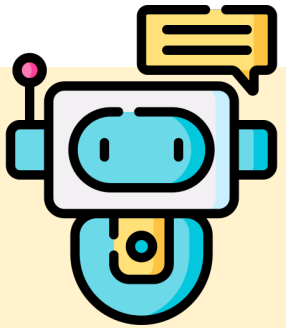
Introduction to AI agents



Francesco Ronzano

Universitat Pompeu Fabra (UPF)

5th, 10th, and 12th February 2026 - Barcelona

The rise of autonomous AI platforms

AI E-COMMERCE PAYMENTS

Mastercard Launches Agentic AI Suite for Banking, Retail Automation

The service is designed to help enterprises build, test, and deploy AI-driven workflows as agentic systems gain traction.

Fintech News Singapore — January 28, 2026 2 Mins Read

INNOVATION > AI

Agentic AI Takes Over — 11 Shocking 2026 Predictions

By Mark Minevich, Contributor. Mark Minevich is a N... Follow Author

Published Dec 31, 2025, 10:57pm EST, Updated Jan 07, 2026, 12:59pm EST

Technology And Analytics

Forbes

nature

NEWS EXPLAINER | 03 October 2025 | Correction 07 October 2025

How AI agents will change research: a scientist's guide

Researchers are increasingly turning to artificial-intelligence tools that can handle complex, multi-step processes.

By Elizabeth Gibney

Preparing Your Brand for Agentic AI

LLMs and agents are reshaping how consumers research and buy. Most companies aren't ready. by Oguz A. Acar and David A. Schweidel

From the Magazine (forthcoming March–April 2026)

HARVARD BUSINESS REVIEW

Gartner Predicts 60% of Brands Will Use Agentic AI to Deliver Streamlined One-to-One Interactions by 2028

STAMFORD, Conn., January 15, 2026

Marketers Must Strengthen Data Governance, Embrace Transparency, and Adapt Organizational Models to Succeed in an AI-Driven Future

Gartner predicts at least 15% of day-to-day work decisions will be made autonomously through agentic AI by 2028, up from 0% in 2024. In addition, 33% of enterprise software applications will include agentic AI by 2028, up from less than 1% in 2024.

Gartner

CHAPTER 2 • TECH TRENDS 2026

The agentic reality check: Preparing for a silicon-based workforce

Despite its promise, many agentic AI implementations are failing. But leading organizations that are reimagining operations and managing agents as workers are finding success.

By Jim Rowan, Nitin Mittal, Parth Patwari, Ed

19-min read • 10 December 2025

Deloitte. Insights

TECHNOLOGY EXECUTIVE COUNCIL

From Google to Expedia, AI travel agents planning future trip far beyond 'assistant' status

CNBC

PUBLISHED FRI, MAY 16 2025-11:00 AM EDT

Trevor Laurence Jockims

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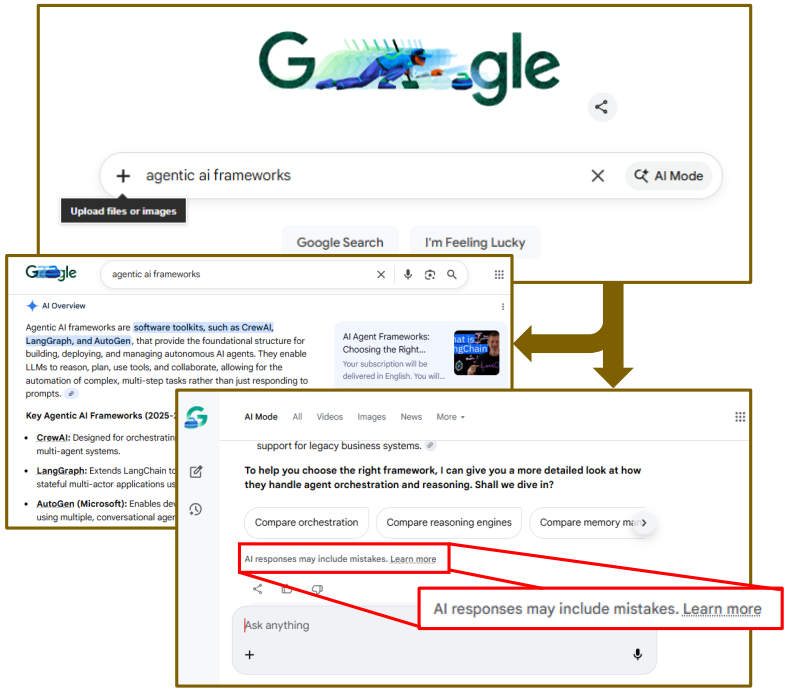
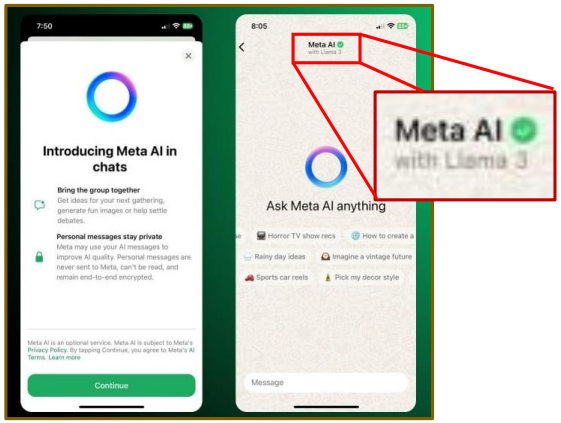
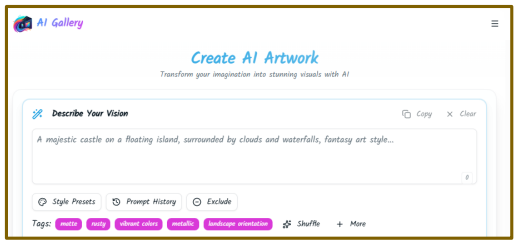
The rise of autonomous AI platforms

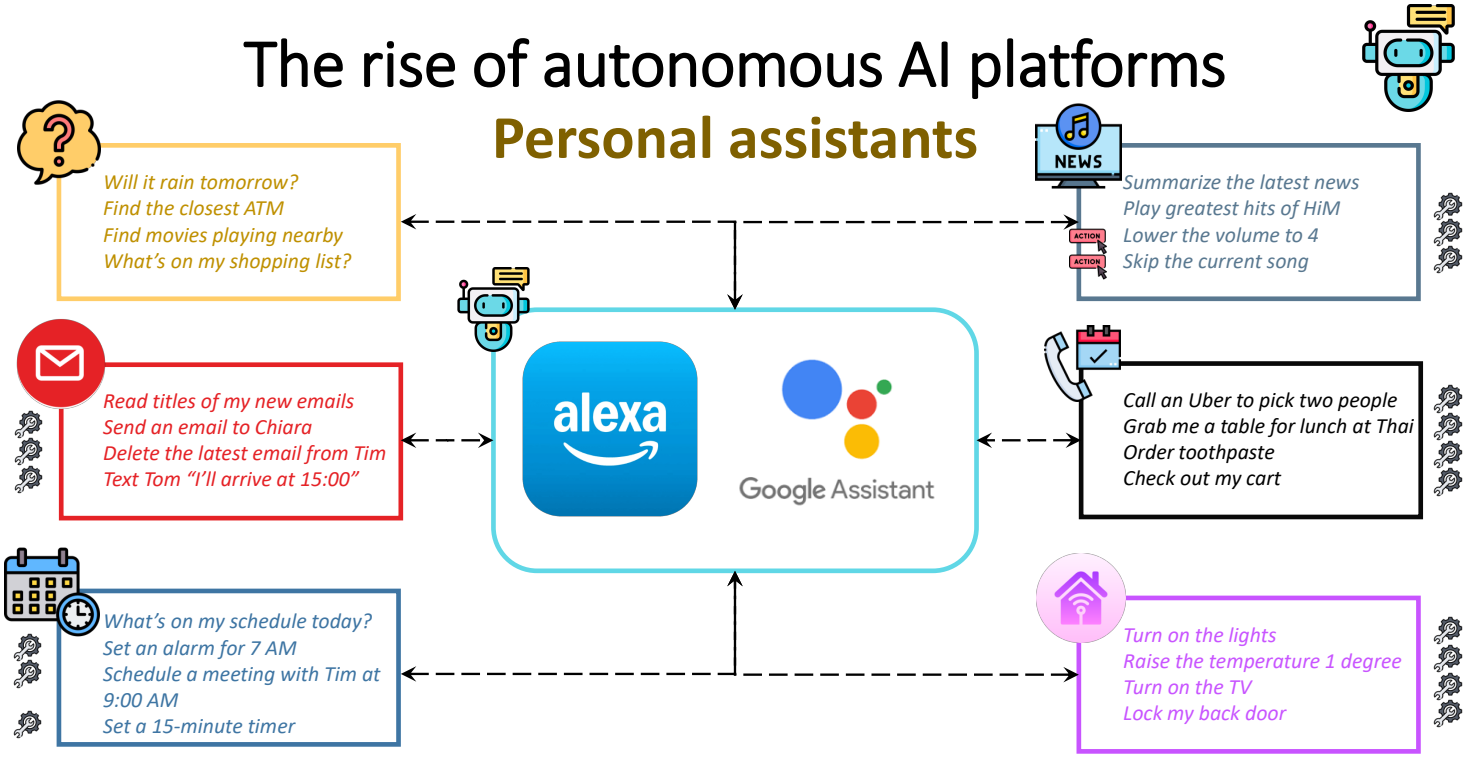






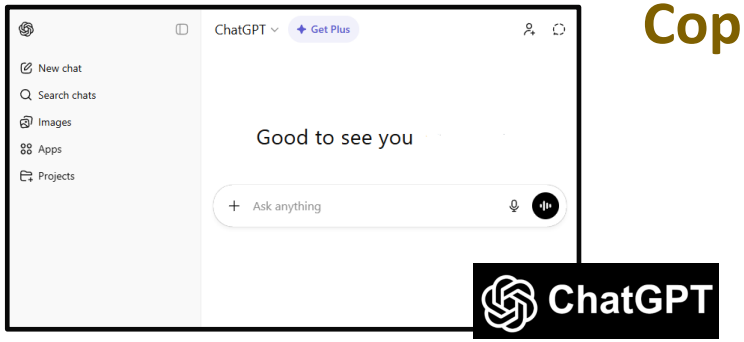
The rise of autonomous AI platforms

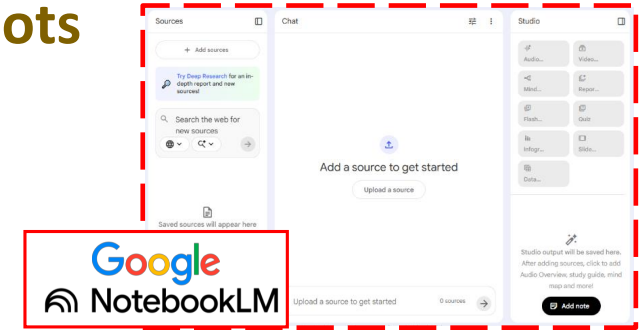
Personal assistants

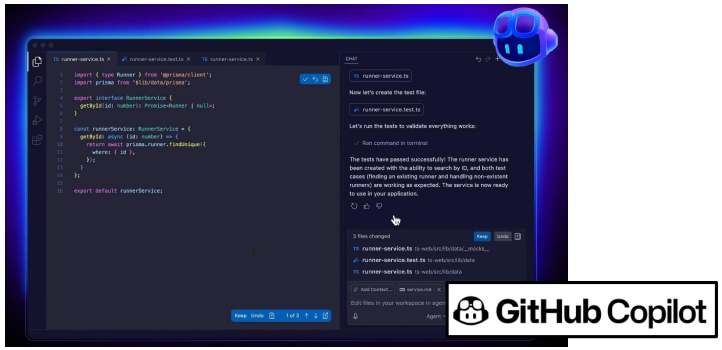


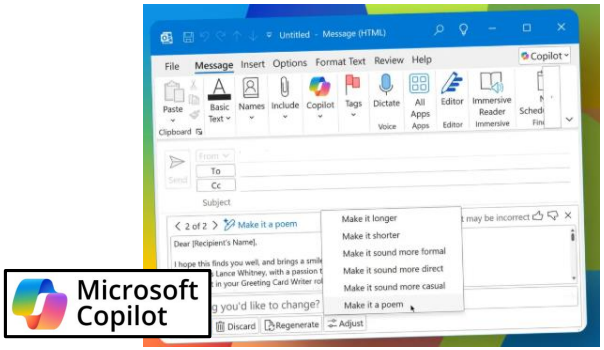
The rise of autonomous AI platforms

Copilots









The rise of autonomous AI platforms

Examples of impacted business processes

Customer support

Content generation

Software engineering

HR selection & onboarding

Deep research & knowledge synthesis

Infrastructure monitoring

Compliance monitoring

Fraud detection

Inventory management

Laboratory management

What are Agentic AI seminars about?

Explore the inner working and experiment with modern AI agents based on Generative Language Models

- Delve into the **key traits of agentic AI**
- Understand the reasoning engine of AI agents: **Generative Language Models**
- Explore how AI agents can **reason**, **remember**, **interact**, and **collaborate**
- Discover how to **measure the success and reliability of AI agents**
- Review key **peculiarities** to consider and **risks** to mitigate when operationalizing AI agents

+

Python-lab: **build an AI agent with LangChain**

What are Agentic AI seminars about?

PART I

What is an AI agent?
Generative Language Models: the brain of AI agents
The training journey of Generative Language Models

5th February 2026

PART II

Core capabilities of AI agents: reasoning, tool use, memory, and collaboration
Assessing the performance of AI agents

10th February 2026

PART III-LAB

Python-lab: building an AI agent with LangChain

12th February 2026

Introduction to AI agents

PART I

What is an AI agent?

Generative Language Models: the brain of AI agents

The training journey of Generative Language Models

5th February 2026 - Barcelona

Key traits of an AI agent

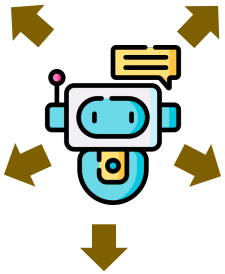
AI agents are software systems capable to complete tasks or pursue goals with *limited human supervisions*, *relying on artificial intelligence*

Agency

autonomously perform actions to *interact with* and *modify* the environment

Reasoning and planning

rely on logic and available information to solve problems and draw conclusions, by *decomposing complex scenarios into smaller tasks* and *choosing the best course of action*



Adaptability and resilience

dynamically adjust behavior to deal with the *circumstantial specificities of the task* to carry out *and the environment* to interact with

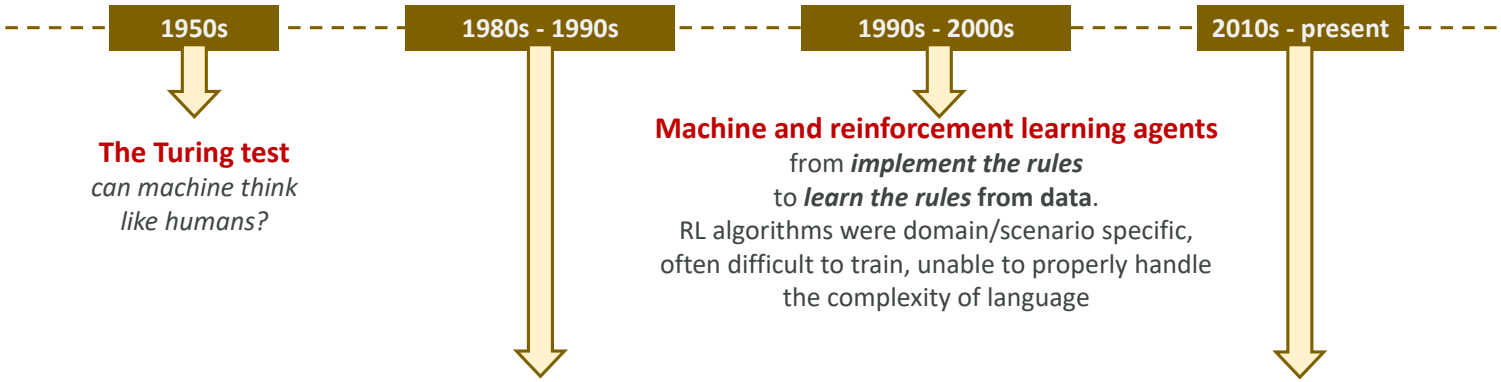
Learning and self-improvement

continuously learn while iterating over specific tasks, *self-refining knowledge and capabilities*

Collaboration

communicate and coordinate with external actors (agents or humans) towards the achievement of a common goal

AI agents: not a “new concept”



AI agents: not a “new concept”

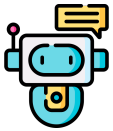
Distinct types of AI enabled by deep learning **2010s - present**

Perception AI

perceive and process specific external signals

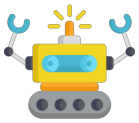
Generative AI

learn patterns in data and generate new content



Agentic AI

learn, reason, interact with computer systems, and take decisions

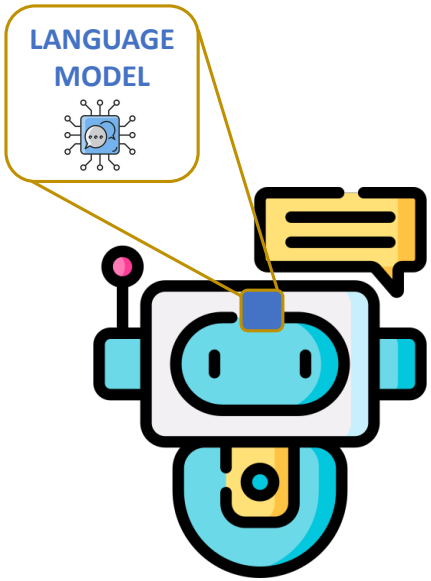


Physical AI

understand spatial relationships and the physical behavior of the 3D world we all live in and interact with it

Source: Jensen Huang Keynote at Nvidia Consumer Electronics Show 2025

LLM-based Agentic AI: “new brain” for an old framework



Language Model enables agents to virtually deal with any domain and scenario by allowing **interactions mediated by language communication**

From…	to…
predefined action spaces	*virtually infinite action spaces*
predefined set of actions	*dynamic definitions of actions and available tool / APIs*
rigid, scenario-specific execution flows	*adaptable, reasoning-driven planning*

Introduction to AI agents

PART I

What is an AI agent?

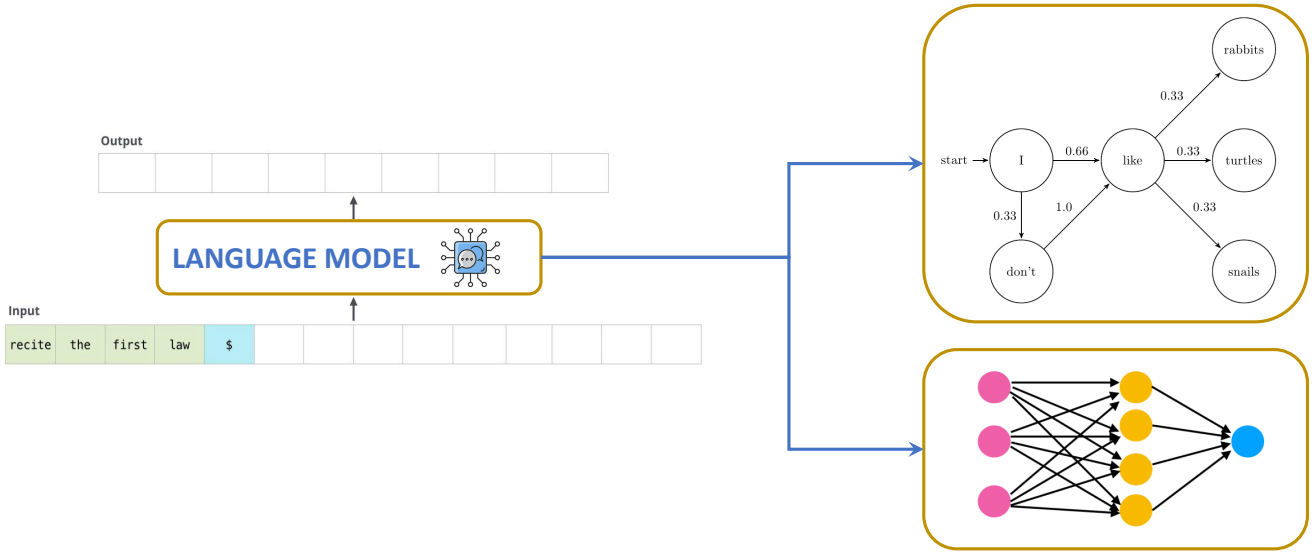
Generative Language Models: the brain of AI agents

The training journey of Generative Language Models

5th February 2026 - Barcelona

What is a Language Model?

A **Language Model** is a *statistical* or *machine learning* model trained to **coherently predict and generate human-like text**



Source: https://lena-voita.github.io/nlp_course/language_modeling.html

What is a Language Model?

A **Language Model** is a *statistical* or *machine learning* model trained to **coherently predict and generate human-like text**

Representing natural language by numbers | It's all about context

The ability to effectively carry out a specific task on raw data like natural language text strongly depends on the choice of a proper representation of this data

...for humans

Representation 1

Could you divide CCX by VI?

Representation 2

Could you divide 210 by 6?

...for machines

Could you add the number 33 to an ordered list of *n* integers?

Representation 1

Ordered list of numbers

Time required

O(*n*)

Representation 2

RB tree

O(*log(n)*)

Source: https://lena-voita.github.io/nlp_course/language_modeling.html

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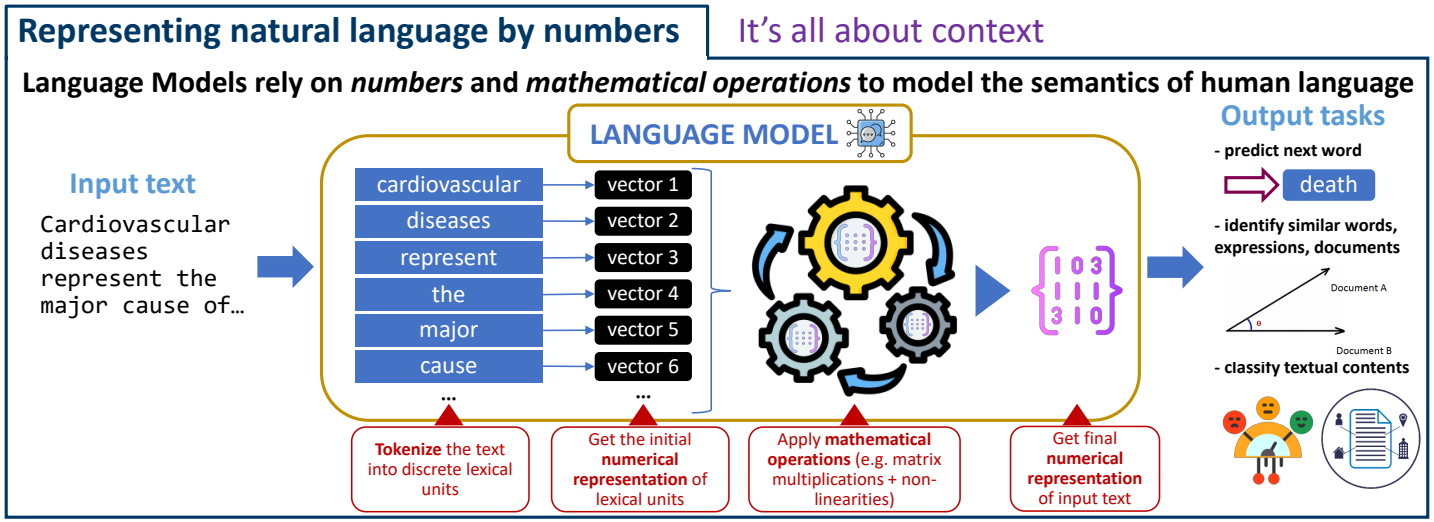


What is a Language Model?

A **Language Model** is a *statistical* or *machine learning* model
trained to **coherently predict and generate human-like text**

Representing natural language as numbers

It's all about word context

The semantics of words (or other *linguistics units*) can be derived by inspecting
their **context of occurrence** in large collections of textual data

"You shall know a word by the company it keeps!" *(J.R.Firth)*

Swiss **?** accounts have been commissioned.

Which word is **?** *replacing?*

The **?** of England is the UK government's central **?**.

You need to realize the **?** transfer of 30 euro in a period of 5 days from your personal account.

Central **?** implement a country's chosen monetary policy.

A minimum of 100 euro is required to open a **?** account.

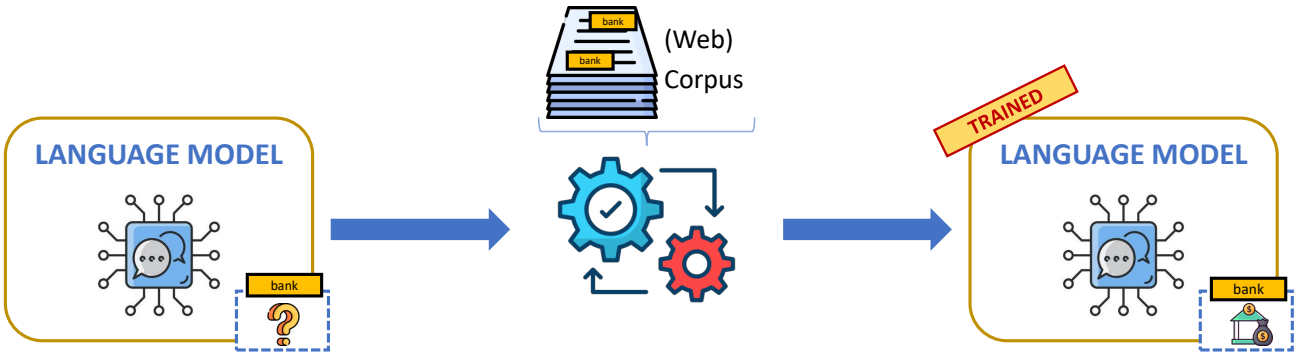
What is a Language Model?

A **Language Model** is a *statistical* or *machine learning* model
trained to **coherently predict and generate human-like text**

Representing natural language as numbers

It's all about word context

Language Models bootstrap their understanding of text semantics
by learning the meaning of lexical units (e.g. words, tokens) from huge amount of "in-context" examples



What is a Language Model?

A **Language Model** is a *statistical* or *machine learning* model trained to **coherently predict and generate human-like text**

Representing natural language as numbers

It's all about word context

How does *context* affect the quality of Language Models?

1) **CONTEXT SIZE**: Language Models able to process larger contexts are usually better at interpreting text semantics

± 2 words context

You need to realize the **bank** transfer of 30 euro in a period of 5 days from your personal account.

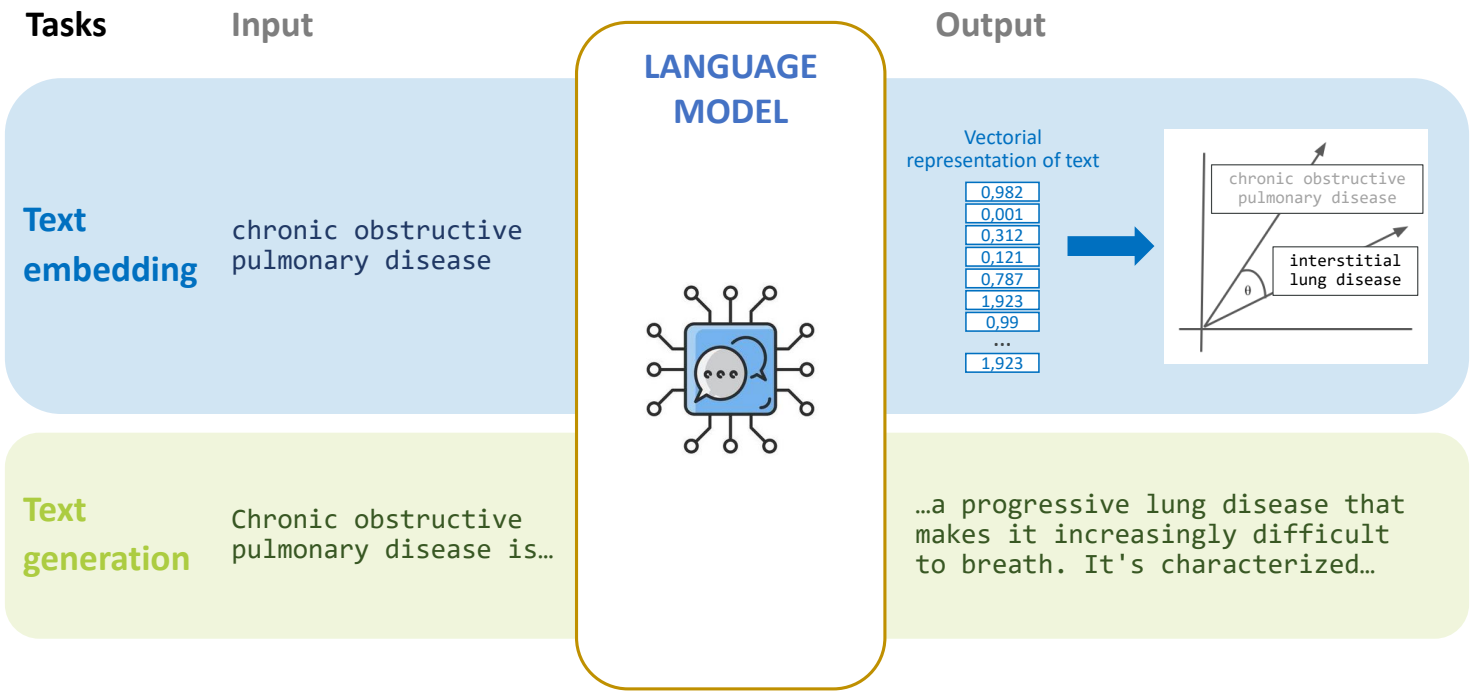
± 4 words context

2) **CONTEXT VARIETY**: Language Models trained on a larger, more varied set of in-context examples of words are usually better modelling text semantics

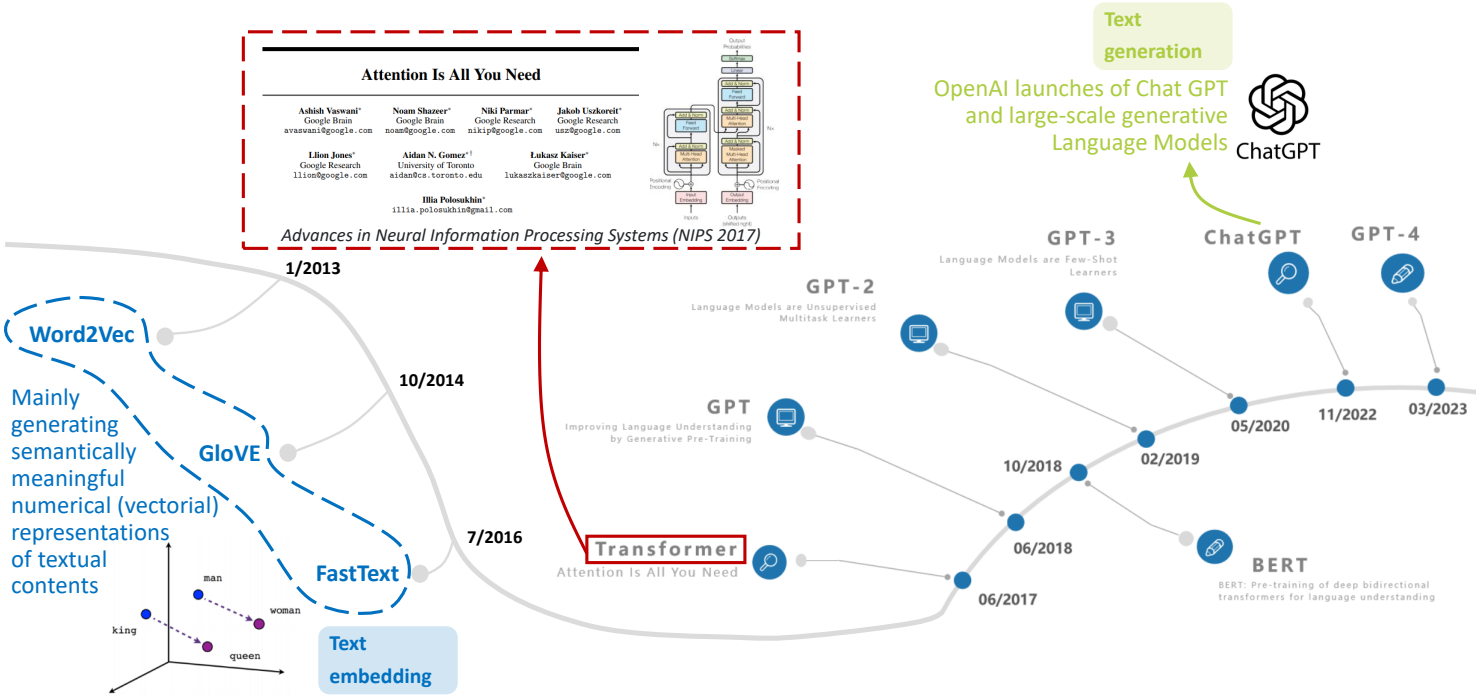
You need to realize the **bank** transfer of 30 euro in a period of 5 days from your personal account.

The left **bank** of Kingdom lake is surrounded by grass and many trees.

What is a Language Model?



The rushing evolution of natural language modelling



Transformer: the foundation of modern Neural Language Models

*Transformer is referred to as **"foundation model"** because they have been driving a paradigm shift in AI and language modeling*

Transformer is **one of the most powerful classes of neural Language Models (i.e. sequential data models) invented to date**

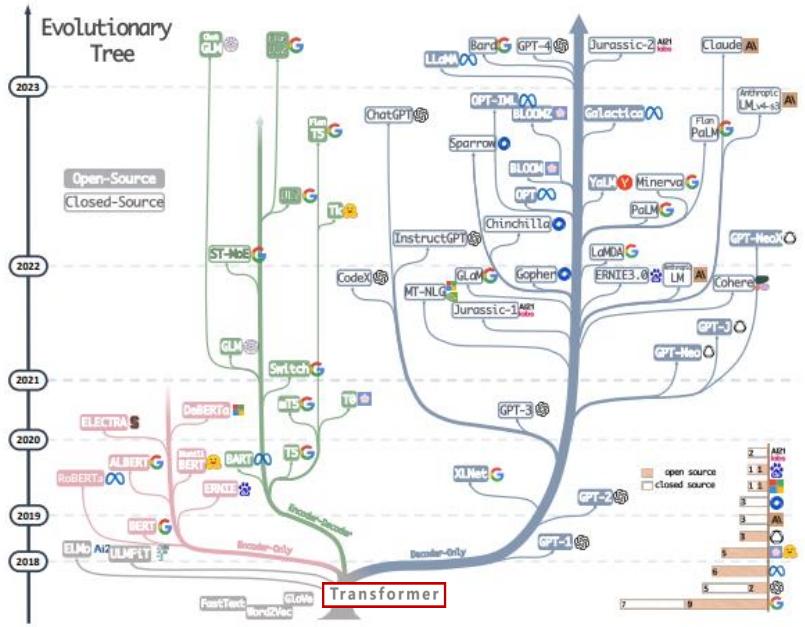
Transformer **solved the limitations of previous neural architectures for language modeling**

RNN and LSTM

- **Sequential processing**, word by word (slow training/inference)
- **Long-range word dependences** are difficult to model and exploit to improve predictions

Convolutional

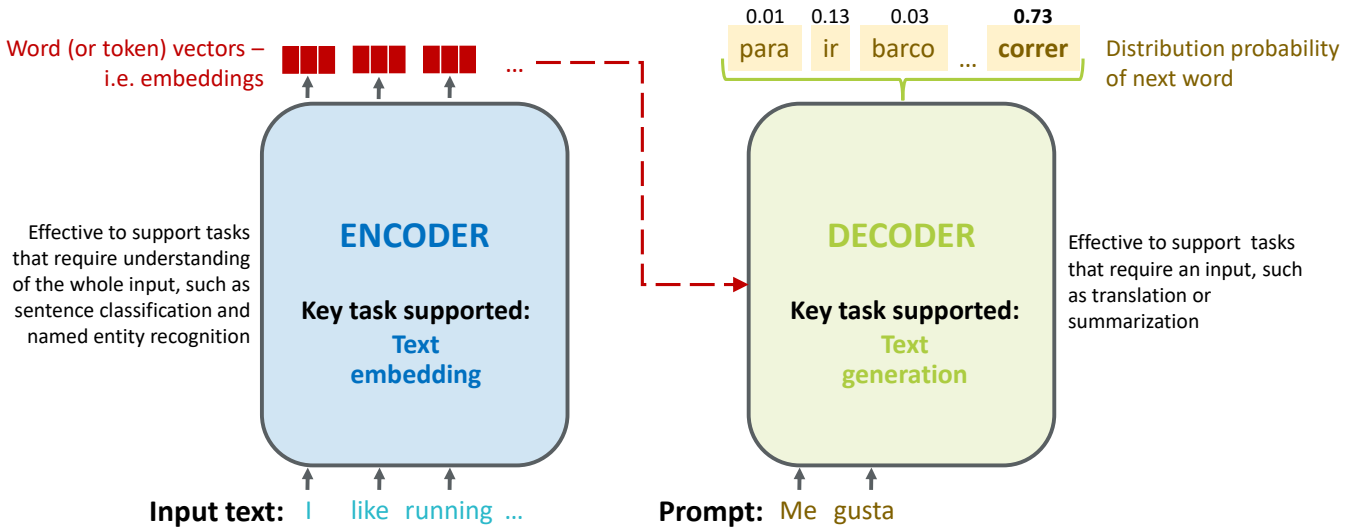
- **Impractical number of convolutional filters** to properly model short- and long-range dependences among words



From: Yang, J. et al. (2024). Harnessing the power of llms in practice: A survey on chatgpt and beyond. *ACM Transactions on Knowledge Discovery from Data*, *18*(6), 1-32.

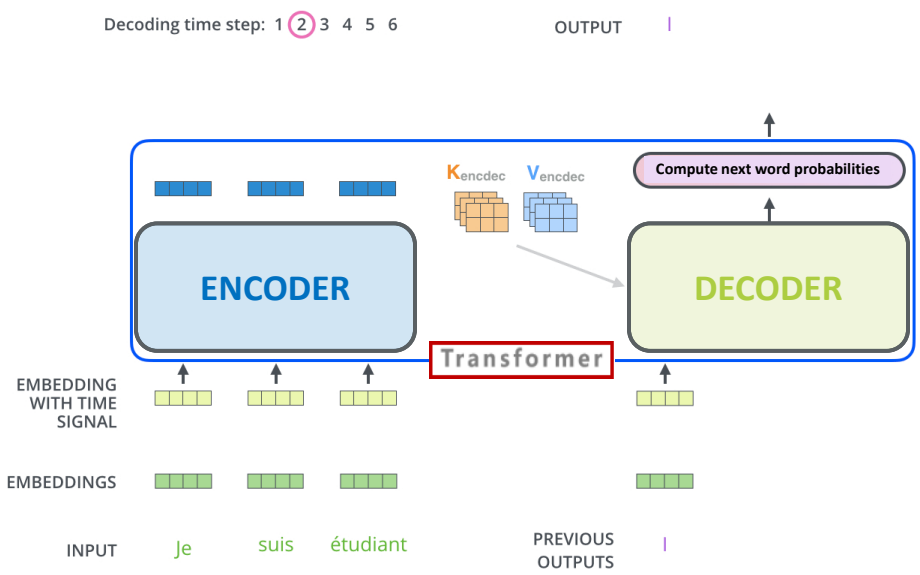
Transformer: the foundation of modern Neural Language Models

Which are the main architectural blocks of a Transformer ?



Transformer: the foundation of modern Neural Language Models

Which are the main architectural blocks of a Transformer ?



Transformer: the foundation of modern Neural Language Models

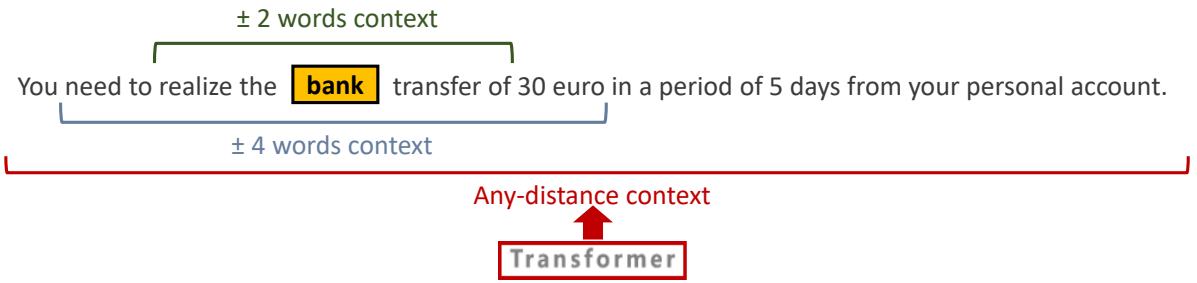
Which is the key innovation introduced by the Transformer architecture?

Attention mechanism

Neural architecture that enables the Language Model to *learn and model the semantics of words by jointly considering words from* ***extremely large contexts*** (i.e. huge number of surrounding words)

Thus, Transformers can ***learn any-distance relationships*** *in sequential data*,
like the words (or tokens) of text excerpts

Context of distinct sizes – i.e. co-occurring words that contribute to characterize the semantics of the word bank



Transformer: the foundation of modern Neural Language Models

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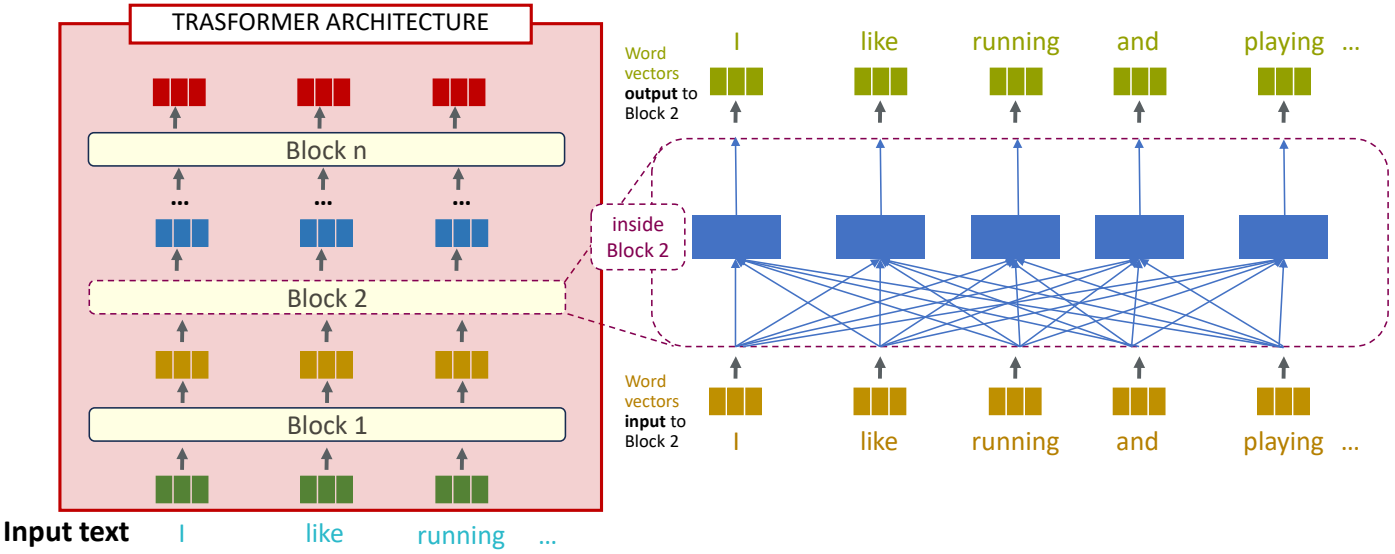

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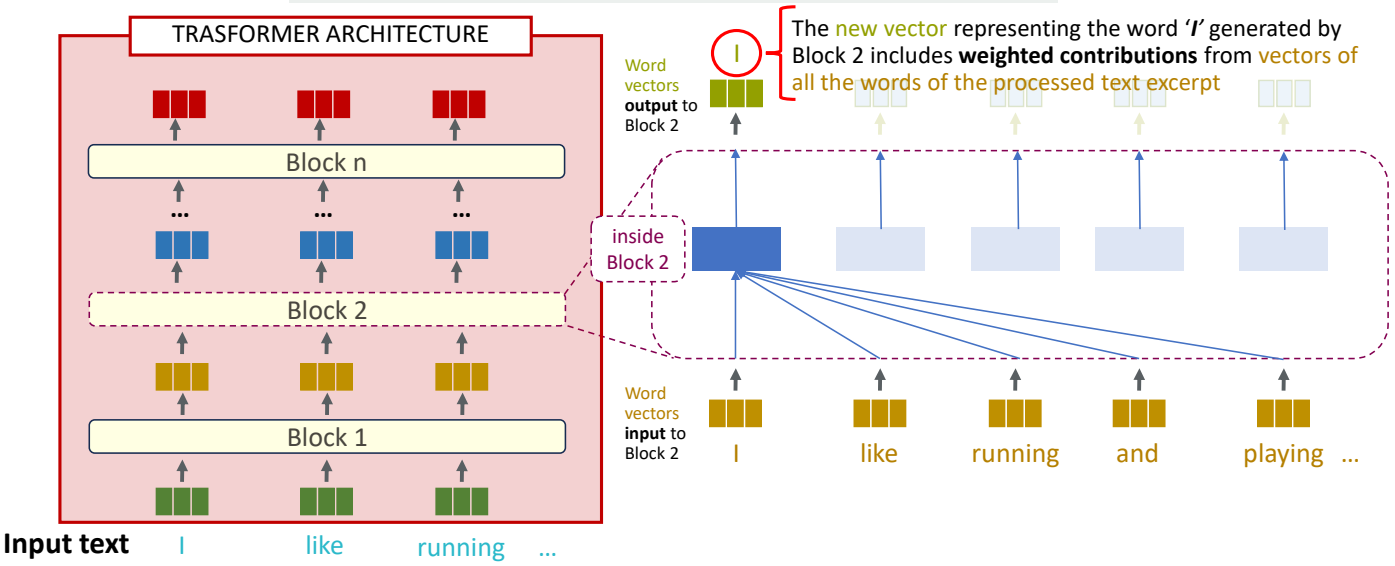

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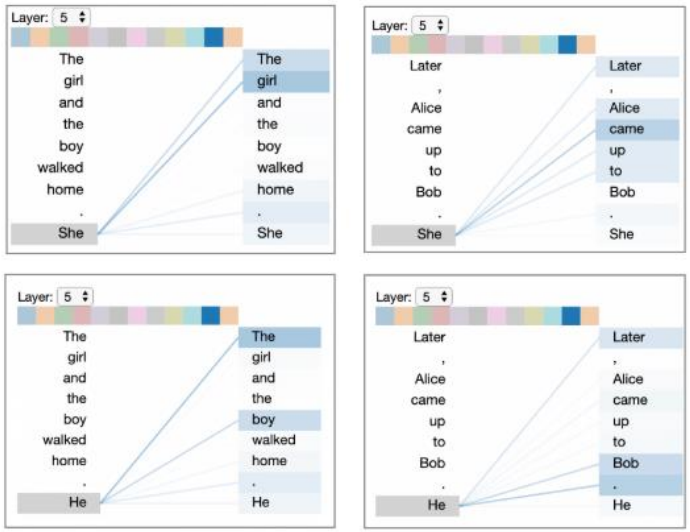
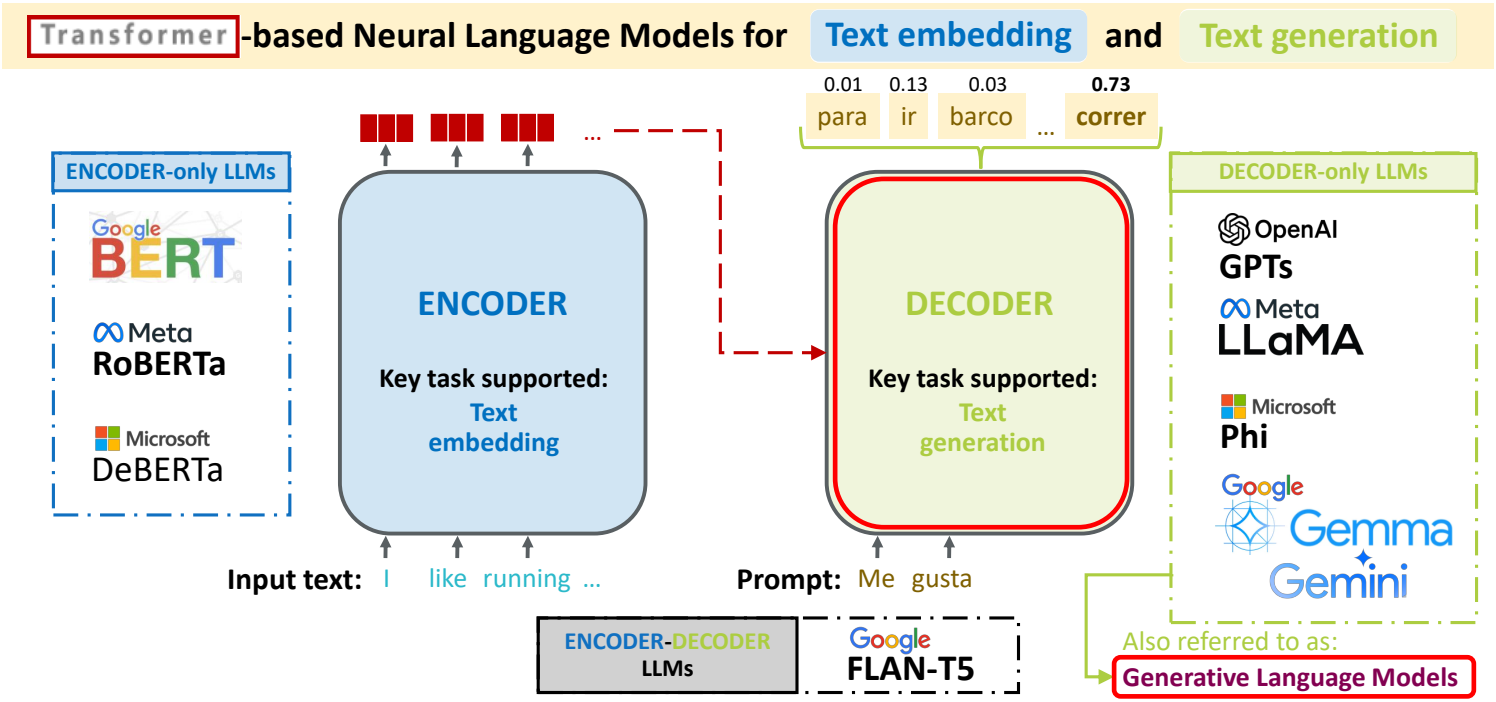


The quality of each embedding generated as output of a specific transformer layer is improved by **learning to aggregate relevant information from semantically related token embedding**

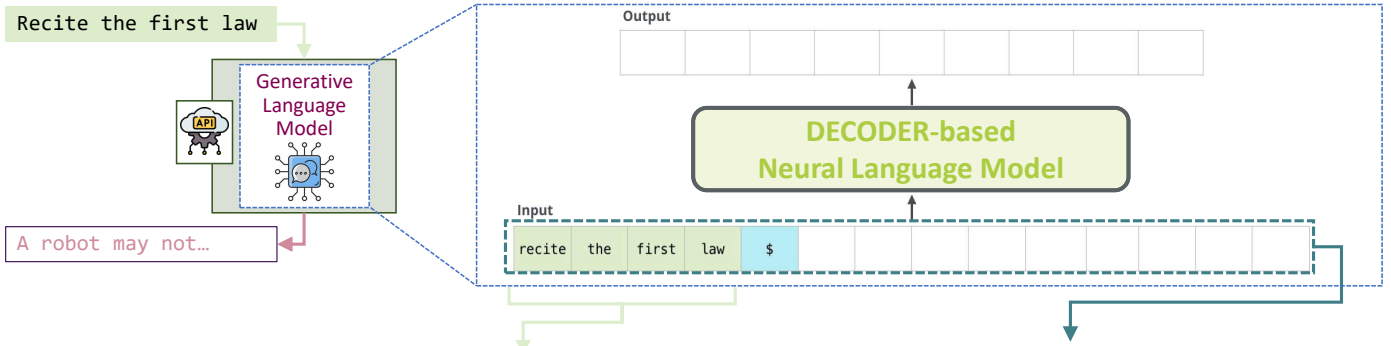
Transformer: the foundation of modern Neural Language Models



Generative Language Models: key traits

When a Language Model is invoked…

…iteratively it generates textual contents, one word (or token) at time

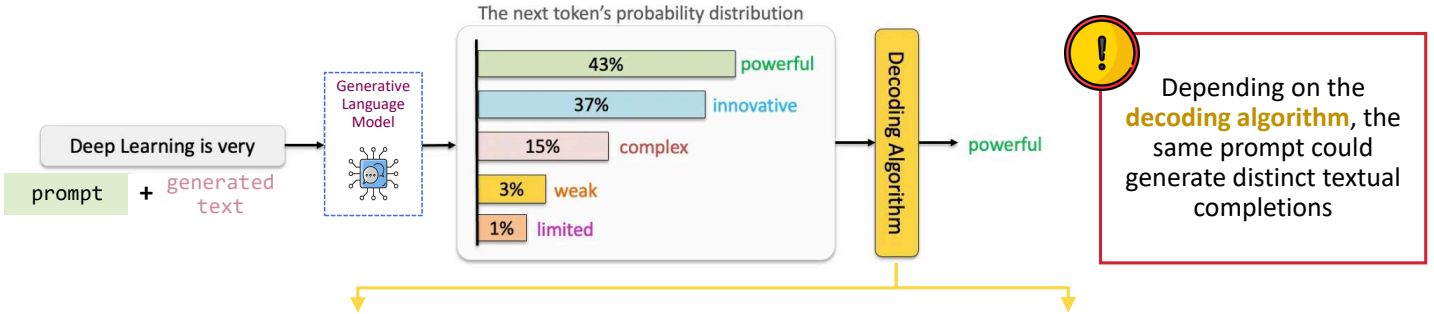


Text generation is triggered by a `prompt`, an input text useful to provide contextual information and instructions to condition the creation of new textual content

The context of the model is the input text (`prompt` + `generated text`) used by the model to understand, and generate text

Generative Language Models: tuning text generation

The decoding algorithm exploits the *next-token probability distribution* computed by the Generative Language Model to choose the next token to be outputted



DETERMINISTIC

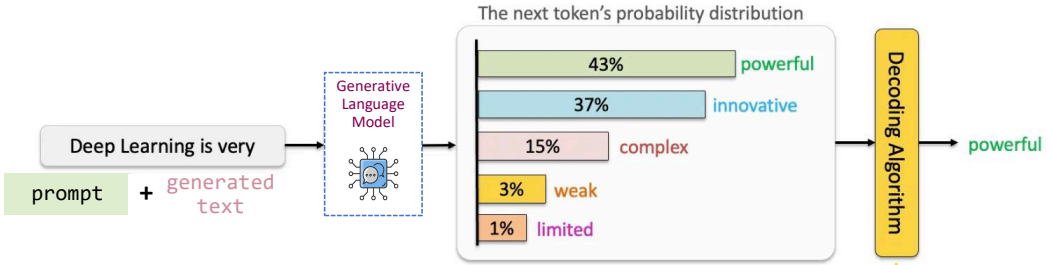
a specific input text (i.e. prompt)
always generates the same textual contents

NON-DETERMINISTIC

a specific input text (i.e. prompt)
can generate distinct textual contents
every time the Generative Language Model is invoked

Generative Language Models: tuning text generation

The decoding algorithm exploits the *next-token probability distribution* computed by the Generative Language Model to choose the next token to be outputted

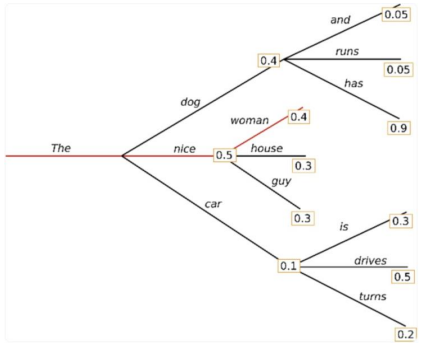


Depending on the **decoding algorithm**, the same prompt could generate distinct textual completions

DETERMINISTIC

D.1) Greedy decoding algorithm

Given a `prompt` + `generated text`, at each token generation step, choose the most likely next token



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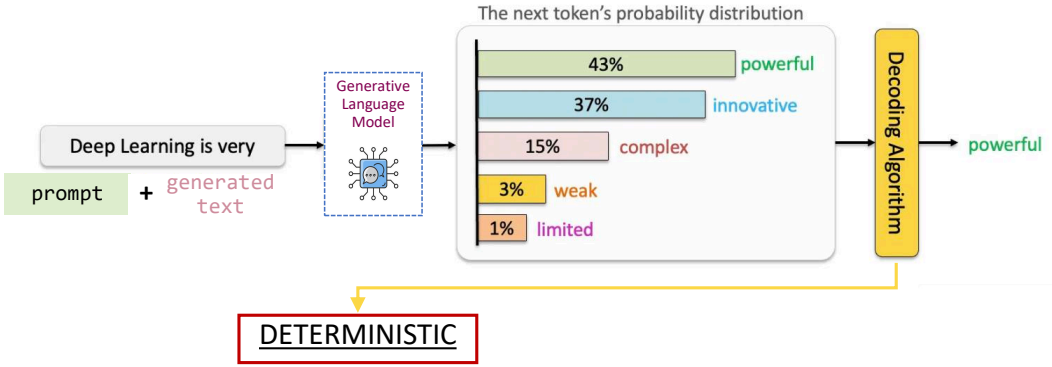
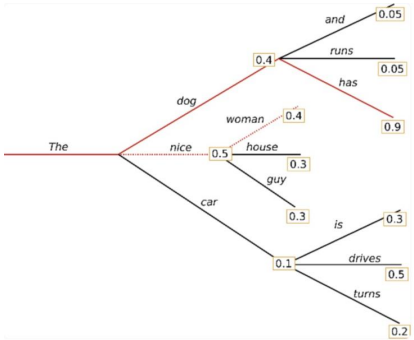


Depending on the **decoding algorithm**, the same prompt could generate distinct textual completions

D.2) Beam search algorithm

Given a `prompt` + `generated text`, at each token generation step, consider the n most likely next tokens. Repeat the procedure until a maximum number of token is reached, then choose as output the sequence of token (beam) with the greatest overall score



Generative Language Models: tuning text generation

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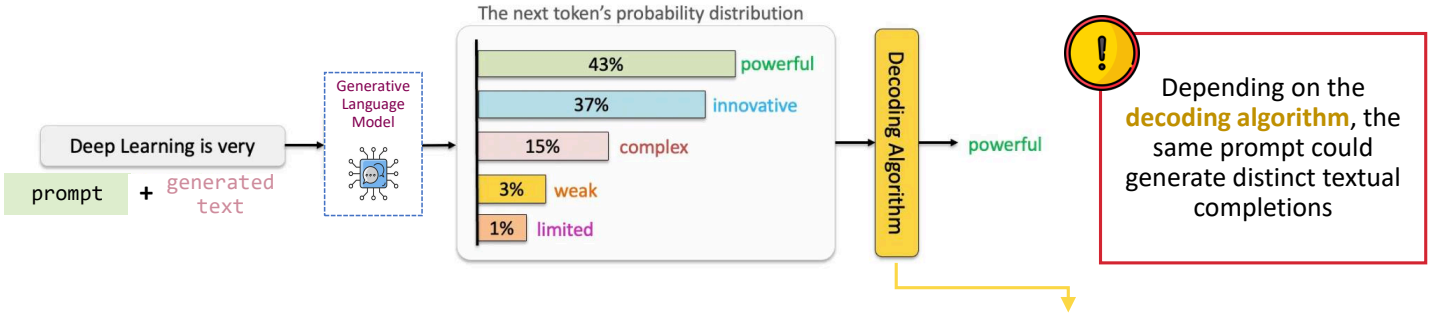
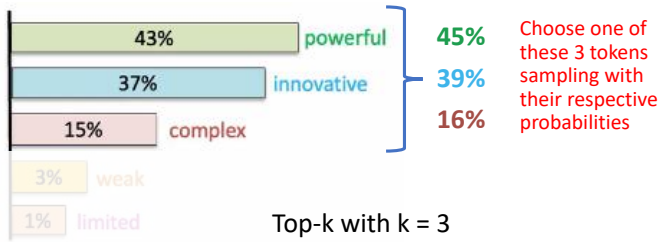


ND.1) Top-k algorithm

Given a `prompt` + `generated text`, at each token generation step, choose randomly one of the top-k most likely next tokens, normalizing relative probabilities among these tokens



Generative Language Models: tuning text generation

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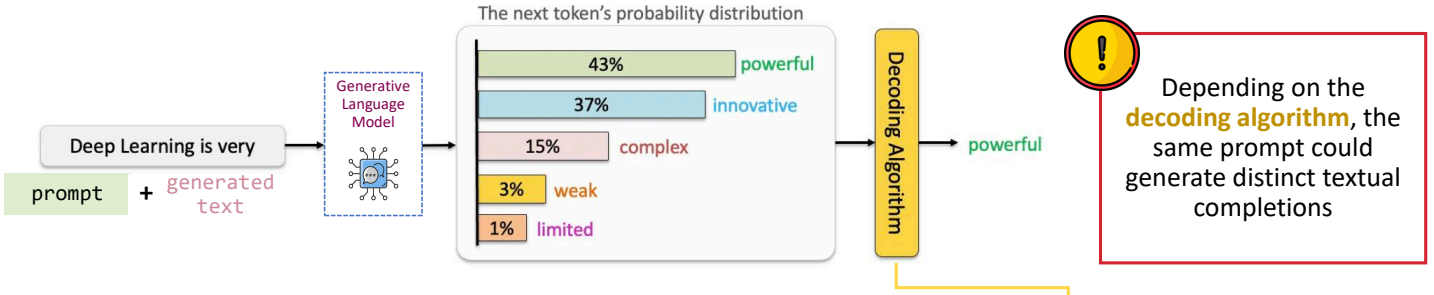


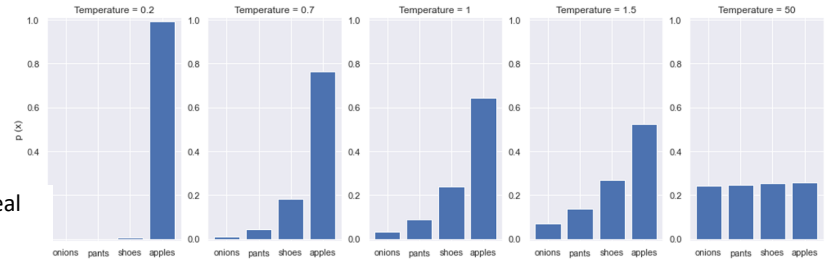
ND.1) Top-k algorithm

Temperature (!= 1) is parameter useful to modify next token's probability distribution

Temperature < 1: increase deterministic and focused outputs, ideal for tasks requiring factual accuracy, such as *summarization* or *translation*

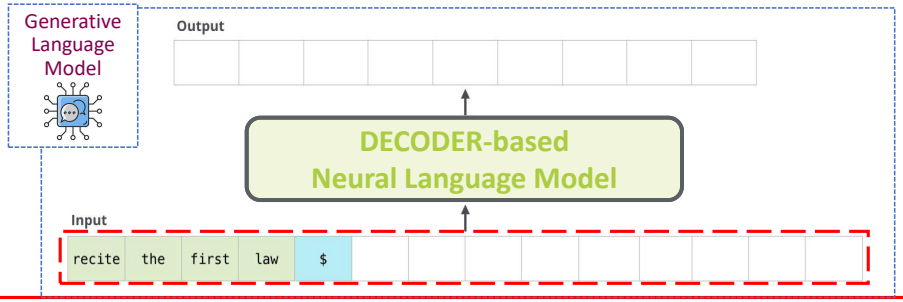
Temperature > 1: increase diversity and creativity in outputs, ideal for tasks requiring variety, like *creative writing* or *brainstorming*

Source: https://www.hopsworks.ai/dictionary/llm-temperature



Generative Language Models: stateless behavior

The input textual content `prompt` (together with the `generated text`)
constitute the *working memory that supports each interaction* with the Language Model



- In every interaction with a Generative Language Model, the textual content of the `prompt` should include **all contextual information needed to drive text generation**

- By default, across-interactions, Generative Large Language models **remember exclusively the information they have learnt during the training** (more on this in next slides)

`prompt`
- Context / role setting
- Up-to-date knowledge
- User information / preferences
- History of past interactions
- Instructions
- Examples of task
- Output format description
- Specific rules / procedures to follow
- Questions to answer

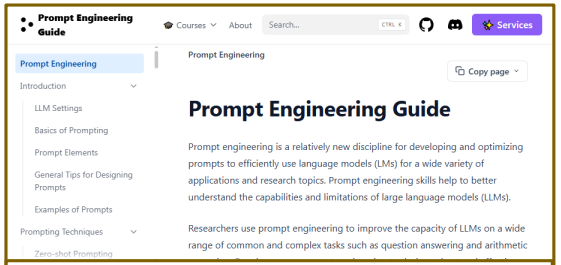
Generative Language Models: stateless behavior

The input textual content `prompt` (together with the `generated text`)
constitute the *working memory that supports each interaction* with the Language Model

PROMTP ENGINEERING

Optimization of the textual interactions with a Language Model to use as effectively as possible its text generation capabilities

- Start with simple instructions, **iteratively refining the prompt**
- State instructions and requests **precisely** and **unambiguously**
- Make explicit also **the behaviors that the model should avoid** (e.g. do `not ask the user for personal information`)
- Provides **examples of the task to be executed**
- Ask the model to **"reason step by step"** explaining why a specific answer has been provided
- Ask the model to **analyze how the prompt can be improved**, rephrase it



https://www.promptingguide.ai/

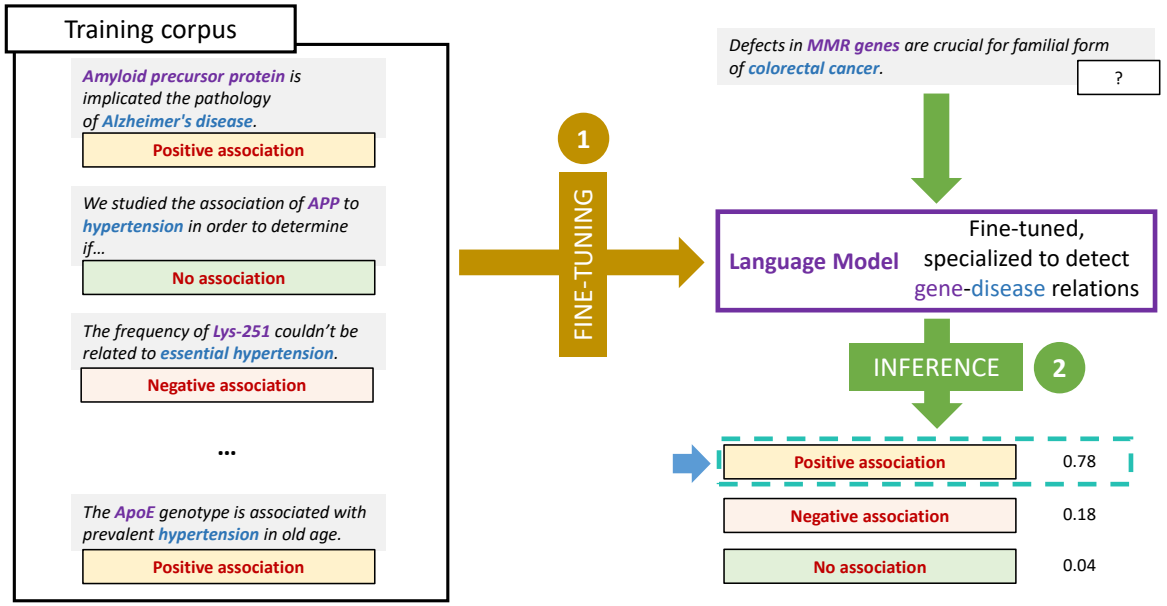
https://amatria.in/blog/PromptEngineering

⚠ Effective prompt engineering is a key step to improve the performance of Language Models

…with agentic AI prompt engineering has has evolved into **CONTEXT ENGINEERING** (more on thins next sessions)

Emergent abilities of Generative Language Models: from fine-tuning to in-context learning

Detection of gene-disease relations by FINE-TUNING



Emergent abilities of Generative Language Models: from fine-tuning to in-context learning

scaling up language models greatly improves task-agnostic, few-shot performance, reaching competitiveness with prior state-of-the-art finetuning approaches

Greatly simplifies the way humans can interact with a Generative Language Model

- using natural language questions and examples
- enabling a wider public to interact with this tools and improve questions and examples

Out-of-the box Large Language Model can perform several distinct downstream task with **results that are competitive with respect to the ones of Large Language Models customized to a single task**

Language Models are Few-Shot Learners

OpenAI, 2020

GPT-3, a 175 billion parameters Large Language Model can **effectively perform a wide and diverse set of NLP tasks, via textual interactions with the model, without any parameter update specific to the task**

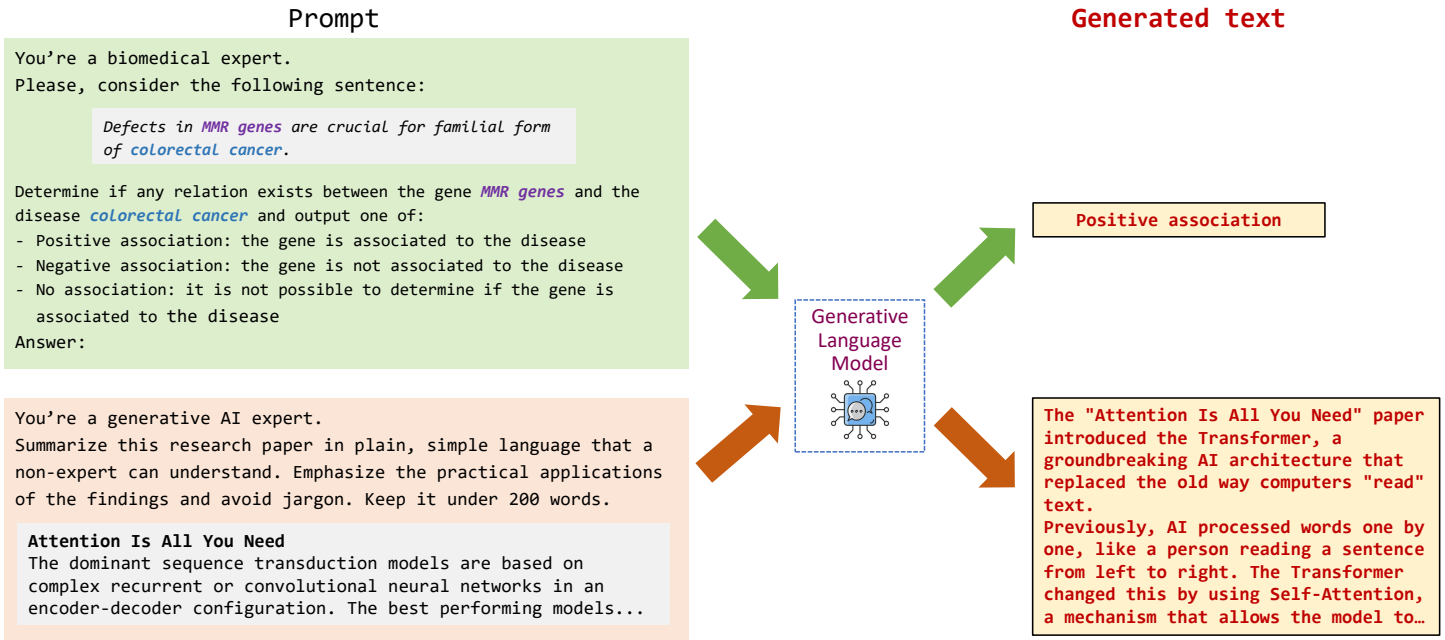
Generative Language Model can be asked to perform a wide variety of tasks without task-specific training

The efforts needed to adapt to / exploit a Large Language Model for a downstream task are significantly lower since such

Large Language Models mirror human reasoning by interacting in a dialogue-like style

Emergent abilities of Generative Language Models: from fine-tuning to in-context learning

Detection of gene-disease relations by IN-CONTEXT LEARNING



Enhancing emergent abilities of Generative Language Models

Modern Large Language Models achieves deeper layers of language comprehension and generation, **far beyond simple next-word predictions**

Core ability

Generating the most plausible text in response to an input

Emergent abilities

- Generating coherent and creative textual content
- Understanding complex contextual information
- Problem-solving and reasoning skills
- Summarizing content from multiple and varied sources

Comparing ChatGPT and GPT-4 performance in USMLE soft skill assessments

Dana Brin, Vera Sorin, Akhil Vaid, Ali Soroush, Benjamin S. Glicksberg, Alexander W. Charney, Girish Nadkarni & Eyal Klang

Scientific Reports **13**, Article number: 16492 (2023) | Cite this article

10k Accesses | **9** Citations |

LLM versus human

When comparing AI performance to human performance, AMBOSS[illegible] an average correct response rate of 78% by its users for the same questions we utilized in our study. ChatGPT showed lower accuracy than human users, 61%, while GPT-4 had a higher accuracy rate of 86.4%.

nature human behaviour

Article

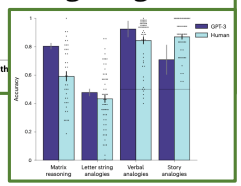
https://doi.org/10.1038/s41562-023-01659-w

Emergent analogical reasoning in large language models

Received: 18 December 2022

Accepted: 16 June 2023

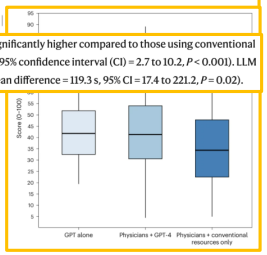
Taylor Webb[illegible], Keith[illegible]



GPT-4 assistance for improvement of physician performance on patient care tasks: a randomized controlled trial

Nature Medicine **31**, 1233–1238 (2025)

Physicians using the LLM scored significantly higher compared to those using conventional resources (mean difference = 6.5%, 95% confidence interval (CI) = 2.7 to 10.2, $P < 0.001$). LLM users spent more time per case (mean difference = 119.3 s, 95% CI = 17.4 to 221.2, $P = 0.02$).



Enhancing emergent abilities of Generative Language Models

Emergent abilities

- Generating coherent and creative textual content
- Understanding complex contextual information
- Problem-solving and reasoning skills
- Summarizing content from multiple and varied sources

How can **Emergent abilities** be improved?

SCALING THE SIZE OF LARGE LANGUAGE MODELS

Model name	Release date	Number params
BERT-large	Oct. 2018	345M
GPT-2	Feb. 2019	1.5B
GPT-3	Jun. 2020	175B
PaLM	Mar. 2023	540B
GPT-4	Mar. 2023	1000B

Once an **Emergent ability** emerges, there's **no guarantee that it will continue to improve with scale** (still to be better investigated)

Enhancing emergent abilities of Generative Language Models

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Once an **Emergent ability** emerges, there's **no guarantee that it will continue to improve with scale** (still to be better investigated)

Improving **Emergent abilities** of Large Language Models by **increasing the size of the model** is expensive in terms of **money**, **compute power** and **environmental cost**

*Which alternative approaches can be exploited to improve **Emergent abilities** at smaller scale?*

- IMPROVED MODEL ARCHITECTURE
- TRAINING DATA SELECTION / GENERATIONS
- TRAINING / FINE-TUNING
- INFERENCE-TIME SCALING

Introduction to AI agents

PART I

What is an AI agent?

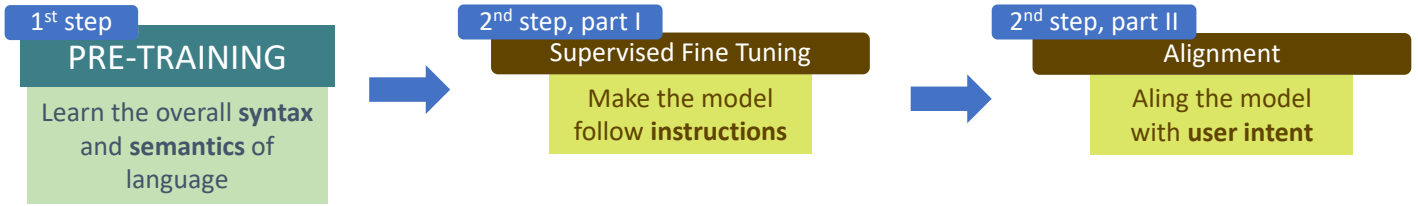
Generative Language Models: the brain of AI agents

The training journey of Generative Language Models

5th February 2026 - Barcelona

Generative Language Models: the training journey

Training a Generative Language Model - i.e. typically a Transformer neural network - involves a sequence of steps through with the model learns how to generate textual contents with **syntactic and semantic coherence**, **following specific instructions**, and **adhering to desired interaction patterns and behaviours**



Generative Language Models: the training journey

1st step

PRE-TRAINING

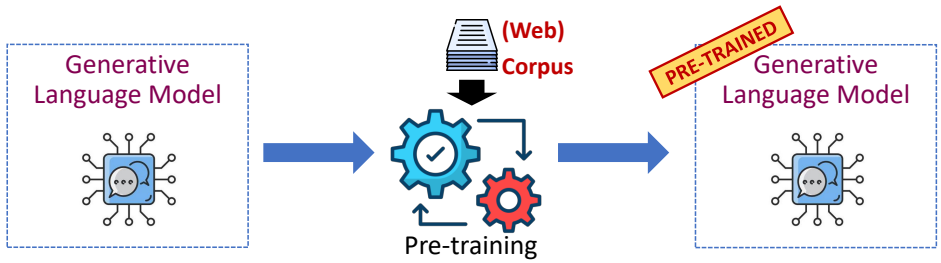
The model learns patterns and relationships from large volumes of textual data to generate new text

The Generative Language Model **learns** the overall semantics of language by means of **unsupervised training** over **huge collections of textual data**

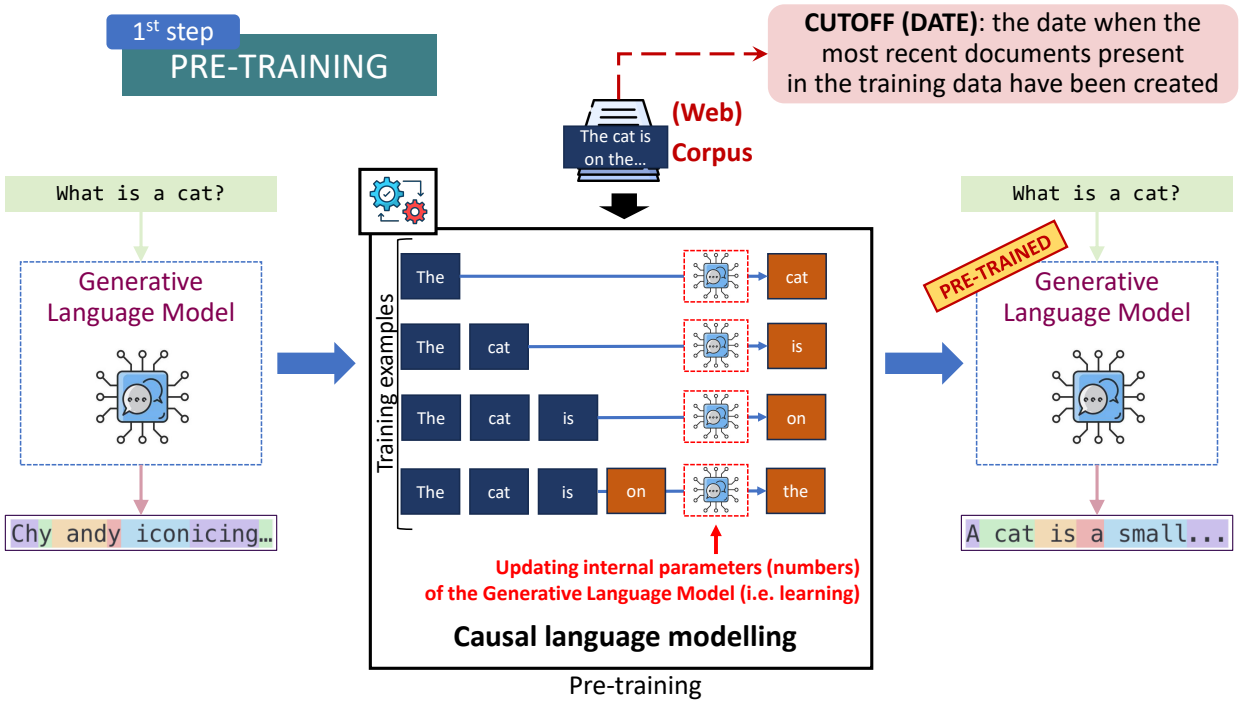
The model learns patterns (mainly) from unlabeled data

CommonCrawl dataset (Web Corpus)
November/December 2023

- **3.35 billion** Web pages, > **600 billion** tokens
- **454 TiB** of uncompressed content



Generative Language Models: the training journey



Generative Language Models: the training journey

1st step

PRE-TRAINING

Expensive process in terms of **money** and environmental cost

Model name	Release date	Number params	Cost (approx.)
BERT-large	Oct. 2018	345M	7,000$
GPT-2	Feb. 2019	1.5B	40,000$
GPT-3	Jun. 2020	175B	4,600,000$
PaLM	Mar. 2023	540B	13,000,000$
GPT-4	Mar. 2023	1000B	> 100,000,000$

GPT-4 was pre-trained on 25,000 Nvidia A100 GPUs for 100 days

Generative Language Models: the training journey

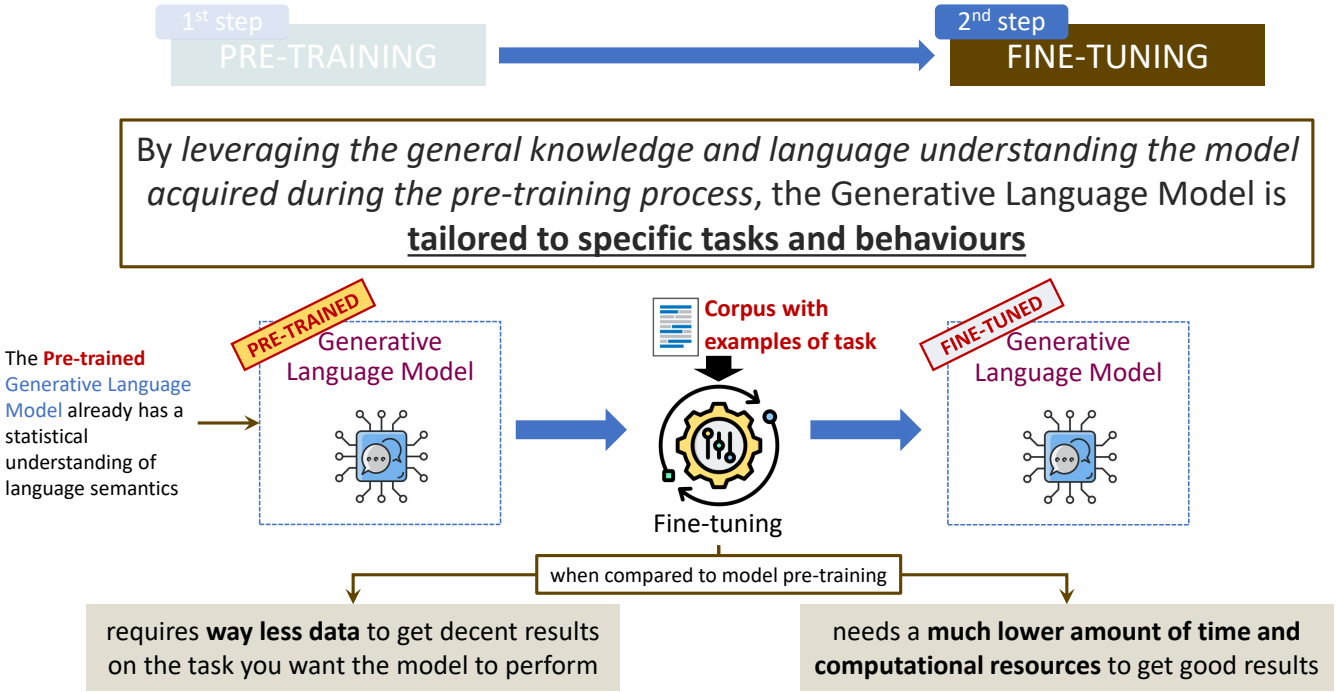
1st step
PRE-TRAINING

Expensive process in terms of money and **environmental cost**

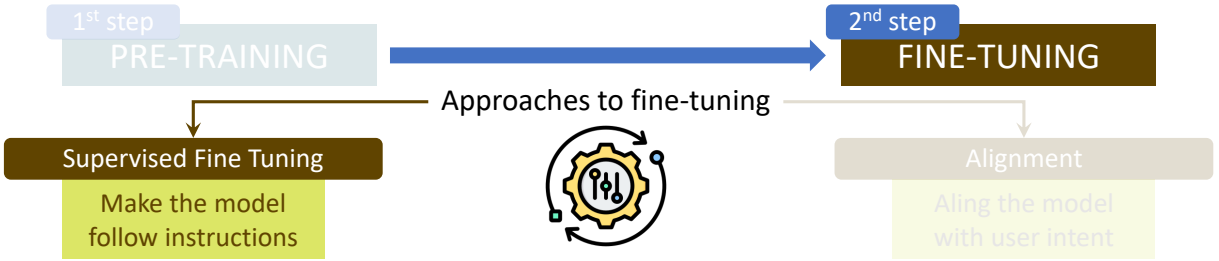
Model name	Release date	Number params	Cost (approx.)	CO2 emissions
BERT-large	Oct. 2018	345M	7,000$	**6,000 kg**
GPT-2	Feb. 2019	1.5B	40,000$	**300,000 kg**
GPT-3	Jun. 2020	175B	4,600,000$	**552,000 kg**
PaLM	Mar. 2023	540B	13,000,000$	**271,000 Kg**
GPT-4	Mar. 2023	1000B	> 100,000,000$	**6,912,000 kg**

- 1-year life in USA: **16,400 kg CO2**
- Driving one average American cars through its lifetimes (incl. fuel): **80,000 kg**

Generative Language Models: the training journey

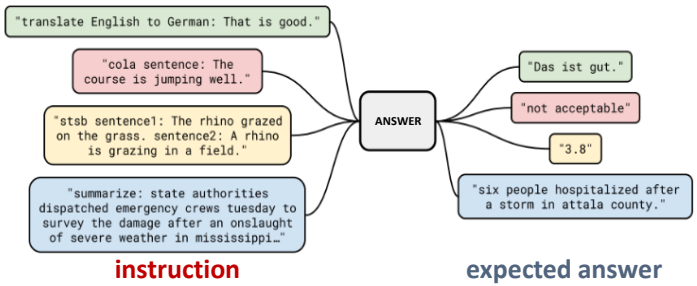


Generative Language Models: the training journey

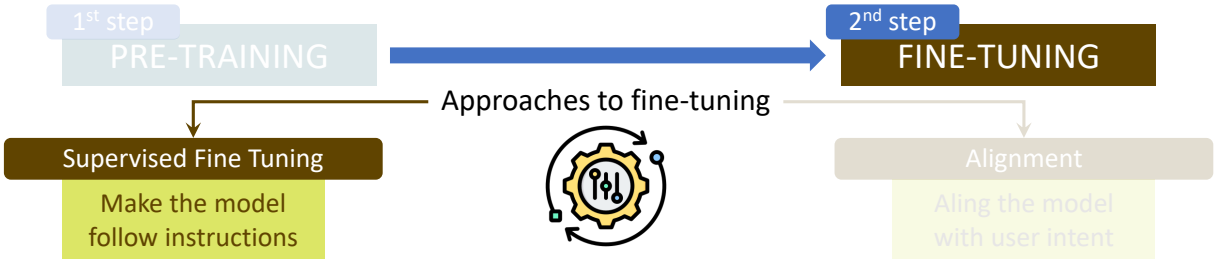


Can we improve the way a Generative Language Model would understand and follow user provided instructions, when generating their answers?

Instruction tuning dataset
collection of **<instruction, expected answer>**, pairs, exploited to support model learning (i.e. supervised fine tuning based on instruction, also referred to instruction fine tuning)

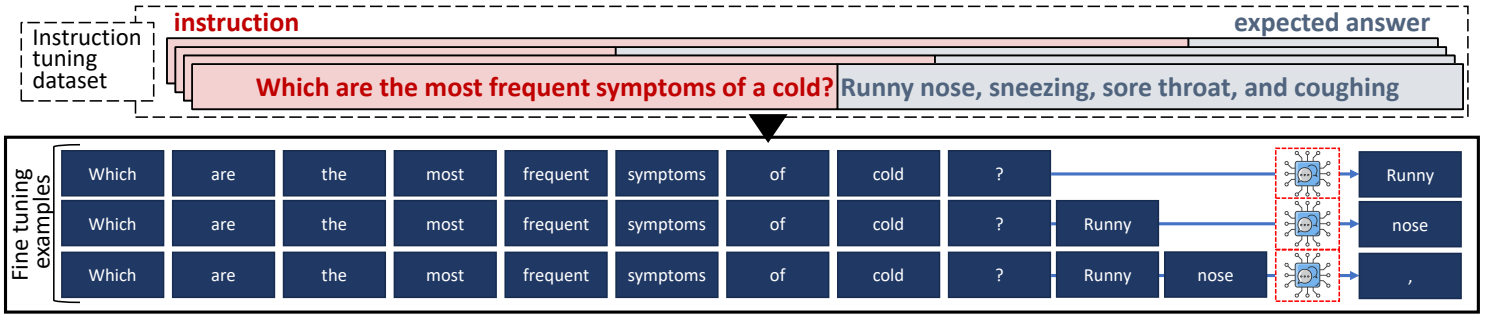


Generative Language Models: the training journey

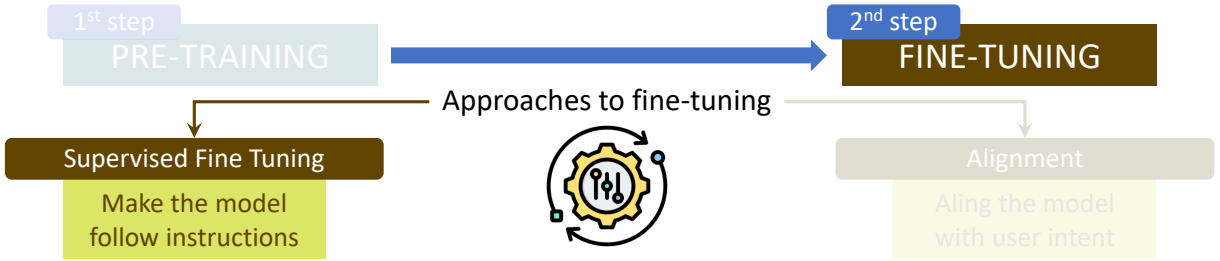


How does the model lean in Supervised Fine Tuning?

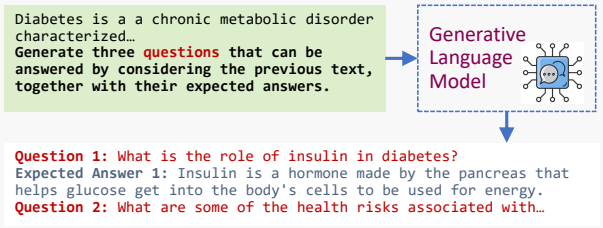
Like in pre-training, the Generative Language Model is trained on **next-token prediction over the expected answers**



Generative Language Models: the training journey



Instructions are often **artificially-generated** by relying on powerful Generative Language Models

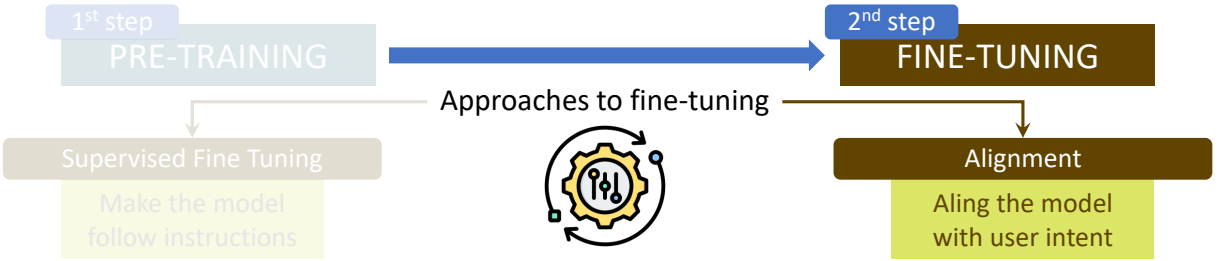


→ The **quality and diversity of instructions are fundamental** to effectively perform instruction fine tuning

→ The **performance of small Language Models can be substantially increased** by instruction fine tuning

→ Using powerful Language Models to generate instructions can reduce cost but could **reinforce biases and shortcomings present in the instruction generator Language Model**

Generative Language Models: the training journey



How can we enforce a Generative Language Model to act in accordance with human goals, principles, and preferences?

Generative Language Model **align their text generation strategies based on preference scores**:

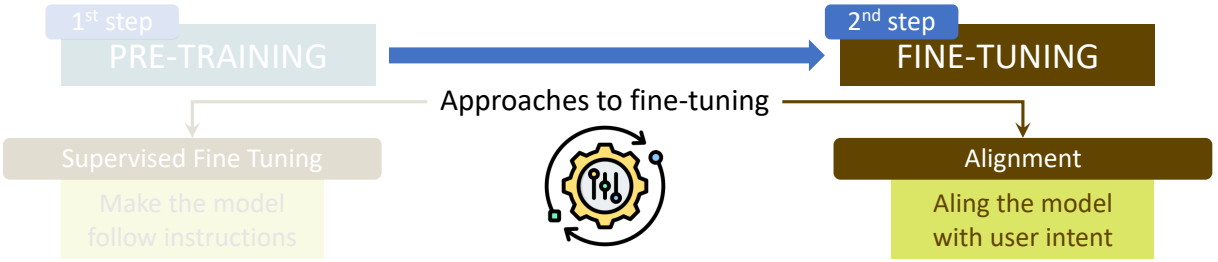
- **valid, well-phrased responses** (i.e. generated texts) receive *high preference scores* and their generation will be favored
- **invalid, misleading, biased responses** (i.e. generated texts) receive *low preference scores* and their generation will be discouraged

Supervised Fine Tuning restricts the model to learn the sequence of tokens of a specific **expected answer**, given the related **instruction**

Alignment dataset

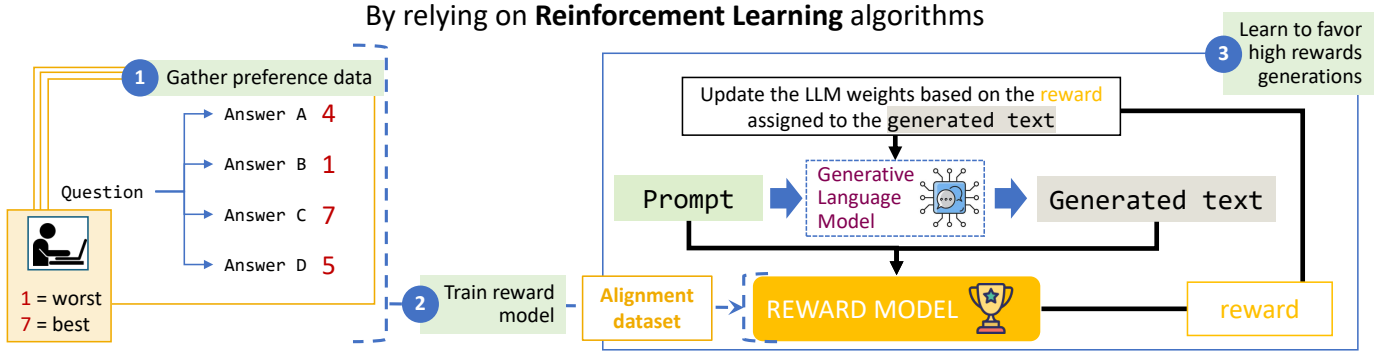
Prompt	Chosen Response	Rejected Response
What is the capital of France?	Paris	The capital of France is Berlin.
Write a short poem about the ocean.	The ocean waves crash on the shore...	The ocean is a big puddle.
Explain the concept of photosynthesis.	Photosynthesis is the process by which plants...	Photosynthesis is when plants grow.

Generative Language Models: the training journey

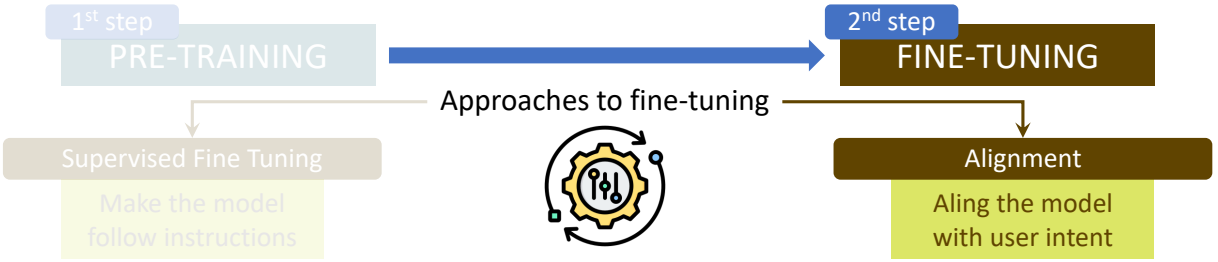


How does the model is aligned to (learns to follow) human preferences?

By relying on **Reinforcement Learning** algorithms



Generative Language Models: the training journey



Training language models to follow instructions with human feedback

OpenAI, 2022

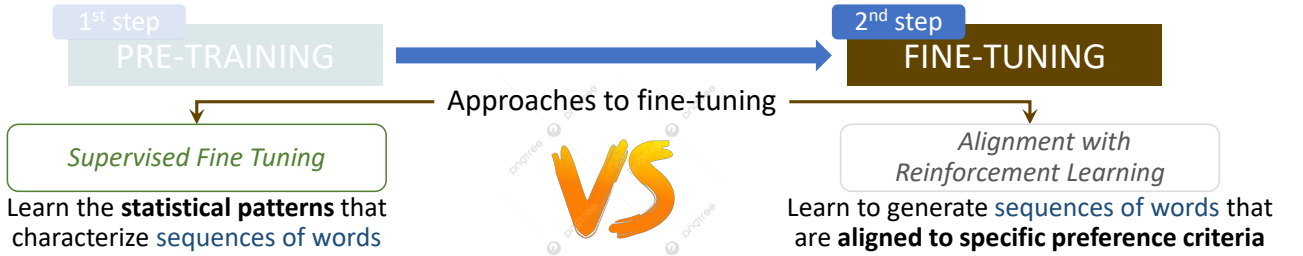
Align Language Models with user intent on a wide range of tasks by Reinforcement Learning from Human Feedback (RLHF)

In human evaluations, ***outputs from the 1.3B parameter InstructGPT model are preferred to outputs from the 175B GPT-3****, despite having 100x fewer parameters*

Relevant examples of alignment algorithms

- Reinforcement Learning from AI Feedback (RLAIF)
- Direct Preference Optimization (DPO)
- Group Relative Policy Optimization (GPRO)

Generative Language Models: the training journey



In *Supervised Fine Tuning* the Generative Language Model is **forced to match the demonstrated response (completion)**, even if wrong or semantically ambiguous

Question: What's an example of a language?
Expected answer: Spanish

This would **penalize other semantically correct responses like 'Java'**. This is mitigated by *alignment with Reinforcement Learning*.

Alignment with Reinforcement Learning has been shown effective in **reducing LLM hallucinations** and has been effectively exploited to **boost reasoning capabilities** of Generative Language Models

Supervised Fine Tuning mainly exploits positive signals to train the model (i.e. the expected completion for a prompt), **without considering / exploiting bad responses**, while *alignment with Reinforcement Learning* enables the exploitation of negative feedbacks to enhance / align the target LLM

Alignment with Reinforcement Learning can be **hard to properly tune** and needs to be supported by **preference models that are effective in reward estimation** (the latter issues is mitigated by the exploitation of automatically verifiable tasks)

Generative Language Models: the training journey

1st step

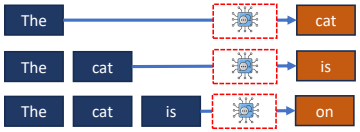
PRE-TRAINING

Learn the overall syntax and semantics of language

(Web) Corpus

billions to trillions of tokens

Next-token prediction

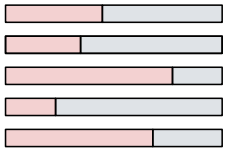


2nd step, part I

Supervised Fine Tuning

Make the model follow instructions

<question, expected answer> pairs



Question: Which is the capital of France?
Expected answer: Paris

tens to hundreds of thousands of prompt-completion pairs

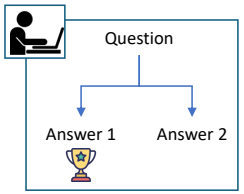
Next-token prediction

like pre-training, but relying prompt-completion pairs instead of free-text to make the LLM learn how to follow and answer to specific instructions

2nd step, part II

Alignment

Aling the model with user intent



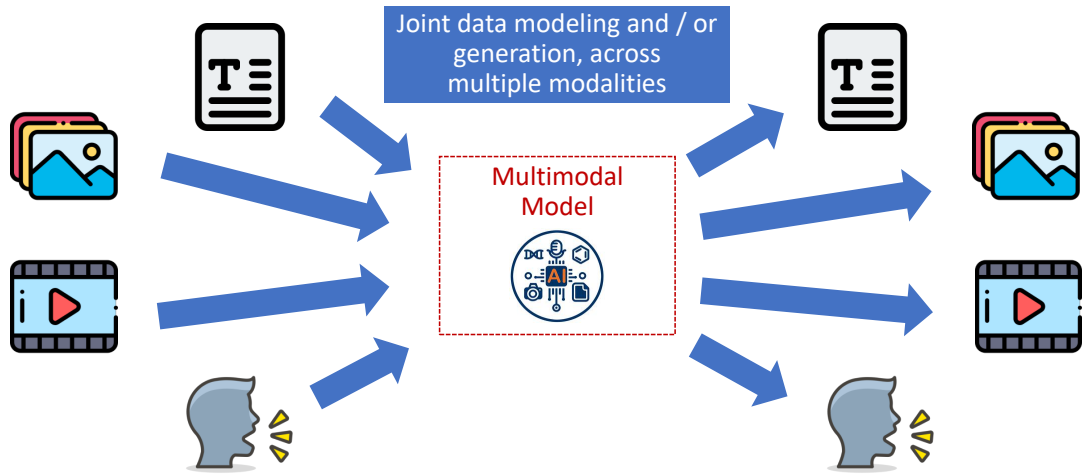
tens to hundreds of thousands of evaluation pairs

Reinforcement learning on (human) preferences

to iteratively improve the ability of the LLM to generate text that is compliant with a defined set of values and preferences

Beyond text: extending Language Models with additional modalities

Multimodal Language Models can consider distinct input modalities (e.g. text, images, etc.) to drive the generation of textual content



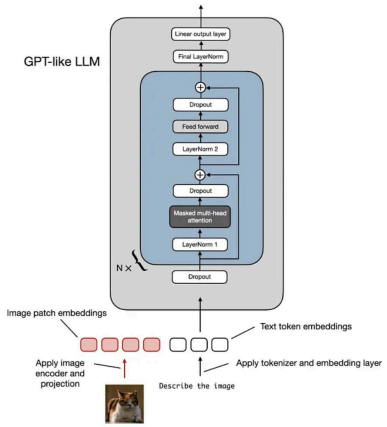
Soruce: Wadekar, S. N. et al. (2024). The evolution of multimodal model architectures. *arXiv preprint arXiv:2405.17927*.

Beyond text: extending Language Models with additional modalities

Multimodal Language Models can consider distinct input modalities (e.g. text, images, etc.) to drive the generation of textual content

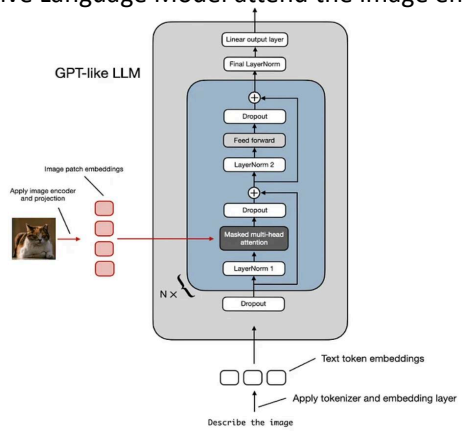
Approaches to integrate images as additional input modality to Generative Language Models

Generate and (learn to) project image (or patches) embedding as additional input tokens for the Generative Language Model



Soruce: https://magazine.sebastianraschka.com/p/understanding-multimodal-llms

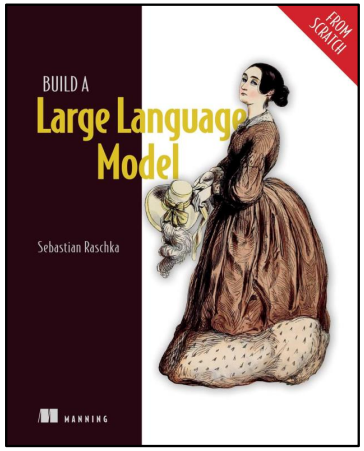
Rely on cross modality attention to condition to make the Generative Language Model attend the image embeddings

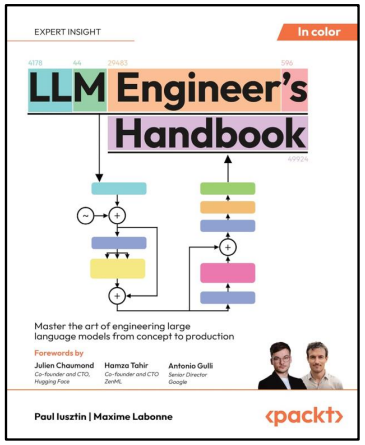


Conclusions

- The recent rise of agentic AI is grounded on the **availability of powerful Generative Language Models** acting as the brains of AI agents, and enabling AI agents to virtually deal with any domain and scenario thanks to **interactions mediated by natural language communication** (i.e. in context-learning)
- Most of current Generative Language Models strongly rely on the key traits of the **Transformer neural architecture, proposed in 2017**, enhancing its *scale*, *learning patterns*, and *optimization approaches*
- When interacting with Generative Language Models (and AI agents build on top of them), two key concerns to consider are **non-deterministic text generation** and **stateless nature**
- The **sequences of steps (pre-training, fine-tuning, alignment) exploited to make Generative Language Models learn the semantics of language** strongly affect their text understanding, reasoning and alignment abilities

Suggested resources





upf.

Tanks for your attention!
Any question?

In-flight feedback

https://qr.codes/bCtvHp

Introduction to AI agents

PART I

> What is an AI agent?

> Generative Language Models: the brain of AI agents

> The training journey of Generative Language Models

Francesco Ronzano

Universitat Pompeu Fabra (UPF)

5th February 2026 - Barcelona