intelligence



The Foundation of AI



History of AI



Applications of AI

Intelligence in Computing.....

- Real

- Artificial

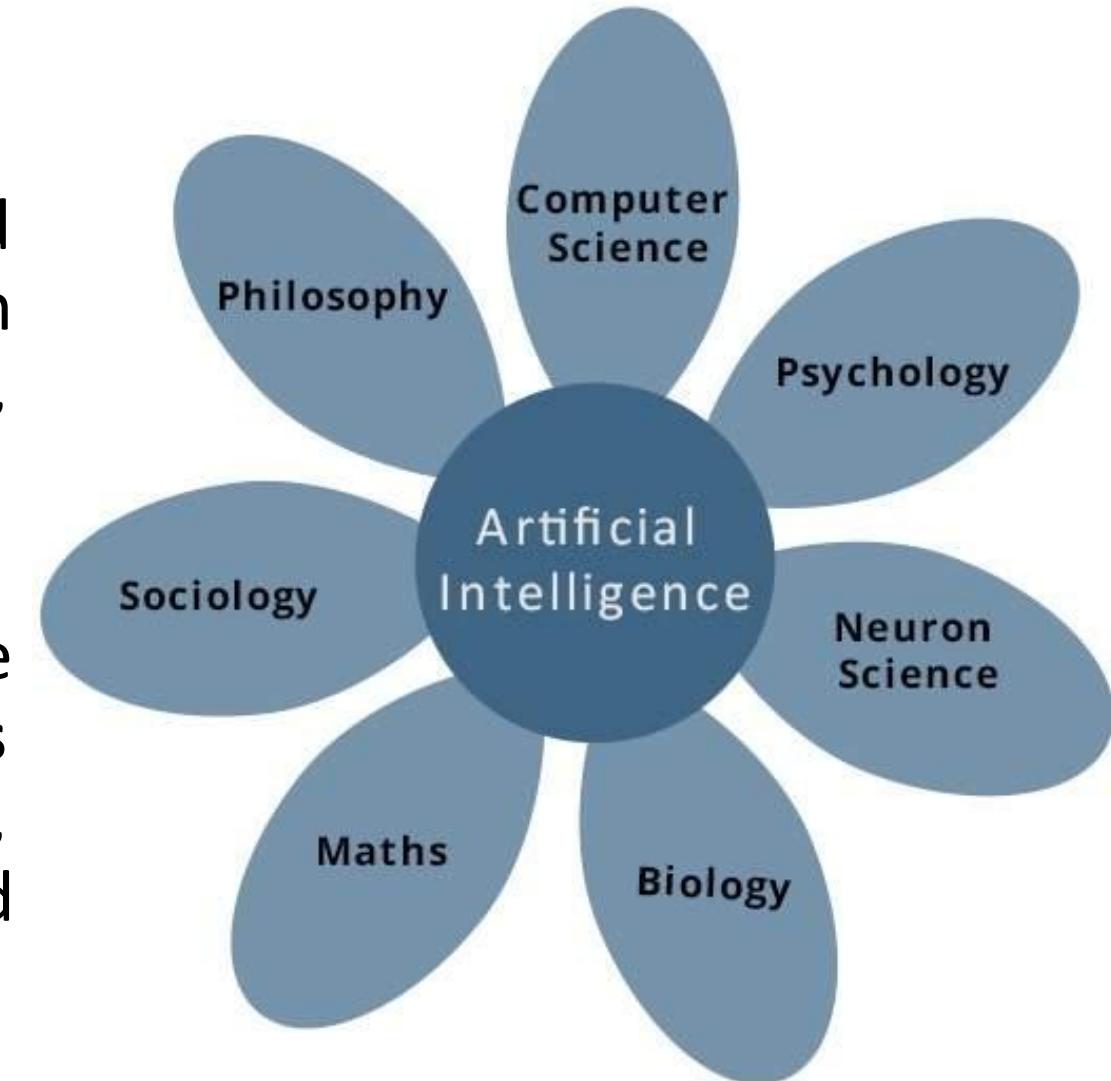


What is AI?

- There is no precise definition of **Intelligence**
- However, intelligent behavior is exhibited by **certain characteristics**:
 - Ability to **acquire knowledge (Learning)**
 - Ability to **apply knowledge** to make decisions in new situations
 - Ability to **solve complex problems**
 - Ability to **reason logically?**
 - Ability to **Create** something by using imagination and original ideas
 - Ability to be **self-aware**: have a good knowledge and understanding, **be aware of your own feelings and character**

Artificial Intelligence

- Artificial intelligence is a science and technology based on disciplines such as Computer Science, Biology, Psychology, Linguistics, Mathematics, and Engineering.
- A major thrust of AI is in the development of **computer functions associated with human intelligence**, such as learning, reasoning, and problem solving.



Academic Disciplines important to AI.

Philosophy

- Study of human intelligence began with no formal expression
- Initiate the idea of mind as a machine and its internal operations and processes
- Logic, methods of reasoning
- foundations of learning, language rationality.

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)

Economics

- utility, decision theory

Neuroscience

- neurons as information processing units.

Academic Disciplines important to AI.

Psychology/ Cognitive Science

- How do humans think and act?
- The study of human reasoning and acting
- Provides reasoning models for AI
- How do people behave, perceive, process information, represent knowledge.

Computer Engineering

- Building fast and efficient computers
- The power of computer makes computation of large and difficult problems more easily

Control Theory

- Design systems that maximize an objective function over time
- How can artifacts operate under their own control?
- The artifacts adjust their actions

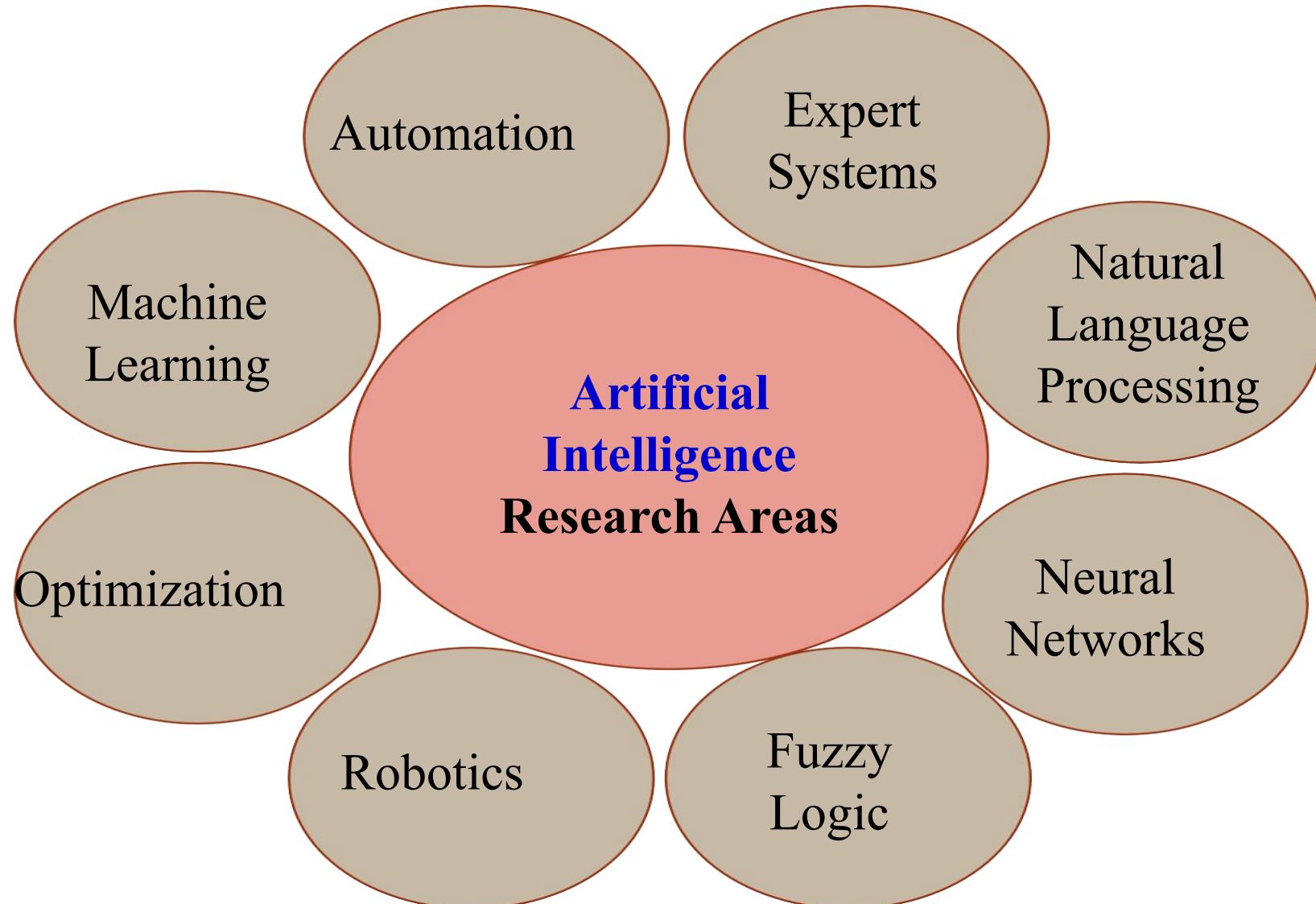
Linguistics

- Knowledge representation, grammar
- For understanding natural languages
- Syntactic and semantic analysis

Artificial Intelligence for us

- It is all about **building intelligent systems to assist humans and society.**
- Artificial intelligence is **shaping the future of humanity** across nearly every industry.
- It is already the main driver of emerging technologies like big data, robotics and IoT, and it will continue to act as a **technological innovator for the foreseeable future.**

AI Research Areas



Typical problems to which AI methods are applied

- Pattern recognition
- Optical character recognition
- Handwriting recognition
- Speech recognition
- Face recognition
- Computer vision
- Virtual reality
- Image processing
- Diagnosis

Typical problems to which AI methods are applied

- Translation and Chatterboxes
- Nonlinear control and Robotics
- Artificial life
- Automated reasoning
- Automation
- Biologically inspired computing
- Concept mining
- Data mining
- Knowledge representation

Typical problems to which AI methods are applied

- Game theory and Strategic planning
- Natural Language Processing(NLP)
- Semantic Web
- E-mail spam filtering
- Cognitive
- Cybernetics
- Hybrid intelligent system
- Intelligent agent
- Intelligent control

Search

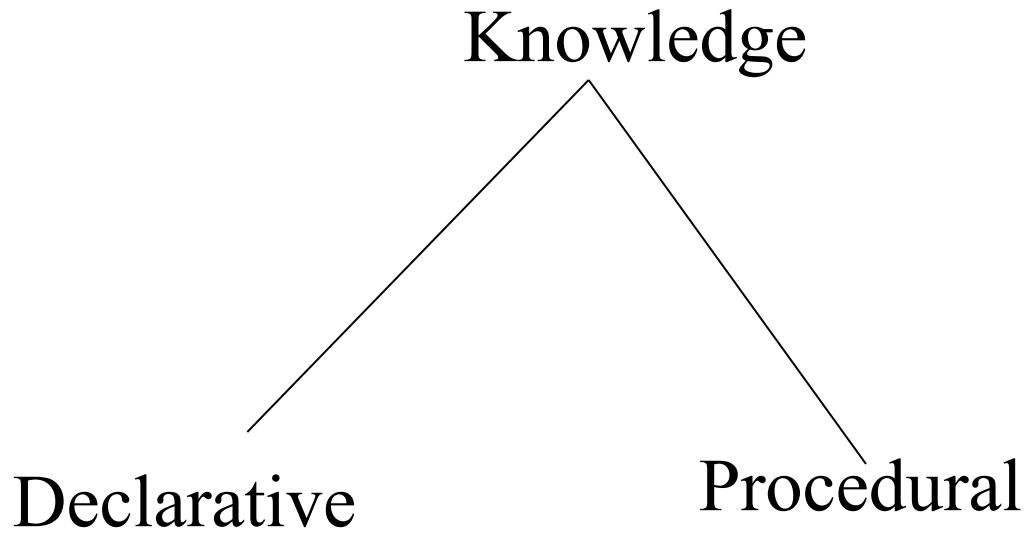
- *Search* is the fundamental technique of AI.
 - Possible answers, decisions or courses of action are structured into an abstract space, which we then search.
- Search is either "blind" or “uninformed”:
 - blind
 - we move through the space without worrying about what is coming next, but recognizing 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.

Search algorithms in artificial intelligence

- Problem Representation
- Search Space
- Uninformed Search Algorithms
 - Breadth-First Search (BFS)
 - Depth-First Search (DFS)
 - Uniform Cost Search
- Informed Search Algorithms
 - *A* Search*
 - Greedy Best-First Search
- Heuristics
- Optimality and Completeness
- Local Search Algorithms
- Game Playing Algorithms

Knowledge Representation & Reasoning

- The second most important concept in AI
- If we are going to act rationally in our environment, then we must have some way of describing that environment and drawing inferences from that representation.
 - how do we describe what we know about the world ?
 - how do we describe it *concisely* ?
 - how do we describe it so that we can get hold of the right piece of knowledge when we need it ?
 - how do we generate new pieces of knowledge ?
 - how do we deal with *uncertain* knowledge ?



- 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?

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

Some Examples

- What sort of jobs can be done
- Then what knowledge and skills we need to learn in order to be competitive in today's market

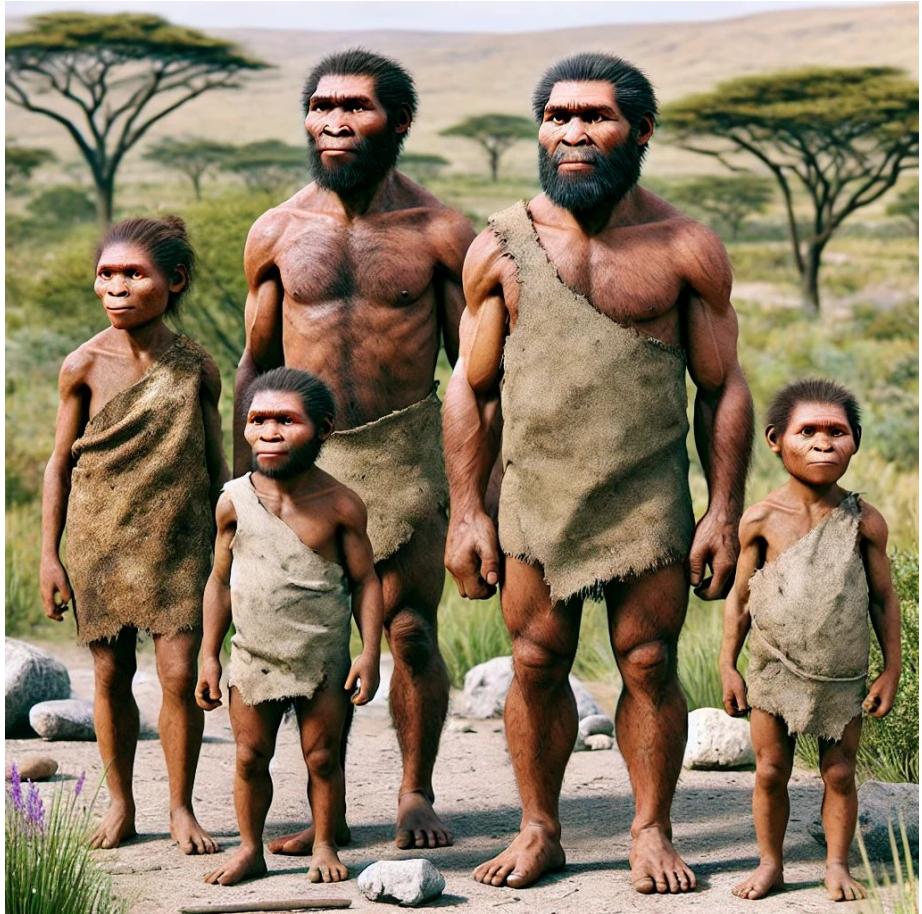
Simple Search Reveals

1. Programming skills
2. Mathematical skills
3. Domain knowledge
4. Communication skills
5. Critical thinking skills
6. Creativity skills

<https://www.linkedin.com/advice/0/what-skills-do-you-need-work-ai-skills-artificial-intelligence>

History of AI

family and their home 1 million years ago



Angry horse attacking a lion



History of AI

The birth of artificial intelligence (1943–56)

- McCulloch and Pitts, A Logical Calculus of the Ideas Immanent in Nervous Activity, 1943
- Alan Turing, Computing Machinery and Intelligence, 1950
- The Electronic Numerical Integrator and Calculator (ENIAC) project (Von Neumann)
- Shannon, Programming a Computer for Playing Chess, 1950
- The Dartmouth College summer workshop on machine intelligence, artificial neural nets and automata theory, 1956

The rise of artificial intelligence (1956–late 1960s)

- Invention of LISP (John McCarthy)
- The General Problem Solver (GPR) project (Newell and Simon)
- Gelertner: Geometry Theorem Prover
- Newell and Simon, Human Problem Solving, 1972
- Minsky, A Framework for Representing Knowledge, 1975

History of AI

Reality dawns

1966—73:

- Realization that many AI problems are intractable
- Limitations of existing neural network methods identified
- Neural network research almost disappears

Adding domain knowledge

1969—85:

- 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

Rise of machine learning

1986--

- Neural Networks return to popularity
- Major advances in machine learning algorithms and applications

History of AI

**Role of
uncertainty**
1990--

**Major
advances in
all areas of AI**
- 1990

- Bayesian networks as a knowledge representation framework

- Significant demonstrations in machine learning
- Case-based reasoning
- Multi-agent planning
- Scheduling
- Data mining, Web Crawler
- natural language understanding and translation
- Vision, Virtual Reality
- Games

History of AI

AI as Science 1995--

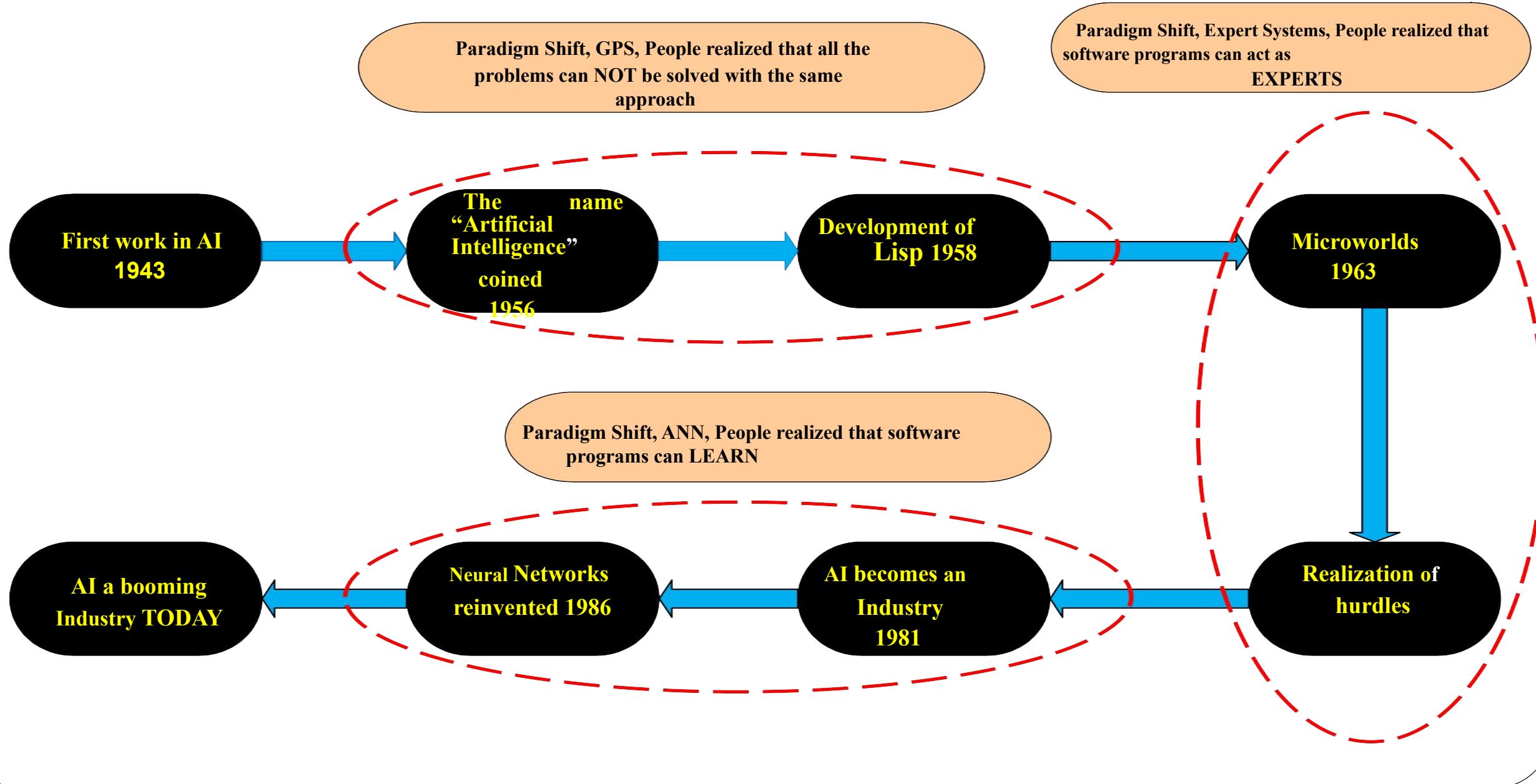
- Integration of learning, reasoning, knowledge representation
- AI methods used in vision, language, data mining, etc

1997

- The Deep Blue Chess Program beats the then world chess champion, Garry Kasparov.

2000

- Interactive robot pets become commercially available. MIT displays Kismet, a robot with a face that expresses emotions. The robot Nomad explores remote regions of Antarctica and locates meteorites.



AI Applications

AI applications

News Generation – Did you know that artificial intelligence programs can write news stories? According to Wired, the AP, Fox, and Yahoo! all use AI to write simple stories like financial summaries, sports recaps, and fantasy sports reports.

AI isn't writing in-depth investigative articles, but it has no problem with very simple articles that don't require a lot of synthesis. Automated Insights, the company behind the Wordsmith software, says that e-commerce, financial services, real estate, and other "data-driven" industries are already benefitting from the app.

AI Applications

● Autonomous Planning & Scheduling:

- Autonomous rovers.

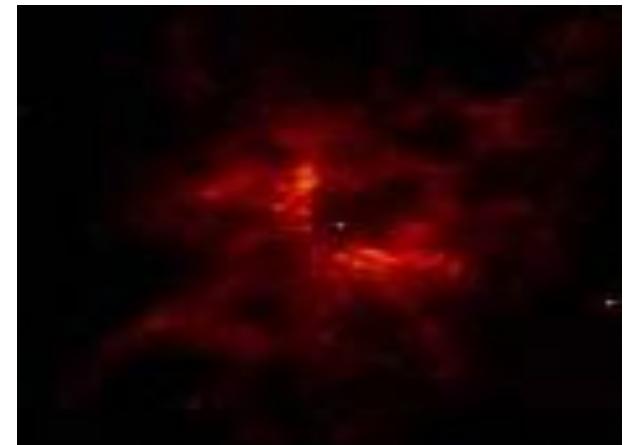
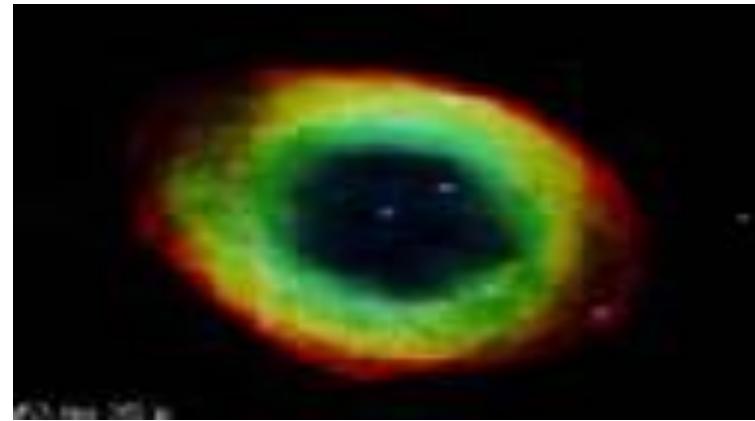


- Telescope scheduling



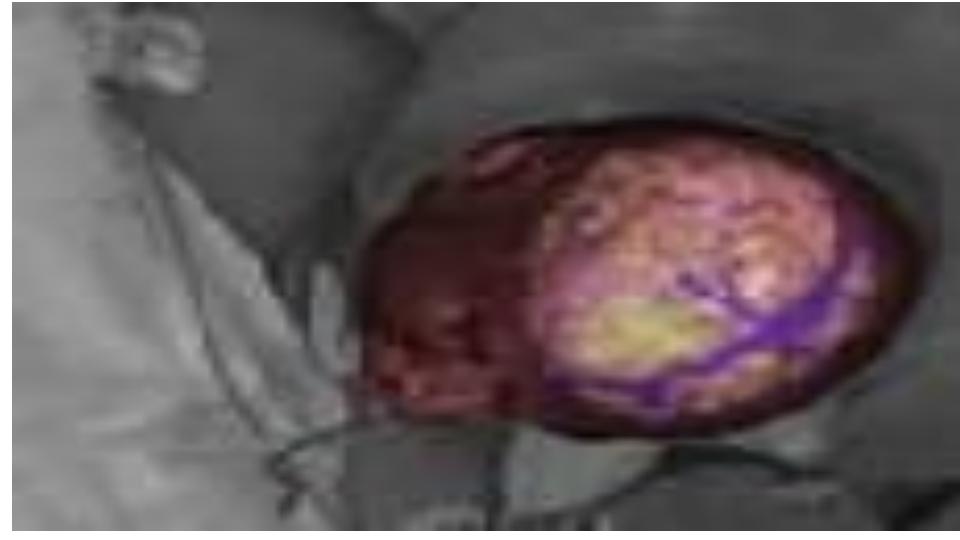
AI Applications

- Autonomous Planning & Scheduling:
- Analysis of data:



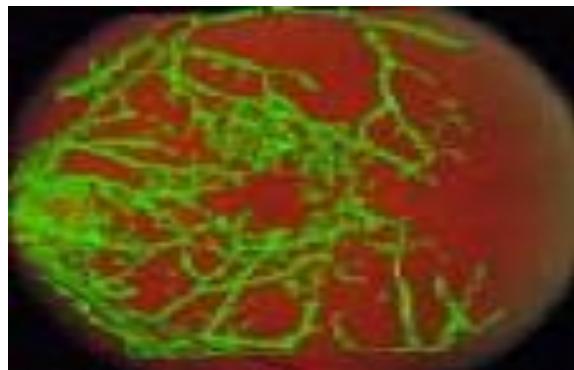
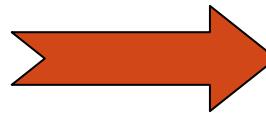
AI Applications

- Medicine:
- Image guided surgery



AI Applications

- Medicine:
- Image analysis and enhancement



AI applications

- **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.

- **Intelligent Robots** – Robots can perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, 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

AI Applications

- **Smart Cars** – While fully autonomous vehicles are still evolving, self- driving technology is rapidly advancing. Projects like **Google’s Waymo** and **Tesla’s Autopilot** have made significant progress in autonomous driving. These smart cars rely on sensors, AI algorithms, and real-time data to navigate roads safely.
- Recent developments suggest that AI-powered systems may eventually learn to drive similarly to humans—through experience. According to a **Washington Post** report, Google has been working on an algorithm that enables self-driving cars to improve their driving skills over time by learning from real-world scenarios.

- **Transportation:**

- **Autonomous vehicle control:**



AI Applications

- Transportation:
- Pedestrian detection:



Games: 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.

AI Applications



AI Applications

- **Robotics for Heavy industry** – Robots have become an essential part of many industries, particularly in tasks that are **dangerous, repetitive, or physically demanding** for humans. They improve efficiency, reduce human error, and enhance workplace safety by handling hazardous materials, operating in extreme environments, and performing precision-based tasks.
- In **2014**, China, Japan, the United States, South Korea, and Germany accounted for **70% of the total global sales of industrial robots**. The **automotive industry**, which has one of the highest levels of automation, heavily relies on robotics. **Japan leads in industrial robot density**, with **1,414 robots per 10,000 employees**, the highest in the world.
- **Robotic toys:**



AI applications

Human Performance Modeling

(HPM) is a method of quantifying human behavior, cognition, and processes; a tool used by human factors researchers and practitioners for both the analysis of human function and for the development of systems designed for optimal user experience and interaction .

Data Mining and Data warehousing (Big –Data)

warehousing focuses on collecting, storing, and managing large volumes of structured data, data mining involves extracting patterns, trends, and insights from that data. These techniques are widely used in business intelligence, healthcare, finance, and artificial intelligence to support data- driven decision-making.

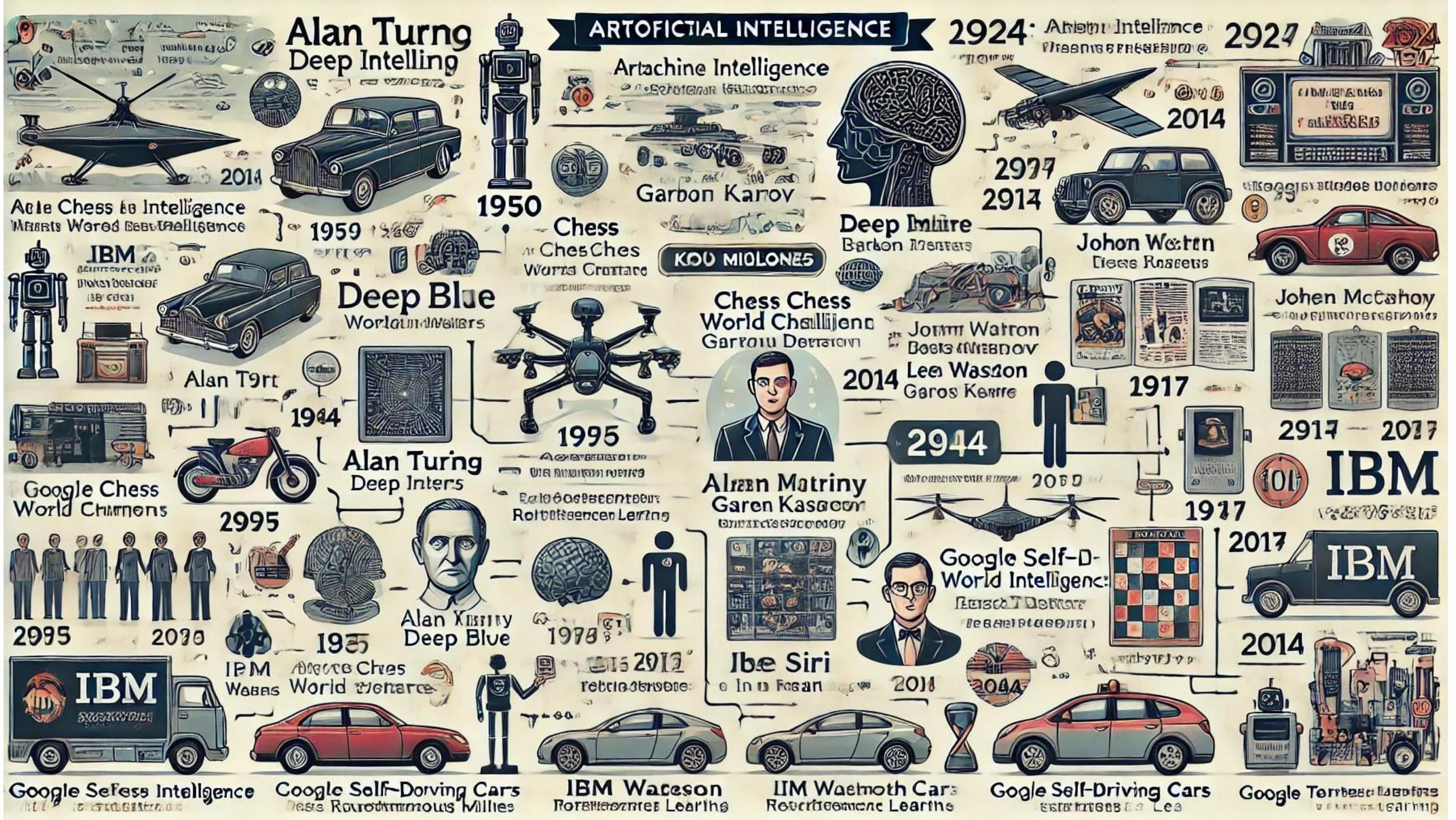
AI applications

- **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.
- **Vision Systems** – These systems understand, interpret, and comprehend visual input on the computer. For example,
- **A spying aero plane** – takes photographs, which are used to figure out spatial information or map of the areas.
- **Clinical expert system** – Doctors use it to diagnose the patient.
- **Face recognition** – Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

AI Applications

Other application areas:

- **Bioinformatics:**
 - Gene expression data analysis
 - Prediction of protein structure
- **Text classification, document sorting:**
 - Web pages, e-mails
 - Articles in the news
- **Video, image classification**
- **Music composition, picture drawing**
- **Natural Language Processing**



AI Timeline and Milestones:

1. **1950 - Alan Turing's Theory:** Alan Turing publishes a paper introducing the concept of machine intelligence, laying the foundation for AI.
2. **1956 - Artificial Intelligence Coined:** John McCarthy coins the term "Artificial Intelligence" at the Dartmouth Conference, marking the birth of AI as a field.
3. **1995 - Predator UAV:** The U.S. Department of Defense deploys the Predator UAV in the Balkan war, showcasing AI applications in defense.
4. **1997 - Deep Blue:** IBM's Deep Blue defeats world chess champion Garry Kasparov, demonstrating AI's capability in strategic decision-making.
5. **2011 - Siri and Watson:** Apple's Siri revolutionizes personal assistants, and IBM Watson wins Jeopardy, showing advancements in natural language processing and AI-driven question answering.
6. **2014 - DeepMind and Atari:** DeepMind's algorithm dominates Atari games, highlighting breakthroughs in reinforcement learning.

AI Timeline and Milestones:

7. **2015 - Self-Driving Cars:** Google's autonomous vehicles achieve 1 million miles of self-driven navigation, showing AI's application in transportation.
8. **2016 - AlphaGo's Victory:** AlphaGo beats grandmaster Lee Sedol in Go, an achievement in mastering complex strategies.
9. **2020 - GPT-3:** OpenAI's GPT-3 is launched, transforming natural language processing and AI-generated text applications.
10. **2022 - Industrial Robotics:** Advancements in autonomous robotics improve manufacturing and heavy industries, enhancing efficiency and safety.
11. **2024 - AI in Healthcare:** AI aids in diagnostics and predictive analytics in healthcare, enabling early disease detection and tailored treatments.

The timeline illustrates the evolution of AI, divided into phases:

AI Timeline and Milestones:

- **Theory (1950–1960s)**: Conceptualization of AI.
- **Weak AI (Expert Systems, 1970s–1990s)**: Early practical systems for specific tasks.
- **Strong AI (Machine Learning, 2000s–2010s)**: Machine learning drives breakthroughs.
- **Deep Learning (2010s–Present)**: Advances in neural networks revolutionize AI.

How one can know if a System is Intelligent?

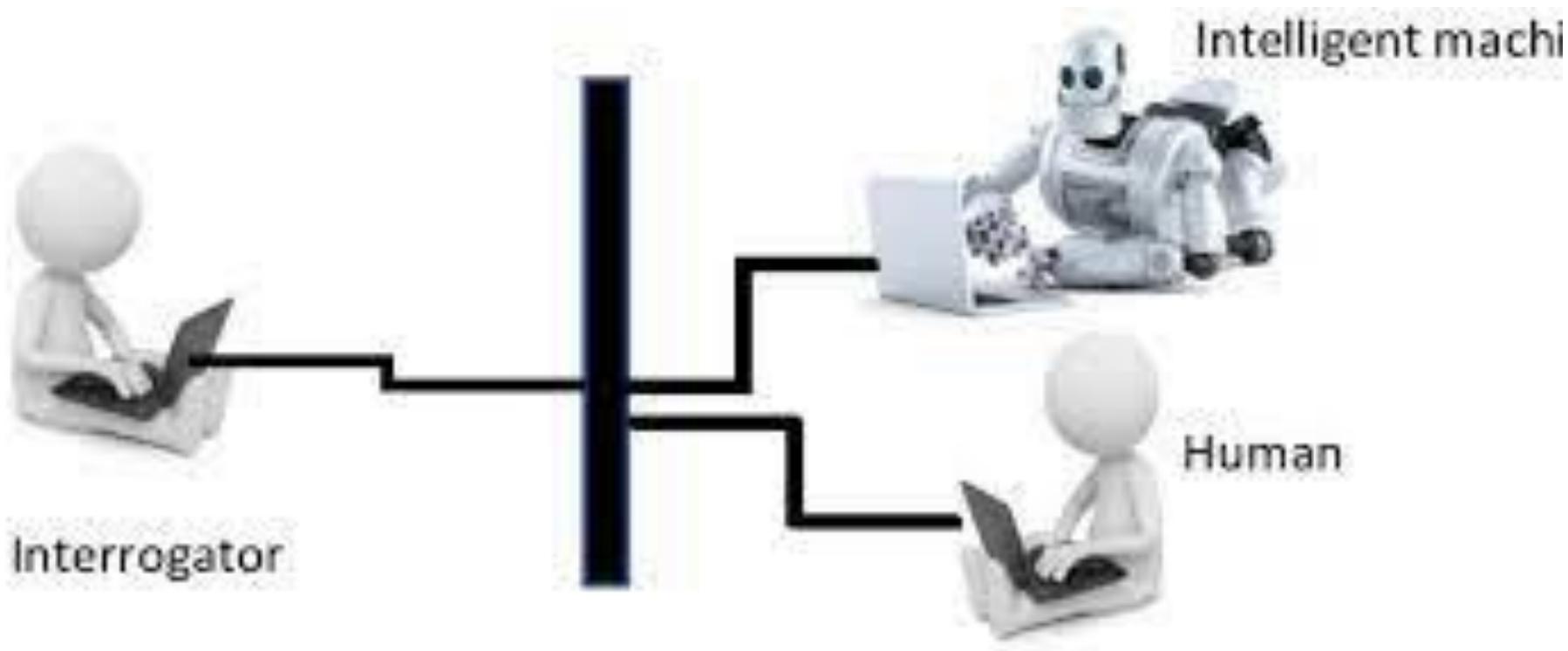
- The Turing Test is a method of inquiry in artificial intelligence (AI) for **determining whether a computer can think like a human being**.
- The test is named after Alan Turing. (Devised in 1950)
- Normally, Despite major advances in artificial intelligence, **no computer has ever passed the Turing test in general**.



TURING'S TEST

- Three isolated rooms having **interrogator, machine subject, human subject**
- Interrogator cannot see the subjects, can only communicate with the subjects using a terminal
- Interrogator does not know which subject is human and which is machine
- By asking a series of questions to both subjects, interrogator has to distinguish between the two subjects
- **Human subject is not allowed to lie, machine subject can lie or do anything to fool the interrogator** into thinking that it is human
- The machine passes the test if interrogator is unable to distinguish the two subjects

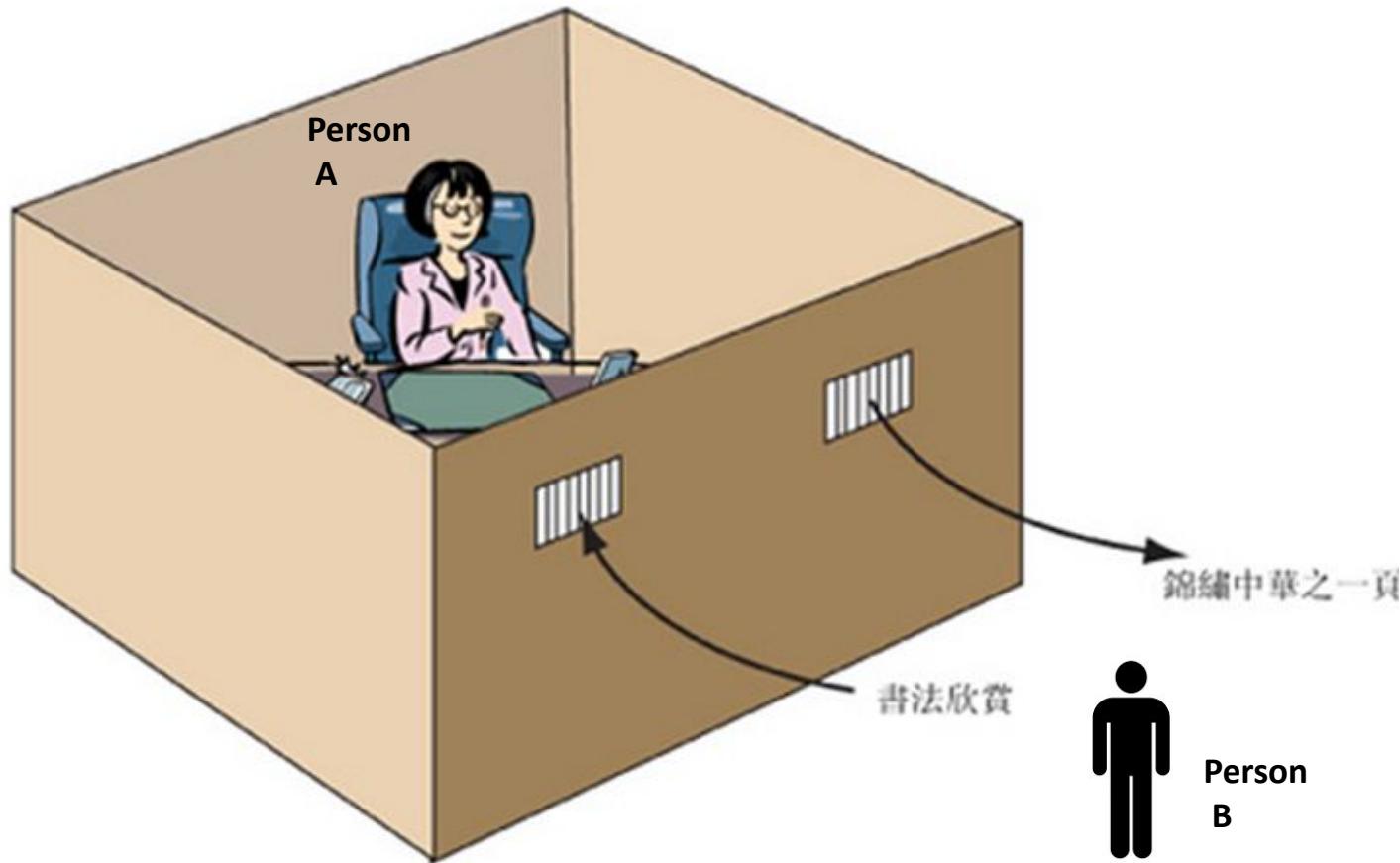
TURING'S TEST



If a machine passes the Turing's test, we can conclude that the machine has **weak AI**

We cannot conclude anything about **strong AI**, because Turing's test is based only on behavior of the machine only

CHINESE ROOM EXPERIMENT



Conclusion

- Just as the Room appears to understand Chinese language, the machine appears to have intelligence
- There is nothing in the room which **understands** Chinese
- Similarly, there is nothing in the machine which has intelligence
- Person in the room simply acts upon the instructions in the rule book, likewise, the machine simply acts upon the instructions (program) given to it without conscious understanding of the behavior it produces

CHINESE ROOM EXPERIMENT

- Computers use syntactic rules to manipulate symbol strings, but have no understanding of meaning or semantics.
- Theory that human minds are computer-like computational or information processing systems is refuted (disproved).
- Instead minds must result from biological processes;
- computers can at best simulate these biological processes.

The State of the Art

- **Game playing**
- **ALPHAZERO**, used no input from humans (except for the rules of the game), and was able to **learn through self-play** alone to defeat all opponents, human and machine, Go, chess, and shogi (Silver et al., 2018).
- <https://www.chess.com/terms/alphazero-chess-engine#what>
- AlphaZero is a computer program developed by artificial intelligence research company DeepMind to master the games of chess, shogi and go.