An Introduction to Artificial Neural Network

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INTRODUCTION I

- LLMs have transformed artificial intelligence, extending beyond traditional NLP.
- They learn knowledge and reasoning from data, unlike formal logic systems that struggled with real-world complexity.
- LLMs' ability to acquire knowledge opens up a new avenue in reasoning.
- They may lead to verifiability in many tasks, such as legal analysis, scientific discovery, $\cdots$.
- Traditional reasoning in AI involves applying structured rules to derive conclusions, while LLM-based reasoning integrates natural language understanding and enables multi-step deduction and abstraction.
- Algorithmic reasoning may lead to multi-step thought processes, which may enhance the clarity and trustworthiness of LLM outcomes.

INTRODUCTION II

- Logical, common-sense, and mathematical reasoning are crucial for AI systems
- Provide analytical skills. Formal and symbolic logic-based reasoning will be distinguished from heuristic approaches like Chain-of-Thought prompting.
- The attention mechanism may facilitate coherent thought generation.
- Empirical evidence suggests a correlation between LLM scale and reasoning abilities.
- Parameters and training data (AKA scale) is critical for unlocking reasoning potential. LLM Performance is directly proportional to scale (demonstrated - ELMO→ transformer)
- Deep dive into into the theoretical framework is needed to improve the model design, training, and prompting strategies.

What it is: Starting with a general rule and applying it to a specific situation to reach a certain conclusion.

Simple Example

- **General Rule:** All dogs bark.
- **Specific Case:** Fido is a dog.
- **Deductive Conclusion:** Therefore, Fido barks.

Generally good at simple deductions, but struggle with complex, multi-step logic or strict coherence in long arguments.

INDUCTIVE REASONING (BOTTOM-UP LOGIC)

Forming a general rule or conclusion from specific examples or observations. This conclusion is likely, but not necessarily true.

Simple Example

- **Observation 1:** I am a saggitarian. I spill coffee ;)
- **Observation 2:** My uncle is a saggitarian and he spills coffee
- **Inductive Conclusion:** Therefore, many saggitarians probably spill coffee.

LLMs excel at generalizing from observed patterns but might not invent entirely novel hypotheses far beyond their training data.

ABDUCTIVE REASONING (MAKING THE BEST GUESS)

Observing an outcome and guessing the most likely cause based on incomplete information, like a detective making an educated guess.

Simple Example

- **Observation:** The street outside is wet.
- **Possible Explanations:** It rained, a street cleaner went by, someone spilled water.
- **Abductive Conclusion (Best Guess):** The most likely explanation is that it rained (based on common occurrences).

Suggest plausible explanations based on data correlations, but lack true understanding of causality and context, limiting reliability in complex situations.

ANALOGICAL REASONING (FINDING SIMILARITIES)

Comparing similar things or situations to learn, infer, or explain something about one of them.

Simple Example

Just like a **seed** needs soil and water to grow into a *plant*, a *child* needs care and education to grow into a capable *adult*.

Capable of generating basic analogies based on linguistic similarity, they may miss deeper, conceptual parallels due to a lack of real-world understanding of the underlying relationships.