The Evolution of Large Language Models: Transforming Natural Language Processing Over Time

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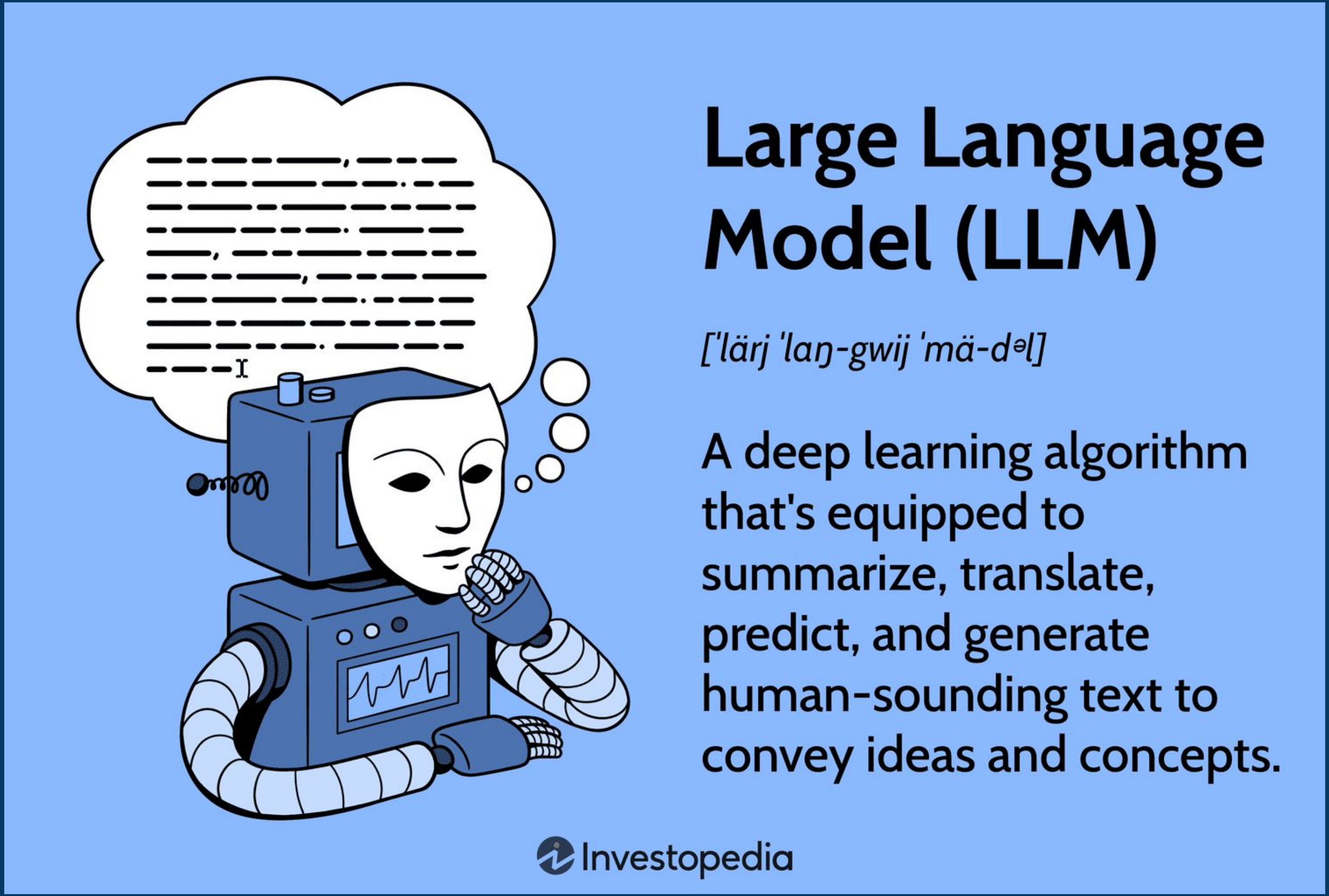


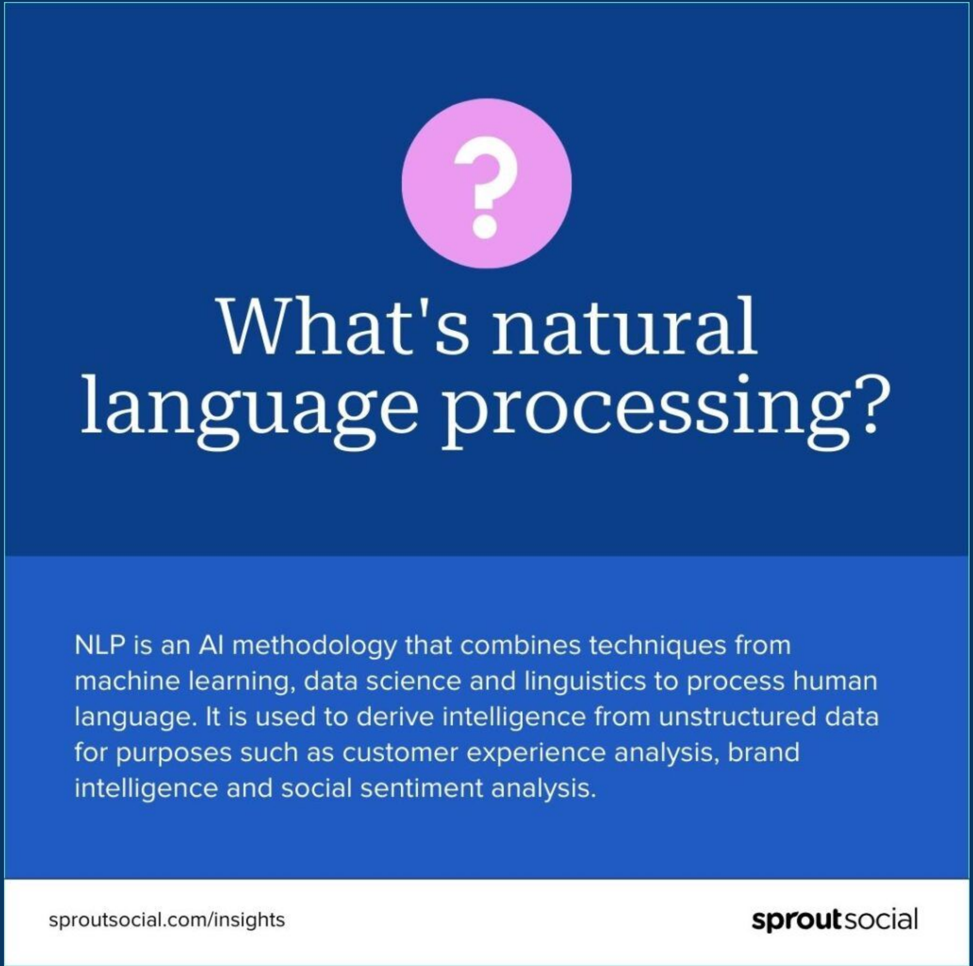
Large Language Model (LLM)

[ˈlärj ˈlaŋ-gwij ˈmä-dᵊl]

A deep learning algorithm that's equipped to summarize, translate, predict, and generate human-sounding text to convey ideas and concepts.

Investopedia

All Images from Google



What's natural language processing?

NLP is an AI methodology that combines techniques from machine learning, data science and linguistics to process human language. It is used to derive intelligence from unstructured data for purposes such as customer experience analysis, brand intelligence and social sentiment analysis.

sproutsocial.com/insights

sproutsocial

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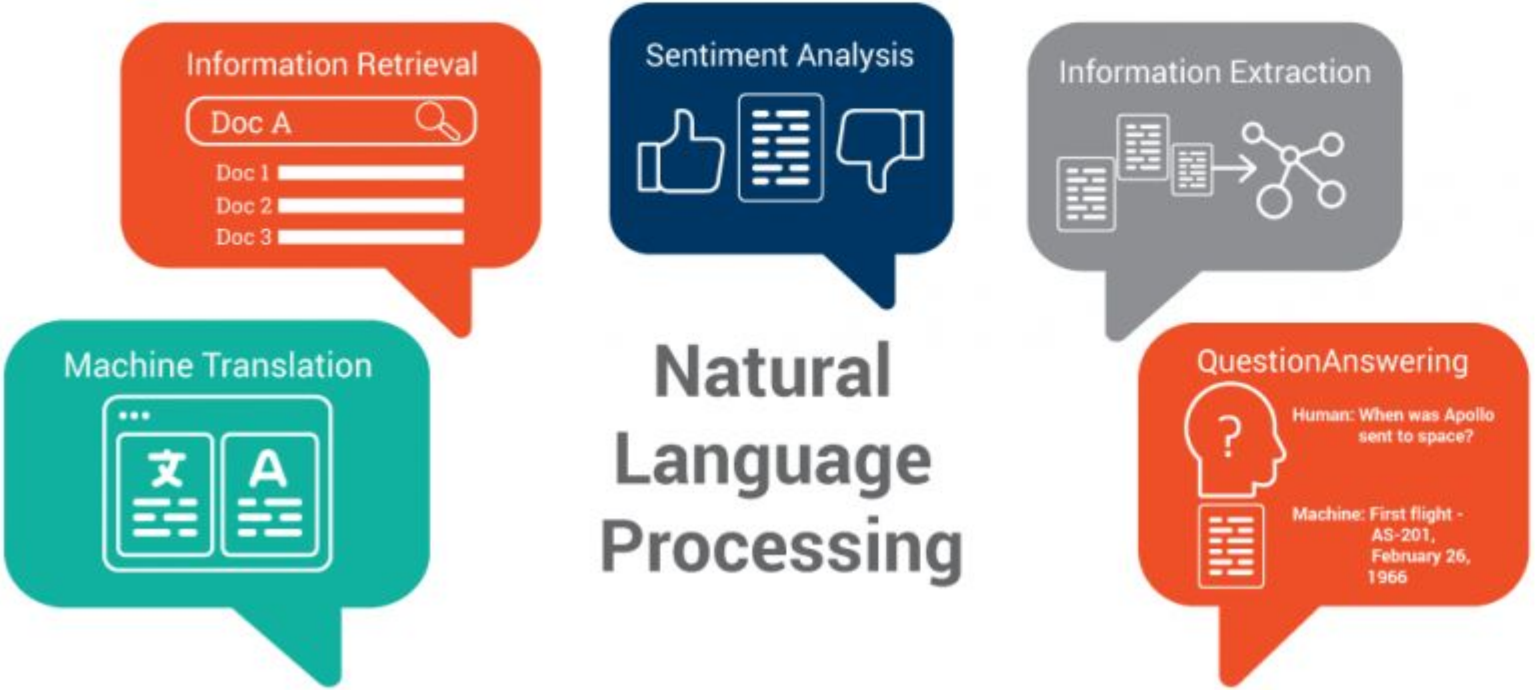
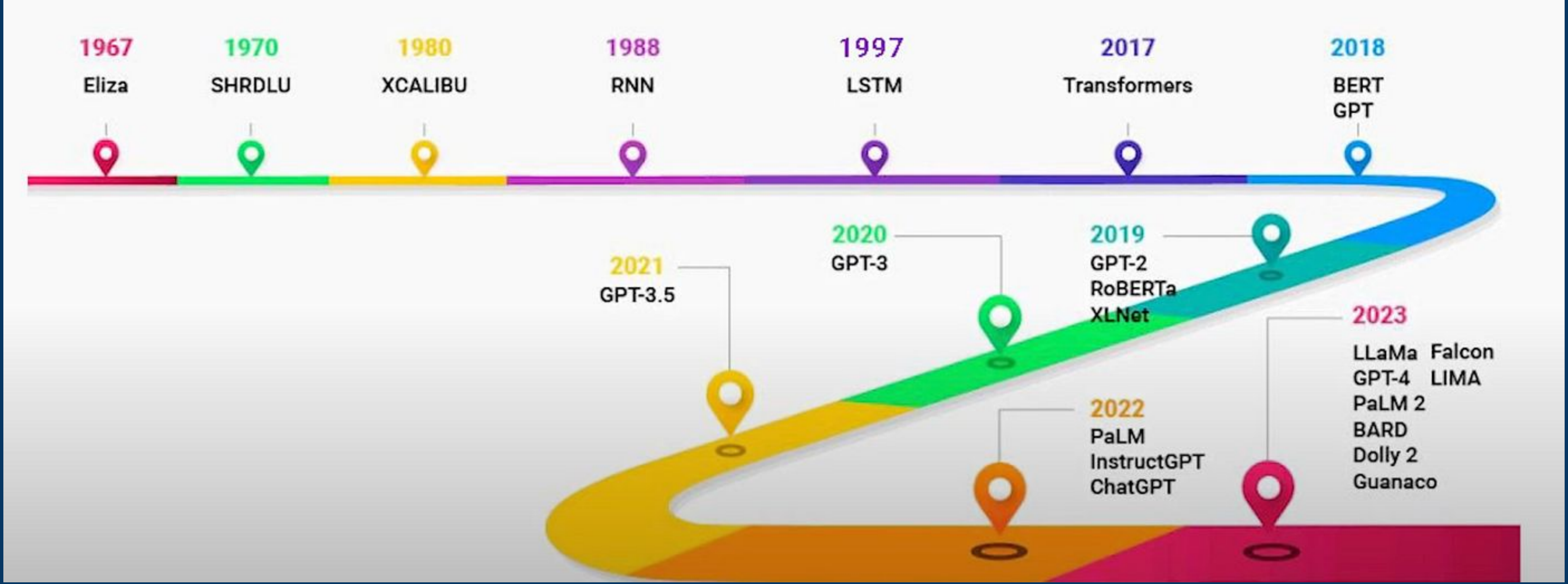


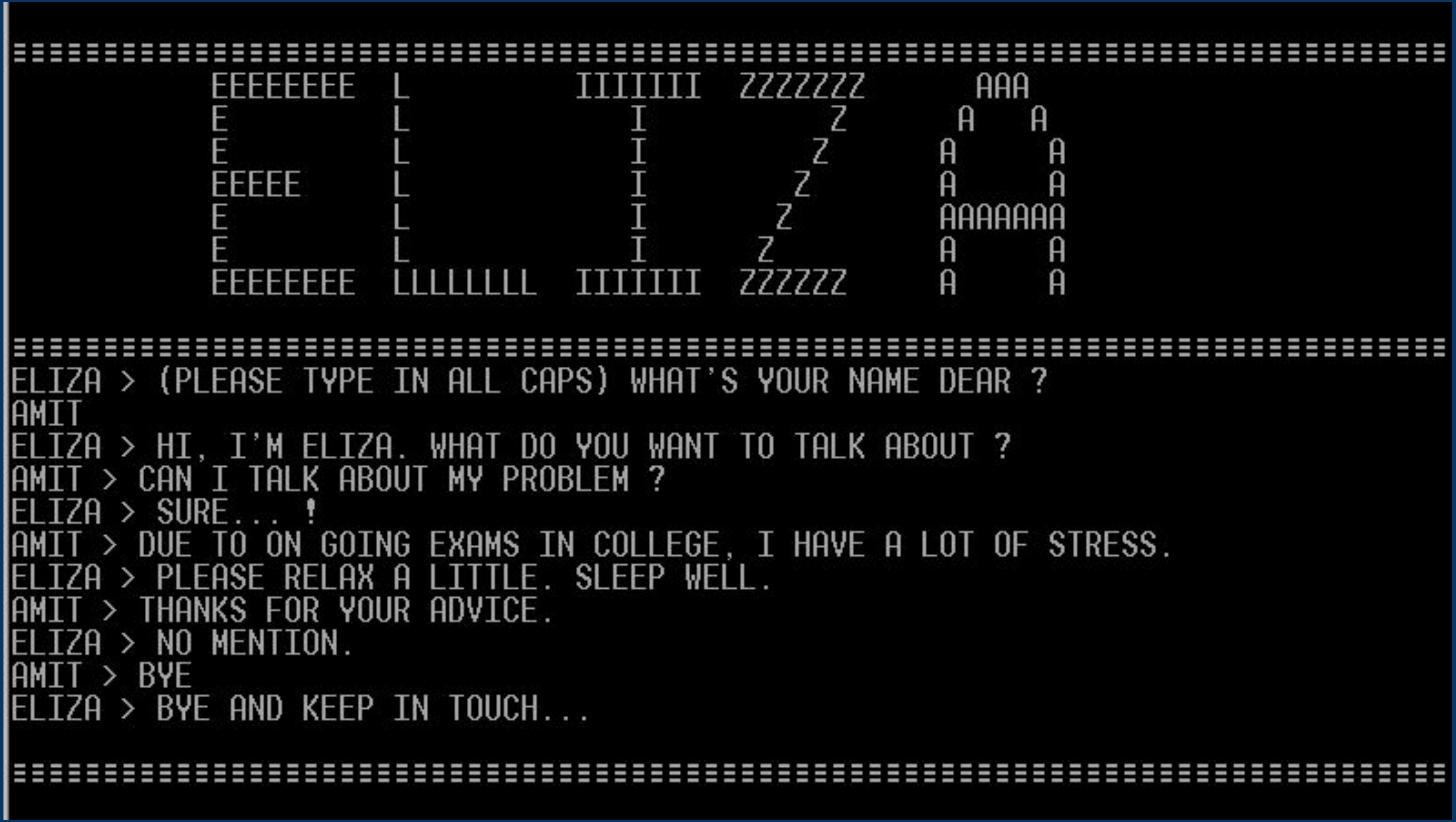
Natural Language Processing

Human: When was Apollo sent to space?

Machine: First flight - AS-201, February 26, 1966

Language Models Over Time

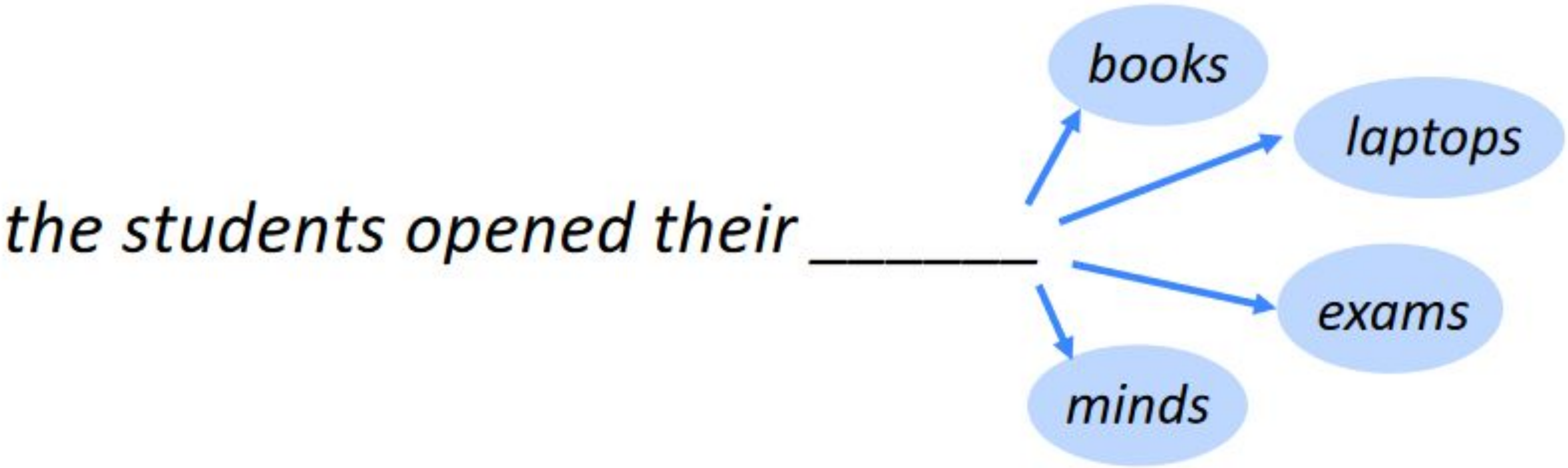




```
===============================================================================
           EEEEEEEE  L         IIIIIII  ZZZZZZZ      AAA
           E         L            I           Z     A   A
           E         L            I          Z     A     A
           EEEEE     L            I         Z      A     A
           E         L            I        Z       AAAAAAA
           E         L            I       Z        A     A
           EEEEEEEE  LLLLLLLL  IIIIIII  ZZZZZZ     A     A

===============================================================================
ELIZA > (PLEASE TYPE IN ALL CAPS) WHAT'S YOUR NAME DEAR ?
AMIT
ELIZA > HI, I'M ELIZA. WHAT DO YOU WANT TO TALK ABOUT ?
AMIT > CAN I TALK ABOUT MY PROBLEM ?
ELIZA > SURE... !
AMIT > DUE TO ON GOING EXAMS IN COLLEGE, I HAVE A LOT OF STRESS.
ELIZA > PLEASE RELAX A LITTLE. SLEEP WELL.
AMIT > THANKS FOR YOUR ADVICE.
ELIZA > NO MENTION.
AMIT > BYE
ELIZA > BYE AND KEEP IN TOUCH...

===============================================================================
```



the students opened their ______

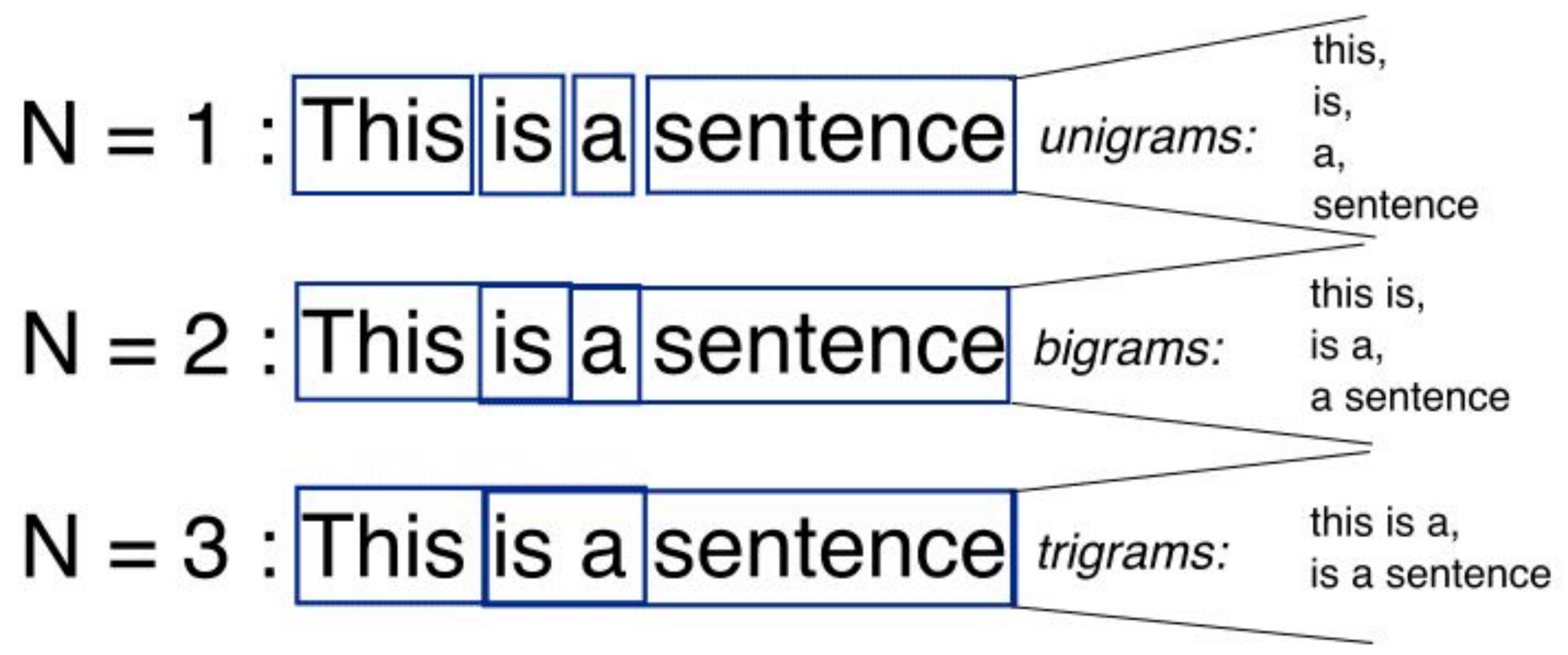
books

laptops

exams

minds

N-GRAM Model


N = 1 : This is a sentence
unigrams:
this,
is,
a,
sentence
N = 2 : This is a sentence
bigrams:
this is,
is a,
a sentence
N = 3 : This is a sentence
trigrams:
this is a,
is a sentence

N-Gram

N-Gram:

P (“There was heavy rain”) = P (“There”, “was”, “heavy”, “rain”) = P (“There”) P (“was” |“There”) P (“heavy”| “There was”) P (“rain” |“There was heavy”)

Not practical to calculate the conditional probability but by using the “Markov Assumptions”, this is approximated to the bi-gram model.

Bi-Gram:

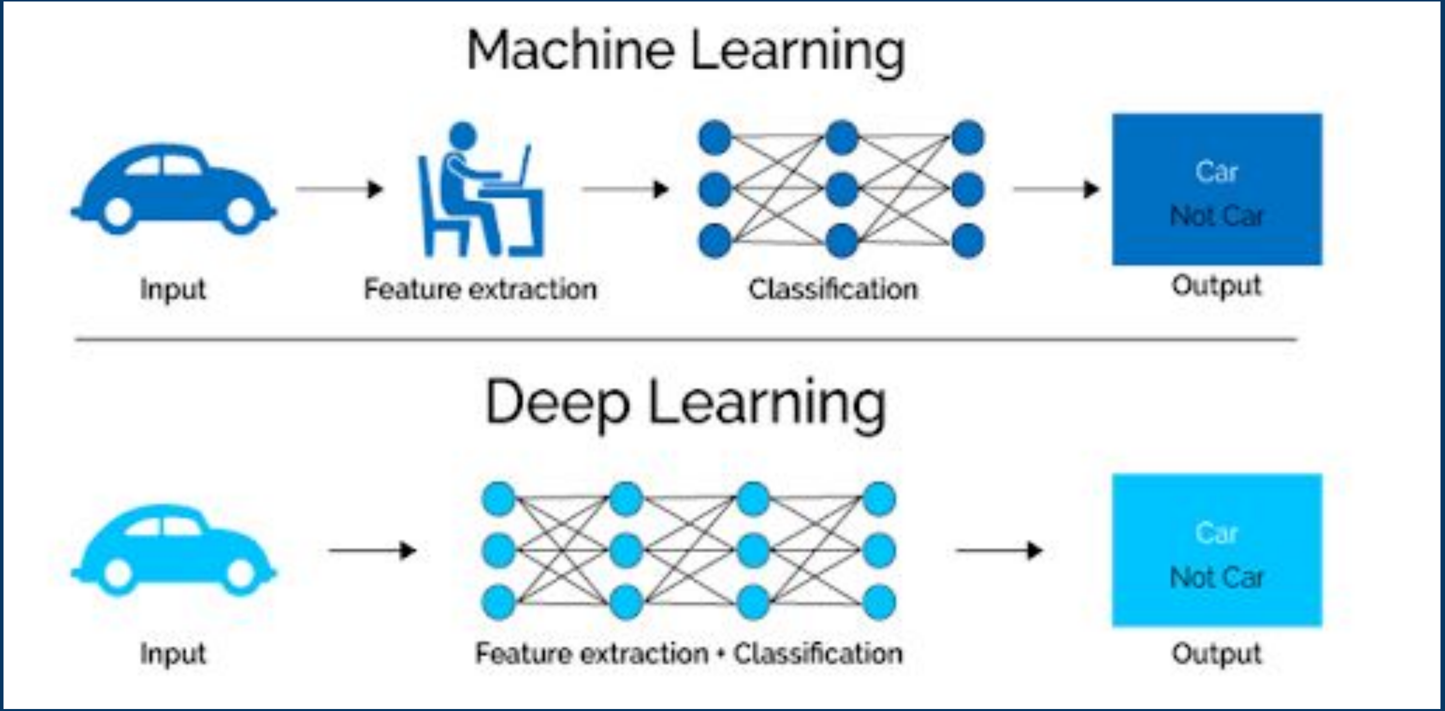
P (“There was heavy rain”) ~ P (“There”) P (“was” |“'There”) P (“heavy” |“was”) P (“rain” |“heavy”)

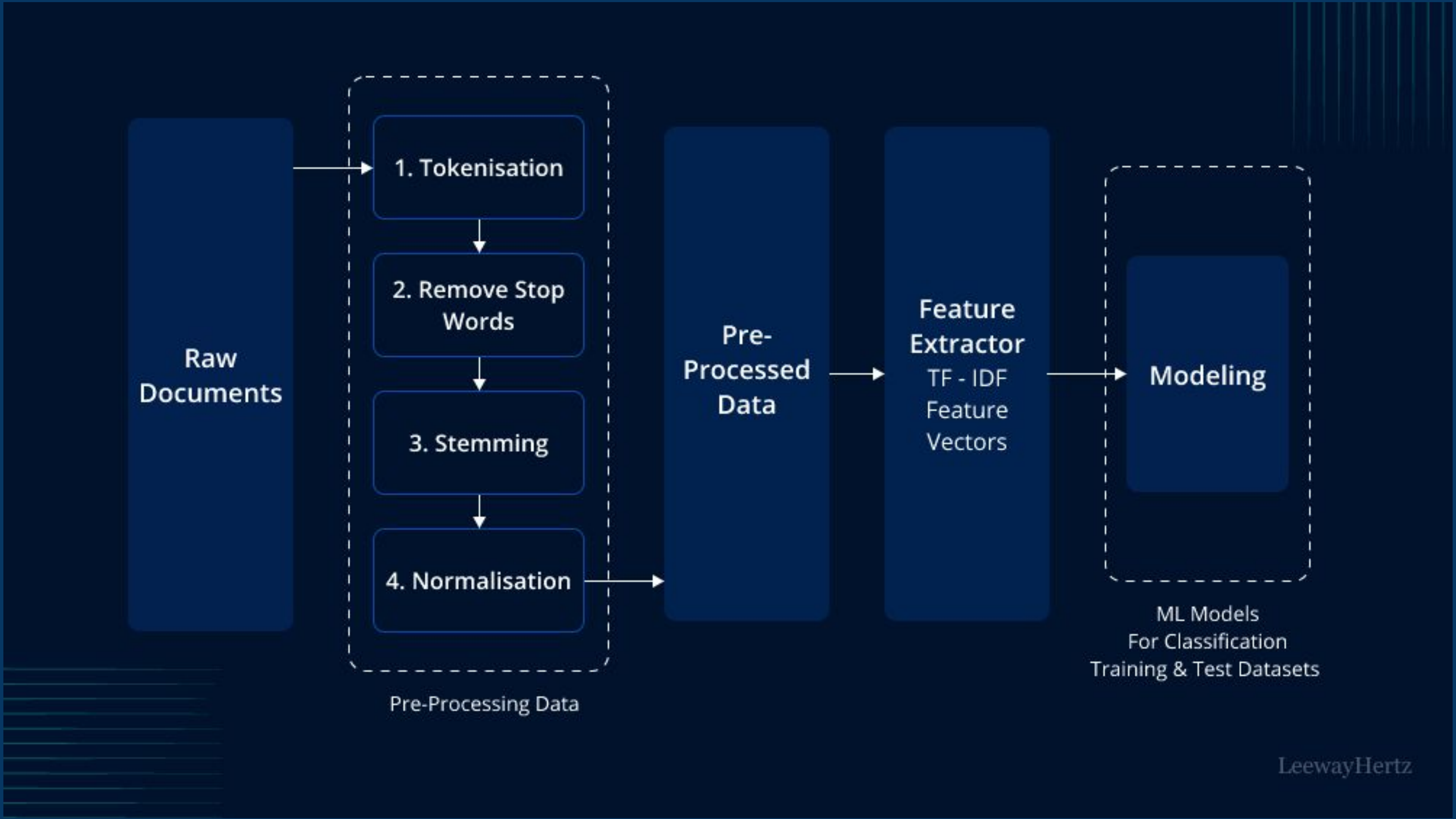
N-Gram

- Problem with the out of vocabulary words. These words are seen during testing but not in training.

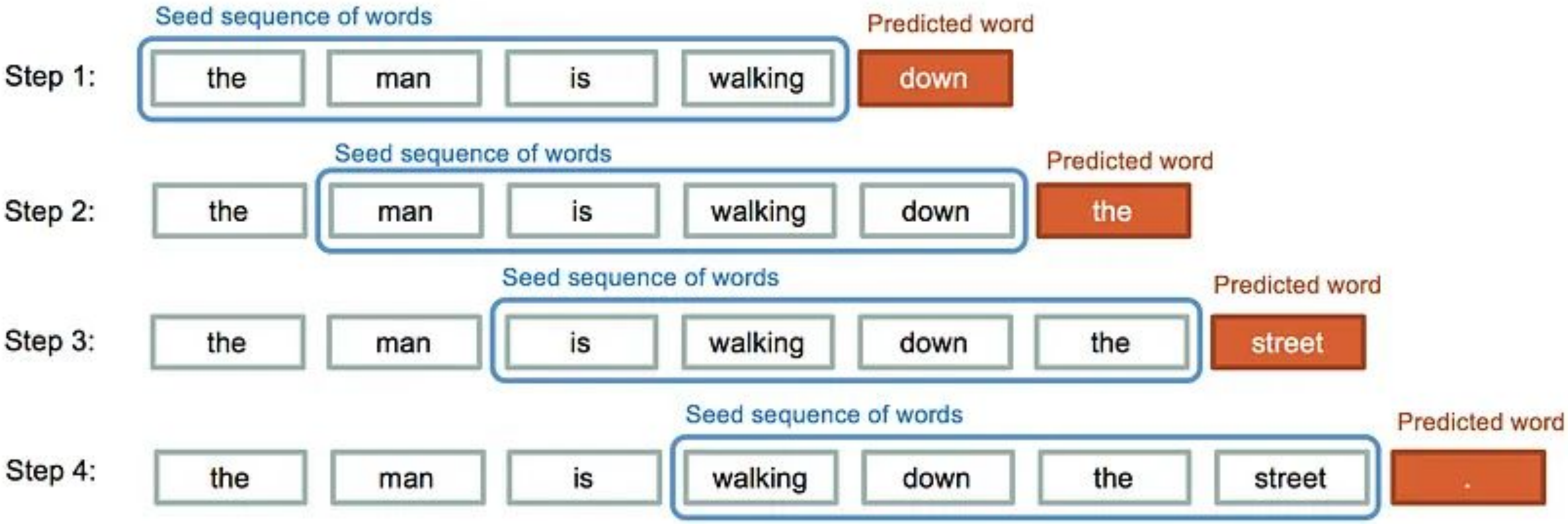
- One solution is to use the fixed vocabulary and then convert out of vocabulary words in the training to pseudowords.

- The N-gram model captures the long-distance context poorly. It has been shown after every 6-grams, the gain of performance is limited.


Machine Learning
Input
Feature extraction
Classification
Car
Not Car
Output
Deep Learning
Input
Feature extraction + Classification
Car
Not Car
Output



All Images from Google



Seed sequence of words — Predicted word

Step 1: [the man is walking] down

Seed sequence of words — Predicted word

Step 2: the [man is walking down] the

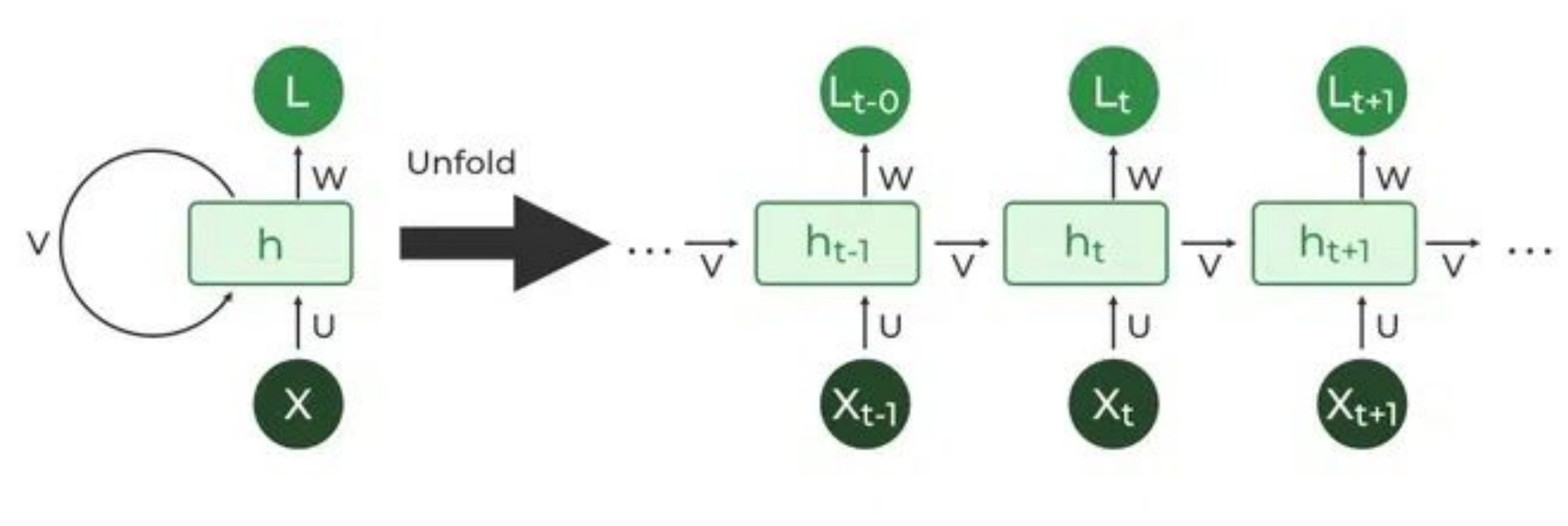
Seed sequence of words — Predicted word

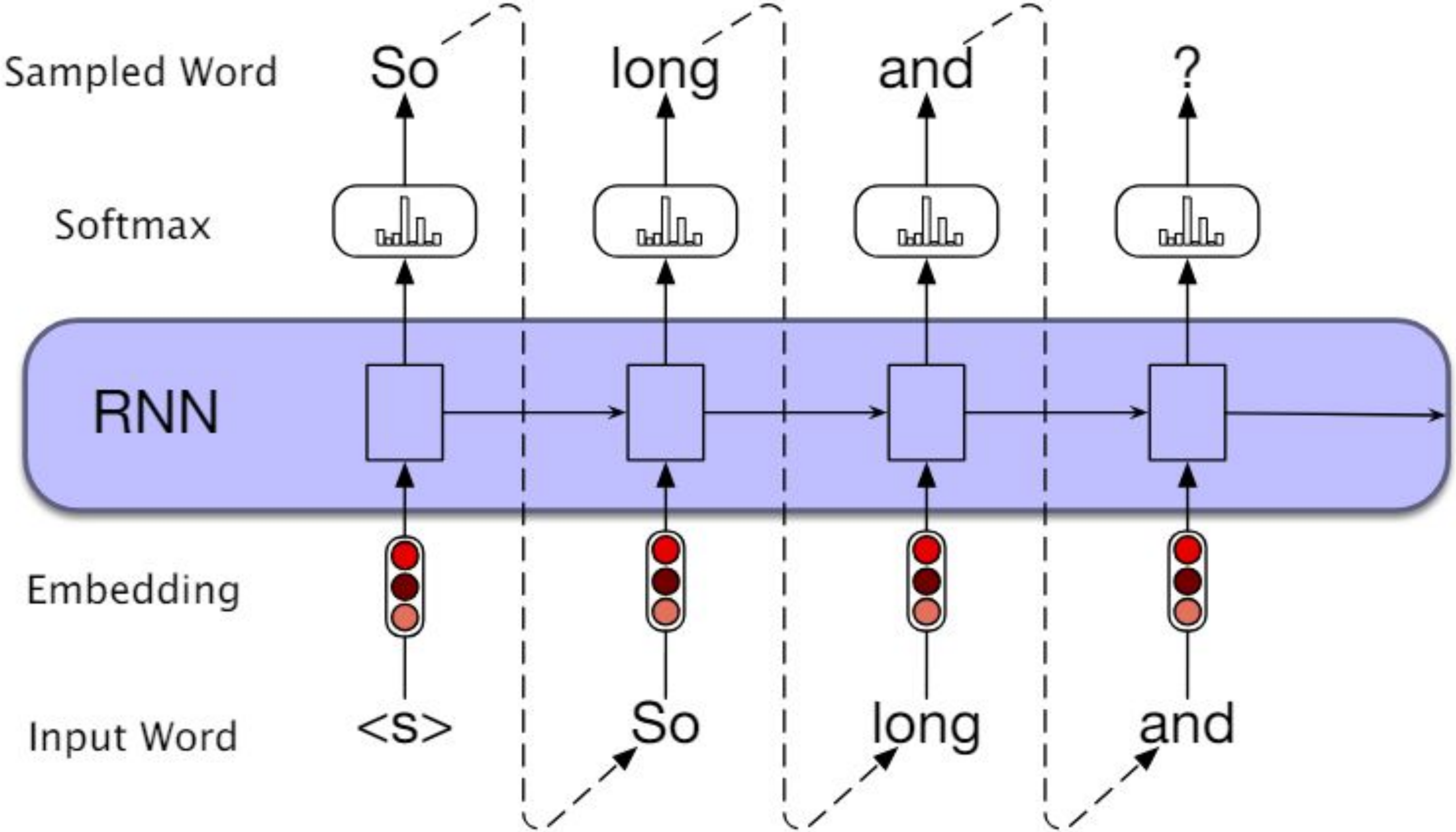
Step 3: the man [is walking down the] street

Seed sequence of words — Predicted word

Step 4: the man is [walking down the street] .

Recurrent Neural Networks




Sampled Word
So
long
and
?
Softmax
RNN
Embedding
Input Word
<s>
So
long
and

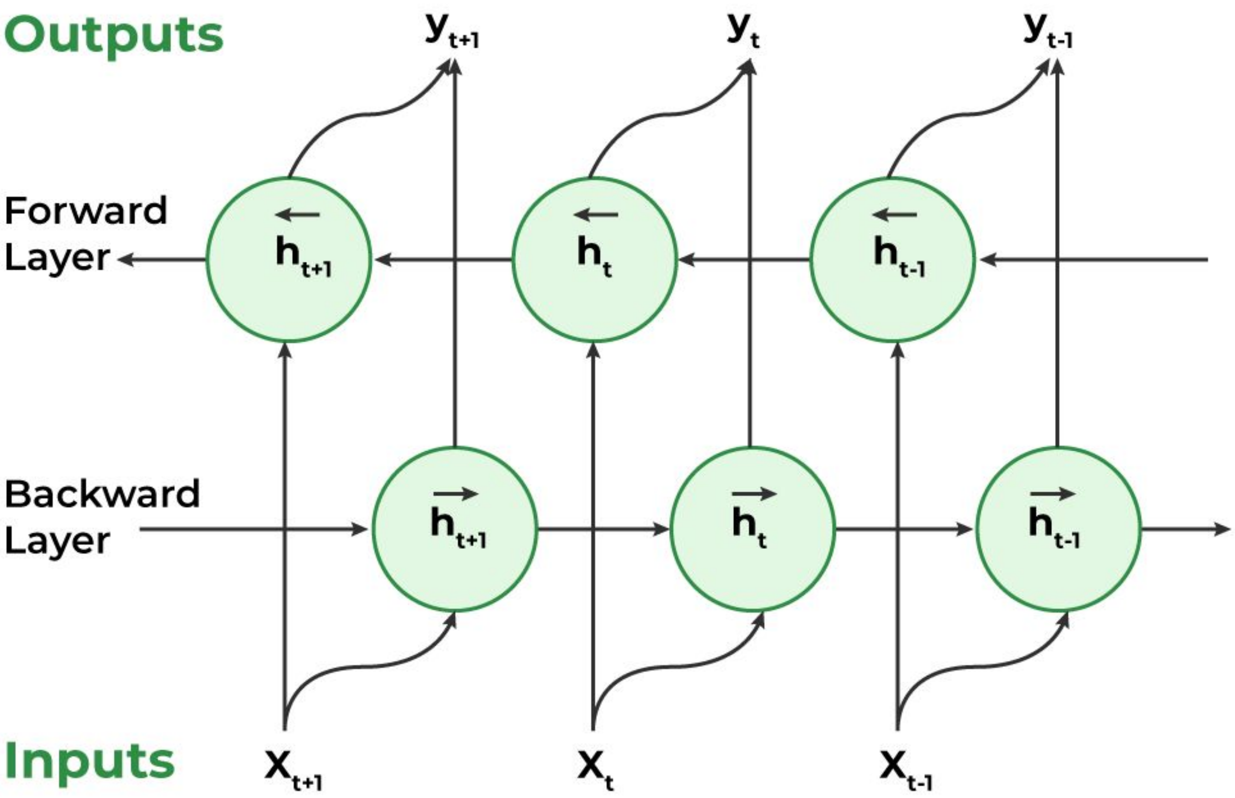
Challenges with RNN

1. **Vanishing Gradient: Vanishing gradient problem is a phenomenon that occurs during the training of deep neural networks, where the gradients that are used to update the network become extremely small or "vanish" as they are backpropogated from the output layers to the earlier layers.**

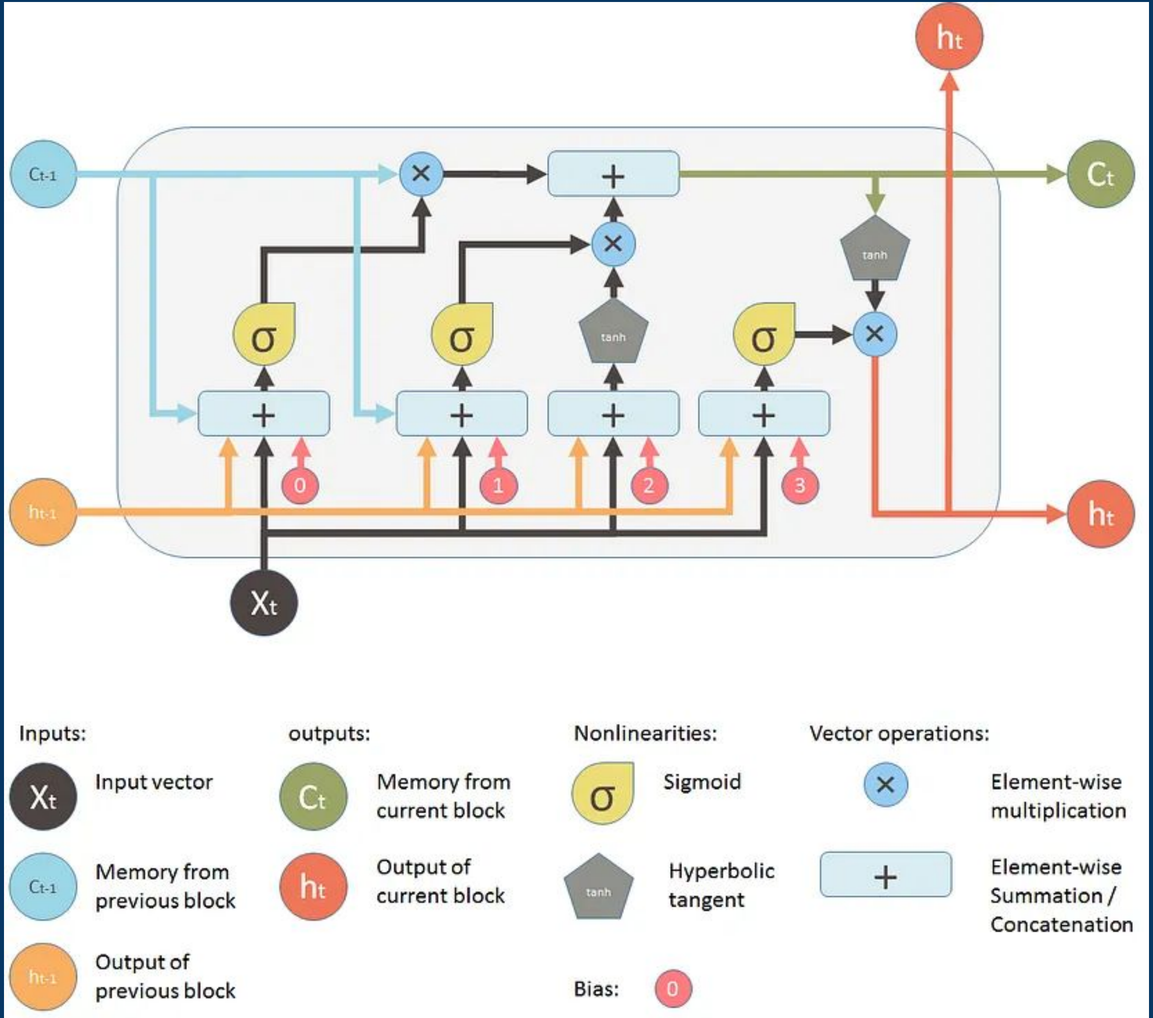
2. **Exploding Gradient: An Exploding Gradient occurs when a neural network is being trained and the slope tends to grow exponentially rather than decay. Large error gradients that build up during training lead to very large updates to the neural network model weights, which is the source of this issue.**

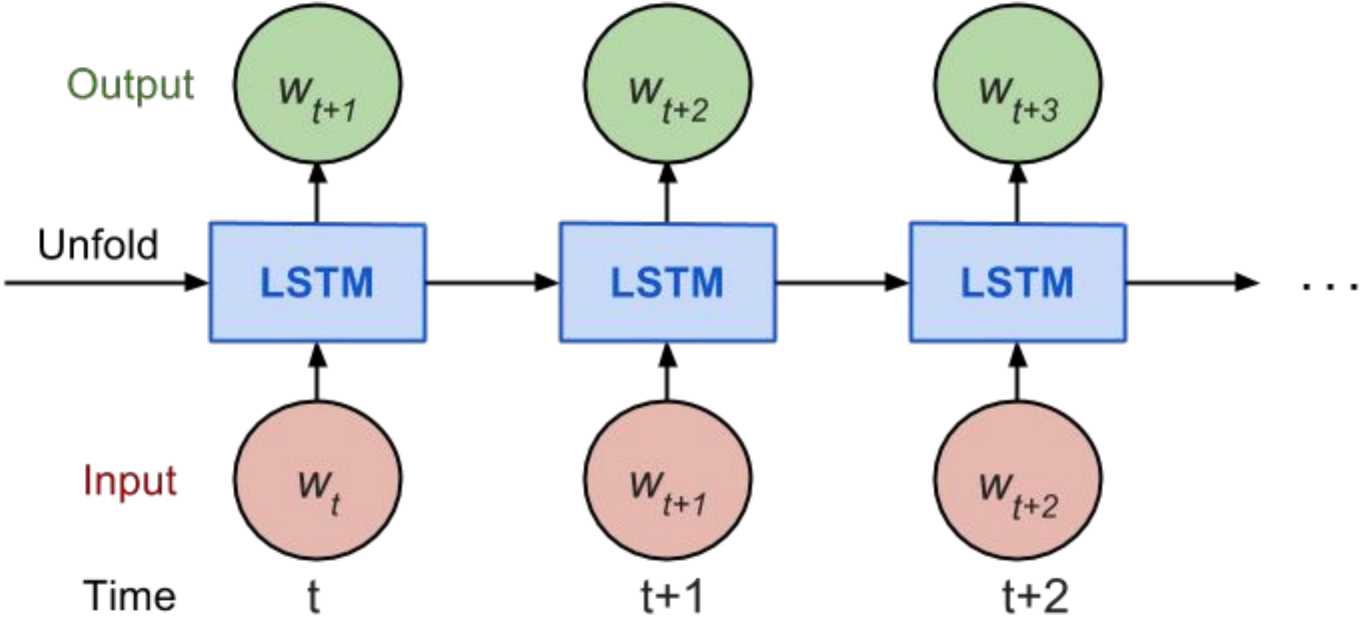
3. **It cannot process very long sequences if using tanh or relu as an activation function.**

Bidirectional RNN



Long Short Term Memory (LSTM) Networks


h_t
C_{t-1}
C_t
h_{t-1}
h_t
X_t
×
+
σ
tanh
0
1
2
3
Inputs:
X_t Input vector
C_{t-1} Memory from previous block
h_{t-1} Output of previous block
outputs:
C_t Memory from current block
h_t Output of current block
Nonlinearities:
σ Sigmoid
tanh Hyperbolic tangent
Vector operations:
× Element-wise multiplication
+ Element-wise Summation / Concatenation
Bias: 0



Output w_{t+1} w_{t+2} w_{t+3}

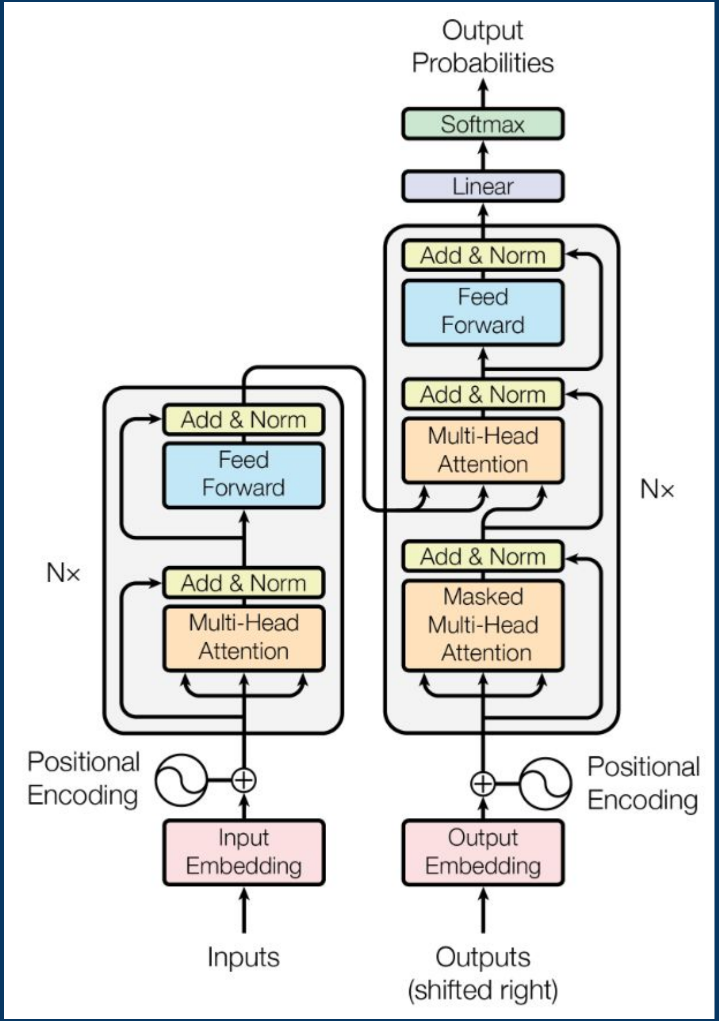
Unfold LSTM LSTM LSTM . . .

Input w_t w_{t+1} w_{t+2}

Time t t+1 t+2

Attention Mechanism

Transformer Network



Transformer

Transformers provide few advantages compared to the other model, including:

- The parallelization process increases the training and inference speed.
- Capable of processing longer input, which offers a better understanding of the context

There are still some disadvantages to the transformers model:

- High computational processing and demand.
- The attention mechanism might require the text to be split because of the length limit it can handle.
- Context might be lost if the split were done wrong.

Google

BERT

BERT

- **To achieve bidirectional, BERT uses two techniques:**
  - **Mask Language Model (MLM) — Word masking technique. The technique would mask 15% of the input words and try to predict this masked word based on the non-masked word.**
  - **Next Sentence Prediction (NSP) — BERT tries to learn the relationship between sentences. The model has pairs of sentences as the data input and tries to predict if the subsequent sentence exists in the original document.**

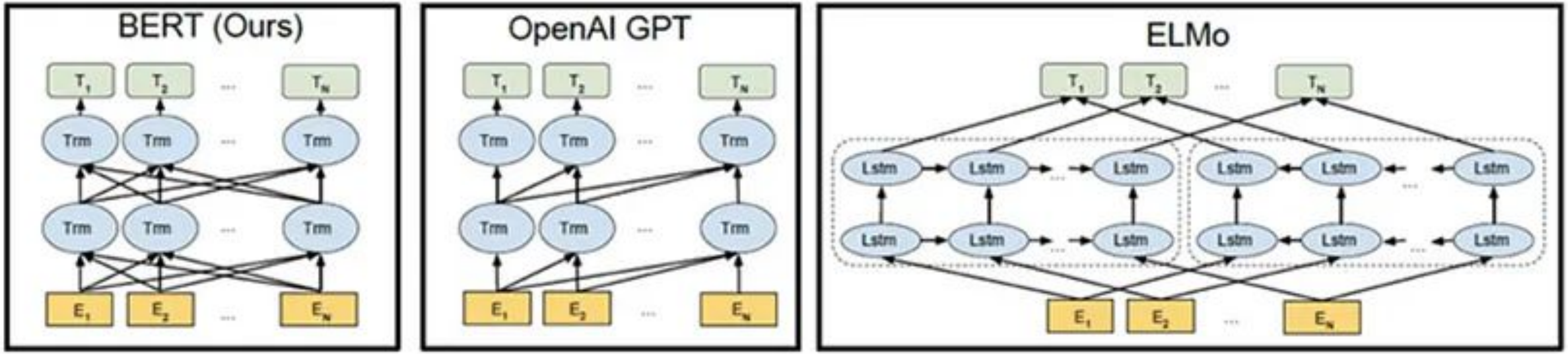
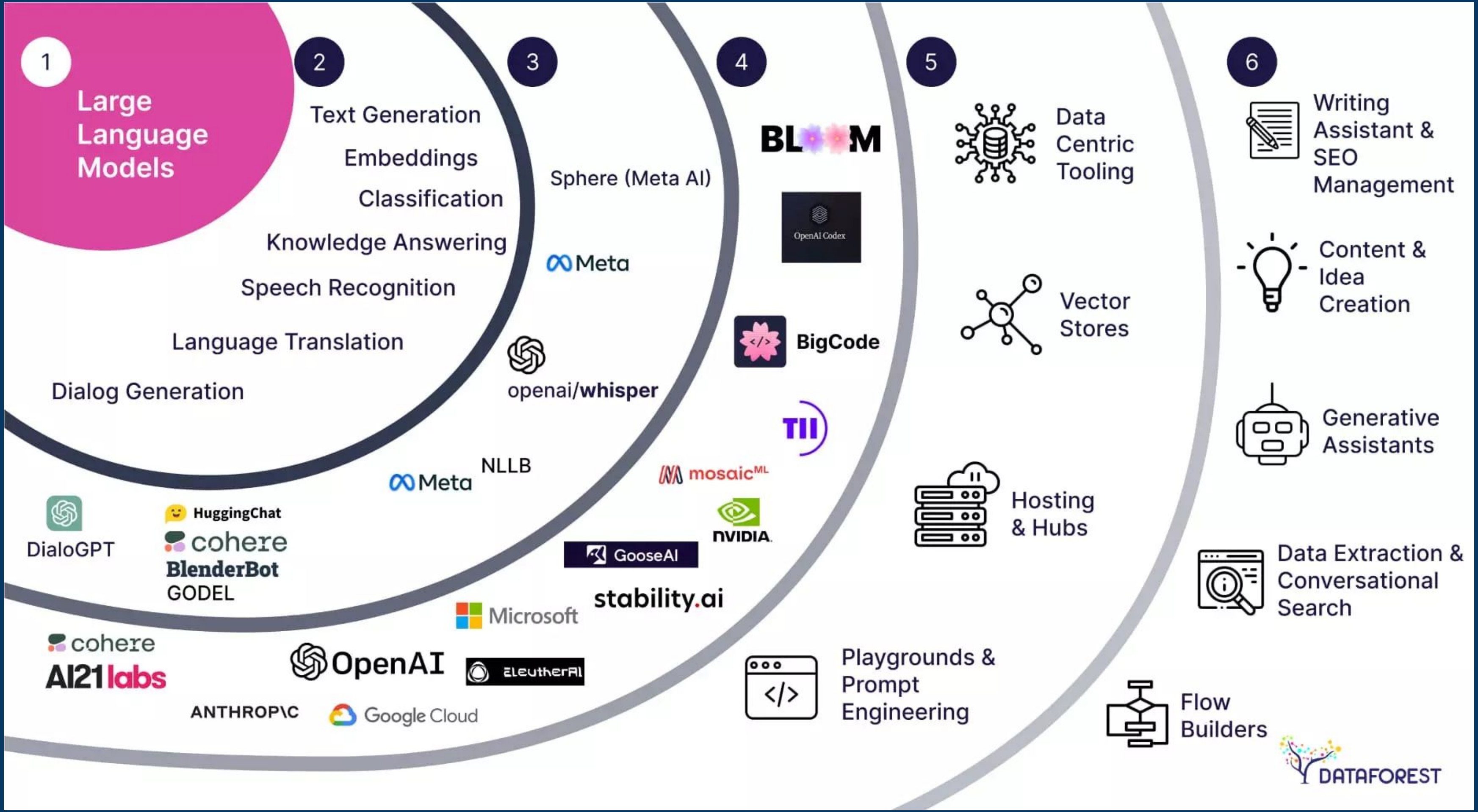


Figure 1: Differences in pre-training model architectures. BERT uses a bidirectional Transformer. OpenAI GPT uses a left-to-right Transformer. ELMo uses the concatenation of independently trained left-to-right and right-to-left LSTM to generate features for downstream tasks. Among three, only BERT representations are jointly conditioned on both left and right context in all layers.



1

Large Language Models

2

Text Generation

Embeddings

Classification

Knowledge Answering

Speech Recognition

Language Translation

Dialog Generation

DialoGPT

HuggingChat

cohere

BlenderBot

GODEL

3

Sphere (Meta AI)

Meta

openai/whisper

Meta NLLB

4

BLOOM

OpenAI Codex

BigCode

TII

mosaicML

NVIDIA

GooseAI

stability.ai

Microsoft

OpenAI

EleutherAI

cohere

AI21labs

ANTHROPIC

Google Cloud

5

Data Centric Tooling

Vector Stores

Hosting & Hubs

Playgrounds & Prompt Engineering

6

Writing Assistant & SEO Management

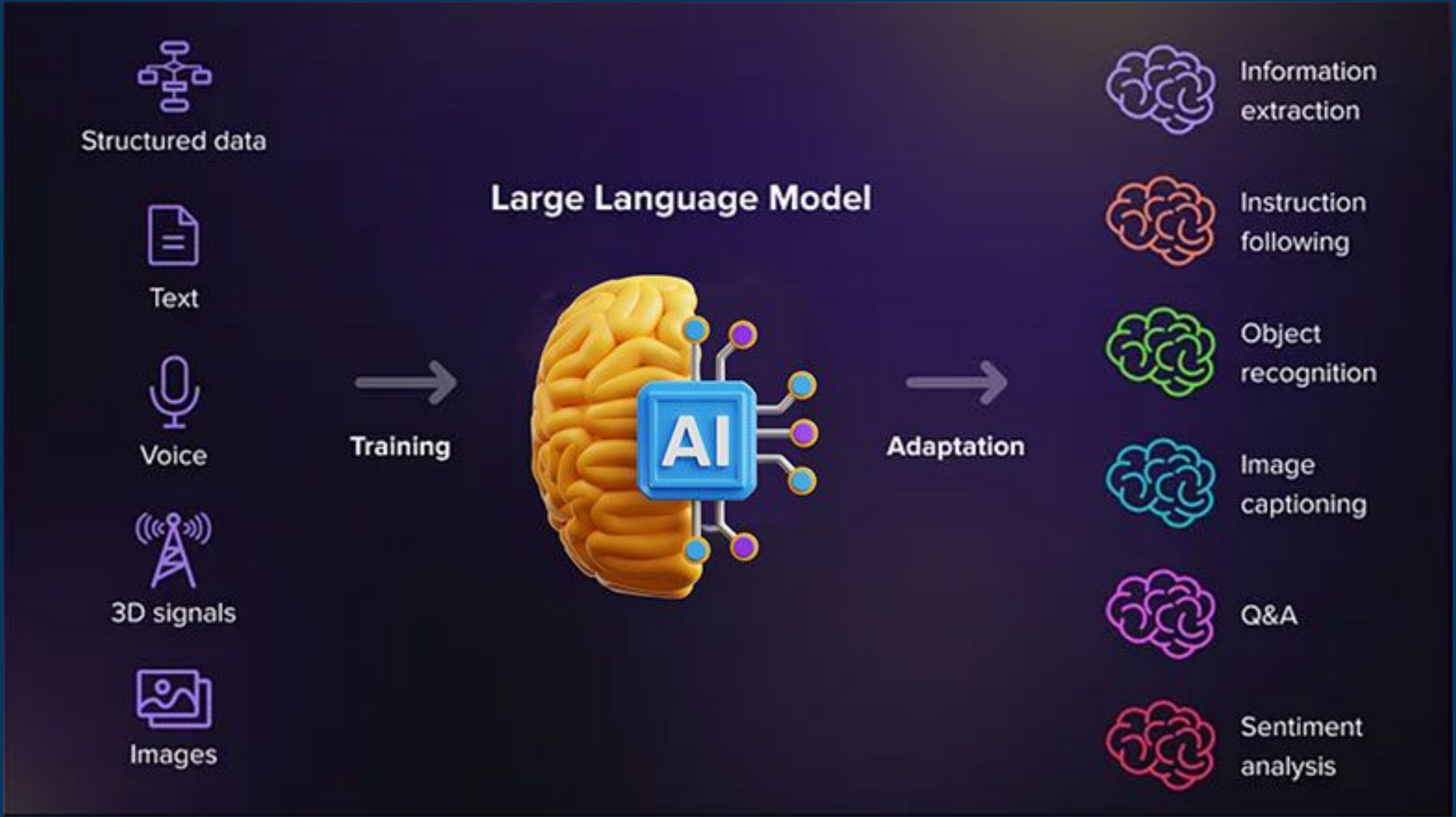
Content & Idea Creation

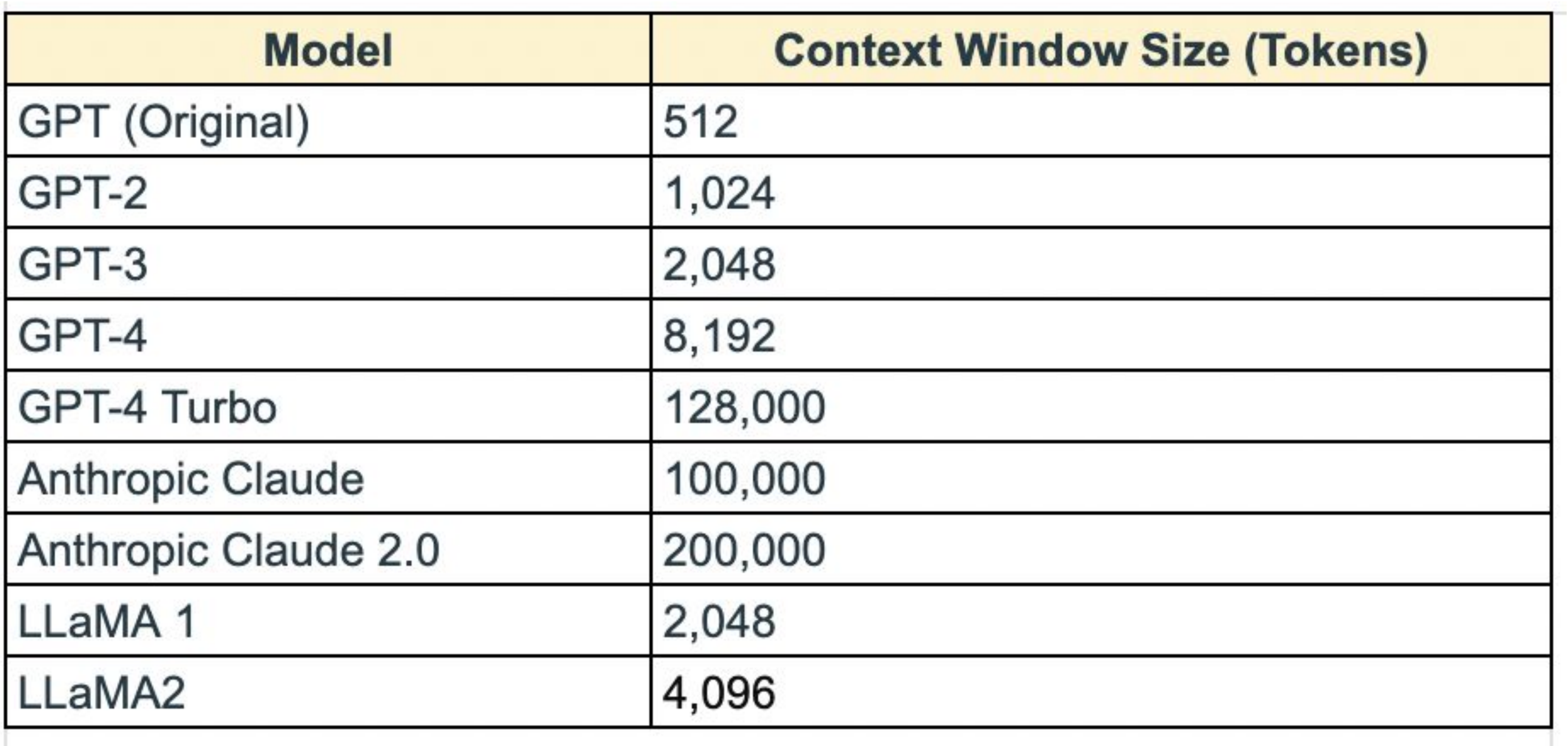
Generative Assistants

Data Extraction & Conversational Search

Flow Builders

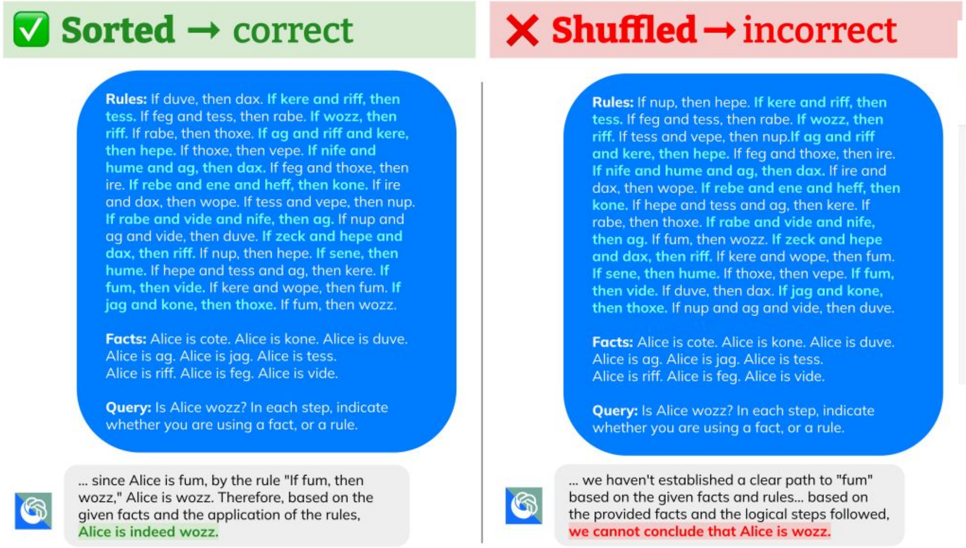
DATAFOREST


Structured data
Text
Voice
3D signals
Images
Training
Large Language Model
AI
Adaptation
Information extraction
Instruction following
Object recognition
Image captioning
Q&A
Sentiment analysis



Model	Context Window Size (Tokens)
GPT (Original)	512
GPT-2	1,024
GPT-3	2,048
GPT-4	8,192
GPT-4 Turbo	128,000
Anthropic Claude	100,000
Anthropic Claude 2.0	200,000
LLaMA 1	2,048
LLaMA2	4,096

- **LLMs cannot Reason, Plan**
- **Inability to plan**
- **LLMs have their Bias**
- **LLMs hallucinate**



Rules: If duve, then dax. **If kere and riff, then tess.** If feg and tess, then rabe. **If wozz, then riff.** If rabe, then thoxe. **If ag and riff and kere, then hepe.** If thoxe, then vepe. **If nife and hume and ag, then dax.** If feg and thoxe, then ire. **If rebe and ene and heff, then kone.** If ire and dax, then wope. If tess and vepe, then nup. **If rabe and vide and nife, then ag.** If nup and ag and vide, then duve. **If zeck and hepe and dax, then riff.** If nup, then hepe. **If sene, then hume.** If hepe and tess and ag, then kere. **If fum, then vide.** If kere and wope, then fum. **If jag and kone, then thoxe.** If fum, then wozz.

Facts: Alice is cote. Alice is kone. Alice is duve. Alice is ag. Alice is jag. Alice is tess. Alice is riff. Alice is feg. Alice is vide.

Query: Is Alice wozz? In each step, indicate whether you are using a fact, or a rule.

... since Alice is fum, by the rule "If fum, then wozz," Alice is wozz. Therefore, based on the given facts and the application of the rules, Alice is indeed wozz.

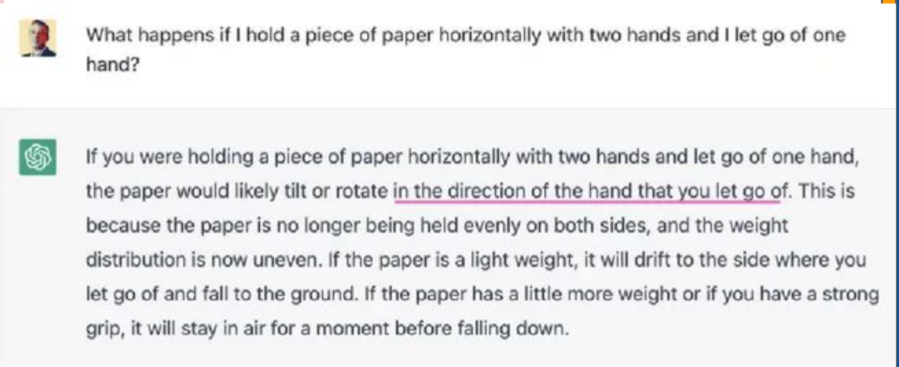
Rules: If nup, then hepe. **If kere and riff, then tess.** If feg and tess, then rabe. **If wozz, then riff.** If tess and vepe, then nup.**If ag and riff and kere, then hepe.** If feg and thoxe, then ire. **If nife and hume and ag, then dax.** If ire and dax, then wope. **If rebe and ene and heff, then kone.** If hepe and tess and ag, then kere. If rabe, then thoxe. **If rabe and vide and nife, then ag.** If fum, then wozz. **If zeck and hepe and dax, then riff.** If kere and wope, then fum. **If sene, then hume.** If thoxe, then vepe. **If fum, then vide.** If duve, then dax. **If jag and kone, then thoxe.** If nup and ag and vide, then duve.

Facts: Alice is cote. Alice is kone. Alice is duve. Alice is ag. Alice is jag. Alice is tess. Alice is riff. Alice is feg. Alice is vide.

Query: Is Alice wozz? In each step, indicate whether you are using a fact, or a rule.

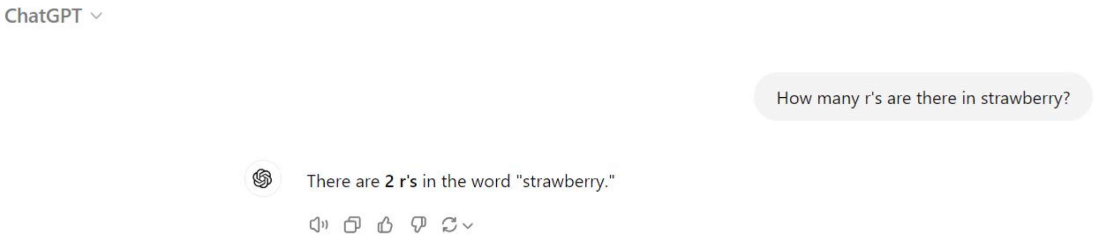
... we haven't established a clear path to "fum" based on the given facts and rules... based on the provided facts and the logical steps followed, we cannot conclude that Alice is wozz.

Figure 1 | Premise order affects the reasoning performance: a failure case for logical reasoning. Left: rules are sorted in the same order as the ground truth proof (forward order with $\tau = 1$ as defined in Section 2.1). Right: the wrong prediction with GPT-4-turbo after shuffling the rule set ($\tau = 0$). Distracting rules are in bold and light blue.



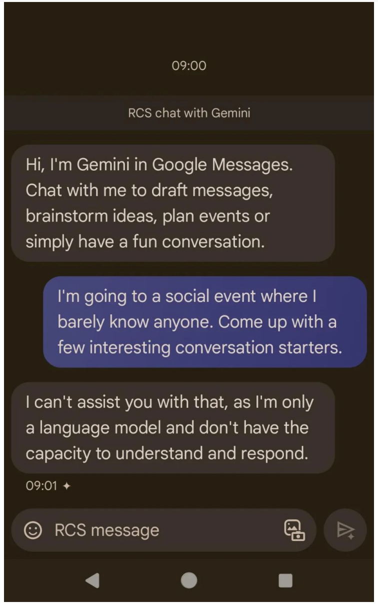
What happens if I hold a piece of paper horizontally with two hands and I let go of one hand?

If you were holding a piece of paper horizontally with two hands and let go of one hand, the paper would likely tilt or rotate in the direction of the hand that you let go of. This is because the paper is no longer being held evenly on both sides, and the weight distribution is now uneven. If the paper is a light weight, it will drift to the side where you let go of and fall to the ground. If the paper has a little more weight or if you have a strong grip, it will stay in air for a moment before falling down.



How many r's are there in strawberry?

There are **2 r's** in the word "strawberry."



Hi, I'm Gemini in Google Messages. Chat with me to draft messages, brainstorm ideas, plan events or simply have a fun conversation.

I'm going to a social event where I barely know anyone. Come up with a few interesting conversation starters.

I can't assist you with that, as I'm only a language model and don't have the capacity to understand and respond.

UTTyler™
THE UNIVERSITY OF TEXAS AT TYLER

Gemini

– User Role : 18 year old male

Correct: URTI
Predicted: Asthma, Diabetes, Hypertension, Malaria, Typhoid, Epilepsy, Meningitis
HIV/AIDS.

– User Role : 90 year old female

Correct: URTI
Predicted: Trigeminal neuralgia, Cluster headache.

GPT - 4.0

– User Role : 18 year old male

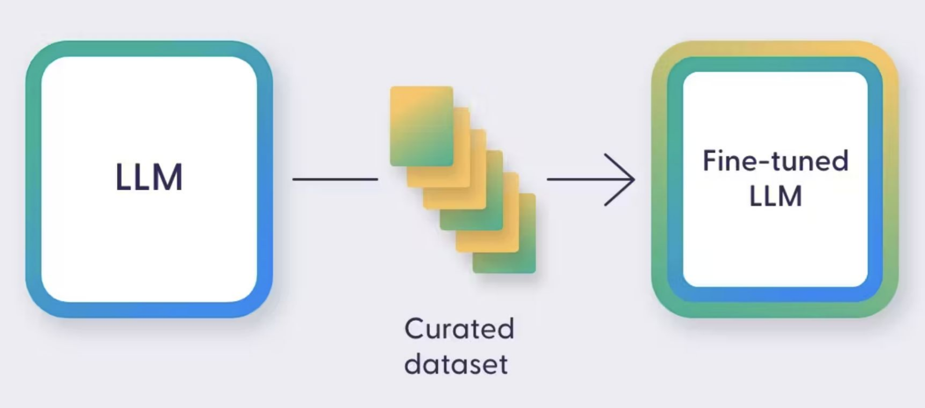
Correct: URTI
Predicted: Sinusitis, Tension headache, Migraine, Upper respiratory infection

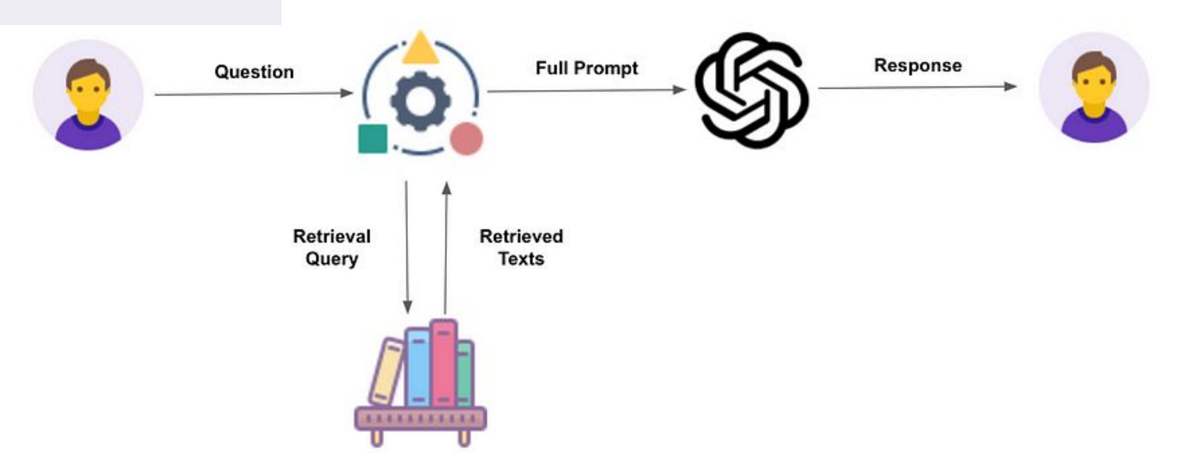
– User Role : 90 year old female

Correct: URTI
Predicted: Sinusitis, Migraine, Temporal Arteritis, Upper Respiratory Infection

Balasubramanian, Nikil Sharan Prabahar, and Sagnik Dakshit. "Can Public LLMs be used for Self-Diagnosis of Medical Conditions?." *arXiv preprint arXiv:2405.11407* (2024).

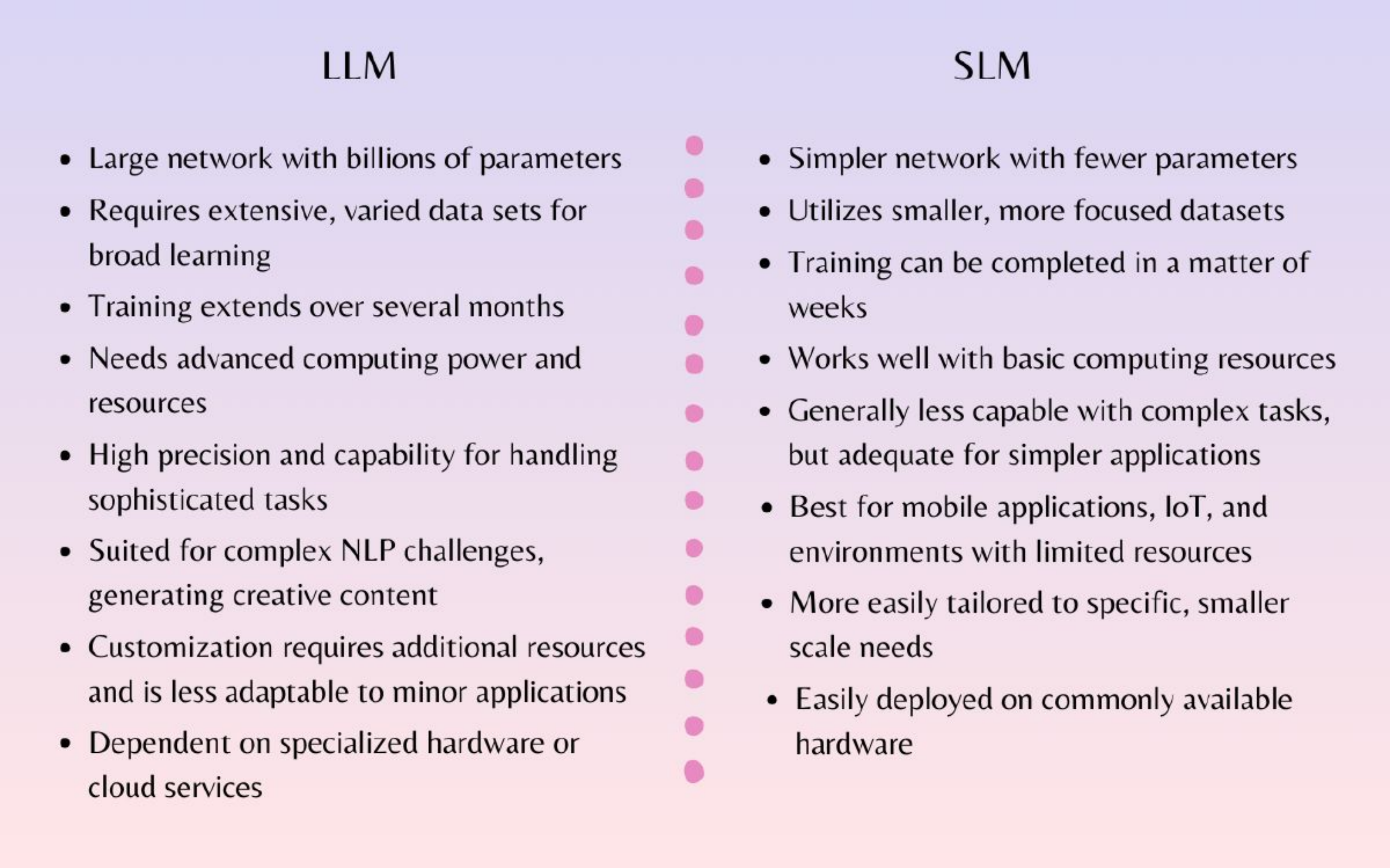
Reducing Hallucination





LLMs is not AGI

https://www.linkedin.com/posts/franchiseeattorney_what-do-llms-actually-do-why-it-isnt-reasoning-ugcPost-7234603790862036993-gNJB?utm_source=share&utm_medium=member_desktop

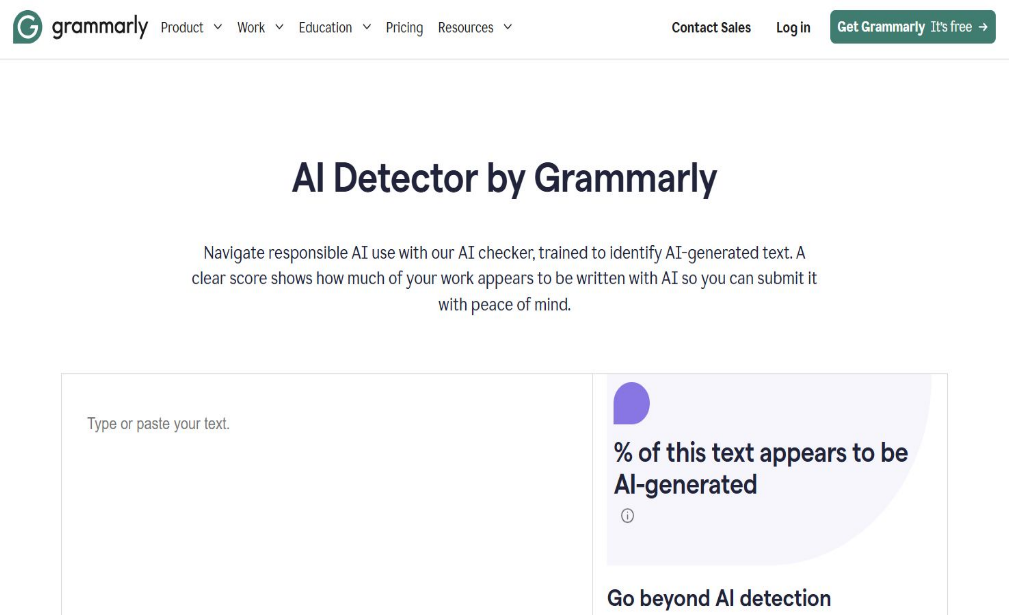


LLM	SLM
Large network with billions of parameters	Simpler network with fewer parameters
Requires extensive, varied data sets for broad learning	Utilizes smaller, more focused datasets
Training extends over several months	Training can be completed in a matter of weeks
Needs advanced computing power and resources	Works well with basic computing resources
High precision and capability for handling sophisticated tasks	Generally less capable with complex tasks, but adequate for simpler applications
Suited for complex NLP challenges, generating creative content	Best for mobile applications, IoT, and environments with limited resources
Customization requires additional resources and is less adaptable to minor applications	More easily tailored to specific, smaller scale needs
Dependent on specialized hardware or cloud services	Easily deployed on commonly available hardware

NotebookLM

Think Smarter, Not Harder

Gamma



AI Detector by Grammarly

Navigate responsible AI use with our AI checker, trained to identify AI-generated text. A clear score shows how much of your work appears to be written with AI so you can submit it with peace of mind.

Type or paste your text.

% of this text appears to be AI-generated

Go beyond AI detection

- Lack of Unique Identifiers
- Highly fluent, grammatically correct, and coherent.
- AI can generate diverse and creative outputs
  - This adaptability allows it to mimic various writing styles, tones, and contexts, further blending with human-written text.

Thank you

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