ARTIFICAL INTELLIGENCE

June 2025 27 11:34

1.

INTRODUCTION TO AI

- *Artificial Intelligence is an exciting scientific discipline that studies how we can make computers exhibit intelligent* behavior*, e.g. do those things that human*
  doing.

- *Originally, computers were invented by Charles Babbage to operate on numbers following a well-defined procedure - an algorithm. Modern computers, even thou*
  more advanced than the original model proposed in the 19th century, still follow the same idea of controlled computations. Thus it is possible to program a comp
  something if we know the exact sequence of steps that we need to do in order to achieve the goal.

DIFFERENCE BETWEEN WEAK AI AND STRONG AI

- ***Weak AI (Narrow AI):***

- ***Definition**: AI that is designed and trained for a specific task.*

- ***Capabilities**: It can **simulate** human intelligence but doesn't truly understand or possess consciousness.*

- ***Examples**:*
  *Voice assistants like **Siri**, **Alexa***
  Recommendation systems (e.g., Netflix, Amazon)
  Chatbots and image recognition tools

  ✅ ***Good at performing one task extremely well***
  ❌ ***Cannot generalize to other tasks***

- ***Strong AI (Artificial General Intelligence, AGI):***
- ***Definition**: AI with **human-like cognitive abilities**—able to understand, learn, and apply knowledge across a wide range of tasks.*

- ***Capabilities**: It would have **consciousness**, **self-awareness**, and **true understanding**—not just simulating intelligence.*

- ***Examples**: Purely theoretical at this point—**no current system** is truly Strong AI.*
  ✅ ***Can think, reason, and adapt like a human***
  ❌ ***Still hypothetical and under research***

- ***<u>TURING TEST</u>***

- *When speaking about AGI we need to have some way to tell if we have created a truly intelligent system. <u>Alan Turing</u> proposed a way called a <u>Turing Test</u>, which also a of intelligence. The test compares a given system to something inherently intelligent - a real human being, and because any automatic comparison can be bypassed by program, we use a human interrogator. So, if a human being is unable to distinguish between a real person and a computer system in text-based dialogue - the system intelligent.*

- ## *Different Approaches to AI*

There are two possible approaches to this problem:

Top-down Approach (Symbolic Reasoning)	Bottom-up Approach (Neural Networks)
A top-down approach models the way a person reasons to solve a problem. It involves extracting knowledge from a human being, and representing it in a computer-readable form. We also need to develop a way to model reasoning inside a computer.	*A bottom-up approach models the structure of a human brain, consisting of a huge n units called neurons. Each neuron acts like a weighted average of its inputs, and we of neurons to solve useful problems by providing training data.*

-There are also some other possible approaches to intelligence:

- *An Emergent, Synergetic or multi-agent approach are based on the fact that complex intelligent behaviour can be obtained by an interaction of a large number of simp According to evolutionary cybernetics, intelligence can emerge from more simple, reactive behaviour in the process of metasystem transition.*
- *An Evolutionary approach, or genetic algorithm is an optimization process based on the principles of evolution.*

- *In a top-down approach, we try to model our reasoning. Because we can follow our thoughts when we reason, we can try to formalize this process and program it insid This is called symbolic reasoning.*
  People tend to have some rules in their head that guide their decision making processes. For example, when a doctor is diagnosing a patient, he or she may realize that fever, and thus there might be some inflammation going on inside the body. By applying a large set of rules to a specific problem a doctor may be able to come up with diagnosis.
  This approach relies heavily on knowledge representation and reasoning. Extracting knowledge from a human expert might be the most difficult part, because a docto would not know exactly why he or she is coming up with a particular diagnosis. Sometimes the solution just comes up in his or her head without explicit thinking. Son determining the age of a person from a photograph, cannot be at all reduced to manipulating knowledge.
- *Bottom-Up Approach*
  Alternately, we can try to model the simplest elements inside our brain – a neuron. We can construct a so-called artificial neural network inside a computer, and then solve problems by giving it examples. This process is similar to how a newborn child learns about his or her surroundings by making observations

- Machine Learning (ML)
  - *How it works: Learns from data and patterns, not from hard-coded rules.*

  Types:
  Supervised learning – Learns from labeled examples (e.g., spam vs. not spam)
  Unsupervised learning – Finds patterns in unlabeled data
  Reinforcement learning – Learns through trial and error (like training a dog)

✅ *Very powerful and flexible*
❌ *Needs lots of data*

A Brief History of AI

How did AI start?

- *In the **1950s**, scientists wanted computers to think like people.*
- *They used **rules** and **logic** to build programs.*
- *One big success was **expert systems** — programs that gave advice like a doctor or engineer.*
- ***BUT** it was hard:*
- *Writing all the rules was slow.*
- *Keeping the computer's knowledge updated was too much work.*
- *So, people lost interest. This was called the **AI Winter** in the **1970s**.*

💥 *What changed?*

- *Computers became **cheaper** and **faster**.*
- *We got **lots of data** (thanks to the internet).*
- *Scientists started using **neural networks** — a way for computers to **learn from examples**.*
- *Neural networks became really good at:*
- *Recognizing images (computer vision).*
- *Understanding speech.*

♟ *Chess – A Cool Example*

- ***Old method**: Computers guessed lots of moves and picked the best one using logic (search and rules).*
- ***Better method**: Computers learned from past human games (case-based reasoning).*
- ***Today**: AI learns by **playing with itself** and improving over time using **neural networks** + **reinforcement learning** (like how humans practice).*
- *That's how programs like **AlphaZero** can beat world champions!*
- ✅ ***Other games AI learned to play:***

- ***Go*** *(AlphaGo beat a world champ!)*
- **Poker**
- **StarCraft II**
- **Dota 2**

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AI FOR BEGINNER PART-2 / SYMBOLIC AI

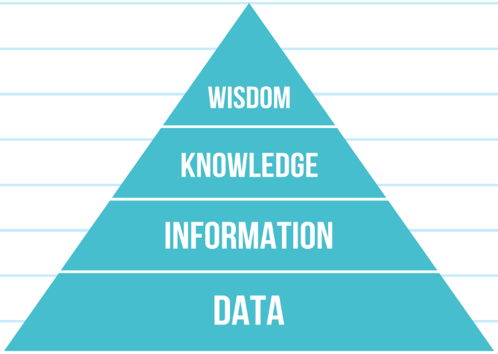
Knowledge Representation and Expert Systems----

What is Knowledge?

- *Knowledge is what we know and understand about the world.*
- *It's not just information we see or hear — it's what we learn and connect in our minds.*
- *For example, you read a book (data), understand the meaning (information), and then remember and use it in real life — that's knowledge.*

DIKW Pyramid (From Data to Wisdom)

1. *Data – Just raw facts.*
   📘 *Example: The word "computer" printed in a book.*
   ➤ *It's just text — doesn't mean anything until someone reads it.*
2. *Information – When we understand what the data means.*
   🧠 *Example: You read "computer" and know it's a machine.*
   ➤ *Now the word has meaning.*
3. *Knowledge – When we connect information to what we already know.*
   🔗 *Example: You learn how a computer works, what it's used for, and where to buy one.*
   ➤ *It becomes part of your personal understanding of the world.*
4. *Wisdom – Knowing how and when to use your knowledge.*
   🤔 *Example: You decide when using a computer is helpful or why someone might not need one.*
   ➤ *It's smart decision-making based on knowledge.*



Classifying Computer Knowledge Representations-------

Network Representations (Semantic Networks)

- *Think of a mind map or a web of ideas.*
- *In our brain, we connect ideas like:*
  "Python → is a → programming language"
- *A semantic network does the same thing on a computer — it shows concepts (nodes) and relationships (arrows or edges) between them.*

🧠 *Example:*

[Python] — is —> [Untyped Language]
[Python] — invented by —> [Guido van Rossum]
[Python] — block syntax —> [Indentation]

🧩 *Object-Attribute-Value Triplets*

- *Another way to store this network in a computer is to break each connection into 3 parts:*
  Object – Attribute – Value

📋 *Example:*

Object	*Attribute*	*Value*
Python	*is*	*Untyped-Language*
Python	*invented-by*	*Guido van Rossum*

Python	block-syntax	indentation
Untyped-Language	doesn't have	type definitions

- This is easy for a computer to store, search, and connect.

Hierarchical Representations – Like a Family Tree

- We humans think in hierarchies — big categories with smaller ones inside.
- Example:

🐤 Canary is a Bird
🐦 Bird is an Animal

- From this, we know:
- All birds (including canaries) have wings.
- So if something is a bird, it inherits bird properties.

🖼️ Frame Representation – Like a Form or Template

- A frame is like a profile or a form that describes an object.
- It has slots, like fields in a form.
- Each slot holds values, default values, or even rules.

🔍 Example: Frame for Python (programming language)

Slot	Value	Default Value	Range or Notes
Name	Python		
Is-A	Untyped-Language		(category it belongs to)
Variable Case		CamelCase	(default case style)
Program Length			5–5000 lines
Block Syntax	Indent		(uses indentation)

➡️ This is like saying:

- Python is an untyped language.
- If we don’t know the case style, we assume it’s CamelCase by default.
- Most Python programs are between 5 to 5000 lines.
- It uses indentation for blocks.

Procedural Representations – "Knowledge as Actions"

- *In this type, knowledge is stored as a set of actions or steps to take when something happens.*
- *It’ s like if-this-happens → then-do-this.*

📄 1. *Production Rules – IF-THEN Statements*

- *These are simple rules that help us make decisions.*
- *Example (Doctor’ s Rule):*

👉 *IF a patient has high fever OR high C-reactive protein*

👉 *THEN they probably have inflammation*

- *Once we know one part is true, we can use it to conclude something else.*

2. Algorithms – Step-by-Step Procedures

- *Algorithms are a set of fixed steps to solve a problem.*
- *Like a recipe in cooking:*
- *Step 1: Boil water*
- *Step 2: Add pasta*
- *Step 3: Cook for 10 minutes*

💡 *But in AI, algorithms aren’ t used much as direct knowledge – they’ re more for programming, not for understanding "facts."*

📐 *3. Logic – Representing Universal Knowledge*

- *Logic is a **formal way to represent facts and reasoning**.*
- *It started with **Aristotle**, who tried to describe how humans think using rules.*

🧩 *Types of Logic Used in* **AI:**

➤ **Predicate Logic**

- *Used to describe facts like:*

👉 *"All birds can fly" or "Socrates is a man"*

- *It's very powerful, but too complex for computers to handle fully.*

✅ *So we use simpler parts, like Horn clauses (used in Prolog).*

➤ ***Description Logic***

- *Used to describe hierarchies and relationships between objects.*
- *Commonly used in the Semantic Web to define and connect knowledge online.*