2023 NTPU 永續月 【SDGS永續沙龍】

生成式AI在永續發展的應用

Generative AI and ChatGPT for ESG and Sustainable Development

Time: 2023.04.27 (Thu) 12:10-13:30
Place: USR HUB, Office of Sustainability, NTPU
Host: Office of Sustainability, NTPU
https://forms.gle/vYVvYBT6y1ik4RtN7

戴敏育 永續辦公室 社會責任組 組長

Min-Yuh Day, Ph.D, Associate Professor

Institute of Information Management, National Taipei University

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2023-04-27

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Min-Yuh Day, Ph.D.

aws educate | Cloud Ambassador
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Accredited Educator

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Associate Professor, Information Management, NTPU

Visiting Scholar, IIS, Academia Sinica

Ph.D., Information Management, NTU

Director, Intelligent Financial Innovation Technology, IFIT Lab, IM, NTPU

Associate Director, Fintech and Green Finance Center, NTPU

Publications Co-Chairs, IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM 2013-)

Program Co-Chair, IEEE International Workshop on Empirical Methods for Recognizing Inference in TExt (IEEE EM-RITE 2012-)

Publications Chair, The IEEE International Conference on Information Reuse and Integration for Data Science (IEEE IRI 2007-)

國立臺北大學
National Taipei University

中央研究院 ACADEMIA SINICA 1928

Outline

1. 生成式AI的基本概念

   Basic Concepts of Generative AI

2. ChatGPT的基本原理和功能

   Basic Principles and Functions of ChatGPT

3. 生成式AI在永續發展的應用

   Generative AI for ESG and Sustainable Development

4. AI在永續發展上的議題

   Issues of AI for Sustainable Development

2023 NTPU 永續月
【SDGS永續沙龍】

NTPU
國立臺北大學
National Taipei University

NTPU USR
國立臺北大學永續辦公室
OFFICE OF SUSTAINABILITY, NATIONAL TAIPEI UNIVERSITY

AI for Environmental, Social, and Governance (AI4ESG)

Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

AI for Social Good (AI4SG)

Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

Sustainability

SDGs

CSR

ESG

Sustainable Development Goals (SDGs)

Source: https://sdgs.un.org/goals

Sustainable Development Goals (SDGs) and 5P

Partnership

Peace

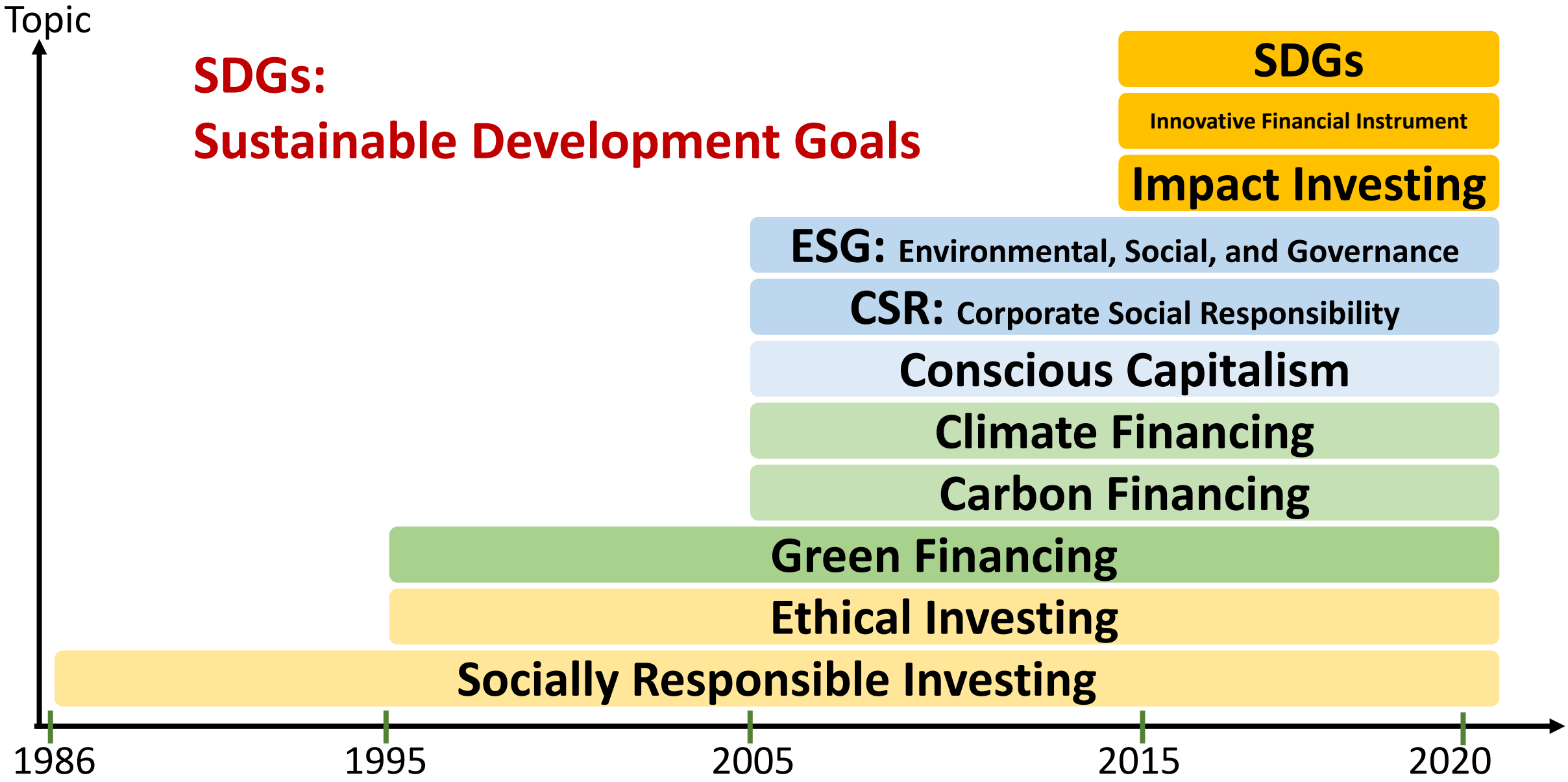
Prosperity

People

Planet

Source: Folke, Carl, Reinette Biggs, Albert V. Norström, Belinda Reyers, and Johan Rockström. "Social-ecological resilience and biosphere-based sustainability science."Ecology and Society 21, no. 3 (2016).

Evolution of Sustainable Finance Research



Source: Kumar, S., Sharma, D., Rao, S., Lim, W. M., & Mangla, S. K. (2022). Past, present, and future of sustainable finance: Insights from big data analytics through machine learning of scholarly research. Annals of Operations Research, 1-44.

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Generative AI

Gen AI

Generative AI (Gen AI)

AI Generated Content (AIGC)

Image Generation

Instruction 1:
An astronaut riding a horse in a photorealistic style.

Instruction 2:
Teddy bears working on new AI research on the moon in the 1980s.

Figure 1

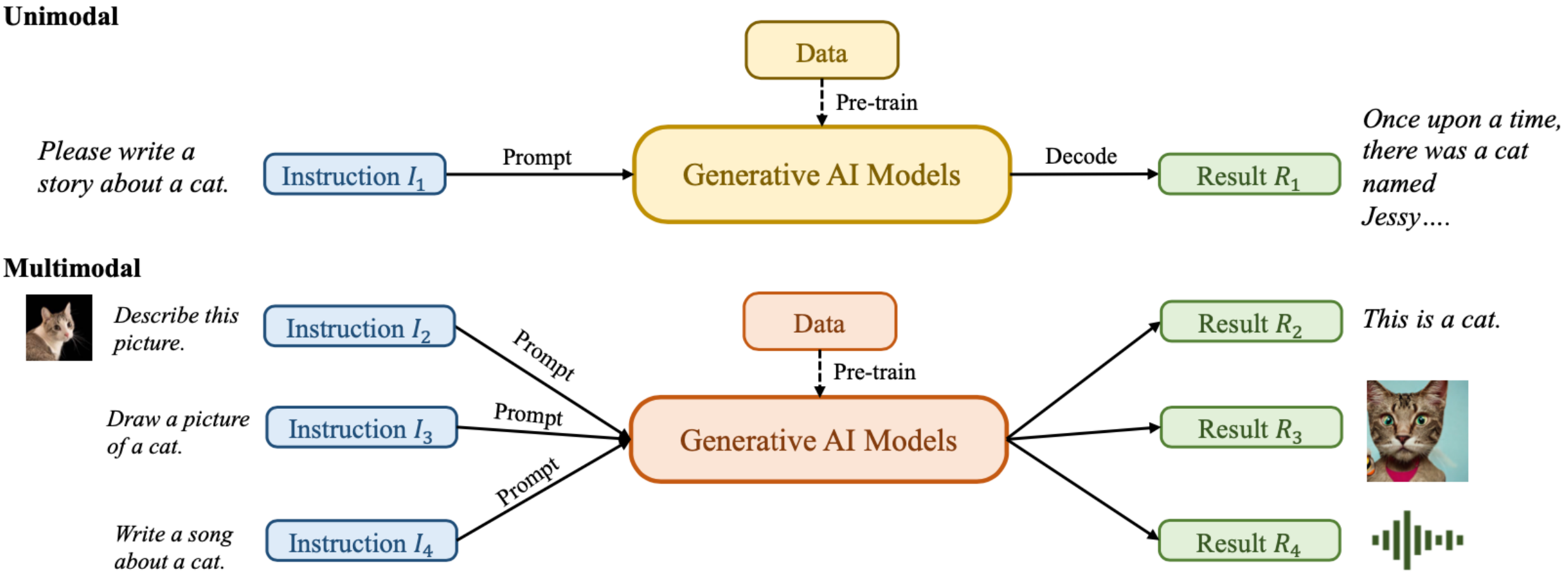
Figure 2

OpenAI DALL·E 2

Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

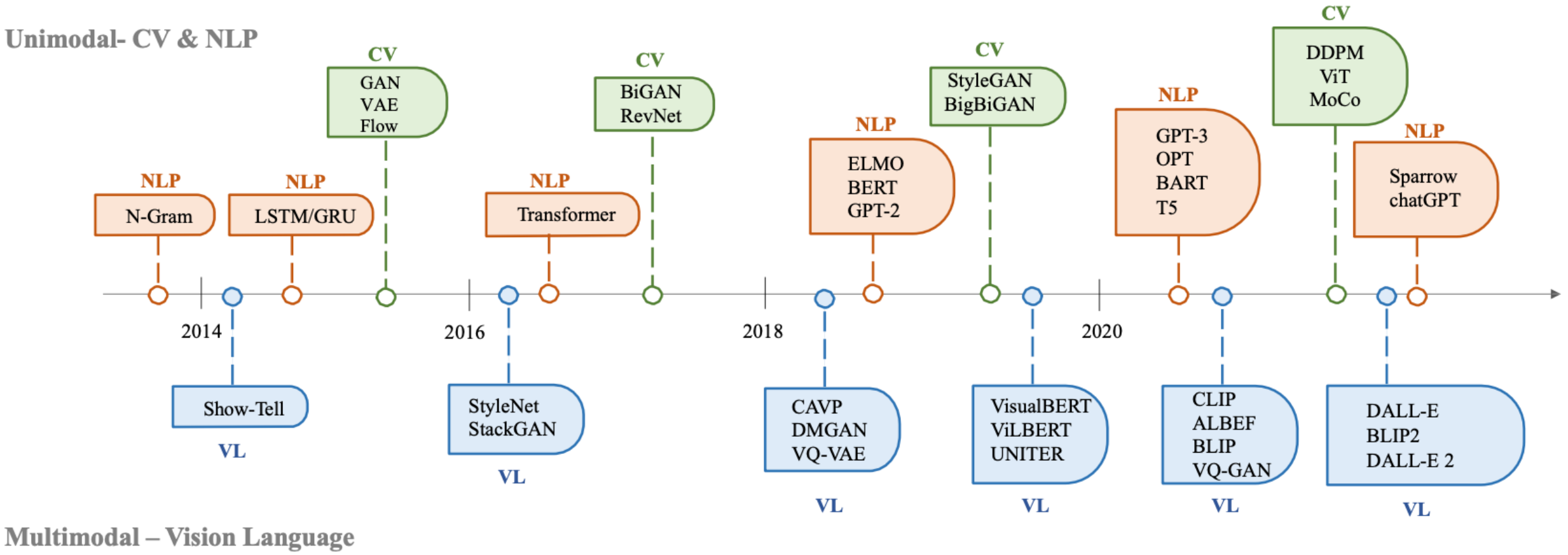
Generative AI (Gen AI)

AI Generated Content (AIGC)



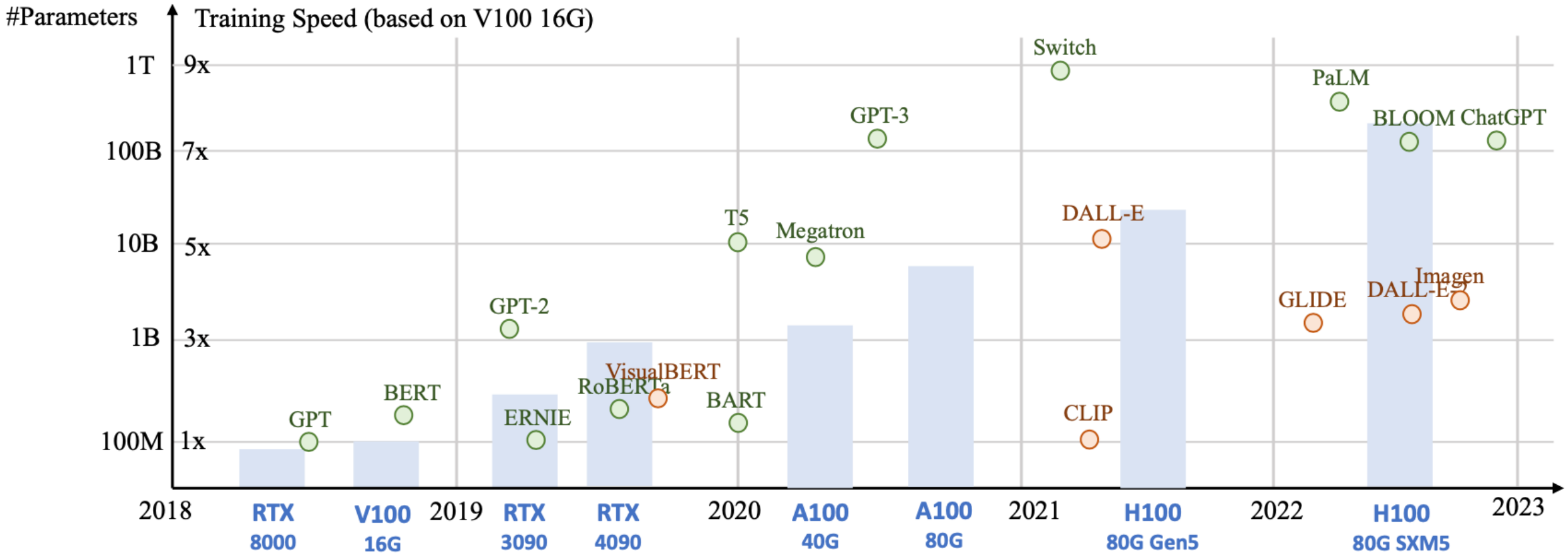
Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

The history of Generative AI in CV, NLP and VL



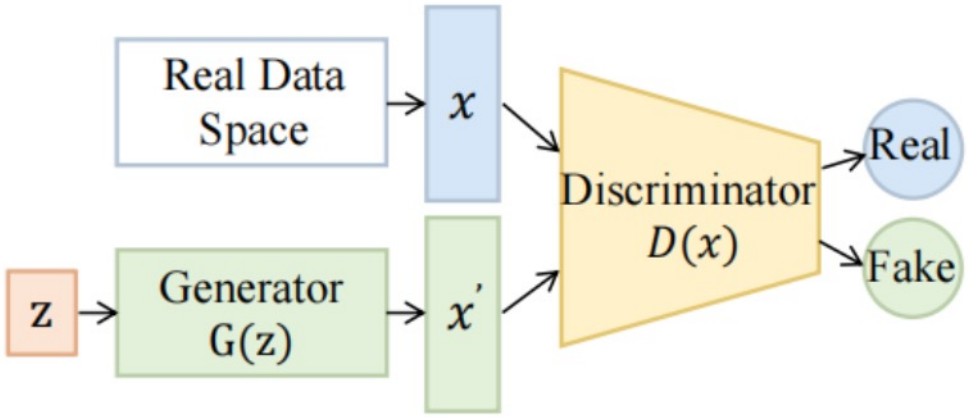
Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

Generative AI Foundation Models

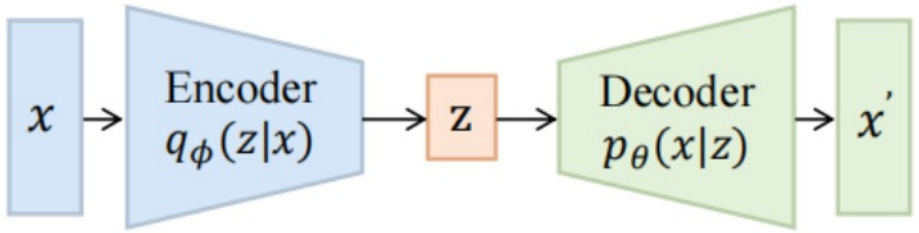


Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

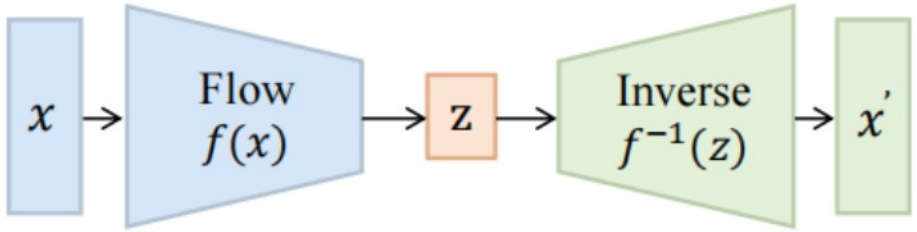
Categories of Vision Generative Models



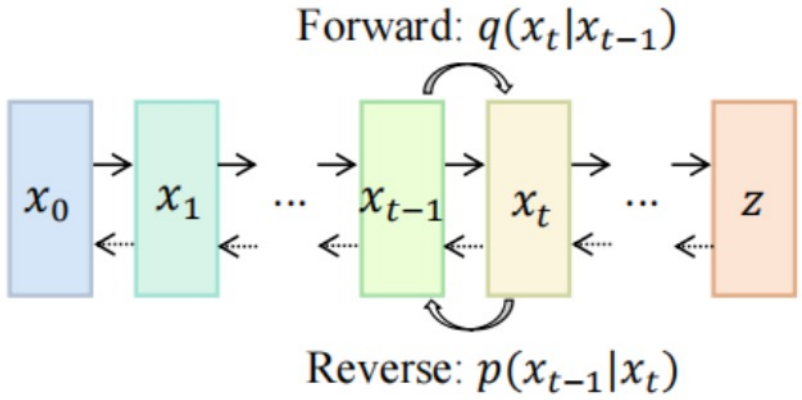
(1) Generative adversarial networks



(2) Variational autoencoders



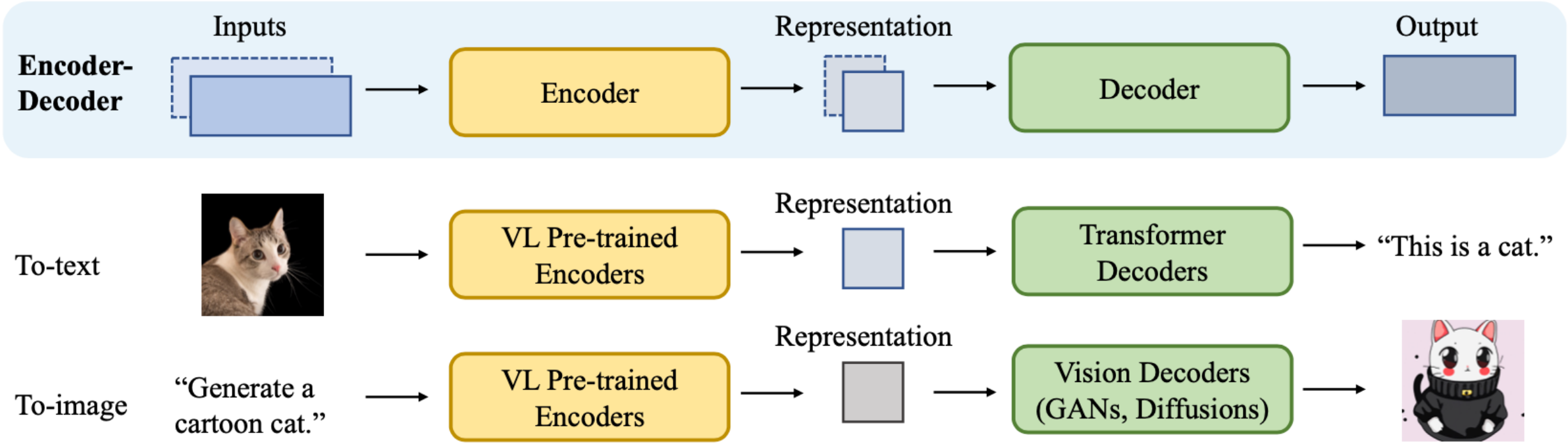
(3) Normalizing flows



(4) Diffusion models

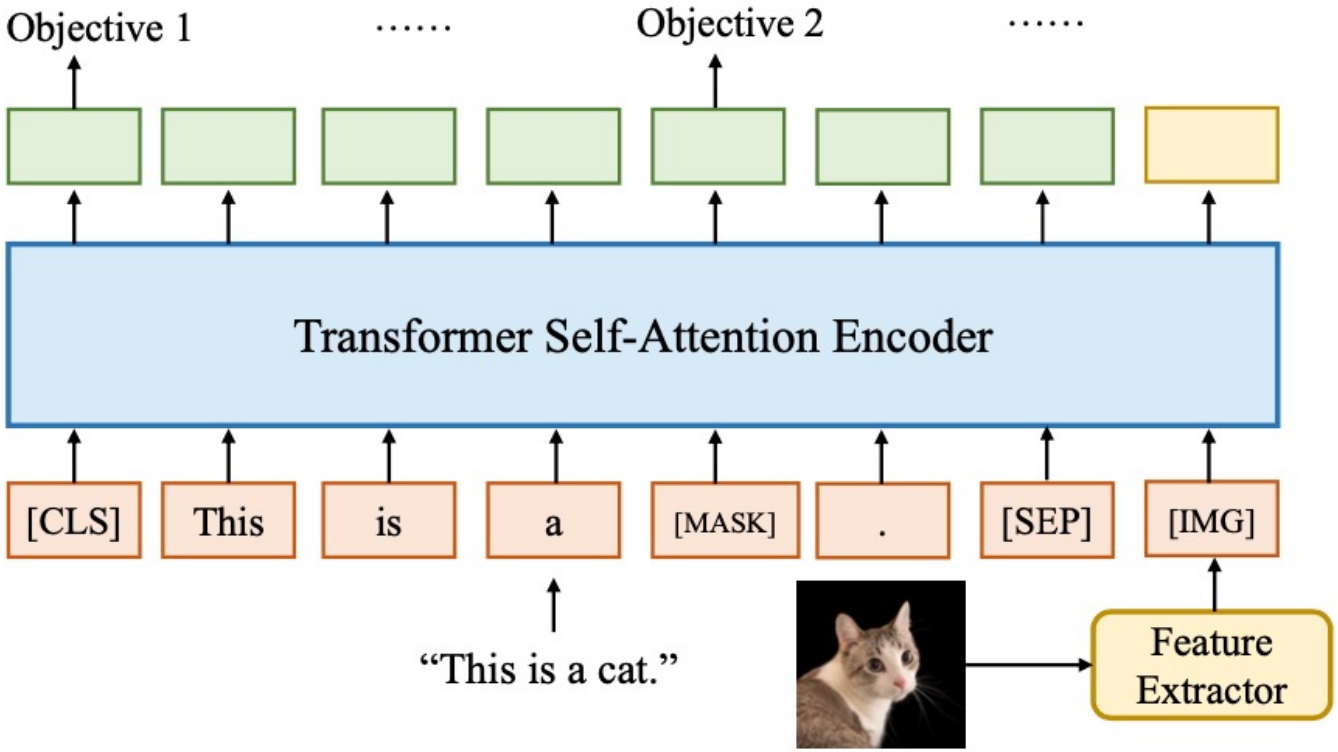
Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

The General Structure of Generative Vision Language

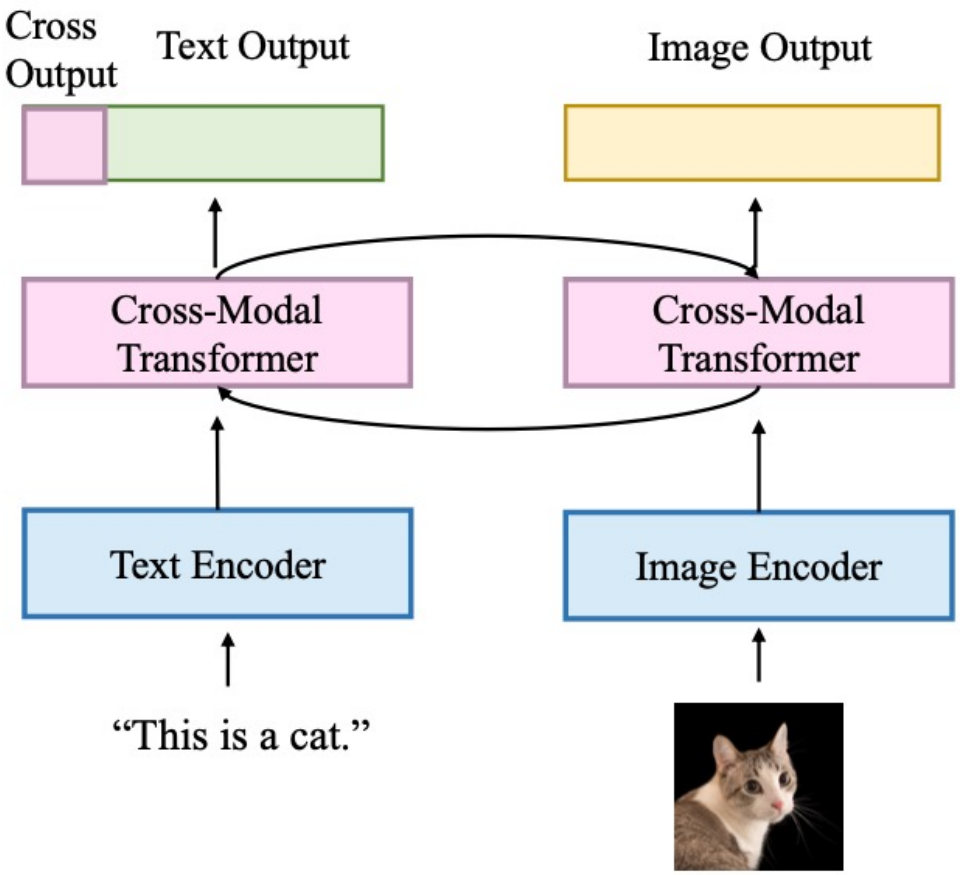


Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

Two Types of Vision Language Encoders:
Concatenated Encoders and Cross-aligned Encoders



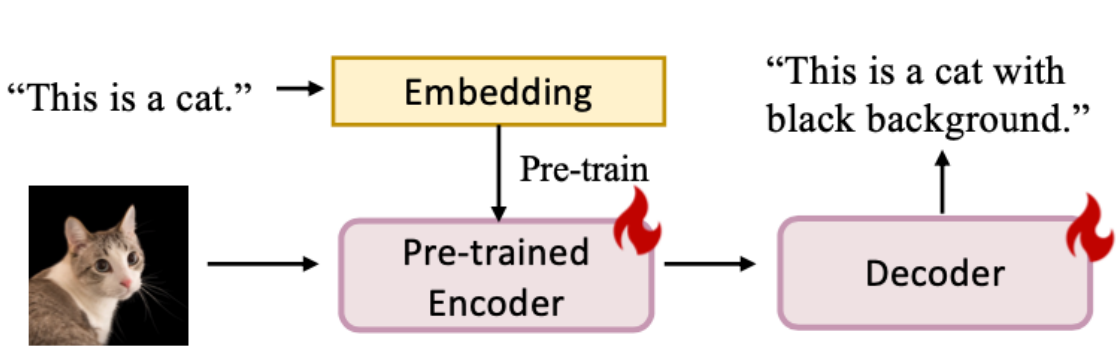
(a) Concatenated Encoder



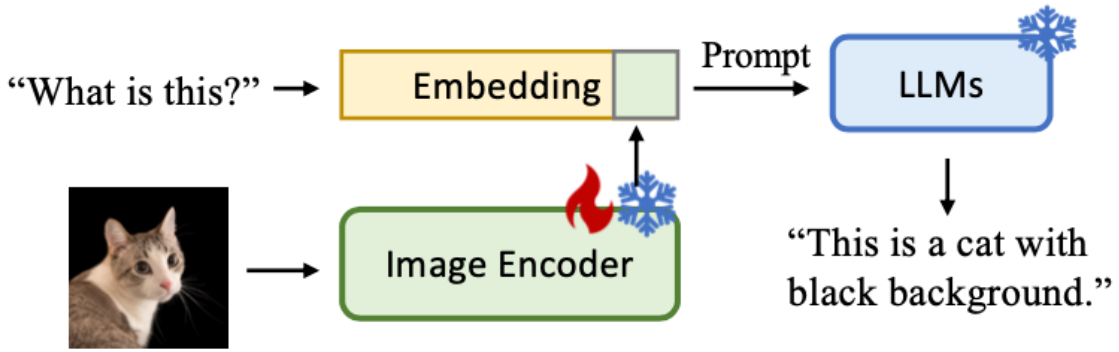
(b) Cross-aligned Encoder

Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

Two Types of to-language Decoder Models: Jointly-trained Models and Frozen Models



(a) Jointly-trained Models

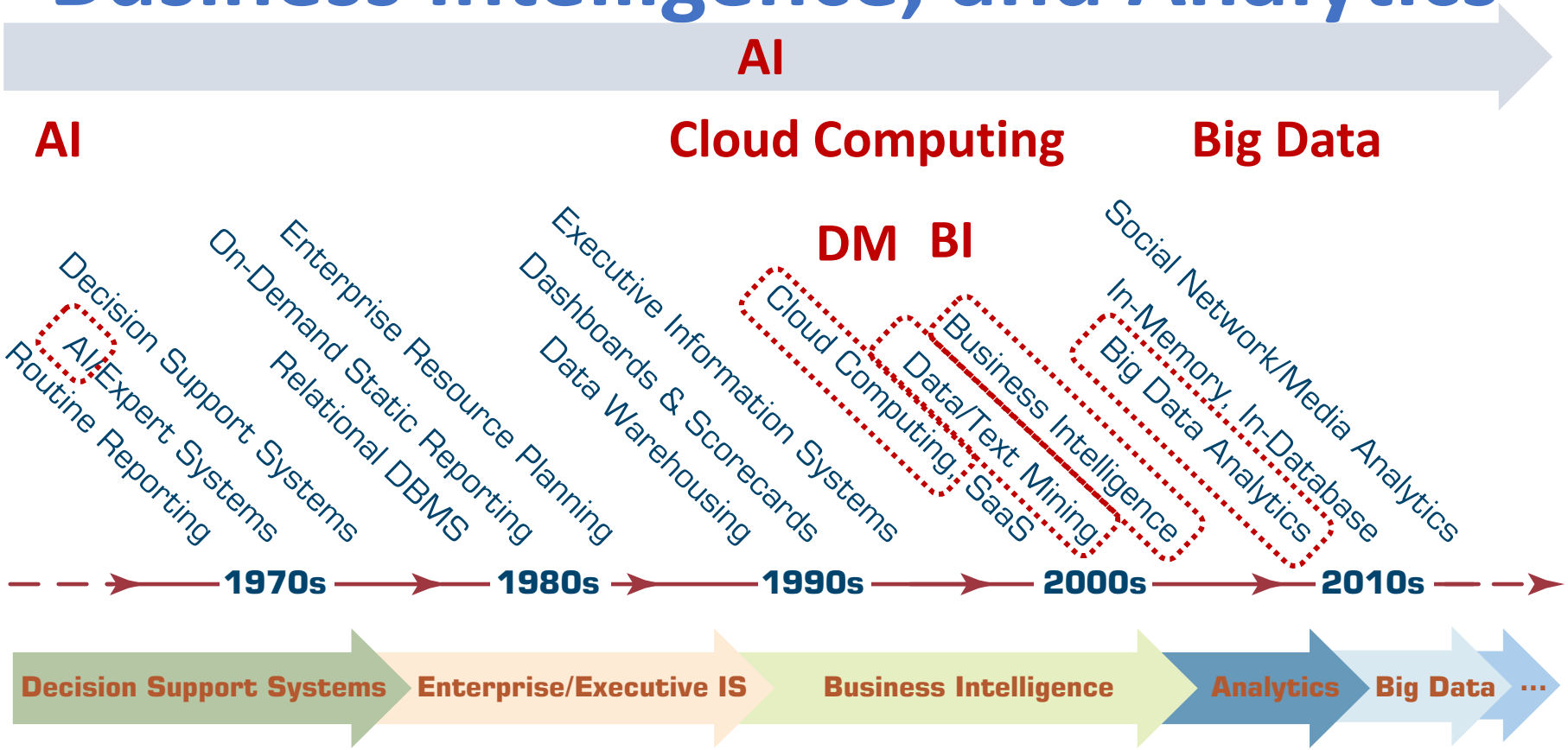


(b) Frozen Models

Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

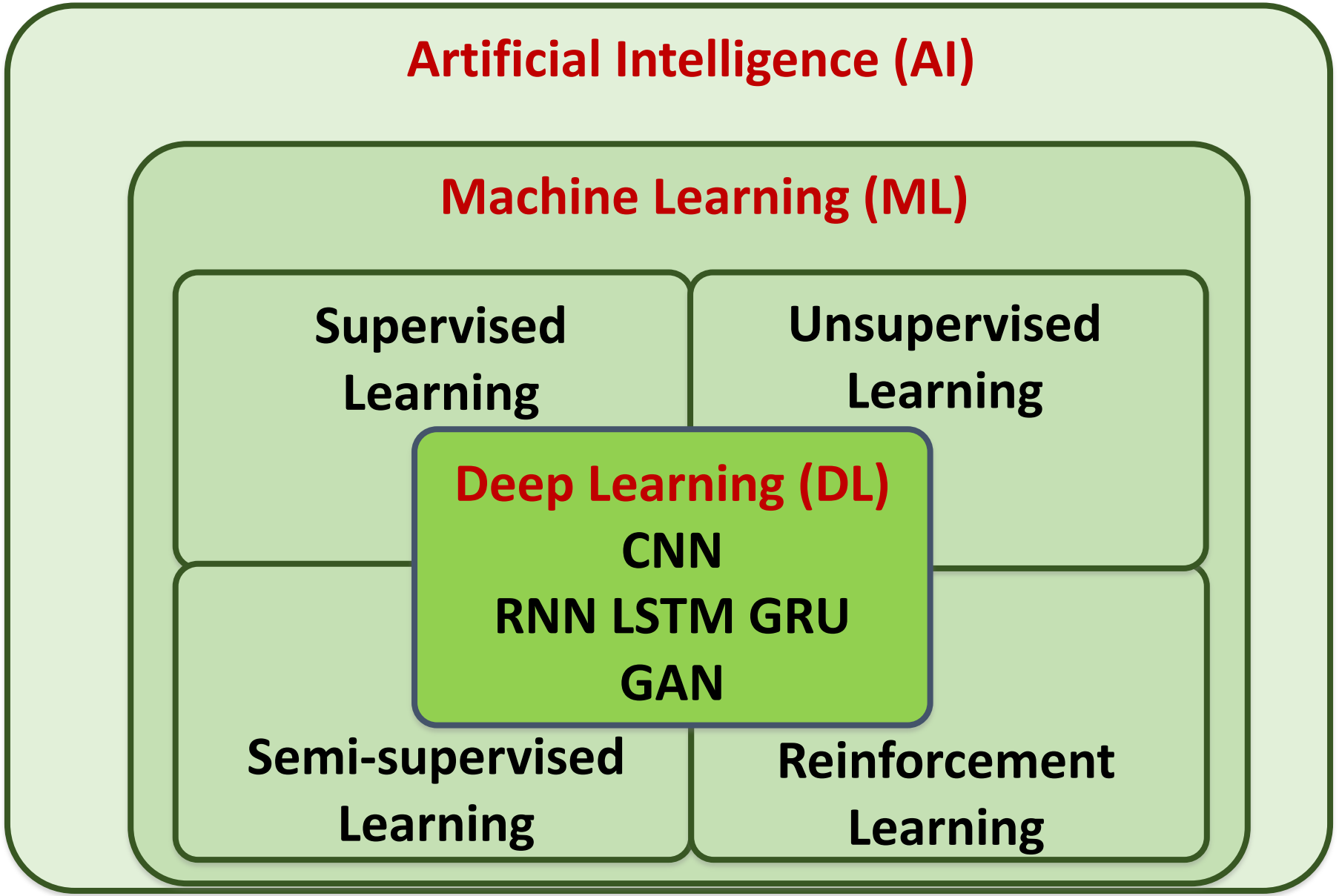
AI, Big Data, Cloud Computing

Evolution of Decision Support, Business Intelligence, and Analytics



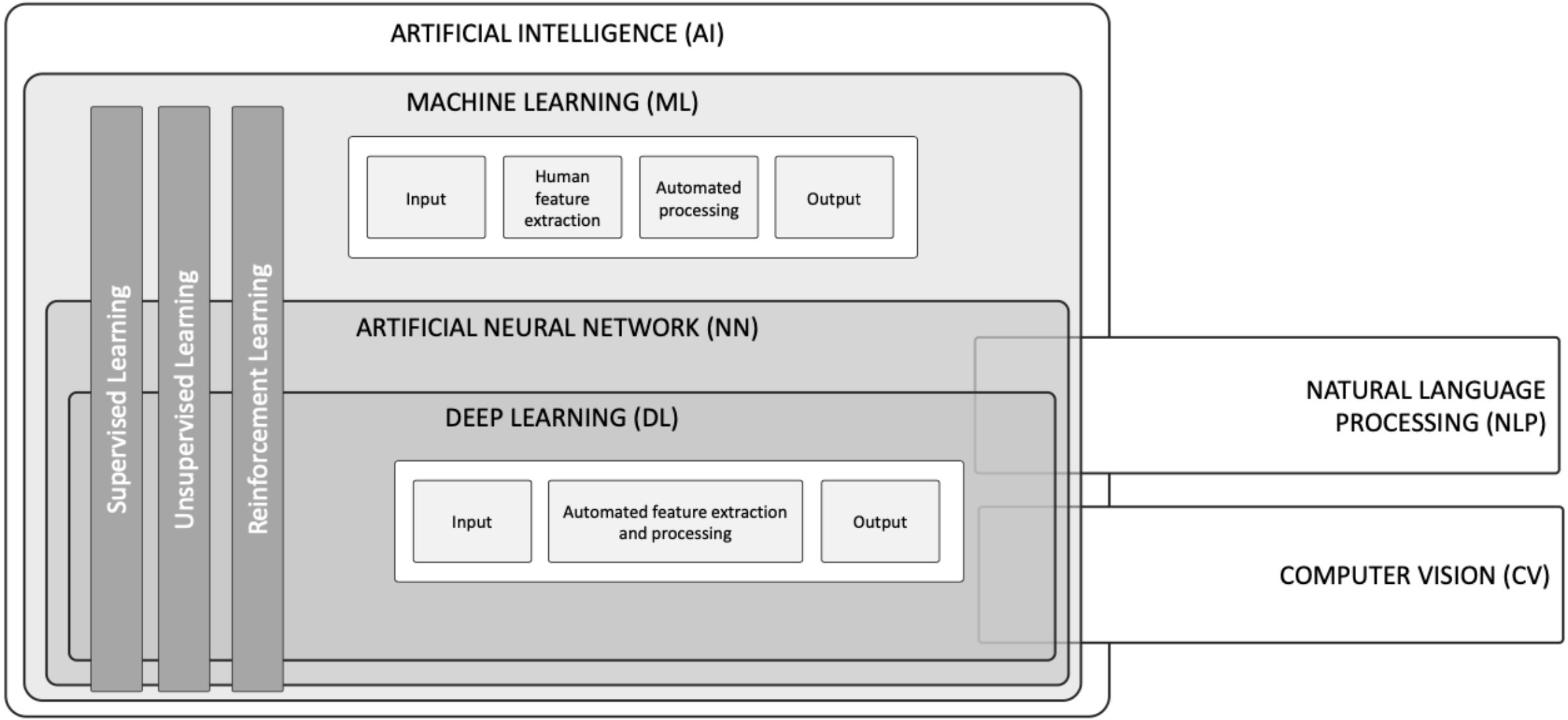
Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017),
Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

AI, ML, DL



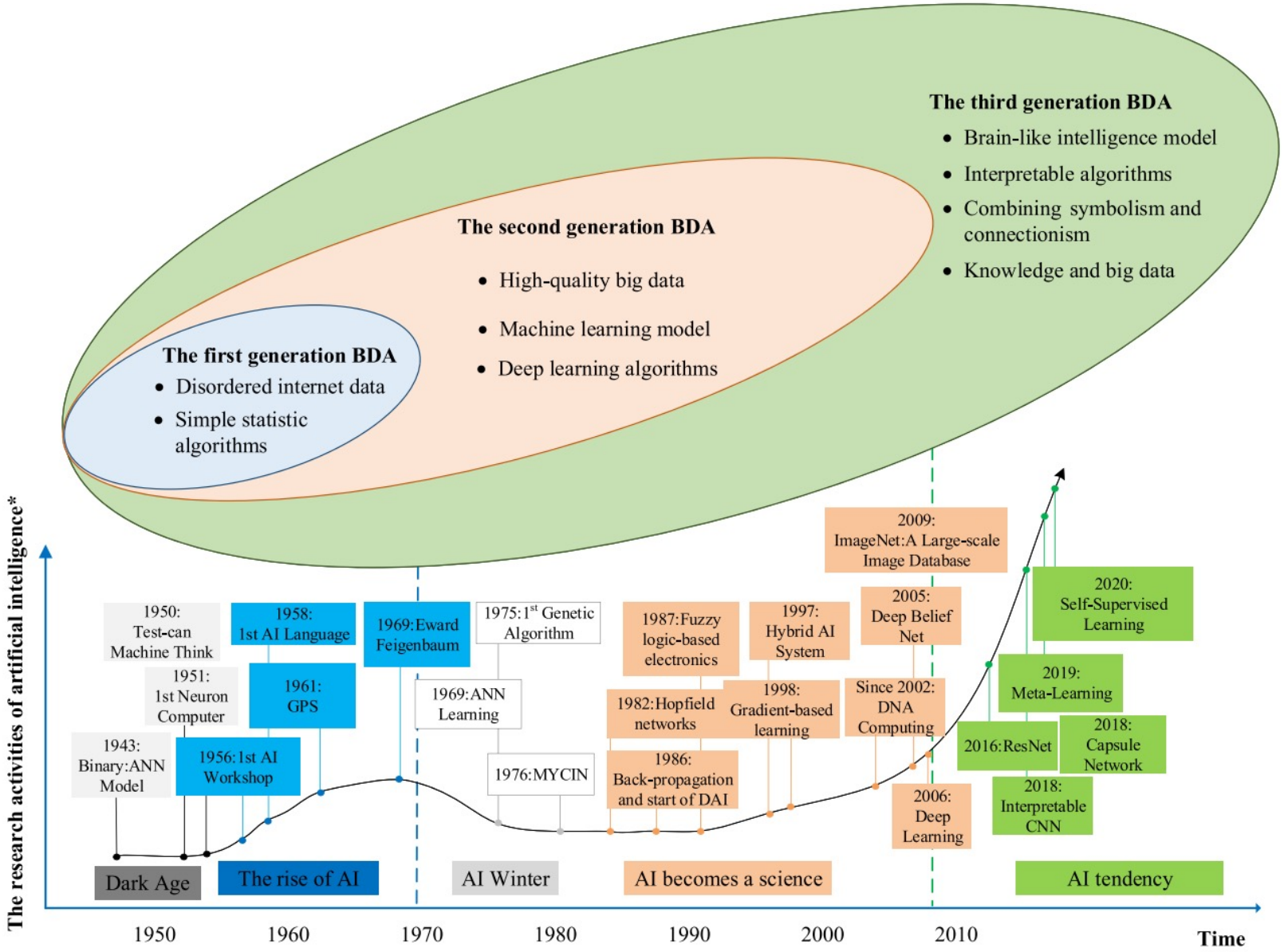
Source: https://leonardoaraujosantos.gitbooks.io/artificial-inteligence/content/deep_learning.html

AI, ML, NN, DL



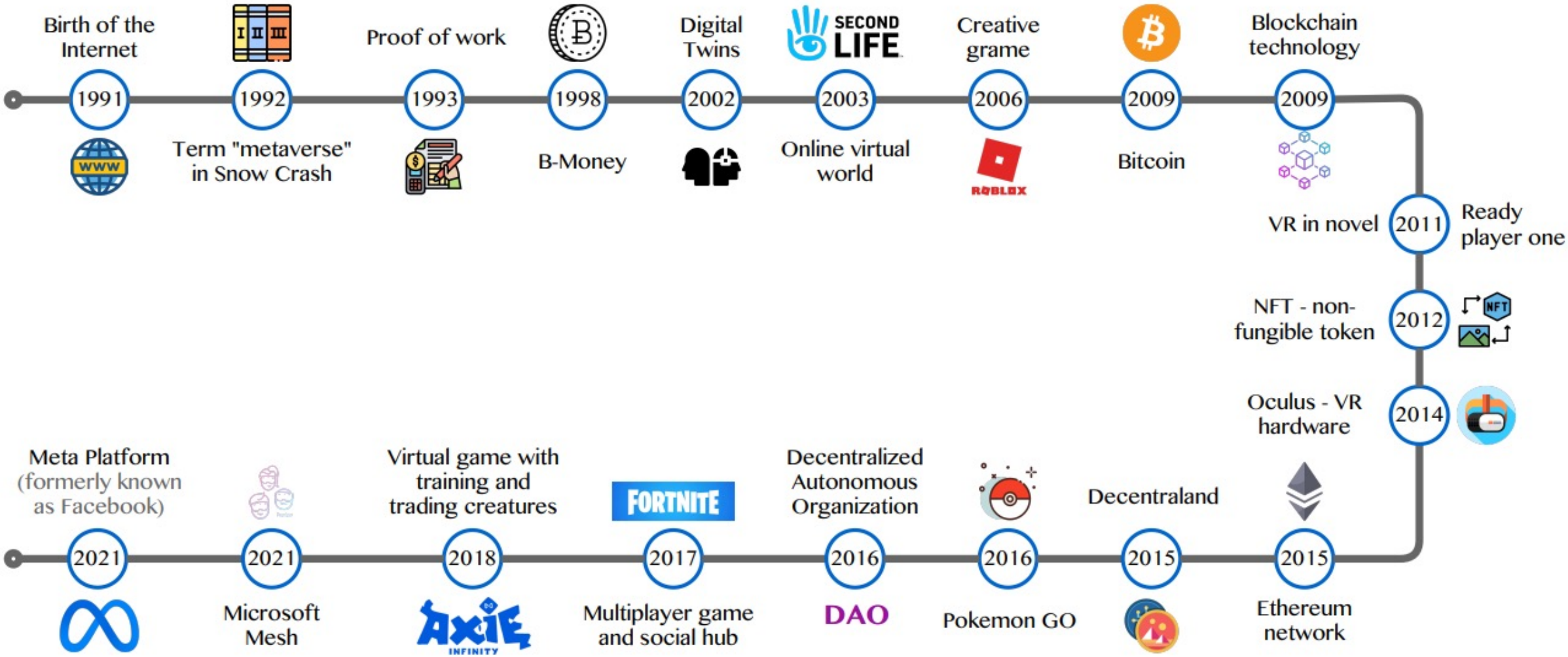
Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023). Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

AI and Big Data Analytics (BDA)



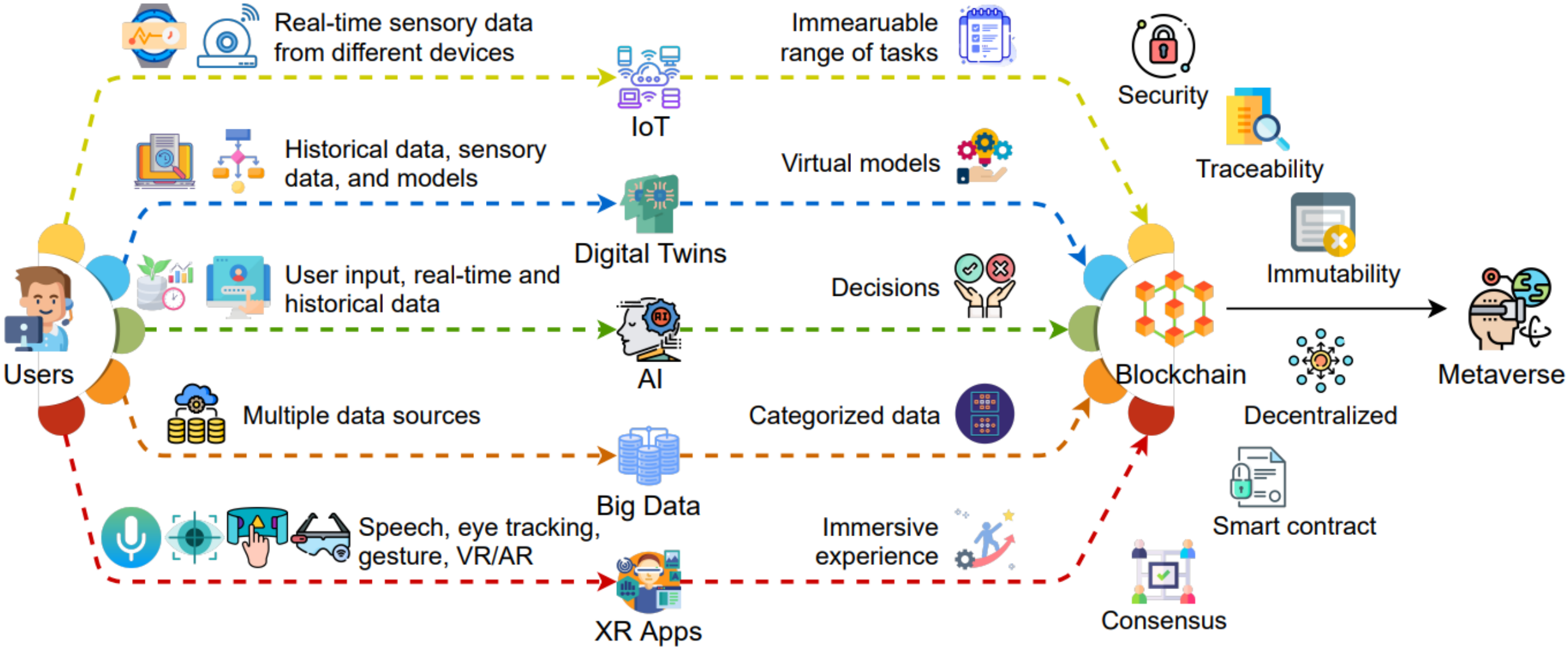
Source: Wang, Junliang, Chuqiao Xu, Jie Zhang, and Ray Zhong (2022). "Big data analytics for intelligent manufacturing systems: A review." Journal of Manufacturing Systems 62 (2022): 738-752.

Metaverse Development



Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

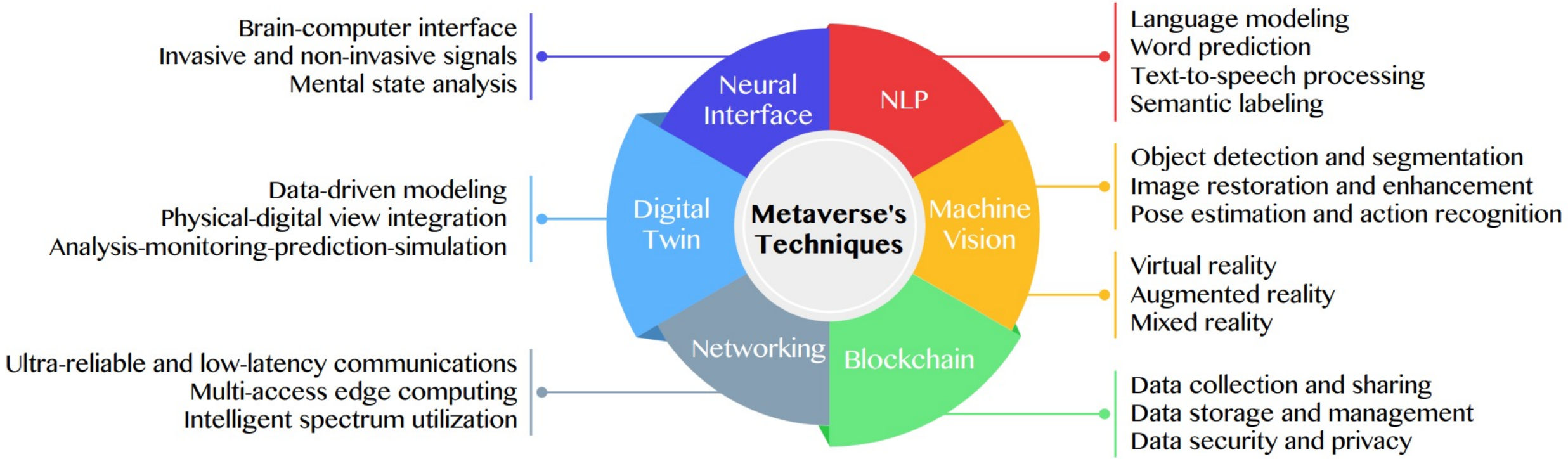
AI and Blockchain
Key Enabling Technologies of the Metaverse



Source: Gadekallu, Thippa Reddy, Thien Huynh-The, Weizheng Wang, Gokul Yenduri, Pasika Ranaweera, Quoc-Viet Pham, Daniel Benevides da Costa, and Madhusanka Liyanage (2022). "Blockchain for the Metaverse: A Review." arXiv preprint arXiv:2203.09738..

Primary Technical Aspects in the Metaverse

AI with ML algorithms and DL architectures is advancing the user experience in the virtual world



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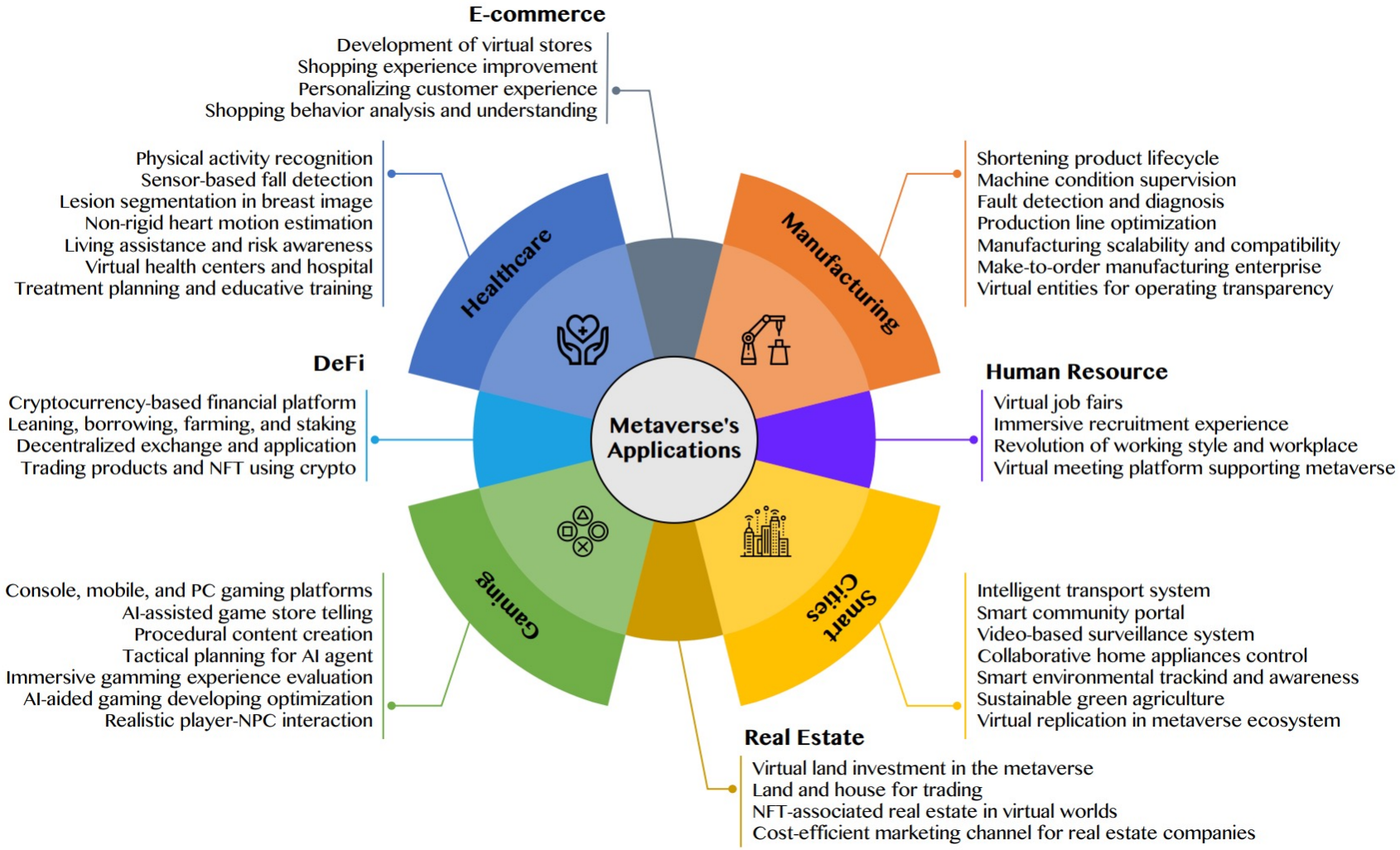
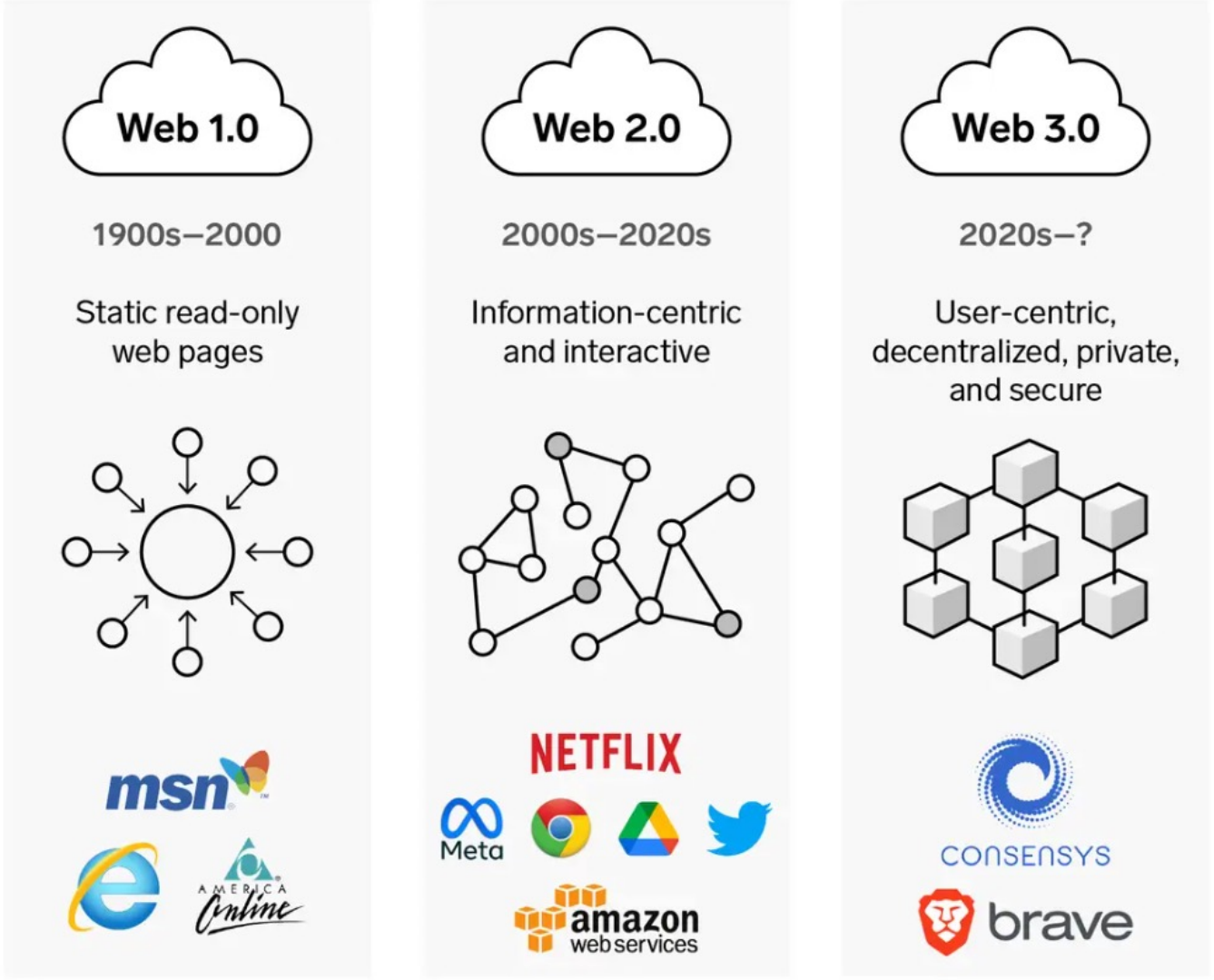
AI for the Metaverse in the Application Aspects

healthcare, manufacturing, smart cities, gaming
E-commerce, human resources, real estate, and DeFi



Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

Web3: Decentralized Web Internet Evolution



Source: https://www.businessinsider.com/personal-finance/what-is-web3

Definition of Artificial Intelligence (A.I.)

Artificial Intelligence

"… the science and engineering of making intelligent machines"

(John McCarthy, 1955)

Source: https://digitalintelligencetoday.com/artificial-intelligence-defined-useful-list-of-popular-definitions-from-business-and-science/

Artificial Intelligence

“… technology that thinks and acts like humans”

Source: https://digitalintelligencetoday.com/artificial-intelligence-defined-useful-list-of-popular-definitions-from-business-and-science/

Artificial Intelligence

"… intelligence exhibited by machines or software"

Source: https://digitalintelligencetoday.com/artificial-intelligence-defined-useful-list-of-popular-definitions-from-business-and-science/

4 Approaches of AI

Thinking Humanly	**Thinking Rationally**
Acting Humanly	**Acting Rationally**

Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

4 Approaches of AI

2. **Thinking Humanly:** **The Cognitive Modeling Approach**	**3.** **Thinking Rationally:** **The "Laws of Thought" Approach**
1. **Acting Humanly:** **The Turing Test Approach (1950)**	**4.** **Acting Rationally:** **The Rational Agent Approach**

Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

AI Acting Humanly:
The Turing Test Approach
(Alan Turing, 1950)

- Knowledge Representation
- Automated Reasoning
- Machine Learning (ML)
  - Deep Learning (DL)
- Computer Vision (Image, Video)
- Natural Language Processing (NLP)
- Robotics

Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

Can machines think?

- Alan Turing rejected the question “Can machines think?” and replaced it with a behavioral test.
  - Alan Turing anticipated many objections to the possibility of thinking machines.
- Concentrate on their systems’ performance on practical tasks
  - rather than the ability to imitate humans.
- Consciousness remains a mystery.

Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

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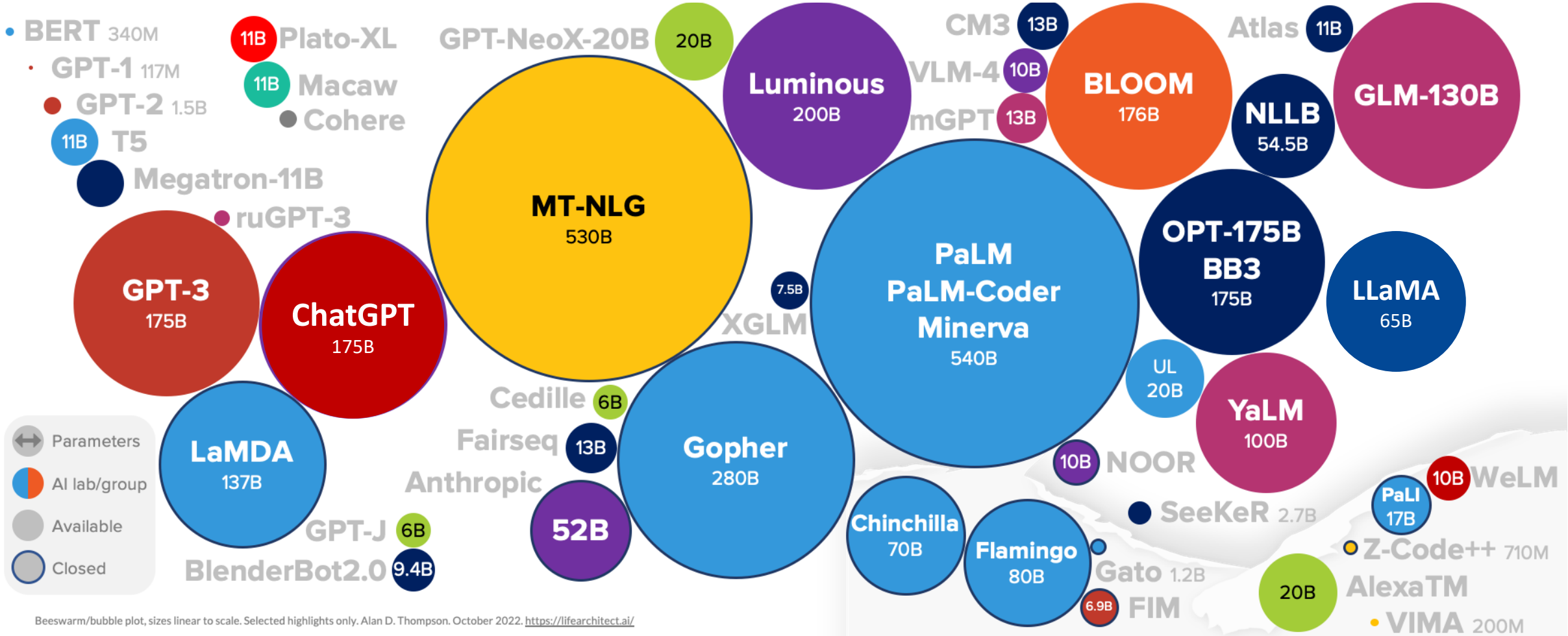
ChatGPT

Large Language Models (LLM)

Foundation Models

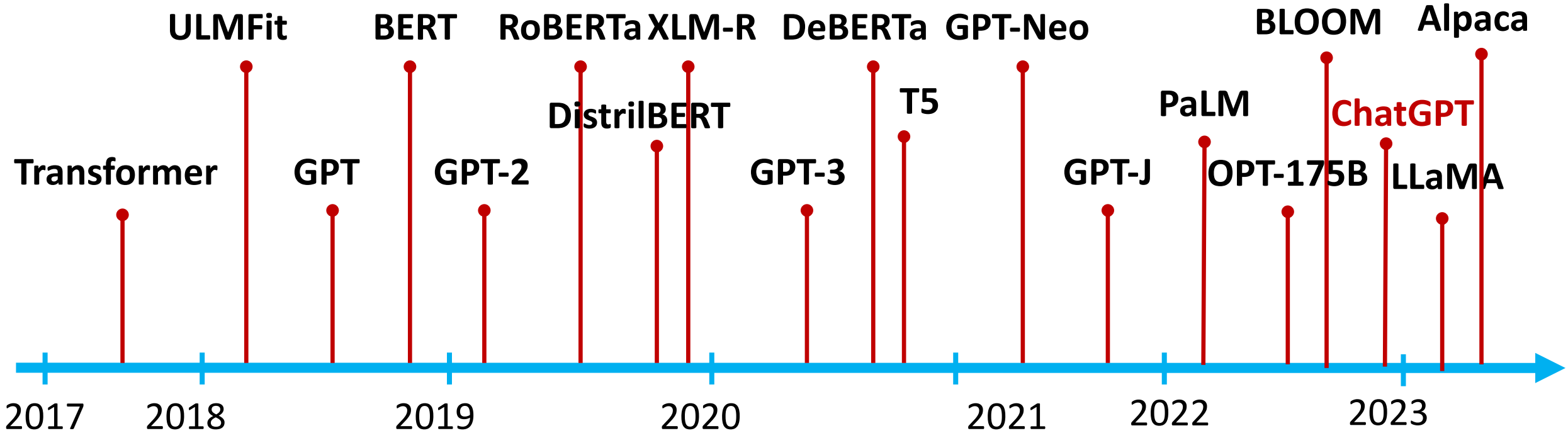
Large Language Models (LLM)

(GPT-3, ChatGPT, PaLM, BLOOM, OPT-175B, LLaMA)



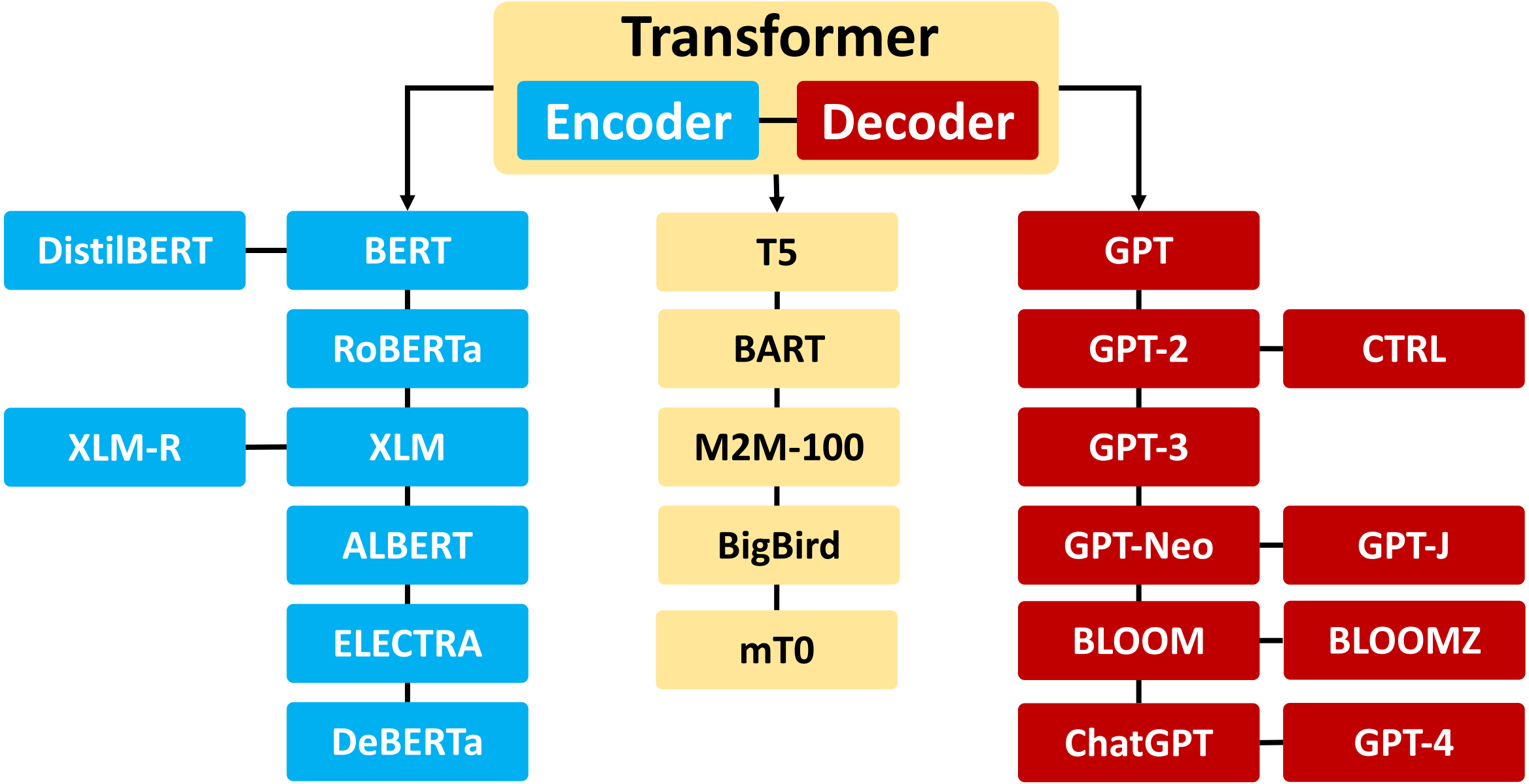
Source: https://lifearchitect.ai/models/

The Transformers Timeline



Source: Lewis Tunstall, Leandro von Werra, and Thomas Wolf (2022), Natural Language Processing with Transformers: Building Language Applications with Hugging Face, O'Reilly Media.

Transformer Models



Source: Lewis Tunstall, Leandro von Werra, and Thomas Wolf (2022), Natural Language Processing with Transformers: Building Language Applications with Hugging Face, O'Reilly Media.

OpenAI ChatGPT

OpenAI

API RESEARCH BLOG ABOUT

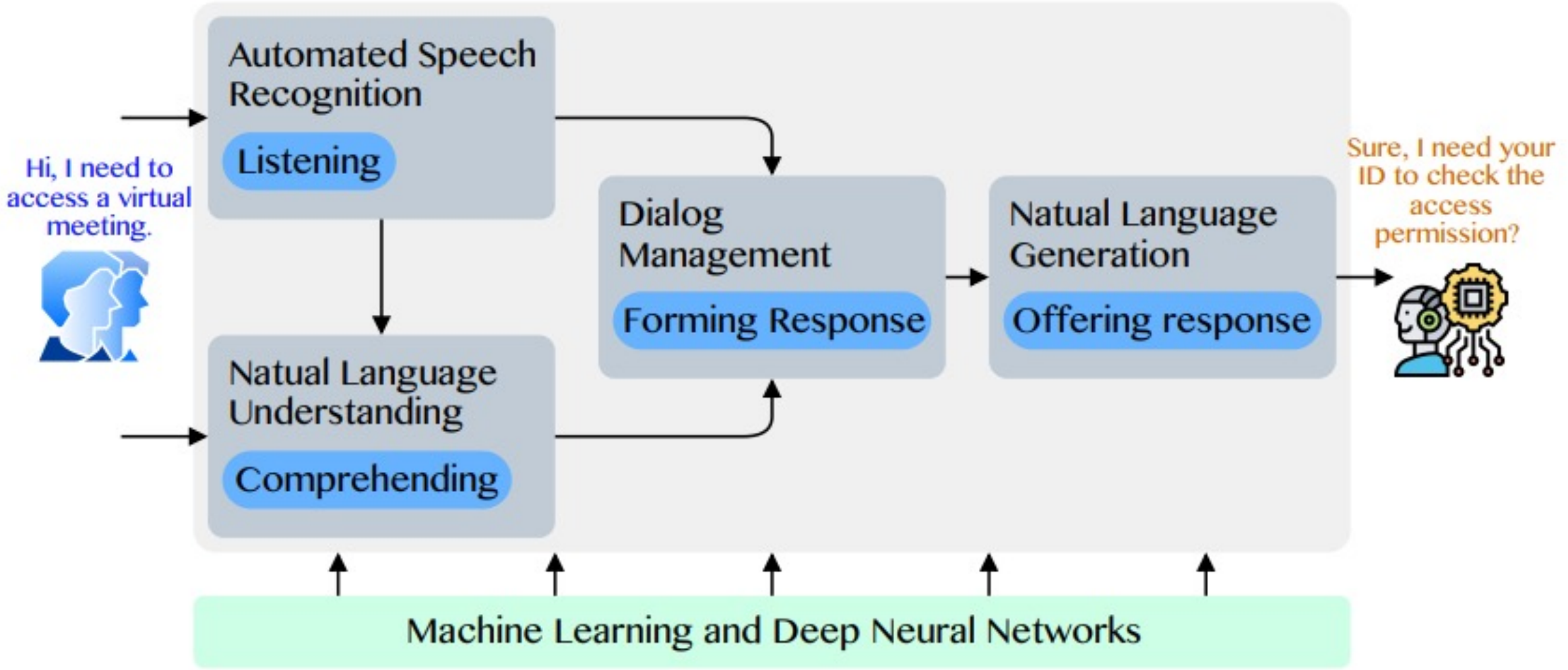
ChatGPT: Optimizing Language Models for Dialogue

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests. ChatGPT is a sibling model to InstructGPT, which is trained to follow an instruction in a prompt and provide a detailed response.

Source: https://openai.com/blog/chatgpt/

Conversational AI

to deliver contextual and personal experience to users



Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

OpenAI ChatGPT

ChatGPT

This is a free research preview.

Our goal is to get external feedback in order to improve our systems and make them safer.

While we have safeguards in place, the system may occasionally generate incorrect or misleading information and produce offensive or biased content. It is not intended to give advice.

Source: https://chat.openai.com/chat

OpenAI ChatGPT

ChatGPT

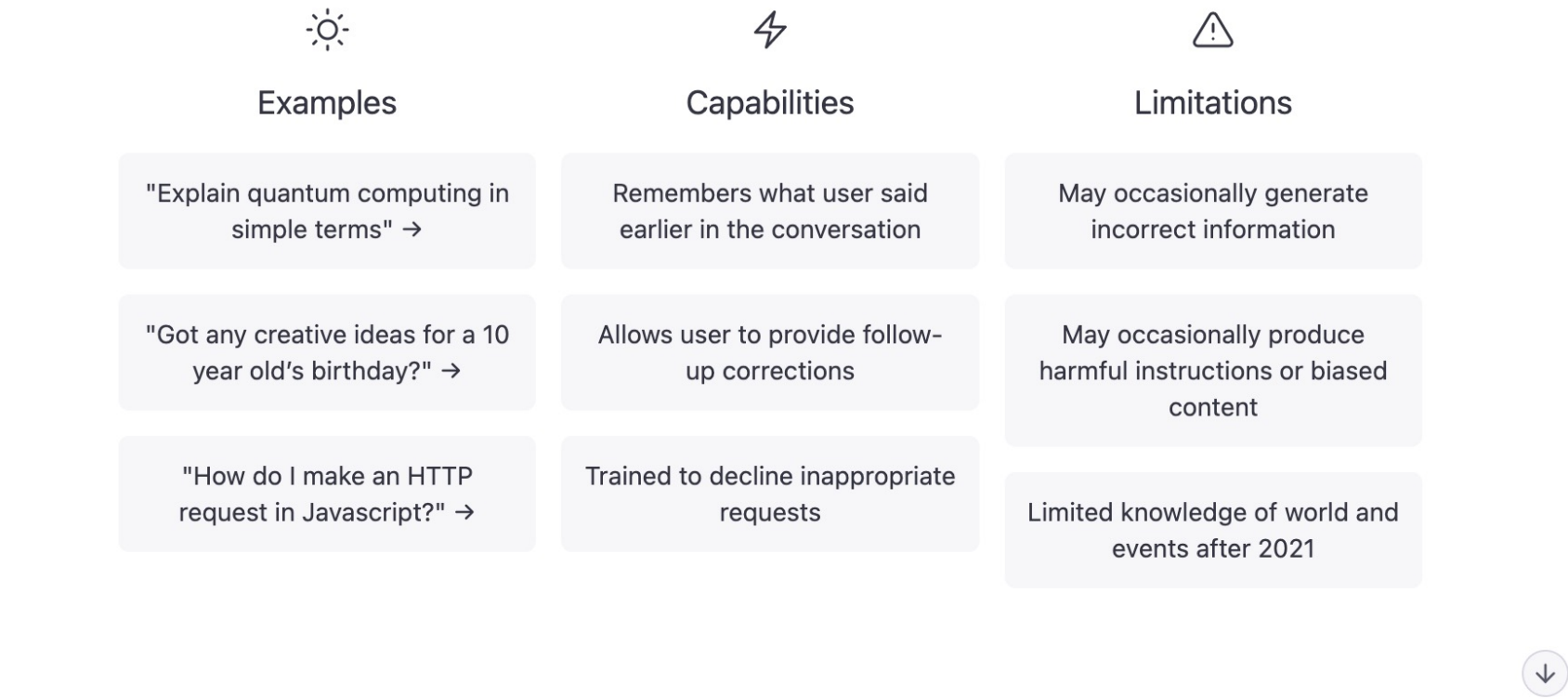
How we collect data

Conversations may be reviewed by our AI trainers to improve our systems.

Please don't share any sensitive information in your conversations.

Source: https://chat.openai.com/chat

OpenAI ChatGPT



Source: https://chat.openai.com/chat

OpenAI ChatGPT

IM

What is the future of AI?

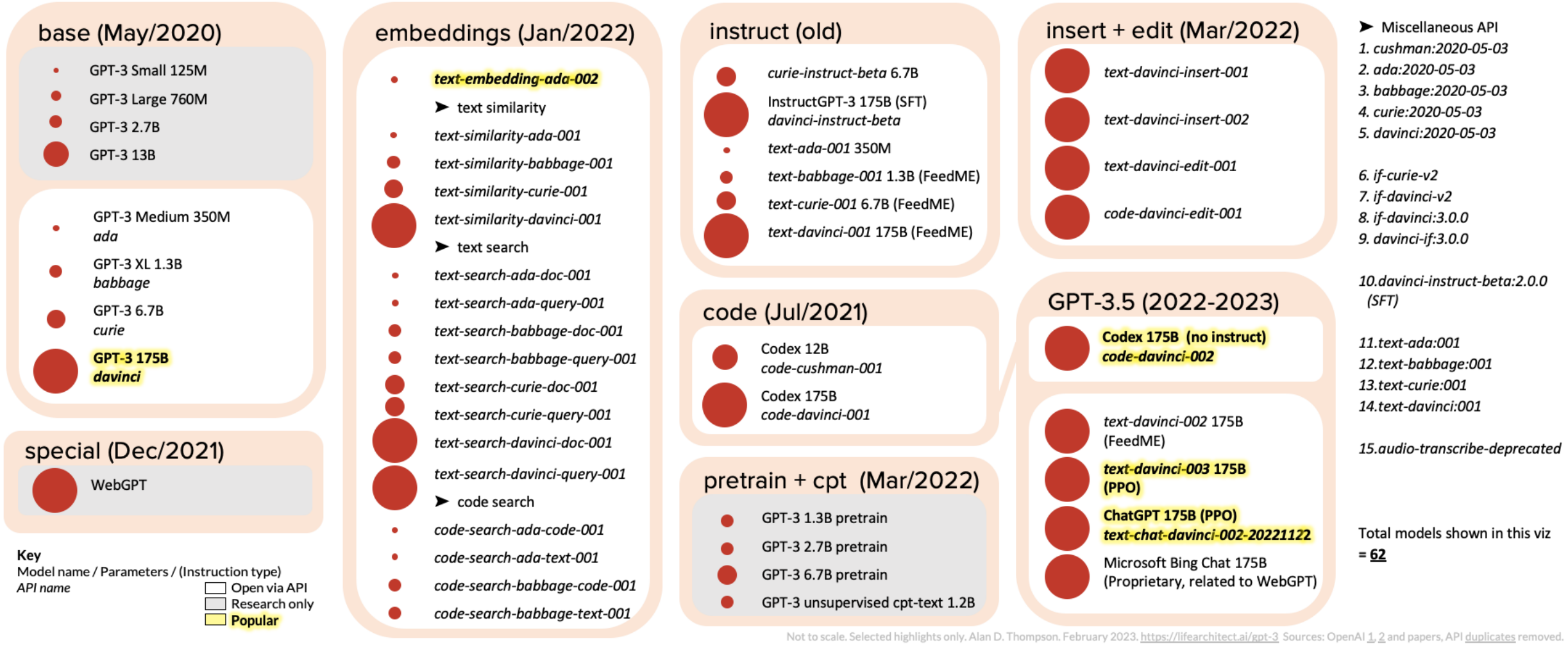
It is difficult to predict the exact future of AI, but many experts believe that it will continue to play an increasingly important role in our lives. Some potential future developments in the field of AI include:

- Improved natural language processing, allowing AI systems to better understand and respond to human speech and writing.
- Enhanced ability to learn and adapt, allowing AI systems to become more autonomous and capable of handling a wider range of tasks.
- Greater integration with the internet of things (IoT), allowing AI systems to control and interact with a wide range of connected devices in the home and workplace.
- Continued advances in machine learning, allowing AI systems to make more accurate predictions and decisions based on data.
- Increased use of AI in healthcare, transportation, and other industries, leading to more efficient and effective processes and services.
- Continued development of ethical and regulatory frameworks to ensure that AI is developed and used responsibly.

Ultimately, the future of AI will depend on how it is developed and used by individuals, organizations, and society as a whole.

Source: https://chat.openai.com/chat

ChatGPT and GPT-3 Family
(GPT-3, InstructGPT, GPT-3.5, ChatGPT)



Source: https://lifearchitect.ai/gpt-3/

OpenAI ChatGPT and Open LLM

GPT-4, LLaMA, Alpaca, Dolly, Cerebras-GPT, GPT4All, Vicuna, ColossalChat, Koala, Phoenix

- OpenAI GPT-4
- Deepmind Chinchilla
- Meta OPT (LLaMA)
- Pythia
- Stanford Alpaca
- Databricks Dolly
- Cerebras-GPT
- GPT4All
- Vicuna
- ColossalChat
- BAIR Koala

Source: https://www.cerebras.net/blog/cerebras-gpt-a-family-of-open-compute-efficient-large-language-models/

Large Language Models (LMM) Openness and Training Philosophy

Model	Model architecture	Training data	Model weights	Checkpoints	Compute-optimal training	License
OpenAI GPT-4	Closed	Closed	No	No	Unknown	Not available
Deepmind Chinchilla	Open	Closed	No	No	Yes	Not available
Meta OPT	Open	Open	Researchers Only	Yes	No	Non-commercial
Pythia	Open	Open	Open	Yes	No	Apache 2.0
Cerebras-GPT	Open	Open	Open	Yes	Yes	Apache 2.0

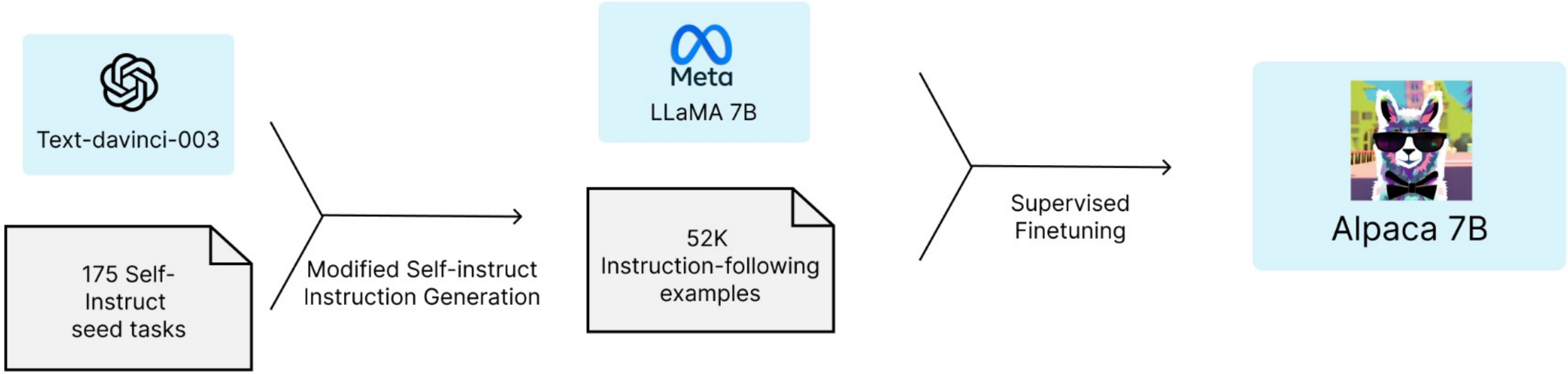
Source: https://www.cerebras.net/blog/cerebras-gpt-a-family-of-open-compute-efficient-large-language-models/

Phoenix: Democratizing ChatGPT across Languages

Model	Backbone	#paras	Open-source		Claimed language	Post-training				Release date
						instruction		conversation		
			model	data		data	lang	data	lang	
ChatGPT	unknown	unknown	✗	✗	multi					11/30/22
Wenxin [7]	unknown	unknown	✗	✗	zh					03/16/23
ChatGLM [8]	GLM	6B	✓ [1]	✗	en/zh					03/16/23
Tongyi [9]	unknown	unknown	✗	✗	zh					04/07/23
Shangliang [10]	unknown	unknown	✗	✗	zh					04/10/23
Alpaca [12]	LLaMA	7B	✗	✓	en	52K	en	✗	✗	03/13/23
Dolly [11] [2]	GPT-J	6B	✓	✓	en	52k	en	✗	✗	03/24/23
BELLE [6]	BLOOMZ	7B	✓	✓	zh	1.5M	ch	✗	✗	03/26/23
Guanaco [12]	LLaMA	7B	✓	✓	en/zh/ja/de	534K [3]	4 [4]	✗	✗	03/26/23
Chinese-alpaca [3]	LLaMA	7/13B	✓	✓	en/zh	2M/3M	en/zh	✗	✗	03/28/23
LuoTuo [7]	LLaMA	7B	✓	✓	zh	52k	cn	✗	✗	03/31/23
Vicuna [2]	LLaMA	7/13B	✓	✓ [5]	en	✗	✗	70K	multi [6]	03/13/23
Koala [13]	LLaMA	13B	✓	✓	en	355K	en	117K	en	04/03/23
BAIZE [17]	LLaMA	7/13/30B	✓	✓	en	✗	✗	111.5K	en	04/04/23
Phoenix	BLOOMZ	7B	✓	✓	multi	267K	40+	189K	40+	04/08/23
Latin Phoenix (Chimera)	LLaMA	7B/13B	✓	✓	Latin	267K	40+	189K	40+	04/08/23

Source: https://github.com/FreedomIntelligence/LLMZoo

Stanford Alpaca:
A Strong, Replicable Instruction-Following Model



Example seed task

Instruction: Brainstorm a list of possible New Year's resolutions.

Output:
- Lose weight
- Exercise more
- Eat healthier

Example Generated task

Instruction: Brainstorm creative ideas for designing a conference room.

Output:
... incorporating flexible components, such as moveable walls and furniture ...

Stanford Alpaca

Source: https://crfm.stanford.edu/2023/03/13/alpaca.html

GPT4All:
Training an Assistant-style Chatbot with Large Scale Data Distillation from GPT-3.5-Turbo

- **Demo, data and code to train an assistant-style large language model with ~800k GPT-3.5-Turbo Generations based on LLaMa**
- **Reproducibility**
  - **Trained LoRa Weights:**
    - gpt4all-lora (four full epochs of training):
      - https://huggingface.co/nomic-ai/gpt4all-lora

Source: https://github.com/nomic-ai/gpt4all

GPT4All-J

An Apache-2 Licensed Assistant-Style Chatbot

GPT4All-J (GPT4All v2) based on Open Source GPT-J model

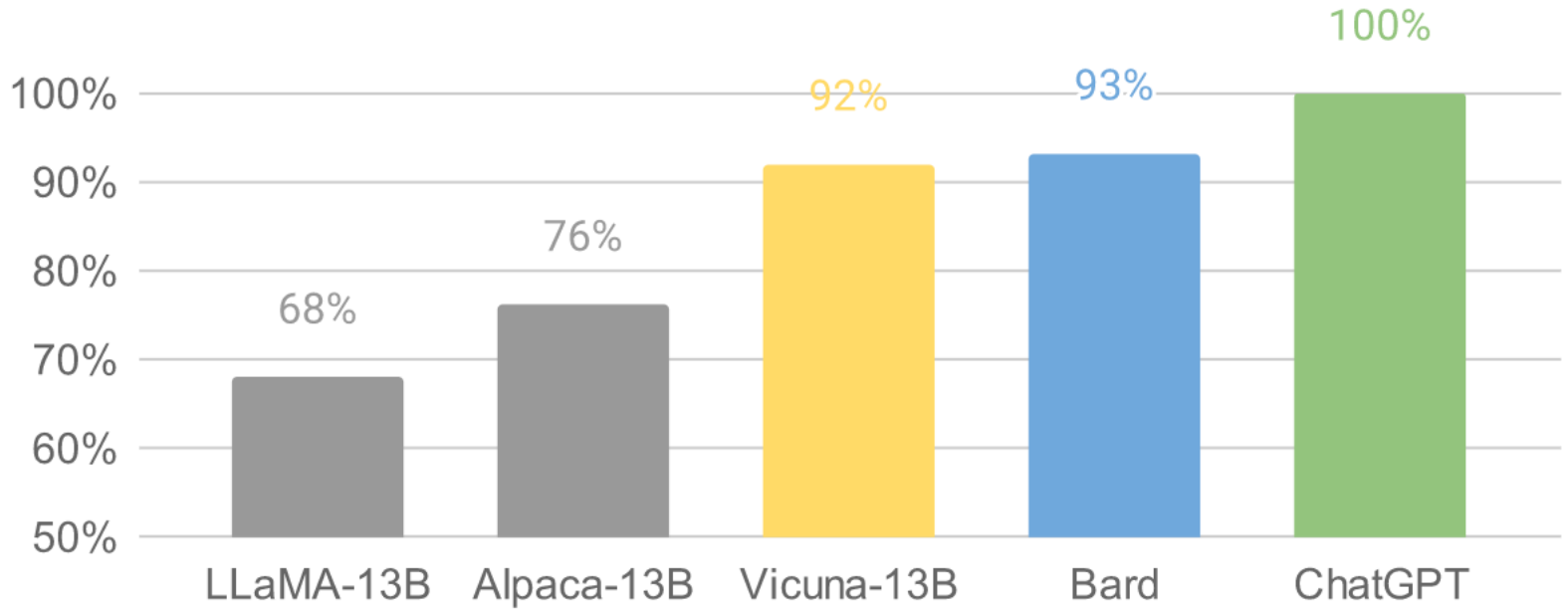
Model	BoolQ	PIQA	HellaSwag	WinoGrande	ARC-e	ARC-c	OBQA
GPT4All-J 6.7B	73.4	74.8	63.4	64.7	54.9	36.0	40.2
GPT4All-J Lora 6.7B	68.6	75.8	66.2	63.5	56.4	35.7	40.2
GPT4All LLaMa Lora 7B	73.1	77.6	72.1	67.8	51.1	40.4	40.2
Dolly 6B	68.8	77.3	67.6	63.9	62.9	38.7	41.2
Dolly 12B	56.7	75.4	71.0	62.2	**64.6**	38.5	40.4
Alpaca 7B	73.9	77.2	73.9	66.1	59.8	43.3	43.4
Alpaca Lora 7B	**74.3**	**79.3**	**74.0**	**68.8**	56.6	**43.9**	**42.6**
GPT-J 6.7B	65.4	76.2	66.2	64.1	62.2	36.6	38.2
LLaMa 7B	73.1	77.4	73.0	66.9	52.5	41.4	42.4
Pythia 6.7B	63.5	76.3	64.0	61.1	61.3	35.2	37.2
Pythia 12B	67.7	76.6	67.3	63.8	63.9	34.8	38

Source: https://github.com/nomic-ai/gpt4all

Vicuna: An Open-Source Chatbot Impressing GPT-4 with 90%* ChatGPT Quality

by the Team with members from UC Berkeley, CMU, Stanford, and UC San Diego

- **Vicuna-13B: an open-source chatbot trained by fine-tuning LLaMA on user-shared conversations collected from ShareGPT.**
- **The cost of training Vicuna-13B is around $300.**



Source: https://vicuna.lmsys.org/

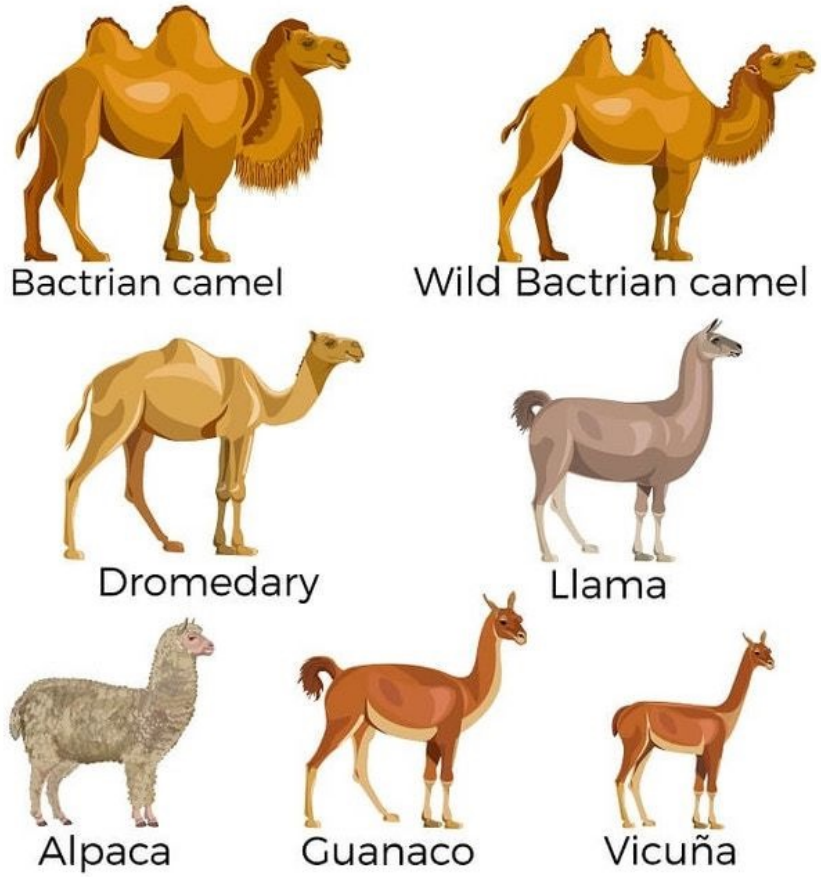
Chinese-Vicuna:

A Chinese Instruction-following LLaMA-based Model

一個中文低資源的 llama+lora方案

Dataset Preview Size: 409 MB </> API Go to dataset viewer

instruction (string)	input (string)	output (string)
"用一句话描述地球为什么是独一无二的。\n "	""	"地球上有适宜生命存在的条件和多样化的生命形式。"
"给出一段对话，要求GPT模型使用合适的语气和回答方式继续对话。 对话： A：你今…	""	"A: 这太好了！你的新工作听起来很令人兴奋。你对接下来的日子有什么期望吗？ B: 是啊，我非…
"基于以下提示填写以下句子的空格。 提示： - 提供多种现实世界的场景 - 空格…	""	"多种形容词可填，以下是其中一些例子： - 愉快的 - 惬意的 - 轻松的 - 安静的 - 美妙的"
"请生成一个新闻标题，描述一场正在发生的大型自然灾害。\n "	""	""强烈飓风肆虐，数百万人疏散！""
"为指定的词汇创建一个关于该词汇的简短解释。 “人工智能”"	""	"人工智能是一种科技，通过使用计算机程序和算法实现类似于人类智能的能力，例如学习、推理和自…
"在给定的文本中查找并替换特定的单词。原始文本: "这个句子中有一个错误的单词…	""	"替换后的文本: "这个句子中有一个修改的单词""
"根据给定的年份，计算该年是否为闰年。\n \n1996\n"	""	"是闰年。"



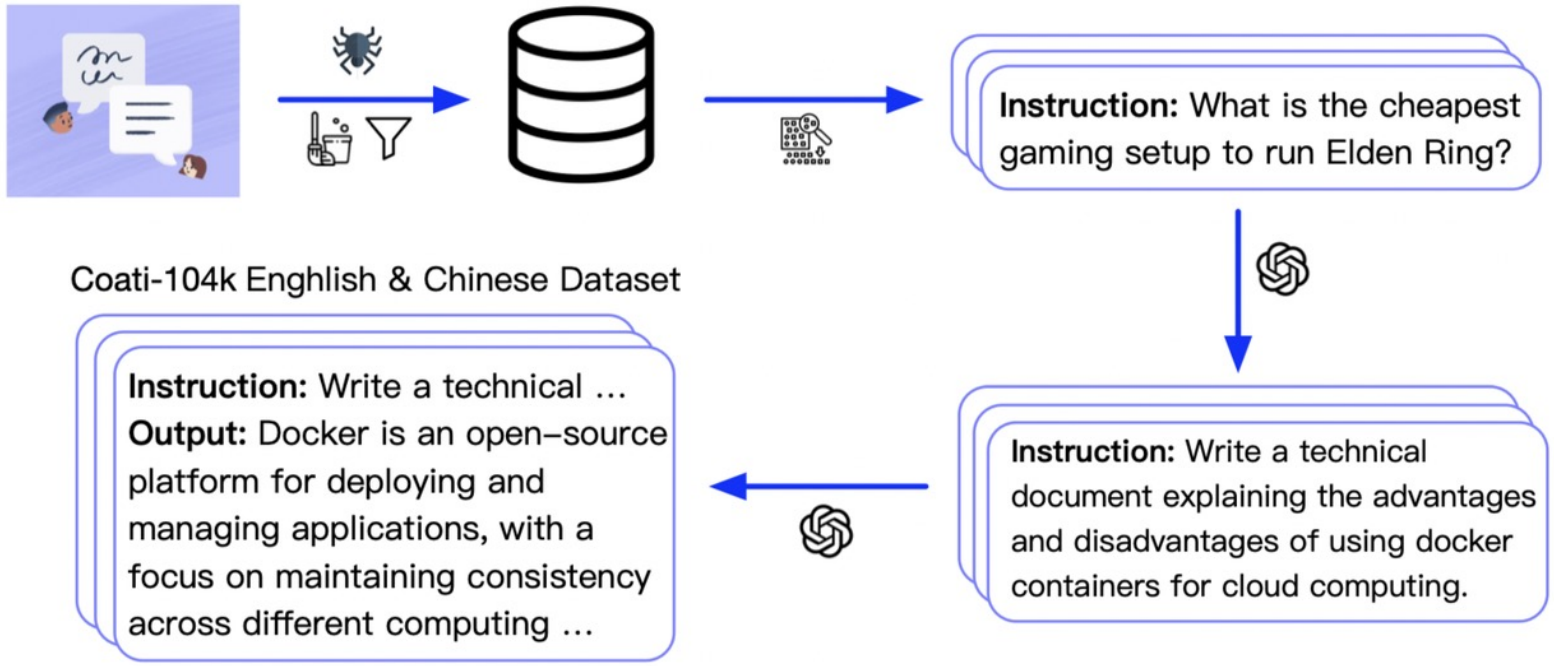
Chinese-Vicuna based on **Guanaco Dataset** and **Belle Dataset**

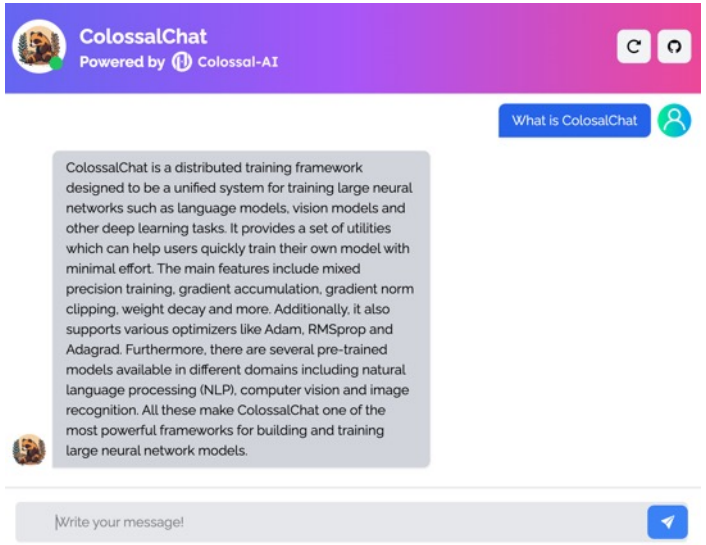
Source: https://huggingface.co/datasets/Chinese-Vicuna/guanaco_belle_merge_v1.0

Source: https://github.com/Facico/Chinese-Vicuna

ColossalChat

- **ColossalChat is the project to implement LLM with RLHF, powered by the Colossal-AI project.**
- **Coati stands for ColossalAI Talking Intelligence.**





Source: https://chat.colossalai.org/
https://github.com/hpcaitech/ColossalAI/tree/main/applications/Chat

Dolly v2
Open Source Instruction-Tuned LLM

- **Databricks' Dolly is an instruction-following large language model trained on the Databricks machine learning platform that is licensed for commercial use.**
- **Based on pythia-12b, Dolly is trained on ~15k instruction/response fine tuning records databricks-dolly-15k generated by Databricks employees in capability domains from the InstructGPT paper, including brainstorming, classification, closed QA, generation, information extraction, open QA and summarization.**
- **dolly-v2-12b is not a state-of-the-art model, but does exhibit surprisingly high quality instruction following behavior not characteristic of the foundation model on which it is based.**

Source: https://github.com/databrickslabs/dolly

StableLM
Stability AI Language Models

- StableLM-Alpha models are trained on the new dataset that build on The Pile, which contains 1.5 trillion tokens, roughly 3x the size of The Pile.
  - These models will be trained on up to 1.5 trillion tokens.
  - The context length for these models is 4096 tokens.
- Fine-tuned the model with Stanford Alpaca's procedure using a combination of five recent datasets for conversational agents: Stanford's Alpaca, Nomic-AI's gpt4all, RyokoAI's ShareGPT52K datasets, Databricks labs' Dolly, and Anthropic's HH.

Source: https://github.com/Stability-AI/StableLM

RedPajama

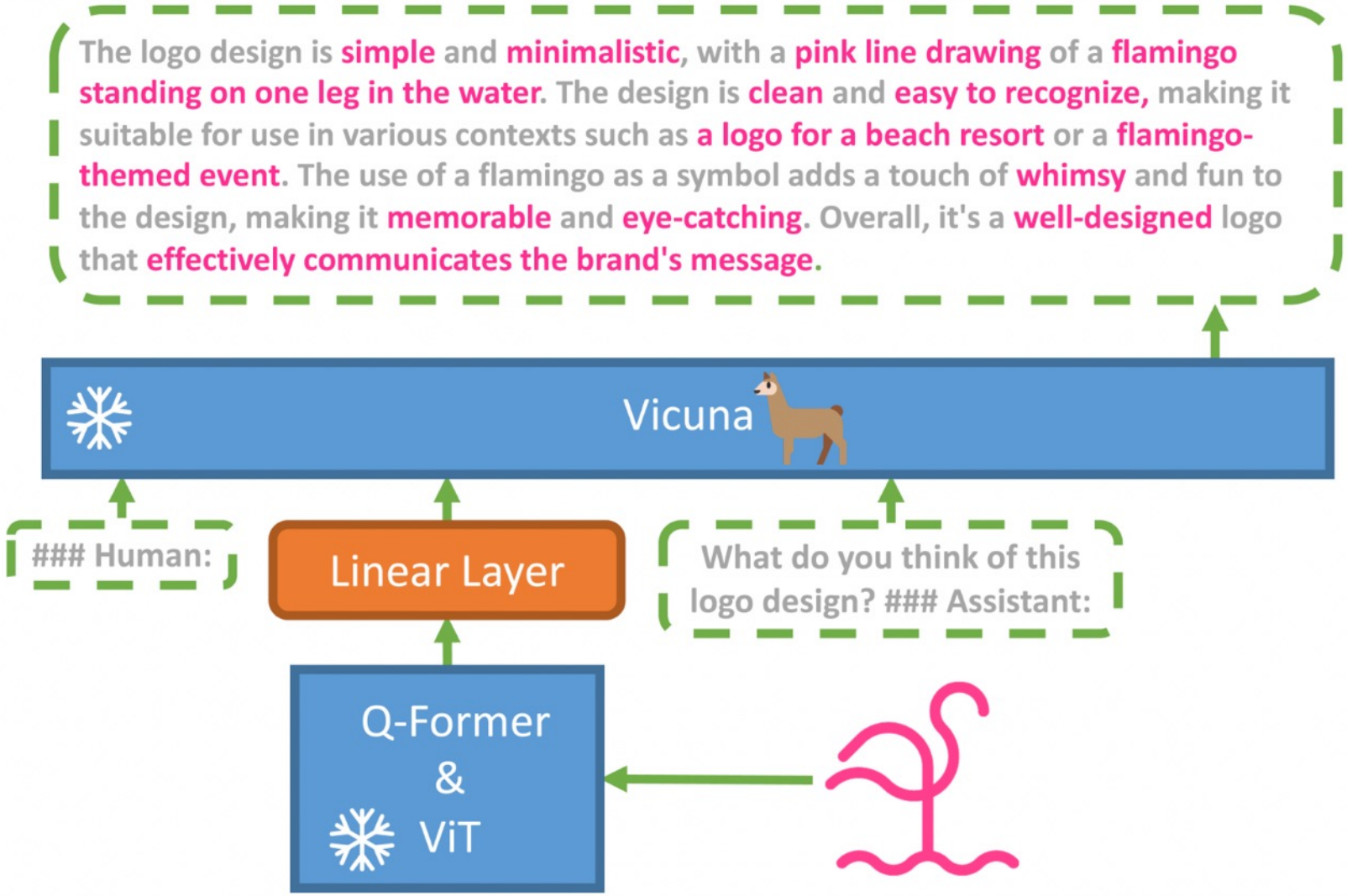
a project to create leading open-source models, starts by reproducing LLaMA training dataset of over 1.2 trillion tokens

Dataset	RedPajama	LLaMA*
CommonCrawl	878 billion	852 billion
C4	175 billion	190 billion
Github	59 billion	100 billion
Books	26 billion	25 billion
ArXiv	28 billion	33 billion
Wikipedia	24 billion	25 billion
StackExchange	20 billion	27 billion
Total Tokens	**1.2 trillion**	**1.25 trillion**

Source: https://github.com/togethercomputer/RedPajama-Data

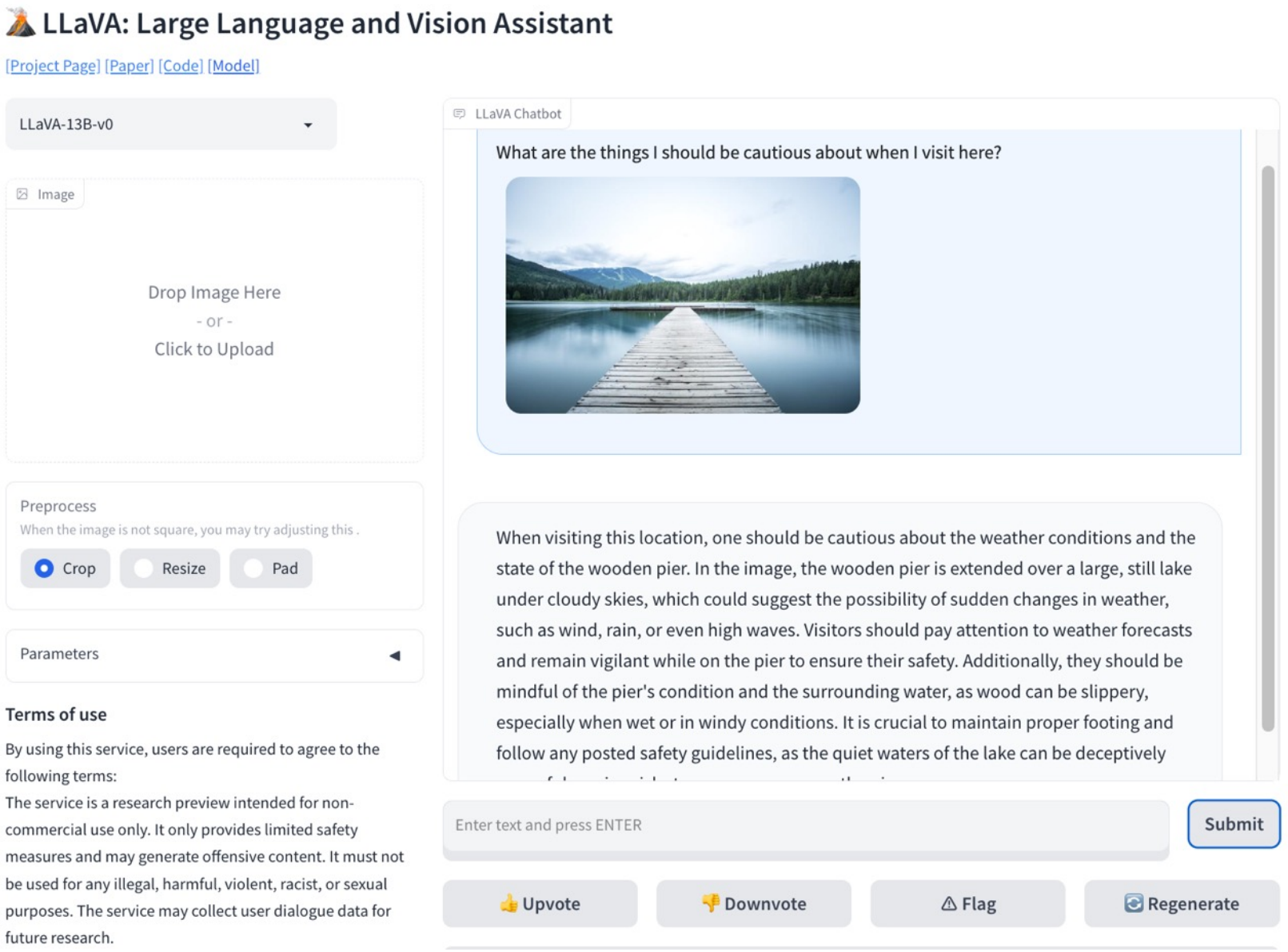
MiniGPT-4:

Enhancing Vision-language Understanding with Advanced Large Language Models



Source: https://minigpt-4.github.io/

LLaVA: Large Language and Vision Assistant



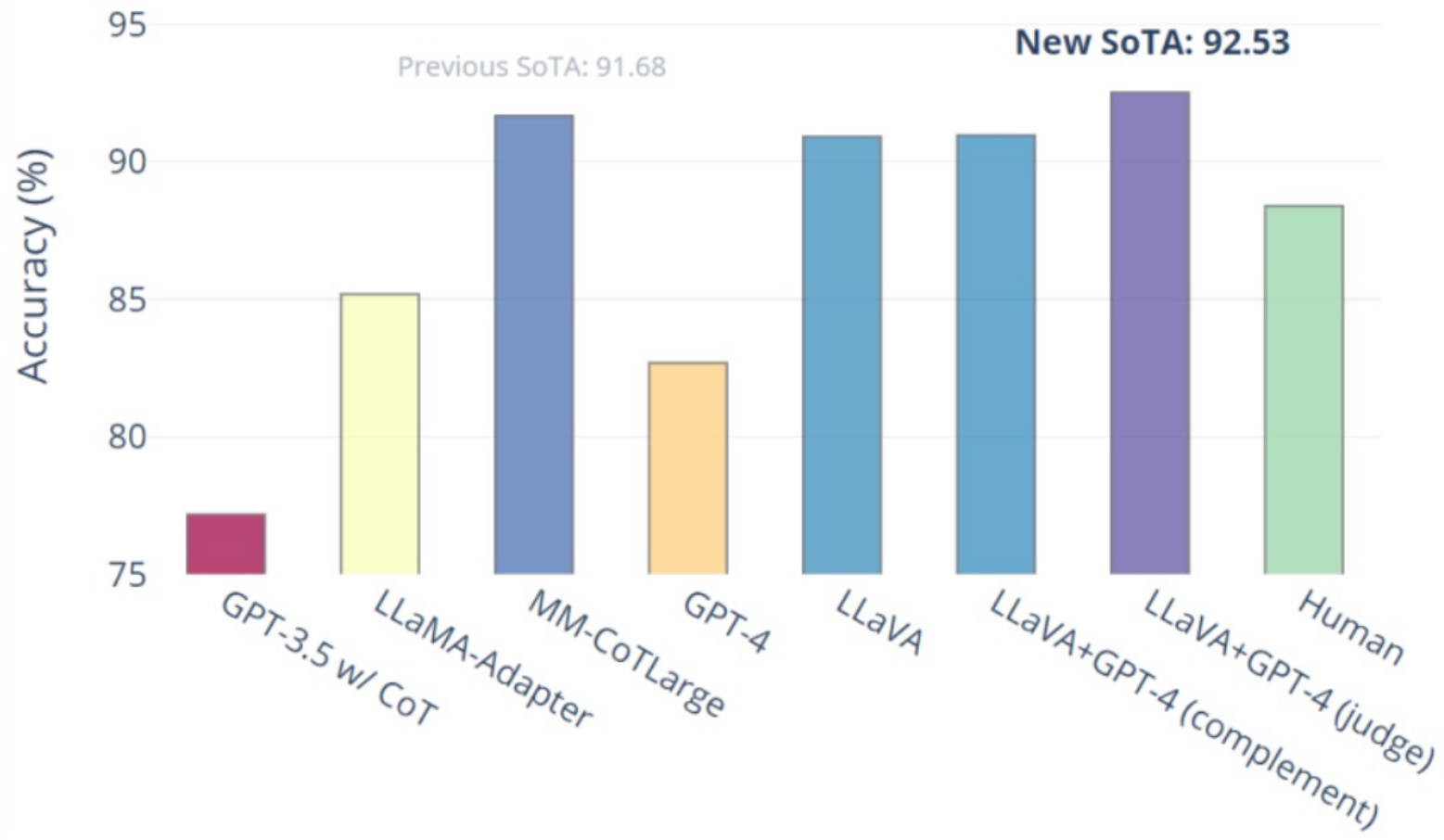
Source: https://llava-vl.github.io/

Visual Instruction Tuning

LLaVA: Large Language and Vision Assistant

University of Wisconsin-Madison, Microsoft Research, Columbia University

Science QA: New SoTA with the synergy of LLaVA with GPT-4

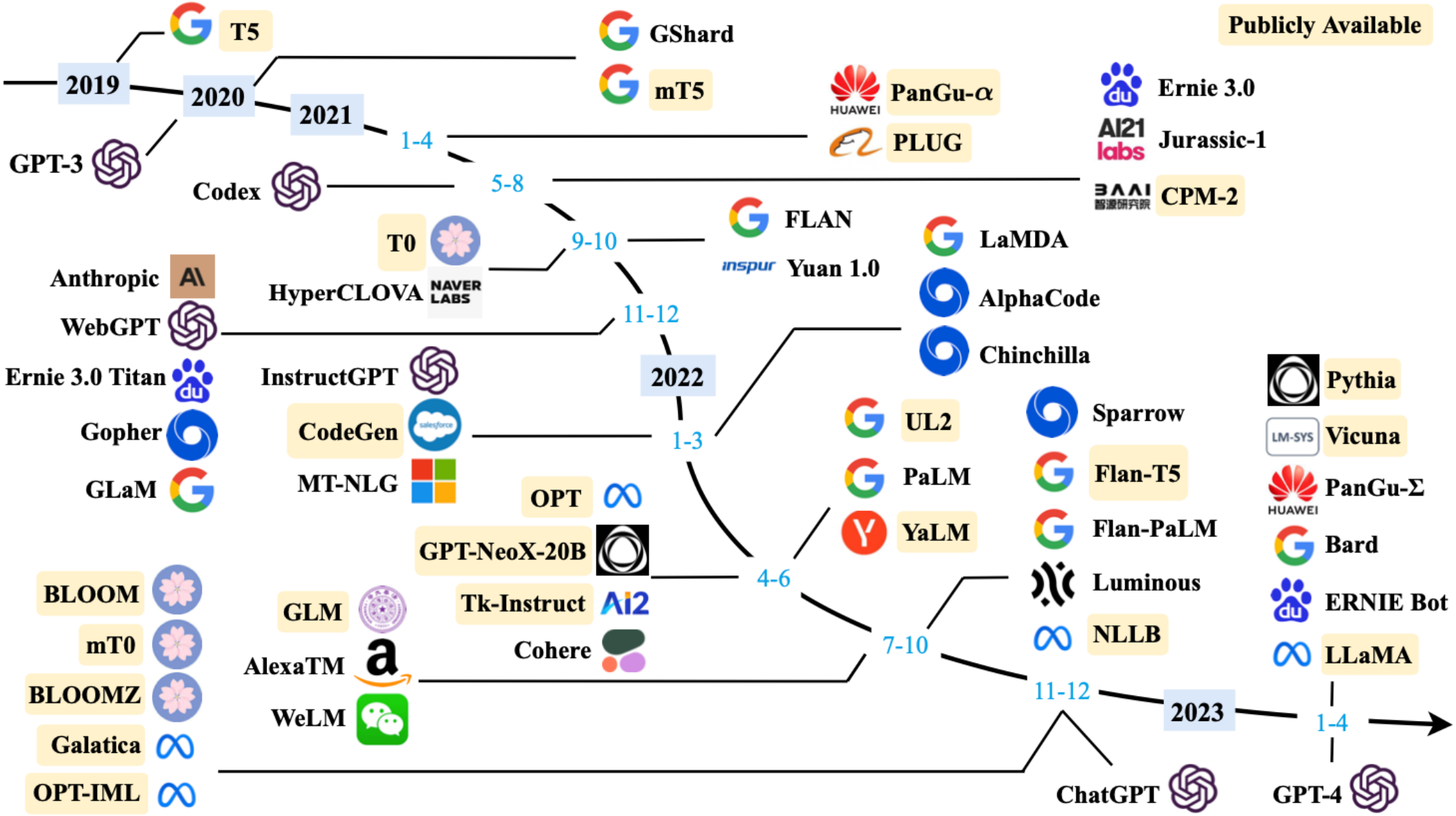


LLaVA represents a novel end-to-end trained large multimodal model that combines a vision encoder and Vicuna for general-purpose visual and language understanding, achieving impressive chat capabilities mimicking spirits of the multimodal GPT-4 and setting a new state-of-the-art accuracy on Science QA.

Source: https://llava-vl.github.io/

Large Language Models (LLMs)
Foundation Models

Large Language Models (LLMs) (larger than 10B)



Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Large Language Models (LLMs) (larger than 10B)

	Model	Release Time	Size (B)	Base Model	Adaptation IT	Adaptation RLHF	Pre-train Data Scale	Latest Data Timestamp	Hardware (GPUs / TPUs)	Training Time	Evaluation ICL	Evaluation CoT
Publicly Available	T5 [72]	Oct-2019	11	-	-	-	1T tokens	Apr-2019	1024 TPU v3	-	✓	-
	mT5 [73]	Oct-2020	13	-	-	-	1T tokens	-	-	-	✓	-
	PanGu-α [74]	Apr-2021	13*	-	-	-	1.1TB	-	2048 Ascend 910	-	✓	-
	CPM-2 [75]	Jun-2021	198	-	-	-	2.6TB	-	-	-	-	-
	T0 [28]	Oct-2021	11	T5	✓	-	-	-	512 TPU v3	27 h	✓	-
	CodeGen [76]	Mar-2022	16	-	-	-	577B tokens	-	-	-	✓	-
	GPT-NeoX-20B [77]	Apr-2022	20	-	-	-	825GB	-	96 40G A100	-	✓	-
	Tk-Instruct [78]	Apr-2022	11	T5	✓	-	-	-	256 TPU v3	4 h	✓	-
	UL2 [79]	May-2022	20	-	-	-	1T tokens	Apr-2019	512 TPU v4	-	✓	✓
	OPT [80]	May-2022	175	-	-	-	180B tokens	-	992 80G A100	-	✓	-
	NLLB [81]	Jul-2022	54.5	-	-	-	-	-	-	-	✓	-
	GLM [82]	Oct-2022	130	-	-	-	400B tokens	-	768 40G A100	60 d	✓	-
	Flan-T5 [83]	Oct-2022	11	T5	✓	-	-	-	-	-	✓	✓
	BLOOM [68]	Nov-2022	176	-	-	-	366B tokens	-	384 80G A100	105 d	✓	-
	mT0 [84]	Nov-2022	13	mT5	✓	-	-	-	-	-	✓	-
	Galactica [35]	Nov-2022	120	-	-	-	106B tokens	-	-	-	✓	✓
	BLOOMZ [84]	Nov-2022	176	BLOOM	✓	-	-	-	-	-	✓	-
	OPT-IML [85]	Dec-2022	175	OPT	✓	-	-	-	128 40G A100	-	✓	✓
	LLaMA [57]	Feb-2023	65	-	-	-	1.4T tokens	-	2048 80G A100	21 d	✓	-
	Pythia [86]	Apr-2023	12	-	-	-	300B tokens	-	256 40G A100	-	✓	-

Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Large Language Models (LLMs) (larger than 10B)

	Model	Release Time	Size (B)	Base Model	Adaptation IT	Adaptation RLHF	Pre-train Data Scale	Latest Data Timestamp	Hardware (GPUs / TPUs)	Training Time	Evaluation ICL	Evaluation CoT
Closed Source	GPT-3 [55]	May-2020	175	-	-	-	300B tokens	-	-	-	✓	-
	GShard [87]	Jun-2020	600	-	-	-	1T tokens	-	2048 TPU v3	4 d	-	-
	Codex [88]	Jul-2021	12	GPT-3	-	-	100B tokens	May-2020	-	-	✓	-
	ERNIE 3.0 [89]	Jul-2021	10	-	-	-	375B tokens	-	384 V100	-	✓	-
	Jurassic-1 [90]	Aug-2021	178	-	-	-	300B tokens	-	800 GPU	-	✓	-
	HyperCLOVA [91]	Sep-2021	82	-	-	-	300B tokens	-	1024 A100	13.4 d	✓	-
	FLAN [62]	Sep-2021	137	LaMDA	✓	-	-	-	128 TPU v3	60 h	✓	-
	Yuan 1.0 [92]	Oct-2021	245	-	-	-	180B tokens	-	2128 GPU	-	✓	-
	Anthropic [93]	Dec-2021	52	-	-	-	400B tokens	-	-	-	✓	-
	WebGPT [71]	Dec-2021	175	GPT-3	-	✓	-	-	-	-	✓	-
	Gopher [59]	Dec-2021	280	-	-	-	300B tokens	-	4096 TPU v3	920 h	✓	-
	ERNIE 3.0 Titan [94]	Dec-2021	260	-	-	-	300B tokens	-	2048 V100	28 d	✓	-
	GLaM [95]	Dec-2021	1200	-	-	-	280B tokens	-	1024 TPU v4	574 h	✓	-
	LaMDA [96]	Jan-2022	137	-	-	-	2.81T tokens	-	1024 TPU v3	57.7 d	-	-
	MT-NLG [97]	Jan-2022	530	-	-	-	270B tokens	-	4480 80G A100	-	✓	-
	AlphaCode [98]	Feb-2022	41	-	-	-	967B tokens	Jul-2021	-	-	-	-
	InstructGPT [61]	Mar-2022	175	GPT-3	✓	✓	-	-	-	-	✓	-
	Chinchilla [34]	Mar-2022	70	-	-	-	1.4T tokens	-	-	-	✓	-
	PaLM [56]	Apr-2022	540	-	-	-	780B tokens	-	6144 TPU v4	-	✓	✓
	AlexaTM [99]	Aug-2022	20	-	-	-	1.3T tokens	-	128 A100	120 d	✓	✓
	Sparrow [100]	Sep-2022	70	-	-	✓	-	-	64 TPU v3	-	✓	-
	WeLM [101]	Sep-2022	10	-	-	-	300B tokens	-	128 A100 40G	24 d	✓	-
	U-PaLM [102]	Oct-2022	540	PaLM	-	-	-	-	512 TPU v4	5 d	✓	✓
	Flan-PaLM [83]	Oct-2022	540	PaLM	✓	-	-	-	512 TPU v4	37 h	✓	✓
	Flan-U-PaLM [83]	Oct-2022	540	U-PaLM	✓	-	-	-	-	-	✓	✓
	GPT-4 [46]	Mar-2023	-	-	✓	✓	-	-	-	-	✓	✓
	PanGu-Σ [103]	Mar-2023	1085	PanGu-α	-	-	329B tokens	-	512 Ascend 910	100 d	✓	-

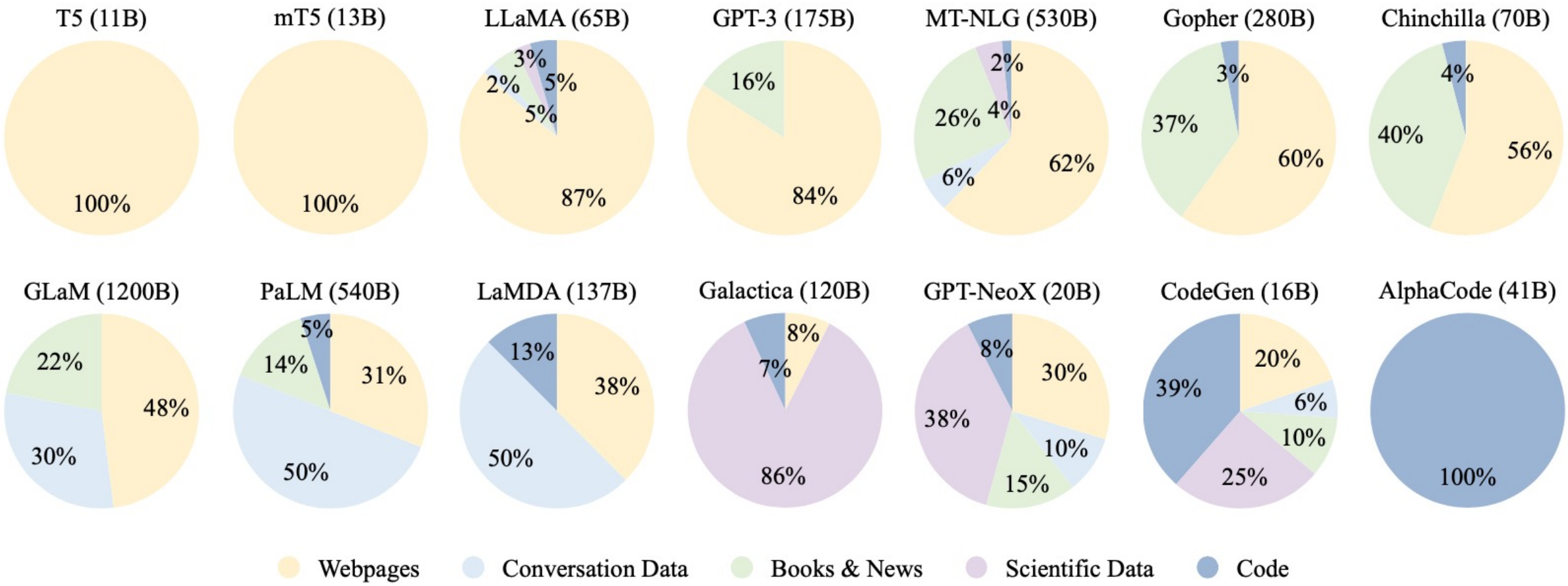
Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Statistics of Commonly-used Data Sources for LLMs

Corpora	Size	Source	Latest Update Time
BookCorpus [109]	5GB	Books	Dec-2015
Gutenberg [110]	-	Books	Dec-2021
C4 [72]	800GB	CommonCrawl	Apr-2019
CC-Stories-R [111]	31GB	CommonCrawl	Sep-2019
CC-NEWS [27]	78GB	CommonCrawl	Feb-2019
REALNEWs [112]	120GB	CommonCrawl	Apr-2019
OpenWebText [113]	38GB	Reddit links	Mar-2023
Pushift.io [114]	-	Reddit links	Mar-2023
Wikipedia [115]	-	Wikipedia	Mar-2023
BigQuery [116]	-	Codes	Mar-2023
the Pile [117]	800GB	Other	Dec-2020
ROOTS [118]	1.6TB	Other	Jun-2022

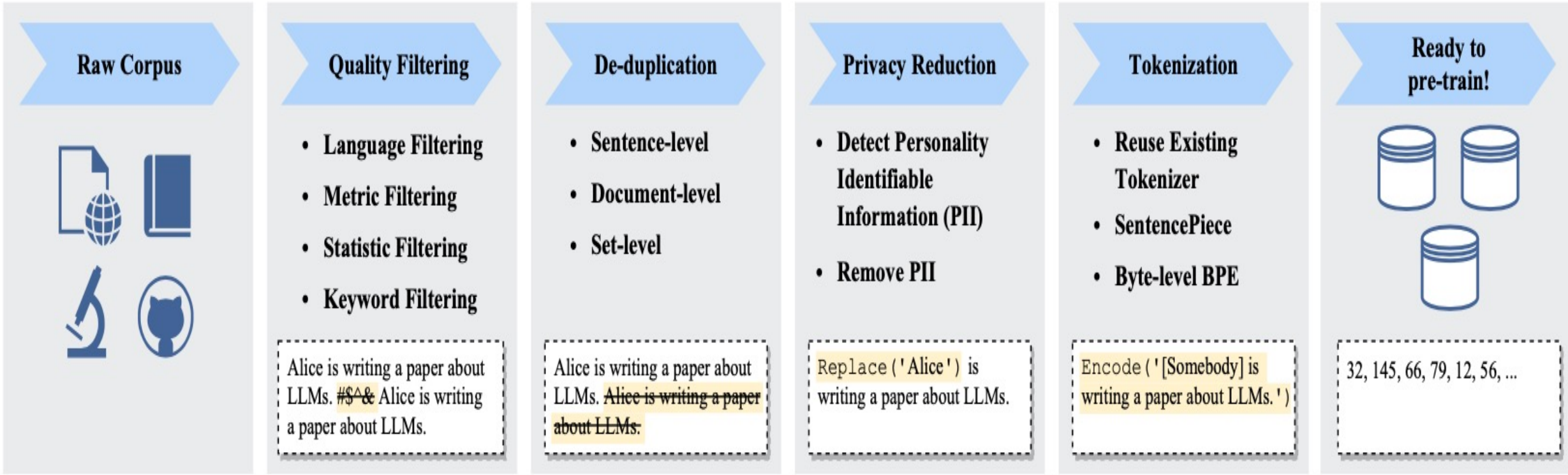
Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Ratios of various data sources in the pre-training data for existing LLMs



Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Typical Data Preprocessing Pipeline for Pre-training Large Language Models (LLMs)



Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

LLMs with Public Configuration Details

Model	Category	Size	Normalization	PE	Activation	Bias	#L	#H	d_{model}	MCL
GPT3 [55]	Causal decoder	175B	Pre Layer Norm	Learned	GeLU	✓	96	96	12288	2048
PanGU- α [74]	Causal decoder	207B	Pre Layer Norm	Learned	GeLU	✓	64	128	16384	1024
OPT [80]	Causal decoder	175B	Pre Layer Norm	Learned	ReLU	✓	96	96	12288	2048
PaLM [56]	Causal decoder	540B	Pre Layer Norm	RoPE	SwiGLU	×	118	48	18432	2048
BLOOM [68]	Causal decoder	176B	Pre Layer Norm	ALiBi	GeLU	✓	70	112	14336	2048
MT-NLG [97]	Causal decoder	530B	-	-	-	-	105	128	20480	2048
Gopher [59]	Causal decoder	280B	Pre RMS Norm	Relative	-	-	80	128	16384	2048
Chinchilla [34]	Causal decoder	70B	Pre RMS Norm	Relative	-	-	80	64	8192	-
Galactica [35]	Causal decoder	120B	Pre Layer Norm	Learned	GeLU	×	96	80	10240	2048
LaMDA [96]	Causal decoder	137B	-	Relative	GeGLU	-	64	128	8192	-
Jurassic-1 [90]	Causal decoder	178B	Pre Layer Norm	Learned	GeLU	✓	76	96	13824	2048
LLaMA [57]	Causal decoder	65B	Pre RMS Norm	RoPE	SwiGLU	✓	80	64	8192	2048
GLM-130B [82]	Prefix decoder	130B	Post Deep Norm	RoPE	GeGLU	✓	70	96	12288	2048
T5 [72]	Encoder-decoder	11B	Pre RMS Norm	Relative	ReLU	×	24	128	1024	512

Note: PE denotes position embedding, #L denotes the number of layers, #H denotes the number of attention heads, d_{model} denotes the size of hidden states, and MCL denotes the maximum context length during training.

Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Detailed Optimization Settings of LLMs

Model	Batch Size (#tokens)	Learning Rate	Warmup	Decay Method	Optimizer	Precision Type	Weight Decay	Grad Clip	Dropout
GPT3 (175B)	32K→3.2M	6×10^{-5}	yes	cosine decay to 10%	Adam	FP16	0.1	1.0	-
PanGu-α (200B)	-	2×10^{-5}	-	-	Adam	-	0.1	-	-
OPT (175B)	2M	1.2×10^{-4}	yes	manual decay	AdamW	FP16	0.1	-	0.1
PaLM (540B)	1M→4M	1×10^{-2}	no	inverse square root	Adafactor	BF16	lr^2	1.0	0.1
BLOOM (176B)	4M	6×10^{-5}	yes	cosine decay to 10%	Adam	BF16	0.1	1.0	0.0
MT-NLG (530B)	64 K→3.75M	5×10^{-5}	yes	cosine decay to 10%	Adam	BF16	0.1	1.0	-
Gopher (280B)	3M→6M	4×10^{-5}	yes	cosine decay to 10%	Adam	BF16	-	1.0	-
Chinchilla (70B)	1.5M→3M	1×10^{-4}	yes	cosine decay to 10%	AdamW	BF16	-	-	-
Galactica (120B)	2M	7×10^{-6}	yes	linear decay to 10%	AdamW	-	0.1	1.0	0.1
LaMDA (137B)	256K	-	-	-	-	BF16	-	-	-
Jurassic-1 (178B)	32 K→3.2M	6×10^{-5}	yes	-	-	-	-	-	-
LLaMA (65B)	4M	1.5×10^{-4}	yes	cosine decay to 10%	AdamW	-	0.1	1.0	-
GLM (130B)	0.4M→8.25M	8×10^{-5}	yes	cosine decay to 10%	AdamW	FP16	0.1	1.0	0.1
T5 (11B)	64K	1×10^{-2}	no	inverse square root	AdaFactor	-	-	-	0.1
ERNIE 3.0 Titan (260B)	-	1×10^{-4}	-	-	Adam	FP16	0.1	1.0	-
PanGu-Σ (1.085T)	0.5M	2×10^{-5}	yes	-	Adam	FP16	-	-	-

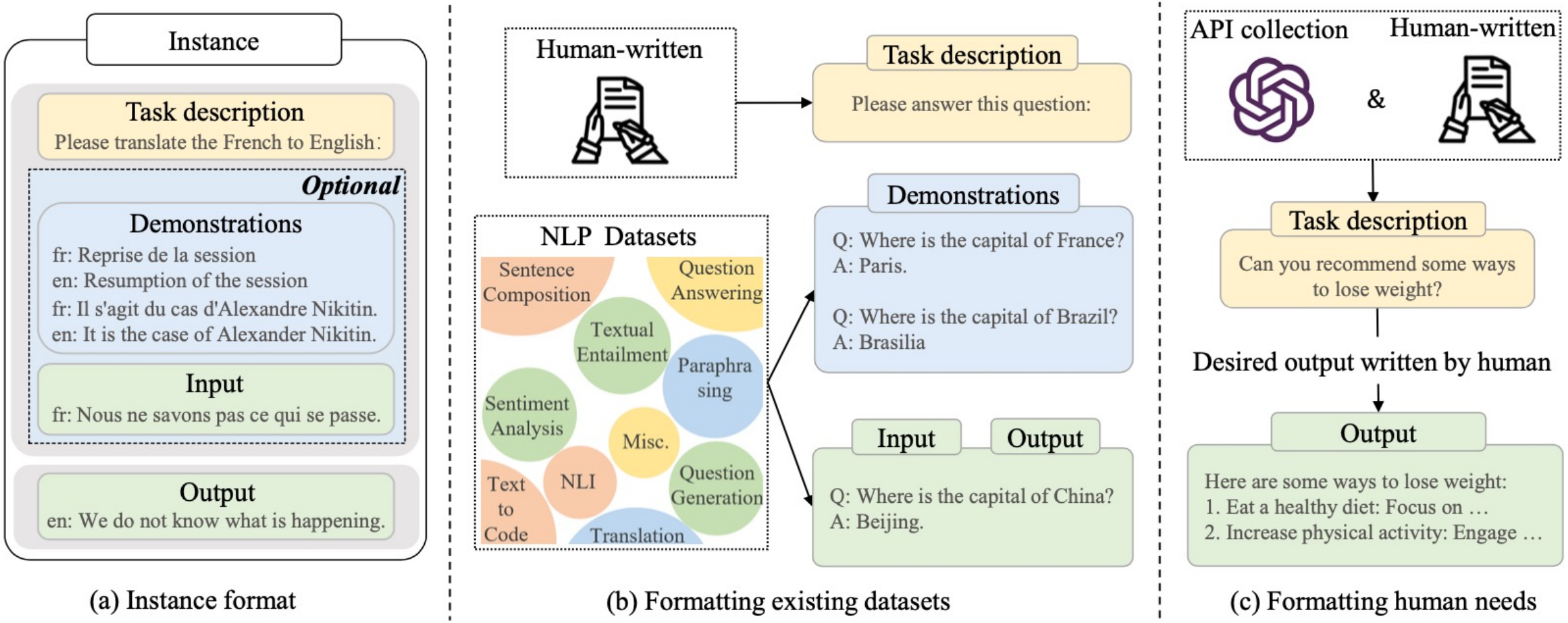
Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Available Task Collections for Instruction Tuning

Collections	Time	#Task types	#Tasks	#Examples
Nat. Inst. [193]	Apr-2021	6	61	193K
CrossFit [194]	Apr-2021	13	160	7.1M
FLAN [62]	Sep-2021	12	62	4.4M
P3 [195]	Oct-2021	13	267	12.1M
ExMix [196]	Nov-2021	11	107	18M
UnifiedSKG [197]	Jan-2022	6	21	812K
Super Nat. Inst. [78]	Apr-2022	76	1616	5M
MVPCorpus [198]	Jun-2022	11	77	41M
xP3 [84]	Nov-2022	17	85	81M
OIG[14]	Mar-2023	-	-	43M

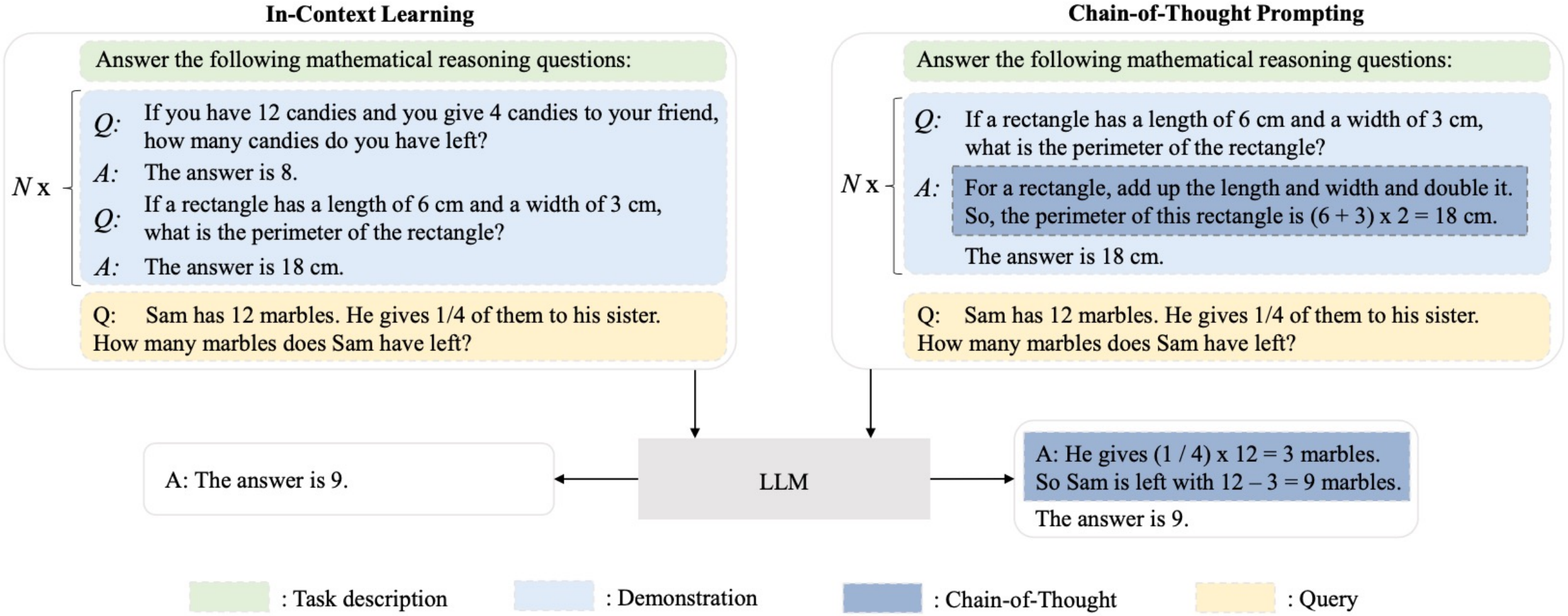
Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Instance Formatting and Two Different Methods for Constructing the Instruction-formatted Instances



Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

In-context Learning (ICL) and Chain-of-thought (CoT) Prompting

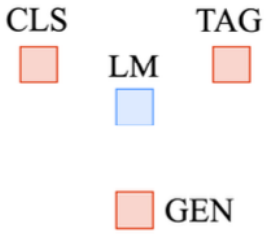
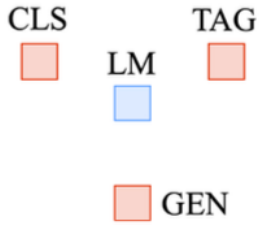
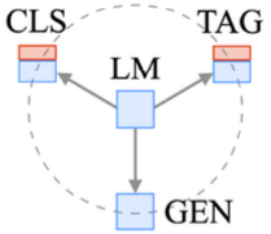
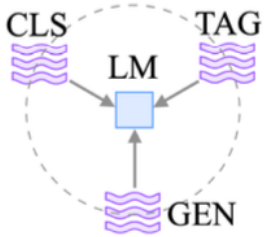


Source: Wayne Xin Zhao, Kun Zhou, Junyi Li, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min et al. (2023) "A Survey of Large Language Models." arXiv preprint arXiv:2303.18223.

Pre-train, Prompt, and Predict: Prompting Methods in Natural Language Processing (LLMs)

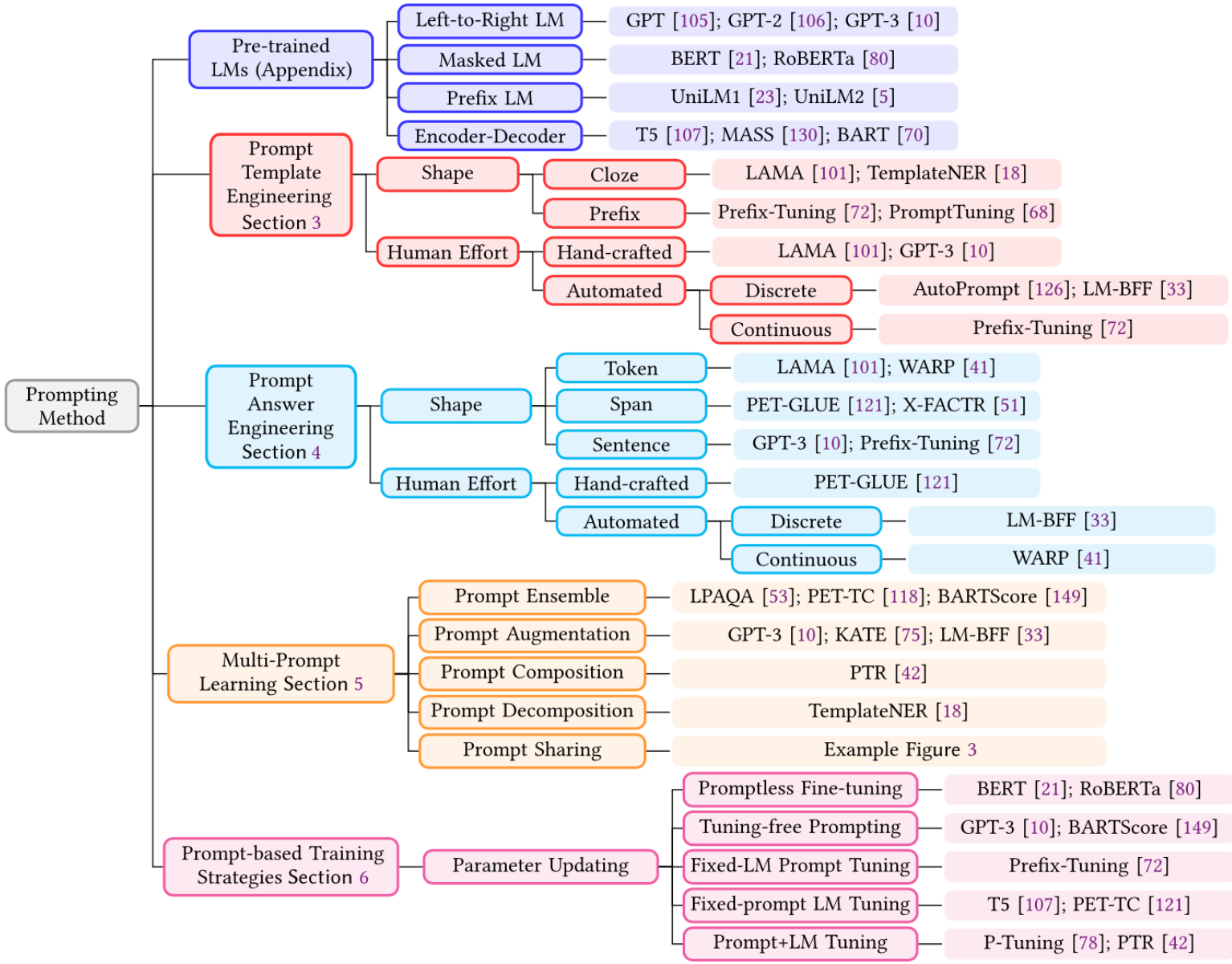
Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

Four Paradigms in NLP

Paradigm	Engineering	Task Relation
a. Fully Supervised Learning (Non-Neural Network)	Feature (e.g. word identity, part-of-speech, sentence length)	
b. Fully Supervised Learning (Neural Network)	Architecture (e.g. convolutional, recurrent, self-attentional)	
c. Pre-train, Fine-tune	Objective (e.g. masked language modeling, next sentence prediction)	
d. Pre-train, Prompt, Predict	Prompt (e.g. cloze, prefix)	

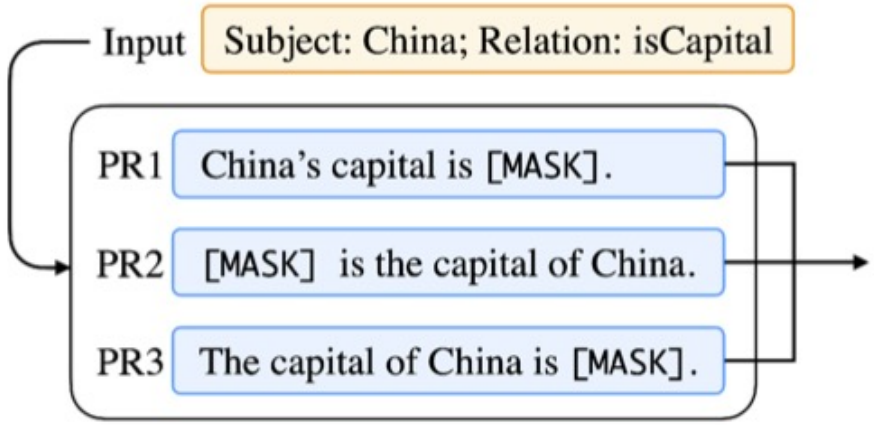
Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

Typology of Prompting Methods

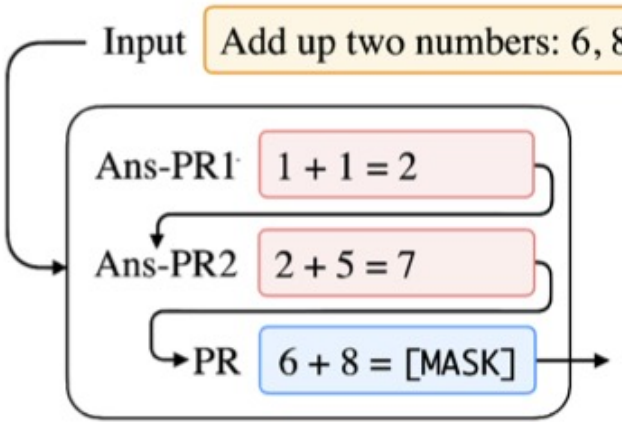


Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

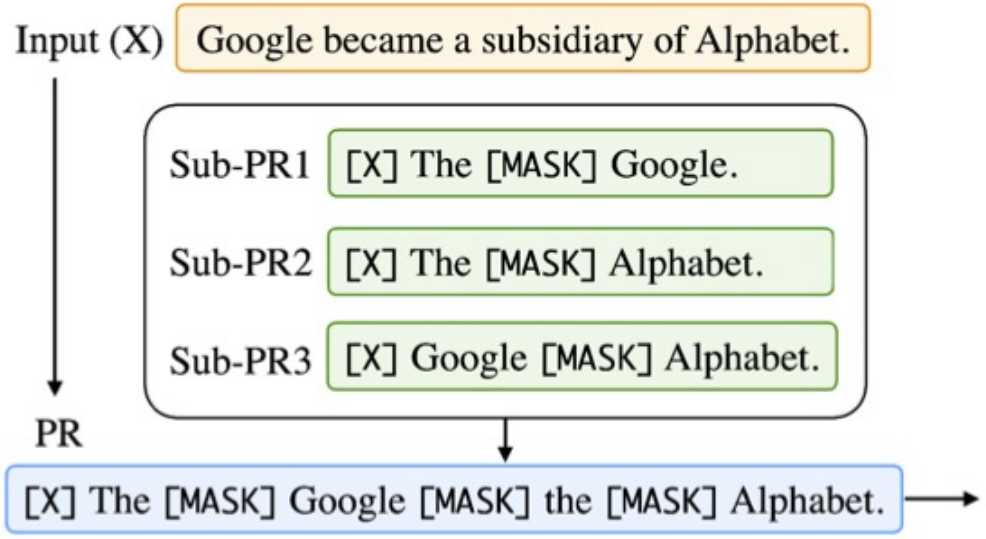
Different Multi-Prompt Learning Strategies



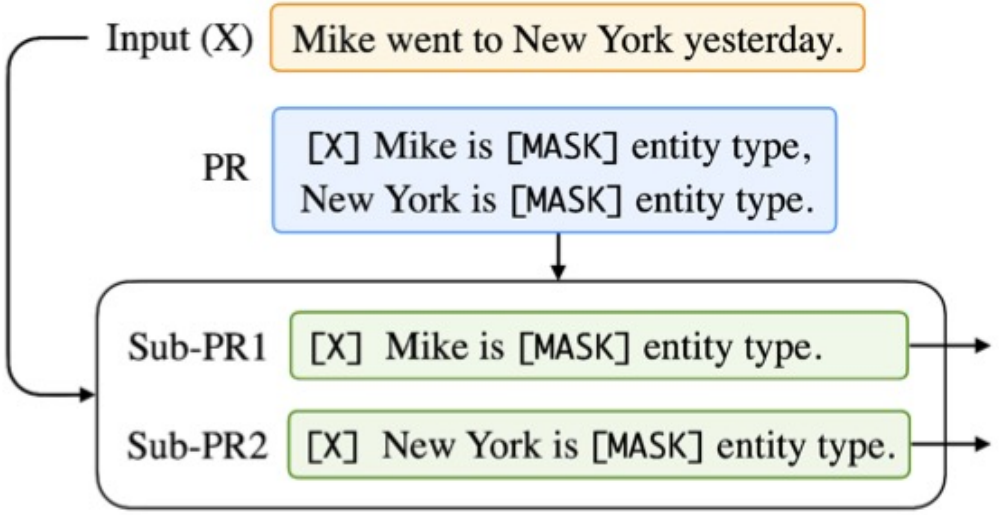
(a) Prompt Ensembling.



(b) Prompt Augmentation.



(c) Prompt Composition.



(d) Prompt Decomposition.

Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

Examples of Input, Template, and Answer for Different Tasks

Type	Task Example	Input ([X])	Template	Answer ([Z])
Text Classification	Sentiment	I love this movie.	[X] The movie is [Z].	great fantastic ...
	Topics	He prompted the LM.	[X] The text is about [Z].	sports science ...
	Intention	What is taxi fare to Denver?	[X] The question is about [Z].	quantity city ...
Text-span Classification	Aspect Sentiment	Poor service but good food.	[X] What about service? [Z].	Bad Terrible ...
Text-pair Classification	Natural Language Inference	[X1]: An old man with ... [X2]: A man walks ...	[X1]? [Z], [X2]	Yes No ...
Tagging	Named Entity Recognition	[X1]: Mike went to Paris. [X2]: Paris	[X1][X2] is a [Z] entity.	organization location ...
Text Generation	Summarization	Las Vegas police ...	[X] TL;DR: [Z]	The victim ... A woman ... ...
	Translation	Je vous aime.	French: [X] English: [Z]	I love you. I fancy you. ...
Regression	Textual Similarity	[X1]: A man is smoking. [X2]: A man is skating.	[X1] [Z], [X2]	Yes No ...

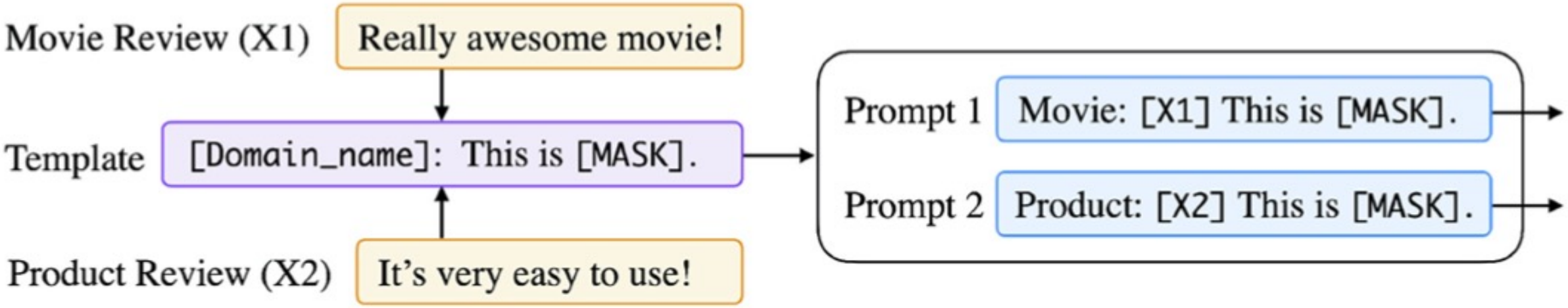
Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

Characteristics of Different Tuning Strategies

Strategy	LM Params	Prompt Params		Example
		Additional	Tuned	
Promptless Fine-tuning	Tuned	–		ELMo [97], BERT [20], BART [69]
Tuning-free Prompting	Frozen	✗	✗	GPT-3 [9], AutoPrompt [125], LAMA [100]
Fixed-LM Prompt Tuning	Frozen	✓	Tuned	Prefix-Tuning [71], Prompt-Tuning [67]
Fixed-prompt LM Tuning	Tuned	✗	✗	PET-TC [117], PET-Gen [118], LM-BFF [32]
Prompt+LM Fine-tuning	Tuned	✓	Tuned	PADA [5], P-Tuning [77], PTR [41]

Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

Multi-prompt Learning for Multi-task, Multi-domain, or Multi-lingual Learning



Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

Reinforcement Learning from Human Feedback (RLHF)

ChatGPT: Optimizing Language Models for Dialogue

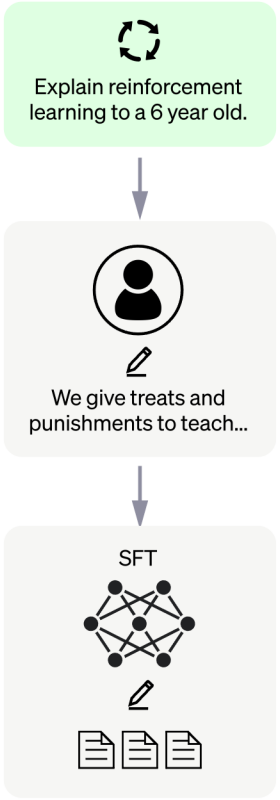
Step 1

Collect demonstration data and train a supervised policy.

A prompt is sampled from our prompt dataset.

A labeler demonstrates the desired output behavior.

This data is used to fine-tune GPT-3.5 with supervised learning.



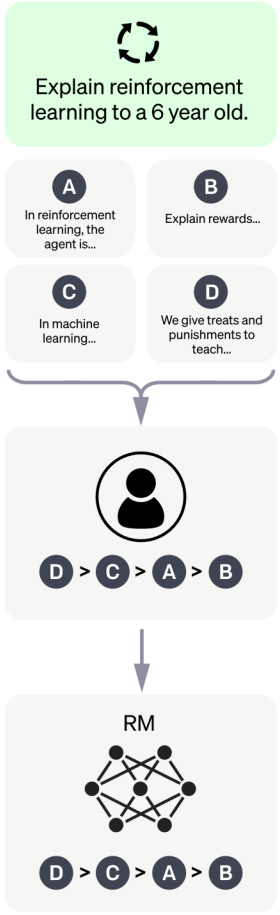
Step 2

Collect comparison data and train a reward model.

A prompt and several model outputs are sampled.

A labeler ranks the outputs from best to worst.

This data is used to train our reward model.



Step 3

Optimize a policy against the reward model using the PPO reinforcement learning algorithm.

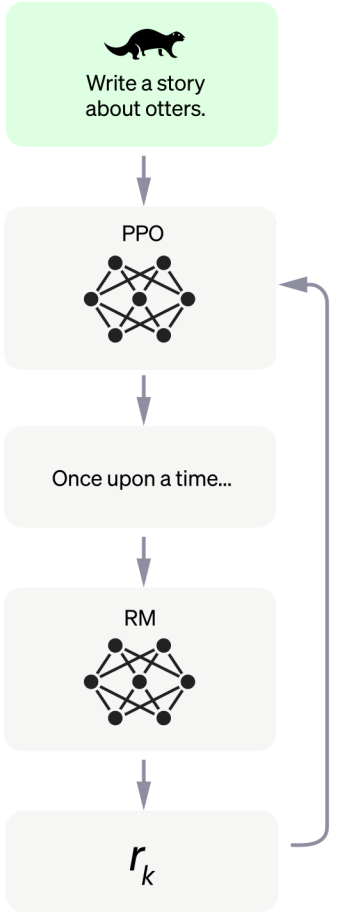
A new prompt is sampled from the dataset.

The PPO model is initialized from the supervised policy.

The policy generates an output.

The reward model calculates a reward for the output.

The reward is used to update the policy using PPO.



Source: https://openai.com/blog/chatgpt/

Training language models to follow instructions with human feedback

InstructGPT and GPT 3.5

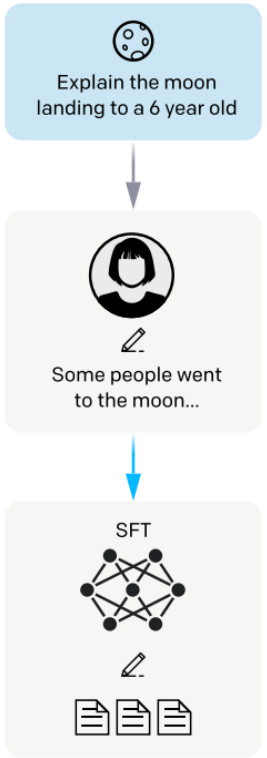
Step 1

Collect demonstration data, and train a supervised policy.

A prompt is sampled from our prompt dataset.

A labeler demonstrates the desired output behavior.

This data is used to fine-tune GPT-3 with supervised learning.



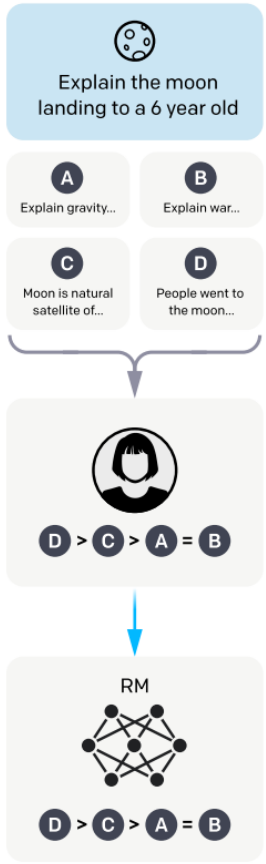
Step 2

Collect comparison data, and train a reward model.

A prompt and several model outputs are sampled.

A labeler ranks the outputs from best to worst.

This data is used to train our reward model.



Step 3

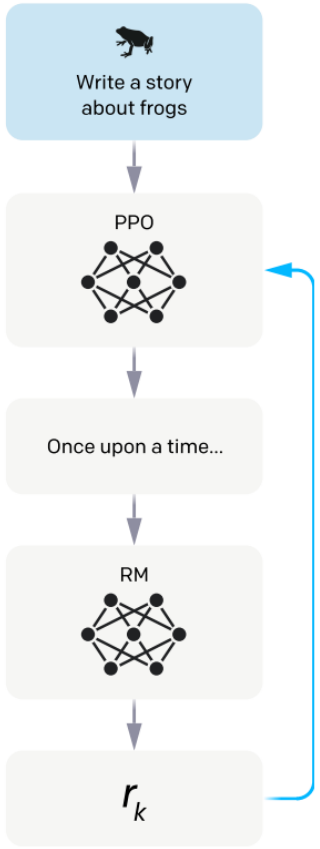
Optimize a policy against the reward model using reinforcement learning.

A new prompt is sampled from the dataset.

The policy generates an output.

The reward model calculates a reward for the output.

The reward is used to update the policy using PPO.



Source: Ouyang, L., Wu, J., Jiang, X., Almeida, D., Wainwright, C. L., Mishkin, P., ... & Lowe, R. (2022). Training language models to follow instructions with human feedback. arXiv preprint arXiv:2203.02155.

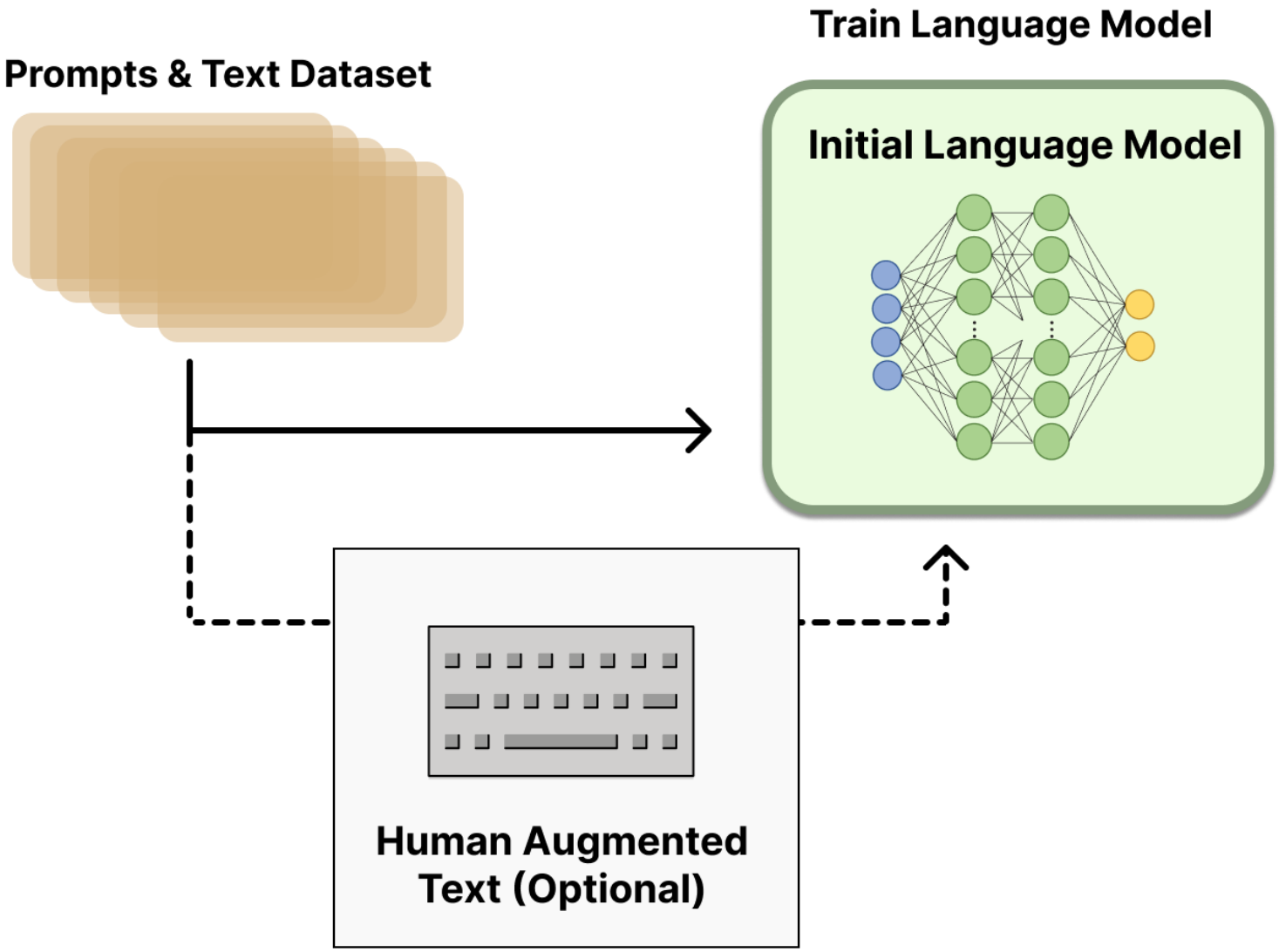
Reinforcement Learning from Human Feedback (RLHF)

1. Pretraining a Language Model (LM)
2. Gathering Data and Training a Reward Model
3. Fine-tuning the LM with Reinforcement Learning

Source: https://huggingface.co/blog/rlhf

Reinforcement Learning from Human Feedback (RLHF)

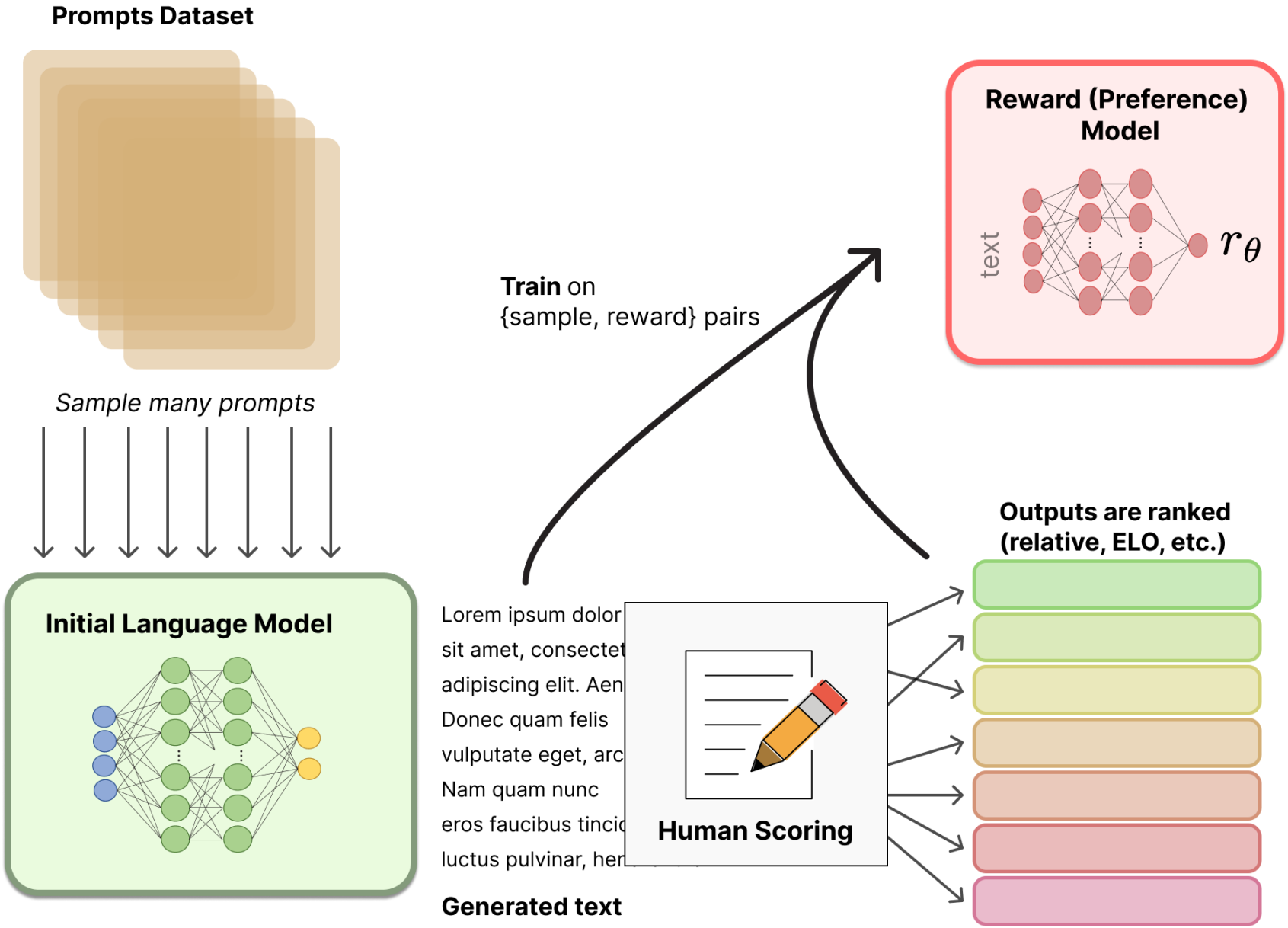
Step 1. Pretraining a Language Model (LM)



Source: https://huggingface.co/blog/rlhf

Reinforcement Learning from Human Feedback (RLHF)

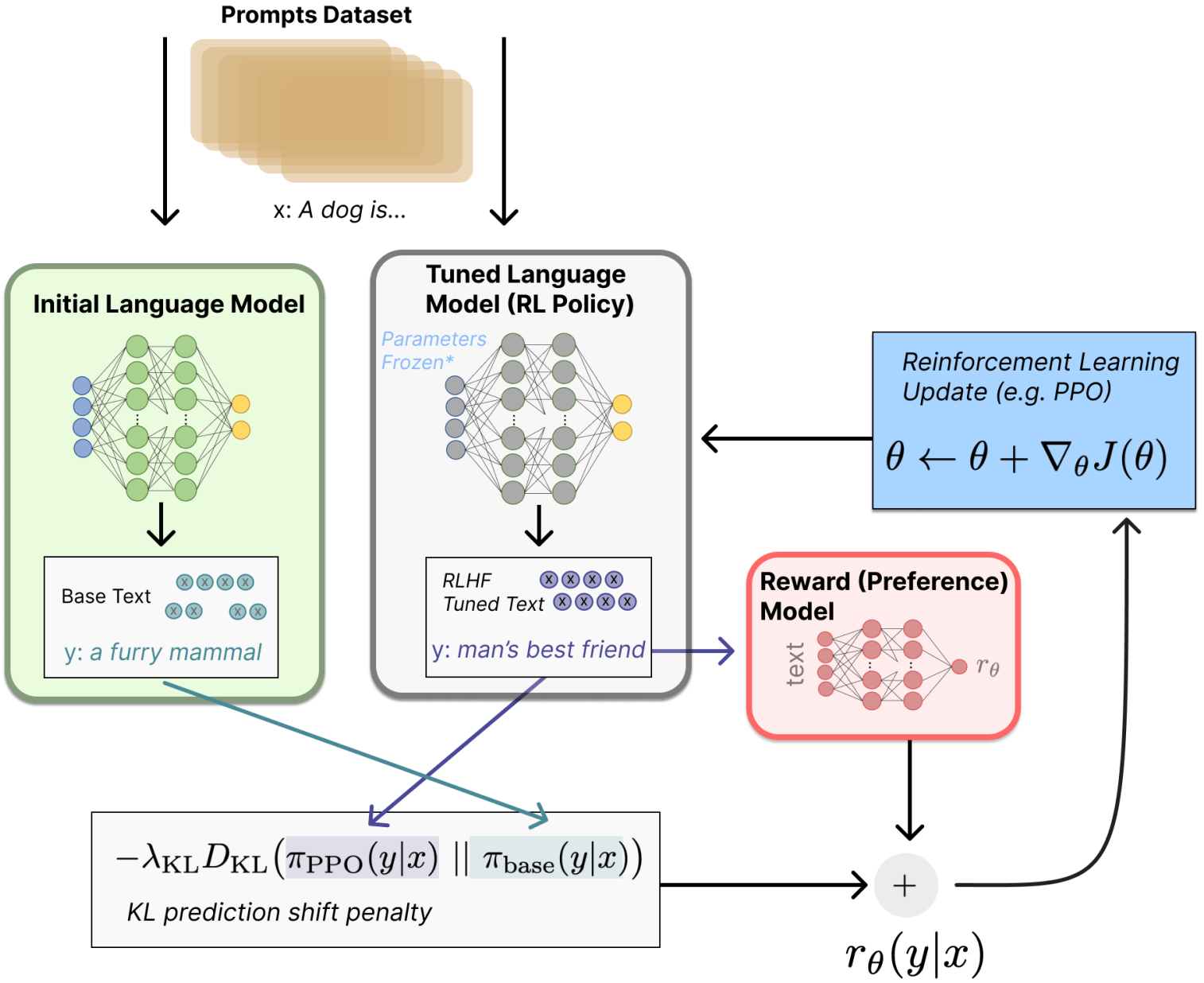
Step 2. Gathering Data and Training a Reward Model



Source: https://huggingface.co/blog/rlhf

Reinforcement Learning from Human Feedback (RLHF)

Step 3. Fine-tuning the LM with Reinforcement Learning



Source: https://huggingface.co/blog/rlhf

Outline

1. 生成式AI的基本概念

   Basic Concepts of Generative AI

2. ChatGPT的基本原理和功能

   Basic Principles and Functions of ChatGPT

3. 生成式AI在永續發展的應用

   Generative AI for ESG and Sustainable Development

4. AI在永續發展上的議題

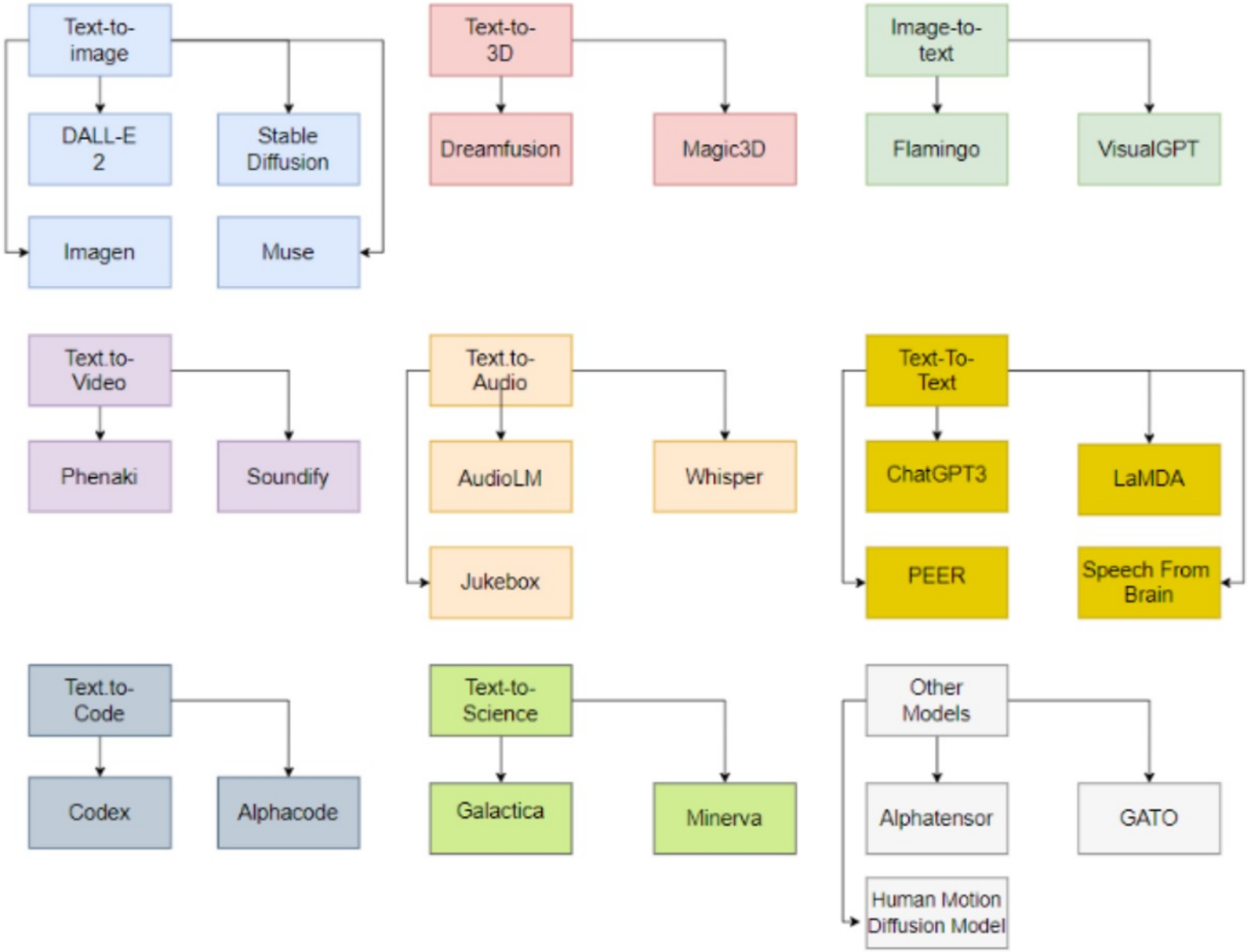
   Issues of AI for Sustainable Development

Generative AI for ESG and Sustainable Development

Generative AI

Text, Image, Video, Audio Applications

Generative AI Models

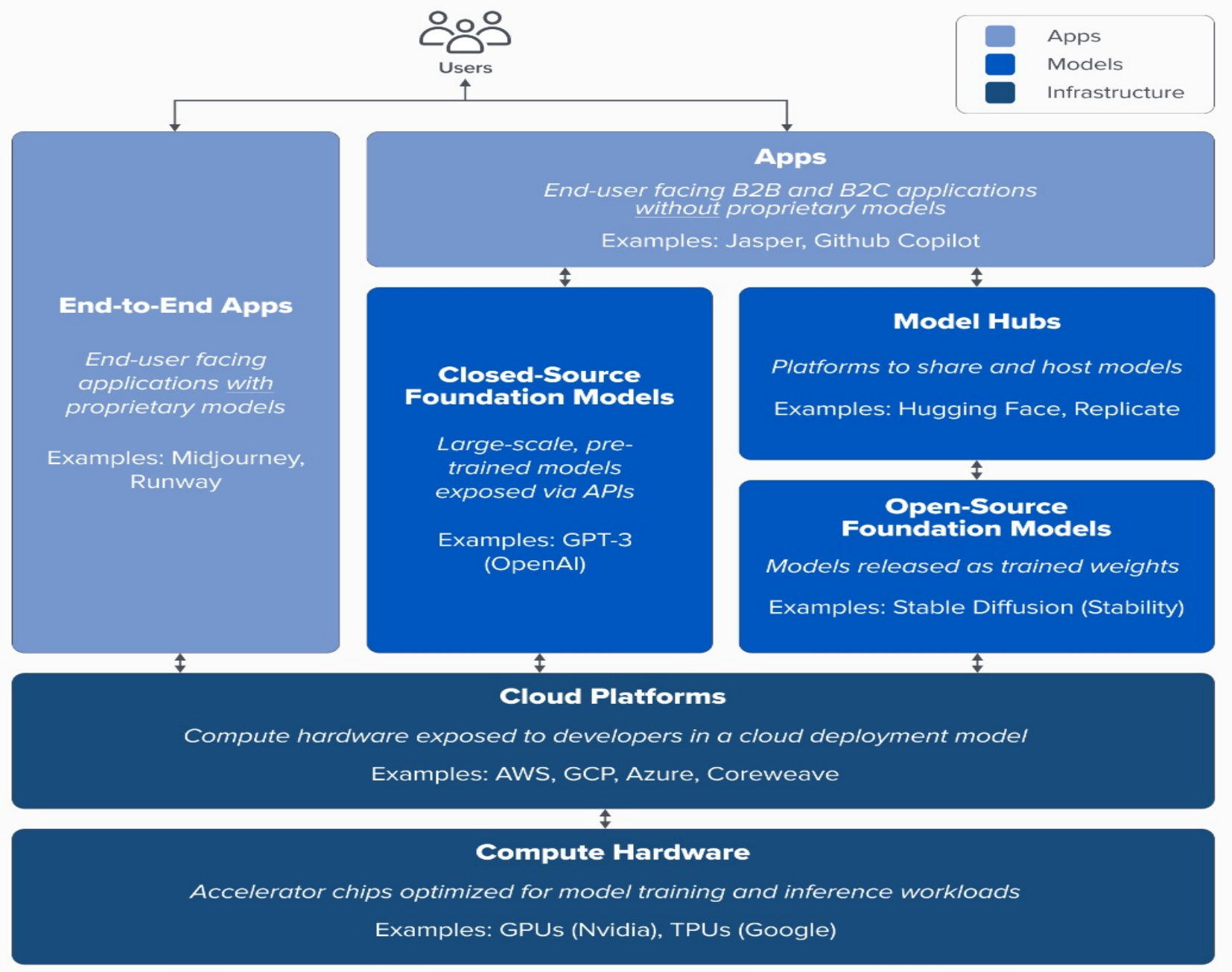


ChatGPT is not all you need

Attention is all you need

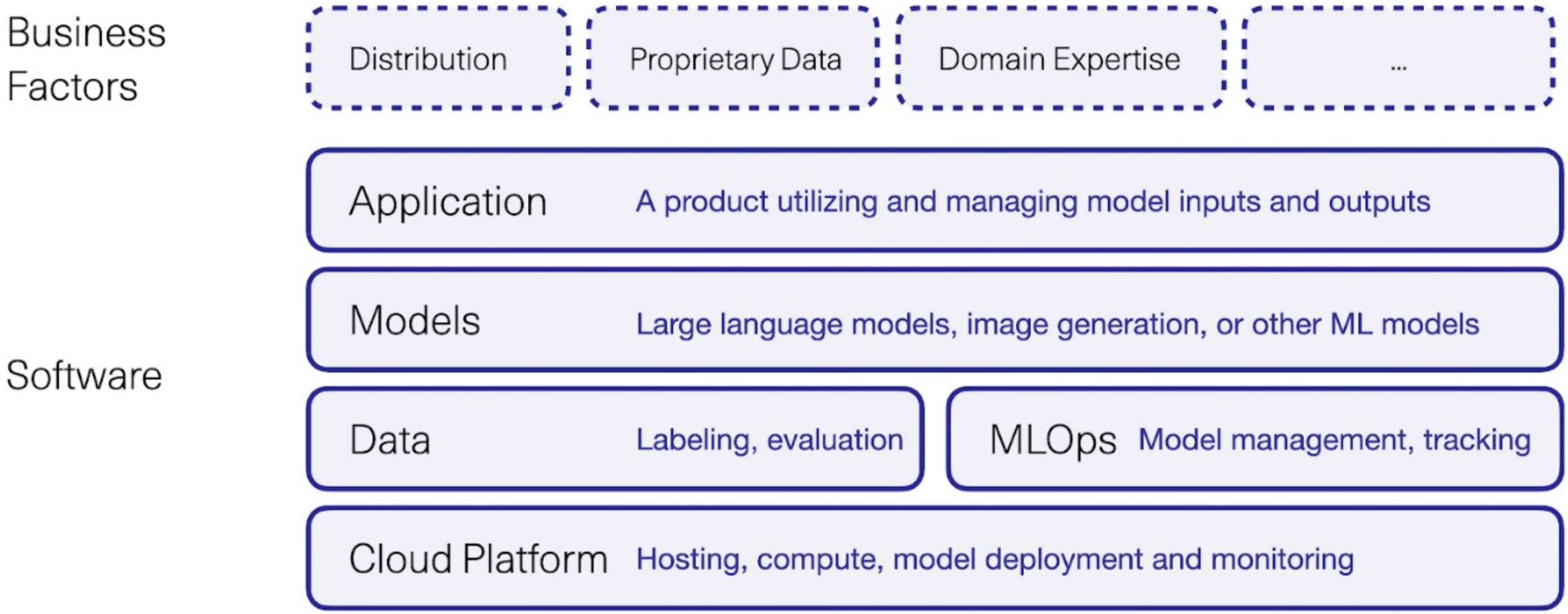
Source: Gozalo-Brizuela, Roberto, and Eduardo C. Garrido-Merchan (2023). "ChatGPT is not all you need. A State of the Art Review of large Generative AI models." arXiv preprint arXiv:2301.04655 (2023).

Generative AI Tech Stack



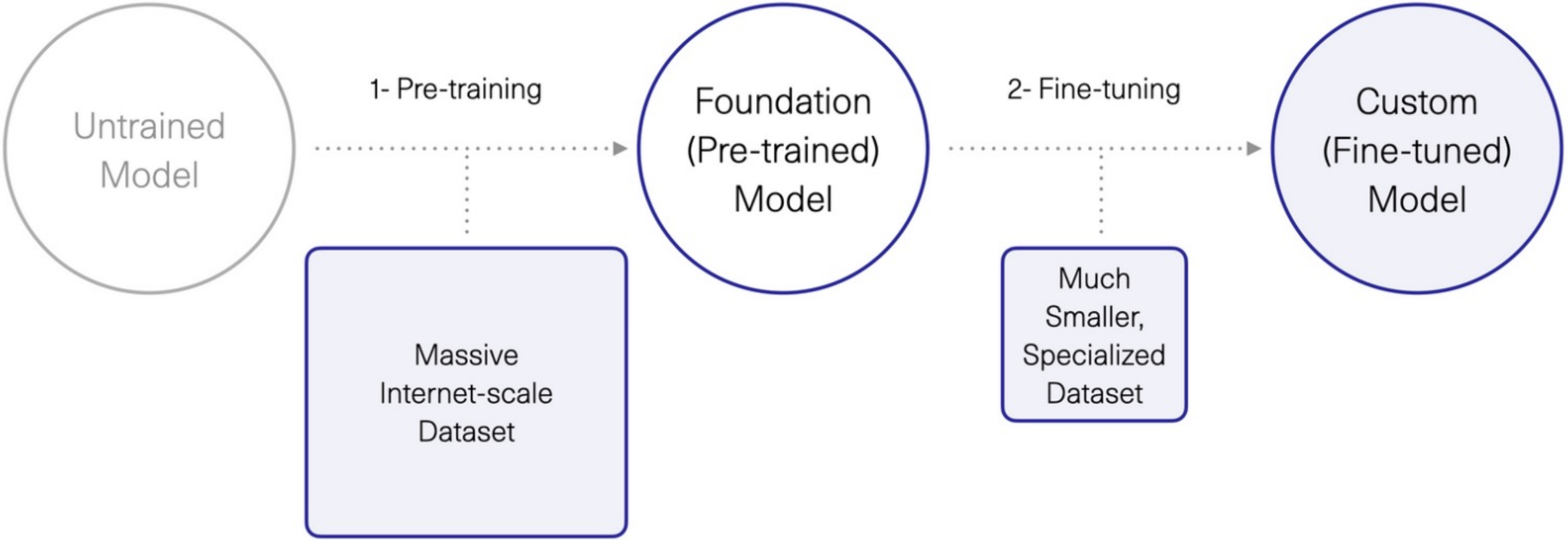
Source: Matt Bornstein, Guido Appenzeller, and Martin Casado (2023), Who Owns the Generative AI Platform?, https://a16z.com/2023/01/19/who-owns-the-generative-ai-platform/

Generative AI Software and Business Factors



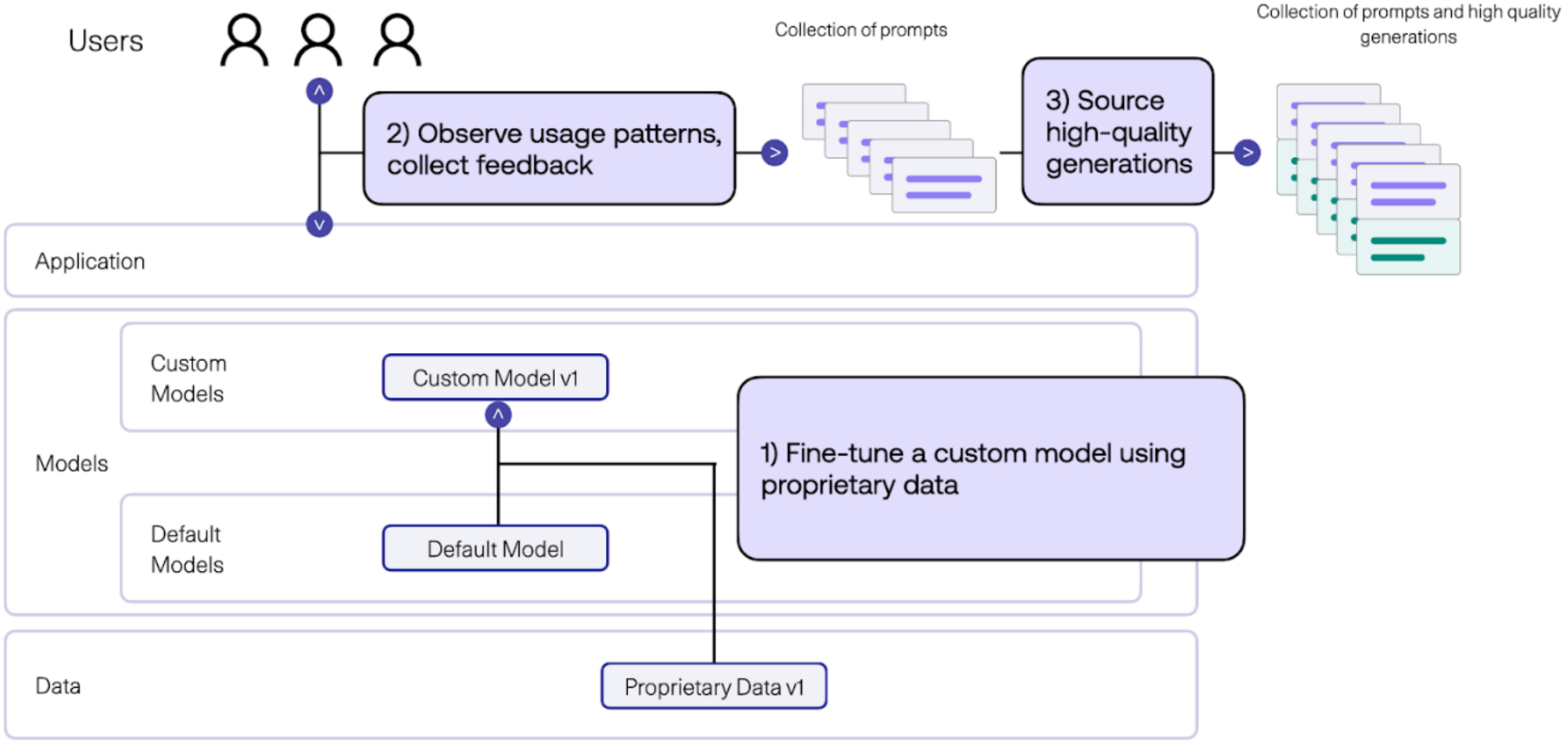
Source: Jay Alammar (2023), AI is Eating The World, https://txt.cohere.com/ai-is-eating-the-world/

Generative AI
1. Pre-training Foundation (Pre-trained) Model
2. Fine-turning Custom (Fine-tuned) Model



Source: Jay Alammar (2023), AI is Eating The World, https://txt.cohere.com/ai-is-eating-the-world/

Generative AI
Fine-tune Custom Models using Proprietary Data



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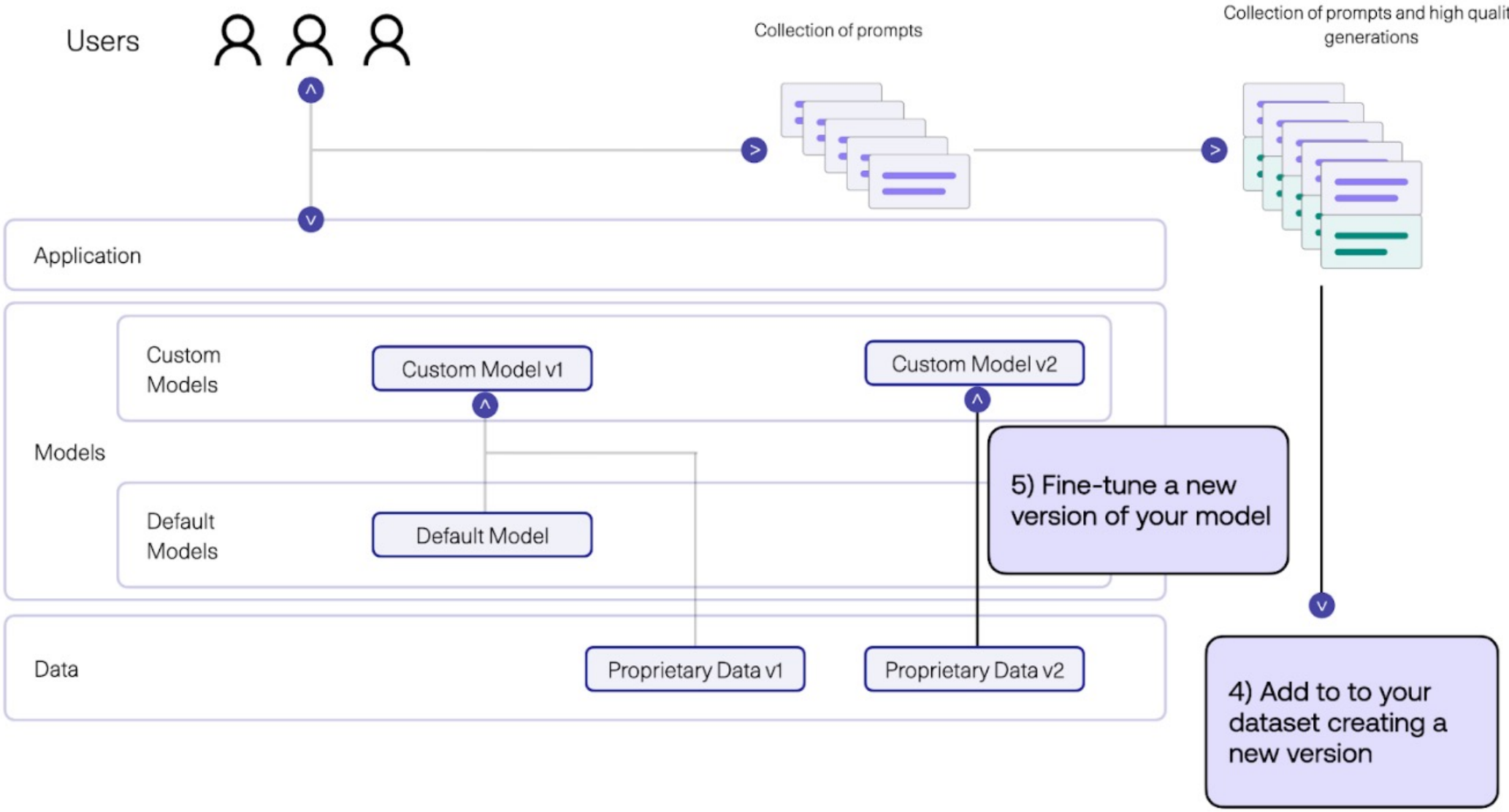
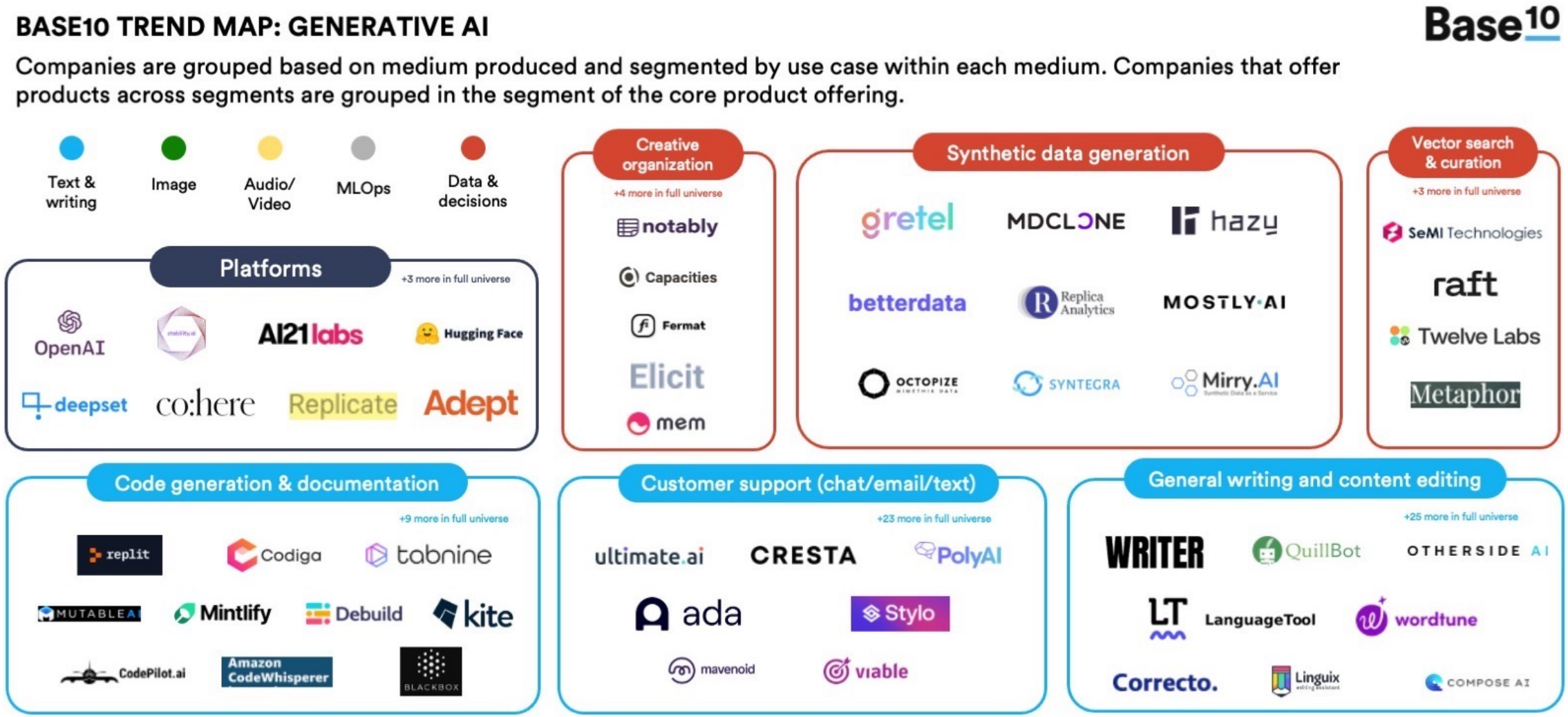
Generative AI
Fine-tune Custom Models using Proprietary Data



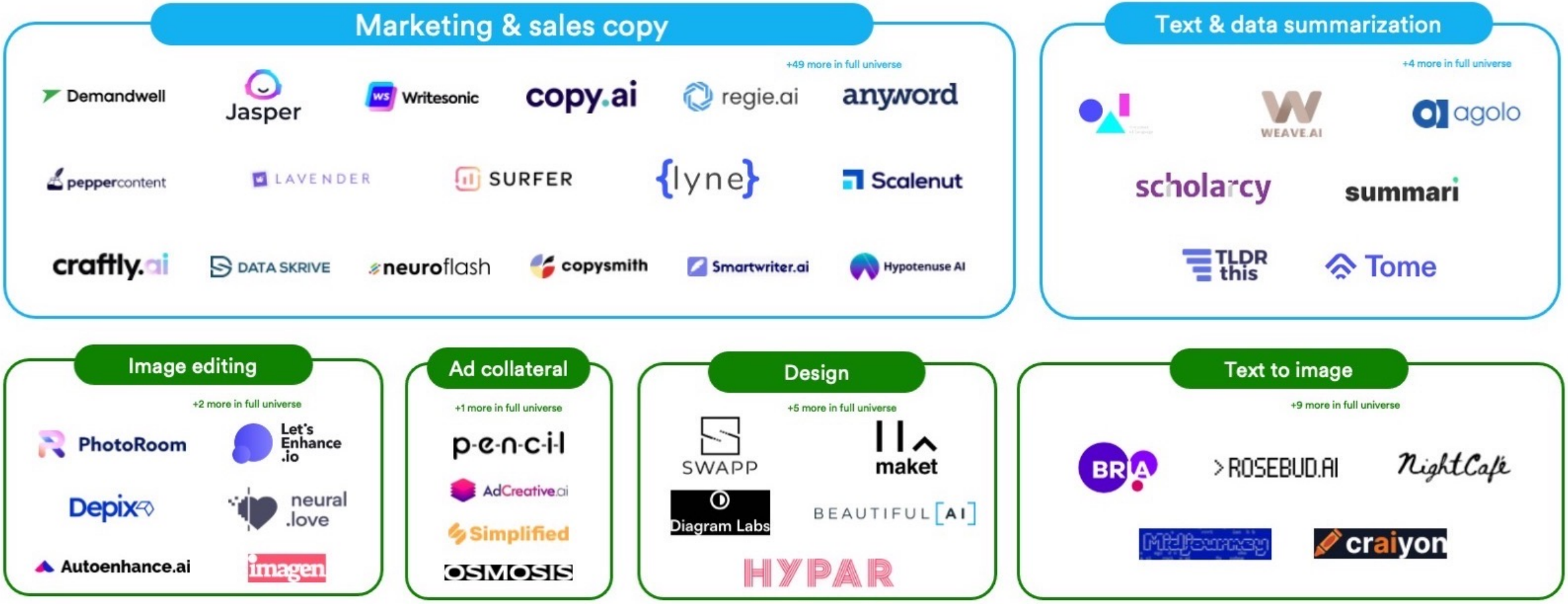
Source: Jay Alammar (2023), AI is Eating The World, https://txt.cohere.com/ai-is-eating-the-world/

Generative AI



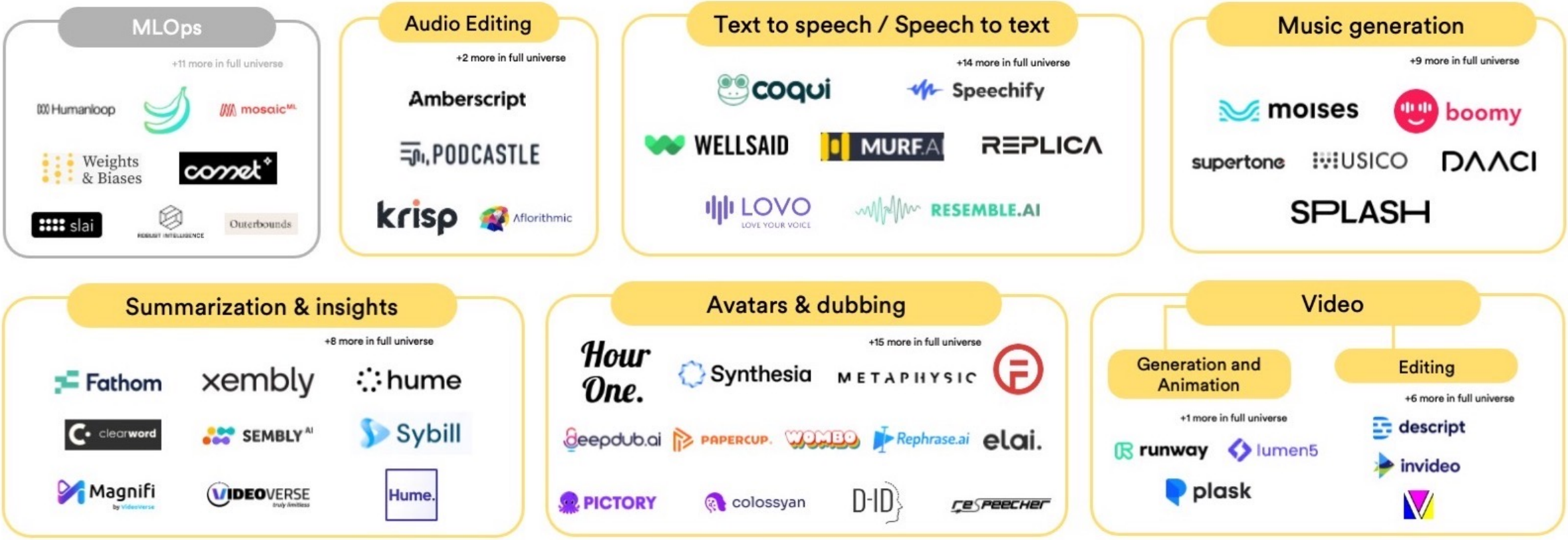
Source: https://base10.vc/post/generative-ai-mission-critical/

Generative AI



Source: https://base10.vc/post/generative-ai-mission-critical/

Generative AI



Source: https://base10.vc/post/generative-ai-mission-critical/

DALL·E 2

Create original, realistic images and art from a text description.
It can combine concepts, attributes, and styles.

TEXT DESCRIPTION

An astronaut Teddy bears A bowl of soup

riding a horse lounging in a tropical resort in space playing basketball with cats in space

in a photorealistic style in the style of Andy Warhol as a pencil drawing

→

DALL·E 2

https://openai.com/dall-e-2/

The Model Structure of DALL-E-2

CLIP Pre-training

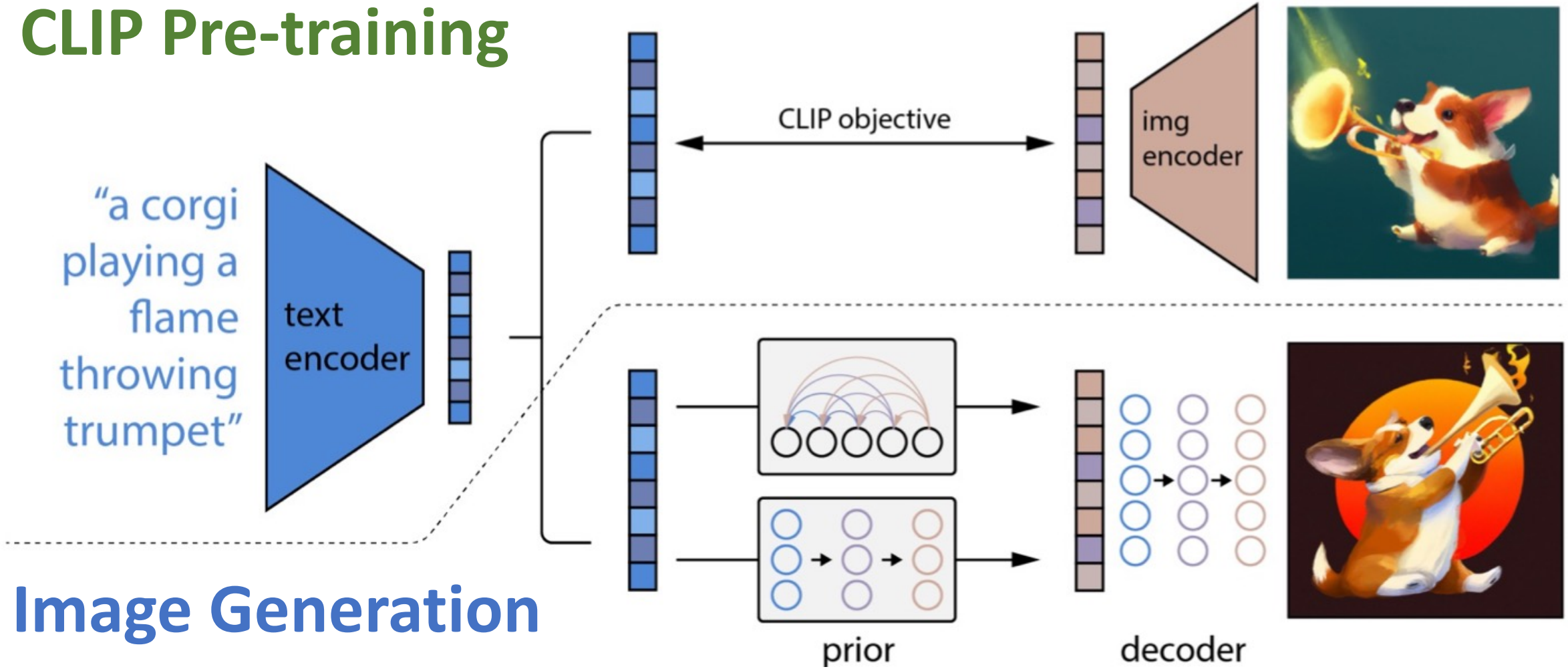


Image Generation

Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

Stable Diffusion

Hugging Face | Search models, datasets, users... | Models | Datasets | Spaces | Docs | Solutions | Pricing

Spaces: stabilityai / stable-diffusion | like 1.89k | Running

App | Files | Community 241 | Linked Models

Stable Diffusion Demo

Stable Diffusion is a state of the art text-to-image model that generates images from text.
For faster generation and forthcoming API access you can try DreamStudio Beta

an insect robot preparing a delicious meal | Generate image

https://huggingface.co/spaces/stabilityai/stable-diffusion

Stable Diffusion Colab

woctezuma / stable-diffusion-colab Public

Notifications | Fork 7 | Star 31

Code | Issues | Pull requests | Actions | Projects | Wiki | Security | Insights

main | 1 branch | 0 tags | Go to file | Code

woctezuma README: add a reference for sampler schedules	37bc02d	24 days ago · 18 commits
LICENSE	Initial commit	27 days ago
README.md	README: add a reference for sampler schedules	24 days ago
stable_diffusion.ipynb	Allow to choose the scheduler	25 days ago

README.md

Stable-Diffusion-Colab

The goal of this repository is to provide a Colab notebook to run the text-to-image "Stable Diffusion" model [1].

Usage

- Run `stable_diffusion.ipynb` . Open in Colab

About

Colab notebook to run Stable Diffusion.

github.com/CompVis/stable-diffusion

deep-learning, colab, image-generation, text-to-image, diffusion, text2image, colaboratory, google-colab, colab-notebook, google-colaboratory, google-colab-notebook, text-to-image-synthesis, huggingface, diffusion-models, text-to-image-generation, latent-diffusion, stable-diffusion, huggingface-diffusers, diffusers, stable-diffusion-diffusers

Readme

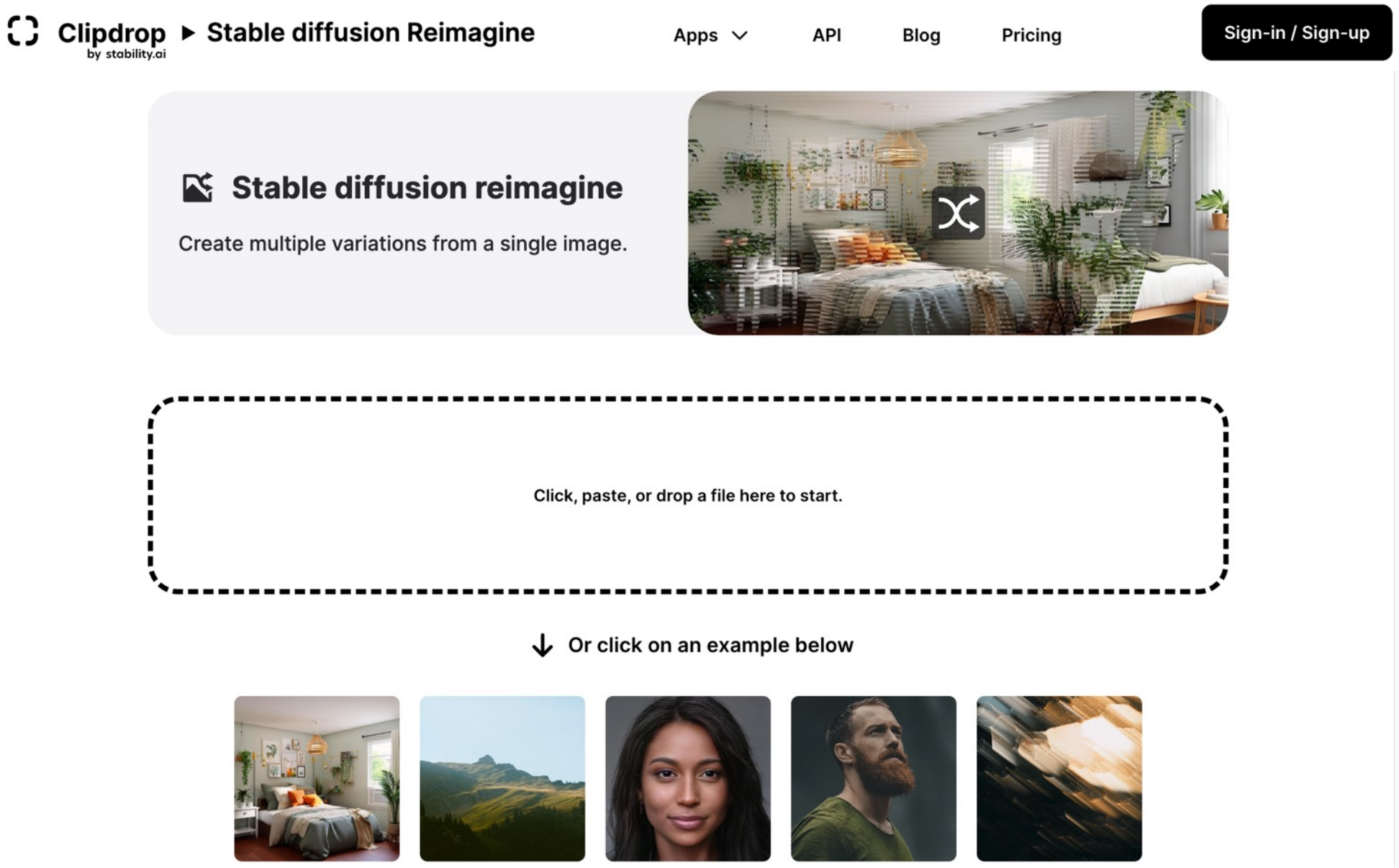
MIT license

31 stars

2 watching

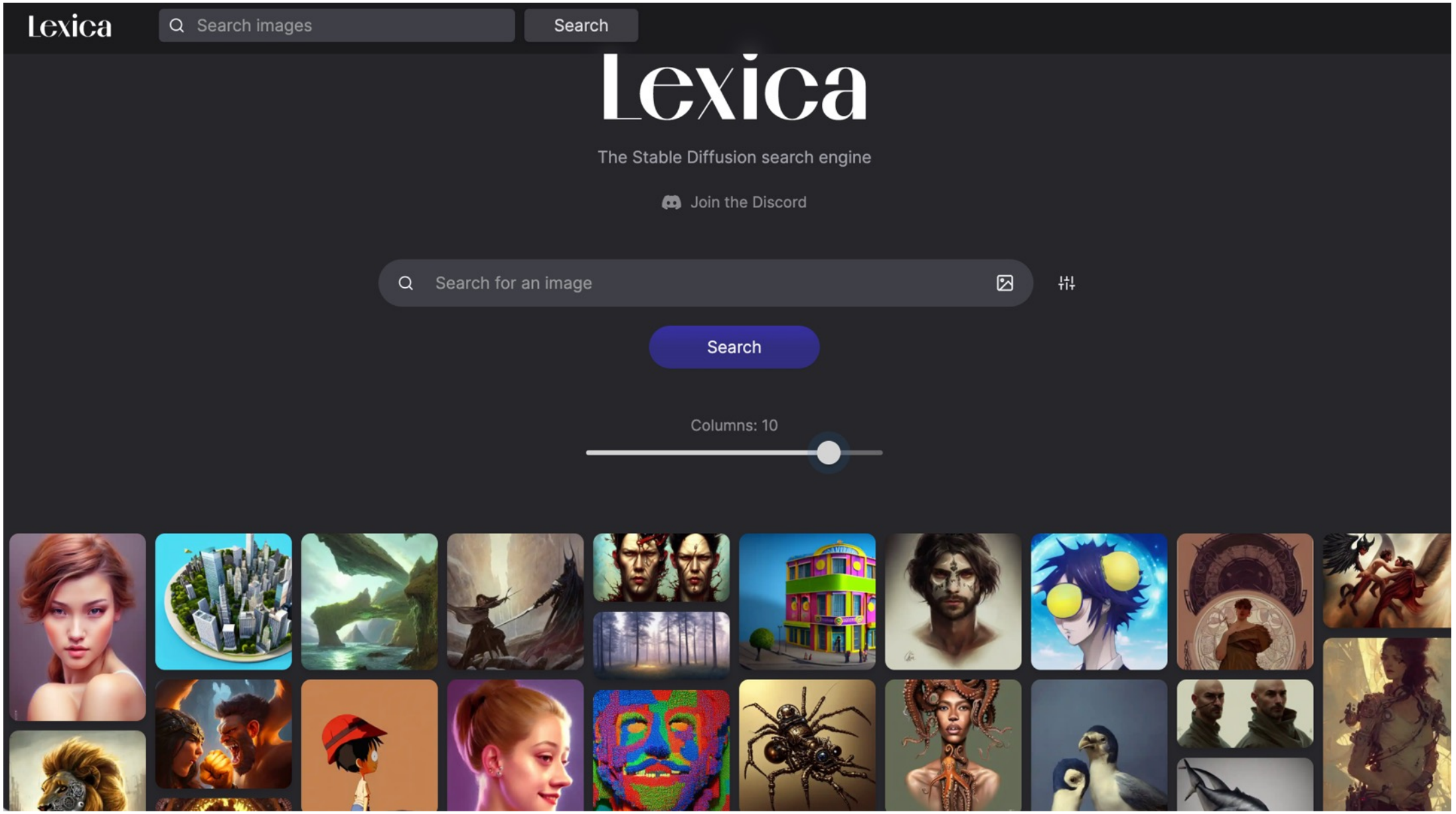
https://github.com/woctezuma/stable-diffusion-colab

Stable Diffusion Reimagine



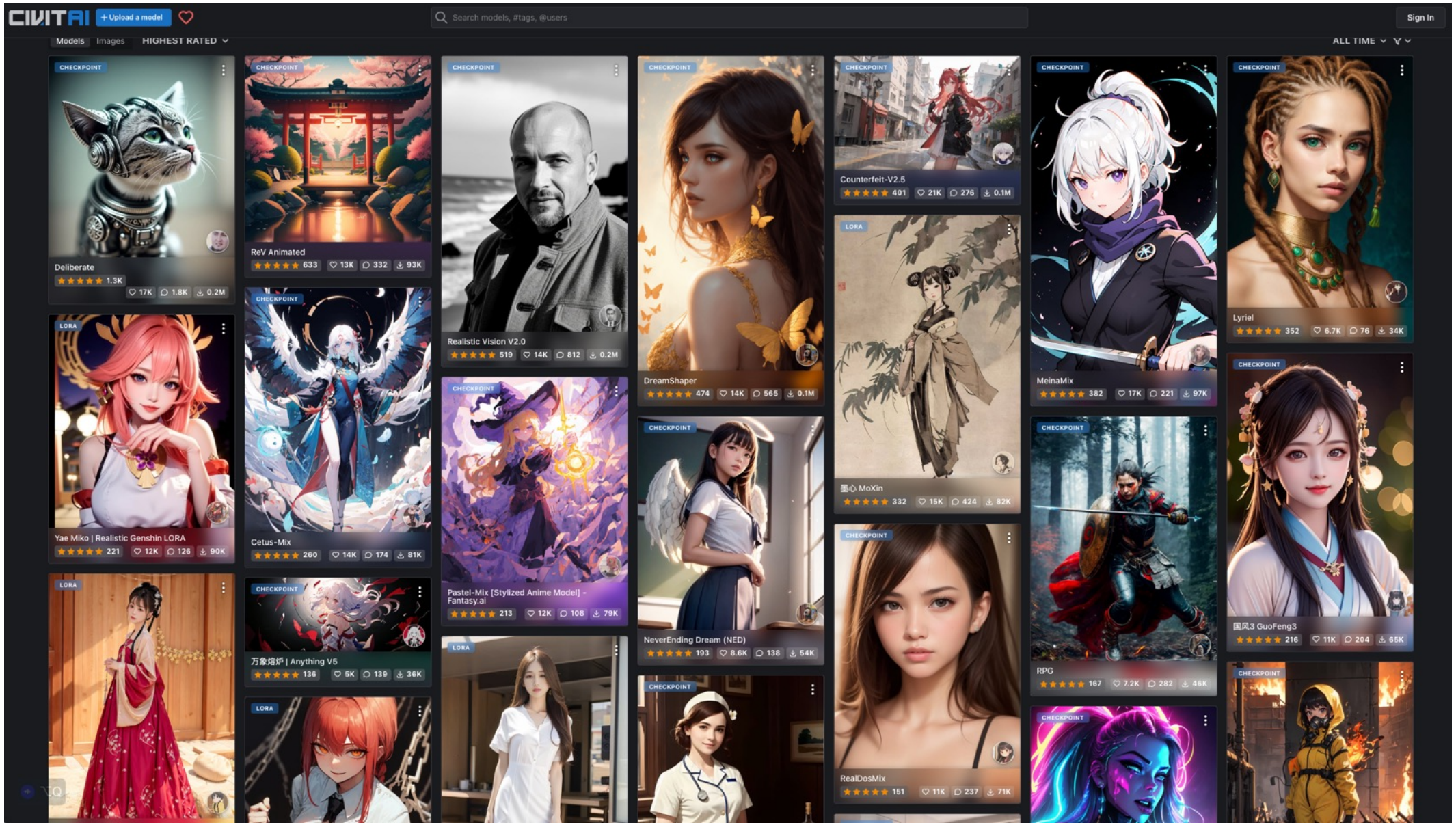
https://clipdrop.co/stable-diffusion-reimagine

Lexica Art: Search Stable Diffusion images and prompts



https://lexica.art/

Civitai: Stable Diffusion AI Art Models



https://civitai.com/

AnyFace: Free-style Text-to-Face Synthesis and Manipulation

AnyFace: Free-style Text-to-Face Synthesis and Manipulation

Jianxin Sun[1,2]*, Qiyao Deng[1,2]*, Qi Li[1,2] †, Muyi Sun[1], Min Ren[1,2], Zhenan Sun[1,2]
[1] Center for Research on Intelligent Perception and Computing, NLPR, CASIA
[2] School of Artificial Intelligence, University of Chinese Academy of Sciences (UCAS)
{jianxin.sun, dengqiyao, muyi.sun, min.ren}@cripac.ia.ac.cn, {qli, znsun}@nlpr.ia.ac.cn

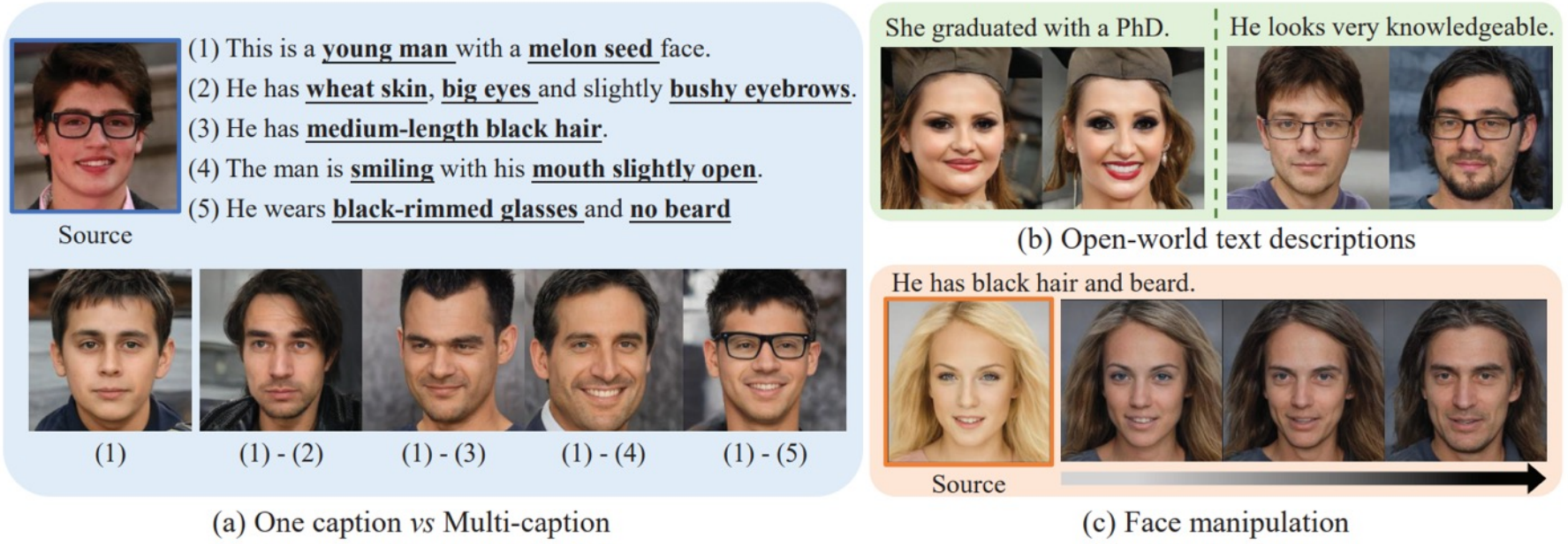
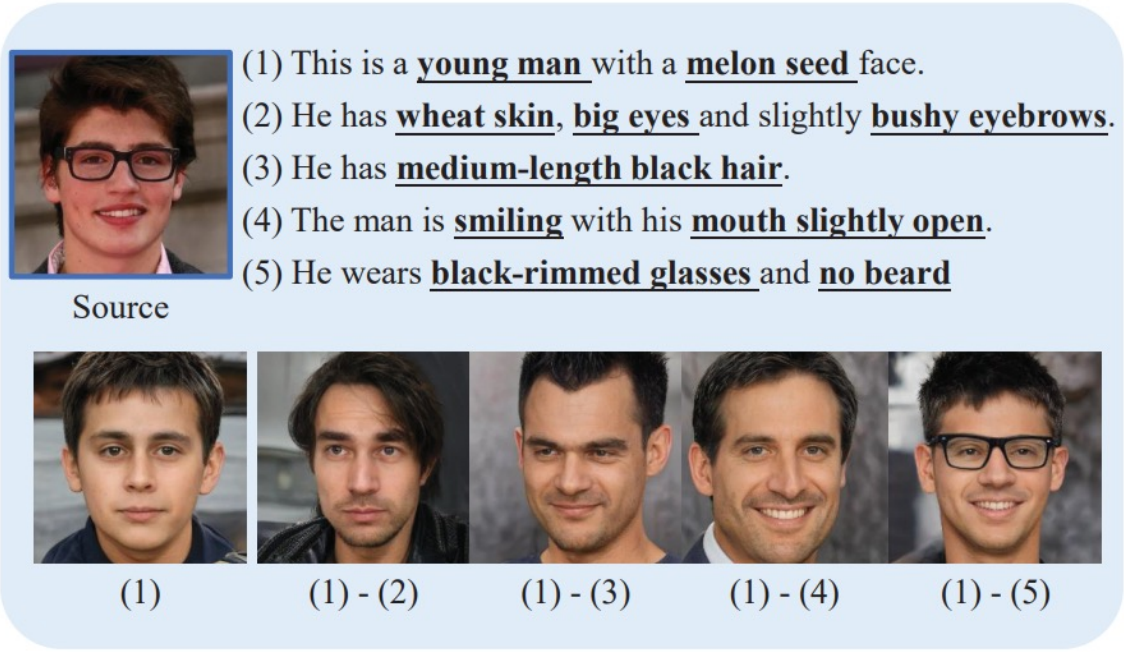


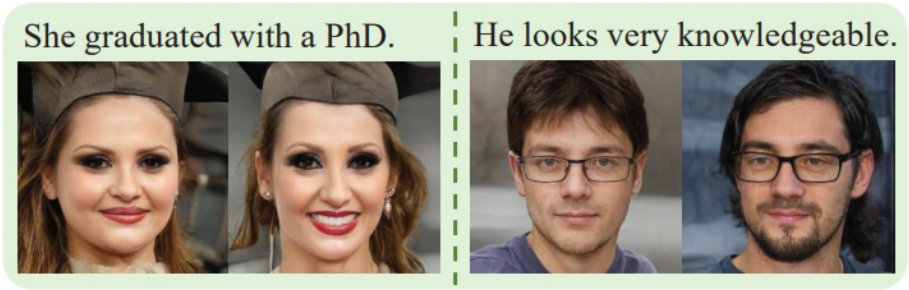
Figure 1. Our AnyFace framework can be used for real-life applications. (a) Face image synthesis with optical captions. The top left is the source face. (b) Open-world face synthesis with out-of-dataset descriptions. (c) Text-guided face manipulation with continuous control. Given source images, AnyFace can manipulate faces with continuous changes. The arrow indicates the increasing relevance to the text.

Source: Sun, Jianxin, Qiyao Deng, Qi Li, Muyi Sun, Min Ren, and Zhenan Sun. (2022) "AnyFace: Free-style Text-to-Face Synthesis and Manipulation." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 18687-18696.

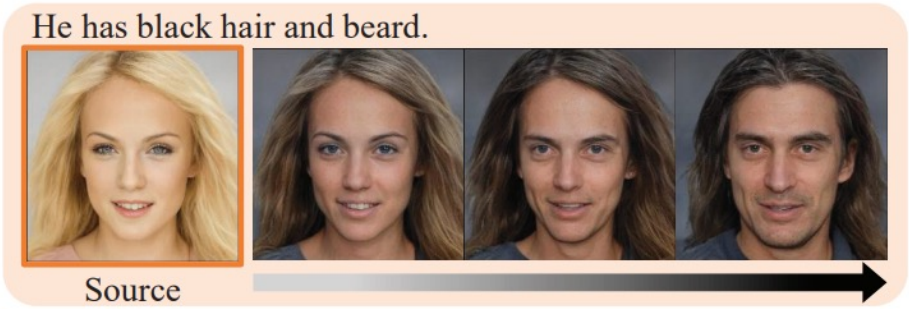
AnyFace: Free-style Text-to-Face Synthesis and Manipulation



(a) One caption *vs* Multi-caption



(b) Open-world text descriptions

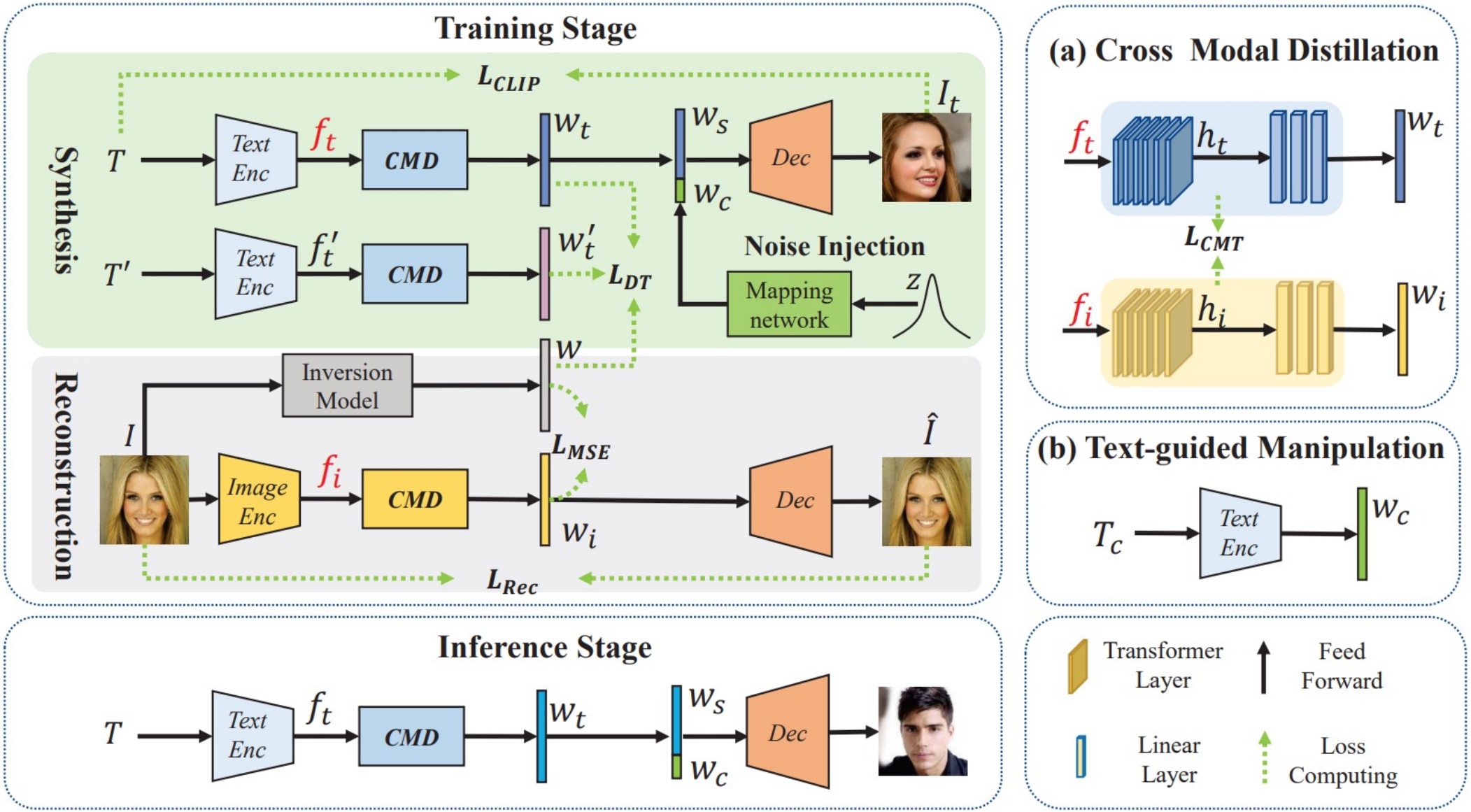


(c) Face manipulation

Methods	AttnGAN [31]	DFGAN [25]	RiFeGAN [1]	SEA-T2F [24]	CIGAN [28]	TediGAN-B [30]	**AnyFace**
Single Model	✓	✓	✓	✓	✓	-	✓
One Generator	-	✓	-	-	✓	✓	✓
Multi-caption	-	-	✓	✓	-	-	✓
High Resolution	-	-	-	-	✓	✓	✓
Manipulation	-	-	-	-	✓	✓	✓
Open-world	-	-	-	-	-	✓	✓

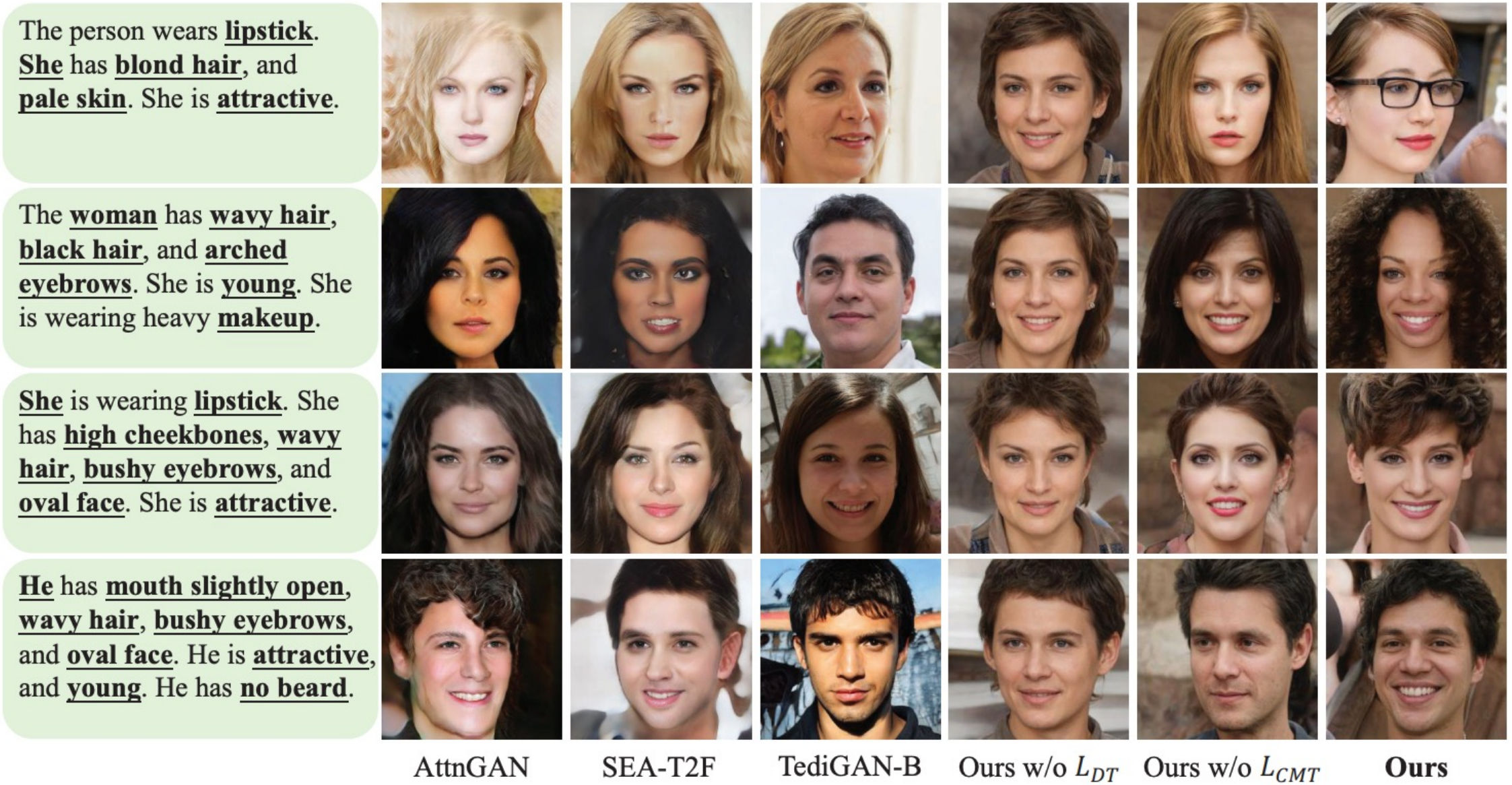
Source: Sun, Jianxin, Qiyao Deng, Qi Li, Muyi Sun, Min Ren, and Zhenan Sun. (2022)
"AnyFace: Free-style Text-to-Face Synthesis and Manipulation." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 18687-18696.

AnyFace: Free-style Text-to-Face Synthesis and Manipulation



Source: Sun, Jianxin, Qiyao Deng, Qi Li, Muyi Sun, Min Ren, and Zhenan Sun. (2022)
"AnyFace: Free-style Text-to-Face Synthesis and Manipulation." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 18687-18696.

AnyFace: Free-style Text-to-Face Synthesis and Manipulation



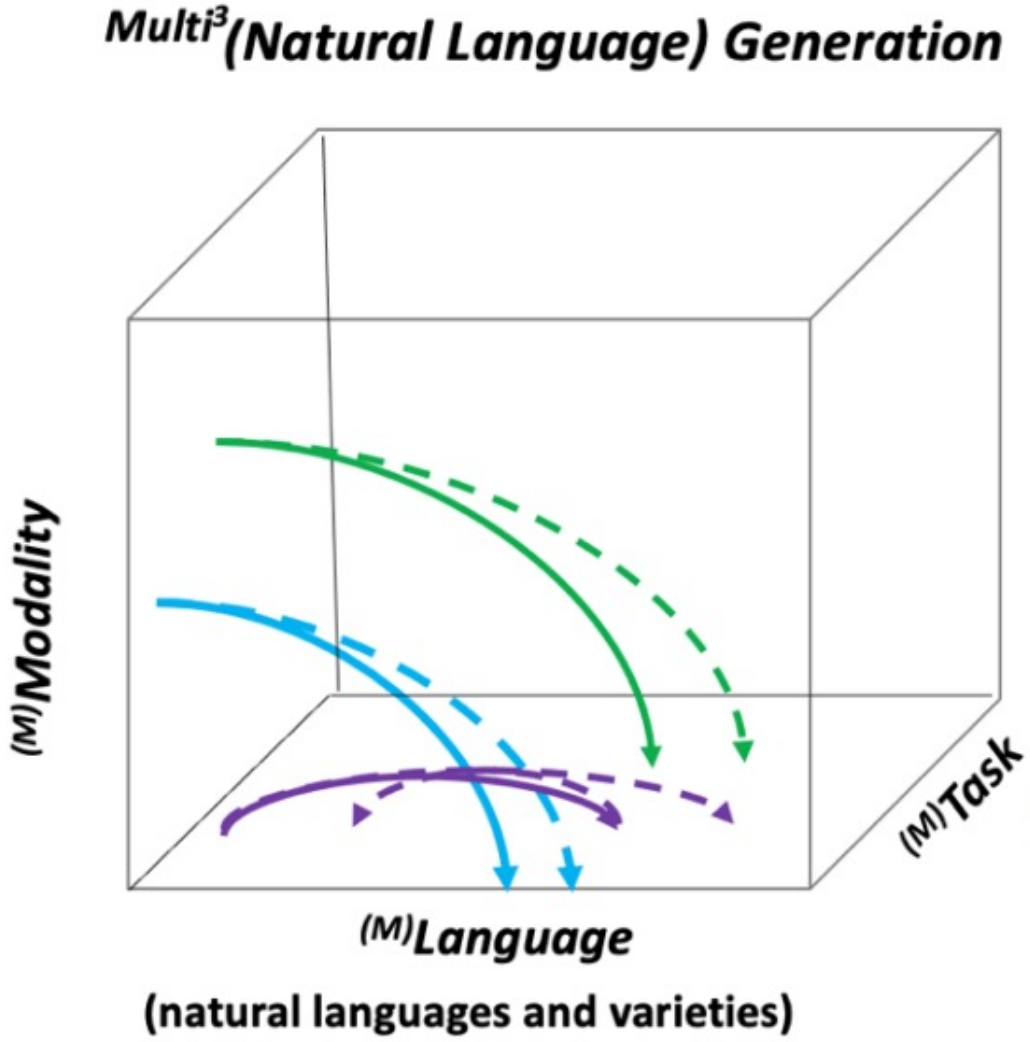
Source: Sun, Jianxin, Qiyao Deng, Qi Li, Muyi Sun, Min Ren, and Zhenan Sun. (2022)
"AnyFace: Free-style Text-to-Face Synthesis and Manipulation." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 18687-18696.

AnyFace: Free-style Text-to-Face Synthesis and Manipulation

Text-guided Face Manipulation

Source: Sun, Jianxin, Qiyao Deng, Qi Li, Muyi Sun, Min Ren, and Zhenan Sun. (2022)
"AnyFace: Free-style Text-to-Face Synthesis and Manipulation." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 18687-18696.

NLG from a Multilingual, Multimodal and Multi-task perspective

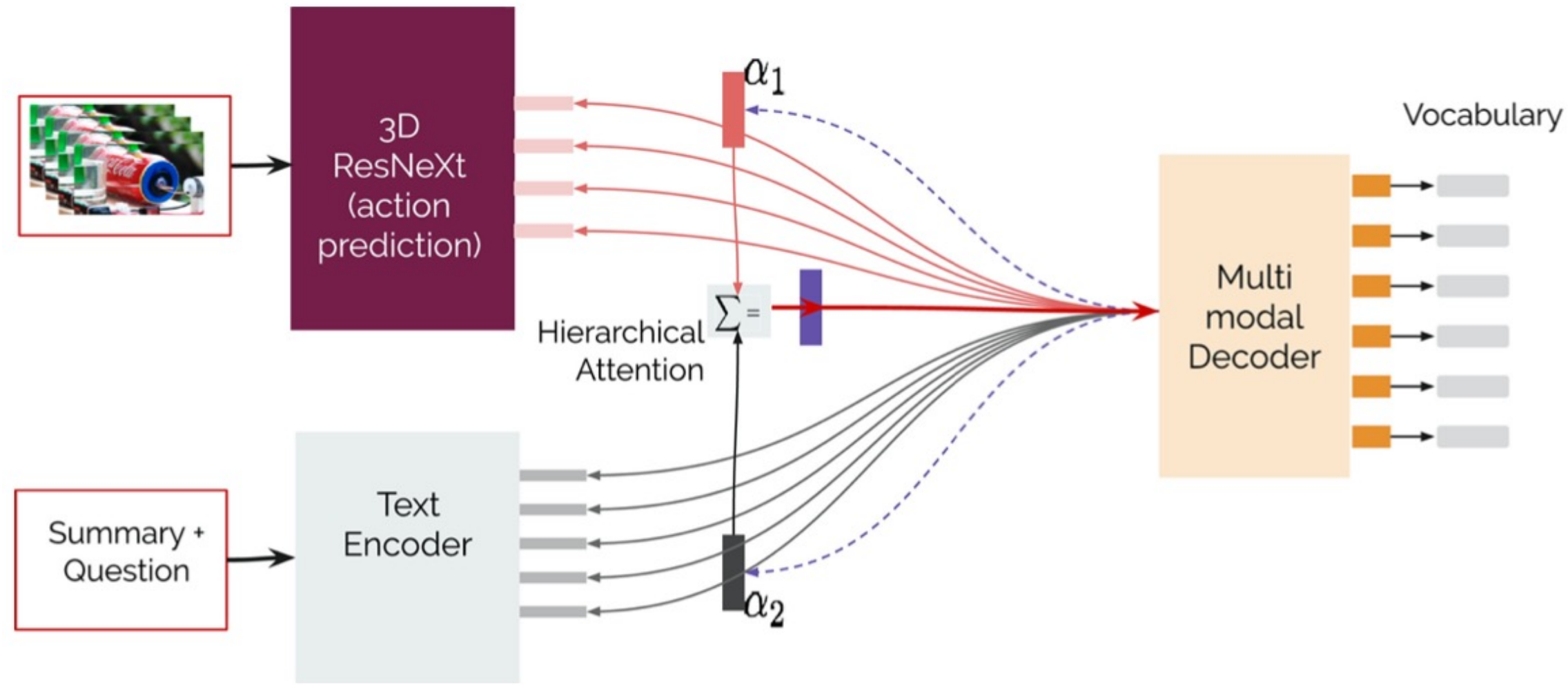


- Text
- Speech
- Vision

- Recognize and transcribe speech (ASR)
- Translate from one language to another (MT)
- Describe, ask or answer questions or converse about visual objects (Captioning, VQA, Visual Dialogue, …)

Source: Erdem, Erkut, Menekse Kuyu, Semih Yagcioglu, Anette Frank, Letitia Parcalabescu, Barbara Plank, Andrii Babii et al. "Neural Natural Language Generation: A Survey on Multilinguality, Multimodality, Controllability and Learning." Journal of Artificial Intelligence Research 73 (2022): 1131-1207.

Text-and-Video Dialog Generation Models with Hierarchical Attention



Source: Erdem, Erkut, Menekse Kuyu, Semih Yagcioglu, Anette Frank, Letitia Parcalabescu, Barbara Plank, Andrii Babii et al. "Neural Natural Language Generation: A Survey on Multilinguality, Multimodality, Controllability and Learning." Journal of Artificial Intelligence Research 73 (2022): 1131-1207.

Multimodal Few-Shot Learning with Frozen Language Models

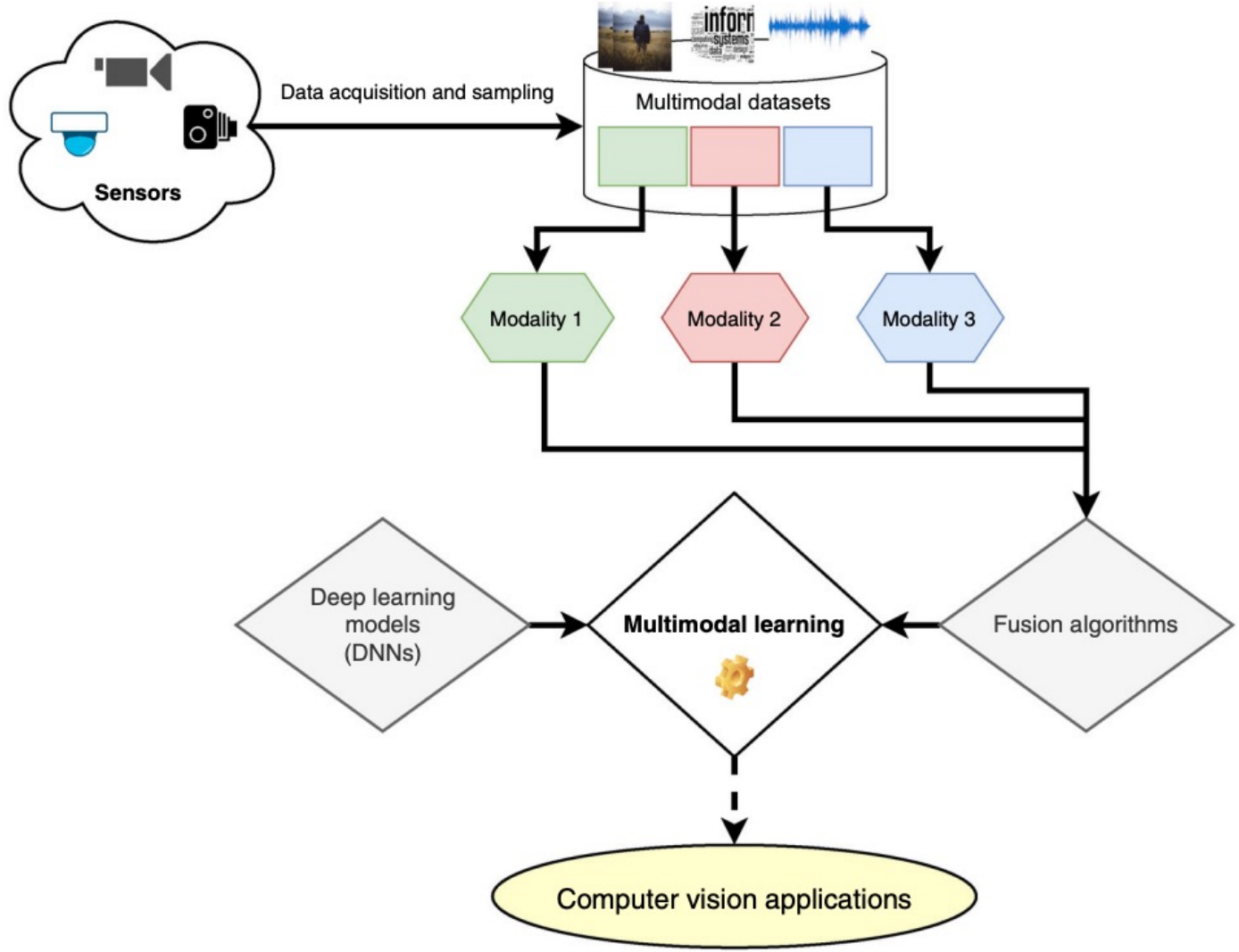
Curated samples with about five seeds required to get past well-known language model failure modes of either repeating text for the prompt or emitting text that does not pertain to the image.

These samples demonstrate the ability to generate open-ended outputs that adapt to both images and text, and to make use of facts that it has learned during language-only pre-training.

Source: Maria Tsimpoukelli, Jacob L. Menick, Serkan Cabi, S. M. Eslami, Oriol Vinyals, and Felix Hill (2021). "Multimodal few-shot learning with frozen language models." Advances in Neural Information Processing Systems 34 (2021): 200-212.

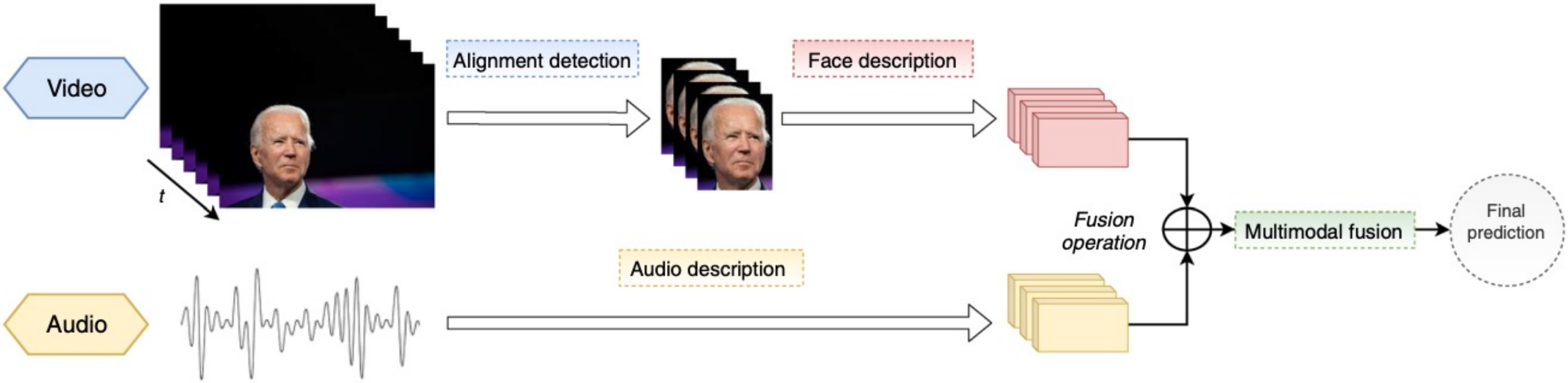
Multimodal Pipeline

that includes three different modalities (Image, Text. Audio)



Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).
"A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets." The Visual Computer 38, no. 8: 2939-2970.

Video and Audio Multimodal Fusion

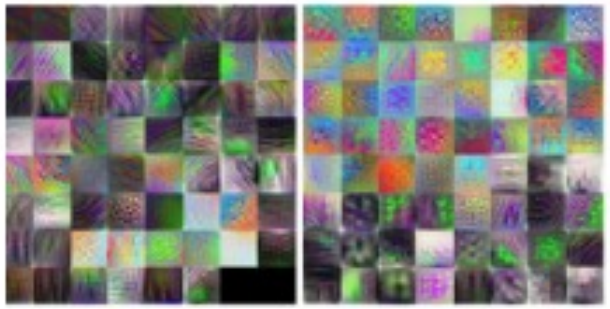


Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).
"A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets." The Visual Computer 38, no. 8: 2939-2970.

Visual and Textual Representation

Image

Visual representations (Dense)



Text

This is the oldest and most important defensive work to have been built along the North African coastline by the Arab conquerors in the early days of Islam. Founded in 796, this building underwent several modifications during the medieval period. Initially, it formed a quadrilateral and then was composed of four buildings giving onto two inner courtyards.

Textual representations (Sparse)

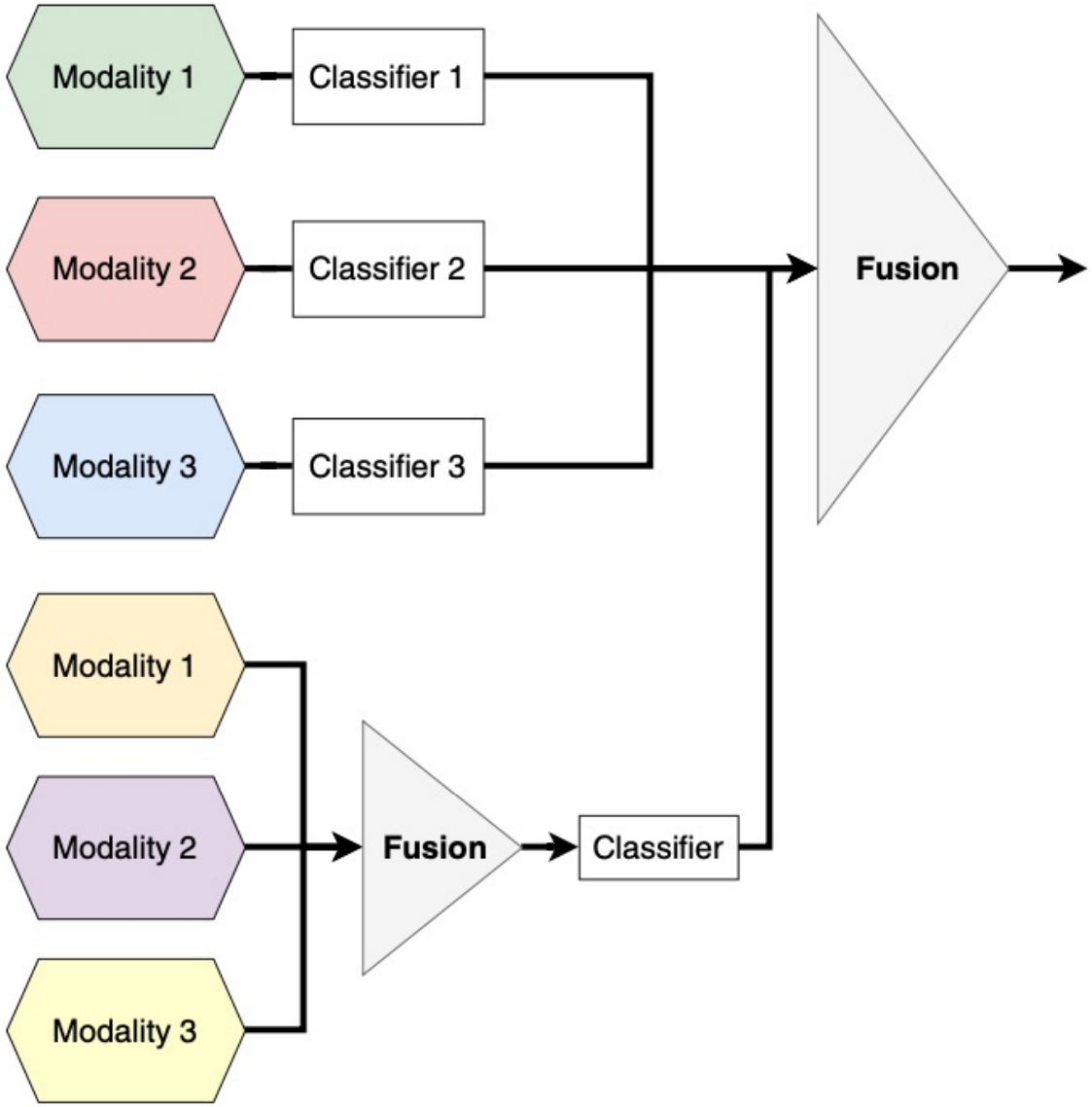
Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).
"A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets." The Visual Computer 38, no. 8: 2939-2970.

Hybrid Multimodal Data Fusion

Text

Audio

Image



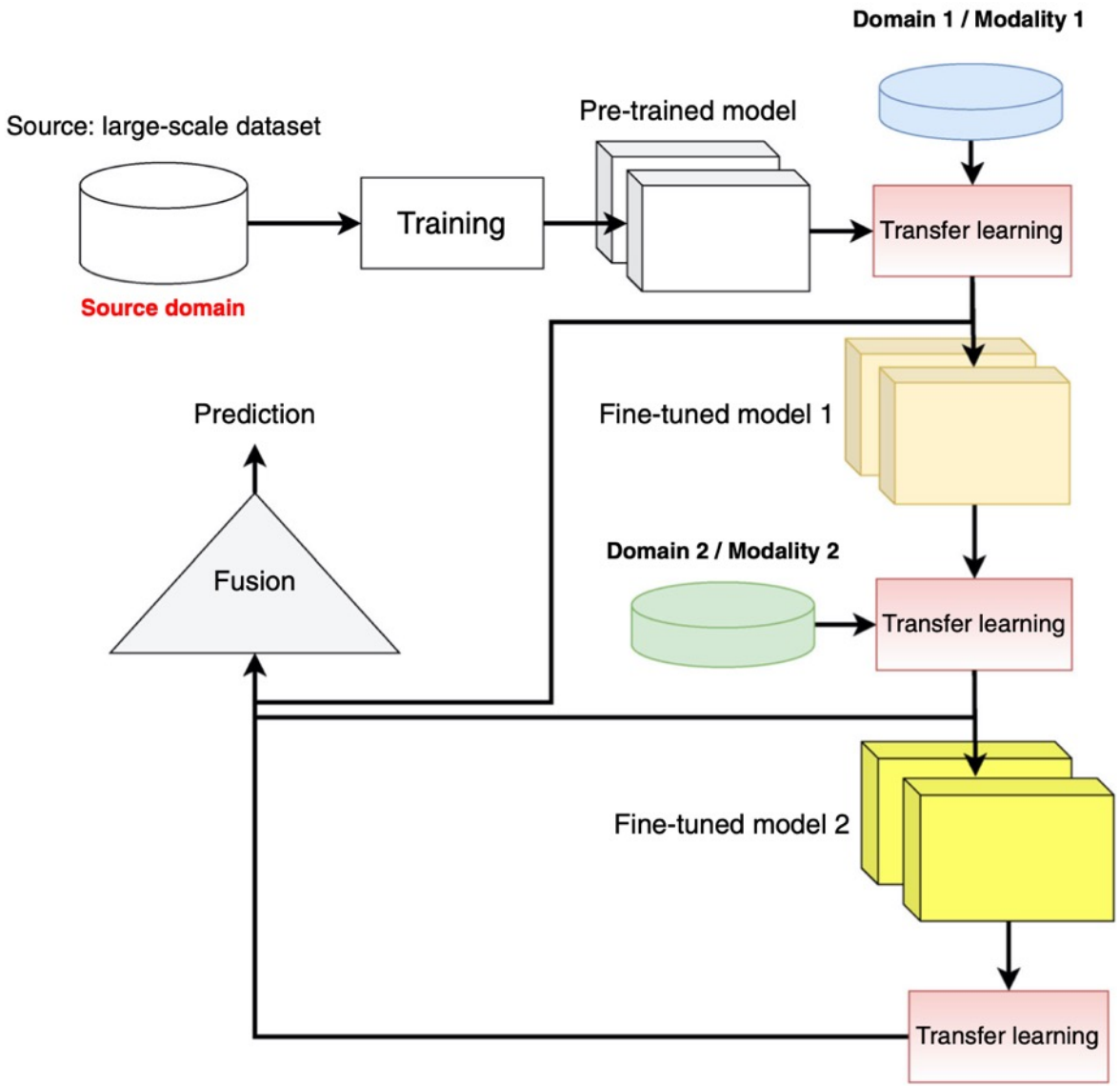
Text

Speech

Video

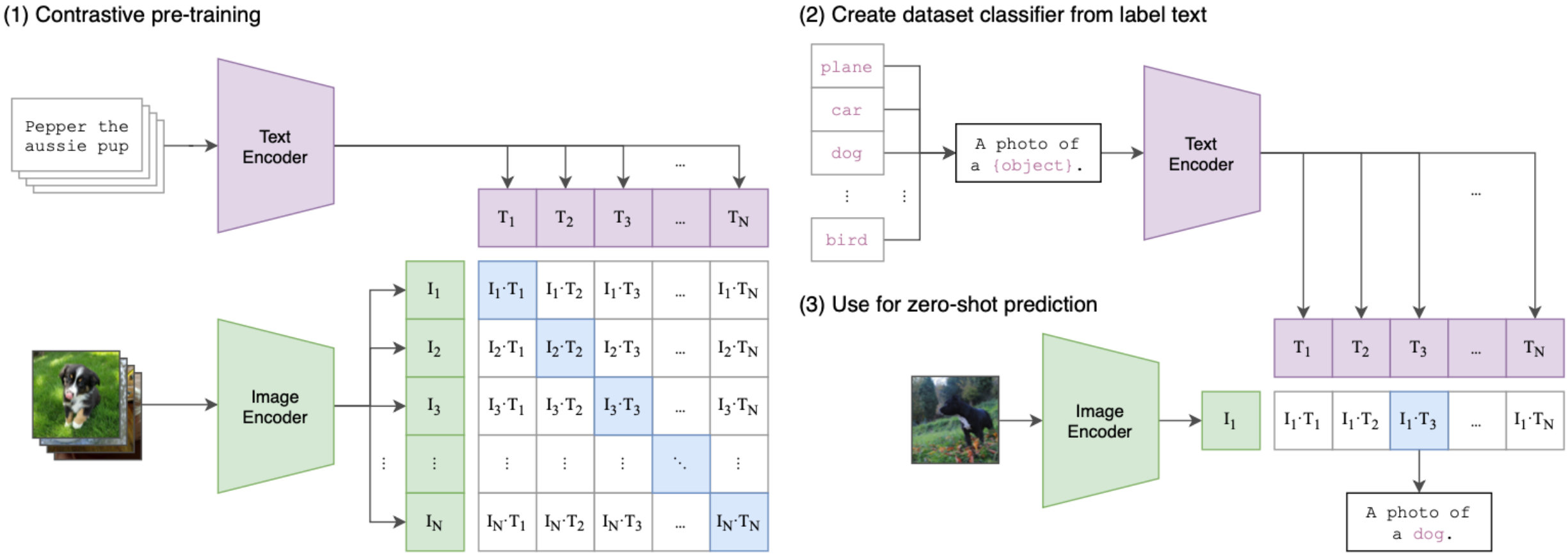
Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).
"A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets." The Visual Computer 38, no. 8: 2939-2970.

Multimodal Transfer Learning



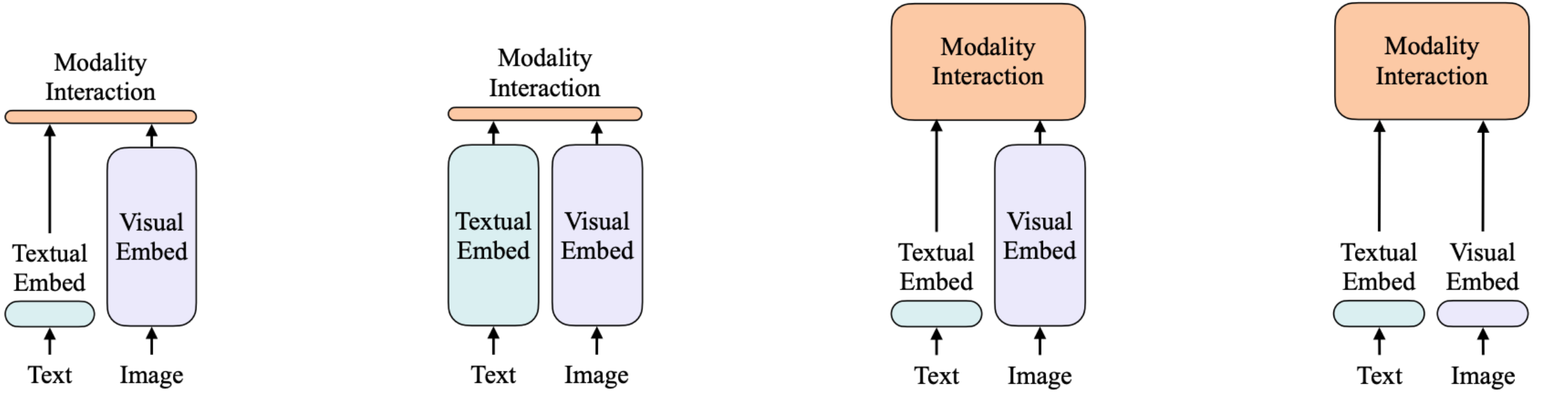
Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).
"A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets." The Visual Computer 38, no. 8: 2939-2970.

CLIP: Learning Transferable Visual Models From Natural Language Supervision



Source: Radford, Alec, Jong Wook Kim, Chris Hallacy, Aditya Ramesh, Gabriel Goh, Sandhini Agarwal, Girish Sastry et al. (2021) "Learning transferable visual models from natural language supervision." In International Conference on Machine Learning, pp. 8748-8763. PMLR.

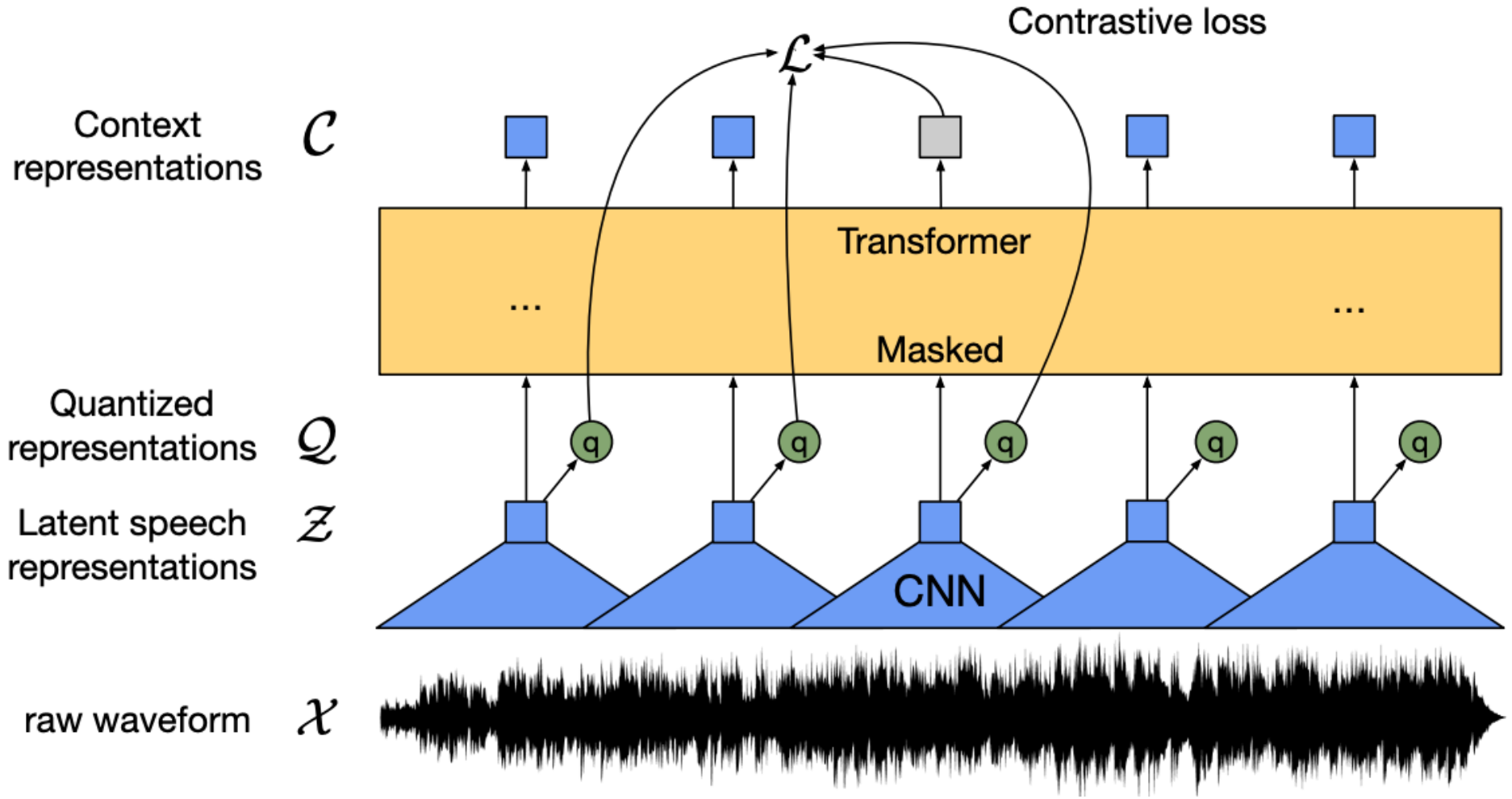
ViLT: Vision-and-Language Transformer Without Convolution or Region Supervision



Source: Kim, Wonjae, Bokyung Son, and Ildoo Kim (2021). "Vilt: Vision-and-language transformer without convolution or region supervision." In International Conference on Machine Learning, pp. 5583-5594. PMLR.

wav2vec 2.0:

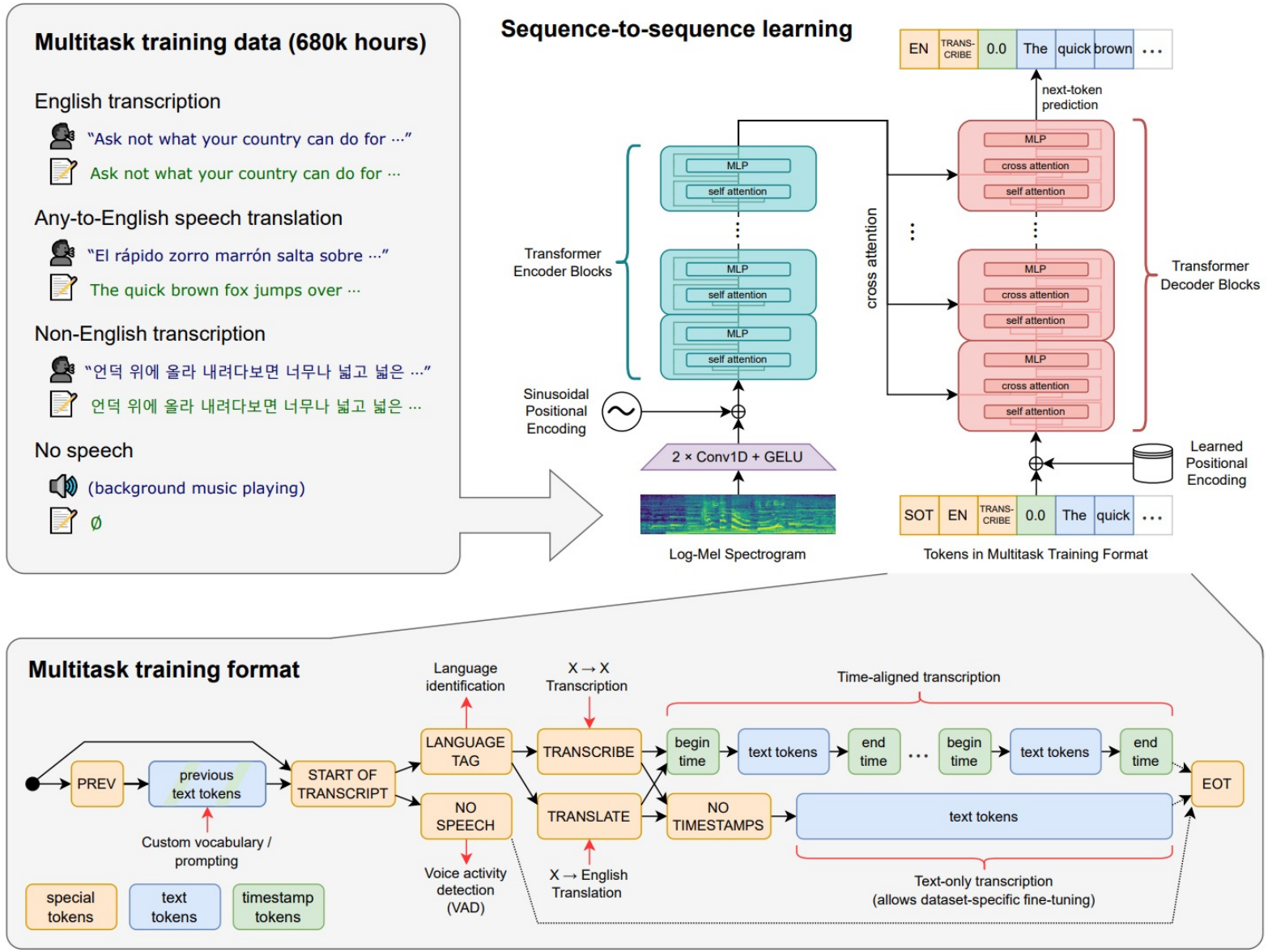
A framework for self-supervised learning of speech representations



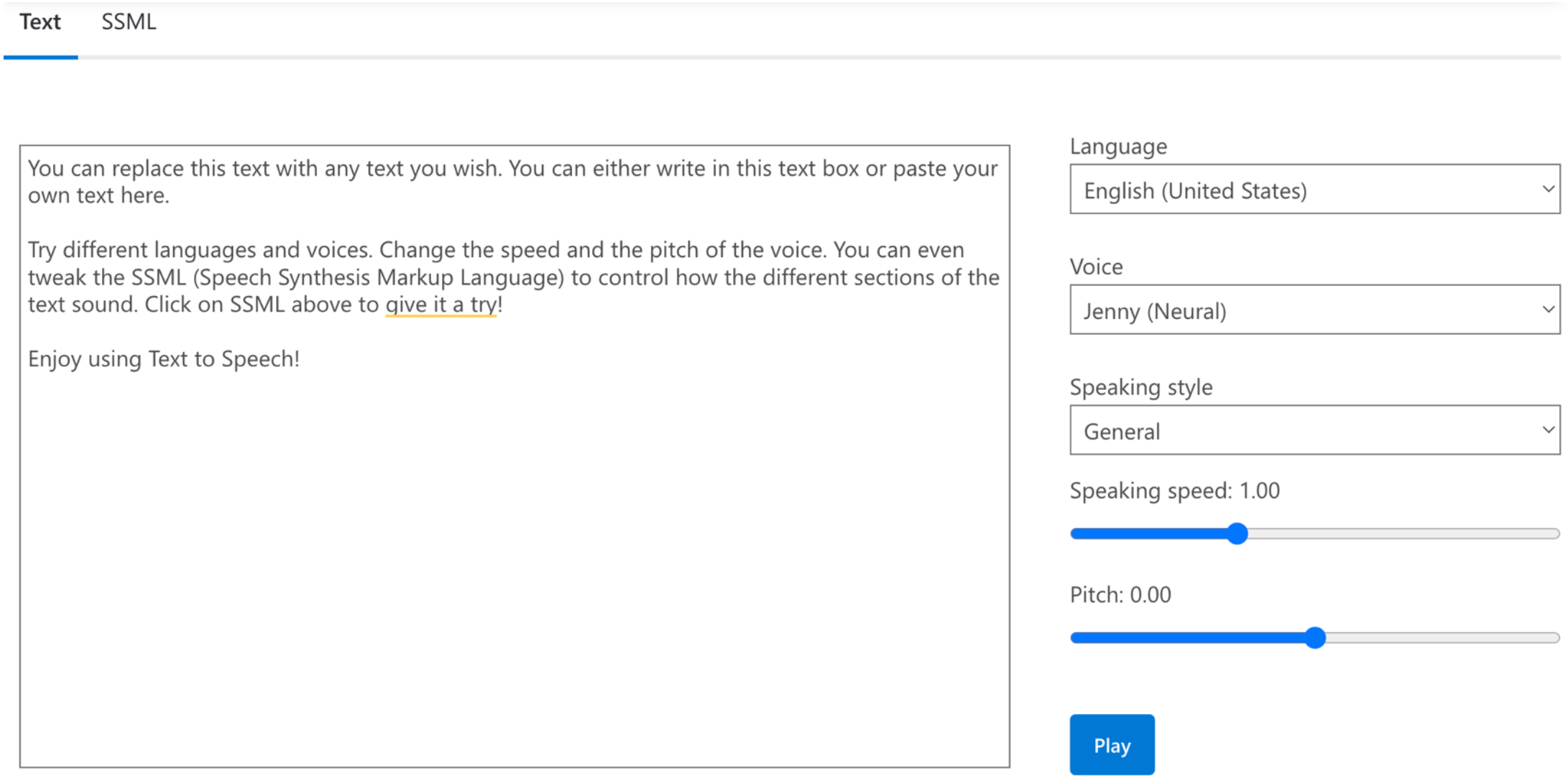
Source: Baevski, Alexei, Yuhao Zhou, Abdelrahman Mohamed, and Michael Auli.
"wav2vec 2.0: A framework for self-supervised learning of speech representations." Advances in Neural Information Processing Systems 33 (2020): 12449-12460.

Whisper:

Robust Speech Recognition via Large-Scale Weak Supervision



Microsoft Azure
Text to Speech (TTS)



Source: https://azure.microsoft.com/en-gb/products/cognitive-services/text-to-speech/

Hugging Face

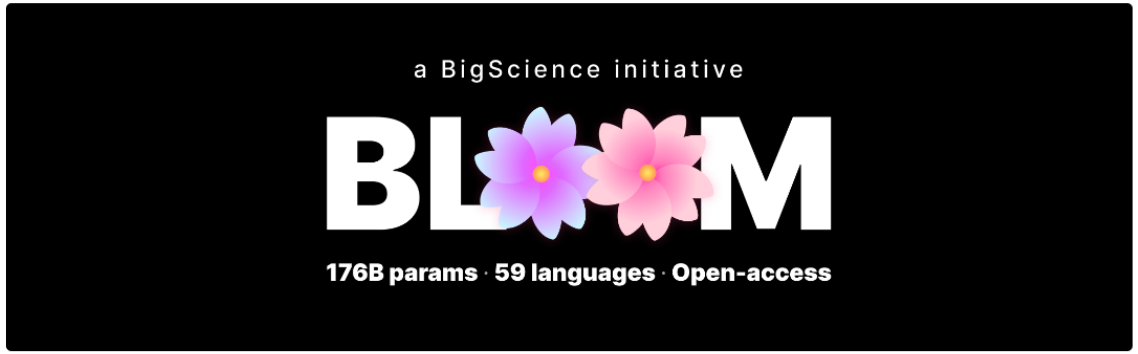
The AI community building the future.

Build, train and deploy state of the art models powered by the reference open source in machine learning.

https://huggingface.co/

BLOOM

BigScience Large Open-science Open-access Multilingual Language Model



BigScience Large Open-science Open-access Multilingual Language Model

Version 1.3 / 6 July 2022

Current Checkpoint: **Training Iteration 95000**

Total seen tokens: **366B**

Downloads last month
12,875

Hosted inference API

Text Generation

Groups | Examples

I love bloom. Super simple, but so effective! I went through a similar process a couple of years ago when I

sampling greedy

BLOOM prompting tips

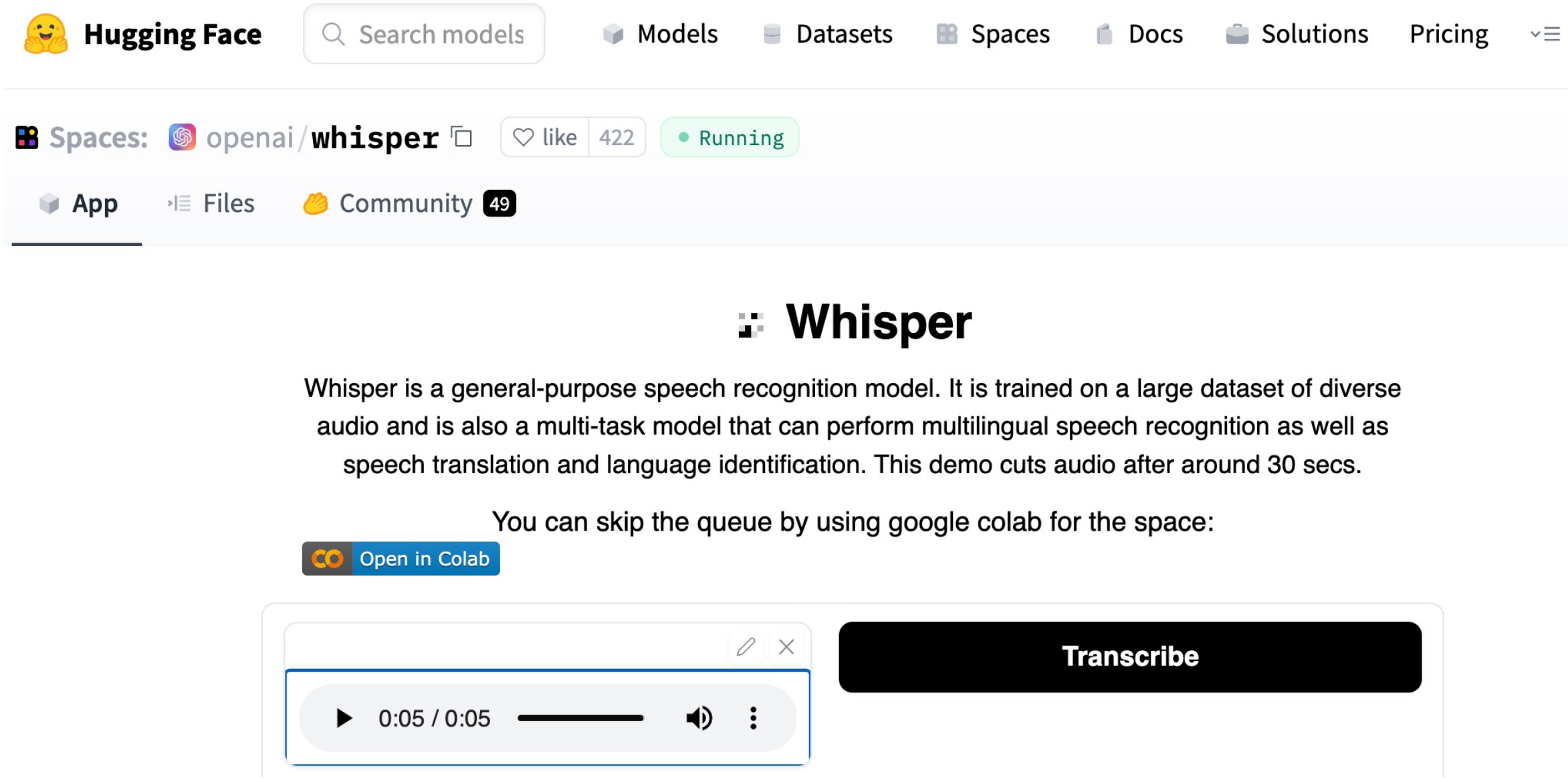
Switch to "greedy" for more accurate completion e.g. math/history/translations (but which may be repetitive/less inventive)

Compute ⌘+Enter

1.3

Source: https://huggingface.co/bigscience/bloom

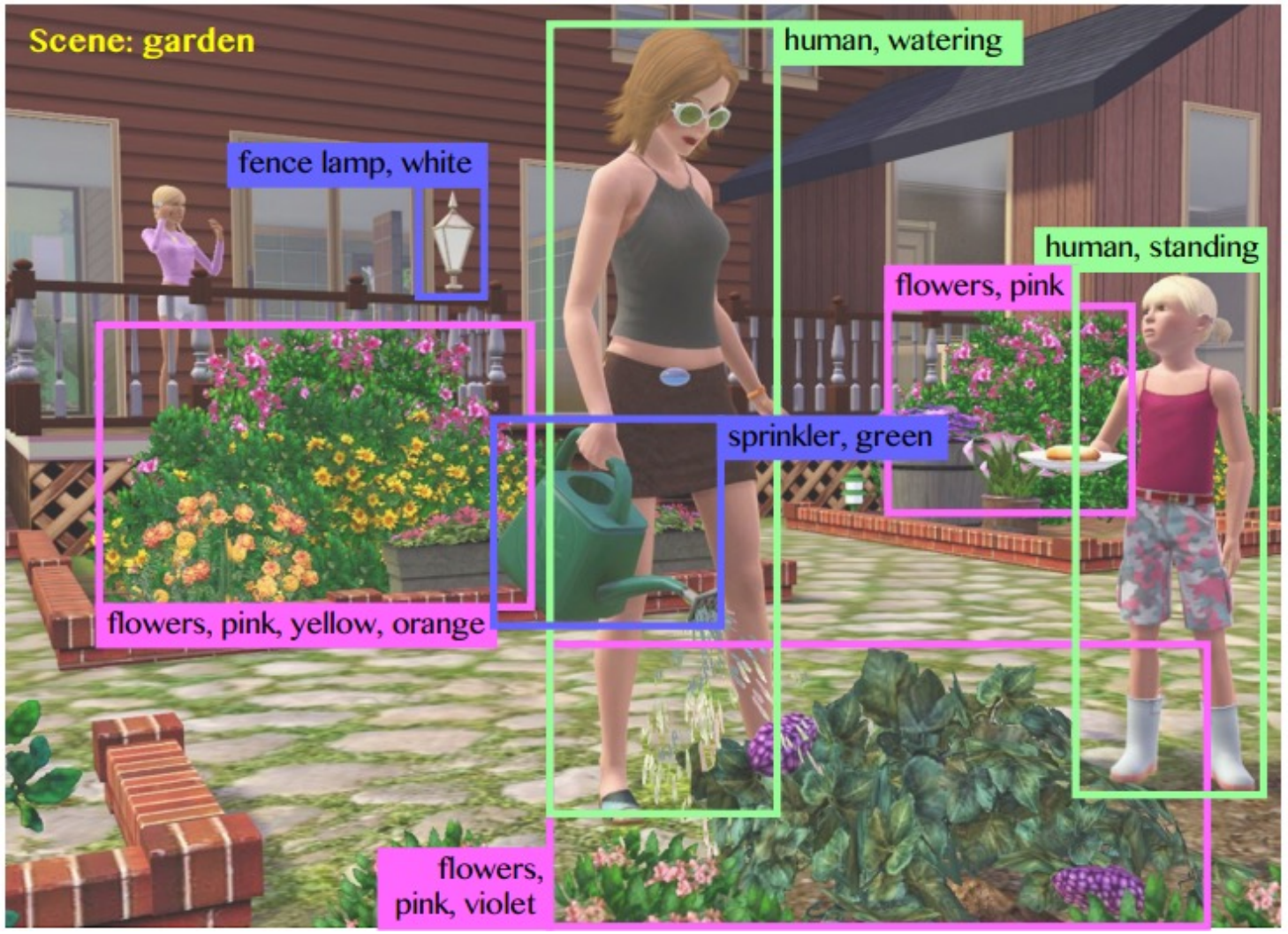
OpenAI Whisper



Source: https://huggingface.co/spaces/openai/whisper

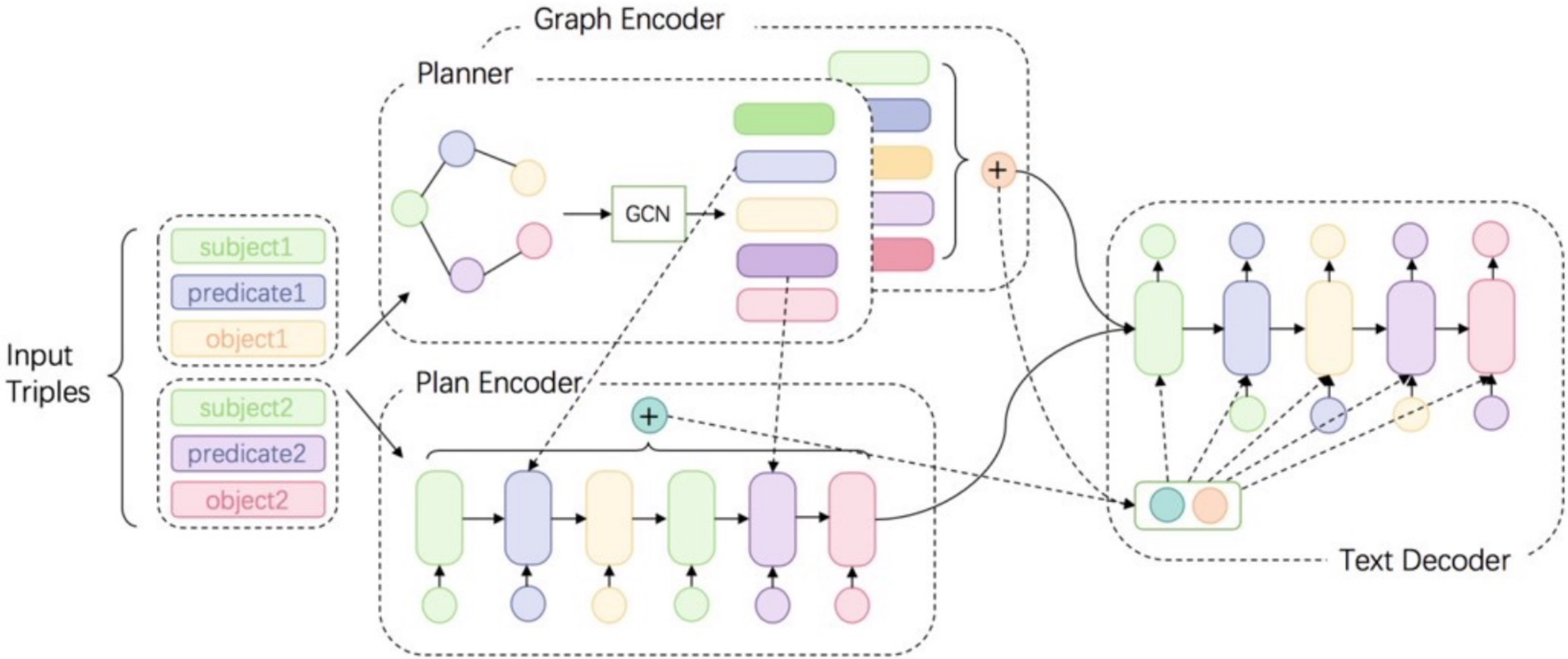
Computer vision in the metaverse

with scene understanding, object detection, and human action/activity recognition



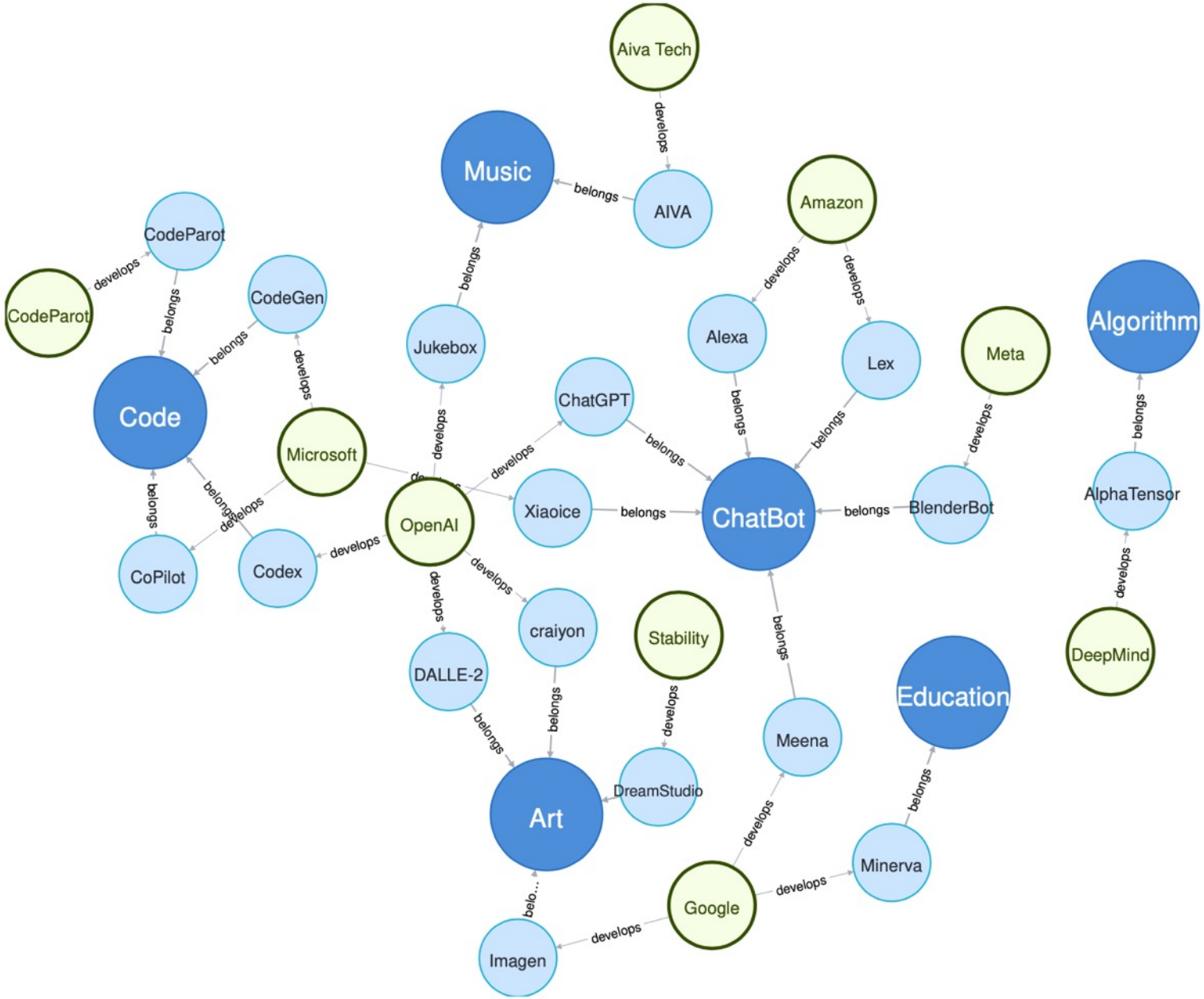
Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

DUALENC: A KG-to-Text Generation Model KG and Graph via Dual-encoding



Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

Generative AI Research Areas, Applications and Companies



Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

Applications of Generative AI Models

Application	Platform/Software	Company	Year	Papaer	Link
ChatBot	Xiaoice	Microsoft	2018	[200]	Xiaoice
ChatBot	Meena	Google	2020	[201]	Meena Blog
ChatBot	BlenderBot	Meta	2022	[202]	Blenderbot
ChatBot	ChatGPT	OpenAI	2022	[10]	ChatGPT
ChatBot	Alexa	Amazon	2014	-	Amazon Alexa
ChatBot	Lex	Amazon	2017	-	Amazon Lex
Music	AIVA	Aiva Tech	2016	-	AIVA
Music	Jukebox	OpenAI	2020	[203]	Jukebox
Code	CodeGPT	Microsoft	2021	[204]	CodeGPT
Code	CodeParrot	CodeParrot	2022	[205]	CodeParrot
Code	Codex	OpenAI	2021	[206]	Codex blog
Code	CoPilot	Microsoft	2021	[206]	CoPilot
Art	DALL-E-2	OpenAI	2022	[5]	DALL-E-2 Blog
Art	DreamStudio	Stability	2022	[13]	Dreamstudio
Art	craiyon	OpenAI	2021	[1]	Craiyon
Art	Imagen	Google	2022	[152]	Imagen
Education	Minerva	Google	2022	[207]	Minerva Blog
Algorithm	AlphaTensor	DeepMind	2022	[208]	AlphaTensor

Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

Outline

1. 生成式AI的基本概念

   Basic Concepts of Generative AI

2. ChatGPT的基本原理和功能

   Basic Principles and Functions of ChatGPT

3. 生成式AI在永續發展的應用

   Generative AI for ESG and Sustainable Development

4. AI在永續發展上的議題

   Issues of AI for Sustainable Development

AI for Sustainable Development

ESG:

Environmental

Social

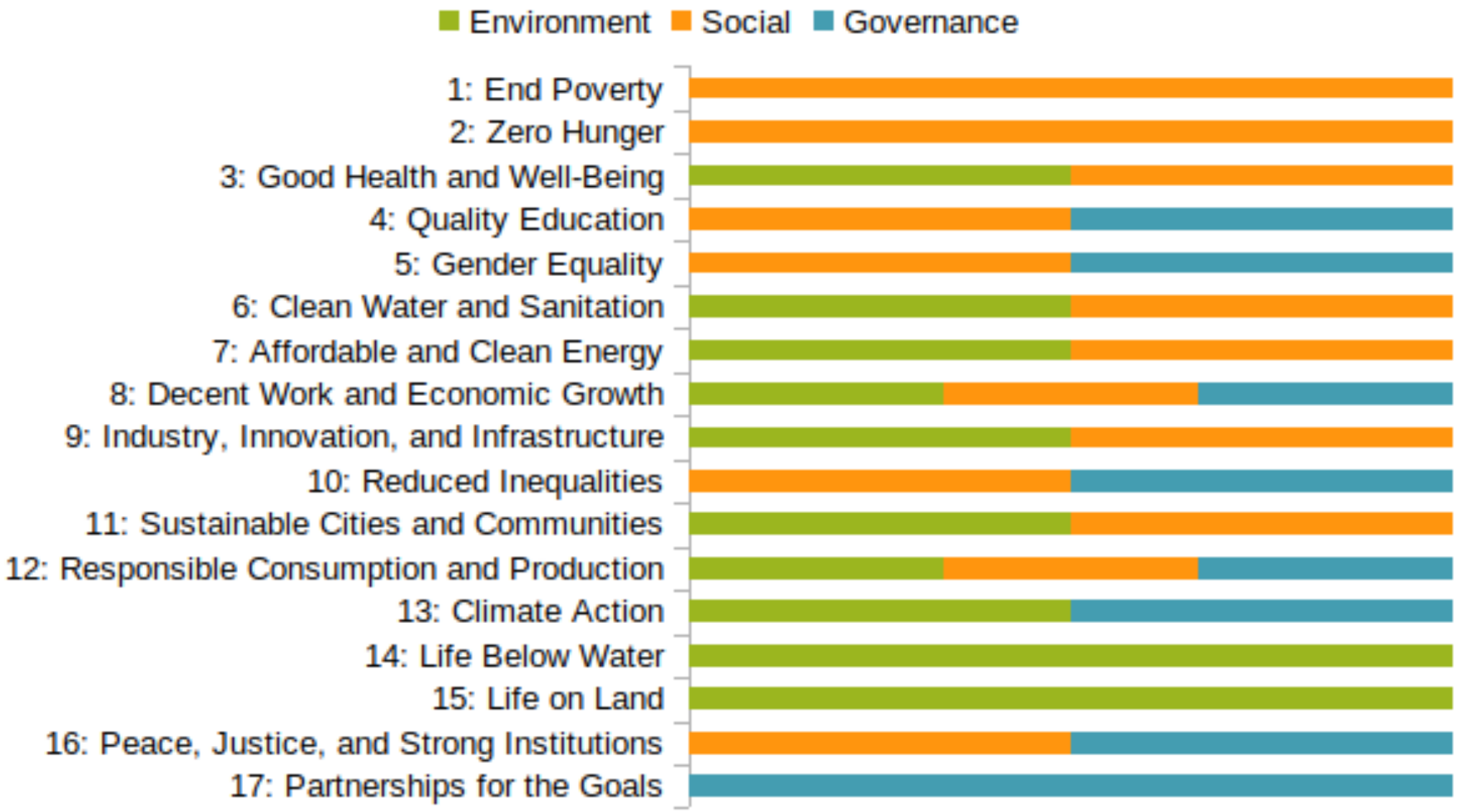
Governance

CSR:
Corporate Social Responsibility

ESG to 17 SDGs

Source: Henrik Skaug Sætra (2021) "A Framework for Evaluating and Disclosing the ESG Related Impacts of AI with the SDGs." Sustainability 13, no. 15 (2021): 8503.

ESG to 17 SDGs



Source: https://sustainometric.com/esg-to-sdgs-connected-paths-to-a-sustainable-future/

AI for Sustainability

AI and Sustainability Development Goals (SDGs)

SDGs	1 No poverty	2 Zero hunger	3 Good health and well-being	4 Quality education	5 Gender equality	6 Clean water and sanitation	7 Affordable and clean energy	8 Decent work and economic growth	9 Industry, innovation and infrastructure	10 Reduces inequalities	11 Sustainable cities and communities	12 Responsible consumption and production	13 Climate action	14 Life below water	15 Life on land	16 Peace, justice and strong institutions	17 Partnerships for the goals
Economic								●	●	●	○						●
Ecological		○					○				○	○	●	●	●		
Social	●	●	●	●	●	●	●				●	●				●	
Positive impact of AI*	100%	76%	69%	10%0	56%	100%	100%	92%	100%	90%	100%	82%	80%	90%	100%	58%	26%

Note: ● adopted from Vinuesa et al. (2020), ○ added based on our analysis.
*The assessment of AI's possible positive impact is based on a consensus-based expert elicitation process (Vinuesa et al., 2020).

Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023). Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

AI for Sustainability

Dimension	Code characteristics					
Primary objective[1]	Develop new (AI) methods *(11/95)*	Compare (AI) methods *(39/95)*	Apply (AI) methods *(53/95)*	Develop new system *(20/95)*	Other objective *(4/95)*	
Sustainability dimension	Economic *(23/95)*		Ecological *(17/95)*		Social *(72/95)*	
Sustainable Development Goals (SDGs)	SDG 1 *(0/95)*	SDG 2 *(2/95)*	SDG 3 *(55/95)*	SDG 4 *(6/95)*	SDG 5 *(0/95)*	SDG 6 *(0/95)*
	SDG 7 *(9/95)*	SDG 8 *(7/95)*	SDG 9 *(8/95)*	SDG 10 *(1/95)*	SDG 11 *(9/95)*	SDG 12 *(8/95)*
	SDG 13 *(2/95)*	SDG 14 *(0/95)*	SDG 15 *(2/95)*	SDG 16 *(11/95)*	SDG 17 *(0/95)*	
Data source	Reviews *(12/95)*	Social media/ Online forums *(31/95)*	Health records *(21/95)*	Environment/ Weather *(10/95)*	Energy *(5/95)*	
Data source plurality	Single source *(50/95)*		Multiple sources *(44/95)*		N/A *(1/95)*	
Data sensitivity	Publicly available data *(64/95)*		Internal data *(16/95)*	Other *(11/95)*	N/A *(9/95)*	
Manual labeling	Yes *(32/95)*			No *(63/95)*		
Technology	ML *(91/95)*		NLP *(42/95)*	CV *(12/95)*	Other *(21/95)*	
Type of learning for ML approach	Supervised learning *(85/95)*			Unsupervised learning *(23/95)*		
Neural vs. non-neural	Non-neural *(45/95)*		Neural *(50/95)*		Deep learning *(38/95)*	
Evaluation	Technical evaluation *(83/95)*			Domain evaluation *(25/95)*		
Paradigm	DSR/ADR *(30/95)*			Non-DSR/ADR *(64/95)*		

	0-9	10-29	30-54	55-69	70-95

Notes: Code dimensions are not mutually exclusive; one article can be classified into one or more code characteristics; [1] 'Compare' does include 'apply'.

Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023). Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

Research Topics of AI for Sustainability

- Building Upon Well-Investigated AI Research
- Taking a Holistic View on Sustainability and Closing Blind Spots
- Examining Opportunities for Data Collecting and Assembly
- Extending the Algorithmic Scope
- Exploring (Unintended) Effects from the Application of AI

Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023).
Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

Exploring (Unintended) Effects from the Application of AI

- Emerging streams of research on ethical principles by design should be considered
  - Responsible AI (Wang et al., 2020)
  - Trustworthy AI (Thiebes et al., 2021)
  - Explainable AI (Bauer et al., 2021; Lukyanenko et al., 2021)
- The use of advanced white-box ML models
  - such as interpretable neural networks and explainable boosting machines (Zschech et al., 2022).
  - Such models can achieve high prediction qualities while providing sufficient transparency, which is a crucial prerequisite to eliminating the social injustices and discrimination effects in AI (Rudin, 2019)

Source: Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023). Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.

Artificial Intelligence for Sustainable Finance

- Developments in Artificial Intelligence (AI) and machine learning have led to the creation of a new type of ESG data that do not necessarily rely on information provided by companies.
- AI in the ESG field
  - textual analysis to measure firms' ESG incidents or verify the credibility of companies' concrete commitments
  - satellite and sensor data to analyse companies' environmental impact or estimate physical risk exposures
  - machine learning to fill missing corporate data (GHG emissions etc.)

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

AI for Sustainable Finance

- Developments in AI and machine learning have led to the creation of a new type of ESG data providers that analyse and collect (or “scrape”) large amounts of unstructured data from different internet sources
  - Using AI and without necessarily relying on information provided by companies

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

AI for Sustainable Finance

- **Textual analysis to measure firms' ESG incidents**
- **Textual analysis to measure/verify the credibility of companies' concrete commitments**
- **Machine learning to fill missing corporate data (GHG emissions etc.)**

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Textual analysis to measure firms' ESG incidents

- Textual analysis tools (e.g., Natural Language Processing (NLP) and knowledge graphs) help identify controversies and important ESG news.
- A large number of textual analysis software has been developed over the last decade, including Reprisk, Truvalue Labs, and others.
  - They make it possible to finely measure controversies involving companies on various subjects such as environmental policies, working conditions, child labour, corruption, etc.
  - Compared with traditional ratings, they have the advantage of more frequent revisions, incorporating real-time company information.

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Textual analysis to measure/verify the credibility of companies' concrete commitments

- AI to assess company disclosures
  - The Task Force on Climate Related Financial Disclosures (TCFD) has conducted an "AI review," using a supervised learning approach to identify compliance with the TCFD Recommended Disclosures.
  - Analyse climate risks disclosure in 10-K reports using BERT, an advanced language understanding algorithm, and identified an increase in transition risks disclosure that outpaced those of physical risks.
  - Use machine learning to automatically identify disclosures of five different types of climate-related risks in companies' annual reports for more than 300 European firms.

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Textual analysis to measure/verify the credibility of companies' concrete commitments

- AI to assess company disclosures
  - ClimateBERT, a context-based algorithm to identify climate-related financial information from the reports (annual reports, standalone sustainability, climate, or TCFD reports, firms' webpage) of 800 TCFD-supporting companies.
    - Whether climate disclosures improved after supporting the TCFD and analyse the development of TCFD disclosures in different sectors and countries.
    - Firms tend to cherry-pick disclosures on those TCFD categories containing the least materially relevant information, supporting the idea that TCFD disclosure is currently "cheap talk".

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Machine learning to fill missing corporate data (GHG emissions etc.)

- Greenhouse gas emissions (GHG emissions) are gases that trap heat in the atmosphere and contribute to global warming.
- Large companies report their GHG emissions based on the GHG Protocol of the World Business Council for Sustainable Development (WBCSD).
  - According to this Protocol, reporting on Scopes 1 and 2 is mandatory, while reporting on Scope 3 (indirect emissions that occur in the company's value chain) is optional.
  - In some sectors, Scope 3 is often the largest component of companies' total GHG emissions.

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Machine learning to fill missing corporate data (GHG emissions etc.)

- Estimating total GHG emissions requires to link, for each company, each stage of its industrial processes with their carbon emissions.
  - The information required to quantify companies' use of those processes, or their intensity in the overall annual production chain, is rarely publicly available.
  - This makes it difficult to apply such models for calculating company emissions at a global level.
  - Specialised data vendors (MSCI ESG CarbonMetrics, Refinitiv ESG Carbon Data, S&P Global Trucost etc.) rely on simple models to predict the likely GHG emissions of some of the companies that do not currently report, based on sector level extrapolations (based on regression models based on the company's size, number of employees, income generated, etc.).

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Modelling Strategy to Forecast Carbon Emissions with AI

DATA

COLLECTING DATA

Target Variables
- Total emissions
- Scope 1, Scope 2 and Scope 3 emissions

Predictors
- Scale of operations
- Business model
- Technology advancement
- Energy factors
- Environmental factors

Data source
- Thomson Reuters Eikon
- World Bank
- IEA

PRE- PROCESSING DATA

Prefilter low quality data
- Insufficient predictors
- Abnormal trends

Data-transformation
- Log transformation

Outliers
- Remove outliers
- Winsorise outliers

Missing values
- List-wide deletion
- Imputation with historical data and peer groups

PREDICTION MODEL

PREDICTOR SELECTION

Classification
- GICS Sector
- GICS Group
- NAICS Sector
- Reclassified NAICS Sector
- Reclassified GICS Group

Firm characteristics
- GBB model
- GLS model
- Combined model
- Extended model
- Step-wise model

Environmental factors
- Carbon law
- Country income group

Energy

Fiscal Years

BUILDING BASE-LEANERS

Linear models
- OLS
- Elastic Net

Non linear models
- Neural Network
- K Nearest Neighbours

Decision tree ensembles
- Random Forests
- Extreme Gradient Boosting

BUILDING META-LEARNERS

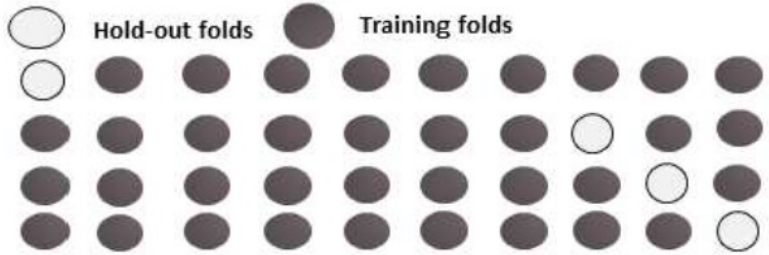
Simple combination
- Arithmetic mean
- Median

Stacked generalization
- Meta OLS
- Meta Elastic Net
- Meta XGB

Hyper-parameter optimization metrics
- Mean Absolute Error (MAE)

MODEL EVALUATION

Double 10-Fold division for base-learners and meta-learners

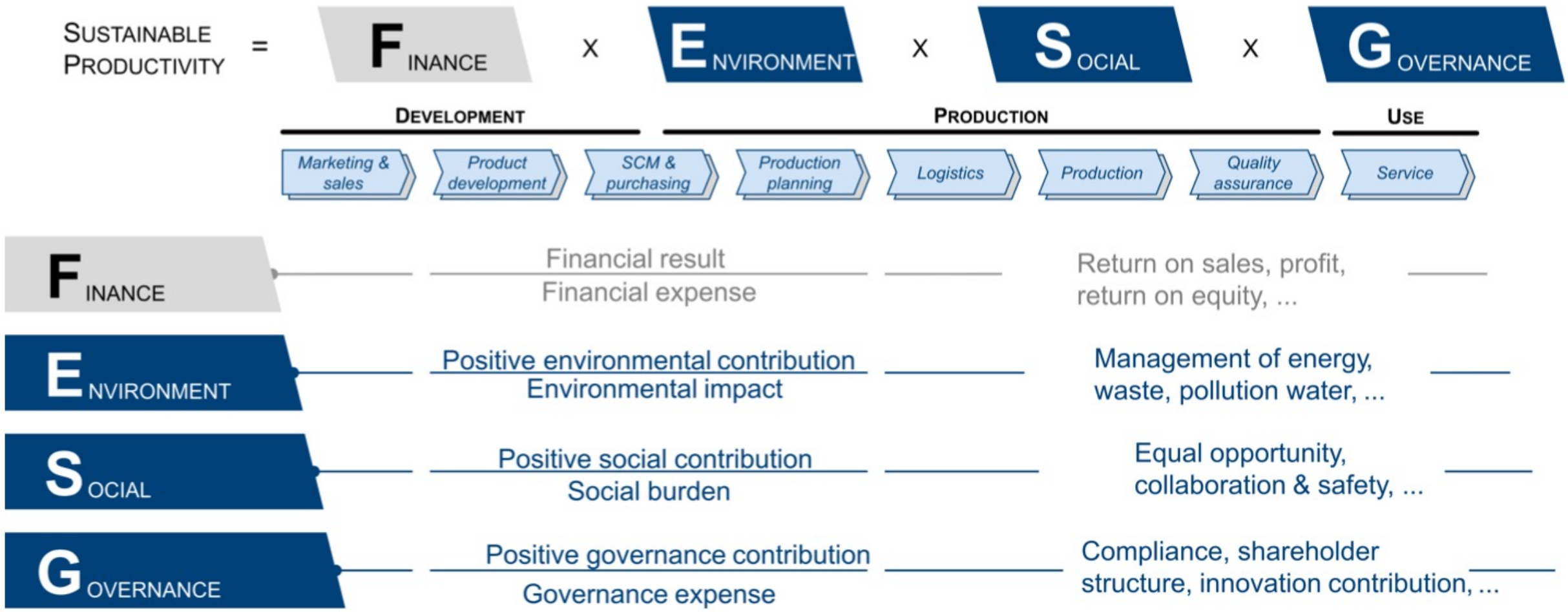


Main Evaluation metrics:
- Mean Absolute Error (MAE)
- Wilcoxon Signed-Rank test

Robustness Tests
- Alternative measures (MAPE, PPAR)
- Test of percentile ranking, mean difference and SP500 membership subgroup

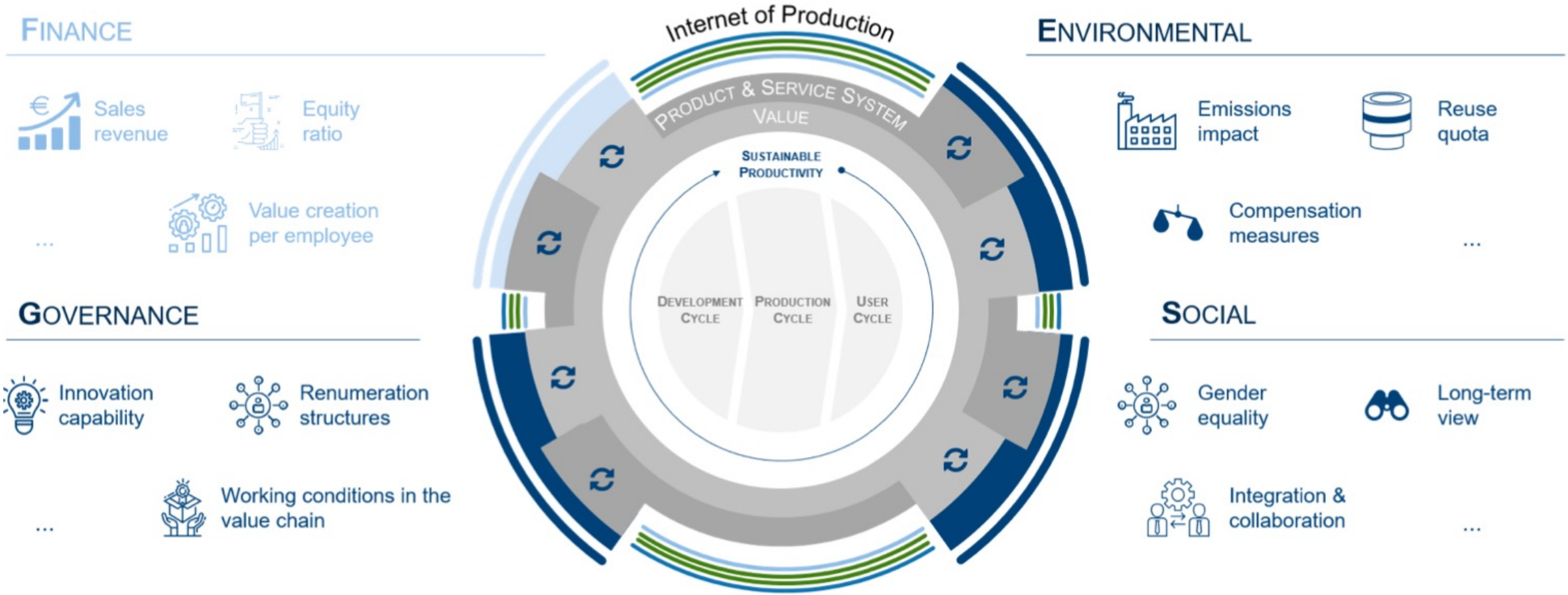
Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Sustainable Productivity: Finance ESG



Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.

Sustainable Resilient Manufacturing
ESG

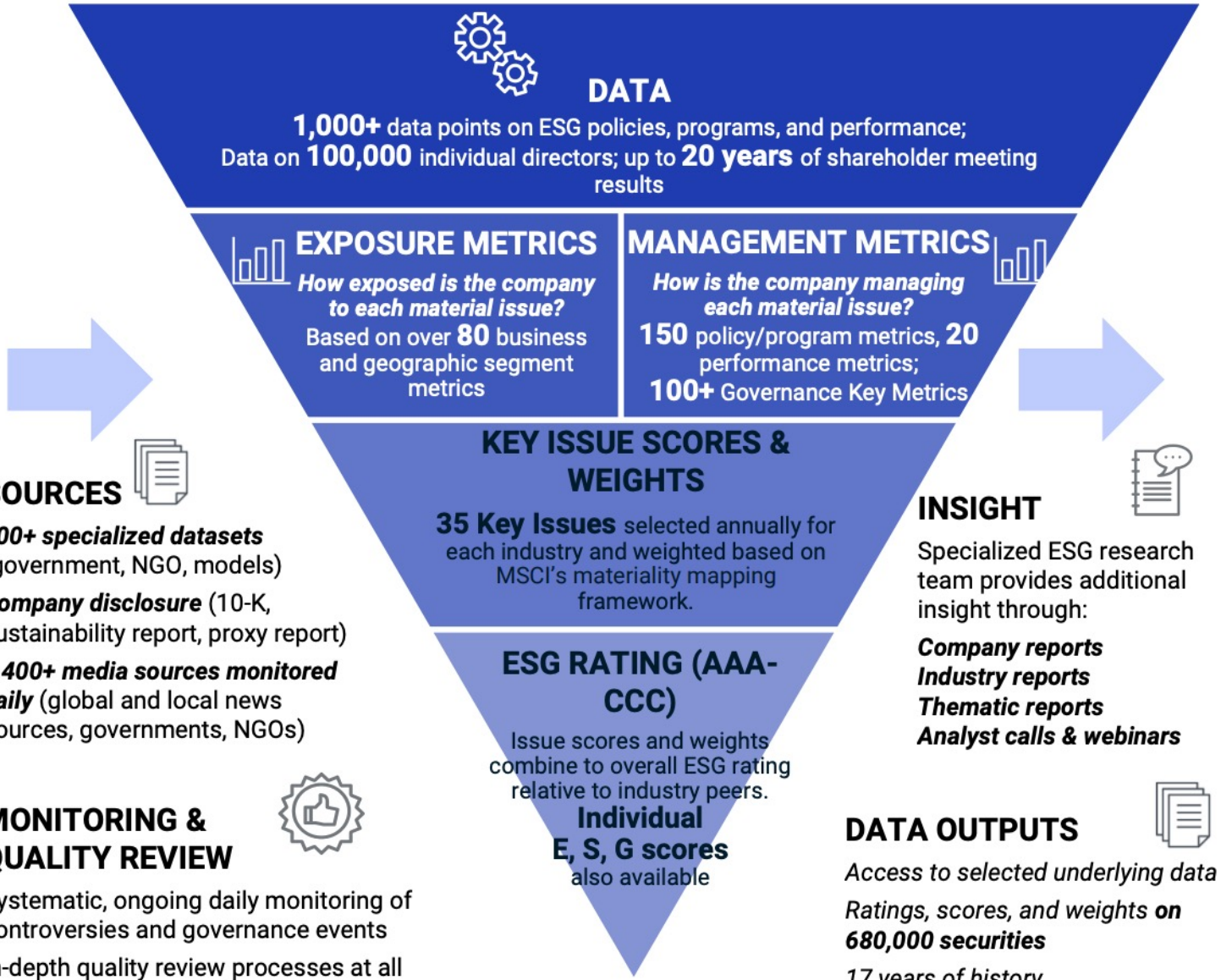


Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.

ESG Indexes

- MSCI ESG Index
- Dow Johns Sustainability Indices (DJSI)
- FTSE ESG Index

MSCI ESG Rating Framework



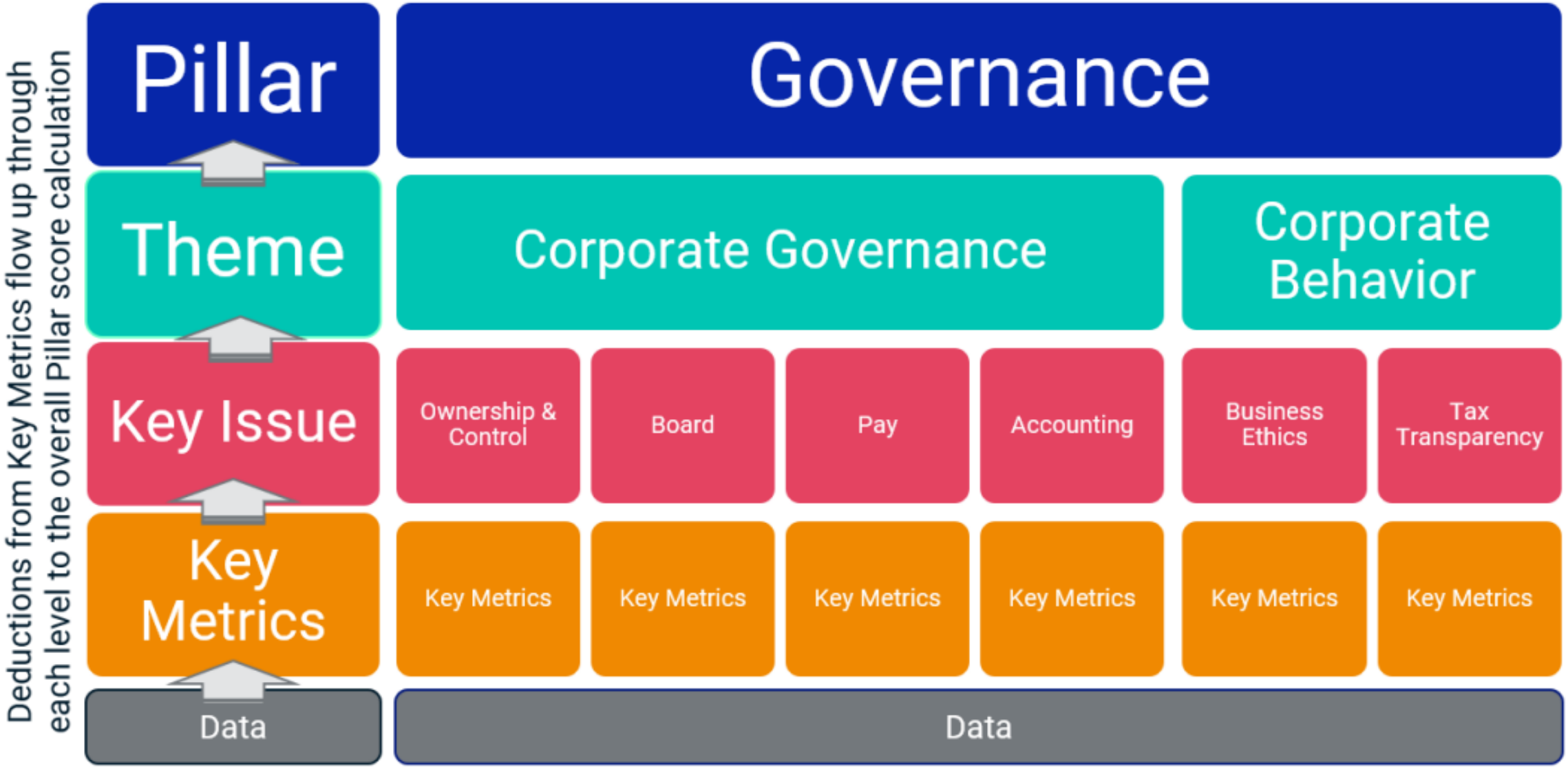
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI ESG Key Issue Hierarchy

3 Pillars	10 Themes	35 ESG Key Issues	
Environment	**Climate Change**	Carbon Emissions	Financing Environmental Impact
		Product Carbon Footprint	Climate Change Vulnerability
	Natural Capital	Water Stress	Raw Material Sourcing
		Biodiversity & Land Use	
	Pollution & Waste	Toxic Emissions & Waste	Electronic Waste
		Packaging Material & Waste	
	Environmental Opportunities	Opportunities in Clean Tech	Opportunities in Renewable Energy
		Opportunities in Green Building	
Social	**Human Capital**	Labor Management	Human Capital Development
		Health & Safety	Supply Chain Labor Standards
	Product Liability	Product Safety & Quality	Privacy & Data Security
		Chemical Safety	Responsible Investment
		Consumer Financial Protection	Health & Demographic Risk
	Stakeholder Opposition	Controversial Sourcing	
		Community Relations	
	Social Opportunities	Access to Communications	Access to Health Care
		Access to Finance	Opportunities in Nutrition & Health
Governance	**Corporate Governance**	Ownership & Control	Pay
		Board	Accounting
	Corporate Behavior	Business Ethics	
		Tax Transparency	

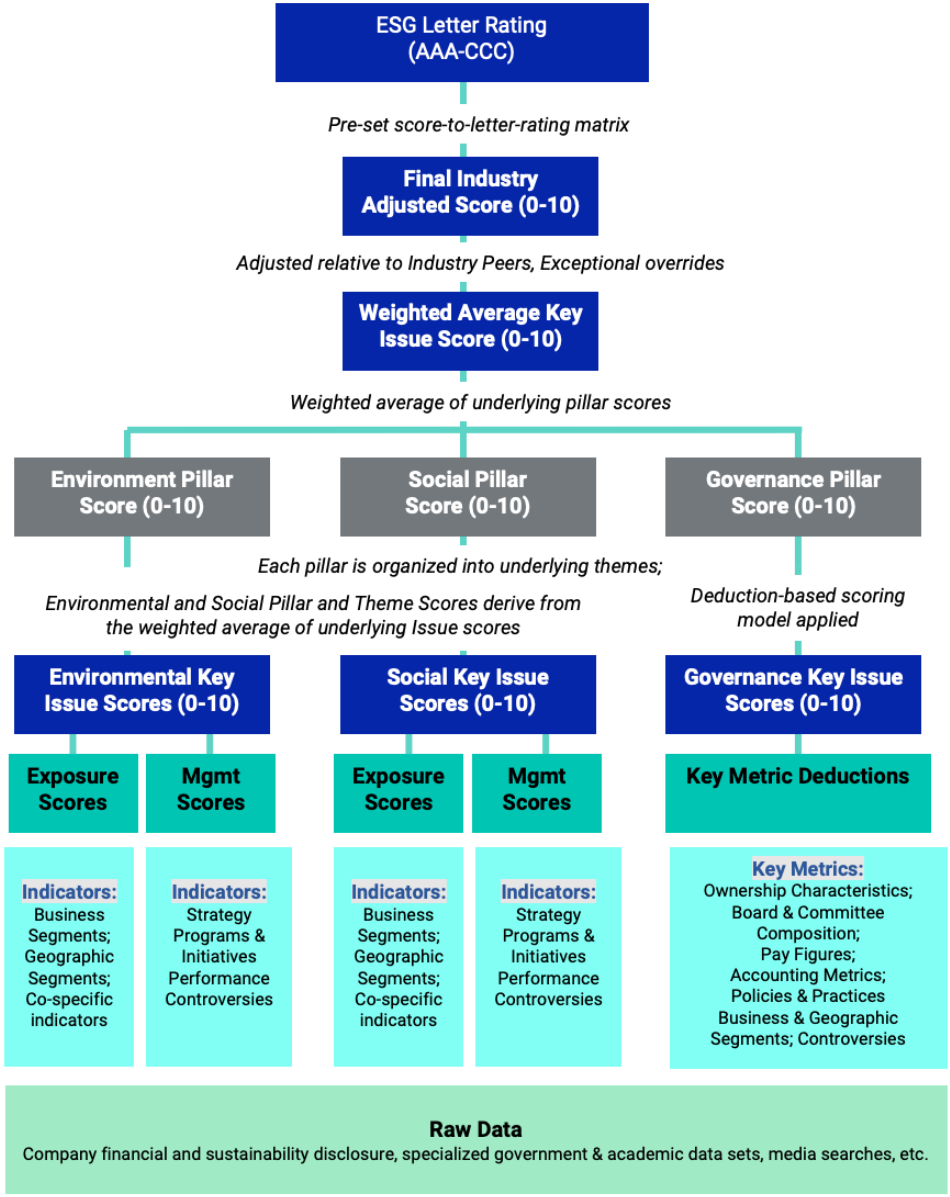
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI Governance Model Structure



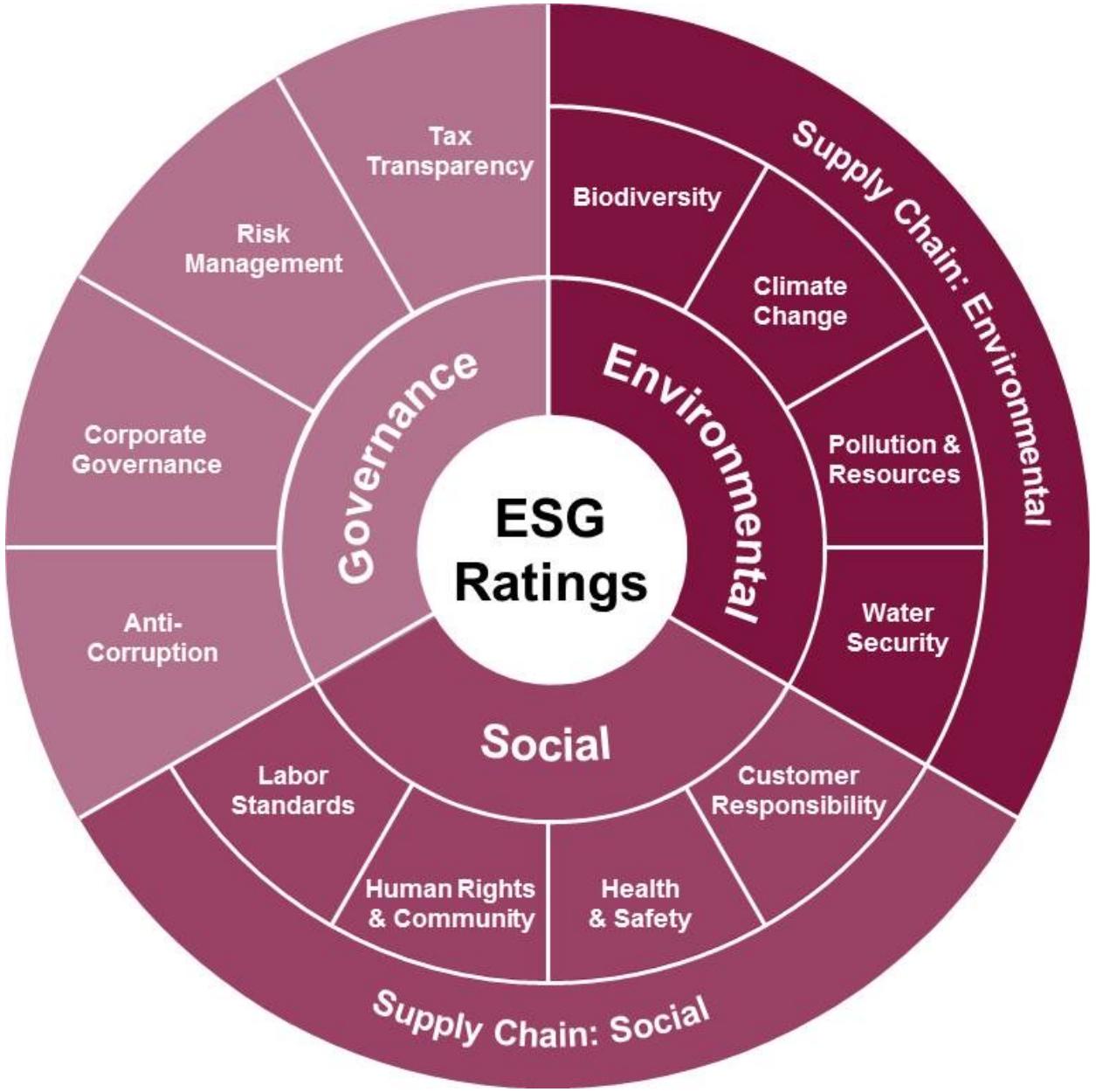
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

MSCI Hierarchy of ESG Scores



Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

FTSE Russell ESG Ratings



Source: https://www.ftserussell.com/data/sustainability-and-esg-data/esg-ratings

SUSTAINALYTICS
a Morningstar company

Sustainalytics ESG Risk Ratings

Sustainalytics' ESG Risk Ratings measure a company's exposure to industry-specific material ESG risks and how well a company is managing those risks.

Negligible	Low	Medium	High	Severe
0 - 10	10 - 20	20 - 30	30 - 40	40+

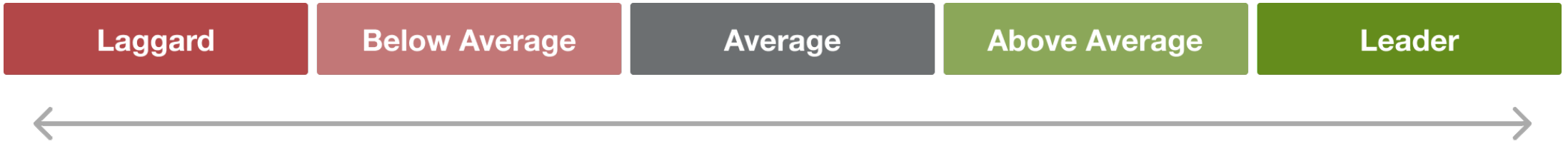
Source: https://www.sustainalytics.com/esg-data

TruValue Labs

FACTSET

Truvalue ESG Ranks

- **Truvalue Labs applies AI to analyze over 100,000 sources and uncover ESG risks and opportunities hidden in unstructured text.**
- **The ESG Ranks data service produces an overall company rank based on industry percentile leveraging the 26 ESG categories defined by the Sustainability Accounting Standards Board (SASB).**
- **The data feed covers 20,000+ companies with more than 13 years of history.**



Source: :https://developer.truvaluelabs.com/data/esg-ranks

AI for Social Good (AI4SG)

Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

AI for Social Good (AI4SG)
AI for Sustainable Development
AI4SG 10 Guidelines

- **AI Technology (G1, G2, G3)**
- **Applications (G4, G5, G6, G7, G8)**
- **Data Handling (G9, G10)**

Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

AI4SG 10 Guidelines
AI Technology (G1, G2, G3)

- **G1: Expectations of what is possible with AI need to be well-grounded.**
- **G2: There is value in simple solutions.**
- **G3: Applications of AI need to be inclusive and accessible, and reviewed at every stage for ethics and human rights compliance.**

Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

AI4SG 10 Guidelines
Applications (G4, G5, G6, G7, G8)

- **G4: Goals and use cases should be clear and well-defined.**
- **G5: Deep, long-term partnerships are required to solve large problems successfully.**
- **G6: Planning needs to align incentives, and factor in the limitations of both communities.**
- **G7: Establishing and maintaining trust is key to overcoming organisational barriers.**
- **G8: Options for reducing the development cost of AI solutions should be explored.**

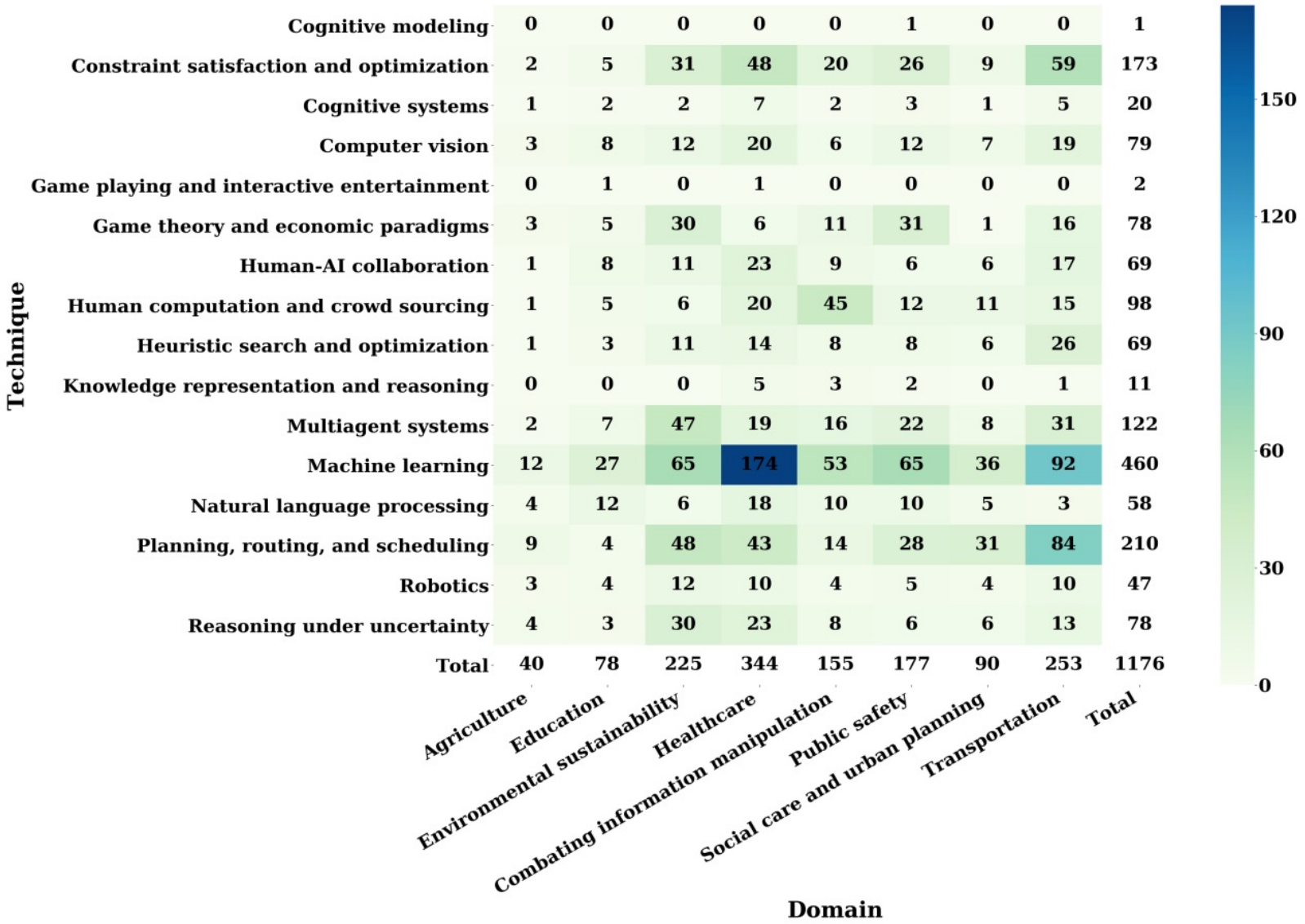
Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

AI4SG 10 Guidelines
Data Handling (G9, G10)

- **G9: Improving data readiness is key.**
- **G10: Data must be processed securely, with utmost respect for human rights and privacy.**

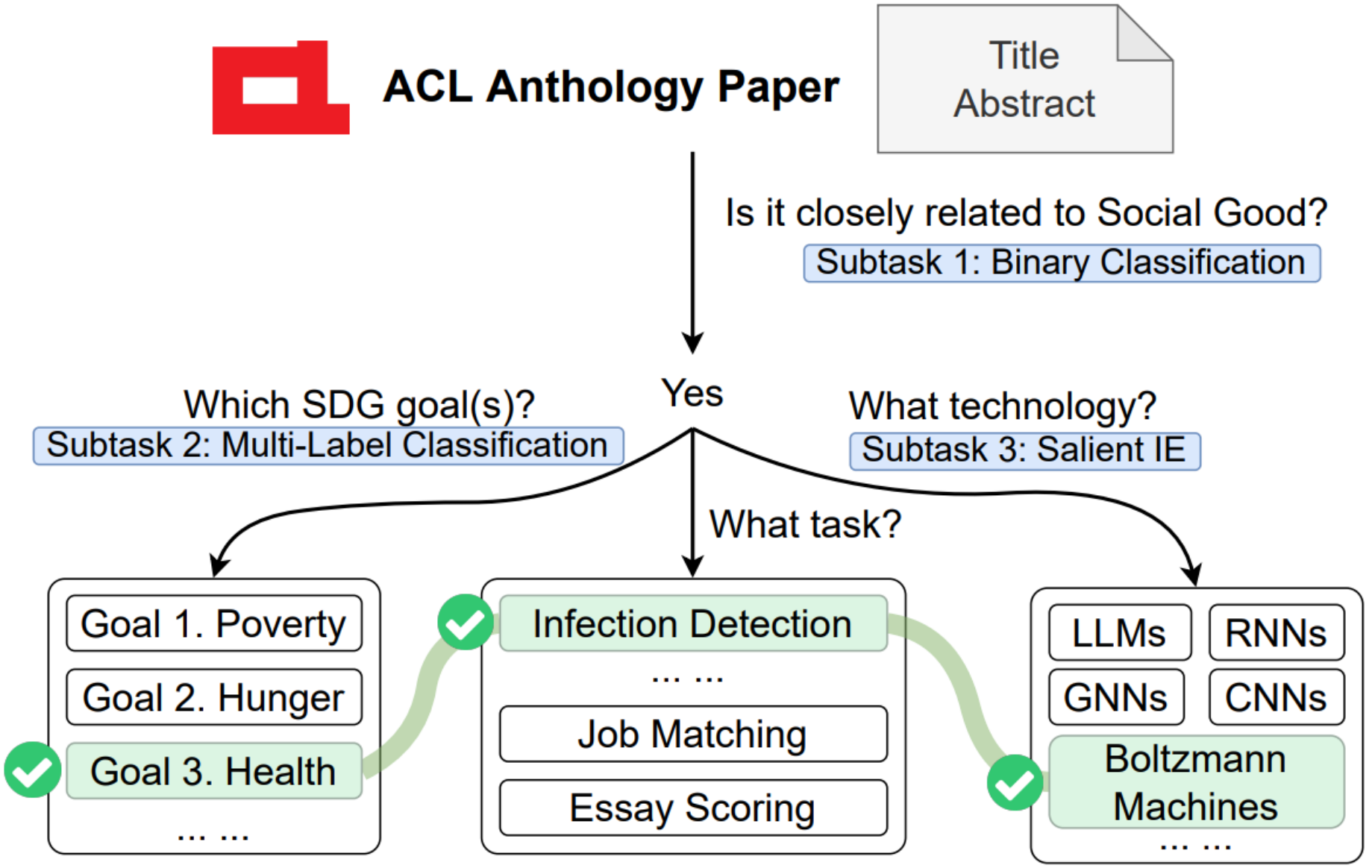
Source: Nenad Tomašev, Julien Cornebise, Frank Hutter, Shakir Mohamed, Angela Picciariello, Bec Connelly, Danielle Belgrave et al. (2020) "AI for social good: unlocking the opportunity for positive impact." Nature Communications 11, no. 1: 1-6.

AI for Social Good (AI4SG)
Domains and Techniques



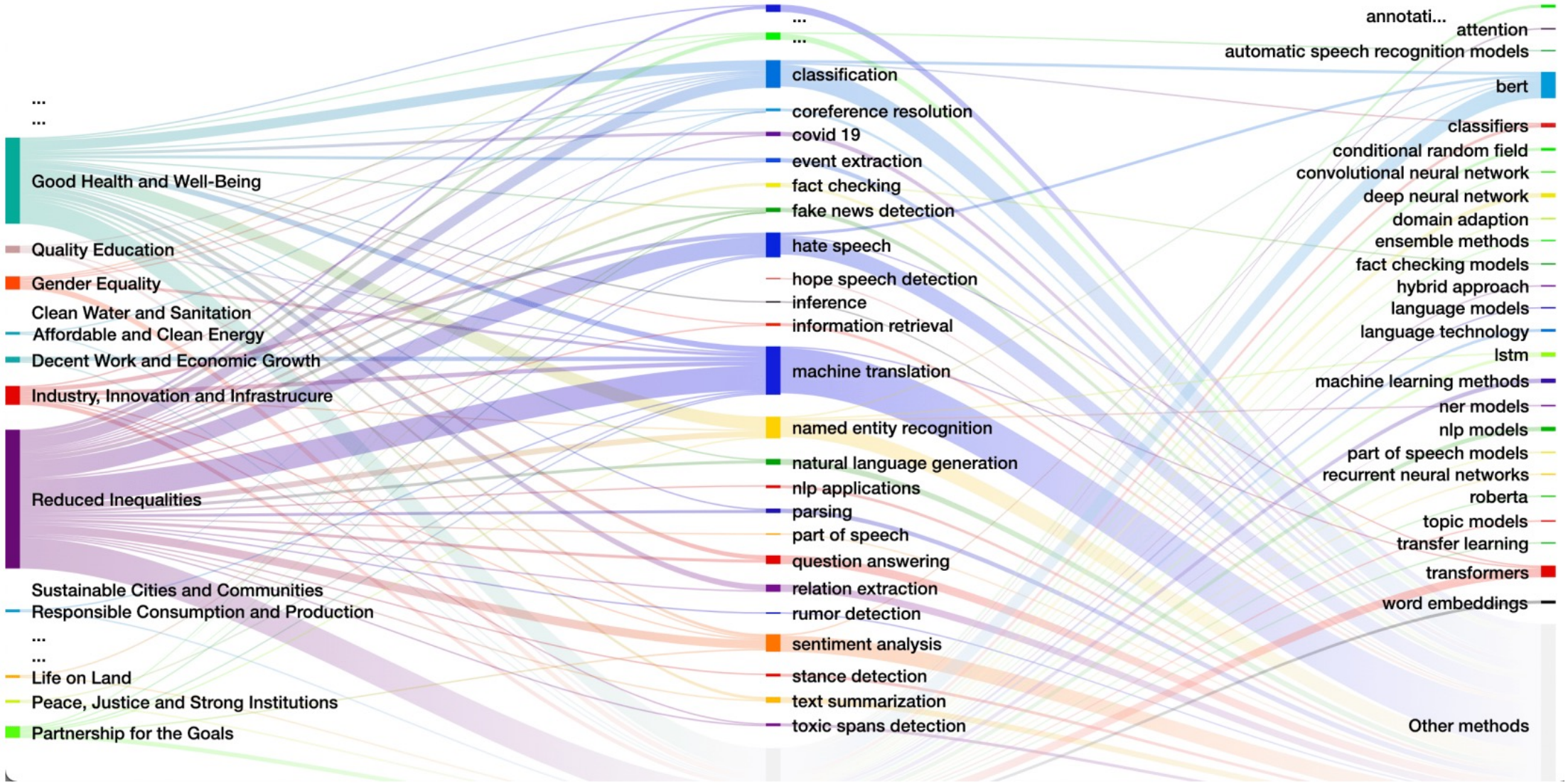
Source: Zheyuan Shi, Ryan, Claire Wang, and Fei Fang (2020). "Artificial intelligence for social good: A survey." arXiv preprint arXiv:2001.01818.

NLP for Social Good (NLP4SG)



Source: Fernando Gonzalez, Zhijing Jin, Jad Beydoun, Bernhard Schölkopf, Tom Hope, Rada Mihalcea, and Mrinmaya Sachan (2022).
"How Is NLP Addressing the 17 UN Sustainability Goals? A Challenge Set of Social Good Paper Classification and Information Extraction."

NLP for Social Good (NLP4SG) Visualization



Source: Fernando Gonzalez, Zhijing Jin, Jad Beydoun, Bernhard Schölkopf, Tom Hope, Rada Mihalcea, and Mrinmaya Sachan (2022).
"How Is NLP Addressing the 17 UN Sustainability Goals? A Challenge Set of Social Good Paper Classification and Information Extraction."

Challenges of AI for Sustainable Finance

- **Transparency**
- **Manipulation risks**
- **Costs**

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Challenges of AI for Sustainable Finance

- **AI methods can be a black box**
  - **Subject to the same types of revisions in the methodologies as in traditional ESG ratings**
  - **NLP techniques relying on an ontology can be incomplete and revised ex-post.**
  - **The criteria used by Truvalue Labs to assess ESG risks of companies tend to largely overweight certain key issues (the ones that generate the more ESG controversies), defined at the company level and which can fluctuate over time, while for traditional rating providers, the weightings tend to be more stable and evenly distributed**

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Challenges of AI for Sustainable Finance

- **Alternative ratings based on NLP signals become more of a public "sentiment" indicator.**
- **More prone to manipulation**
  - **When the primary source of data comes from blogs or social media**
- **Corporate disclosure can also be subject to manipulation**
  - **Firms' communication has been reshaped by machine and AI readership**
  - **Managers are now avoiding words perceived as negative by computational algorithms, exhibiting speech emotion favoured by machine learning software**

Source: Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.

Artificial Intelligence for Sustainable Finance

- **Why AI may help sustainable finance?**
  - Brière, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. Available at SSRN 4252329.
- **How does artificial intelligence boost sustainable development?**
  - Schoormann, T., Strobel, G., Möller, F., Petrik, D., & Zschech, P. (2023). Artificial Intelligence for Sustainability—A Systematic Review of Information Systems Literature. Communications of the Association for Information Systems, 52(1), 8.
- **Does sustainability generate better financial performance?**
  - Atz, U., Van Holt, T., Liu, Z. Z., & Bruno, C. C. (2023). Does sustainability generate better financial performance? review, meta-analysis, and propositions. Journal of Sustainable Finance & Investment, 13(1), 802-825.
- **What are the major research topics in AI for Sustainable finance?**
  - Kumar, S., Sharma, D., Rao, S., Lim, W. M., & Mangla, S. K. (2022). Past, present, and future of sustainable finance: Insights from big data analytics through machine learning of scholarly research. Annals of Operations Research, 1-44.

Acknowledgments: Research Projects

1. **Applying AI technology to construct knowledge graphs of cryptocurrency anti-money laundering: a few-shot learning model**
   - MOST, 110-2410-H-305-013-MY2, 2021/08/01~2023/07/31
2. **Fintech Green Finance for Carbon Market Index, Corporate Finance, and Environmental Policies.** Carbon Emission Sentiment Index with AI Text Analytics
   - NTPU, 112-NTPU_ORDA-F-003，2023/01/01~2024/12/31
3. **Research on speech processing, synthesis, recognition, and sentence construction of people with language disabilities.** Multimodal Cross-lingual Task-Oriented Dialogue System
   - NTPU, 112-NTPU_ORDA-F-004, 2023/01/01~2025/12/31
4. **Use deep learning to identify commercially dental implant systems - observational study**
   - USTP-NTPU-TMU, USTP-NTPU-TMU-112-01, 2023/01/01~2023/12/31
5. **Metaverse Avatar Automatic Metadata Generation Module**
   - FormosaVerse x NTPU, NTPU-111A413E01, 2022/12/01~2023/11/30
6. **Establishment and Implement of Smart Assistive Technology for Dementia Care and Its Socio-Economic Impacts.** Intelligent, individualized and precise care with smart AT and system integration
   - MOST, 111-2627-M-038-001-, 2022/08/01~2023/07/31

Summary

1. 生成式AI的基本概念

   Basic Concepts of Generative AI

2. ChatGPT的基本原理和功能

   Basic Principles and Functions of ChatGPT

3. 生成式AI在永續發展的應用

   Generative AI for ESG and Sustainable Development

4. AI在永續發展上的議題

   Issues of AI for Sustainable Development

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- Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.
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Q & A

生成式AI在永續發展的應用

Generative AI and ChatGPT for ESG and Sustainable Development

Time: 2023.04.27 (Thu) 12:10-13:30
Place: USR HUB, Office of Sustainability, NTPU
Host: Office of Sustainability, NTPU
https://forms.gle/vYVvYBT6y1ik4RtN7

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