AMERICAN UNIVERSITY OF BEIRUT

Fall 2025

EECE 503P/798S: Agentic Systems

C2 - Large Language Models

Reflection on course feedback

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Project and Assignment Challenges

- Students find coming up with innovative project ideas difficult.
  - “Help us shape the project”
- Some feel the first assignment is too theoretical and not well aligned with in-class explanations.
  - “Assignment doesn't match what is explained at all in class”

Pace and Complexity of Material

- Intro and Outro to be given by me.
- Several students mentioned the pace feels fast and some concepts are not intuitive, requiring multiple reviews.
- Those without a strong AI background struggled more with grasping theory.

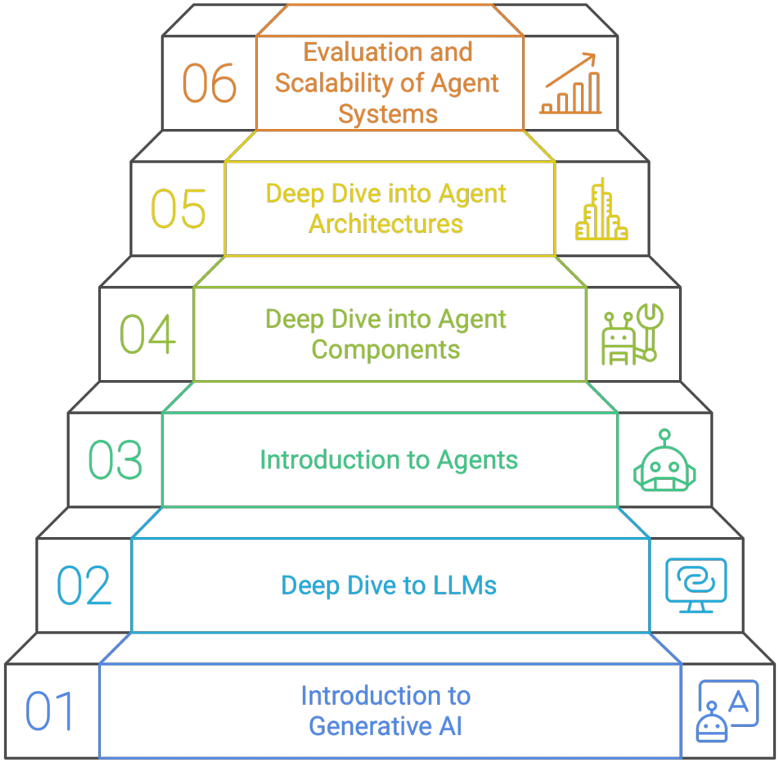
Uncertainty Around Structure & Expectations

- Comments highlighted unclear exam structure and confusion about how to start projects early when Agentic Systems concepts are still being introduced.
  - “Being unaware of the exam structure”

Lesson Objectives

- Define **LLMs** and trace their **evolution** from earlier generative AI.
- Explain what makes a model **“large”** (parameters, data, compute).
- Explore **emergent behaviors** beyond text prediction.
- Learn **key prompting techniques** (zero-shot, few-shot, CoT, multi-step, style).
- Compare **LLM architectures** (encoder-only, decoder-only, encoder–decoder, MoE, multimodal).
- Review **recent advancements** (context windows, scaling laws, reasoning).
- Introduce **fine-tuning** and **evaluation** (instruction tuning, RLHF, DPO, benchmarks, safety).
- Distinguish **open- vs. closed-source** LLMs and highlight Hugging Face.

Course Timeline



We are here

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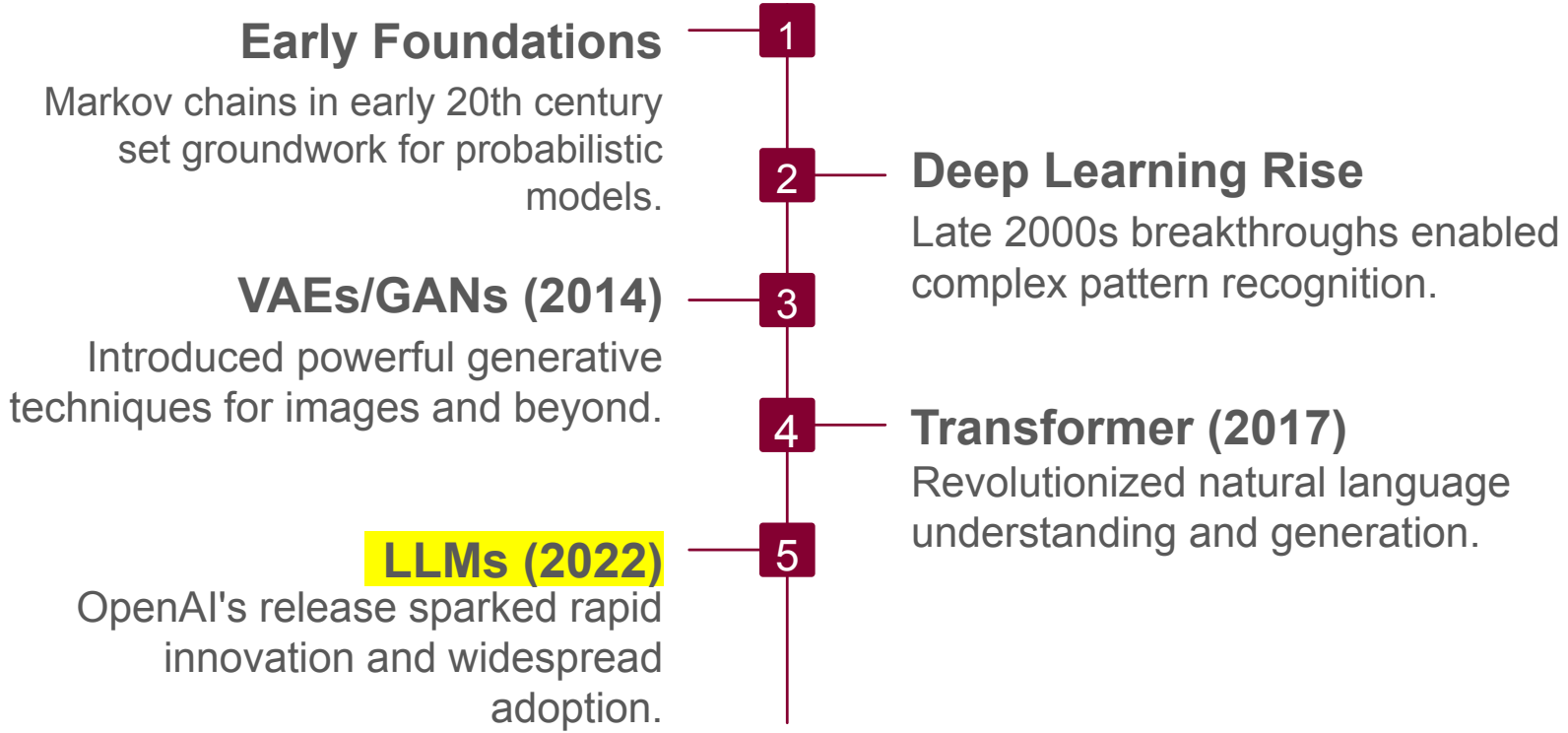
Introduction

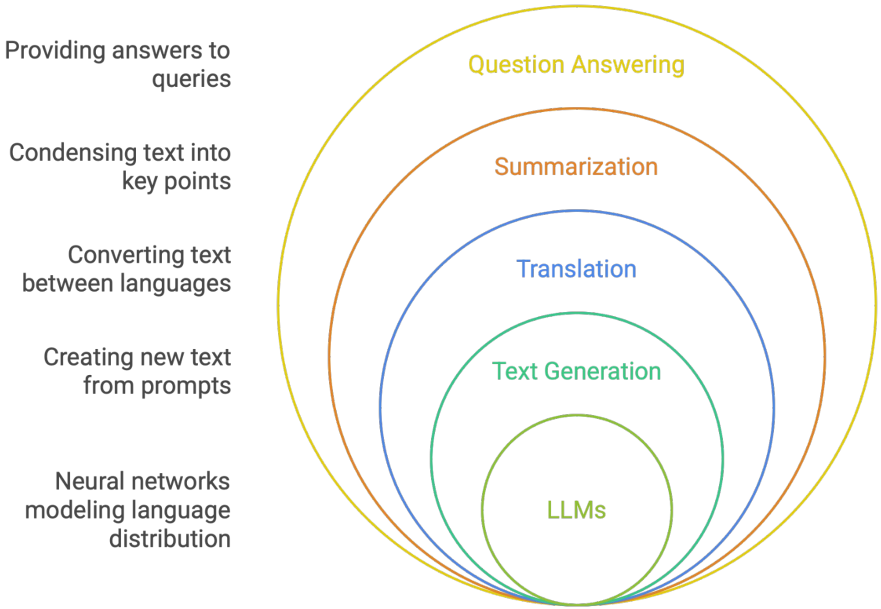
Evolution of Generative AI Models



From Transformers to LLMs

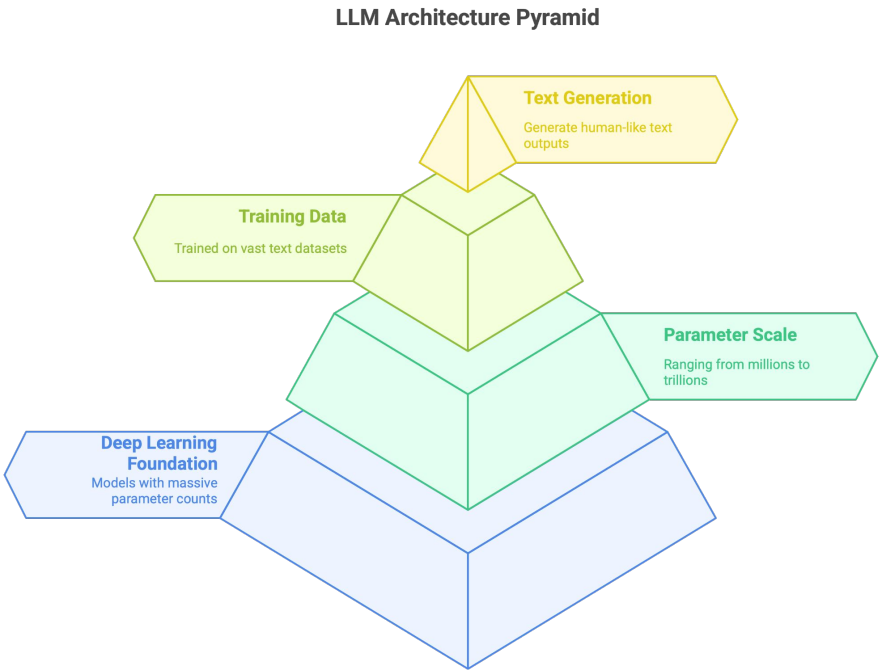
What are LLMs?

- Neural networks trained on **massive text corpora** to model language distribution.
- Capable of **tasks** like text generation, translation, summarization, question answering
- **Are all LLMs transformer-based?** No. We will get to see many variations in the upcoming sections

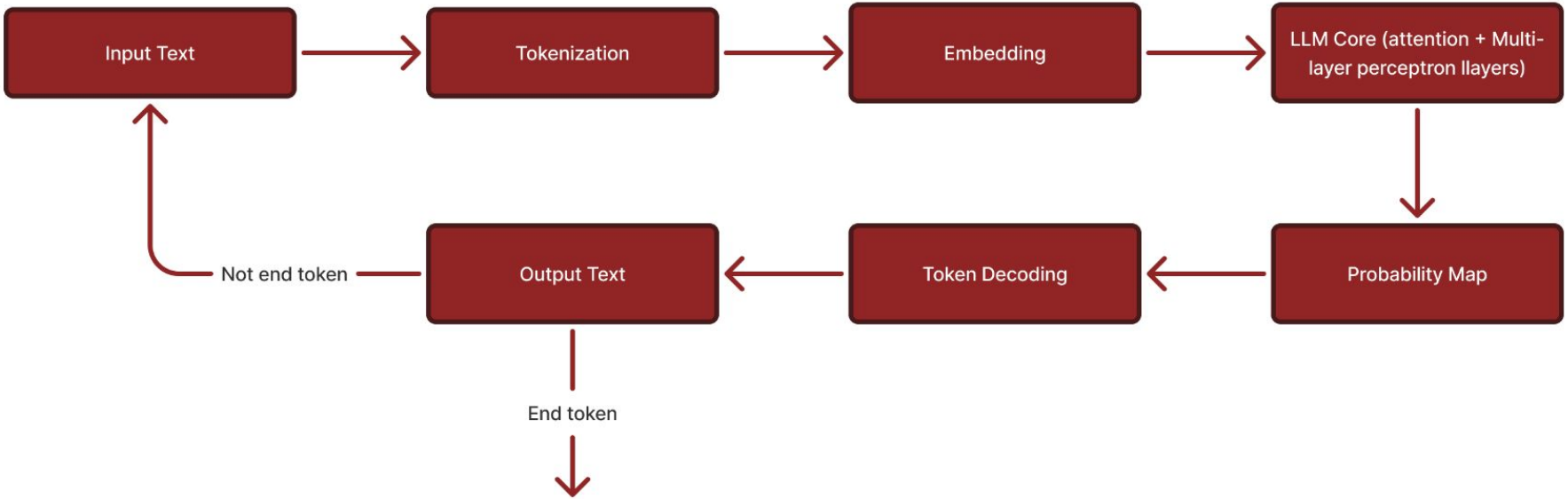


What makes a language model “large”?

- The original transformer architecture, consisting or an **encoder** and a **decoder** block, is a **language model**. It is not a large language model.
- However, if you stack up **hundreds** of encoder blocks and hundreds of decoder blocks until you get **millions-even billions**- of training parameters, the language model is considered large.



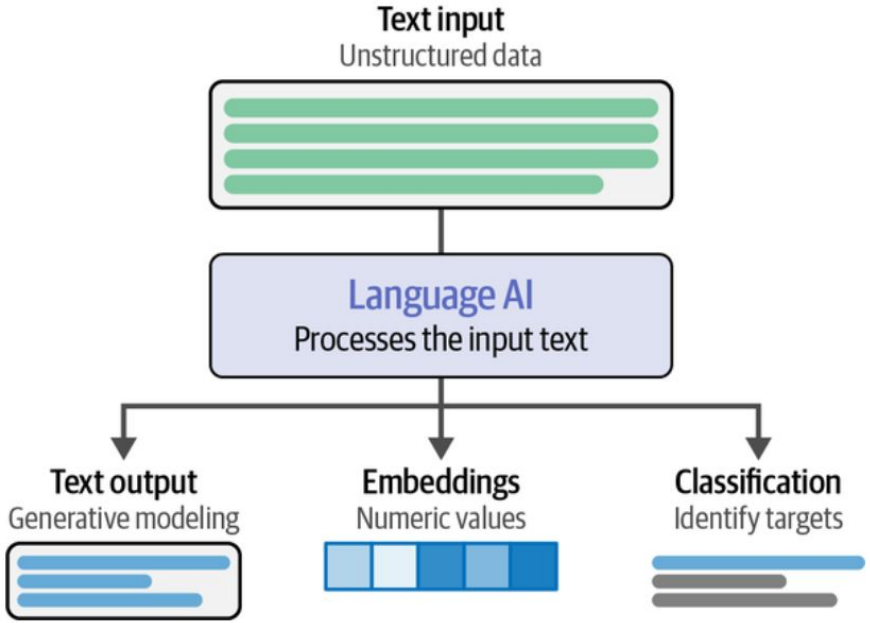
LLM Input and output



Why were LLMs even created?

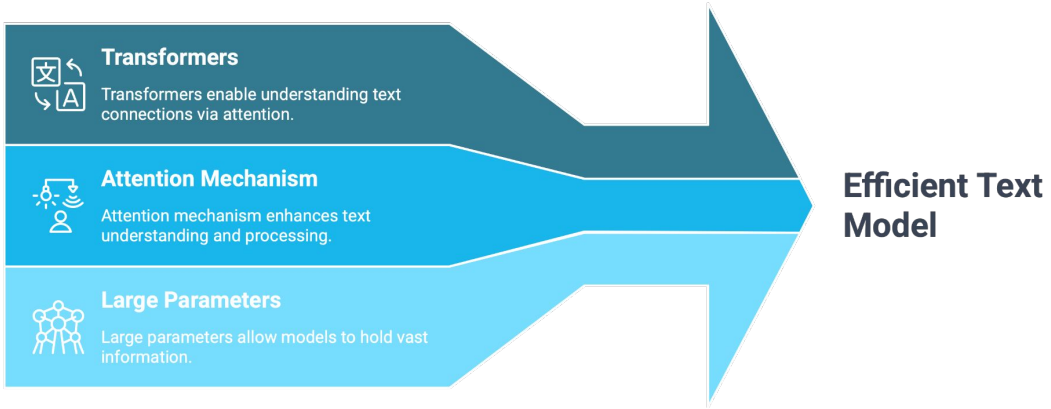
Language Representation

- Language is **challenging** for computers due to its **unstructured nature.**
- Text **loses meaning** when reduced to zeros and ones (individual characters).
- Language AI has historically focused on **structuring language** for easier computer processing.



From Transformers to Large Models

- To have one text model that is extremely efficient in answering any type of question, creative writing, coding, and multi-language generation, we would need to hold a **lot of information** within its weights.
- To have a model that is able to contain a lot of information, we need a **large number of parameters**



Emergent Behaviours of LLMs

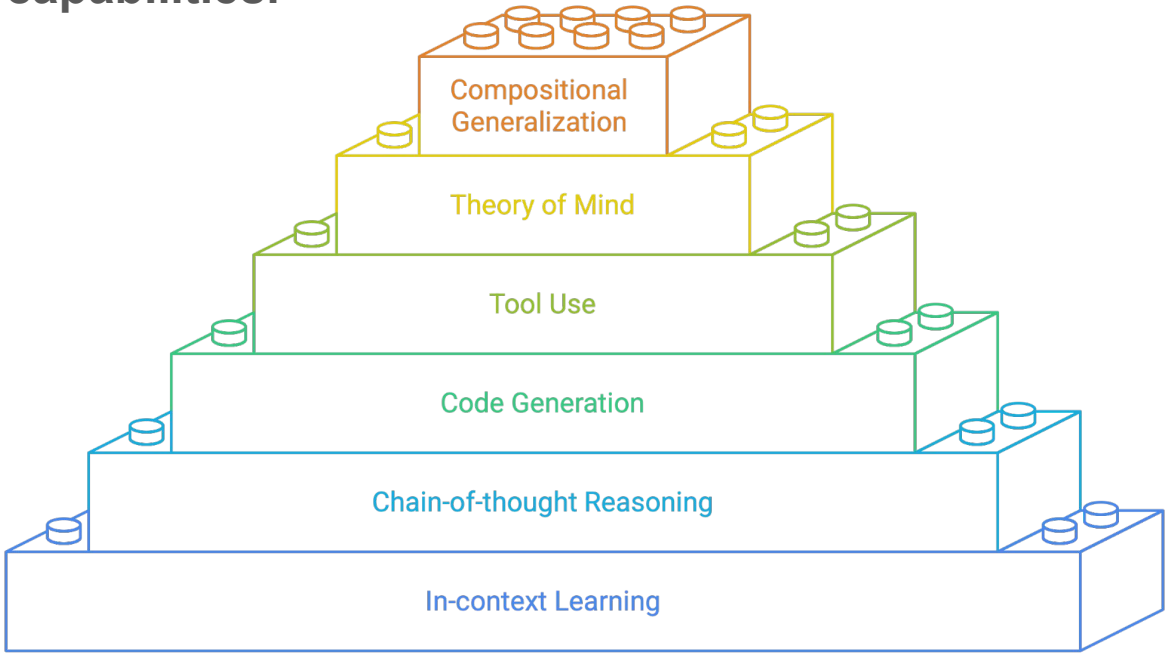
The original purpose of large language models was to perform traditional text tasks with **high accuracy**

Original Purpose of Large Language Models

Characteristic	Description
Predictive Text Modeling	Trained to predict next word
Language Understanding	Capture patterns based on context
Initial Applications	Autocomplete, translation, classification, summarization

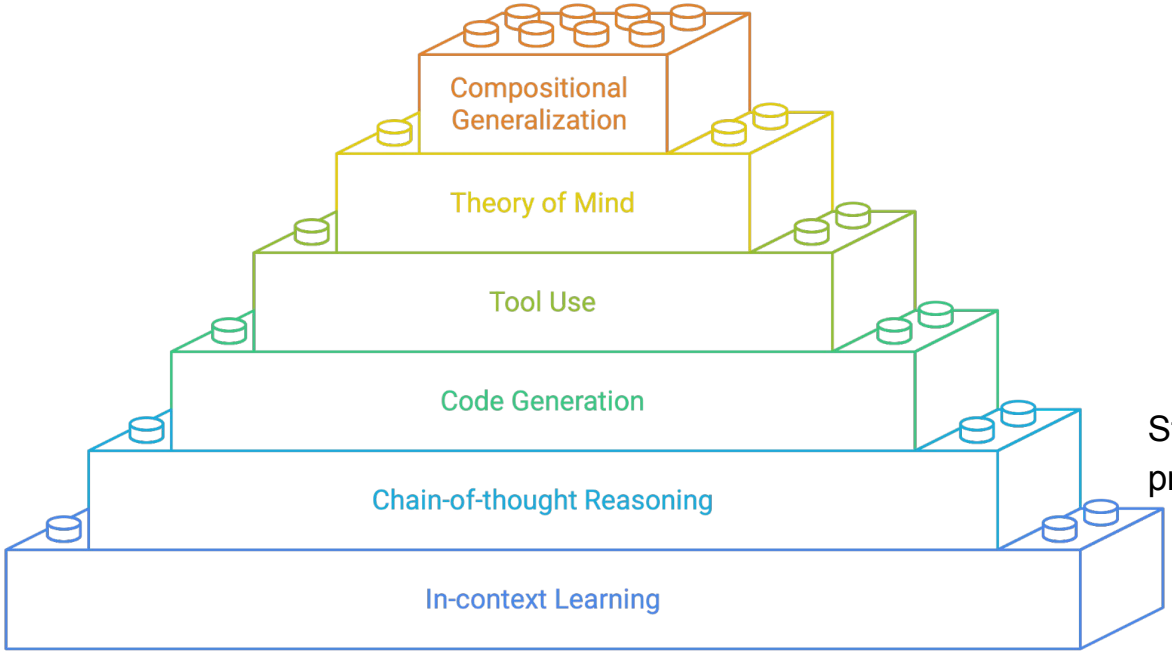
Emergent Behaviours of LLMs

Despite being trained purely to predict text, LLMs unexpectedly **gained powerful capabilities.**



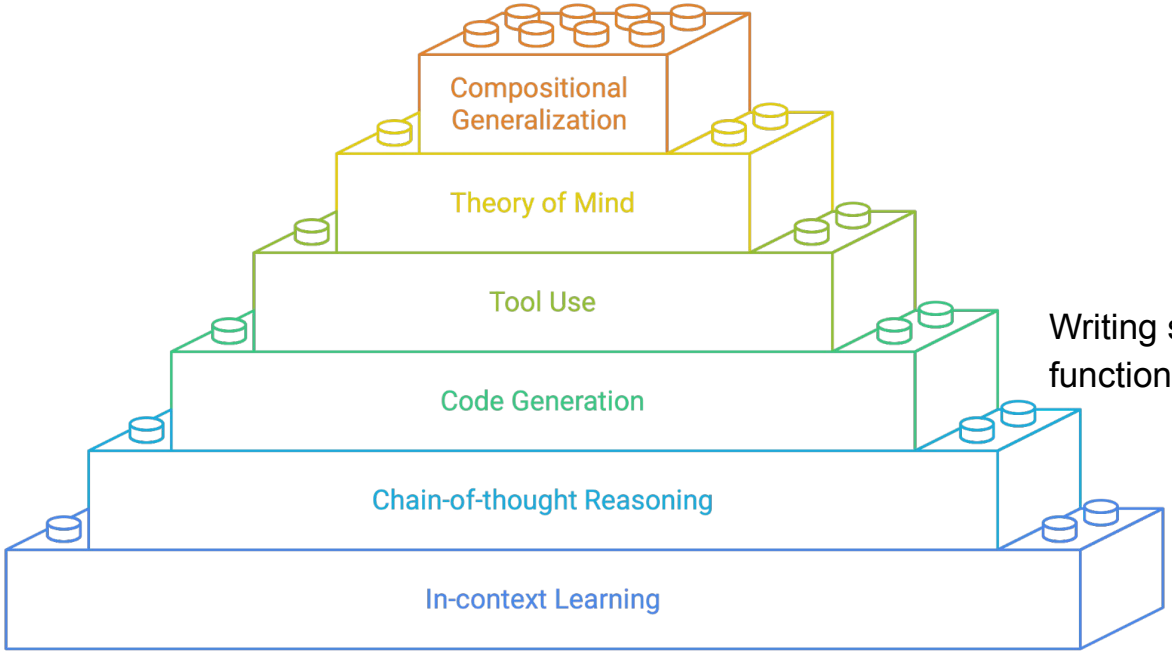
Solving new tasks without gradient updates, just from prompts.

Emergent Behaviours of LLMs



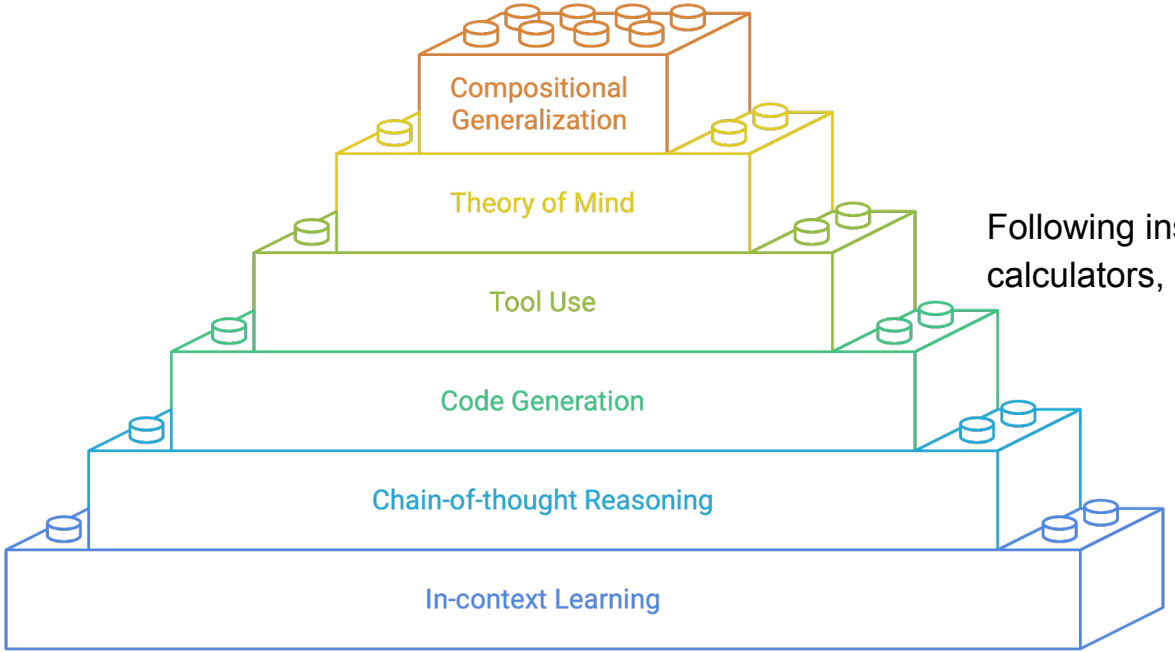
Step-by-step logic emerges when prompted correctly.

Emergent Behaviours of LLMs



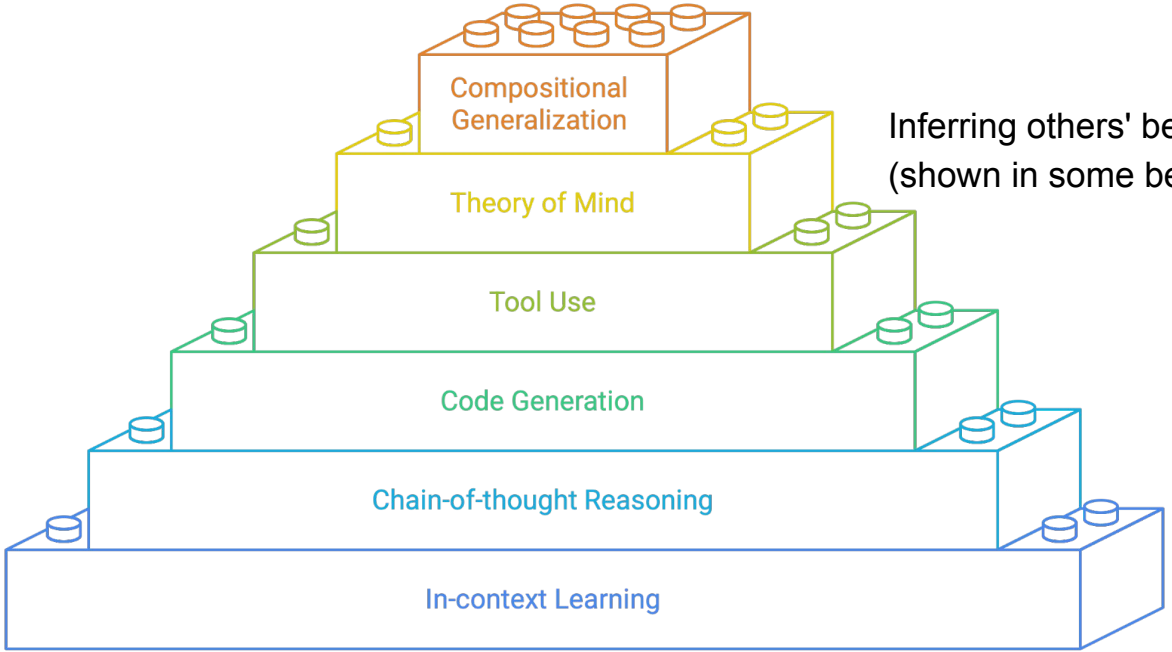
Writing syntactically correct and functional code.

Emergent Behaviours of LLMs



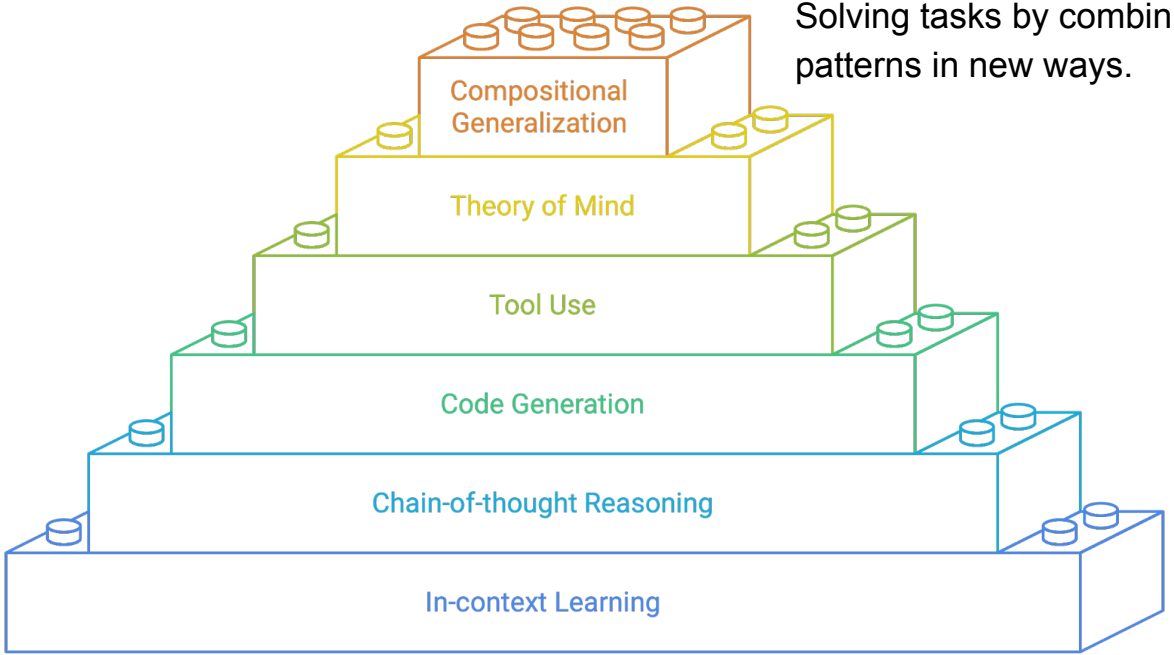
Following instructions to call APIs, use calculators, browse.

Emergent Behaviours of LLMs



Inferring others' beliefs or knowledge (shown in some benchmarks).

Emergent Behaviours of LLMs



Solving tasks by combining learned patterns in new ways.