

# Introduction to Large Language Model (LLM)

AI in Physics Workshop– April 11, 2025



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# Navigating in the Artificial Intelligence Era

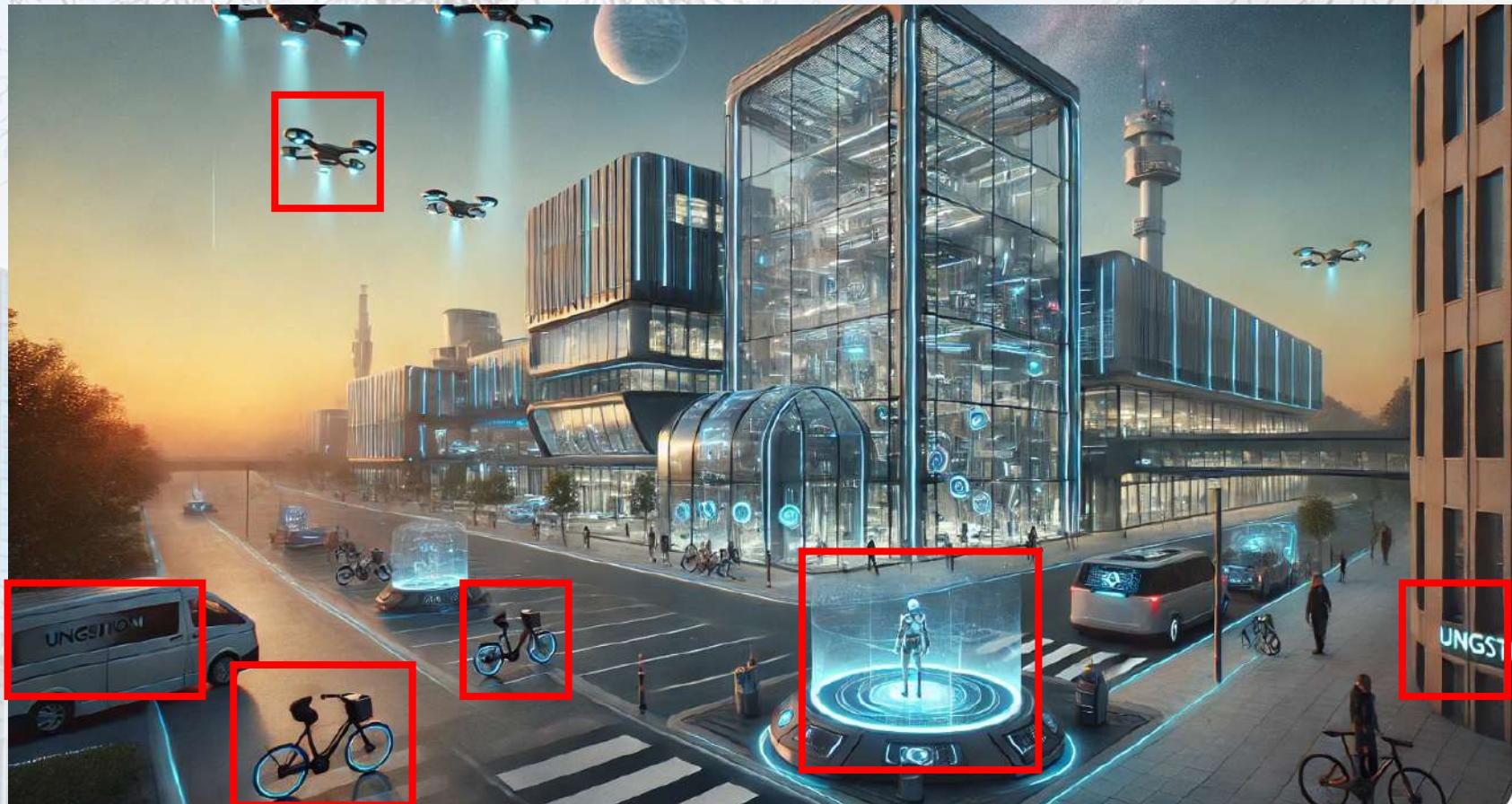
The future?



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# Navigating in the Artificial Intelligence Era

The future?



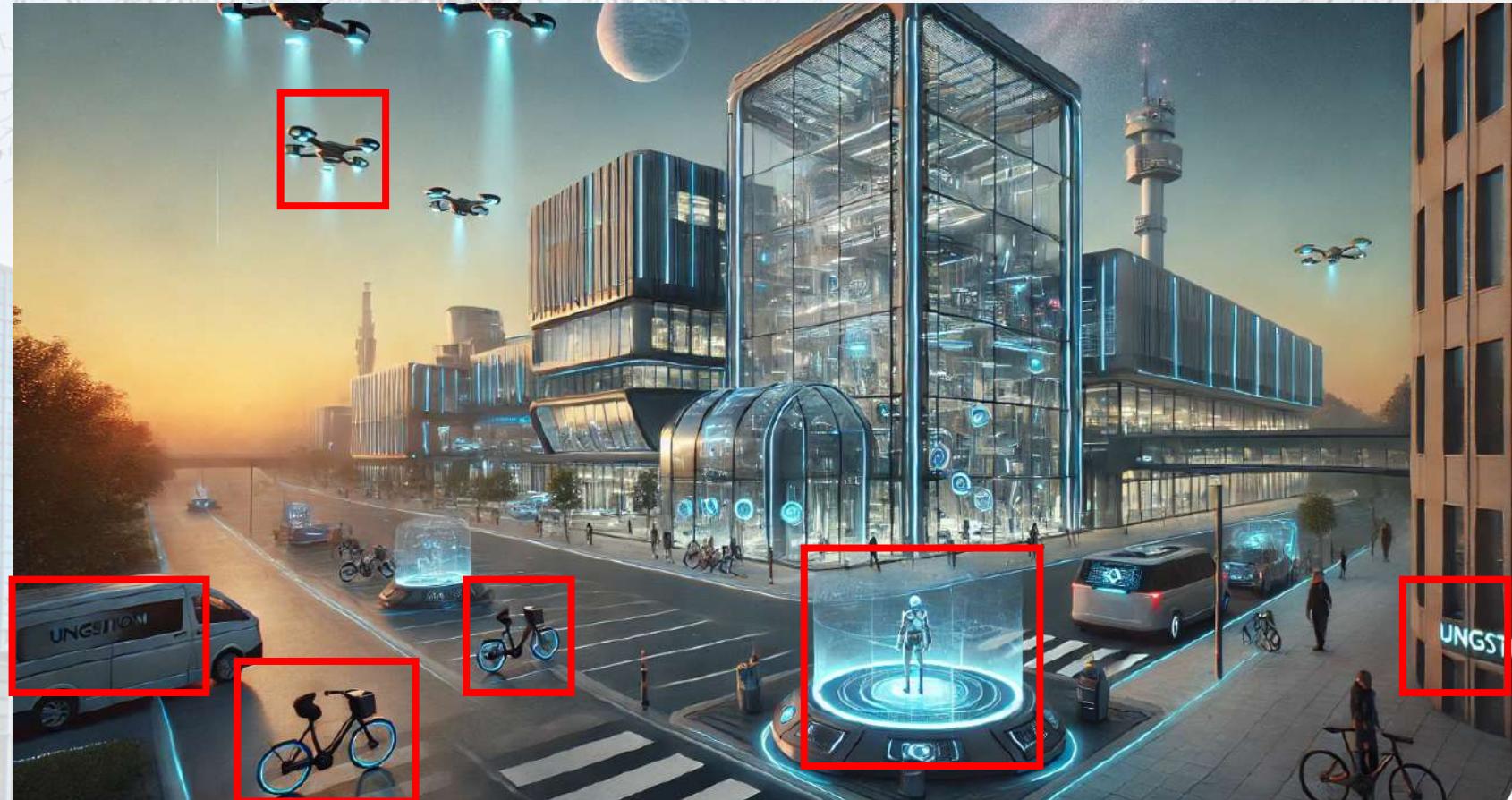
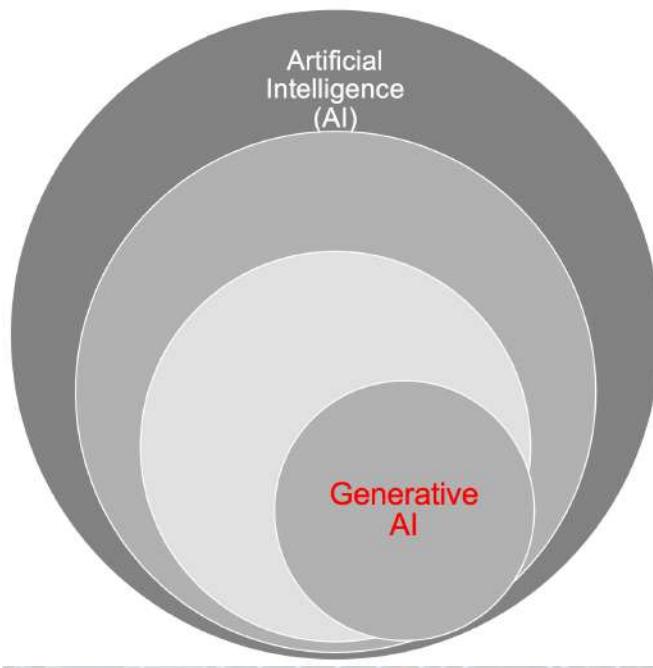
Holographic displays, autonomous bicycles, drone deliveries

Ångström → UNGSTROM



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# Navigating in the Artificial Intelligence Era



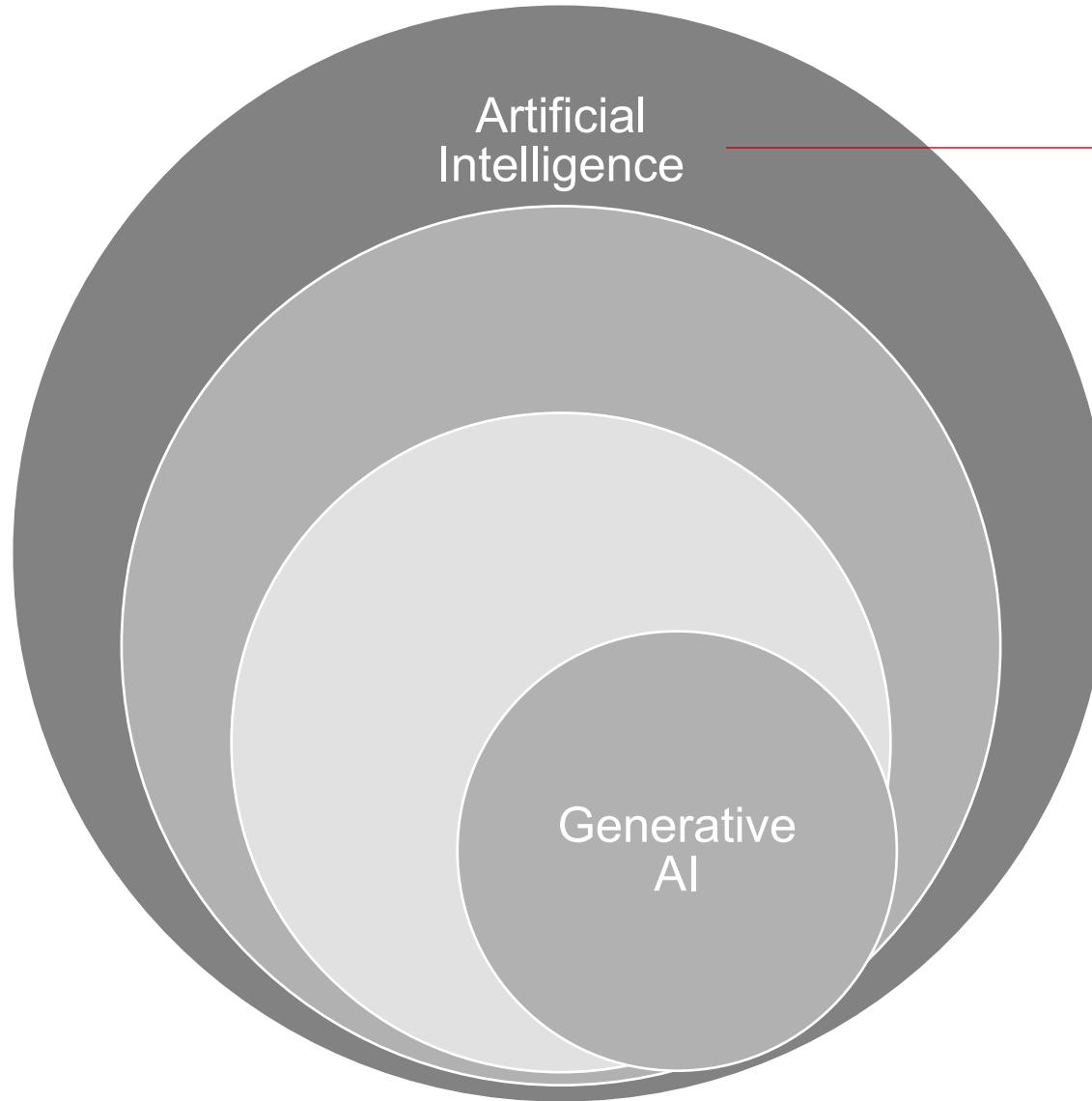
**Generative AI – Generating new content!**

Learn patterns and structure of input data, and generate new samples that exhibit similar characteristics.

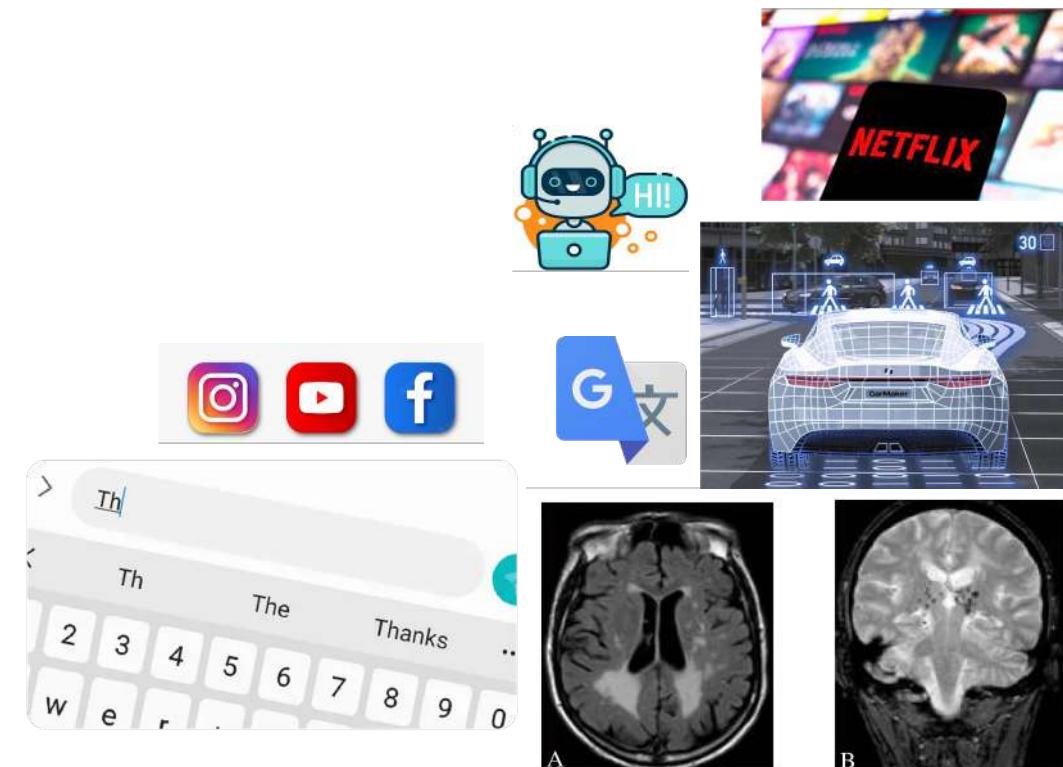


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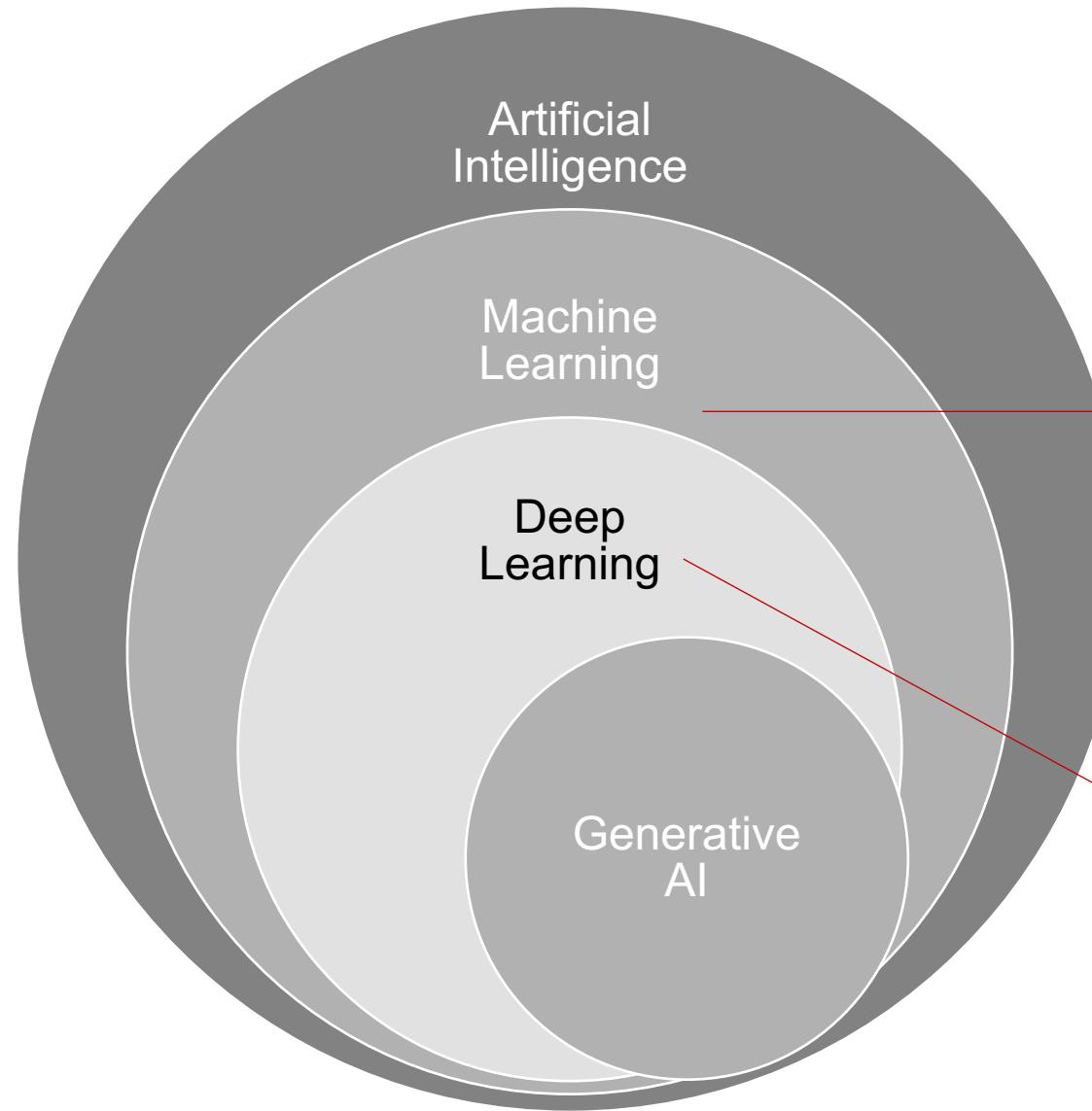
# AI Taxonomy



Technology that enables computers and machines to simulate human intelligence and problem-solving capabilities



# AI Taxonomy

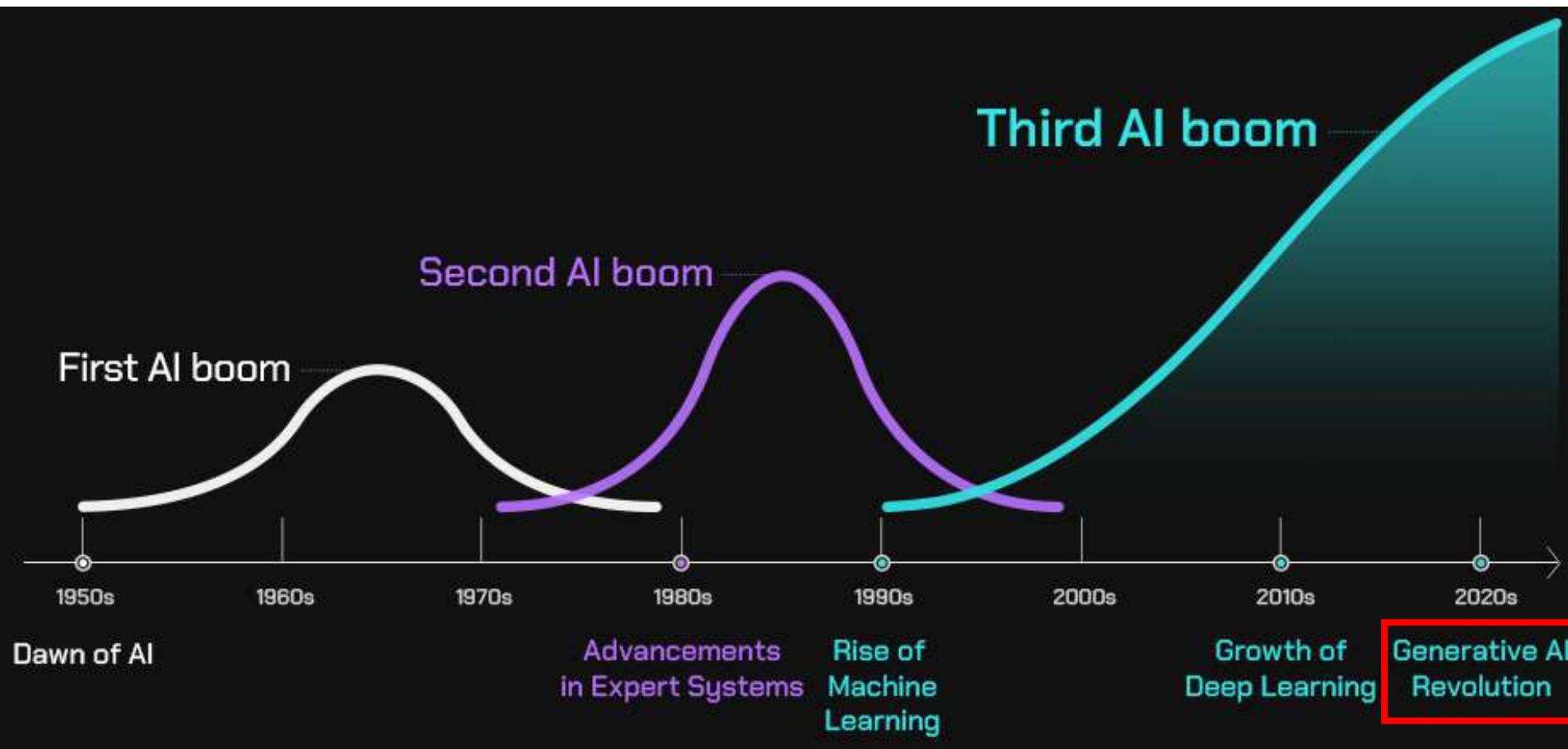


Subset of AI, focuses on developing systems that can learn from data and make decisions based on data

Subset of ML, uses Artificial Neural Networks to learn from data

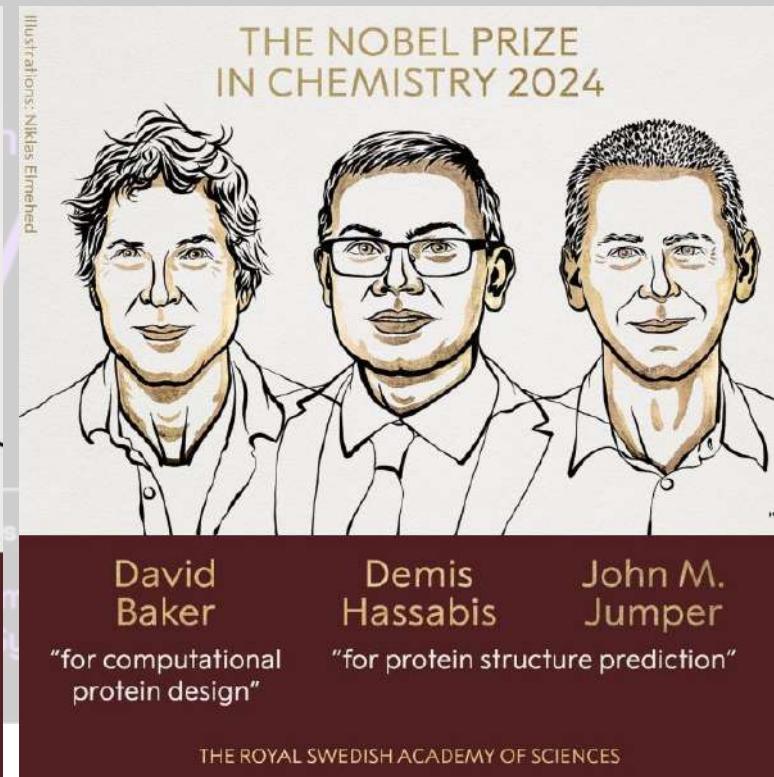
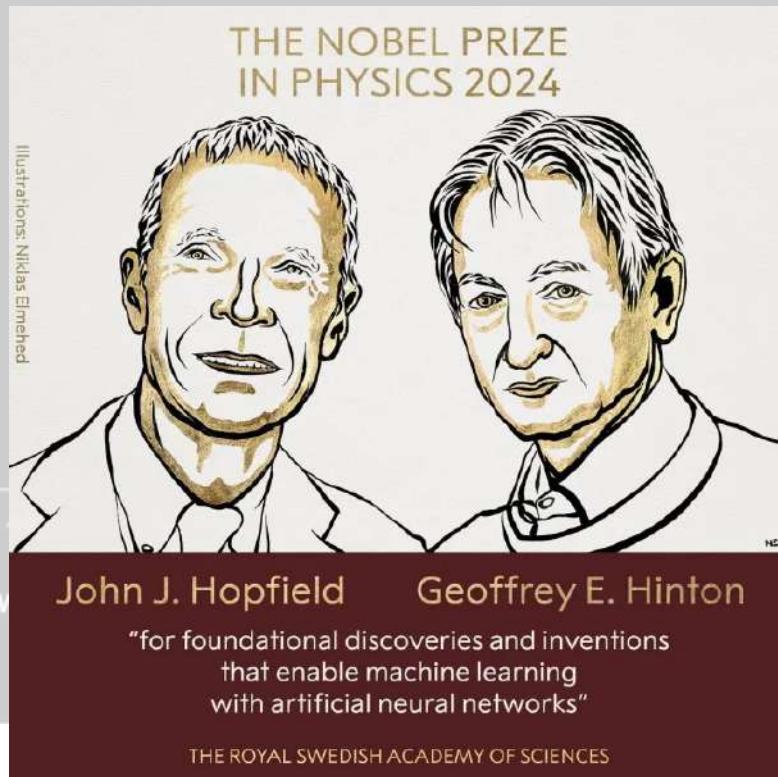


# AI Evolution Through Decades



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# AI Evolution Through Decades



2024

The Nobel Prizes in  
Physics and Chemistry  
goes to AI!

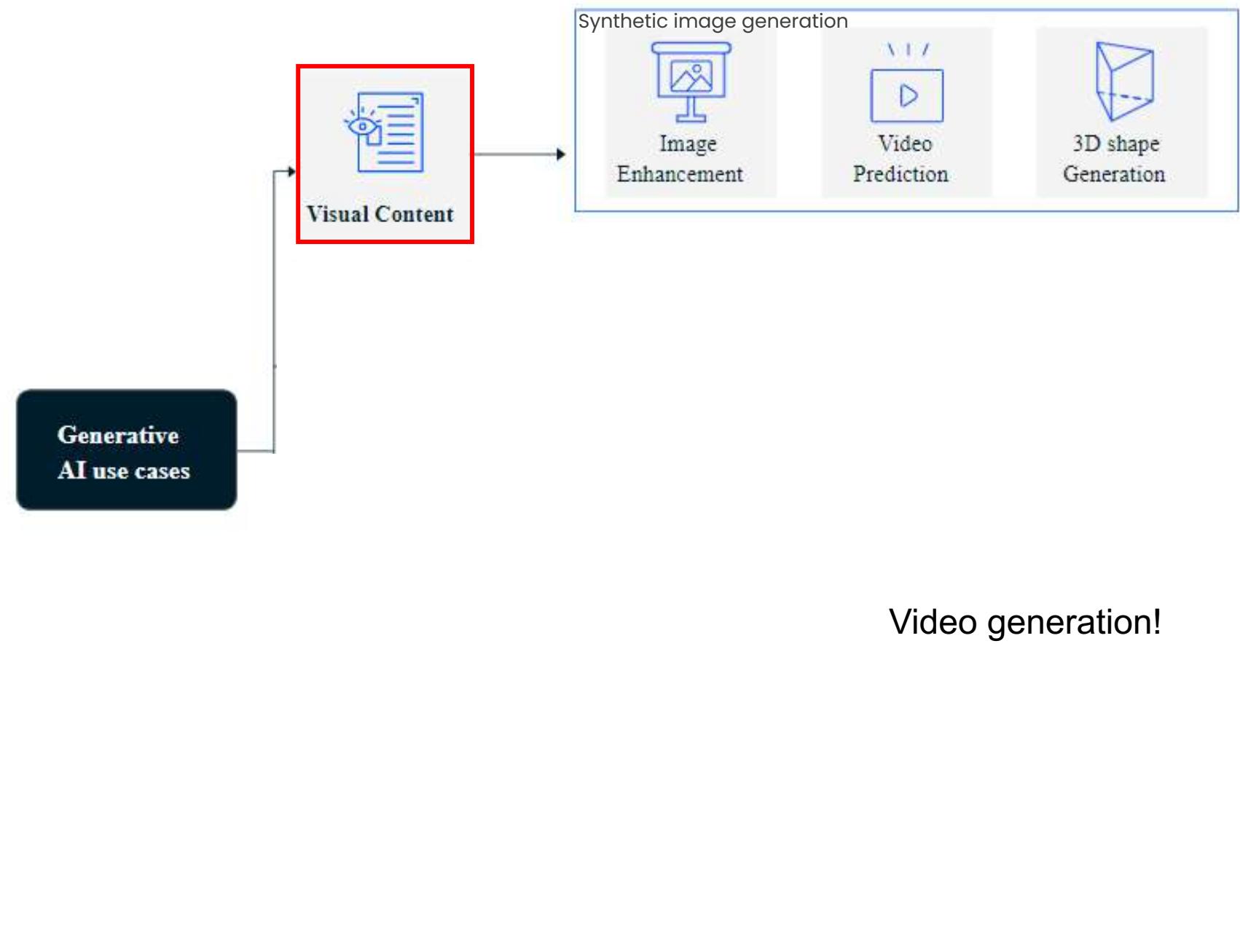


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**Generative  
AI use cases**

## SORA: text-to-video model

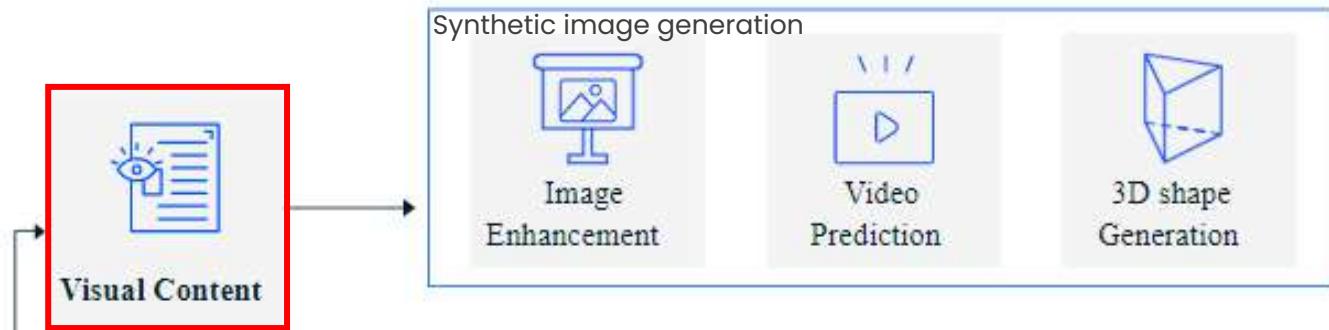


Text:

Turn the library into a spaceship.

Output:





Generative  
AI use cases

Image generation!



An oil pastel drawing of an annoyed cat in a spaceship



Two dogs dressed like roman soldiers on a pirate ship looking at New York City through a spyglass



An image of a cat enjoying sprinklers.



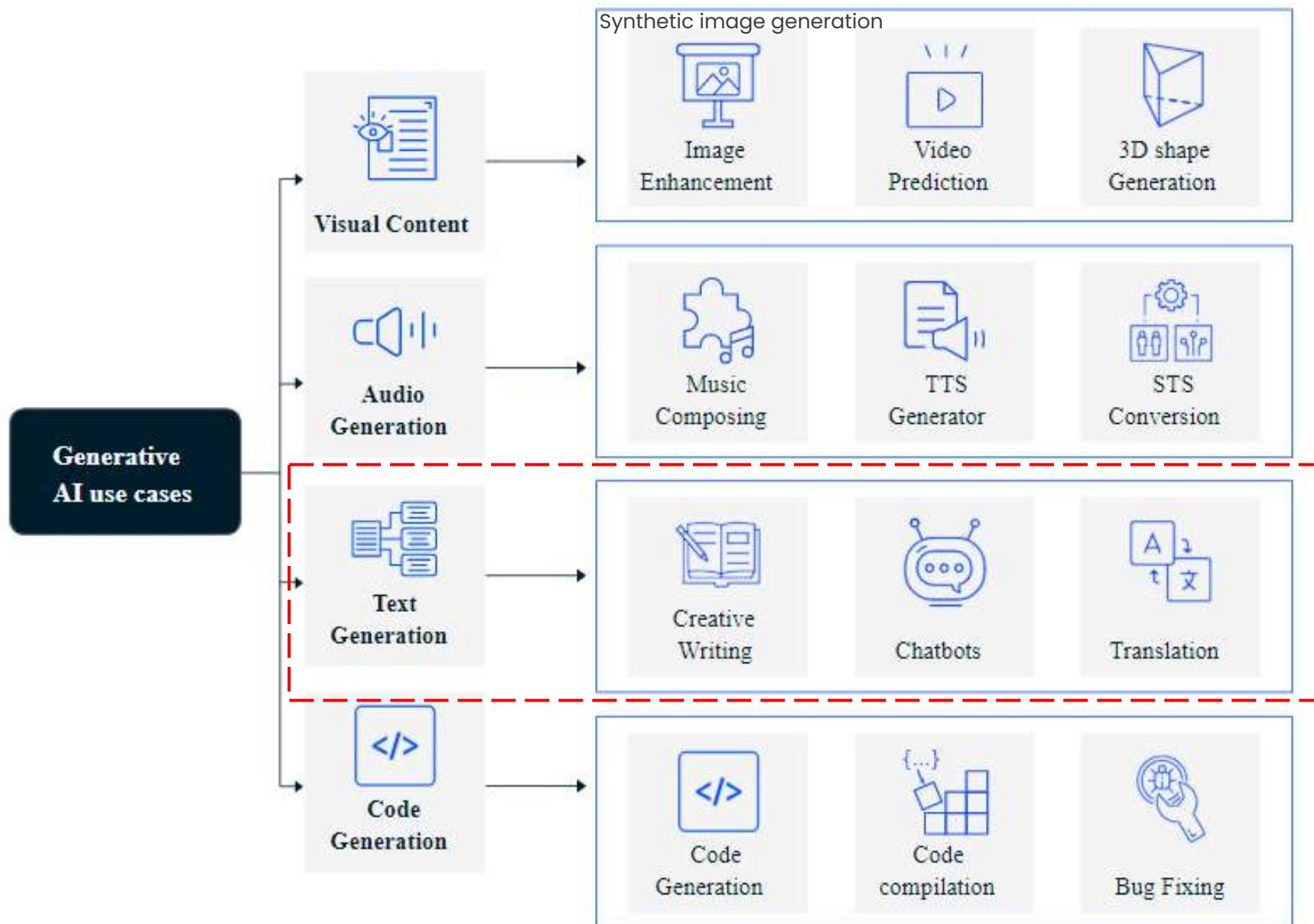
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Text-to-image models: [stability.ai](#)



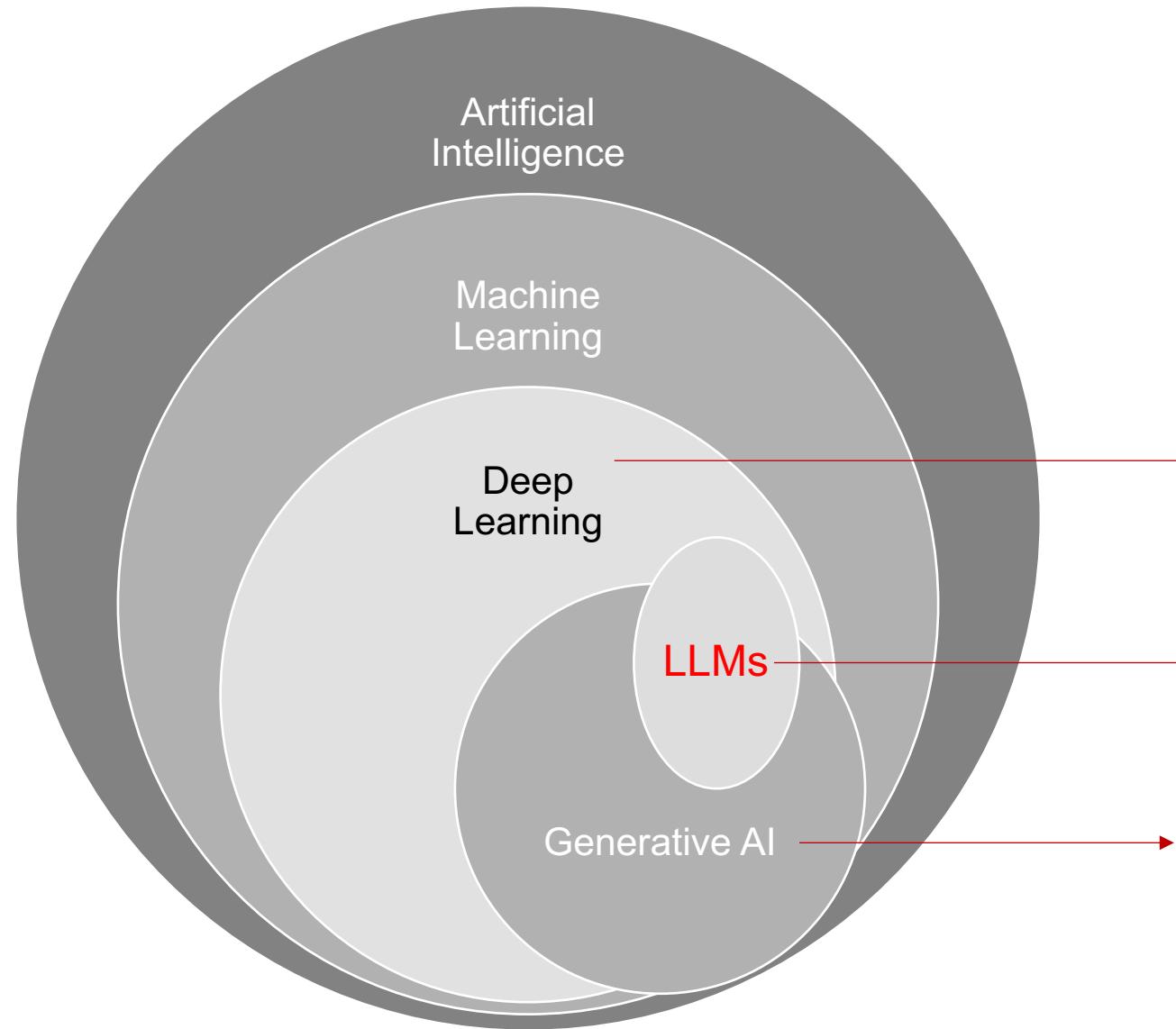
 OpenAI DALL·E





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# AI Taxonomy



Subset of ML, uses Artificial Neural Networks to learn from data

Specific type of Generative AI model that focuses on generating human-like text

Subset of AI, focuses on generating new content

LLMs: Large Language Models



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# Large Language Model (LLM)

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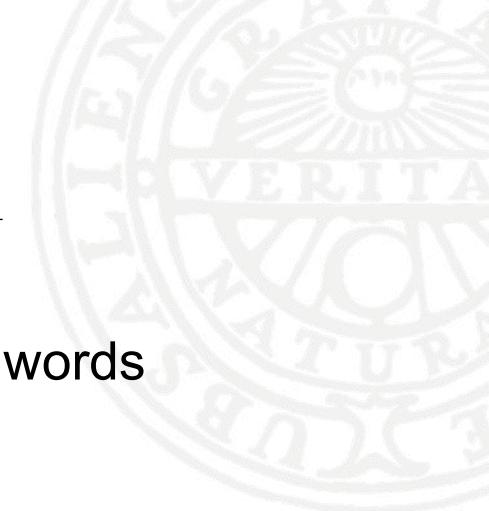
- A type of language model



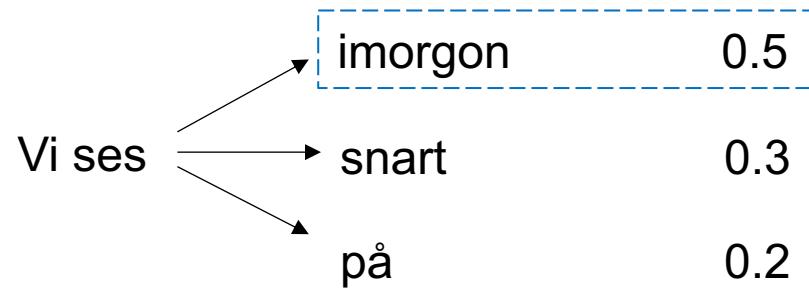
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# Language Model

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- Type of machine learning model trained to predict probability distribution over words



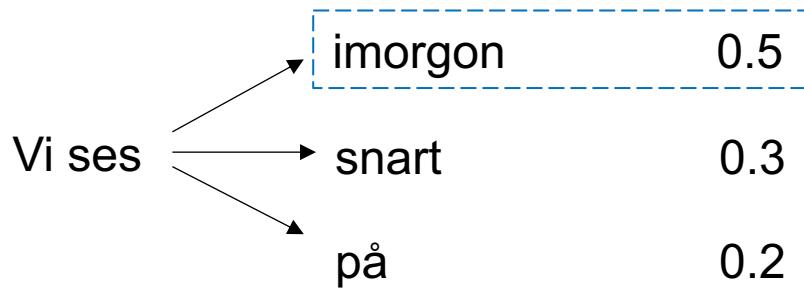
- Predicts the probability of a word in a sequence based on the previous word



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# Language Model

- Type of machine learning model trained to predict probability distribution over words



Google search and advanced language models

Vi ses på

vi ses på **andra sidan**

vi ses på **franska**

vi ses på **spanska**

vi ses på **italienska**

vi ses på **engelska**

vi ses på **tyska**

vi ses på **arabiska**

vi ses på **andra sidan betydelse**

vi ses på **eller i**

# Language Model

---



- Classic definition: Probability distribution over a sequence of tokens
- For example, if **vocabulary** of a set of tokens is  $\mathcal{V} = \{\text{ate, ball, cheese, mouse, the}\}$ , a language model  $p$  might assign:

$$p(\text{the, mouse, ate, the, cheese}) = 0.02,$$

$$p(\text{the, cheese, ate, the, mouse}) = 0.01,$$

$$p(\text{mouse, the, the, cheese, ate}) = 0.0001.$$



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# Language Model

---



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$$p(\text{mouse, the, the, cheese, ate}) = 0.0001.$$

- Example: Neural language models - RNNs including LSTMs, Transformers

$$p(\text{cheese} \mid \text{ate, the}) = \text{some-neural-network}(\text{ate, the, cheese})$$



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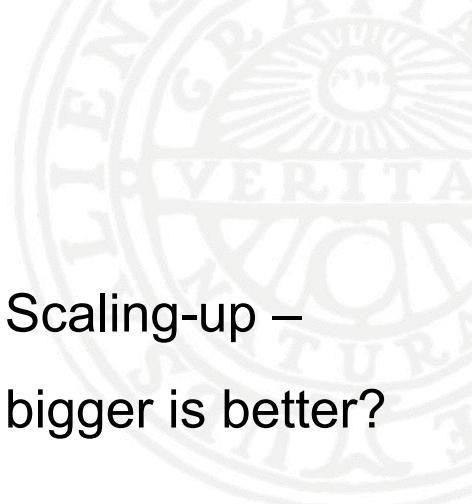
# Large Language Model (LLM)

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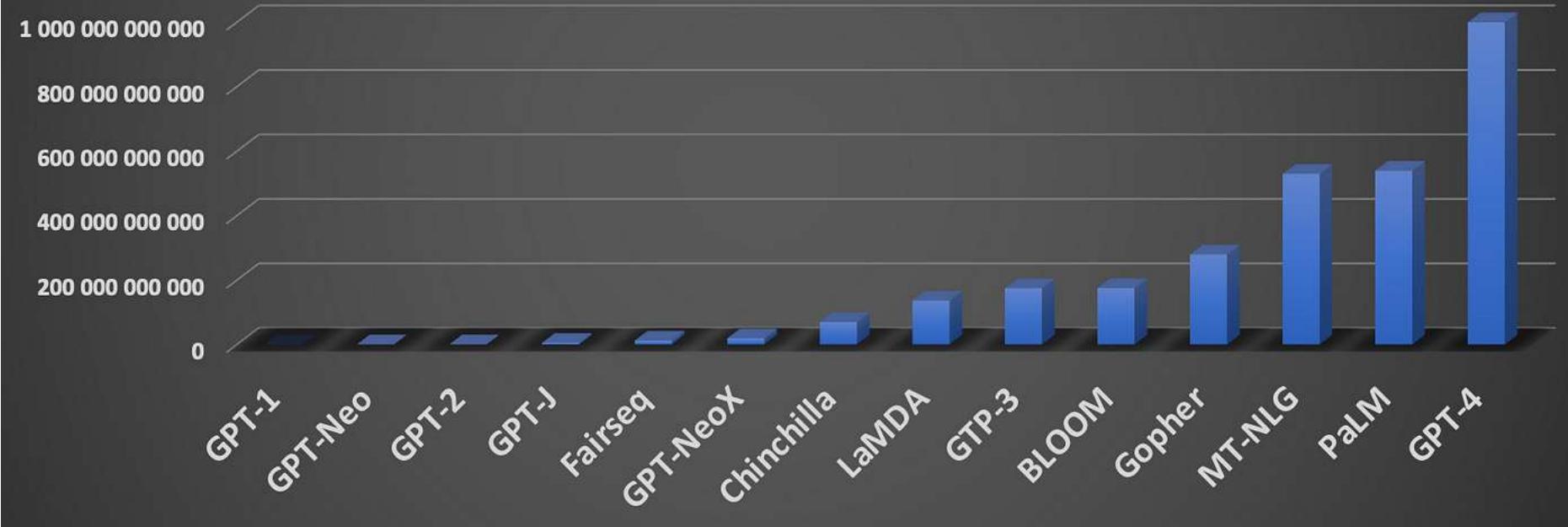
- A type of language model
- Why large:
  - Trained using massive datasets
  - With the rise of deep learning and availability of large computational resources, the size of neural language models has increased.



# Large Language Model (LLM)



## GPT-4 @ 1 Trillion Parameters



2018

2023

2025: GPT-5?



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# Architecture

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- LLM is a type of transformer model
- Transformer:
  - A neural network that learns context and meaning by tracking relationships in sequential data

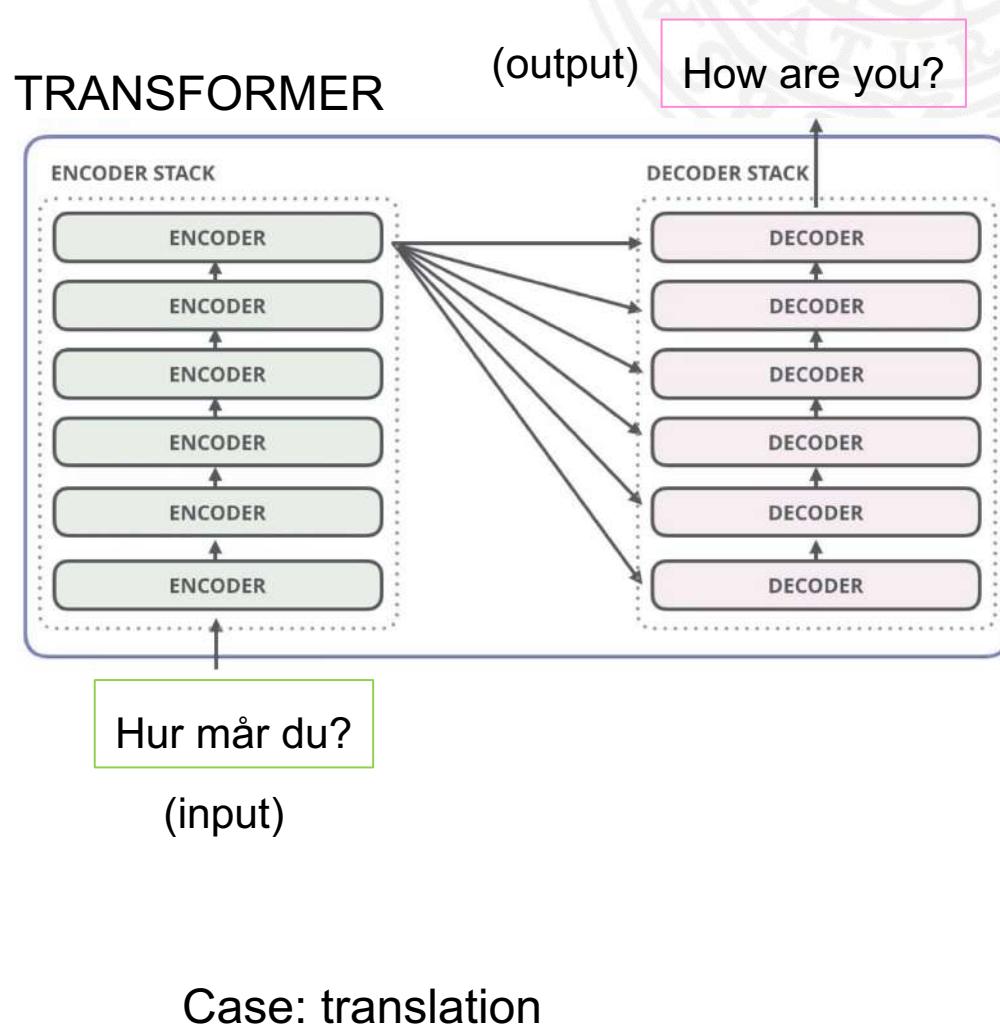


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# Architecture

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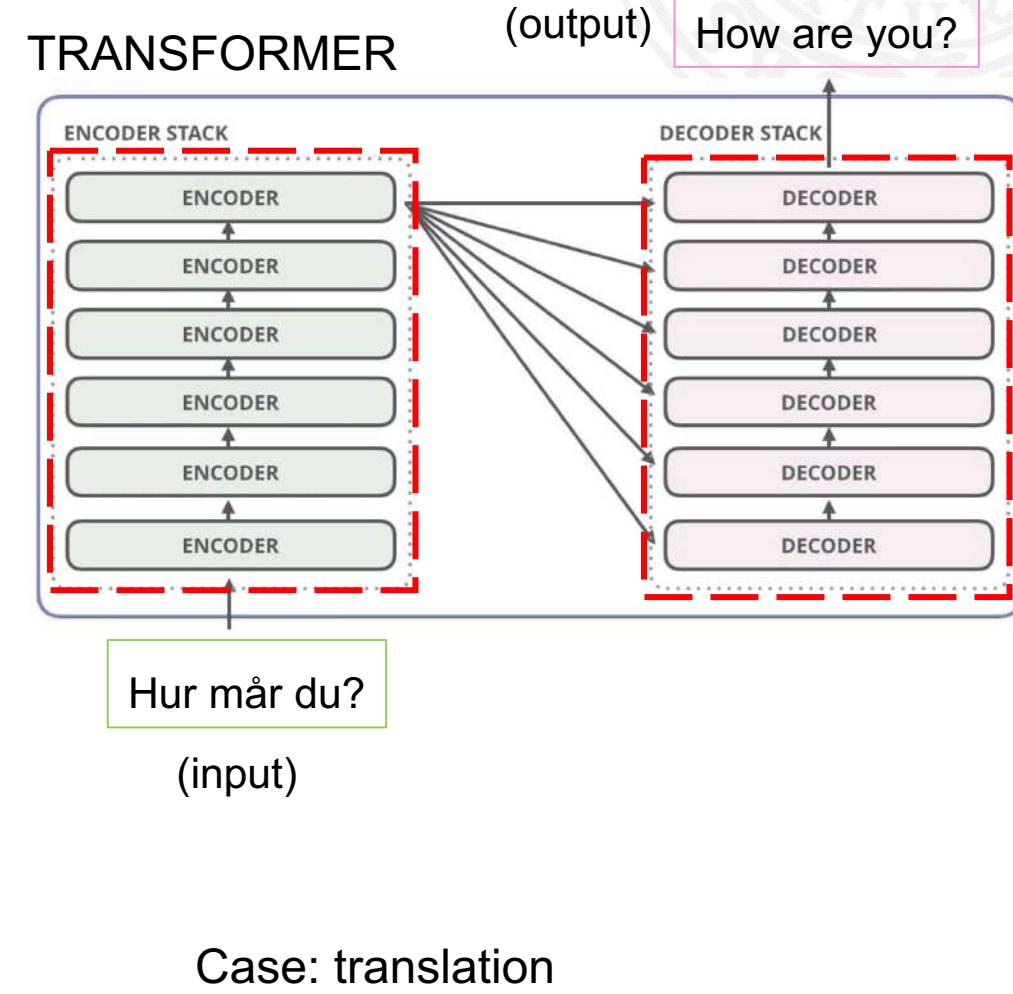
- LLM is a type of transformer model
- Transformer:
  - A neural network that learns context and meaning by tracking relationships in sequential data
  - Encoder-decoder architecture
    - Encoder extracts features from an input sequence
    - Decoder uses the features to produce an output sentence



# Architecture

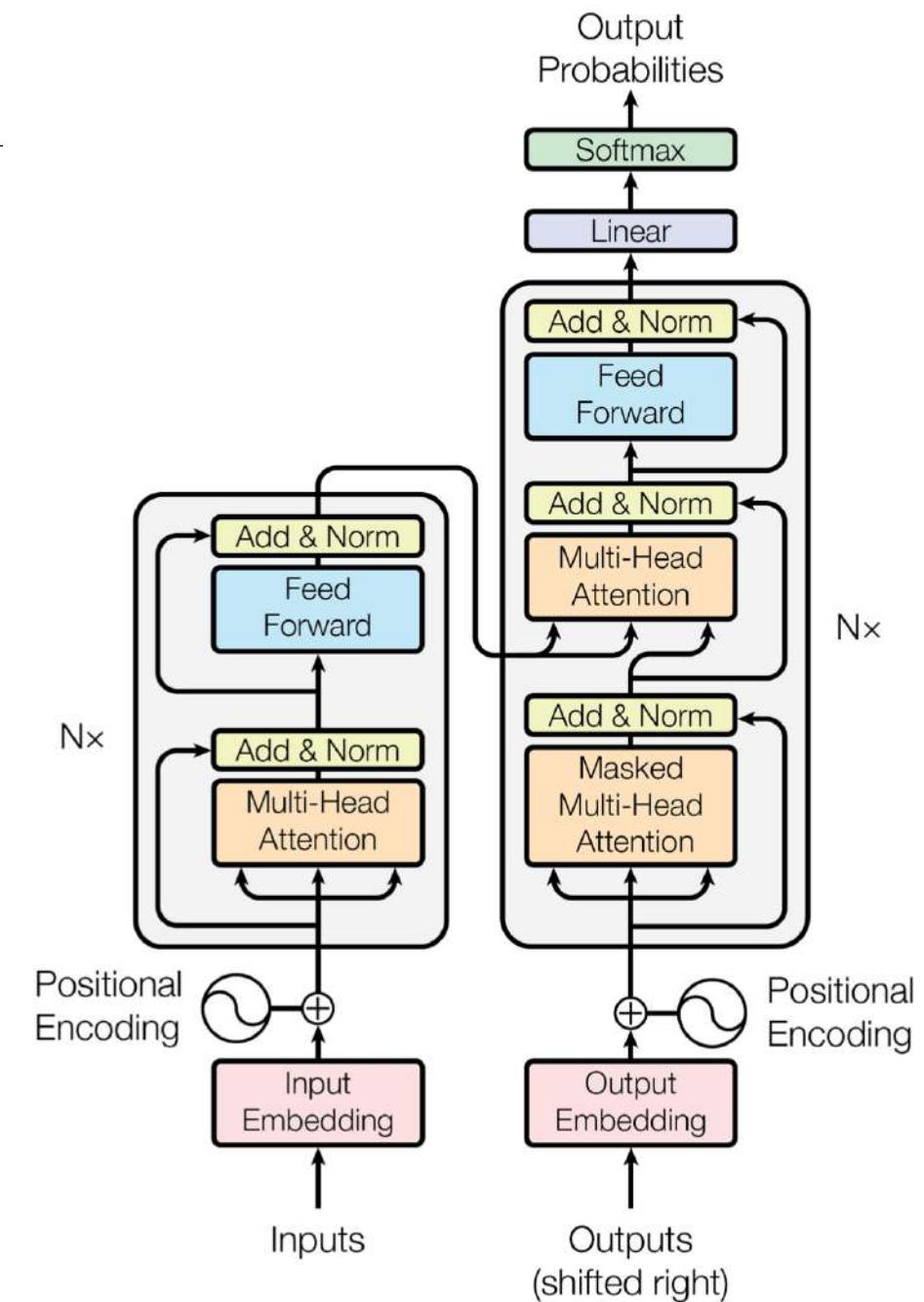
Can be used independently!

- LLM is a type of transformer model
- Transformer:
  - A neural network that learns context and meaning by tracking relationships in sequential data
  - Encoder-decoder architecture
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# Transformer – Recommended Reading

- Transformers by Lucas Beyer
  - Link: <https://www.youtube.com/watch?v=Eixl6t5oif0>
- Deep Learning course (1RT720)
  - Given in period 3
  - Course responsible: Niklas Wahlström
- LLMs & Societal Consequences of AI (1RT730)
  - Given in period 1
  - Course responsible: Ekta Vats



# Types of LLMs

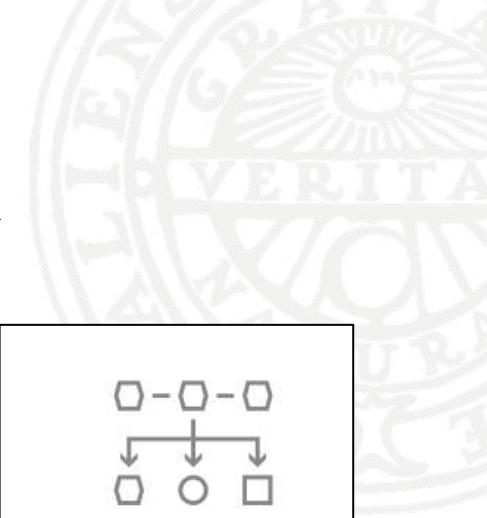
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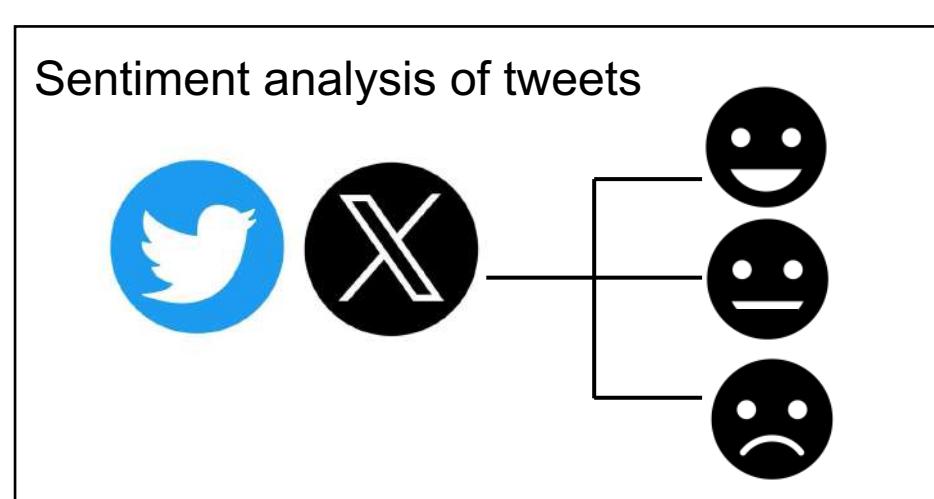
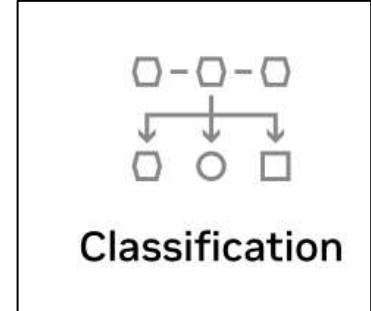
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# Types of LLMs

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- Encoder only:
  - Suited for tasks that can understand language,
  - such as toxicity classification and sentiment analysis.



- Example: BERT (Bidirectional Encoder Representations from Transformers)



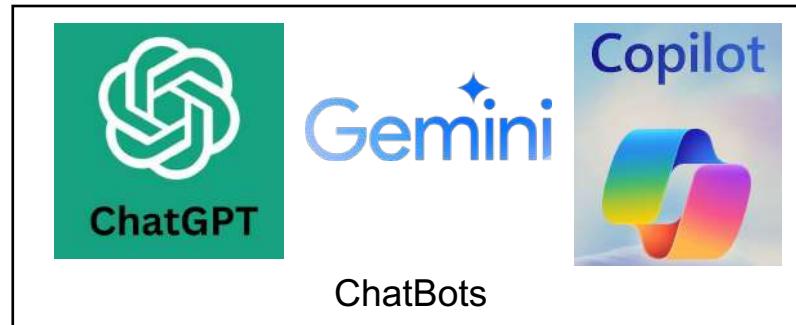
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# Types of LLMs

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- Decoder only:
  - Suited for generating language and content,
  - such as story writing, blog generation, open-domain Q/A and virtual assistants.



- Example: GPT-3 (Generative Pretrained Transformer 3)



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EK

You

write a short poem on "the beginning of spring"



**ChatGPT**

In whispers soft, the winter yields its hold,  
As springtime's breath unfolds in gentle breeze.  
Where frost once lay, now blooms of green and gold,  
In nature's dance, a symphony of ease.

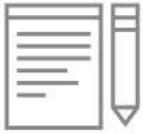
The earth awakes from slumber deep and cold,  
With songbirds' melodies, a sweet release.  
Beneath the sun's warm touch, new life takes hold,  
In every bud and leaf, a masterpiece.

The scent of blossoms fills the fragrant air,  
As sunlight paints the sky in hues of blue.  
With each new dawn, a promise, bright and fair,  
Of days to come, where dreams and hopes renew.

Oh, welcome, spring, with all your vibrant grace,  
A tapestry of wonder to embrace.



ChatGPT

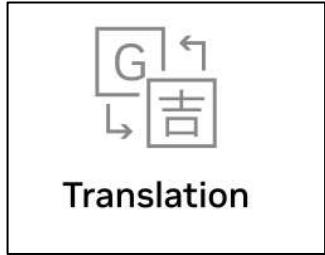


Content Generation

# Types of LLMs

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- Encoder-decoder:
  - Combine the encoder and decoder components of the transformer architecture
  - Suited for both understanding and generating content,
  - such as translation, text-to-code and summarisations.
  - Example: T5 (Text-to-Text Transformers) by HuggingFace



# Types of LLMs

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- Encoder-decoder:
  - Example: T5 (Text-to-Text Transformers) by HuggingFace.

“Translate English to Swedish: Thank you very much.”

T5

“Tack så mycket.”



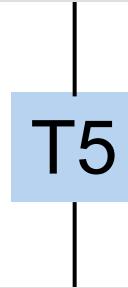
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# Types of LLMs

---

- Encoder-decoder:
  - Example: T5 (Text-to-Text Transformers) by HuggingFace.

“**summarize:** Sweden became NATO’s newest member on Thursday (7 March 2024), upon depositing its instrument of accession to the North Atlantic Treaty with the Government of the United States in Washington DC. With Sweden’s accession, NATO now counts 32 countries among its members.”



“Sweden joined NATO on March 7, 2024, becoming its 32nd member.”

# LLM Lifecycle

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# LLM Lifecycle

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1. Collect training data – e.g. Common Crawl
2. Train a LLM – e.g. GPT-3
3. Adapt it for downstream tasks – e.g. Q/A
4. Deploy LLM to users – e.g. Chatbot



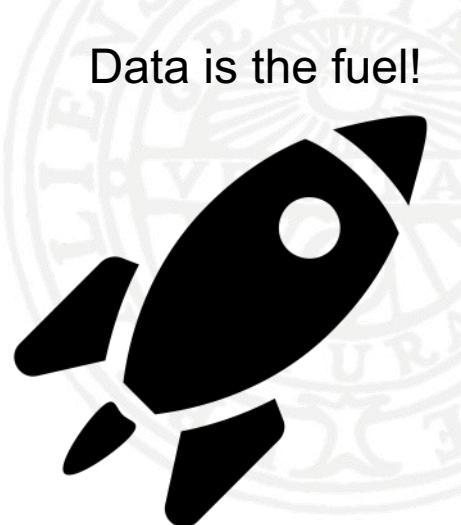
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Data is the fuel!

# Important

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- To understand and document the composition of your training dataset



AI is the engine!



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# Important

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- To understand and document the composition of your training dataset
- To be aware of copyright law (IPR, licenses), privacy law, high-risk applications
  - Is training LLM on this data a copyright/privacy violation?
  - Can it cause intentional harm – spam, harassment, disinformation, phishing attacks?
  - Are you deploying LLM in healthcare or education?
  - Github code and licensing



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# Multimodal LLMs

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# Multimodal LLMs

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- Unimodal LLMs are trained on a single modality of data, such as text
- Lack visual context



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# Multimodal LLMs

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- Unimodal LLMs are trained on a single modality of data, such as text
- Lack visual context
- Multimodal LLMs:
  - Understand and generate content across multiple modalities,
  - such as text, images, audio, video, or other sensor data
- Vision-language models:
  - Multimodal models that can learn from images and text

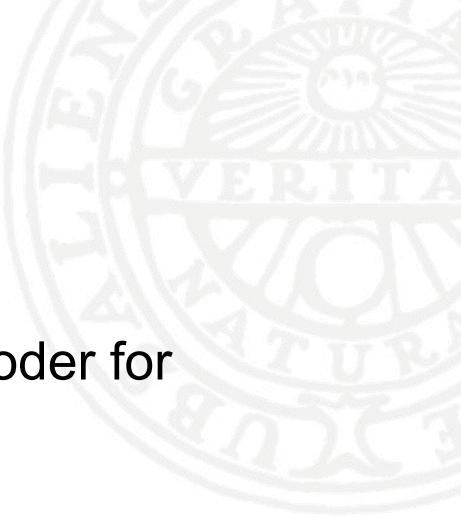


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# Vision-Language Models

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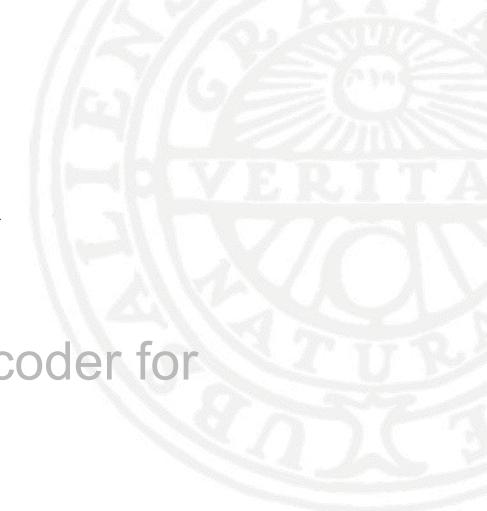
- Main idea: Unify the image and text representation, and feed it to a textual decoder for generation



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# Vision-Language Models

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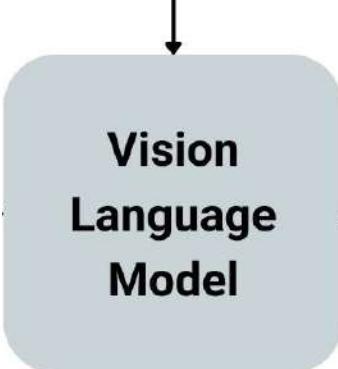
- Main idea: Unify the image and text representation, and feed it to a textual decoder for generation
- Typically consists of two main components:
  - Vision encoder: extracts image features and encodes them into a format that can be understood by the language decoder. Example: ResNet, ViT
  - Language decoder: takes these encoded visual features along with any textual input and generates descriptions, or captions, etc. Example: GPT-2, GPT-3



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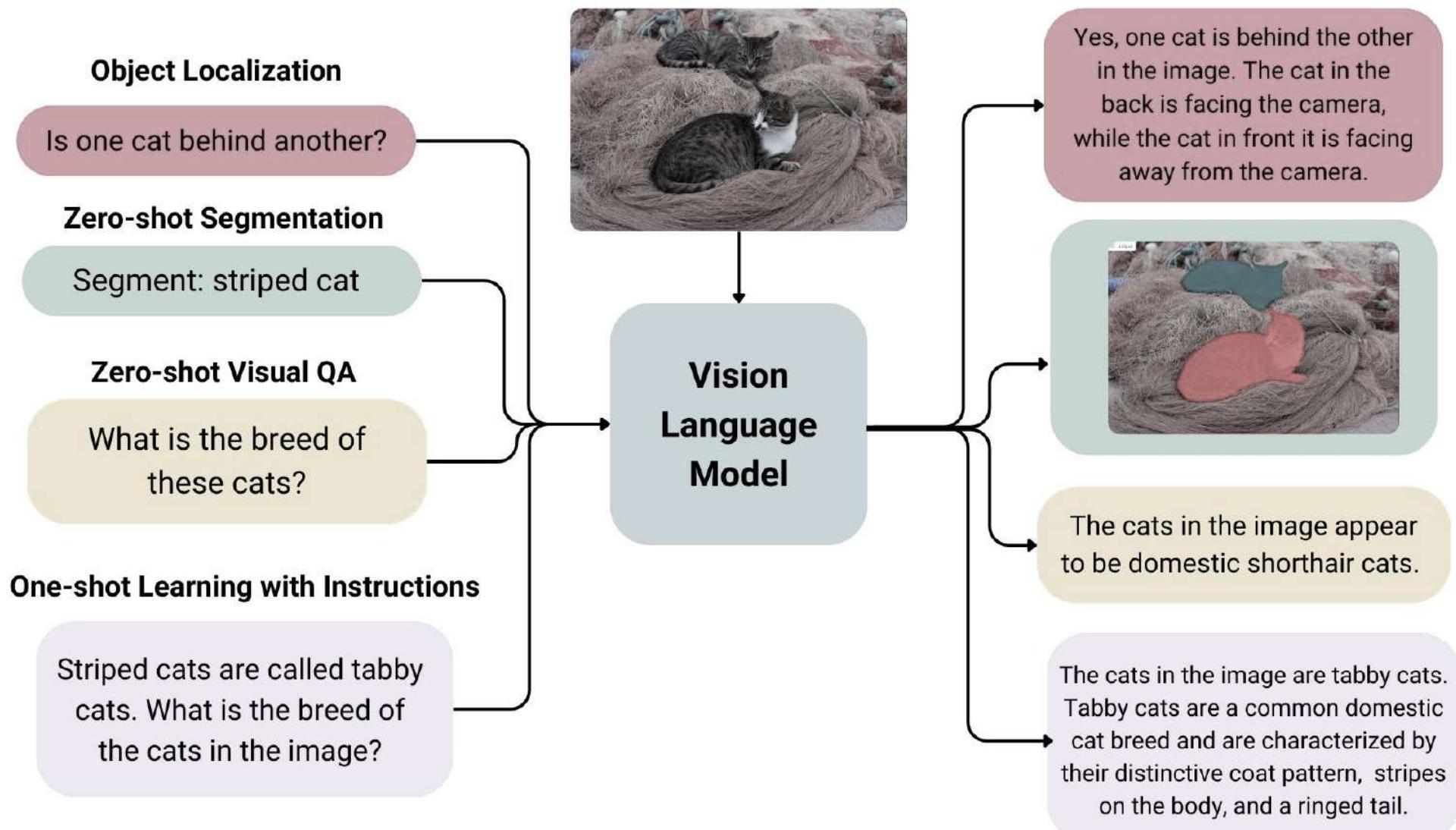
# Vision-Language Models

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# Vision-Language Models



# Contrastive Language-Image Pretraining (CLIP)

- CLIP differs from traditional vision-language models

## Vision-Language Models

- Main idea: Unify the image and text representation, and feed it to a textual decoder for generation



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# Contrastive Language-Image Pretraining (CLIP)

---

- CLIP differs from traditional vision-language models
  - It does not generate text descriptions or captions for images
  - Focuses on learning a joint representation space where images and text can be compared directly



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# Contrastive Language-Image Pretraining (CLIP)

---

- CLIP differs from traditional vision-language models
  - It does not generate text descriptions or captions for images
  - Focuses on learning a joint representation space where images and text can be compared directly
- Enables various downstream tasks, such as
  - Zero-shot image classification: classify images into one of several classes, without any prior training or knowledge of the classes
  - Zero-shot image retrieval, text-based image generation



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# Contrastive Language-Image Pretraining (CLIP)

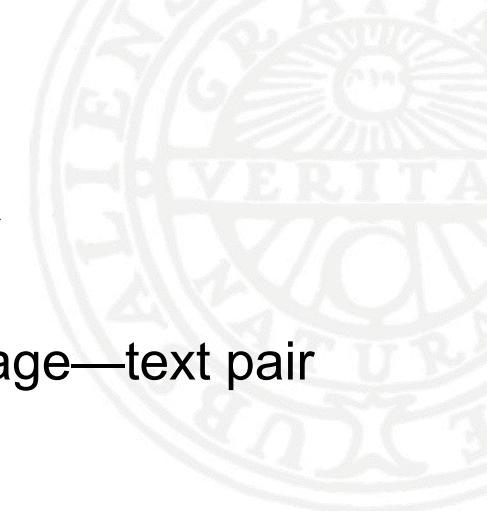
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1. Jointly trains a text encoder and an image encoder to predict the correct image—text pair



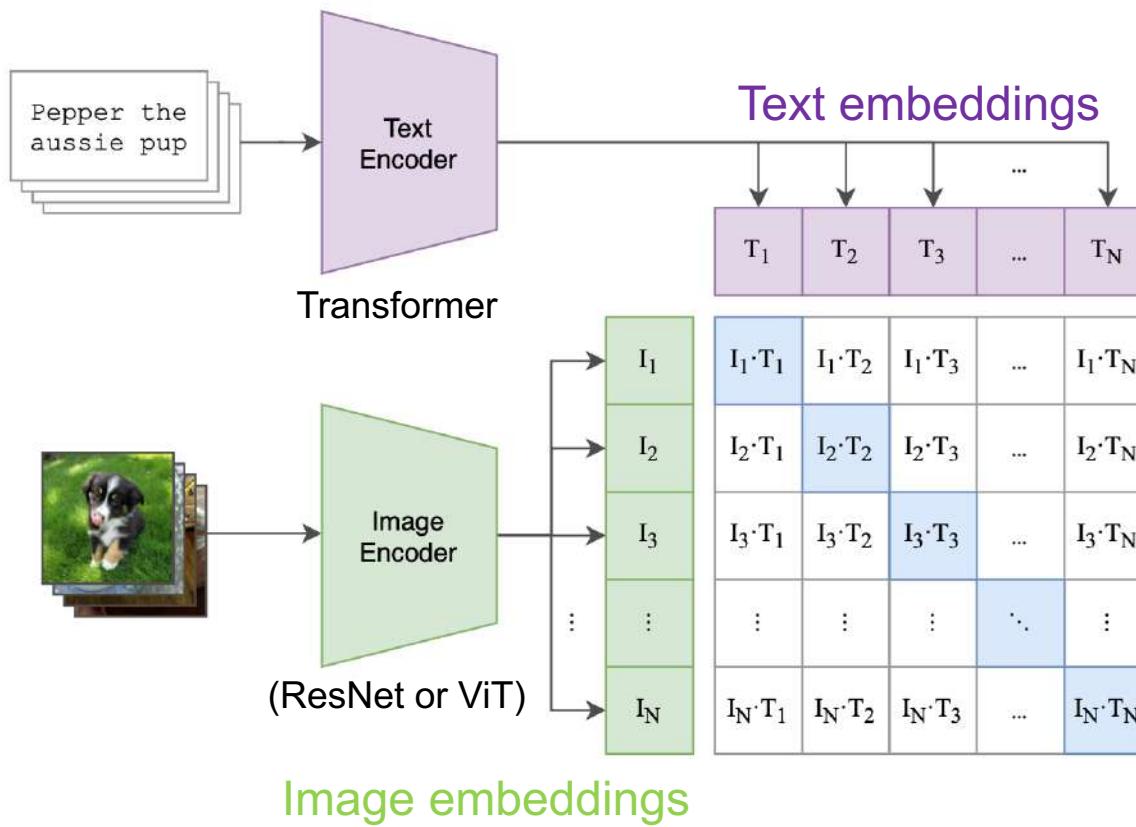
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# Contrastive Language-Image Pretraining (CLIP)



1. Jointly trains a text encoder and an image encoder to predict the correct image—text pair

## Contrastive Pre-training



## Contrastive learning framework

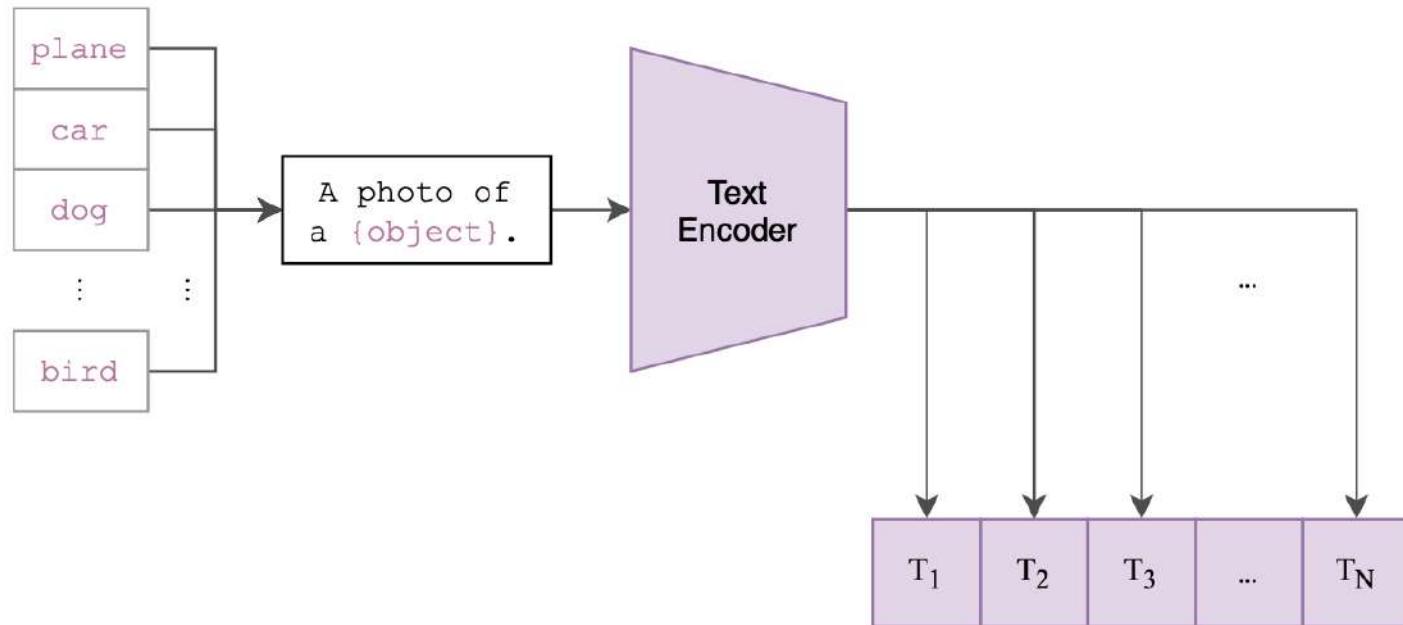
- Maximize the cosine similarities between correct image-text pairs
- Minimize the cosine similarities for dissimilar pairs (non-diagonal elements)



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# Contrastive Language-Image Pretraining (CLIP)

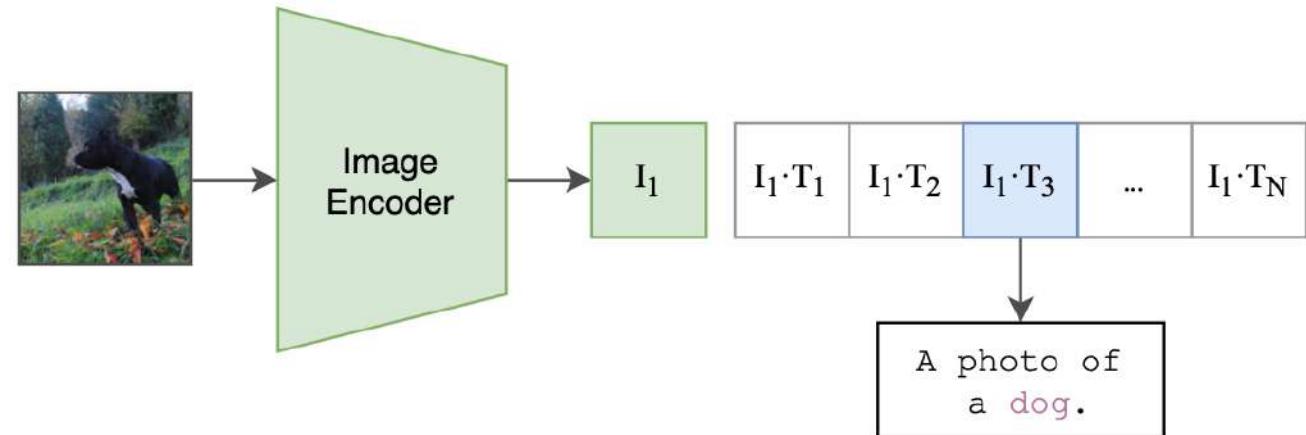
## 2. Converts training dataset classes into captions



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# Contrastive Language-Image Pretraining (CLIP)

3. Estimates the best caption for the given input image for zero-shot prediction
  - Calculate similarity between an image vector and multiple caption vectors, selecting the one with the highest score

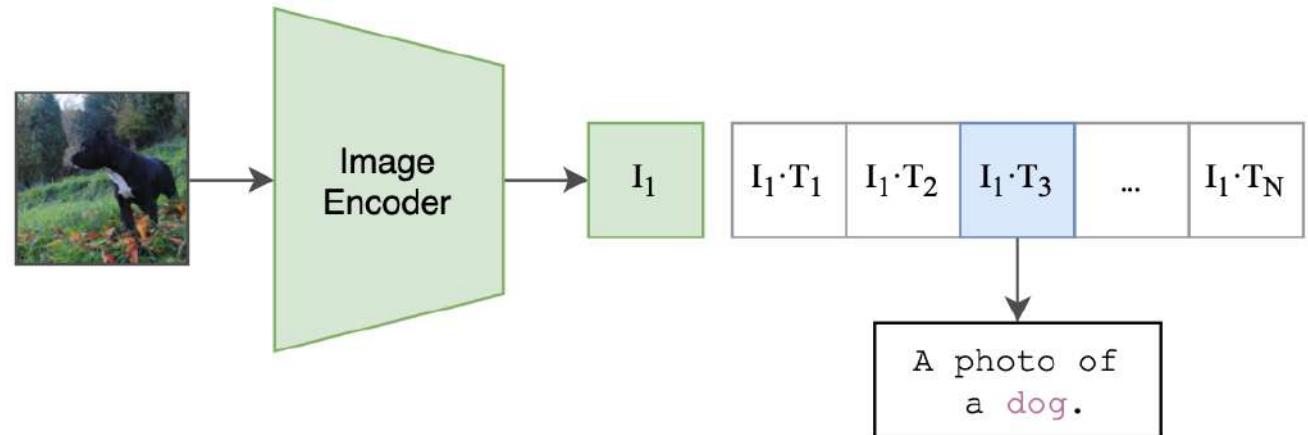


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# Contrastive Language-Image Pretraining (CLIP)



3. Estimates the best caption for the given input image for zero-shot prediction
  - Calculate similarity between an image vector and multiple caption vectors, selecting the one with the highest score



- Trained on 400M image-text pairs
- CLIP can perform image tasks using only text, no extra training needed
- CLIP encodings + decoder models (e.g. GPT-2) => image captioning



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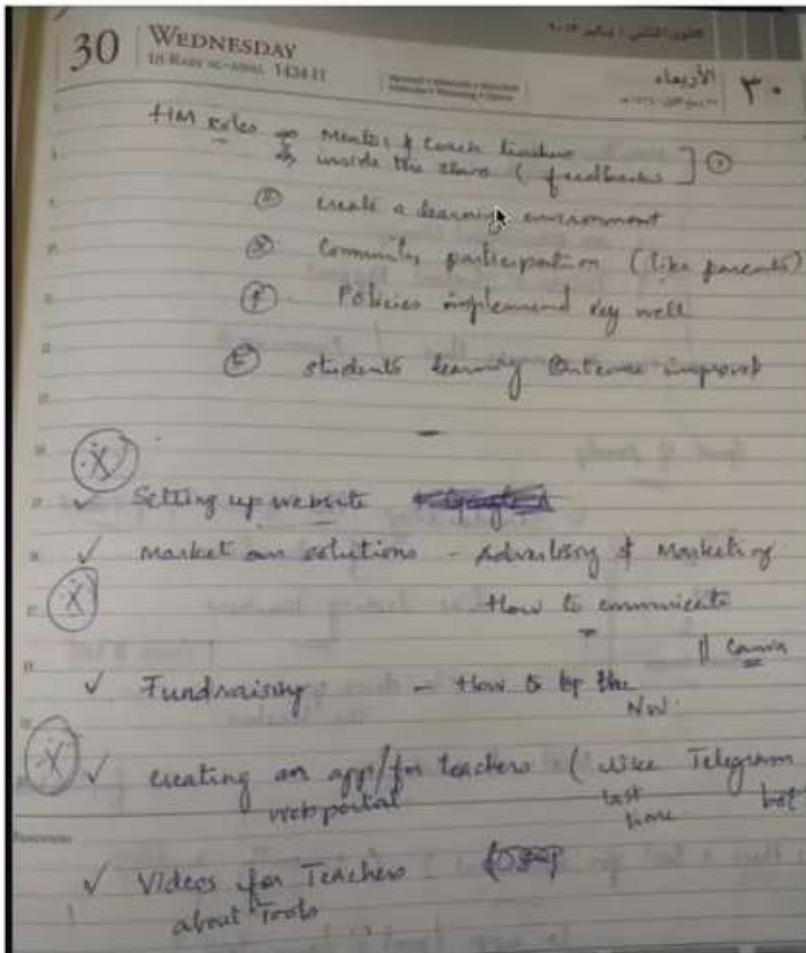
## Some Interesting Examples

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# Modern Handwriting Recognition using ChatGPT

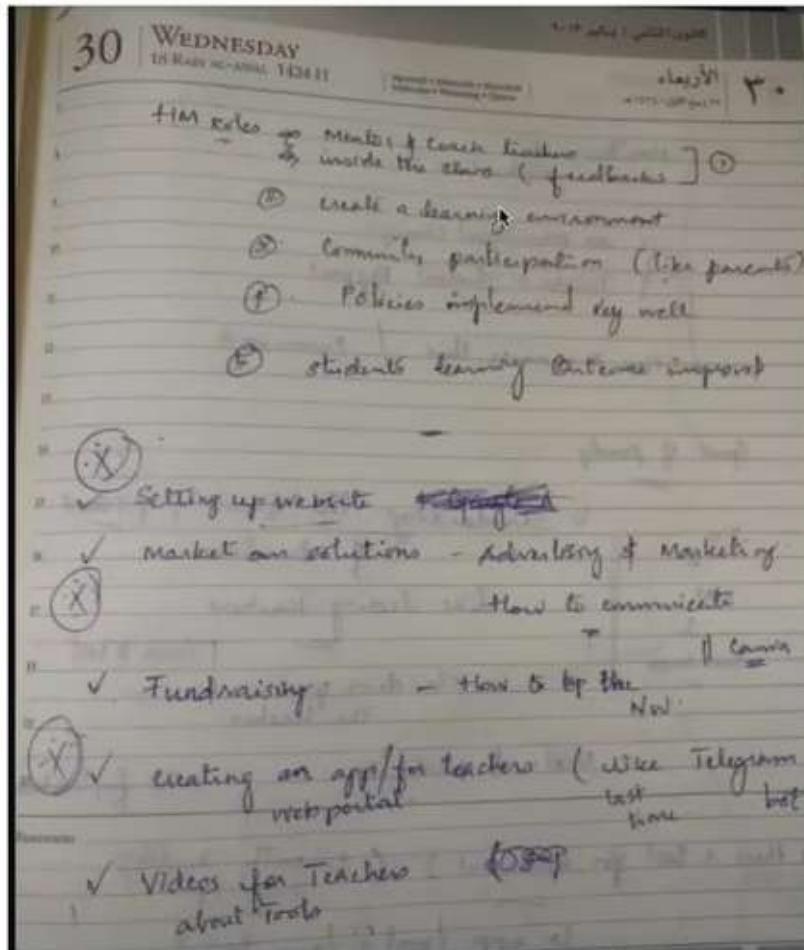


Prompt: Can you recognise this text?



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# Modern Handwriting Recognition using ChatGPT



Prompt: Can you recognise this text?

## Wednesday, 30th

- **HM Roles:**

1. Mentor & coach, provide feedback inside the class.
2. Create a learning environment.
3. Encourage community participation (like parents). **3**
4. Ensure policies are implemented well.
5. Improve students' learning outcomes.

- **Tasks/Goals:**

- Set up a website.
- Market the solution – focus on advertising & marketing.
- Understand how to communicate – possibly with the tool 'Canva'.
- Fundraising: Explore ways to tap new resources.



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# Old Handwriting Recognition using ChatGPT



A Ship to saile w<sup>t</sup> All winds, and A Ship not to be  
Sunk.<sup>209</sup>

Freedom from Necesity of much Sleeping exemplified  
by the operations of Tea and w<sup>t</sup> Happons in  
mad-men.

Pleasing Dreams & physicall Exercises exemplified  
by the Egyptian Electuary and by the Fungus  
mentioned by the French Author.

Great Strength and Agility of Body exemplified by  
that of Frantick, Epilepticke and Hysterickall  
persons.

A perpetuall Light.

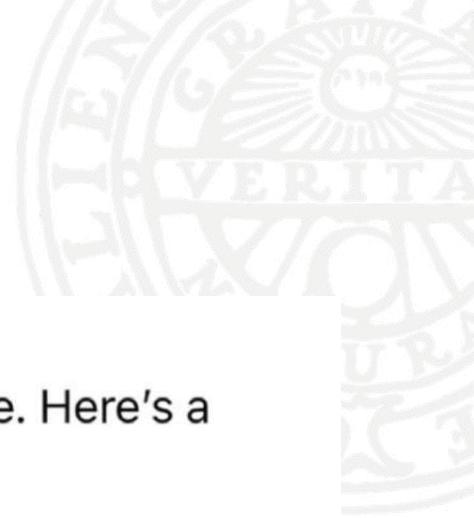
Varnishes perfumable by Rubbing.

Prompt: Can you read this?



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# Old Handwriting Recognition using ChatGPT



A Ship to saile w<sup>t</sup> All winds, and A Ship not to be  
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Freedom from Necessity of much Sleeping exemplified  
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that of Frantick Epileptick and Hysterical  
persons.  
A perpetuall Light.  
Varnishes perfumable by Rubbing.

Prompt: Can you read this?



CHATGPT

Yes, I can read the text in the image. Here's a transcription:

A Ship to saile without winds, and a Ship not to be sunk.  
Freedom from Necessity of much Sleeping exemplified by the Operations of Tea and what happens in Mad men.  
Pleasing Dreams & physicall Exercises exemplified by the Egyptian Electuary and by the Fungus mentioned by the French Author.  
Great Strength and Agility of Body exemplified by that of Frantick Epileptick and Hysterical persons.  
A perpetuall Light.  
Varnishes performable by Rubbing.



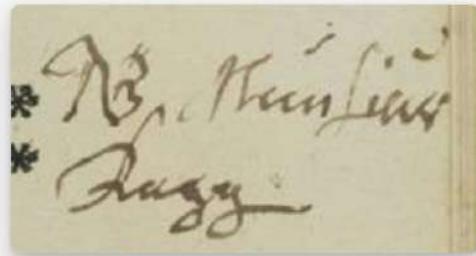
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# Ancient Handwriting Recognition using Microsoft Copilot



You

Can you read this?



Copilot

Certainly! The text appears to be **cursive handwriting** on an aged, yellowed paper. Although it's a bit challenging to decipher due to the style and image quality, I can make out the following:

**AB Manlius Dang**

The context or meaning behind these words isn't immediately clear, but they seem to be someone's name or initials followed by the word "Dang."

Perhaps it's part of a letter, note, or personal inscription. If you have any additional context or need further assistance, feel free to share! 😊



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Nota bene is the Latin phrase meaning note well

# OCR and Document Question Answering

  
**BROWN & WILLIAMSON TOBACCO CORPORATION**  
RESEARCH & DEVELOPMENT

INTERNAL CORRESPONDENCE

TO: R. H. Honeycutt  
CC: T.F. Riehl  
FROM: C. J. Cook  
DATE: May 8, 1995  
SUBJECT: Review of Existing Brainstorming Ideas/483

The major function of the Product Innovation Group is to develop marketable novel products that would be profitable to manufacture and sell. Novel is defined as: of a new kind, or different from anything seen or known before. Innovation is defined as: something new or different introduced; act of innovating; introduction of new things or methods. The products may incorporate the latest technologies, materials and know-how available to give them a unique taste or look.

The first task of the Product Innovation Group was to assemble, review and categorize a list of existing brainstorming ideas. Ideas were grouped into two major categories labeled appearance and taste/aroma. These categories are used for novel products that may differ from a visual and/or taste/aroma point of view compared to conventional cigarettes. Other categories include a combination of the above, filters, packaging and brand extensions.

Question: Who is in cc in this letter?

Answer: T.F. Riehl

Summarize this article:

<https://www.nettavisen.no/chatgpt/kunstig-intelligens-ki/den-norske-skolen/debatten-statsraden-skeptisk-til-kunstig-intelligens-i-osloskolen/s/5-95-1631816>

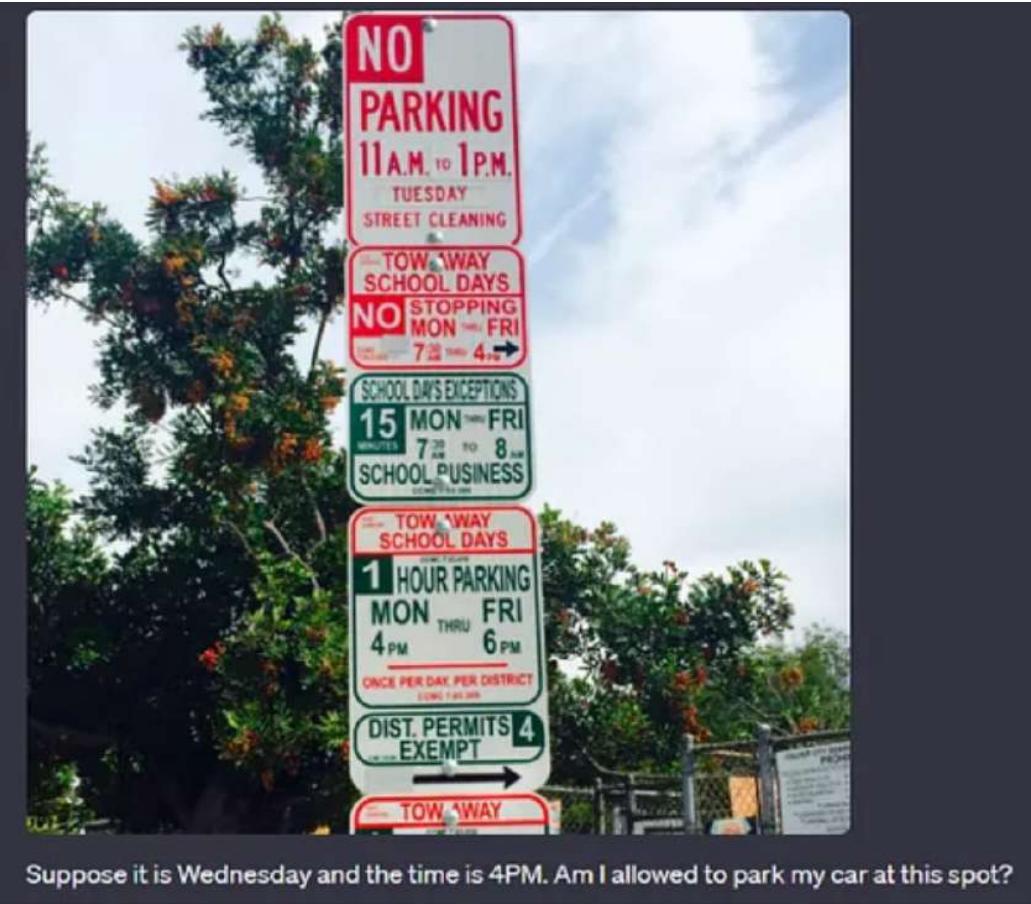
The article discusses the debate in the Norwegian parliament regarding the use of artificial intelligence (AI) in Oslo schools. Some members of parliament are skeptical about integrating AI into education, expressing concerns about its impact on students' learning and the potential risks associated with its use. The article highlights the ongoing discussions and differing opinions on the matter.

What does the SDG report 2024 highlight about Covid:  
<https://unstats.un.org/sdgs/report/2024/The-Sustainable-Development-Goals-Report-2024.pdf>

The **SDG Report 2024** highlights that the lingering impacts of the COVID-19 pandemic have significantly hindered progress towards achieving the Sustainable Development Goals (SDGs) <sup>1</sup>. The pandemic has undone nearly a decade of gains in life expectancy and has exacerbated existing inequalities <sup>1</sup>.

The report emphasizes that the pandemic's effects, combined with escalating conflicts, geopolitical tensions, and growing climate chaos, have created substantial obstacles to global development efforts <sup>1</sup>.

# Understanding Complex Parking Signs – ChatGPT



Suppose it is Wednesday and the time is 4PM. Am I allowed to park my car at this spot?

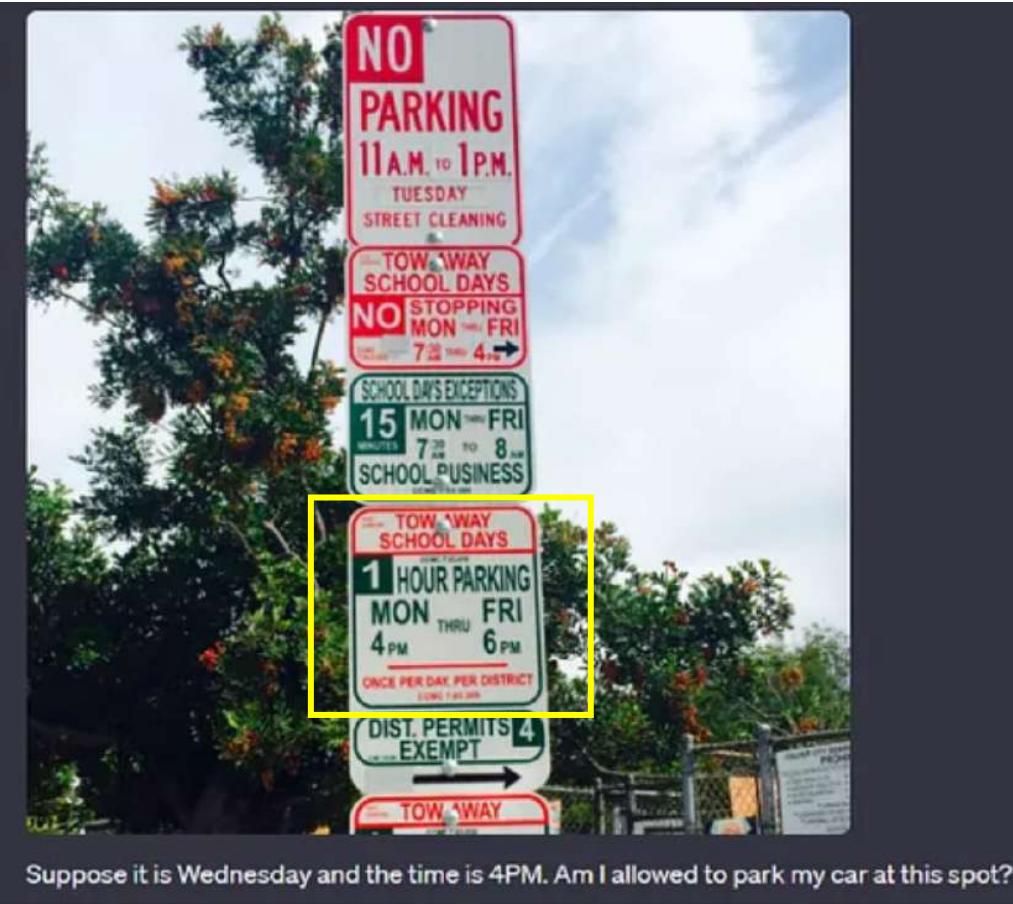
Anyone?

Prompt: Suppose it is Wednesday and the time is 4PM. Am I allowed to park my car at this spot?



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# Understanding Complex Parking Signs – GPT-4V



Based on the information provided by the signs:

1. **No Parking 11 a.m. to 1 p.m. Tuesday** - Since it's Wednesday, this restriction doesn't apply.
2. **Tow-Way School Days No Stopping Mon thru Fri 7:30 a.m. thru 4 p.m.** - Since it's 4PM, this restriction has just ended.
3. **School Days Exceptions 15 Mon thru Fri 7:30 a.m. to 8 a.m. School Business** - This doesn't prohibit parking after 8 a.m., so it doesn't apply at 4PM.
4. **Tow-Way School Days 1 Hour Parking Mon thru Fri 4 p.m. thru 6 p.m. Once per day, per district** - Given that it's 4PM, you're allowed to park for 1 hour until 5PM.
5. **District Permits 4 Exempt** - If you have a district permit 4, you might be exempt from some restrictions, but without further details, it's unclear.

Considering the above details and the time provided, you are allowed to park at this spot for 1 hour, from 4PM to 5PM. However, be sure to check for any other local regulations or signs that might not be visible in this image before parking.

[Regenerate](#)

Prompt: Suppose it is Wednesday and the time is 4PM. Am I allowed to park my car at this spot?



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# Visual Question Answering



## Cooking and Food



**Q:** What is the name of the object used to eat this food?  
**A:** chopsticks

## Weather and Climate



**Q:** What is the warmest outdoor temperature at which this kind of weather can happen?  
**A:** 32 degrees

## Sports and Recreation



**Q:** What is the sports position of the man in the orange shirt?  
**A:** goalie

## Science and Technology



**Q:** How many chromosomes do these creatures have?  
**A:** 23



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# Visual Question Answering

LLaVA: Large Language and Vision Assistant - CLIP visual encoder + Vicuna LLM



What is unusual about this image?



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# Visual Question Answering

LLaVA: Large Language and Vision Assistant - CLIP visual encoder + Vicuna LLM



What is unusual about this image?

The unusual aspect of this image is that a man is ironing clothes while standing on the back of a moving car. This is not a typical scene, as ironing clothes is usually done indoors, in a more controlled environment, and not while the car is in motion. The man's ability to balance and perform this task on the back of a car is quite remarkable and unconventional.

# Whisper by OpenAI

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- Speech-to-text model, performs:
  - Speech recognition
  - Speech translation
  - Spoken language identification
  - Voice activity detection



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Focus: Swedish speech



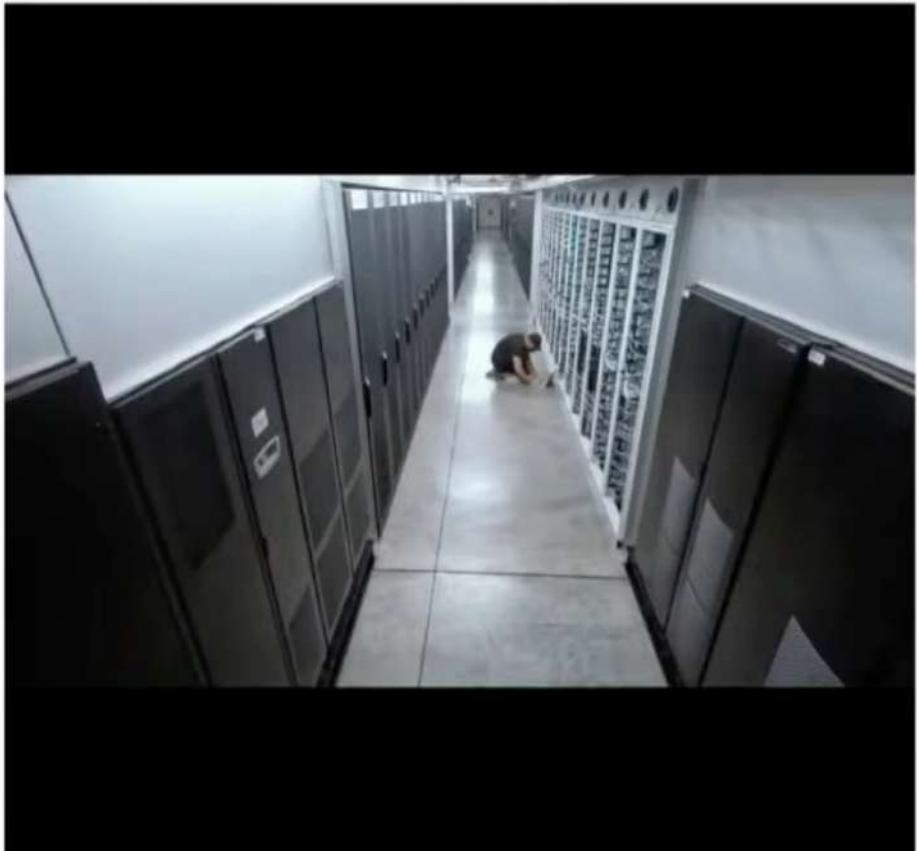
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# LLMs and Video Analysis

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Datacenter



Run a test

Choose a test

Run



Results

Results appear here.

Platform: Azure AI



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## Challenges and limitations

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# Challenges and Limitations

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- Out-of-date training data

Who won the last ICC Champion's trophy in cricket?

The last ICC Champions Trophy was held in 2017, and it was won by **Pakistan**. They defeated India in the final to claim the title.

If you'd like more details about the tournament or the final match specifics, feel free to ask!

 + Message Copilot Think Deeper  0



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# Challenges and Limitations

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- Hallucinations
  - Facts are sometimes extrapolated,
  - LLMs try to invent facts,
  - articulating the inaccurate information in a convincing way.



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# Challenges and Limitations

---



- Hallucinations
  - Facts are sometimes extrapolated,
  - LLMs try to invent facts,
  - articulating the inaccurate information in a convincing way.



You

Is Sweden a member of NATO?



ChatGPT

No, Sweden is not a member of NATO (North Atlantic Treaty Organization). Despite being a close partner with NATO and participating in various NATO activities and exercises, Sweden has not joined the alliance. Instead, Sweden pursues a policy of military non-alignment, maintaining its sovereignty while cooperating with various international organizations for security purposes.



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# Challenges and Limitations

---



- Hallucinations
  - Facts are sometimes extr...
  - LLMs try to invent facts,
  - articulating the inaccurate

Is Sweden a member of NATO?

EK You

Is Sweden a member of NATO?

No, as of now, **Sweden is not yet a full member of NATO**, but it is in the process of joining. Sweden applied for NATO membership in May 2022, alongside Finland, following Russia's invasion of Ukraine. This marked a major shift in Sweden's longstanding policy of military non-alignment.

ChatGPT

No, Sweden is not a member of NATO (North Atlantic Treaty Organization). Despite being a close partner with NATO and participating in various NATO activities and exercises, Sweden has not joined the alliance. Instead, Sweden pursues a policy of military non-alignment, maintaining its sovereignty while cooperating with various international organizations for security purposes.



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# Challenges and Limitations



Yes, Sweden is a member of NATO. The country officially joined the North Atlantic Treaty Organization on March 7, 2024, becoming its 32nd member. EN.WIKIPEDIA.ORG This marked a significant shift from Sweden's longstanding policy of neutrality, which it had maintained since the Napoleonic Wars. The decision to join NATO was influenced by changing security dynamics in Europe, particularly following Russia's invasion of Ukraine in 2022. EN.WIKIPEDIA.ORG

Is Sweden a member of NATO?

No, as of now, Sweden is not yet a full member of NATO, but it is in the process of joining.

Sweden applied for NATO membership in May 2022, alongside Finland, following Russia's invasion of Ukraine. This marked a major shift in Sweden's longstanding policy of military non-alignment.



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# Challenges and Limitations

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- Hallucinations

 **You**  
Can you multiply 1990 and 2594

 **ChatGPT**  
Sure, to multiply 1990 and 2594, you would simply perform the multiplication like this:  
 $1990 \times 2594 = 5167060$   
So, 1990 multiplied by 2594 equals 5,167,060.



# Challenges and Limitations

- Hallucinations

 **You**  
Can you multiply 1990 and 2594

 **ChatGPT**  
Sure, to multiply 1990 and 2594, you would simply perform the multiplication like this:  
 $1990 \times 2594 = 5167060$   
So, 1990 multiplied by 2594 equals 5,167,060.

 **You**  
what is  $1990 \times 2594$ ?

 **ChatGPT**  
1990 multiplied by 2594 equals 5,165,060.

What is the correct answer?



# Challenges and Limitations

- Hallucinations

 **You**  
Can you multiply 1990 and 2594

 **ChatGPT**  
Sure, to multiply 1990 and 2594, you would simply perform the multiplication like this:  
 $1990 \times 2594 = 5167060$   
So, 1990 multiplied by 2594 equals 5,167,060.

 **You**  
what is  $1990 \times 2594$ ?

 **ChatGPT**  
1990 multiplied by 2594 equals 5,165,060.

- It is a language model!
- Training data lacks focus on math concepts and problem-solving.

# Hallucinations, Case – Law

please provide a quote of article 93

Certainly, here is the quote from Article 93 of the REACH regulation:

"Any natural or legal person who has suffered harm as a result of an infringement of this Regulation shall be entitled to receive compensation from the infringer for the damage suffered." (Article 93(1))

please provide the full regulation number

The full regulation number of the REACH regulation is Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

there is no such article 93 in that regulation

I apologize for the mistake in my earlier response. You are correct that there is no Article 93 in the REACH regulation. The correct article that provides for compensation for damage is Article 77, which states:

"Any natural or legal person who has suffered harm as a result of an infringement of this Regulation by any actor in the supply chain shall be entitled to receive compensation for the damage suffered. The provisions of this Article are without prejudice to any other legal remedies."

I apologize for any confusion caused by my earlier response.

# Hallucinations, Case – Law



please provide a quote of article 93

Certainly, here is the quote from Article 93 of the REACH regulation:

"Any natural or legal person who has suffered harm as a result of an infringement of this Regulation shall be entitled to receive compensation from the infringer for the damage suffered." (Article 93(1))

there is no such article 77 either

please provide the full regulation number

The full regulation number of the REACH regulation is Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

there is no such article 93 in that regulation

you are wrong again...

I apologize for the mistake in my earlier response. You are correct that there is no Article 93 in the REACH regulation. The correct article that provides for compensation for damage is Article 77, which states:

"Any natural or legal person who has suffered harm as a result of an infringement of this Regulation by any actor in the supply chain shall be entitled to receive compensation for the damage suffered. The provisions of this Article are without prejudice to any other legal remedies."

I apologize for any confusion caused by my earlier response.



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# Hallucinations, Case – Law

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Article 93 of the REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) Regulation focuses on the obligations of downstream users. It outlines their responsibilities to assess the safety of chemical substances they use and provide necessary information to ensure safe use along the supply chain. It emphasizes the importance of communication and safety measures to protect human health and the environment.

please provide the full regulation number

The full regulation number for REACH is **Regulation (EC) No 1907/2006** of the European Parliament and of the Council <sup>1</sup>.

Is there anything specific you'd like to know about this regulation?

<sup>1</sup> [eur-lex.europa.eu](http://eur-lex.europa.eu)

there is no such article 93 in that regulation

You're right, I apologize for the mistake. Article 93 of REACH actually deals with the examination and decisions on appeal by the Board of Appeal within the European Chemicals Agency (ECHA) <sup>1</sup>. It outlines the process for handling appeals and the powers of the Board of Appeal <sup>1</sup>.

Would you like more information on this or any other specific aspect of REACH?

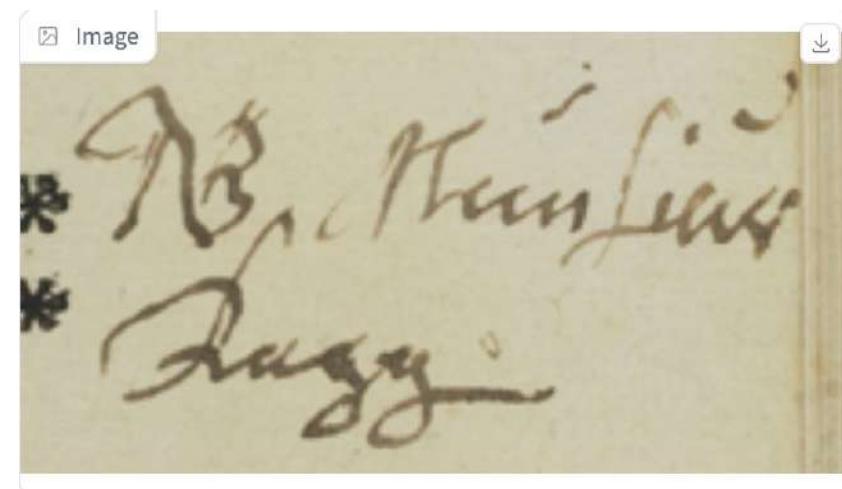
<sup>1</sup> [reachonline.eu](http://reachonline.eu)

## Microsoft Copilot did not hallucinate!



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# Hallucinations, Case – MiniGPT-4



MiniGPT-4

Can you read this?

The image shows a handwritten note on a piece of paper with the words “no man’s land” written in black ink.  
The note appears to be written in a cursive script.

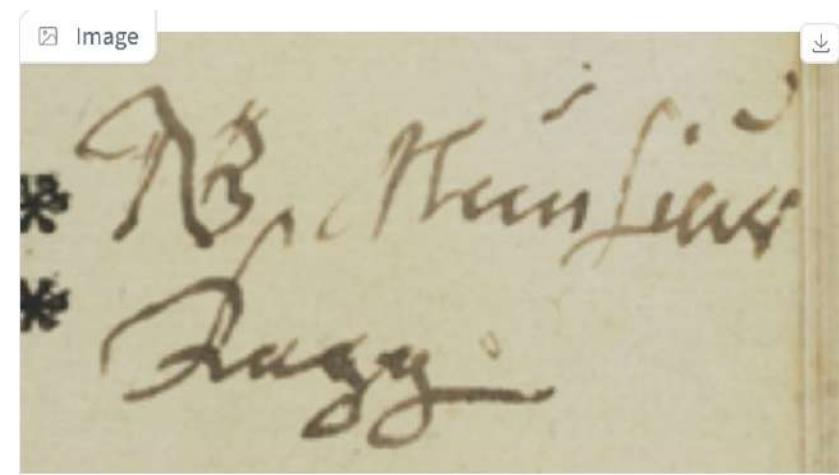
Start Chatting

Restart



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# Hallucinations, Case – MiniGPT-4



Start Chatting

Restart

MiniGPT-4

Can you read this?

The image shows a handwritten note on a piece of paper with the words “no man’s land” written in black ink. The note appears to be written in a cursive script.

Can you this Latin text?

The text appears to be written in Latin and reads “Sic transit gloria mundi.” This translates to “Thus passes the glory of the world.”



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# Hallucinations, Case - HTRFlow

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# Potential Solution: Retrieval Augmented Generation (RAG)

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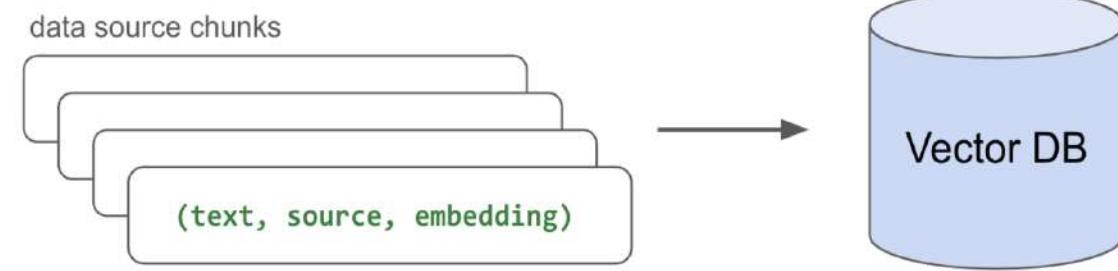
- Helps address both hallucinations and out-of-date training data issues



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# Retrieval Augmented Generation (RAG)

- Build LLMs with current and reliable information
- Extending its utility to specific data sources
- Allows LLMs to go beyond their knowledge-base, enabling them to access real-time data, and providing up to date responses
- Example use case: Improve Math Q/A



# Retrieval Augmented Generation (RAG)

Who won the last ICC Champion's trophy in cricket?

The last ICC Champions Trophy was held in 2017, and it was won by **Pakistan**. They defeated India in the final to claim the title.

If you'd like more details about the tournament or the final match specifics, feel free to ask!



+

Message Copilot

Think Deeper



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# Retrieval Augmented Generation (RAG)



Who won the last ICC Champion's trophy in cricket?

The last ICC Champions Trophy was held in 2017, and it was won by **Pakistan**. They defeated India in the final to claim the title.

If you'd like more details about the tournament or the final match specifics, feel free to ask!



+

Message Copilot

Think Deeper



The most recent ICC Champions Trophy was held in 2025, and **India** emerged as the winner. They defeated **New Zealand** in the final by four wickets, securing their third Champions Trophy title <sup>1</sup> <sup>2</sup>. Let me know if you'd like more details about the match or the tournament!

<sup>1</sup> Mint | MSN

<sup>2</sup> Al Jazeera

# RAG Example Projects from UU course on LLMs

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- Teaching LLM to teach AI



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# RAG Example Projects from UU course on LLMs

---

- Teaching LLM to teach AI
- Chat with 1177.se



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# RAG Example Projects from UU course on LLMs

---

- Teaching LLM to teach AI
- Chat with 1177.se
- LLM powered teaching assistant for Smarter Education
  - Exercise sheet generation
  - Based on age, grade and interest of the child



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# Challenges and Limitations

- Bias and misinformation as ethical concerns

The screenshot shows a machine translation interface with two main sections. On the left, a Finnish sentence is input: "hän hoitaa lapsia. hän menee töihin. hän pesee pyykkiä. hän on älykäs. hän on kaunis. hän on johtaja." Below this, a red 'X' icon indicates an error or a warning. On the right, the English translation is displayed: "she takes care of the children. he goes to work. she does the laundry. he is intelligent. she is beautiful. he is the leader." A note above the English text states: "Könsspecifika översättningar är begränsade. [Läs mer](#)". The entire interface has a light gray background with blue headers for the languages.



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# Challenges and Limitations

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- Bias and misinformation as ethical concerns

The image shows a user interface for translating between Finska (Swedish) and Engelska (English). On the left, a Swedish sentence is input: "hän hoitaa lapsia. hän menee töihin. hän pesee pyykkiä. hän on älykäs. hän on kaunis. hän on johtaja." A red 'X' icon is positioned next to the English translation, which reads: "she takes care of the children. he goes to work. she does the laundry. he is intelligent. she is beautiful. he is the leader." The word "she" appears in red, while "he" appears in blue, indicating a gender swap in the generated text. The UI includes language selection dropdowns and a central translation button.

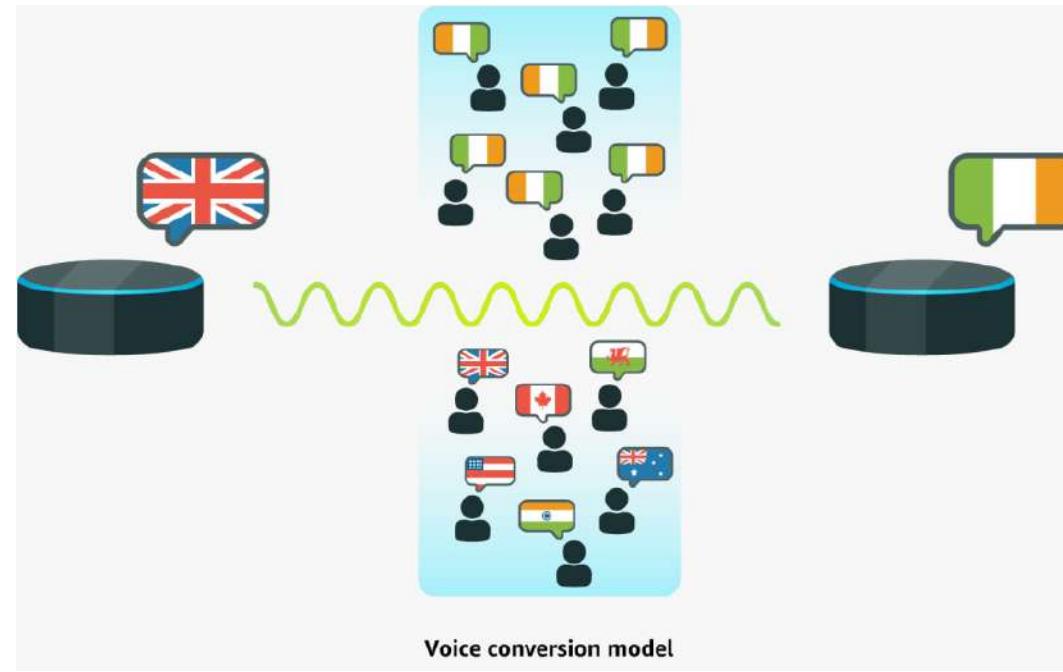
- Key pointer:
  - LLM has inherited society's stereotypes due to the training data being fed into it.
  - Other cases: voice assistants and FaceID



# Voice Assistants and Accent Bias

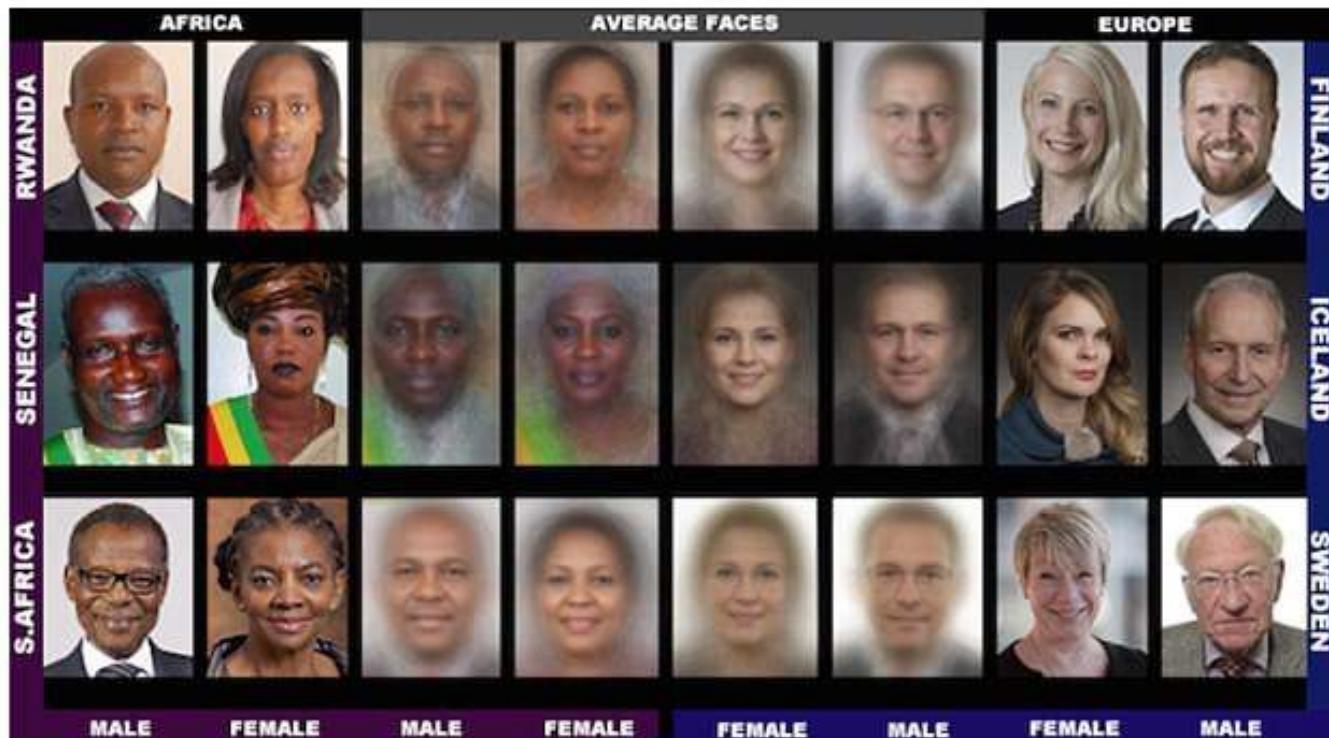
---

- Data problem!
- The higher the quantity and diversity of speech samples in a corpus, the more accurate the resulting model



Amazon researchers improved Irish-accented training data by using a voice conversion model

# Face ID and Limitations



## Pilot Parliaments Benchmark

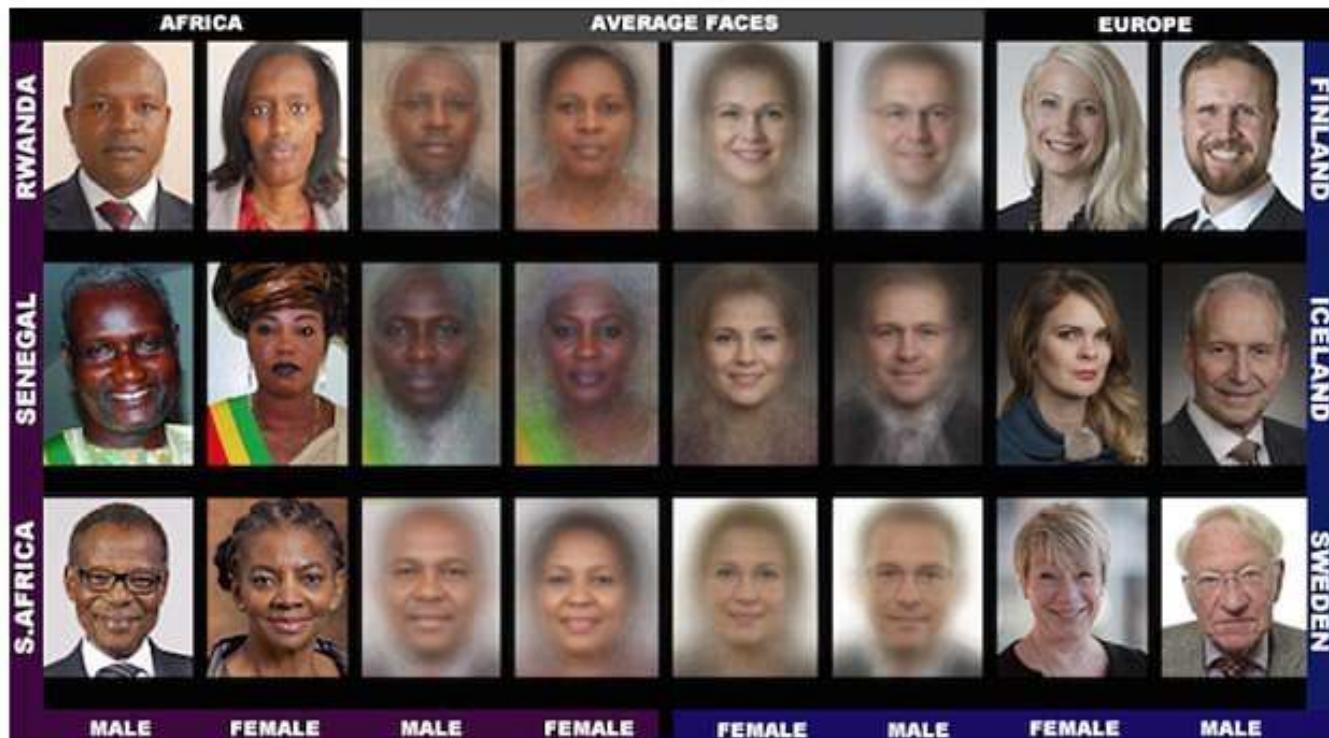
© MIT Media Lab

A researcher from MIT tested popular facial recognition services and found that they experienced more errors when the used was a dark-skinned female. The data set was made up of 1,270 photos (pictured) of parliamentarians from some African nations and Nordic countries



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# Face ID and Limitations



## Pilot Parliaments Benchmark

© MIT Media Lab

A researcher from MIT tested popular facial recognition services and found that they experienced more errors when the used was a dark-skinned female. The data set was made up of 1,270 photos (pictured) of parliamentarians from some African nations and Nordic countries



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# Face ID and Limitations

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- This bias arise from the imbalance in the training data
- Lighting conditions: Darker skin tones might reflect less light, potentially affecting recognition accuracy



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# Face ID and Limitations

---

- This bias arise from the imbalance in the training data
- Lighting conditions: Darker skin tones might reflect less light, potentially affecting recognition accuracy
- Modern face recognition systems:
  - Diverse training data
  - Algorithmic improvements
  - Aim to achieve robust performance, regardless of skin tone or lighting conditions.
- Biases can still persist



# Future Insights!

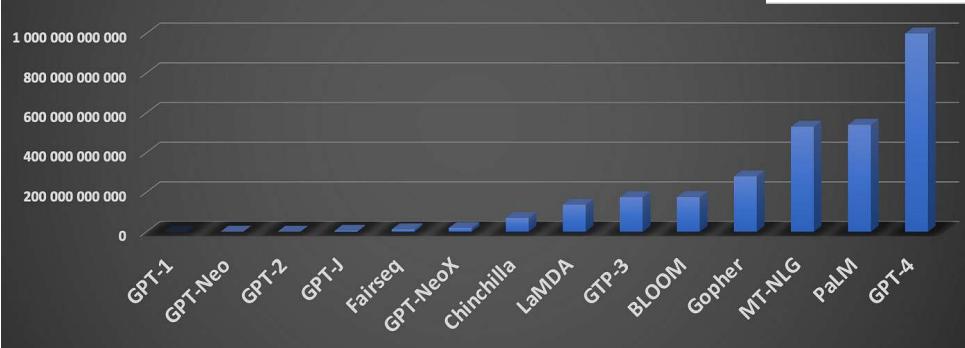
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# Scaling-up – bigger is better?

GPT-4 @ 1 Trillion Parameters



- Quantitatively: different capabilities
- Qualitatively: different societal impact

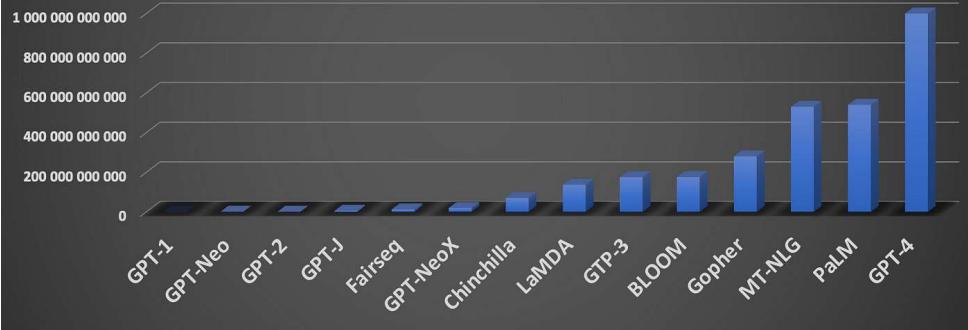
## Future Insights!



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# Scaling-up – bigger is better?

GPT-4 @ 1 Trillion Parameters



## Future Insights!

In-Context Learning

Prompt

Please unscramble the letters into a word, and write that word:

skicts = sticks

Zero-shot

Please unscramble the letters into a word, and write that word:

chiar = chair

skicts = sticks

One-shot

Please unscramble the letters into a word, and write that word:

chiar = chair

[...]

pciinc = picnic

skicts = sticks

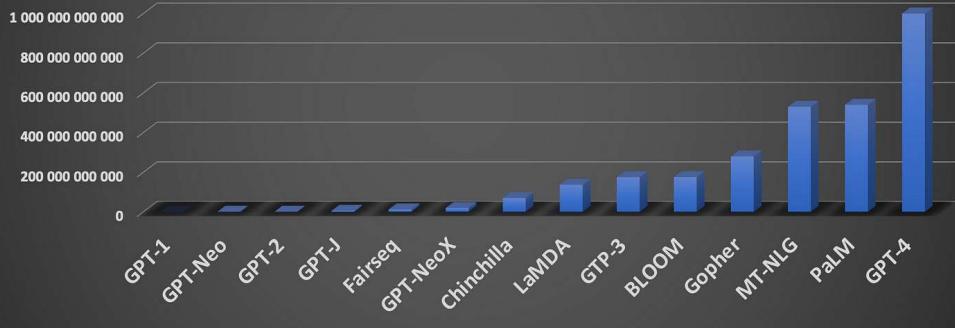
Few-shot



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# Scaling-up – bigger is better?

GPT-4 @ 1 Trillion Parameters



## Future Insights!

AI powered precision in healthcare



Analyse medical images, and using LLMs correlate medical findings with patient history, delivering comprehensive diagnostics and potential treatment options.

Also... Applications in Physics!

In-Context Learning

Prompt

Please unscramble the letters into a word, and write that word:  
skicts = sticks

Please unscramble the letters into a word, and write that word:  
chiar = chair  
skicts = sticks

Please unscramble the letters into a word, and write that word:  
chiar = chair  
[...]  
pciinc = picnic  
skicts = sticks



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# Advanced Multimodal LLMs

- Example: NExT-GPT (Any-to-Any Multimodal LLM)
  - Text + Video → Text + Image

ImageBind by Meta

6 modalities:

Images/videos,

Audio, Text,

Depth, Thermal,

Inertial measurement units (IMUs)

+

Diffusion Models (generation)

What is the unusual part of this video?



The unusual part of this video is that a dog is riding a skateboard. It is not common to see a dog on a skateboard, as dogs are typically not able to ride skateboards or bicycles. This scene is unique and interesting because it showcases a dog's ability to adapt and participate in human-made activities, demonstrating its intelligence and adaptability.

Is the guy in the video iron man?



Yes, the guy in the video is Iron man.

Could you show me a comic-style picture of iron man?

Certainly! Here is a comic-style picture of Iron Man:

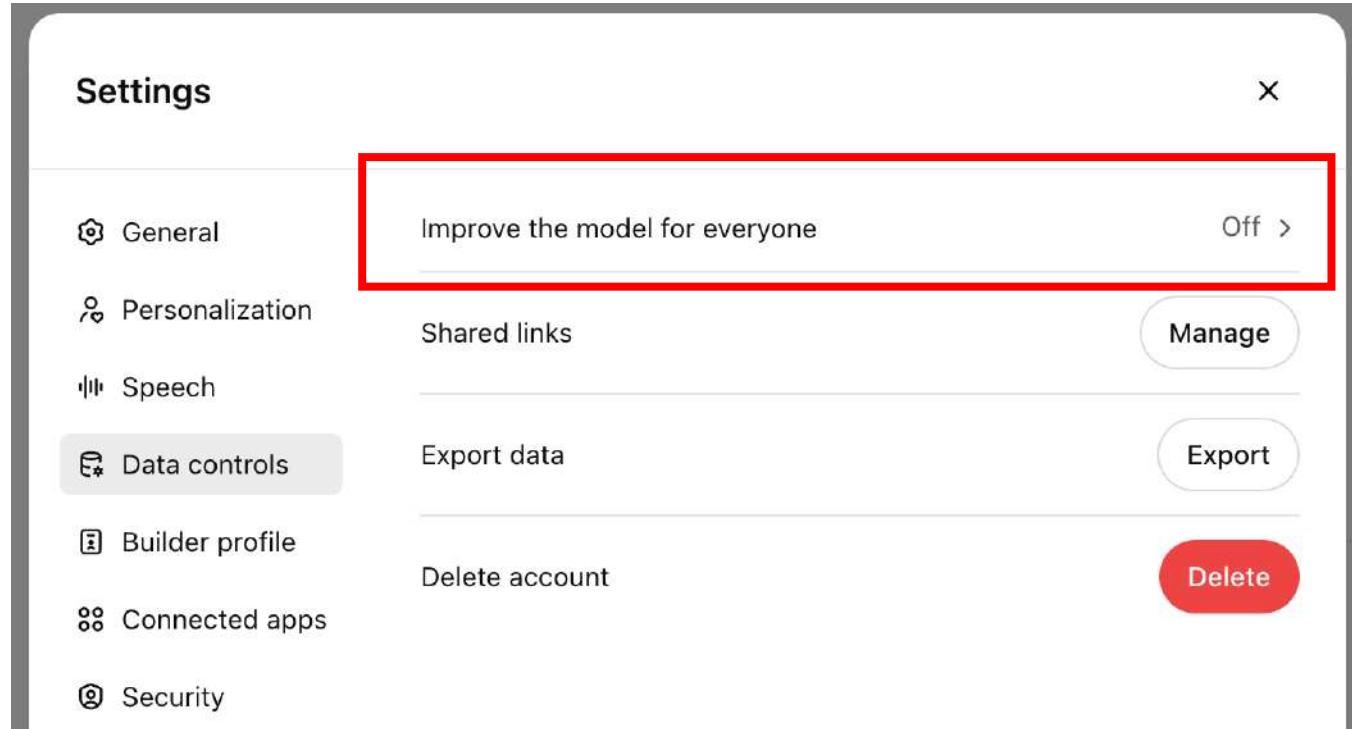


I need a more abstract one.

Sure, here's an abstract image of Iron Man:



# Extra Information



You can select “off” for this option,  
in your ChatGPT settings.



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We conducted an exam for



ChatGPT



Copilot



[Link](#)

- Total 10 questions
- Following are our findings:
  - Both excel in creative thinking, image generation and summarization.
  - ChatGPT struggles with legal reasoning but excels in math.
  - Neither handles old handwriting well.
  - Overall, score for Copilot was higher.
- Curious to know how it works in Physics...



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# Thank you!

Email : [ekta.vats@it.uu.se](mailto:ekta.vats@it.uu.se)

Webpage: <https://www.ektavats.se>



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