Generative AI for Sustainable Entrepreneurship *Large Language Models*

Raffaella Bernardi

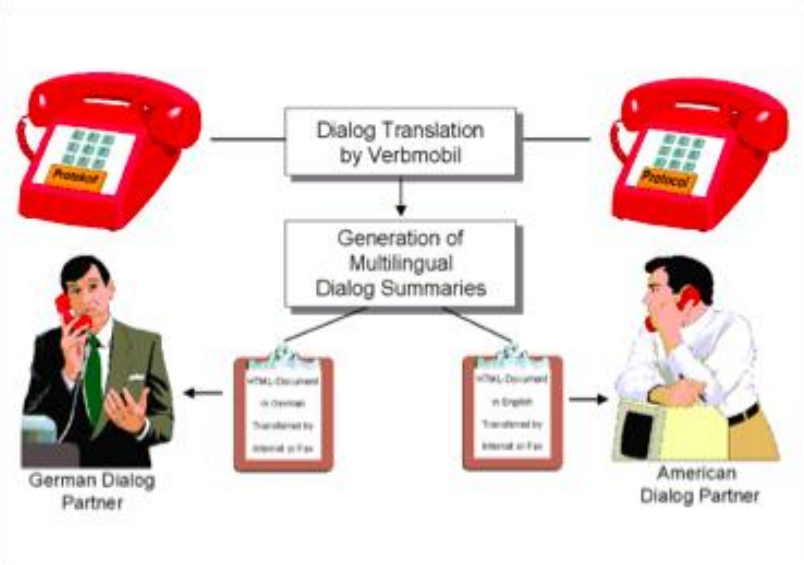
Free University of Bolzano Bozen

unibz
Fakultät für Ingenieurwesen
Facoltà di Ingegneria
Faculty of Engineering

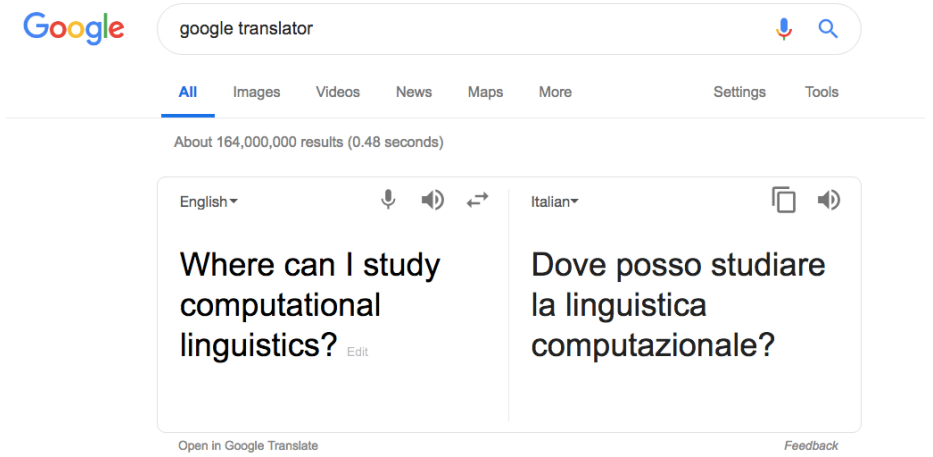
ICA-Edu Special Interest Group 2025 Webinar, 17 September 2025

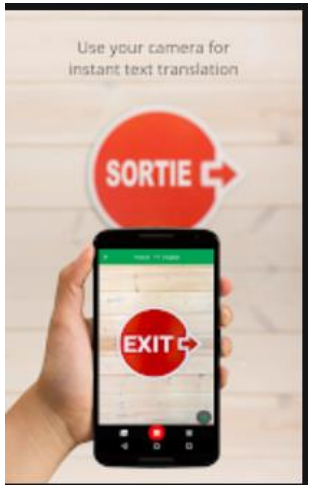
ICA

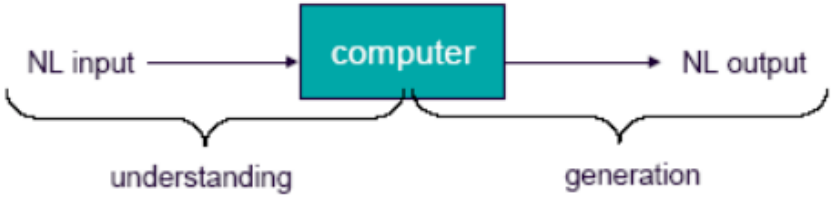
Natural Language Processing (NLP)



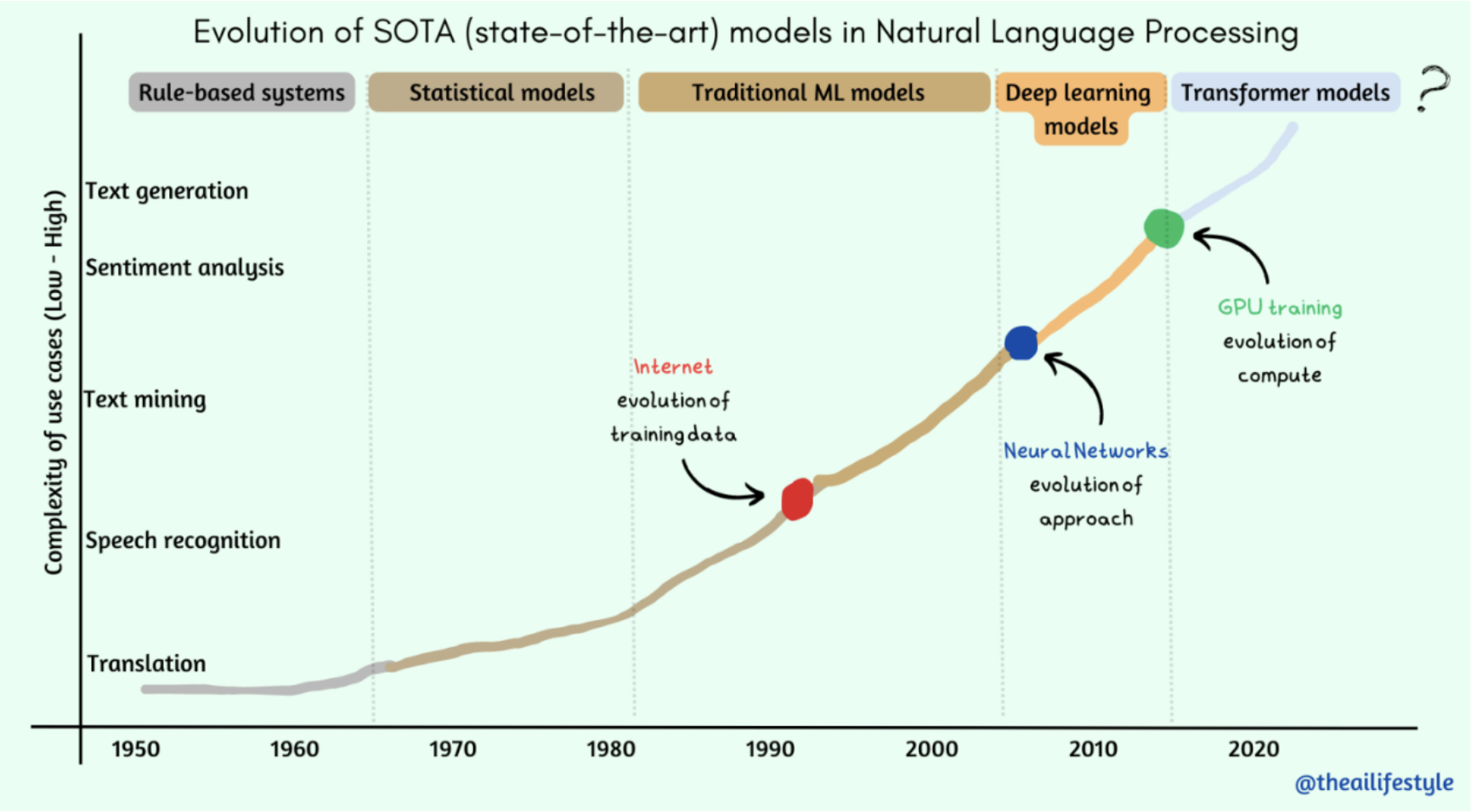
Verbmobil (Dream)
90M euro project in 1993-2000







FROM NLP TO GENERATIVE AI THROUGH DEEP LEARNING

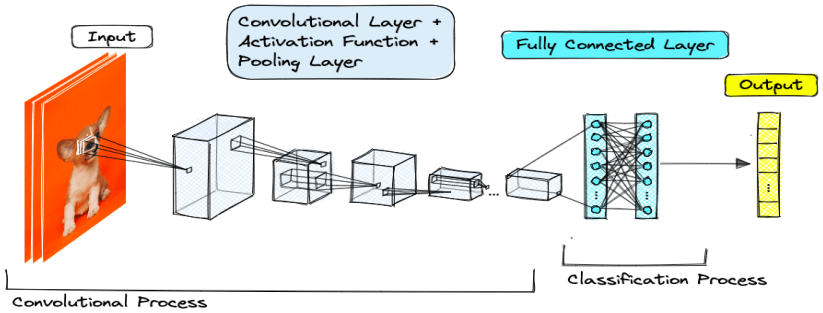


Evolution of SOTA models in NLP and factors affecting them

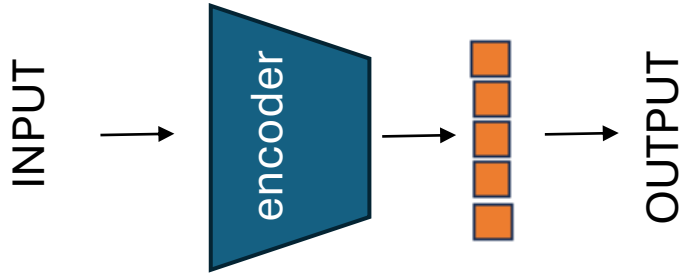
Credits: https://www.linkedin.com/pulse/from-rulesets-transformers-journey-through-evolution-sota-yeddula/

Deep Learning

Computer Vision:
Training a Neural Network to classify an image by computing its **vector representation.**



https://www.pinecone.io/learn/series/image-search/imagenet/

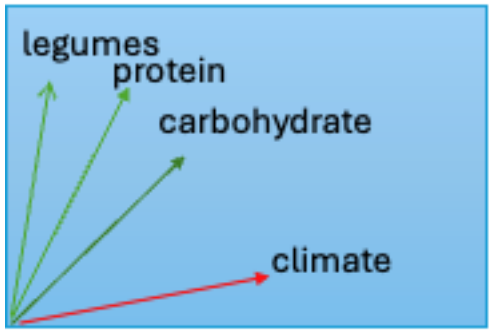


AlexNet, Toronto University, 2012

(idea tracing back to Rochester et al 1956)

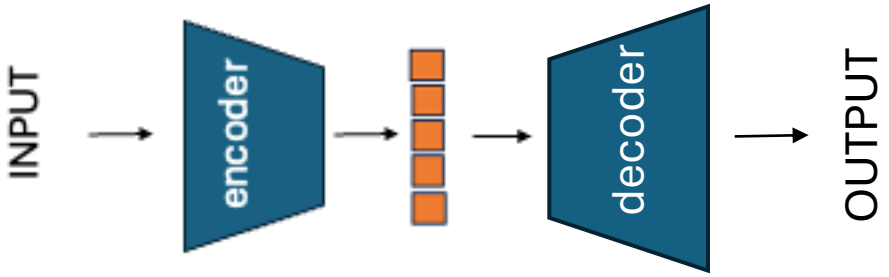
NLP:
word meaning as vectors
e.g. Baroni et al Uni. of Trento

(idea tracing to Harris 1954)

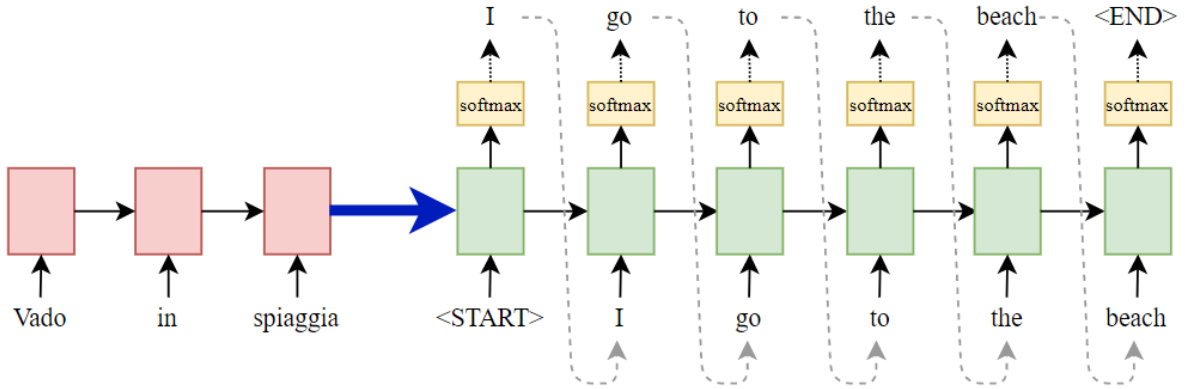


Train a NN to predict a word missing in a context.
Mikolv, 2012 PhD Thesis CZ uni,
Idea tracing back to Shannon 1951 **Language Models**

ICA, Association for European Life Science Universities, is a network of more than 50 universities from the EU and neighbouring countries



Sequence to Sequence, Google, 2014



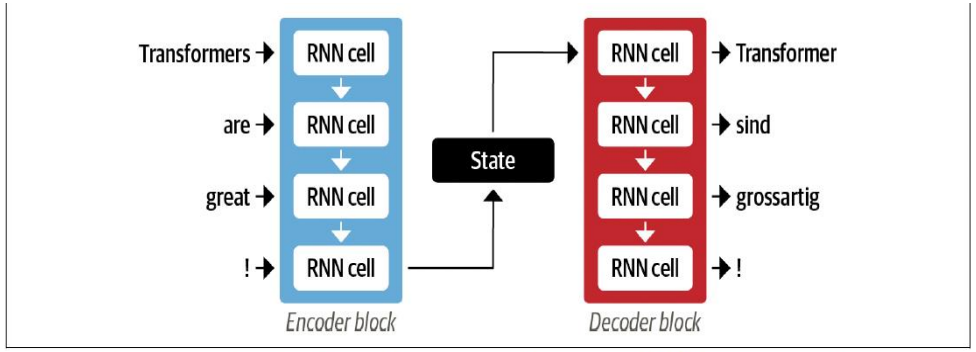
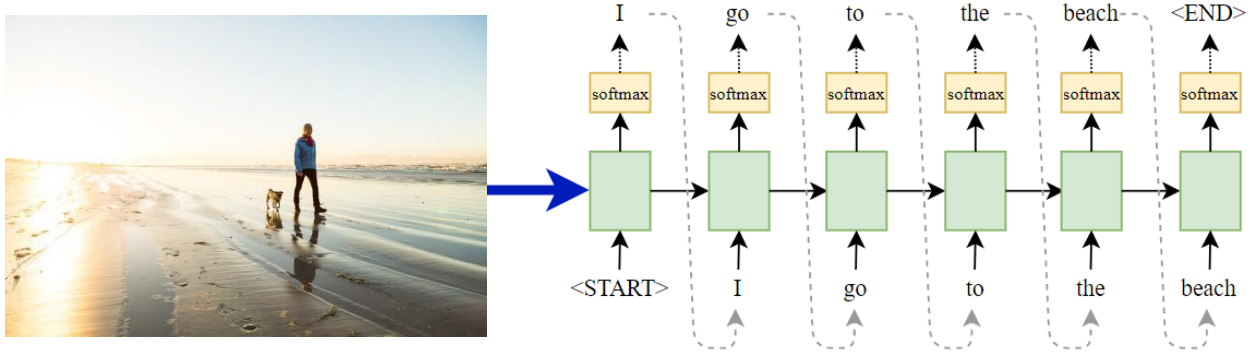


Figure 1-3. An encoder-decoder architecture with a pair of RNNs (in general, there are many more recurrent layers than those shown here)



Transformers:
in parallel, and using attention

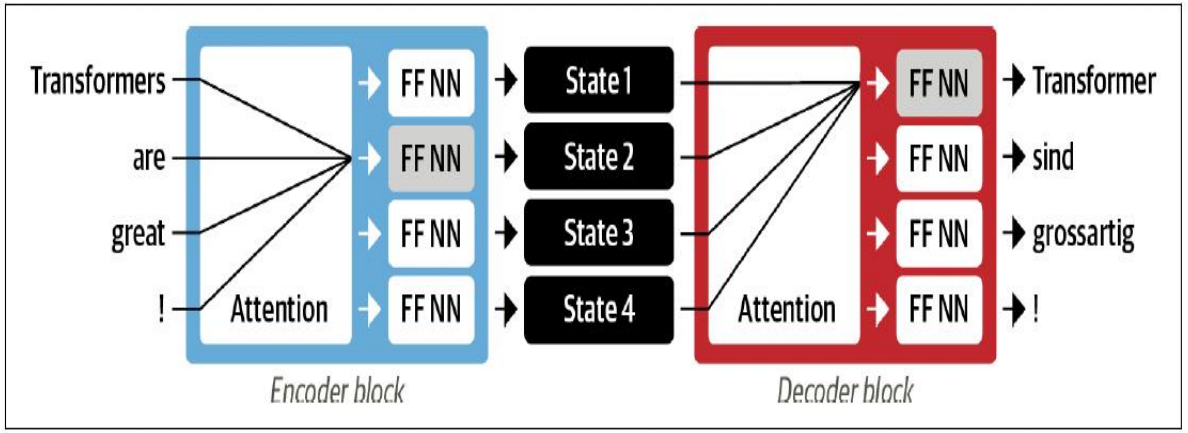
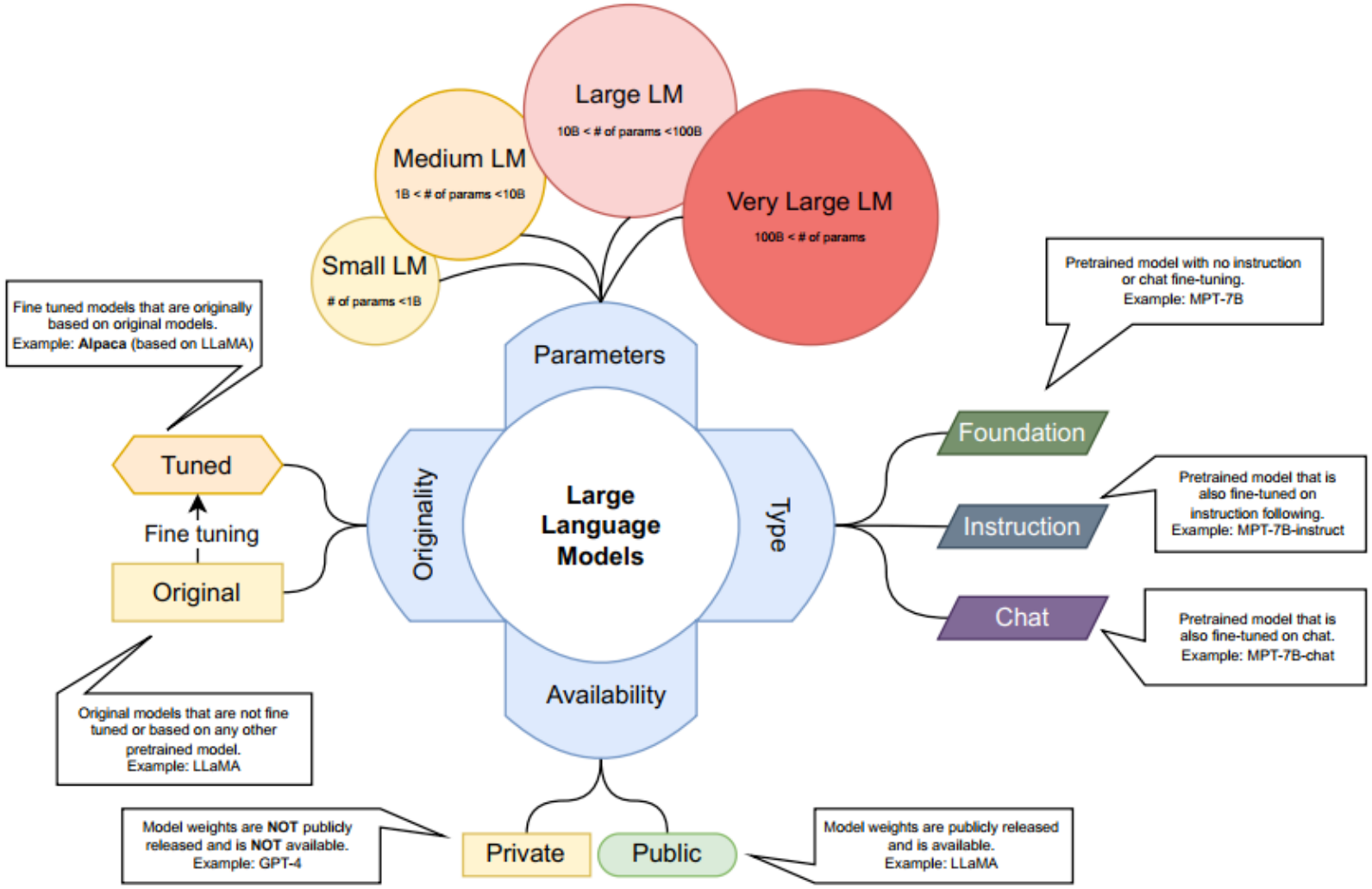


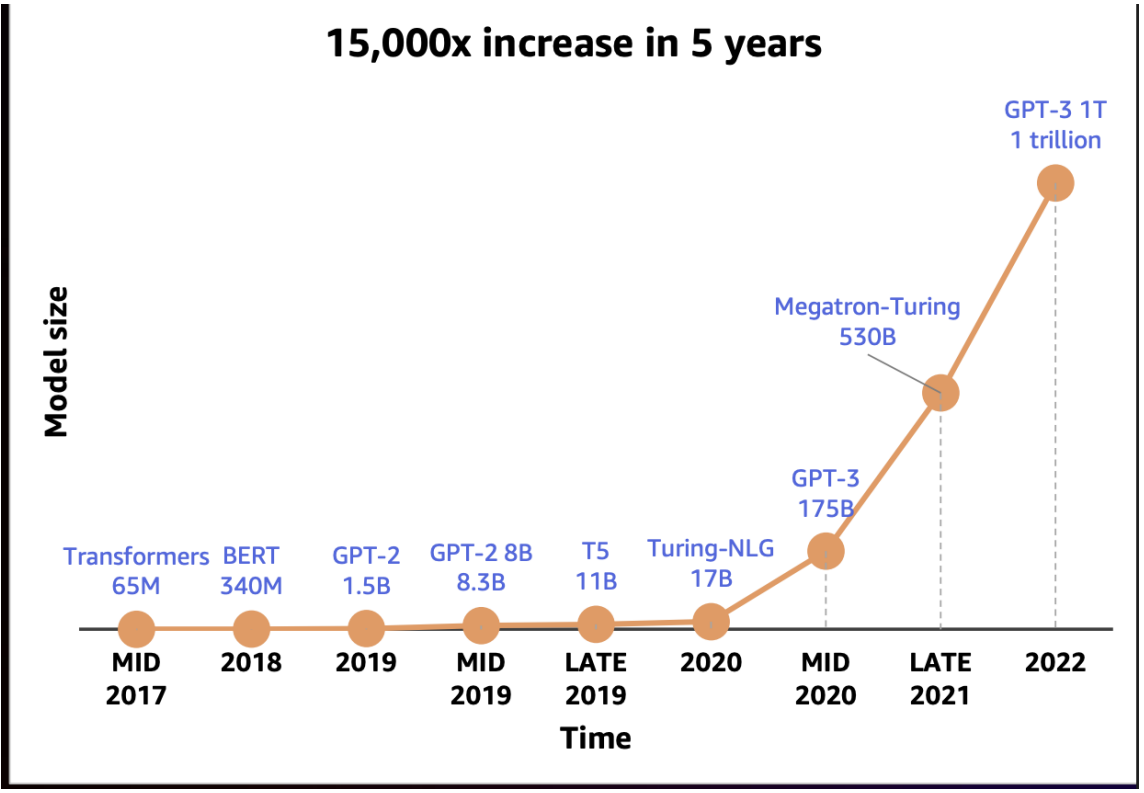
Figure 1-6. Encoder-decoder architecture of the original Transformer

NLP with Transformers, Tunstall et al 2022



LLMs: a Survey, 2025, https://arxiv.org/pdf/2402.06196

Increase of Size and of Computational Costs



Amazon web service (AWS, 2022)

Environmental and financial costs

Consumption	CO_2e (lbs)
Air travel, 1 passenger, NY↔SF	1984
Human life, avg, 1 year	11,023
American life, avg, 1 year	36,156
Car, avg incl. fuel, 1 lifetime	126,000
Training one model (GPU)	
NLP pipeline (parsing, SRL)	39
w/ tuning & experimentation	78,468
Transformer (big)	192
w/ neural architecture search	626,155

Table 1: Estimated CO_2 emissions from training common NLP models, compared to familiar consumption.[1]

		Estimated cost (USD)	
Models	Hours	Cloud compute	Electricity
1	120	$52–$175	$5
24	2880	$1238–$4205	$118
4789	239,942	$103k–$350k	$9870

Table 4: Estimated cost in terms of cloud compute and electricity for training: (1) a single model (2) a single tune and (3) all models trained during R&D.

Energy and Policy Considerations for Deep Learning in NLP. Strubell et al. ACL 2019. https://arxiv.org/abs/1906.02243
On the Dangers of Stochastic Parrots: Can Language Models Be Too Big? 🦜. Bender et al. FAccT 2021. https://dl.acm.org/doi/10.1145/3442188.3445922

https://neptune.ai/blog/nlp-models-infrastructure-cost-optimization

UNESCO Report:

Smaller models are just as smart and accurate as large ones: Small models tailored to specific tasks can cut energy use by up to 90%.

Small models are more accessible

https://www.unesco.org/en/articles/ai-large-language-models-new-report-shows-small-changes-can-reduce-energy-use-90

Mikolov et al BottleCap AI, founded in April 2025 https://www.bottlecapai.com/#blog-section

APPLICATIONS

ChatGPT

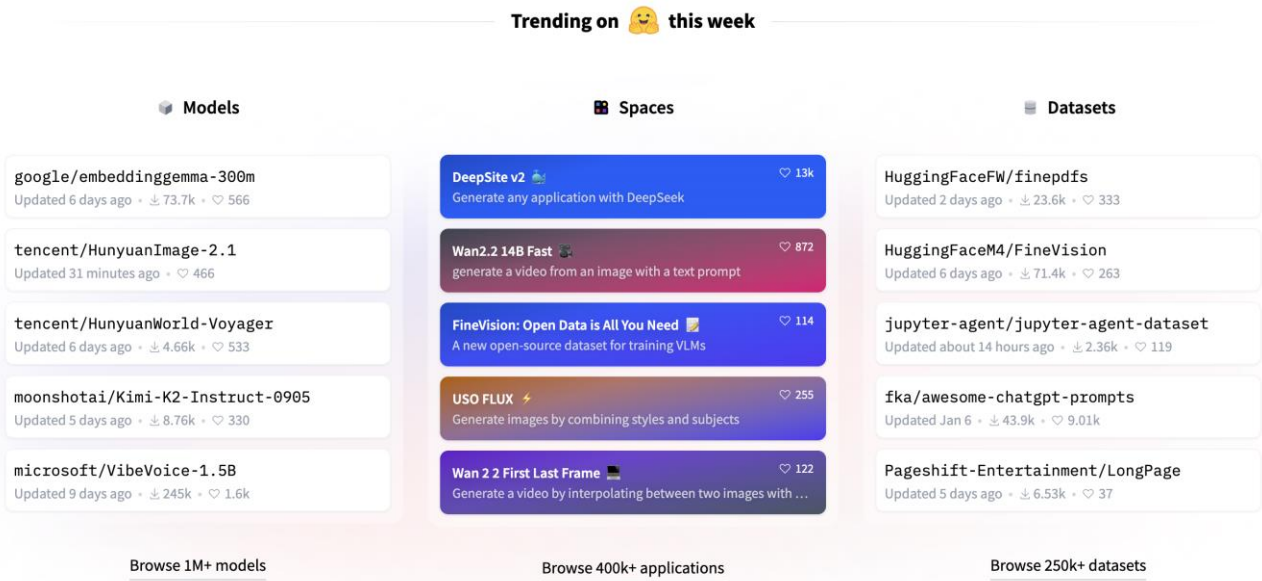
2. **Agriculture, Food & Forestry: Use Cases of LLMs**

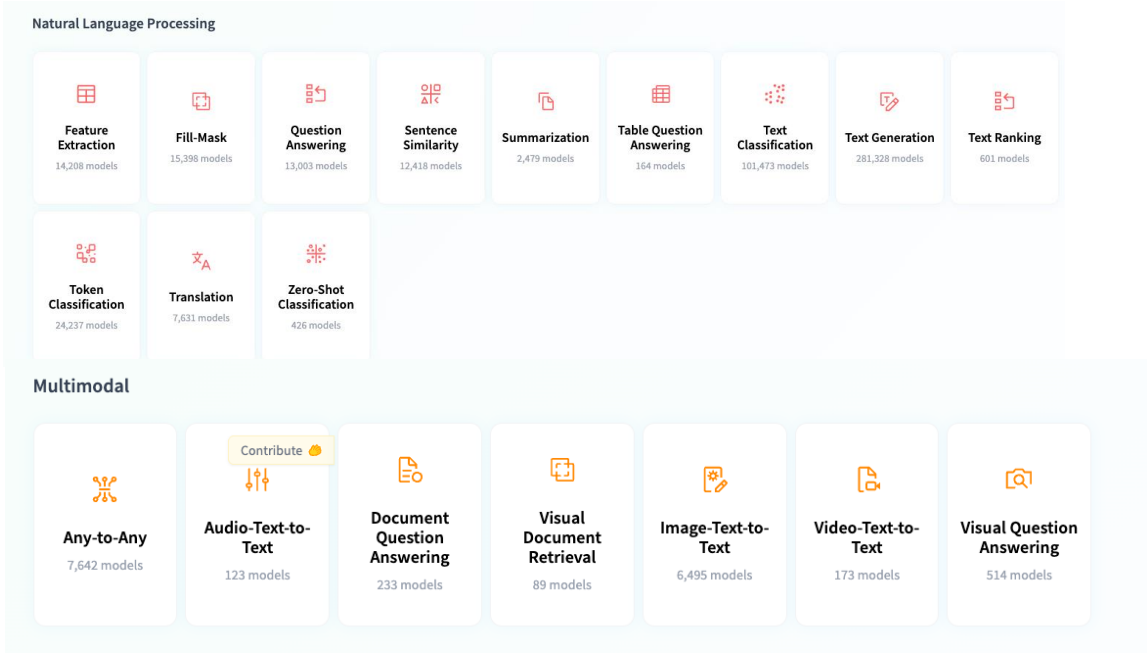
- **Curriculum & Teaching Innovation**: Develop tailored educational materials for agribusiness, food safety, agro-forestry, or bioeconomy—aligned with ICA-Edu and SIG initiatives ica-europe.info +1 .
- **Sustainable Research Support**: Assist with literature reviews, summarizing circular bioeconomy strategies, or synthesizing interdisciplinary insights for students and faculty.
- **Policy & Funding Literacy**: Aid committees like Agrinatura or Agribusiness to craft grant proposals, position papers, or strategy briefings for EU initiatives (e.g., CAP, biodiversity, rural development) ica-europe.info Agriculture and rural development .
- **Forest and Land Management Insights**: Use LLMs to parse and translate technical forestry data or environmental regulations into actionable summaries.
- **Agricultural Monitoring & Multimodal LLMs**: Highlight research like *AgriBench*, a benchmark dataset combining images and language for agro applications. This underpins future AI tools that help in land use, crop assessment, and sustainable decision-making arXiv .

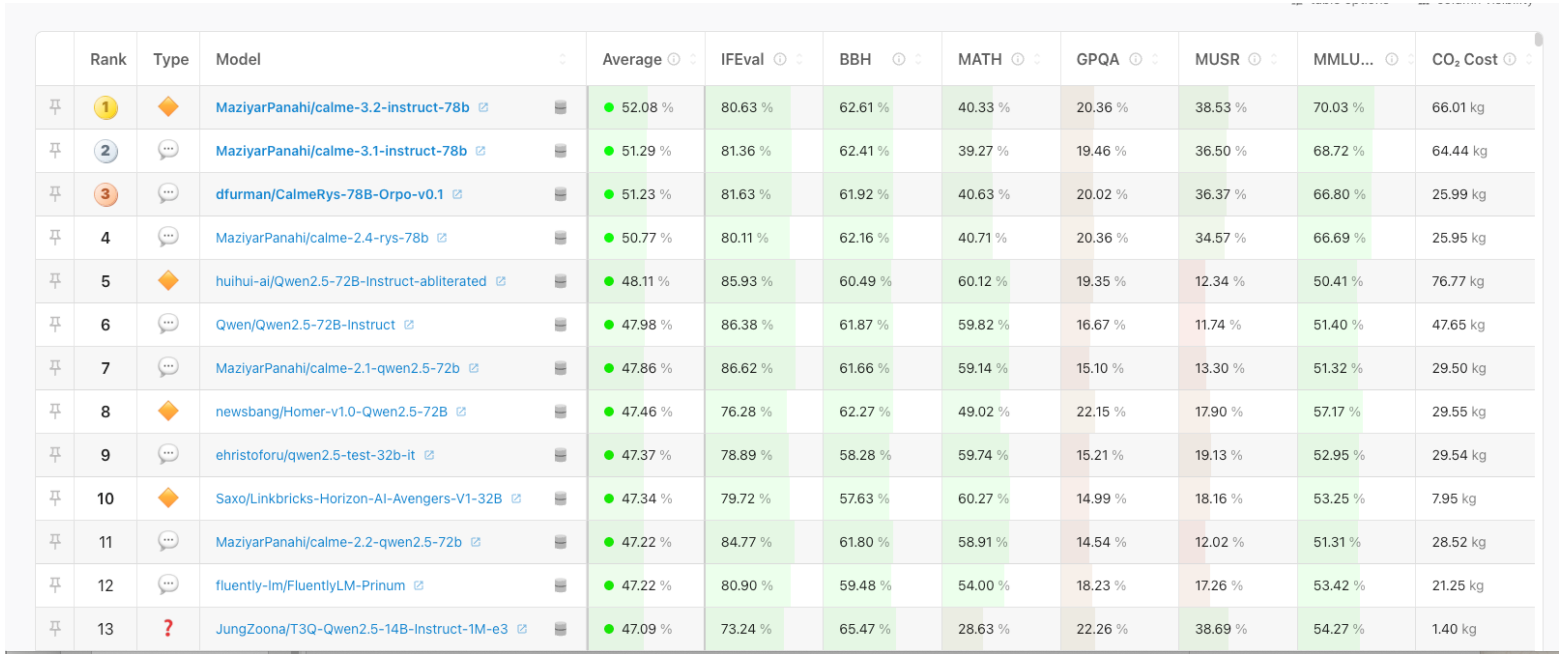
AgriBench, the first agriculture benchmark designed to evaluate MultiModal Large Language Models (MM-LLMs) for agriculture applications. https://arxiv.org/abs/2412.00465

APPLICATIONS: Need synergy

HUGGING FACE







Rank	Type	Model	Average	IFEval	BBH	MATH	GPQA	MUSR	MMLU...	CO_2 Cost
1	🔶	MaziyarPanahi/calme-3.2-instruct-78b	52.08 %	80.63 %	62.61 %	40.33 %	20.36 %	38.53 %	70.03 %	66.01 kg
2	💬	MaziyarPanahi/calme-3.1-instruct-78b	51.29 %	81.36 %	62.41 %	39.27 %	19.46 %	36.50 %	68.72 %	64.44 kg
3	💬	dfurman/CalmeRys-78B-Orpo-v0.1	51.23 %	81.63 %	61.92 %	40.63 %	20.02 %	36.37 %	66.80 %	25.99 kg
4	💬	MaziyarPanahi/calme-2.4-rys-78b	50.77 %	80.11 %	62.16 %	40.71 %	20.36 %	34.57 %	66.69 %	25.95 kg
5	🔶	huihui-ai/Qwen2.5-72B-Instruct-abliterated	48.11 %	85.93 %	60.49 %	60.12 %	19.35 %	12.34 %	50.41 %	76.77 kg
6	💬	Qwen/Qwen2.5-72B-Instruct	47.98 %	86.38 %	61.87 %	59.82 %	16.67 %	11.74 %	51.40 %	47.65 kg
7	💬	MaziyarPanahi/calme-2.1-qwen2.5-72b	47.86 %	86.62 %	61.66 %	59.14 %	15.10 %	13.30 %	51.32 %	29.50 kg
8	🔶	newsbang/Homer-v1.0-Qwen2.5-72B	47.46 %	76.28 %	62.27 %	49.02 %	22.15 %	17.90 %	57.17 %	29.55 kg
9	💬	ehristoforu/qwen2.5-test-32b-it	47.37 %	78.89 %	58.28 %	59.74 %	15.21 %	19.13 %	52.95 %	29.54 kg
10	🔶	Saxo/Linkbricks-Horizon-AI-Avengers-V1-32B	47.34 %	79.72 %	57.63 %	60.27 %	14.99 %	18.16 %	53.25 %	7.95 kg
11	💬	MaziyarPanahi/calme-2.2-qwen2.5-72b	47.22 %	84.77 %	61.80 %	58.91 %	14.54 %	12.02 %	51.31 %	28.52 kg
12	💬	fluently-lm/FluentlyLM-Prinum	47.22 %	80.90 %	59.48 %	54.00 %	18.23 %	17.26 %	53.42 %	21.25 kg
13	❓	JungZoona/T3Q-Qwen2.5-14B-Instruct-1M-e3	47.09 %	73.24 %	65.47 %	28.63 %	22.26 %	38.69 %	54.27 %	1.40 kg

https://huggingface.co/

https://huggingface.co/spaces/open-llm-leaderboard/open_llm_leaderboard#/

Whats Next in NLP

Towards smaller models. Challenges:

BabyLM Challenge
Sample-efficient pretraining on a developmentally plausible corpus
https://babylm.github.io/

LM-Playschool Challenge
A Challenge for Improving LLMs Through **Learning from Dialogue Game Interaction**

MULTIMODAL MODELS (beyond Language and Vision towards EMBODIED AI):

The Grand Challenge on Multimodal Superintelligence
Text, Audio, Vision, and 3D
multimodal-ai.com

CAREFUL EVALUATION

Momentè et al, EMNLP 2025
Triangulating LLM Progress through Benchmarks, Games, and Cognitive Tests

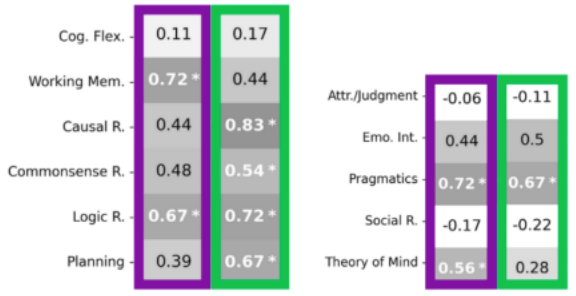
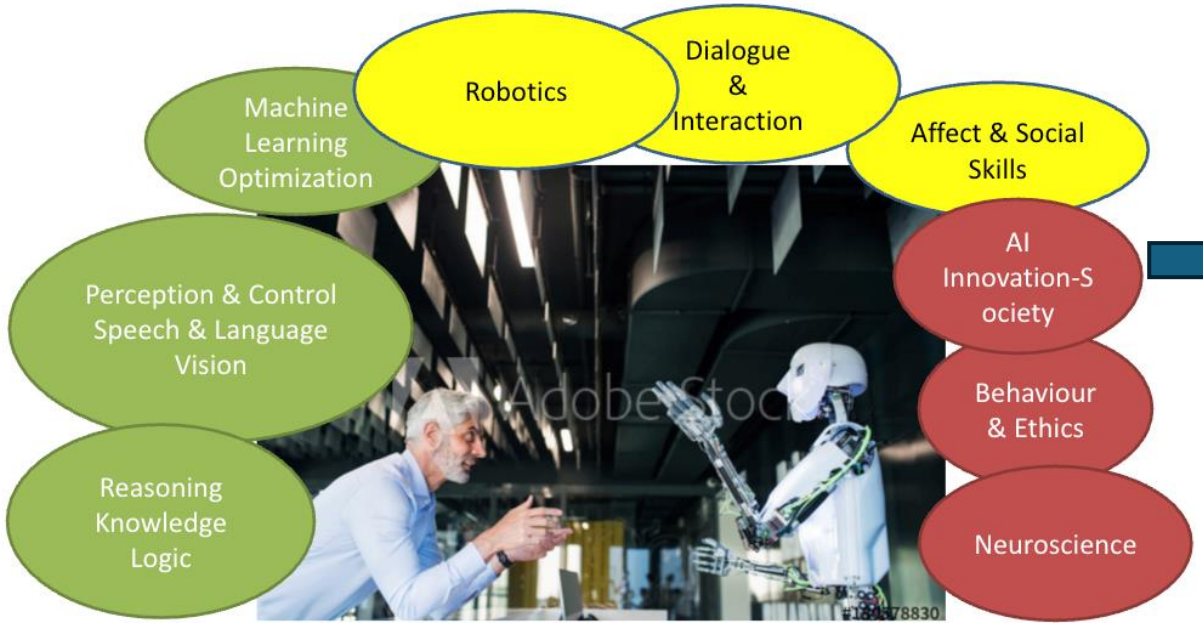
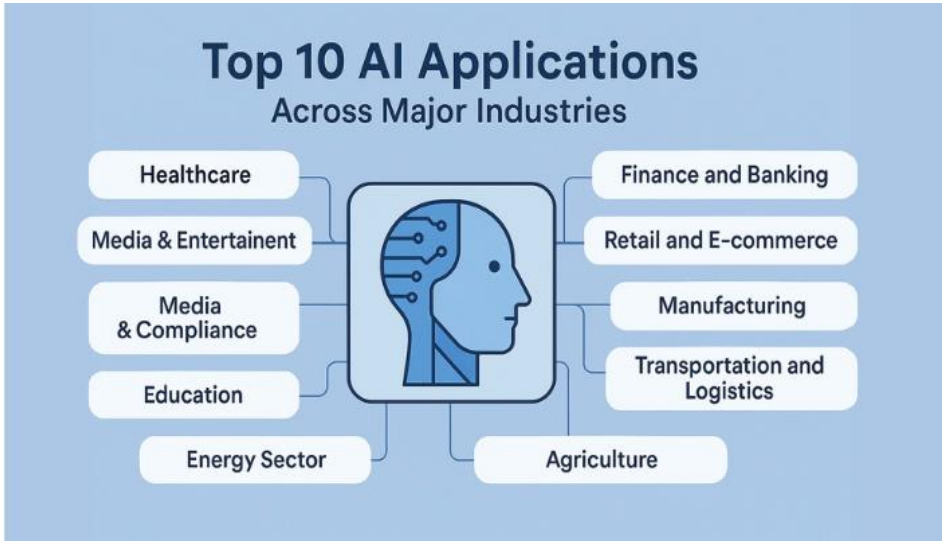


Figure 3: Correlation of cognitive abilities with performance on games and benchmarks (* = $p < 0.05$).

What Next in the society





WORK TOGETHER!