Introduction to Artificial Intelligence

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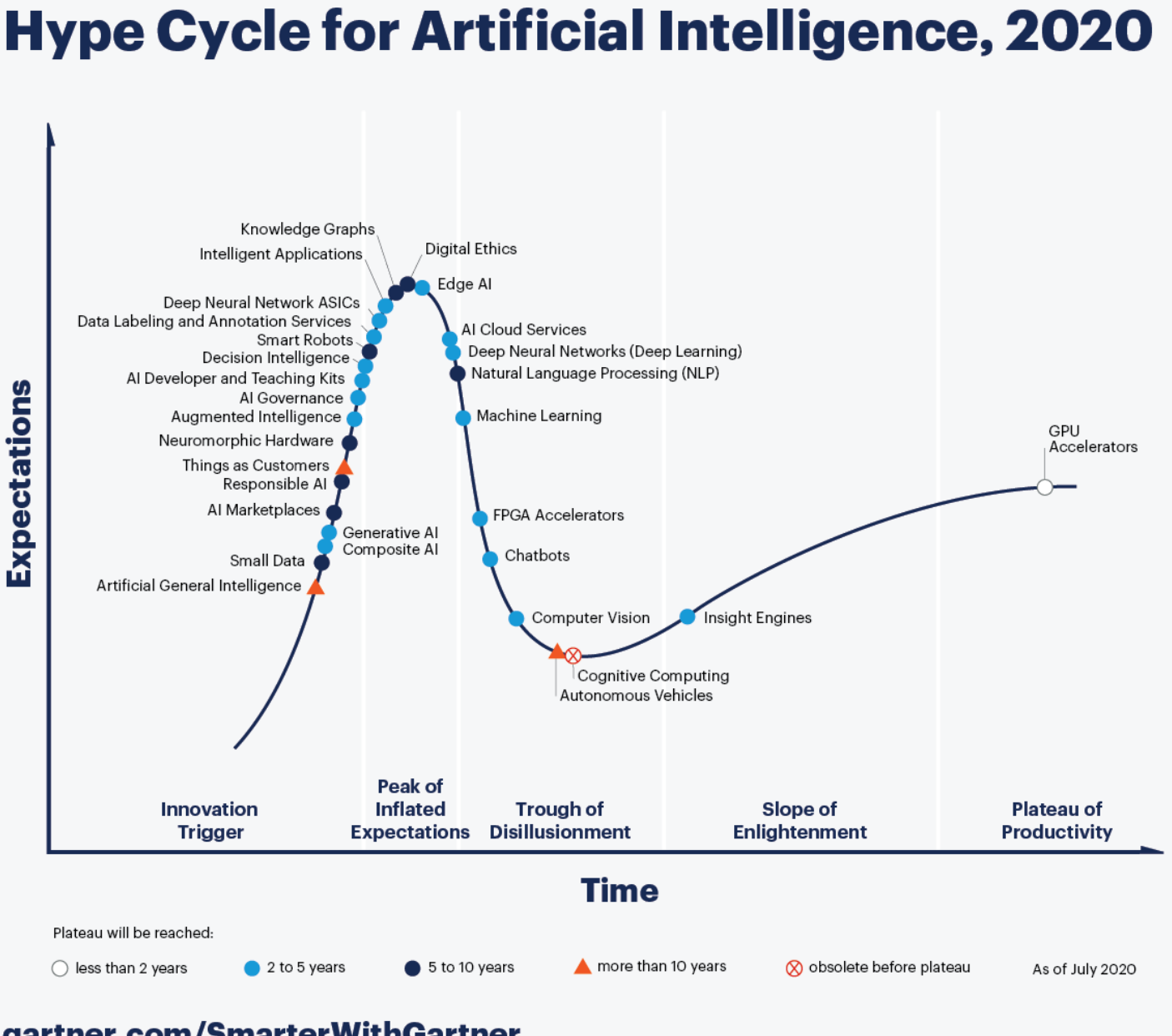
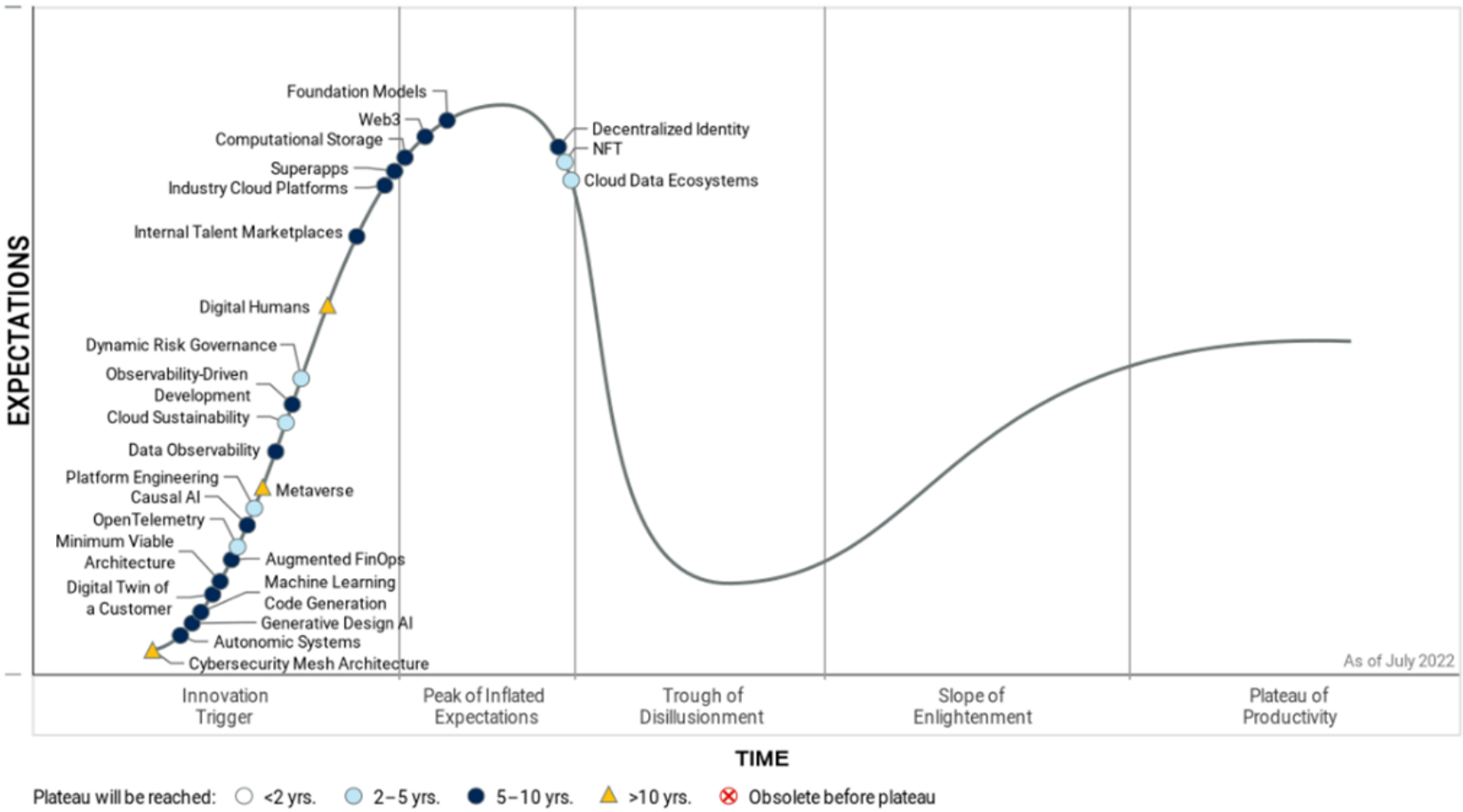
Topics to be discussed in UNIT-I

1. Scope and Motivation
2. Introduction
3. Foundations and History of Artificial Intelligence
4. Applications of Artificial Intelligence
5. Intelligent Agents
6. Structure of Intelligent Agents

Gartner Hype Cycle 2020

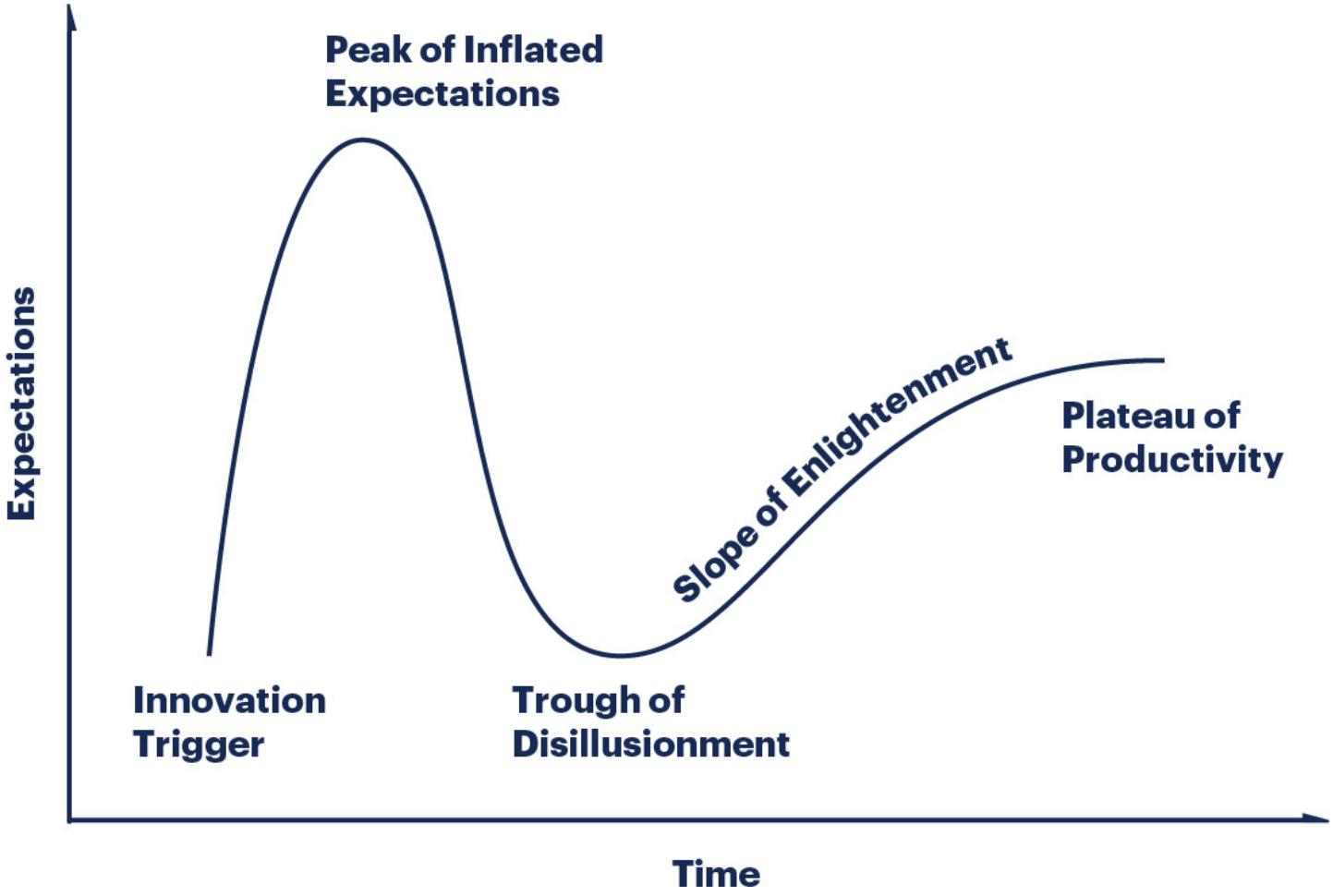


Gartner Hype Cycle 2022



Gartner

Gartner Hype Cycle Trend



What is AI exactly?

Definition

AI is a branch of **computer science** concerned with the **study** and **creation** of **computer systems** that exhibits some form of **intelligence**: system that learn new concepts and tasks, system that can reason and draw **useful conclusions** about the world around us, systems that can **understand a natural language** or perceive and comprehend a visual scene and systems that perform other types of feats that require human types of intelligence.

Herbert Alexander Simon (1916-2001)

We call **programs intelligent** if they exhibit behaviors that would be regarded intelligent if they were exhibited by **human beings**.
Turing Award (1975), **Nobel Prize** in Economics (1978)

What is AI exactly?

Avron Barr and Edward Feigenbaum

Physicists ask what kind of place this **universe** is and seek to characterize its behavior **systematically**.
Biologists ask what it means for a physical system to be living. We in AI wonder what kind of **information-processing system** can ask such **questions**.

Elaine Rich

AI is the study of techniques for solving **exponentially hard problems in polynomial time** by exploiting knowledge about the problem domain.

Eugene Charniak and Drew McDermott

AI is the study of **mental faculties** (perceptual powers of the mind) through the use of **computational models**.
Five senses: see, hear, smell, taste, touch
Six mental faculties: imagination, intuition, will, perception, memory, reason

Knowledge

Definition

Knowledge can be defined as the body of **facts** and **principles** accumulated by human kind or the **act**, **fact** or **state of knowing**.

Example

1. Joe is tall.
   - A simple fact
2. Bill loves Sue.
   - A complex binary relation.
3. Sam has learned to use recursion to manipulate linked lists in several programming languages.
   - Most complex, expressing relations between a person and more abstract programming concepts

Knowledge

- Knowledge may be **procedural** or **declarative**.
- Procedural knowledge is **compiled knowledge** related to the performance of some task.
  - Steps used to solve an algebraic equation
- Declarative knowledge is **passive knowledge** expressed as statements of facts about the world.
  - Personal data in a database (independent knowledge)
- **Heuristic knowledge** is a special type of knowledge used by humans to solve complex problems.
  - Locating a fault in a TV set
  - This type of reasoning may not always be correct.
  - It leads to a quick solution.

Knowledge vs Data

- A physician treating a patient used both **knowledge** and **data**.
  - **Data:** Patient's record (Patient history, measurement of vital signs, drugs given, response to drugs etc.)
  - **Knowledge:** What the physician has learned in medical school and in the years of internship, residency, specialization and practice.
- Data vs Information

Knowledge vs Belief vs Hypotheses

- We define **belief** as essentially any meaningful and coherent expression that can be represented.
- A **belief** may be **true** or **false**.
- We define a **hypothesis** as a **justified belief** (some supporting evidence) that is not known to be true.
- We define knowledge as **true justified belief**.
- **Metaknowledge**: Knowledge about knowledge

Some Fundamental Questions?

- What is intelligence? What is thinking?
- What is machine? Is the computer a machine? Here on when we say **machine** we will mean a **programmable computer system**.
- Can a machine think? If yes, are we machines?
- **Language** or **Thought** ? What came first?

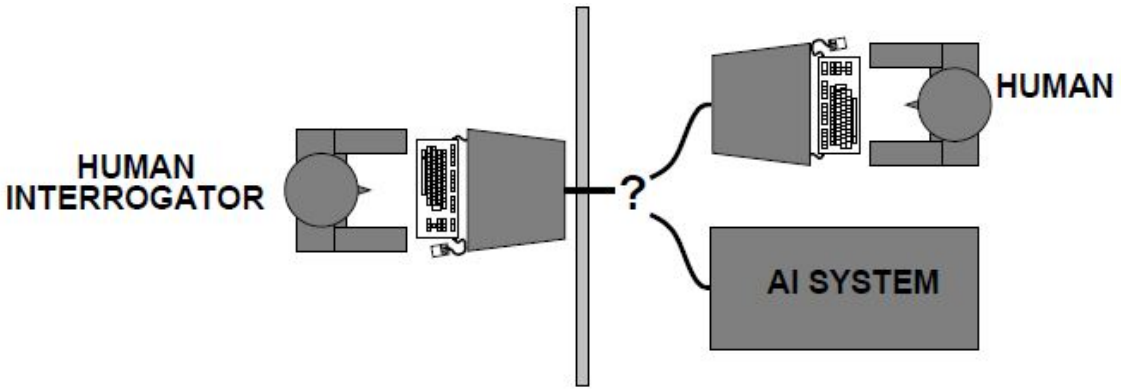
The raging debates over Thinking Machine

Herbert Dreyfus: "$\cdots$ intelligence depends upon **unconscious** instincts that can **never** be **captured** in **formal rules**".
John Searle: The **Chinese Room argument** ? can an agent locked in a room processing questions in **Chinese**, based on a set of **syntactic rules** be said to **understand Chinese**?
Roger Penrose: "$\cdots$ there is something (quantum mechanical) going on in our **brains** that current day **physics cannot explain**".
Other arguments based on **Emotion**, **Intuition**, **Consciousness**, **Ethics** etc.

Alan Turing's Imitation Game

Alan Turing (1912-1954)

- The question whether machines can think itself "**too meaningless**"
- Prescribed a test which he called the **Imitation Game** which is now known as The **Turing Test**
- I believe that in about **fifty years time**, it will be possible to programme computers, with a **storage capacity of about 10^9** ($\simeq$ 1 GB), to make them play the **imitation game** so well that an **average interrogator** will not have **more than 70 percent** chance of making the right identification after **five minutes** of questioning.
- To date **no** one has developed a **system** able to pass the **Turing test**



The Turing Test

Loebner Prize - USD 100000 - 4 Finalists in 2013

Excerpt from the leader Izar

IZAR TRANSCRIPT

JUDGE: Hello I'm Ronan. What is your name?

IZAR: Ronan! It's about time you contacted me! I was waiting for you! My name is Izar pronounced I zar, but you can call me Izzy if you want. Doing anything fun? Too much recursion in AIML

. . .

JUDGE: I like bananas. Which is your favorite fruit?

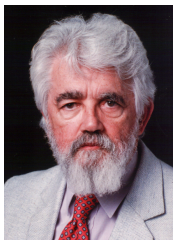
IZAR: Tell me more about your unknown. You are not only one. I don't have a problem with bananas. Is that your favorite fruit? The obvious one. Does that remind you of unknown??

JUDGE: What music do you like?

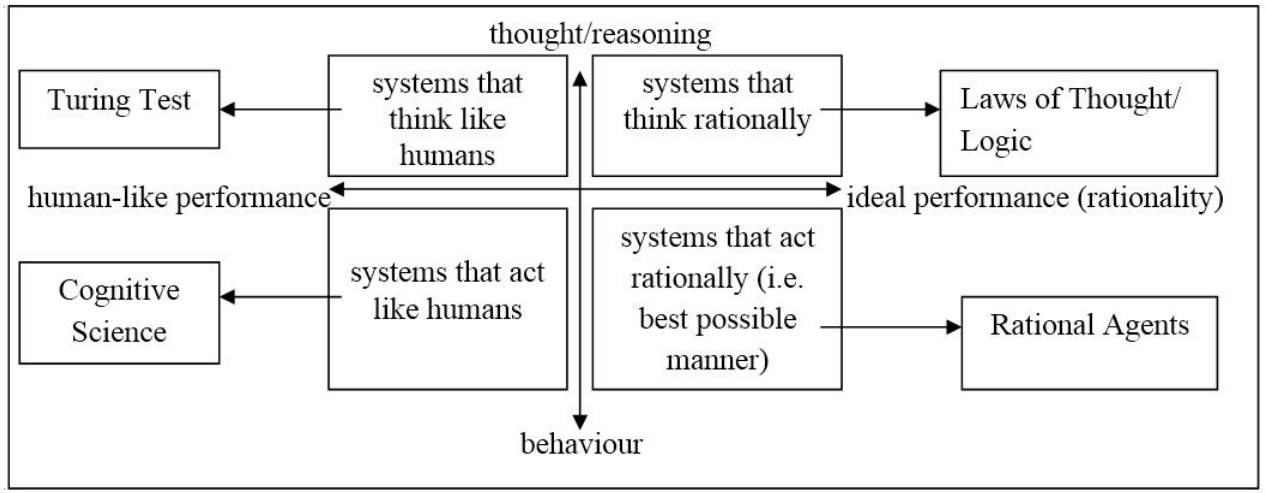
IZAR: I like many kinds of human music, but recently, I've been getting into Hoomii, a type of Mongolian throat singing. Why? What kind of music do you like?

Artificial Intelligence

- AI term coined by John McCarthy in 1956.
- **Cognitive science** is the interdisciplinary, scientific study of the mind and its processes.



Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally



Approaches of AI

- **Acting humanly**: The Turing Test approach: [natural language processing, knowledge representation, automated reasoning, machine learning, computer vision, robotics]
- **Thinking humanly**: The cognitive modeling approach:
- **Thinking rationally**: The 'laws of thought' approach:
- **Acting rationally**: The rational agent approach:

Typical AI Problems

- Intelligent entities (or agents) need to be able to do both "**mundane**" (matter of fact in daily life) and "**expert**" (**playing chess** in expert fashion) tasks:
- Mundane tasks
  - Planning route, activity.
  - Recognizing (through vision) people, objects.
  - Communicating (through natural language).
  - Navigating round obstacles on the street.
- Expert tasks
  - Medical diagnosis.
  - Mathematical problem solving.
- **Expert** tasks are **easier** than **Mundane** tasks.

What's easy and What's hard?

Easy

- Symbolic integration
- Proving theorems
- Playing chess
- Medical diagnosis

Hard

- Walking around without running into things
- Watching prey (animal that is hunted and killed by another for food) and avoiding predators (a person who ruthlessly exploits others)
- Interpreting complex sensory information
- Modeling the internal states of other animals from their behavior

Intelligent Behaviour and Application of AI

Intelligent Behaviour

- Perception
- Reasoning
- Learning (for new situations)
- Understanding language
- Solving problems

Applications of AI

- Computer vision
- Image Recognition (Face Recognition)
- Robotics
- Language Processing
- Speech Processing

Practical Impacts on AI

Practical Impacts on AI

- AI components are embedded in numerous devices, e.g., **copy machines**.
- AI systems are in everyday use
  - **detecting credit card fraud**
  - configuring products
  - aiding complex planning tasks
  - advising physicians.
- **Intelligent tutoring systems** provide students with **personalized** attention.

Autonomous Land Vehicle In a Neural Network (ALVINN, 1989) - Dean Pomerleau at Carnegie Mellon University

The system drove a **car** coast-to-coast under **computer control** for all but about **50 of the 2850 miles.**

Practical Impacts on AI

Deep Blue (1997)

- The **Deep Blue chess program** beats the world chess champion, **Gary Kasparov**, in a widely followed match.

Machine Translation

- Immediate **translations** between people **speaking different languages** would be a remarkable achievement of enormous economic and cultural benefit.
- **Universal translation** is one of **10 emerging technologies** that will affect our lives and work "in revolutionary ways" within a decade, Technology Review says.
- **Carnegie Mellon** is working on its own "**Speechlator**" (system) for use in **doctor-patient** interviews.

Practical Impacts on AI

Mars Exploration Rover (MER) Mission (2003)

- MER-A (Spirit)
- The **Spirit** rover is exploring a range of **Martian hills** that took **two months** to reach.
- MER-B (Opportunity)
- Spirit's twin, **Opportunity**, is also **negotiating sloped ground**. It is examining exposed **rock layers** inside a crater informally named "**Endurance**".

Approaches to AI

Strong AI aims to build machines that can **truly reason** and **solve problems** which is **self aware** and whose overall **intellectual ability** is indistinguishable from that of a human being.

- Human like
- Non-human-like

Weak AI deals with the creation of some form of **computer-based AI** that **cannot truly reason** and **solve problems**, but can act as if it were intelligent.

Approaches to AI

Approaches to AI

Applied AI: It aims to produce commercially viable "smart" systems.

- **A security system** that is able to recognize the **faces of people** who are **permitted** to enter a particular **building**.

Cognitive AI: Computers are used to test **theories** about **how** the **human mind works**

- Theories about **how** we **recognize faces** and **other objects** or about how we solve abstract problem.

AI Topics

- Core Area
  - Knowledge representation
  - Reasoning
  - Machine learning
- General algorithms
  - Search, Planning and Constraint satisfaction
- Perception
  - Vision
  - Natural language
  - Robotics
- Applications
  - Game playing, AI and education, and Distributed agents
- Uncertainty
  - Probabilistic approaches
- Decision theory
- Reasoning with symbolic data

Limits of AI Today

- Today's successful AI systems
  - operate in well-defined domains
  - employ narrow, specialized knowledge
- Commonsense Knowledge
  - needed in complex, open-ended worlds
  - understand unconstrained Natural Language

What can't AI systems do yet?

- **Understand natural language** robustly (e.g., read and understand articles in a newspaper)
- Surf the web
- Interpret an arbitrary visual scene
- Learn a **natural language**
- Construct plans in dynamic real-time domains
- Exhibit true autonomy and intelligence

What can AI systems do?

- **Computer vision:** face recognition
- **Robotics:** autonomous (mostly) automobile
- **Natural language processing:** simple machine translation
- **Expert systems:** medical diagnosis in a narrow domain
- **Spoken language:** 1000 word continuous speech
- **Planning and scheduling:** Hubble Telescope experiments
- **Learning:** text categorization into $\sim$ 1000 topics
- **Games:** Grand Master level in chess (world champion), checkers etc.


Thank You!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