ARTIFICIAL INTELLIGENCE
&
MACHINE LEARNING

SESSION NO : 2

SYMBOLIC AI, SUB SYMBOLIC AI, MACHINE LEARNING, RISE OF DATA-DRIVEN AI

SYMBOLIC AI

AI based on **explicit knowledge representation** using symbols, rules, and logic. It focuses on representing human knowledge in a structured, human-readable form.

How it works: Systems use **logical reasoning** and predefined rules to manipulate these symbols and draw conclusions.

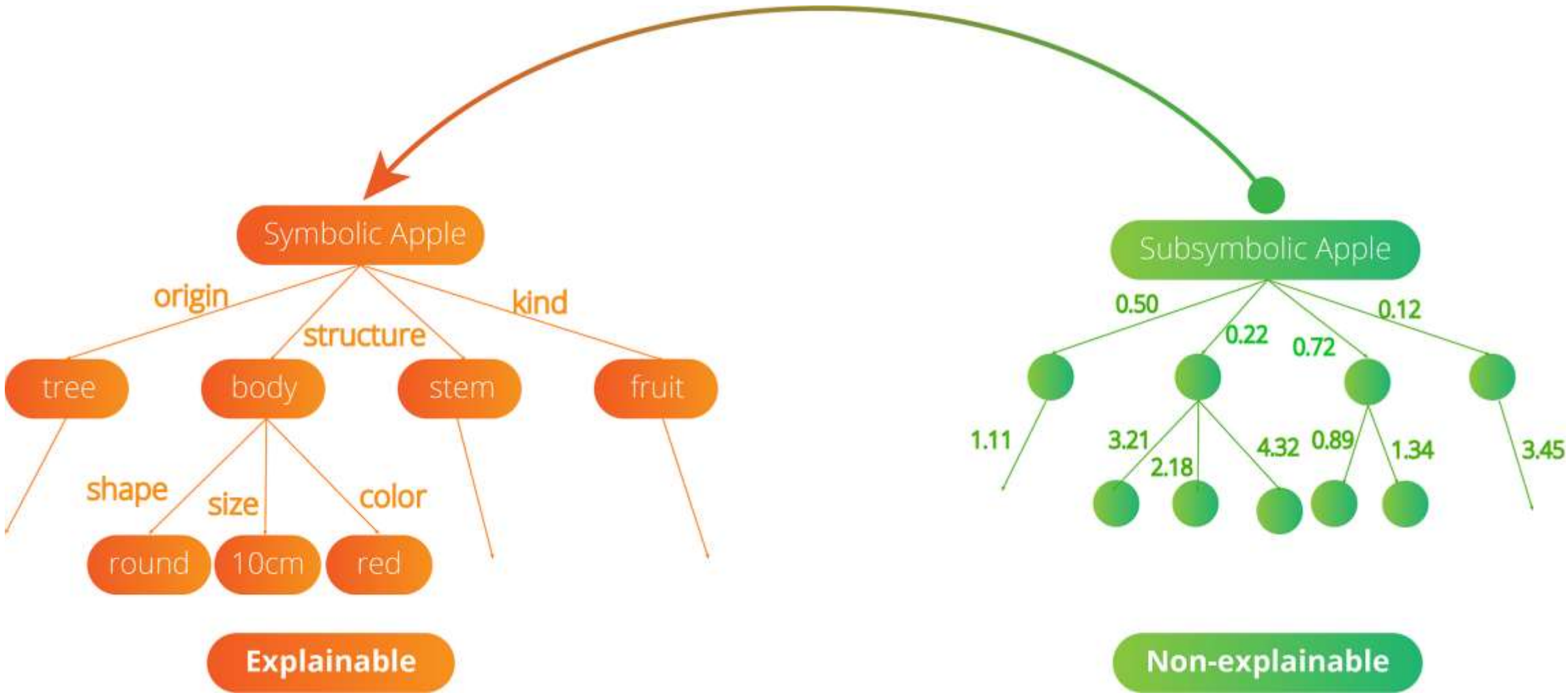
Strengths:

- **Transparency/Explainability** : Easy to understand, because the rules are clear.
- **Logical Consistency** : Excels in domains with well-defined problems and clear rules (Examples: chess, expert systems).
- **Requires Less Data** : Can operate with limited data if the rules are well-defined.

Weaknesses:

- **Brittleness** : Struggles with ambiguity, incomplete data, and real-world noise.
- **Knowledge Acquisition** : Building large knowledge bases can be labor-intensive and difficult to scale.
- **Poor at Perception** : Not well-suited for tasks like image or speech recognition.

Examples: Expert systems (e.g., medical diagnosis systems in AI), A rule-based systems, logical programming.


Symbolic Apple
origin
structure
kind
tree
body
stem
fruit
shape
size
color
round
10cm
red
Explainable
Subsymbolic Apple
0.50
0.22
0.72
0.12
1.11
3.21
2.18
4.32
0.89
1.34
3.45
Non-explainable

SUB-SYMBOLIC AI

AI that learns from data without explicit symbolic rules. It's inspired by the **structure and function of the human brain**, using interconnected units (like neurons).

How it works: Systems learn patterns and relationships directly from large datasets through numerical methods and statistical models. Knowledge is *distributed* across the network's connections.

Strengths:

Pattern Recognition	: Excellent at identifying complex patterns in large, noisy, and unstructured data (Example: Images, Speech).
Adaptability/Flexibility	: Can adapt to new data and situations without being explicitly reprogrammed.
Scalability	: Performs well with "Big Data."

Weaknesses:

Black Box Problem	: Often lacks transparency; it's hard to understand *how* a decision was made (interpretability issues).
Requires Large Datasets	: Needs vast amounts of data for effective training.
Computationally Intensive	: Training can require significant computational resources.

Examples: Neural Networks (including Deep Learning), Machine Learning models (Example: Image recognition, Natural Language Processing, Predictive Analytics).

	Symbolic Approaches	Subsymbolic Approaches
Methods	(Mostly) logical and/or algebraic	(Mostly) analytic
Strengths	Productivity, Recursion Principle, Compositionality	Robustness, Learning Ability, Parsimony, Adaptivity
Weaknesses	Consistency Constraints, Lower Cognitive Abilities	Opaqueness, Higher Cognitive Abilities
Applications	Reasoning, Problem Solving, Planning etc.	Learning, Motor Control, Vision etc.
Relation to CogSci	Not Biologically Inspired	Biologically Inspired
Other Features	Crisp	Fuzzy, Continuous

RISE OF DATA-DRIVEN AI

Shift from Rules to Learning:

AI's evolution from explicit programming to systems that **learn from data**.

Powered by Machine Learning:

Breakthroughs in ML (especially **Deep Learning**) enable systems to find patterns.

Key Enablers:

Big Data:	Vast amounts of digital information.
Compute Power:	Powerful GPUs & cloud resources.
Advanced Algorithms:	Smarter ways to learn from data.

Impact: Revolutionizing fields like image recognition, NLP, personalized recommendations, and autonomous systems.

Core Idea: AI systems now continuously **observe, learn, and improve** by analyzing massive quantities of real-world information.

MACHINE LEARNING

Machine Learning is a Subset of Artificial Intelligence, It is about the construction and study of systems that can learn from data.

Machine Learning can empower computers to learn and behave more intelligently.

Machine learning explore algorithms/build model, Learn from data, Use the model for prediction, decision making and Problem Solving.

REFERENCE BOOKS AND WEB LINKS

Text Books:

1) Russel and Norvig, 'Artificial Intelligence', third edition, Pearson Education, PHI, (2015)
2) Elaine Rich & Kevin Knight, 'Artificial Intelligence', 3nd Edition, Tata McGraw Hill Edition, Reprint (2008)

Web links:

1. https://www.geeksforgeeks.org/agents-artificial-intelligence/
2. https://www.simplilearn.com/what-is-intelligent-agent-in-ai-types-function-article
3. https://www.javatpoint.com/turing-test-in-ai
4. https://www.geeksforgeeks.org/turing-test-artificial-intelligence/
5. https://www.section.io/engineering-education/turing-test-in-ai/