

# Artificial Intelligence

# Generative AI, Philosophy and Ethics of AI and the Future of AI

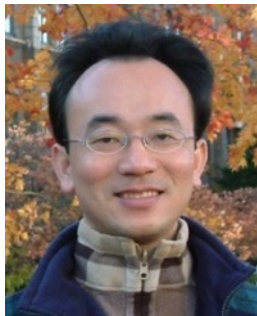
1131AI09

MBA, IM, NTPU (M5276) (Fall 2024)  
Tue 2, 3, 4 (9:10-12:00) (B3F17)



<https://meet.google.com/paj-zhji-mya>

aws  
educate | Cloud  
Ambassador  
2020 Cohort



Min-Yuh Day, Ph.D.  
Professor

Institute of Information Management, National Taipei University

<https://web.ntpu.edu.tw/~myday>



# Syllabus

**Week Date Subject/Topics**

**1 2024/09/10 Introduction to Artificial Intelligence**

2 2024/09/17 Mid-Autumn Festival (Day off)

**3 2024/09/24 Artificial Intelligence and Intelligent Agents; Problem Solving**

**4 2024/10/01 Knowledge, Reasoning and Knowledge Representation;  
Uncertain Knowledge and Reasoning**

**5 2024/10/08 Case Study on Artificial Intelligence I**

**6 2024/10/15 Machine Learning: Supervised and Unsupervised Learning**

# Syllabus

**Week Date Subject/Topics**

**7 2024/10/22 The Theory of Learning and Ensemble Learning**

**8 2024/10/29 Midterm Project Report**

9 2024/11/05 Self-Learning

**10 2024/11/12 Deep Learning and Reinforcement Learning**

**11 2024/11/19 Case Study on Artificial Intelligence II**

**12 2024/11/26 Deep Learning for Natural Language Processing**

# Syllabus

**Week Date Subject/Topics**

**13 2024/12/03 Computer Vision and Robotics**

**14 2024/12/10 Generative AI,  
Philosophy and Ethics of AI and the Future of AI**

**15 2024/12/17 Final Project Report I**

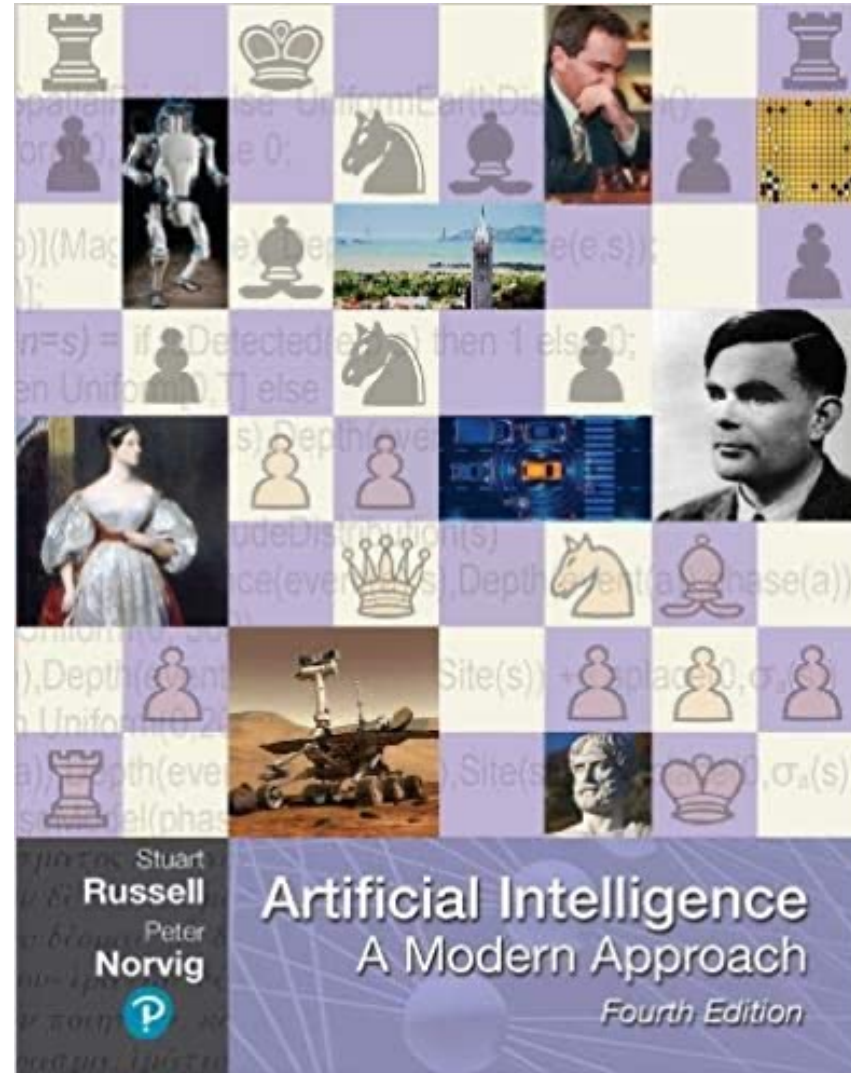
**16 2024/12/24 Final Project Report II**

**Generative AI,  
Philosophy and  
Ethics of AI  
and  
the Future of AI**

# Outline

- **Generative AI**
- **Philosophy, Ethics, and Safety of AI**
  - **The Limits of AI**
  - **Can Machines Really Think?**
  - **The Ethics of AI**
- **The Future of AI**
  - **AI Components**
  - **AI Architectures**

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



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

<https://www.amazon.com/Artificial-Intelligence-A-Modern-Approach/dp/0134610997/>

# Artificial Intelligence: A Modern Approach

- 1. Artificial Intelligence**
- 2. Problem Solving**
- 3. Knowledge and Reasoning**
- 4. Uncertain Knowledge and Reasoning**
- 5. Machine Learning**
- 6. Communicating, Perceiving, and Acting**
- 7. Philosophy and Ethics of AI**

# Artificial Intelligence:

## 7. Philosophy and Ethics of AI

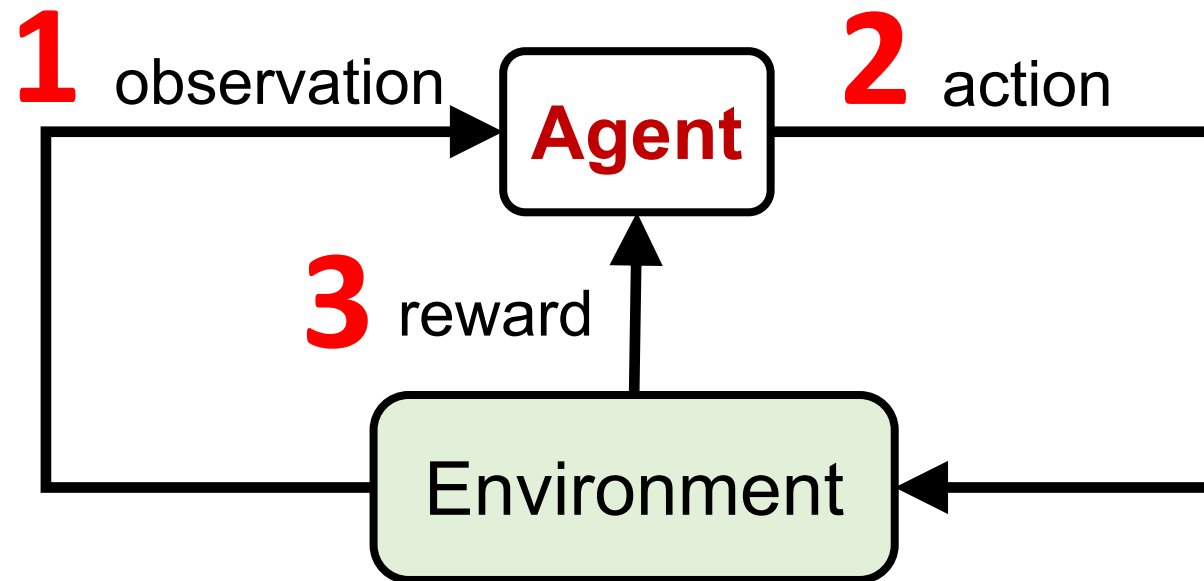
- **Philosophy, Ethics, and Safety of AI**
  - **The Limits of AI**
  - **Can Machines Really Think?**
  - **The Ethics of AI**
- **The Future of AI**
  - **AI Components**
  - **AI Architectures**

# Reinforcement Learning (DL)

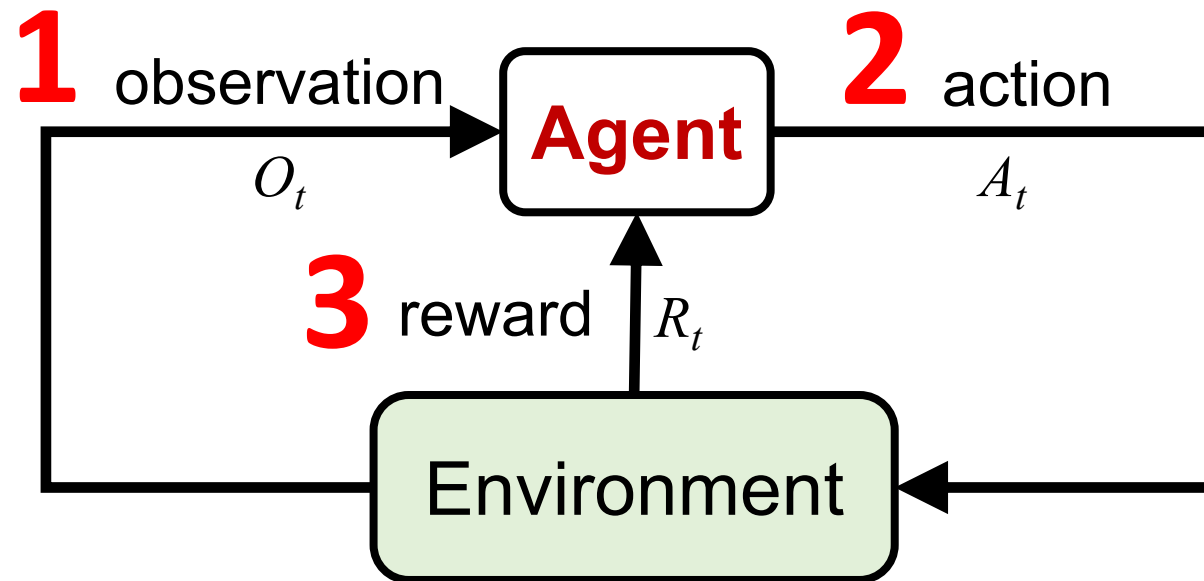
**Agent**

Environment

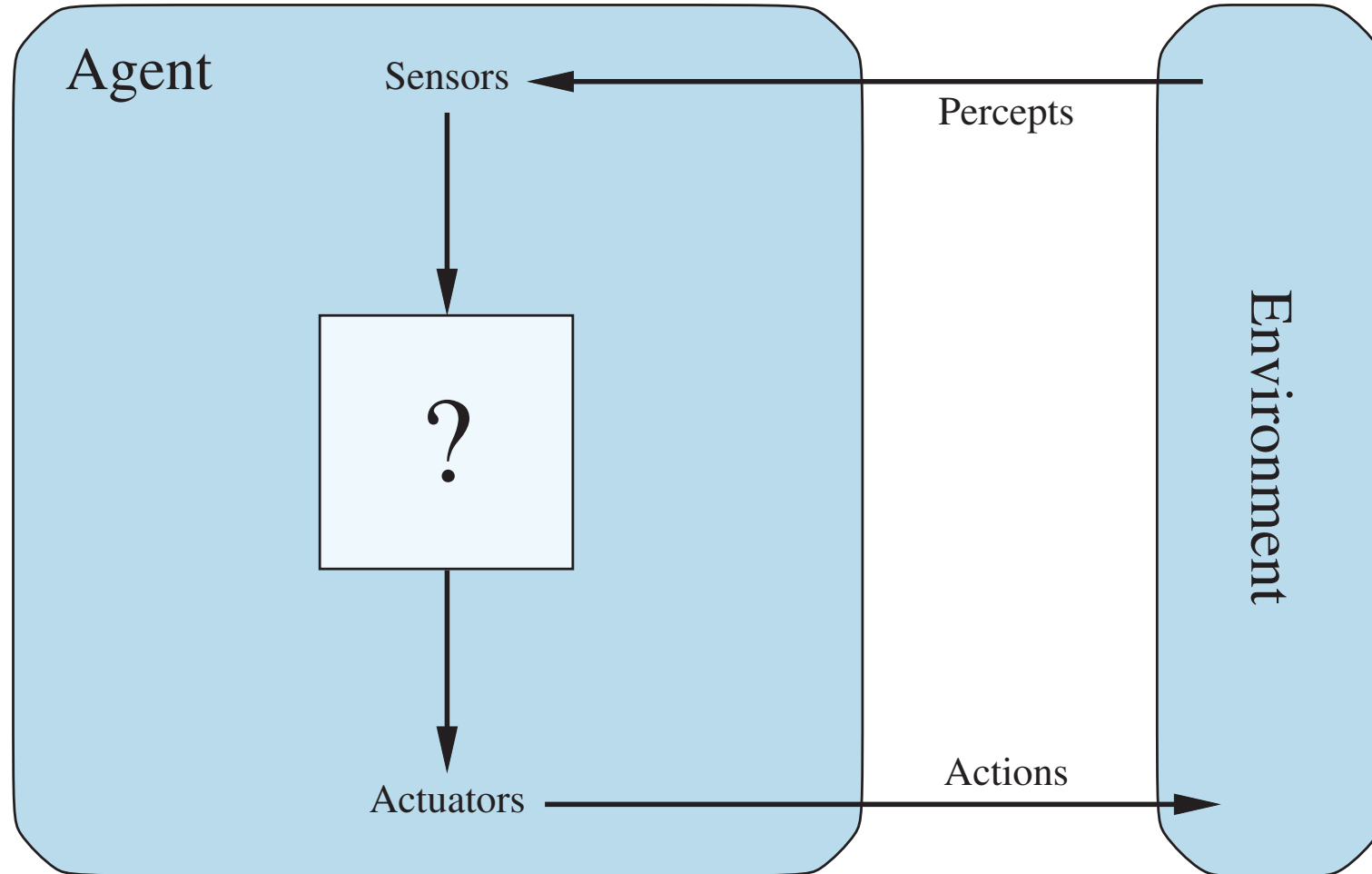
# Reinforcement Learning (DL)



# Reinforcement Learning (DL)



# Agents interact with environments through sensors and actuators



# 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

# **Generative AI**

# **Large Language Models**

# **(LLMs)**

# **Foundation Models**

# NVIDIA Developer Program

<https://developer.nvidia.com/join-nvidia-developer-program>

## NVIDIA

## Deep Learning Institute (DLI)

<https://learn.nvidia.com/>

# Join the NVIDIA Developer Program

take one of the  
complimentary  
technical self-  
paced courses  
(worth up to \$90)

8 hours

## Getting Started With Deep Learning

Explore the fundamentals of deep learning by training neural networks and using results to improve performance and capabilities.

2 hours

## Modeling Time-Series Data With Recurrent Neural Networks in Keras

Explore how to classify and forecast time-series data using recurrent neural networks (RNNs), such as modeling a patient's health over time.

4 hours

## Deploying a Model for Inference at Production Scale

Learn how to deploy your own machine learning models on a GPU server.

8 hours

## Building Real-Time Video AI Applications

Gain the knowledge and skills needed to enable the real-time transformation of raw video data from widely deployed camera sensors into deep learning-based insights.

2 hours

## Introduction to Graph Neural Networks

Learn the basic concepts, models, and applications of graph neural networks.

4 hours

## Introduction to Physics-Informed Machine Learning With Modulus

Learn the various building blocks of NVIDIA Modulus, which turbocharges use cases by building physics-based deep learning models that are 100,000X faster than traditional methods and offers high-fidelity simulation results.

2 hours

## Get Started With Highly Accurate Custom ASR for Speech AI

Learn to build, train, fine-tune, and deploy a GPU-accelerated automatic speech recognition (ASR) service with NVIDIA® Riva that includes customized features.

2 hours

## Integrating Sensors With NVIDIA DRIVE

Find out how to integrate automotive sensors into your applications using NVIDIA DRIVE®.

# NVIDIA Deep Learning Institute (DLI)

Self-Paced Course

**Generative AI Explained**

Free  
2 hours

Self-Paced Course

**Getting Started With Deep Learning**

Certificate available  
\$90  
8 hours

Instructor-Led Workshop

**Fundamentals of Deep Learning**

Certificate available  
\$500  
8 hours

Self-Paced Course

**Introduction to Transformer-Based Natural Language Processing**

Certificate available  
\$30  
6 hours

Self-Paced Course

**Building RAG Agents With LLMs**

Certificate available  
Free  
8 hours

Instructor-Led Workshop

**Building RAG Agents With LLMs**

Certificate available  
\$500  
8 hours

Self-Paced Course

**Generative AI with Diffusion Models**

Certificate available  
\$90  
8 hours

Instructor-Led Workshop

**Generative AI with Diffusion Models**

Certificate available  
\$500  
8 hours

## What do you want to learn today?

### Filters

Level +

Format +

Topics -

- Deep Learning
- Accelerated Computing
- Generative AI/LLM
- Graphics and Simulation
- OpenUSD
- Data Science
- NIMS
- NIM
- RAPIDS

Free / Paid +

Language +

Generative AI



Sort by: -- ▾

Showing 19 results

Generative AI x

# Generative AI

## All Courses

Self-paced

Generative AI Explained

Free  
02:00

Self-paced

Generative AI with Diffusion Models

\$90  
08:00

Instructor-Led

Generative AI with Diffusion Models

08:00

Self-paced

Augment your LLM Using

Self-paced

Introduction to Transformer-

Instructor-Led

Rapid Application

# Generative AI Explained

Self-paced Course

## Generative AI Explained

In this no-coding course, learn Generative AI concepts and applications, as well as the challenges and opportunities in this exciting field.

[About Course](#)[Objectives](#)[Topics Covered](#)[Course Outline](#)[Stay Informed](#)[Contact Us](#)[Continue Learning](#)

## About this Course

Generative AI describes technologies that are used to generate new content based on a variety of inputs. In recent time, Generative AI involves the use of neural networks to identify patterns and structures within existing data to generate new content. In this course, you will learn Generative AI concepts, applications, as well as the challenges and opportunities in this exciting field.

## Learning Objectives

Upon completion, you will have a basic understanding of Generative AI and be able to more effectively use the various tools built on this

## Course Details

**Duration:** 02:00

**Price:** Free

**Level:** Technical - Beginner

**Subject:** Generative AI/LLM

**Language:** English

[https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-15+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-15+V1)

# Introduction to Transformer-Based Natural Language Processing

## Self-paced Course

## Introduction to Transformer-Based Natural Language Processing

Learn how Transformers are used as the building blocks of modern large language models (LLMs). You'll then use these models for various NLP tasks, including text classification, named-entity recognition (NER), author attribution, and question answering.

[About Course](#)[Objectives](#)[Topics Covered](#)[Course Outline](#)[Stay Informed](#)[Contact Us](#)[Continue Learning](#)

## About this Course

Large Language Models (LLMs), or Transformers, have revolutionized the field of natural language processing (NLP). Driven by recent advancements, applications of NLP and generative AI have exploded in the past decade. With the proliferation of applications like chatbots and intelligent virtual assistants, organizations are infusing their businesses with more interactive human-machine experiences. Understanding how Transformer-based large language models (LLMs) can be used to manipulate, analyze, and generate text-based data is essential. Modern pre-trained LLMs can encapsulate the nuance, context, and sophistication of language, just as humans do. When fine-tuned and deployed correctly, developers can use these LLMs to build powerful NLP applications that provide natural and seamless human-computer interactions within chatbots, AI voice agents, and more. In this course, you'll learn how Transformers are used as the building blocks of modern large language models (LLMs). You'll then use these models for various NLP

## Course Details

**Duration:** 06:00**Price:** \$30**Level:** Technical - Beginner**Subject:** Generative AI/LLM**Language:** English

[https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-08+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-08+V1)

# Building RAG Agents with LLMs

Deep Learning Institute Find Training Self Paced Courses Instructor-Led Workshops Educator Programs Enterprise Solutions Certification Resources

Self-paced Course

## Building RAG Agents with LLMs

Agents powered by large language models (LLMs) have shown great retrieval capability for using tools, looking at documents, and plan their approaches. This course will show you how to deploy an agent system in practice with the flexibility to scale up your system to meet the demands of users and customers.



About Course Objectives Topics Covered Course Outline Stay Informed Contact Us

Continue Learning

## About this Course

This course is free for a limited time.

The evolution and adoption of large language models (LLMs) have been nothing short of revolutionary, with retrieval-based systems at the forefront of this technological leap. These models are not just tools for automation; they are partners in enhancing productivity, capable of holding informed conversations by interacting with a vast array of tools and documents. This course is designed for those eager to explore the potential of these systems, focusing on practical deployment and the efficient implementation required to manage the considerable demands of both users and deep learning models. As we delve into the intricacies of LLMs, participants will gain insights into advanced orchestration techniques that include internal reasoning, dialog management, and effective tooling strategies.

## Course Details

**Duration:** 08:00

**Price:** Free

**Level:** Technical - Intermediate

**Subject:** Generative AI/LLM

**Language:** English

**Course Prerequisites:**

Introductory deep learning knowledge, with comfort

[https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-15+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-15+V1)

Self-paced Course

## Generative AI with Diffusion Models

Take a deeper dive into denoising diffusion models, which are a popular choice for text-to-image pipelines, with applications in creative content generation, data augmentation, simulation and planning, anomaly detection, drug discovery, personalized recommendations, and more.

[About Course](#)[Objectives](#)[Topics Covered](#)[Course Outline](#)[Stay Informed](#)[Contact Us](#)[Continue Learning](#)

## About this Course

Thanks to improvements in computing power and scientific theory, generative AI is more accessible than ever before. Generative AI plays a significant role across industries due to its numerous applications, such as creative content generation, data augmentation, simulation and planning, anomaly detection, drug discovery, personalized recommendations, and more. In this course, learners will take a deeper dive into denoising diffusion models, which are a popular choice for text-to-image pipelines.

## Learning Objectives

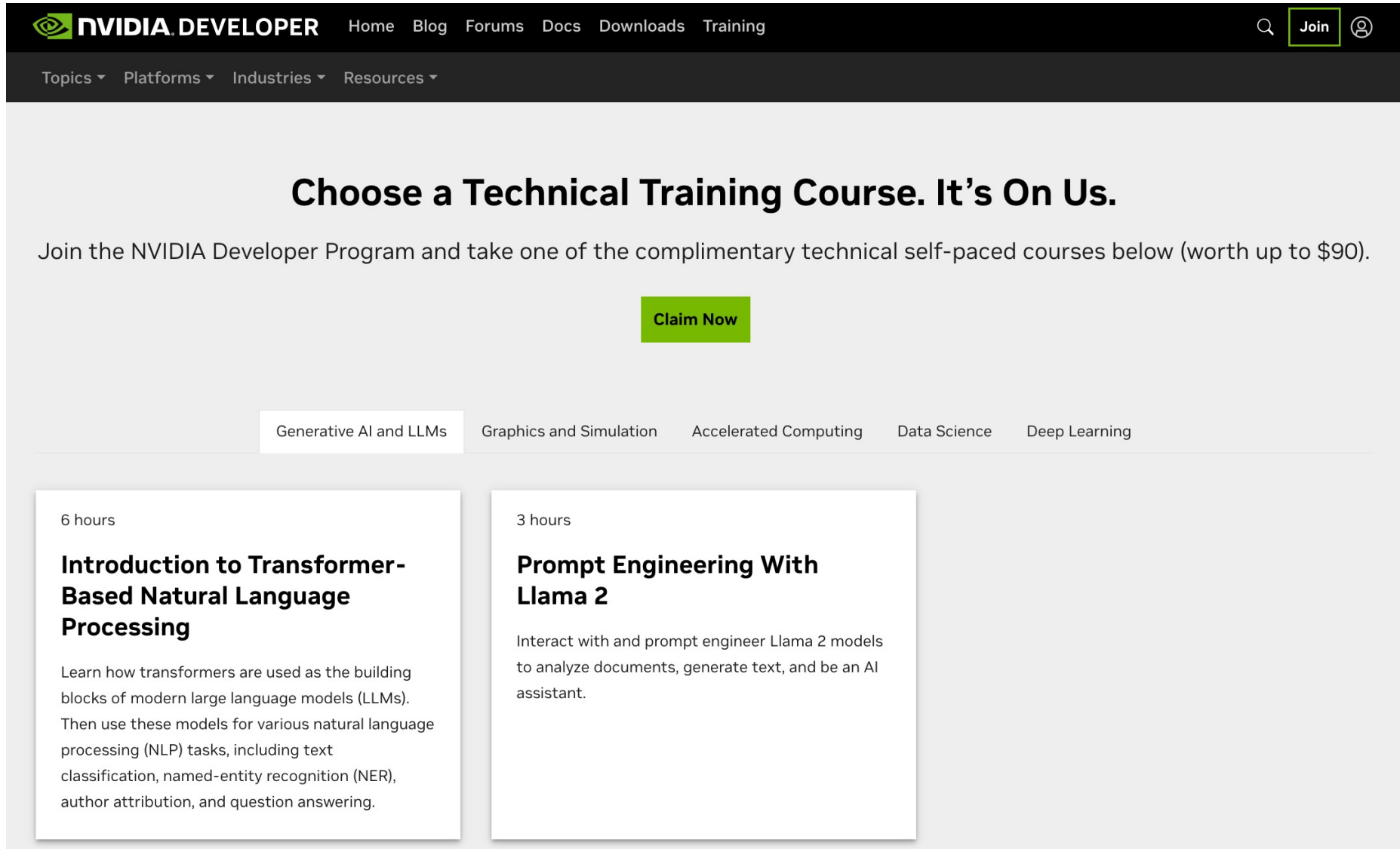
[https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-14+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-14+V1)

## Course Details

**Duration:** 08:00**Price:** \$90**Subject:** Generative AI/LLM**Language:** English**Course Prerequisites:**A basic understanding of [Deep Learning Concepts](#).

# Join the NVIDIA Developer Program

take one of the complimentary technical self-paced courses (worth up to \$90)



The screenshot shows the NVIDIA Developer Program website. At the top, there is a navigation bar with the NVIDIA logo, the text "NVIDIA DEVELOPER", and links for Home, Blog, Forums, Docs, Downloads, and Training. A search icon and a "Join" button are also present. Below the navigation bar, there are dropdown menus for Topics, Platforms, Industries, and Resources. The main content area features a large heading "Choose a Technical Training Course. It's On Us." followed by a sub-heading "Join the NVIDIA Developer Program and take one of the complimentary technical self-paced courses below (worth up to \$90)." and a prominent green "Claim Now" button. Below this, there are several category tabs: "Generative AI and LLMs", "Graphics and Simulation", "Accelerated Computing", "Data Science", and "Deep Learning". The "Generative AI and LLMs" tab is selected. Two course cards are displayed: "Introduction to Transformer-Based Natural Language Processing" (6 hours) and "Prompt Engineering With Llama 2" (3 hours). The first card describes learning about transformers and their use in NLP tasks like text classification and question answering. The second card describes interacting with and engineering Llama 2 models for tasks like document analysis and AI assistance.

**NVIDIA DEVELOPER** Home Blog Forums Docs Downloads Training

Topics ▾ Platforms ▾ Industries ▾ Resources ▾

## Choose a Technical Training Course. It's On Us.

Join the NVIDIA Developer Program and take one of the complimentary technical self-paced courses below (worth up to \$90).

**Claim Now**

Generative AI and LLMs Graphics and Simulation Accelerated Computing Data Science Deep Learning

6 hours

### Introduction to Transformer-Based Natural Language Processing

Learn how transformers are used as the building blocks of modern large language models (LLMs). Then use these models for various natural language processing (NLP) tasks, including text classification, named-entity recognition (NER), author attribution, and question answering.

3 hours

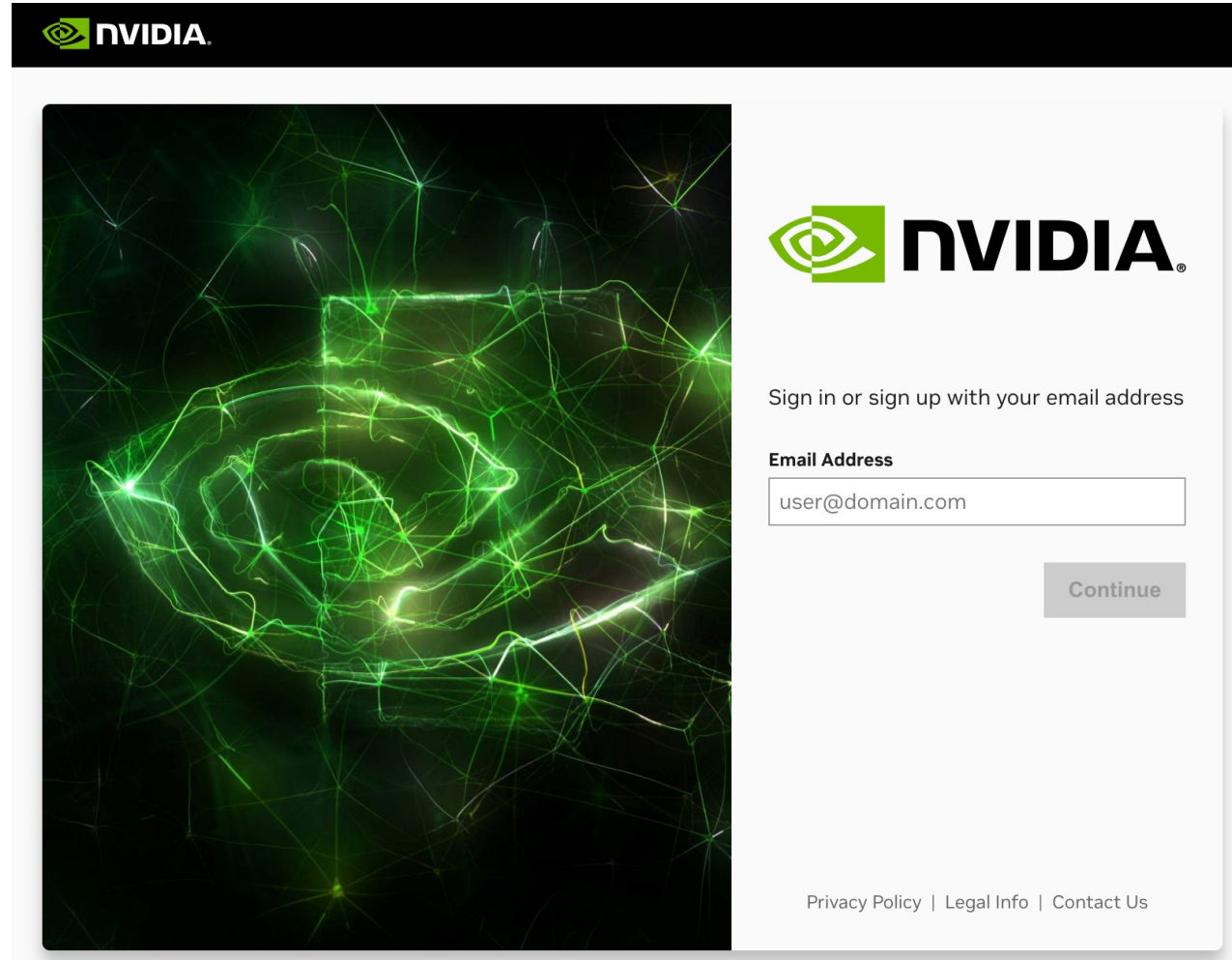
### Prompt Engineering With Llama 2

Interact with and prompt engineer Llama 2 models to analyze documents, generate text, and be an AI assistant.

<https://developer.nvidia.com/join-nvidia-developer-program>

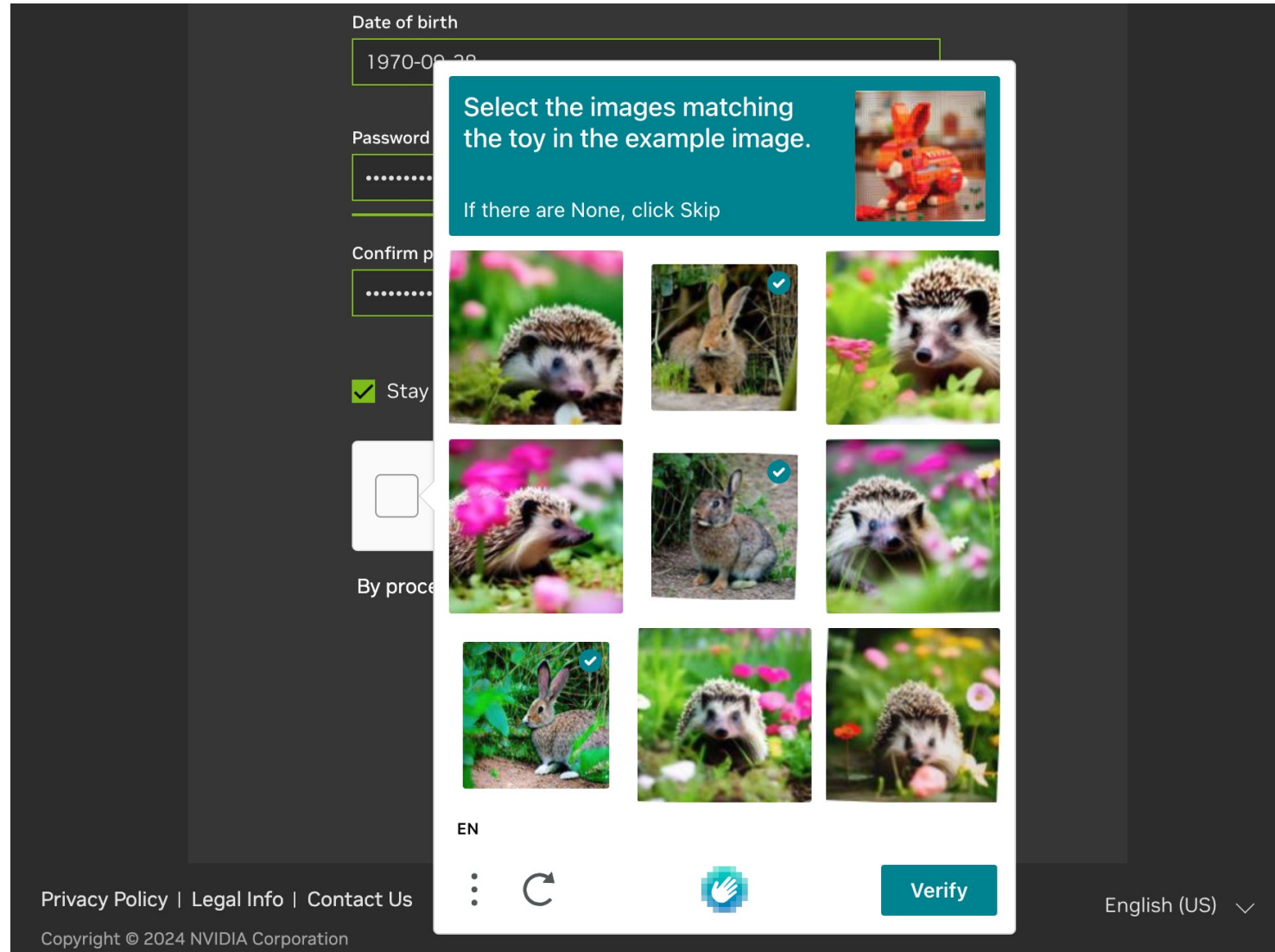
# Join the NVIDIA Developer Program

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# Join the NVIDIA Developer Program

take one of the complimentary technical self-paced courses (worth up to \$90)



The screenshot shows a registration form with fields for Date of birth (1970-00-20), Password, and Confirm password. A CAPTCHA challenge is displayed in a white box over the form. The challenge text reads: "Select the images matching the toy in the example image. If there are None, click Skip". The example image is a red toy rabbit. Below the text are nine images of hedgehogs and rabbits. Three images of rabbits are marked with a blue checkmark, indicating they are the correct matches. At the bottom of the CAPTCHA box are icons for a menu, a refresh button, a hand icon, and a "Verify" button. The background of the registration page is dark grey. At the bottom left of the page, there are links for "Privacy Policy | Legal Info | Contact Us" and "Copyright © 2024 NVIDIA Corporation". At the bottom right, there is a language selector set to "English (US)".

<https://developer.nvidia.com/join-nvidia-developer-program>

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 NVIDIA. DEVELOPER DEEP LEARNING INSTITUTE PROGRAM BENEFITS

## SELECT YOUR FREE COURSE.


Thank you for your participation in the NVIDIA Developer Program. Please select your free DLI course below.

English ▾


- Integrating Sensors with NVIDIA DRIVE®
- Getting Started with Deep Learning
- Deploying a Model for Inference at Production Scale
- Get Started with Highly Accurate Custom ASR for Speech AI
- Introduction to Graph Neural Networks
- Introduction to Transformer-Based Natural Language Processing
- Prompt Engineering with LLaMA-2 (Access Expires Dec. 5th 2025)
- Generative AI with Diffusion Models**
- Building Real-Time Video AI Applications
- Introduction to Robotic Simulations in Isaac Sim

### Generative AI with Diffusion Models

Take a deeper dive into denoising diffusion models, which are a popular choice for text-to-image pipelines, with applications in creative content generation, data augmentation, simulation and planning, anomaly detection, drug discovery, personalized recommendations, and more.

 Certificate Available

---

 Duration: 08:00

[Continue >](#)

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## SELECT YOUR FREE COURSE.


Thank you for your participation in the NVIDIA Developer Program. Please select your free DLI course below.

English ▾


- Modeling Time Series Data with Recurrent Neural Networks in Keras (Access ends 10/16/2024)
- Optimizing CUDA Machine Learning Codes With Nsight Profiling Tools
- Getting Started with Accelerated Computing in CUDA C/C++
- Fundamentals of Accelerated Computing with CUDA Python
- Fundamentals of Accelerated Computing with OpenACC
- Integrating Sensors with NVIDIA DRIVE®
- Getting Started with Deep Learning**
- Deploying a Model for Inference at Production Scale
- Get Started with Highly Accurate Custom ASR for Speech AI

### Getting Started with Deep Learning

Learn how deep learning works through hands-on exercises in computer vision and natural language processing.

 Certificate Available

---

 Duration: 08:00

[Continue >](#)

# Join the NVIDIA Developer Program

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 NVIDIA DEVELOPER DEEP LEARNING INSTITUTE PROGRAM BENEFITS

## SELECT YOUR FREE COURSE.

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English

Get Started with Highly Accurate Custom ASR for Speech AI

Introduction to Graph Neural Networks

Introduction to Transformer-Based Natural Language Processing

Prompt Engineering with LLaMA-2 (Access Expires Dec. 5th 2025)

Generative AI with Diffusion Models

Building Real-Time Video AI Applications

Introduction to Robotic Simulations in Isaac Sim

Introduction to Physics-informed Machine Learning with Modulus

Essentials of USD in Omniverse: Access Expires 09/18/2025

Synthetic Data Generation for Training Computer Vision Models

### Generative AI with Diffusion Models

Take a deeper dive into denoising diffusion models, which are a popular choice for text-to-image pipelines, with applications in creative content generation, data augmentation, simulation and planning, anomaly detection, drug discovery, personalized recommendations, and more.


 Certificate Available

 Duration: 08:00

Continue >

# NVIDIA Deep Learning Institute (DLI)

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Search 

### Monthly Activity

Skill Points	0
Time Spent	
Courses in Progress	1
Courses Completed	0
Watched Videos	
Assessments	

### Skills

### Certificates

  
No Certificates  
You don't have any certificates yet.

## Courses in Progress

Self-paced

**Generative AI with Diffusion Models**

0% Completed  
08:00

## Generative AI with Diffusion Models

[Course](#) [Progress](#) [Bookmarks](#) [Updates](#)

Generative AI with Diffusion Models &gt; Start Here &gt; 0: Server Access

Generative AI with Diffusion Models

[Start Here](#)[Next Steps](#)[Feedback](#)[Previous](#)[Next](#)

### 0: Server Access

[Bookmark this page](#)

Welcome to Generative AI with Diffusion Models. Please click "Next" below to get started.

Underneath each video is a link to start your own private server for hands-on coding practice. Click the "Start" button to boot up the server. In a few minutes after the server is done loading, click "Launch" to access the code labs.

#### 1: From U-Nets to Diffusion

[Bookmark this page](#)

Theory

<https://learn.nvidia.com/my-learning>

Search



## Monthly Activity

Skill Points 0

Time Spent

Courses in Progress 7

Courses Completed 6

## Skills

## Certificates



Introduction to  
Transformer-  
Based Natural  
Language  
Processing



Building RAG  
Agents with  
LLMs

## Completed Courses

View more

Self-paced

Sizing LLM Inference Systems

100% Completed  
03:00

Self-paced

Augment your LLM Using  
Retrieval Augmented  
Generation

100% Completed  
01:00

Self-paced

Building RAG Agents with  
LLMs

100% Completed  
08:00

Self-paced

Generative AI Explained

100% Completed  
02:00

Self-paced

Introduction to Transform  
Based Natural Language  
Processing

100% Completed  
06:00

## All Self-Paced Courses

Accelerated Computing Data Science Deep Learning **Generative AI/LLM** Graphics and Simulation Infrastructure[Share Generative AI/LLM Courses](#)

<b>Self-paced</b> Generative AI Explained  Free 02:00	<b>Self-paced</b> Introduction to NVIDIA NIM™ Microservices  Free 02:00	<b>Self-paced</b> Introduction to Deploying RAG Pipelines for Production at Scale  \$90 03:00	<b>Self-paced</b> Generative AI with Diffusion Models  \$90 08:00
<b>Self-paced</b> Techniques for Improving the Effectiveness of RAG Systems  \$30 03:00	<b>Self-paced</b> Introduction to Transformer- Based Natural Language Processing  \$30 06:00	<b>Self-paced</b> Building LLM Applications With Prompt Engineering  \$90 08:00	<b>Self-paced</b> Synthetic Tabular Data Generation Using Transformers  \$30 04:00
<b>Self-paced</b> Sizing LLM Inference Systems  Free 03:00	<b>Self-paced</b> Building RAG Agents with LLMs  Free 08:00	<b>Self-paced</b> Augment your LLM Using Retrieval Augmented Generation  Free 01:00	

# NVIDIA Deep Learning Institute (DLI)



## Certificate of Competency

This certificate is awarded to

**Min-Yuh Day**

for demonstrating competence in the completion of

**Introduction to Transformer-Based Natural Language Processing**

A handwritten signature in black ink, appearing to read "Greg Estes", written over a horizontal line.

**Greg Estes**

Vice President, NVIDIA

Issue Date: : December 5, 2024

Certification ID: twpWsrB4TDCQ0ErgAoEt6w |

[https://learn.nvidia.com/certificates?id=twpWsrB4TDCQ0ErgAoEt6w/courses/course?course\\_id=course-v1:DLI+S-FX-08+V1](https://learn.nvidia.com/certificates?id=twpWsrB4TDCQ0ErgAoEt6w/courses/course?course_id=course-v1:DLI+S-FX-08+V1)

<https://learn.nvidia.com/certificates?id=twpWsrB4TDCQ0ErgAoEt6w>



## Certificate of Completion

This certificate is awarded to

**Min-Yuh Day**

for successfully completing

**Building RAG Agents with LLMs**

A handwritten signature in black ink, appearing to read "Greg Estes", written over a horizontal line.

**Greg Estes**

Vice President, NVIDIA

Issue Date: : December 8, 2024

Certification ID: ed-qOCIMQatzU8SNUNxgw |

[https://learn.nvidia.com/certificates?id=ed-qOCIMQatzU8SNUNxgw/courses/course?course\\_id=course-v1:DLI+S-FX-15+V1](https://learn.nvidia.com/certificates?id=ed-qOCIMQatzU8SNUNxgw/courses/course?course_id=course-v1:DLI+S-FX-15+V1)

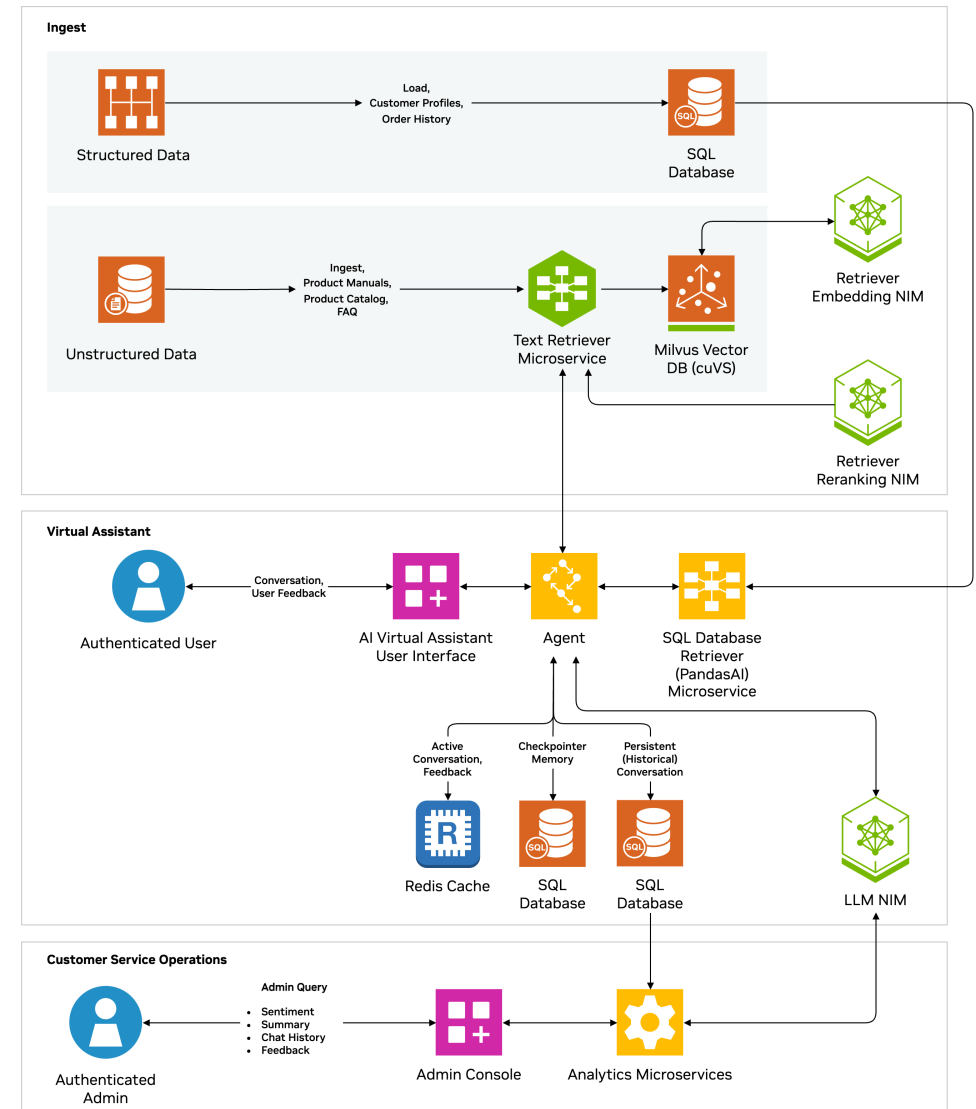
<https://learn.nvidia.com/certificates?id=ed-qOCIMQatzU8SNUNxgw>

# AI Virtual Assistant for Customer Service

AI Virtual Assistant to reduce handling time, boost customer satisfaction

## Benefits

- **Personalized Responses:** Handles structured and unstructured customer queries (e.g., order details, spending history).
- **Multi-Turn Dialogue:** Offers context-aware, seamless interactions across multiple questions.
- **Custom Conversation Style:** Adapts text responses to reflect corporate branding and tone.
- **Sentiment Analysis:** Analyzes real-time customer interactions to gauge sentiment and adjust responses.
- **Multi-Session Support:** Allows for multiple user sessions with conversation history and summaries.
- **Data Privacy:** Integrates with on-premises or cloud-hosted knowledge bases to protect sensitive data.

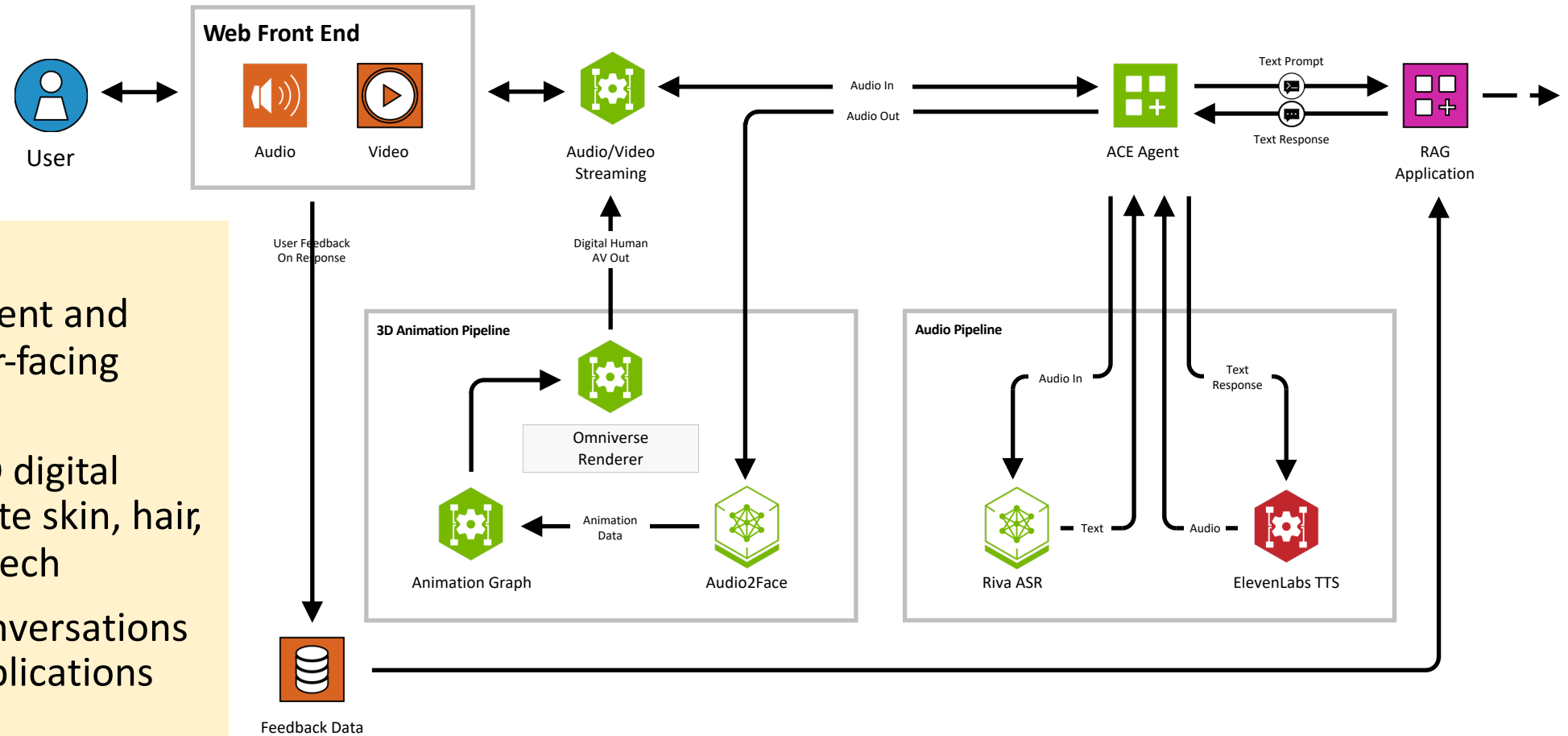


# Digital Humans for Customer Service

\$125B market for digital human economy by 2035

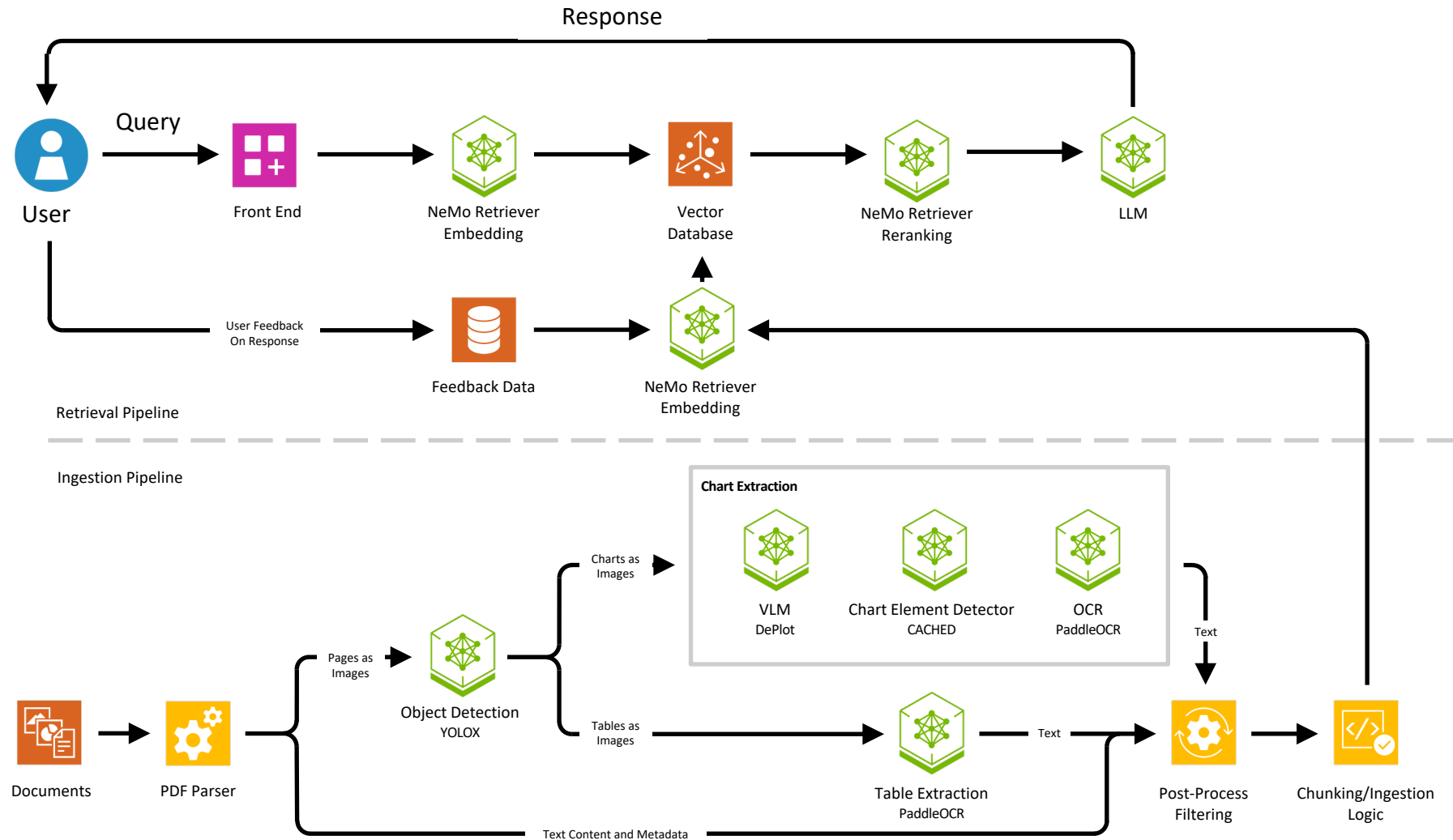
## Benefits

- Increases engagement and satisfaction for user-facing applications
- Creates a lifelike 3D digital human with accurate skin, hair, animation, and speech
- Enables natural conversations with enterprise applications and data



# Multimodal PDF Data Extraction for Enterprise RAG

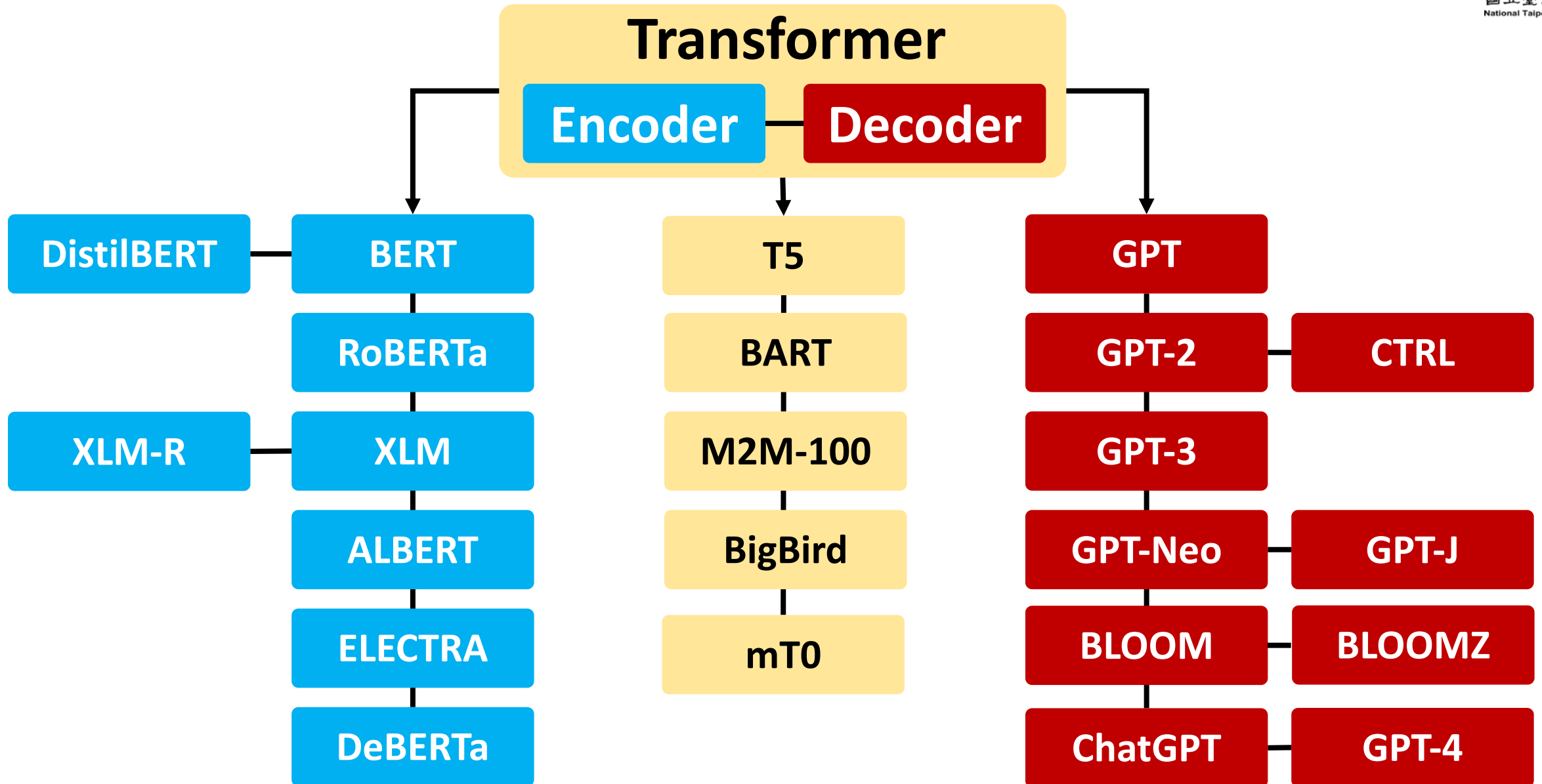
## Unlocks Knowledge from trillions of PDFs



### Benefits

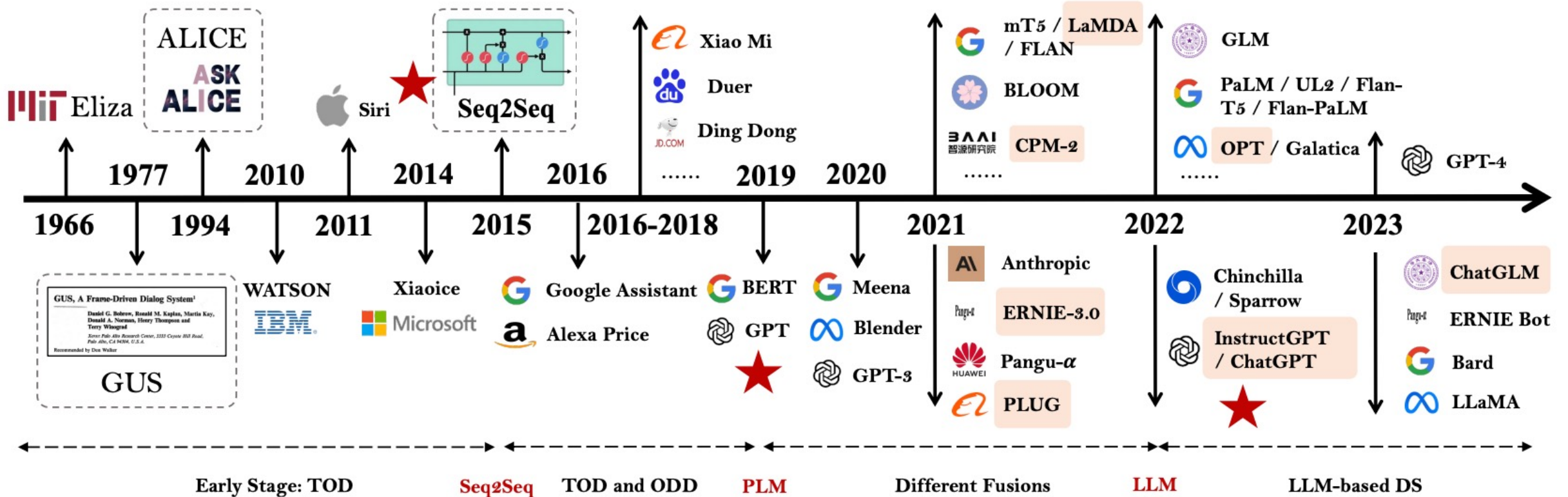
- Unlocks the next level of indexable enterprise data from text to images and charts
- High-accuracy extraction and responses
- Enterprise-scale PDF ingestion

# Transformer Models



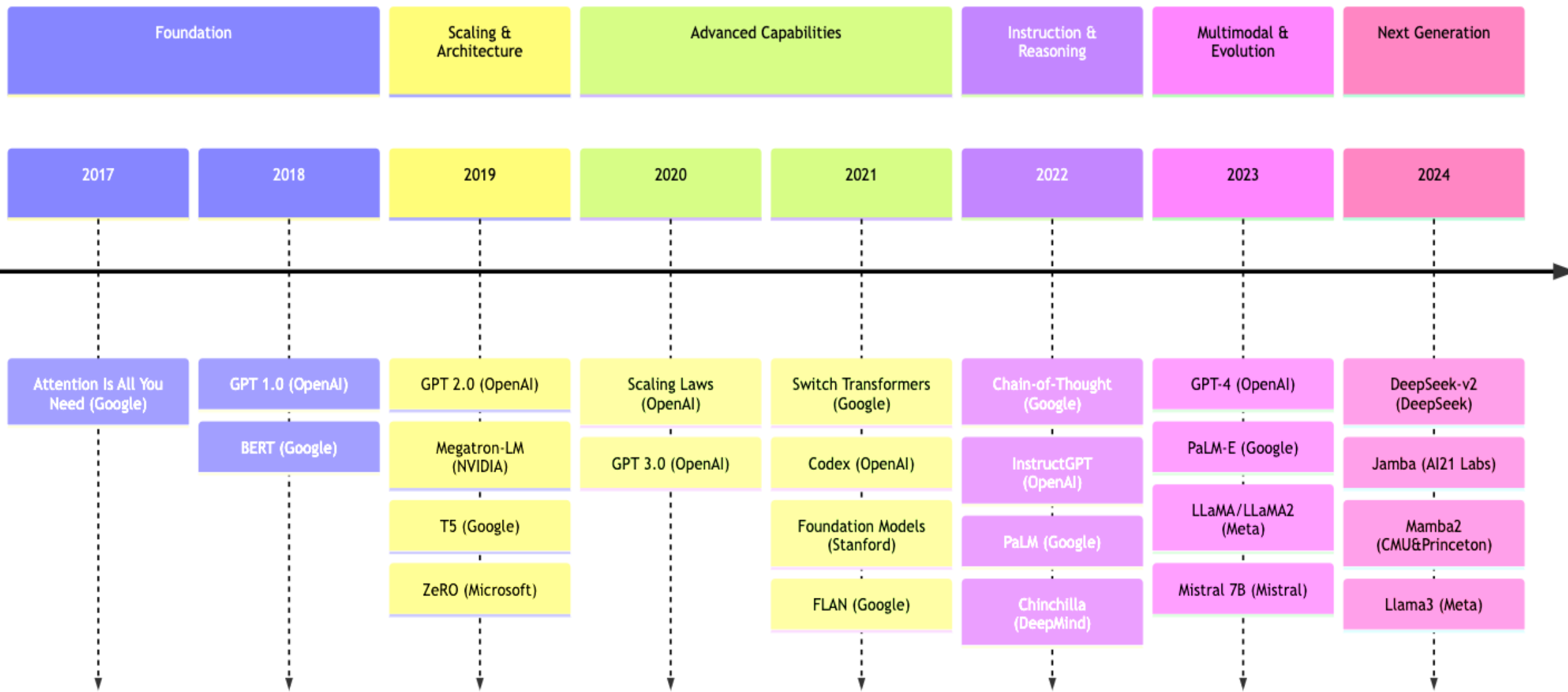
# The Development of LM-based Dialogue Systems

- 1) Early Stage (1966 - 2015)
- 2) The Independent Development of TOD and ODD (2015 - 2019)
- 3) Fusions of Dialogue Systems (2019 - 2022)
- 4) LLM-based DS (2022 - Now)

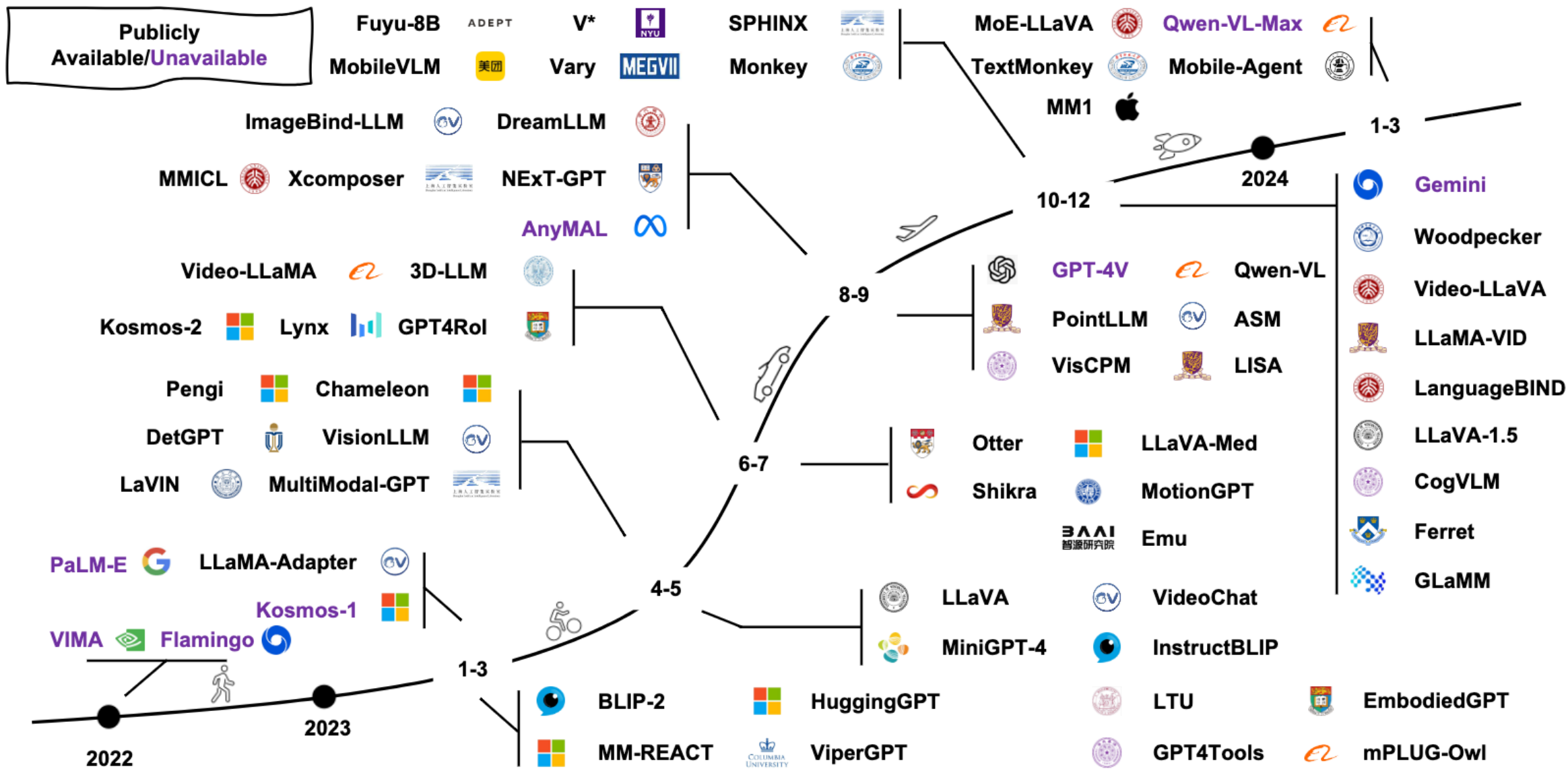


Task-oriented DS (TOD), Open-domain DS (ODD)

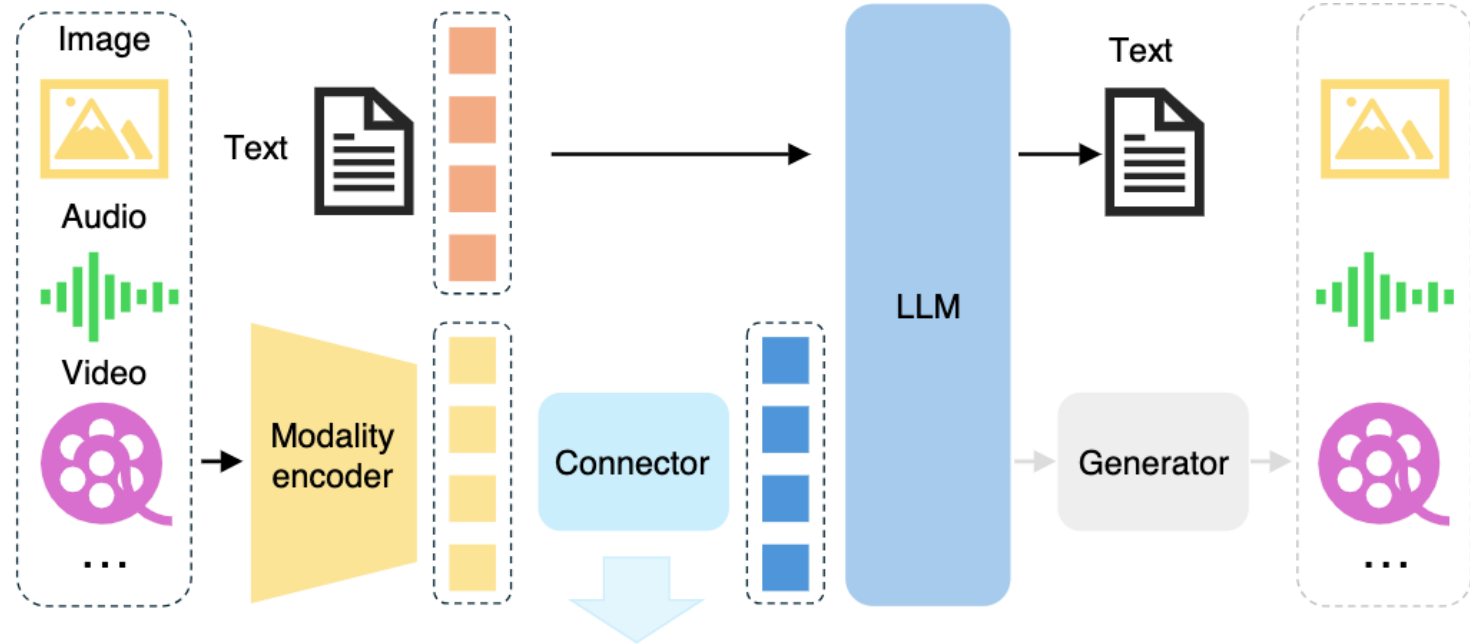
# Major GenAI LLMs Research Milestones (2017-2024)



# Multimodal Large Language Models (MLLM)



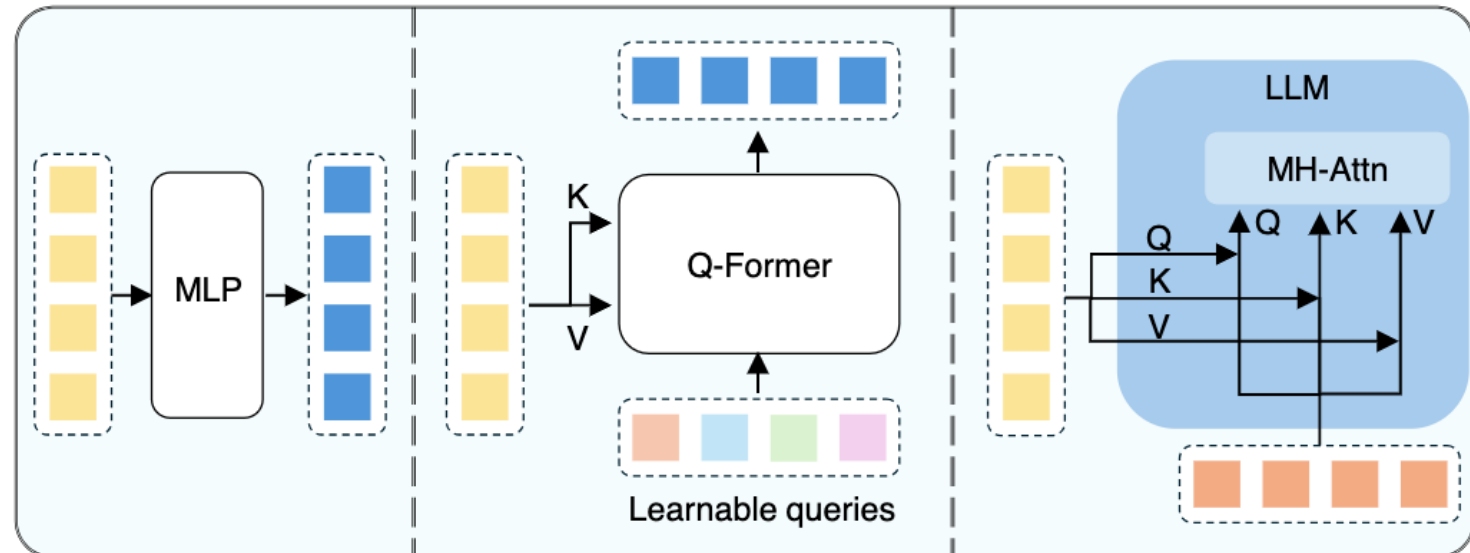
# Multimodal Large Language Models (MLLM)



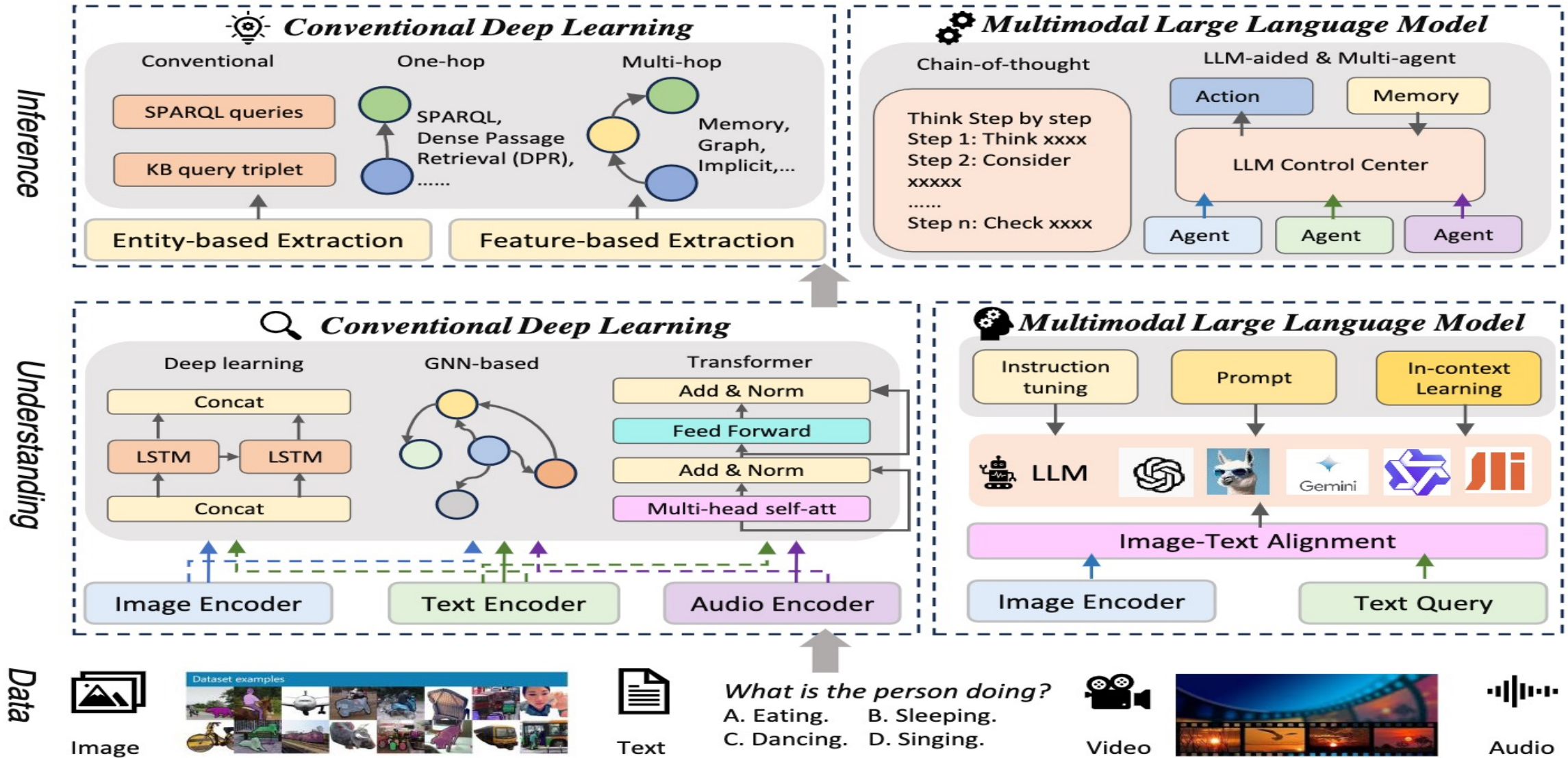
## Multimodal LLM

Three types of connectors:

1. projection-based
2. query-based
3. fusion-based connectors



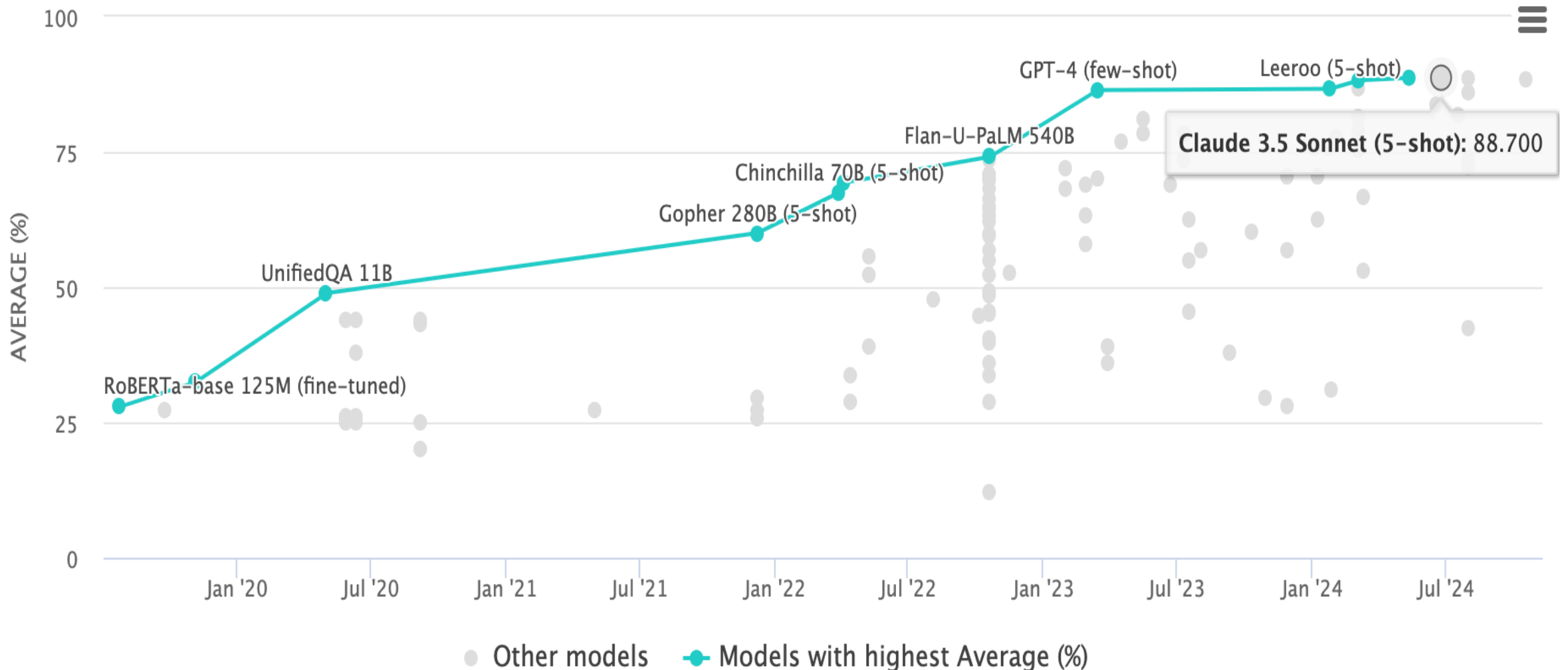
# Multimodal Large Language Model (MLLM) for Vision Question Answering



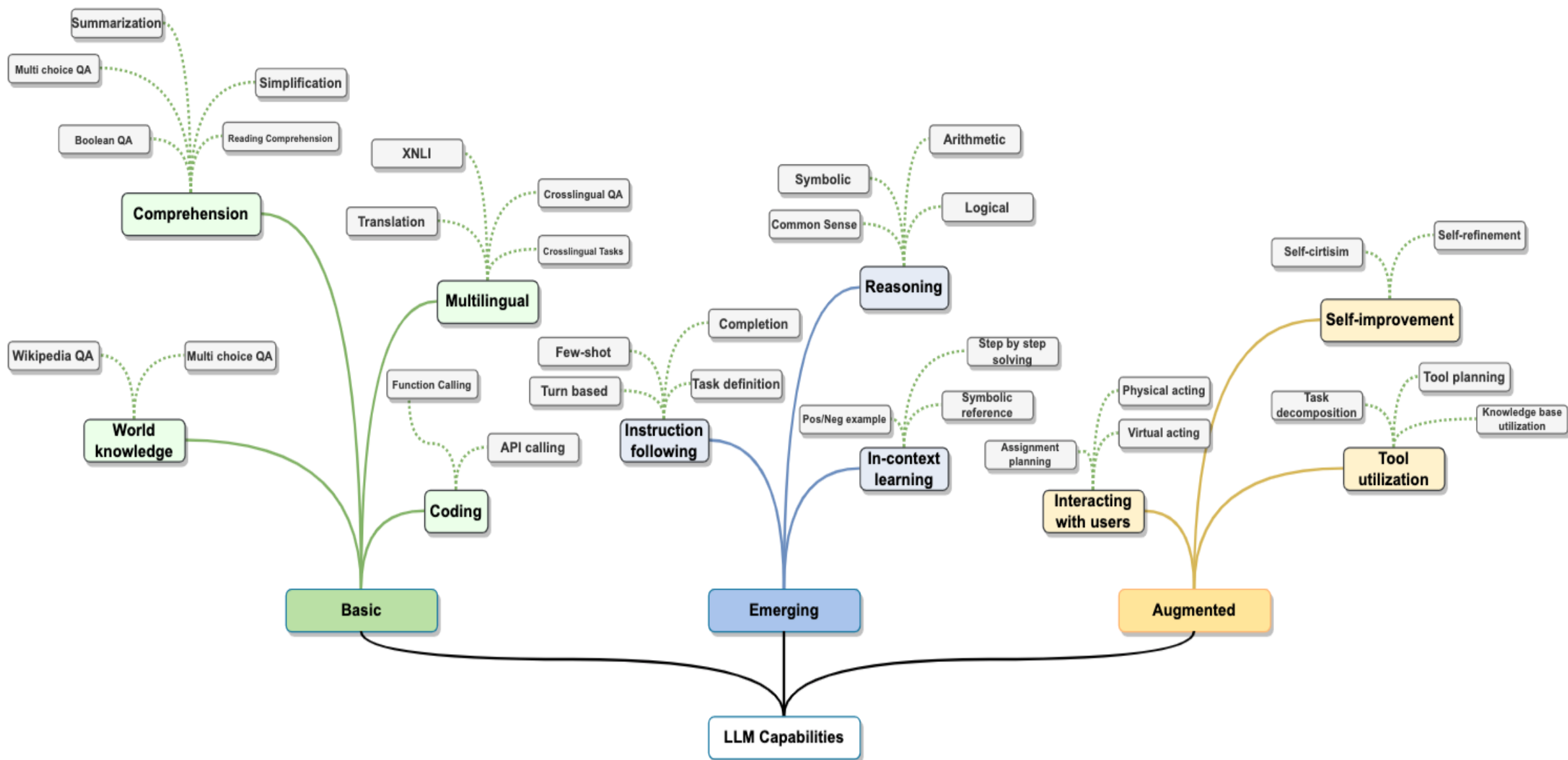
# Multi-task Language Understanding on MMLU

## GPT-4, Claude 3.5 Sonnet

### Massive Multitask Language Understanding (MMLU)

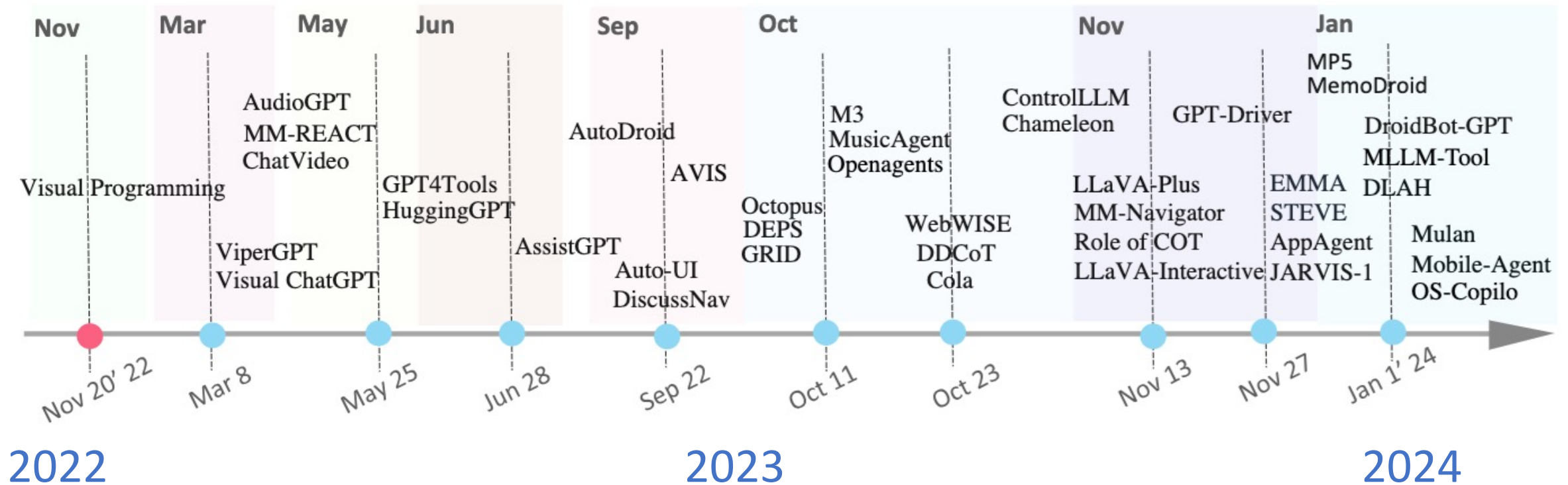


# LLM Capabilities


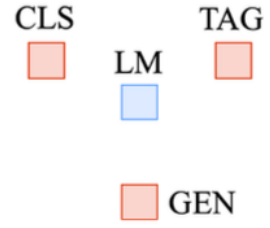
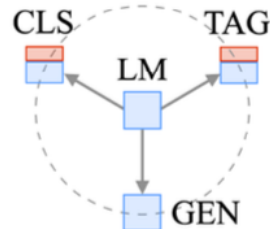
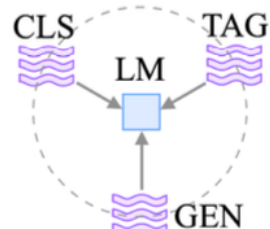


# LLM-powered Multimodal Agents

## Large Multimodal Agents (LMAs)

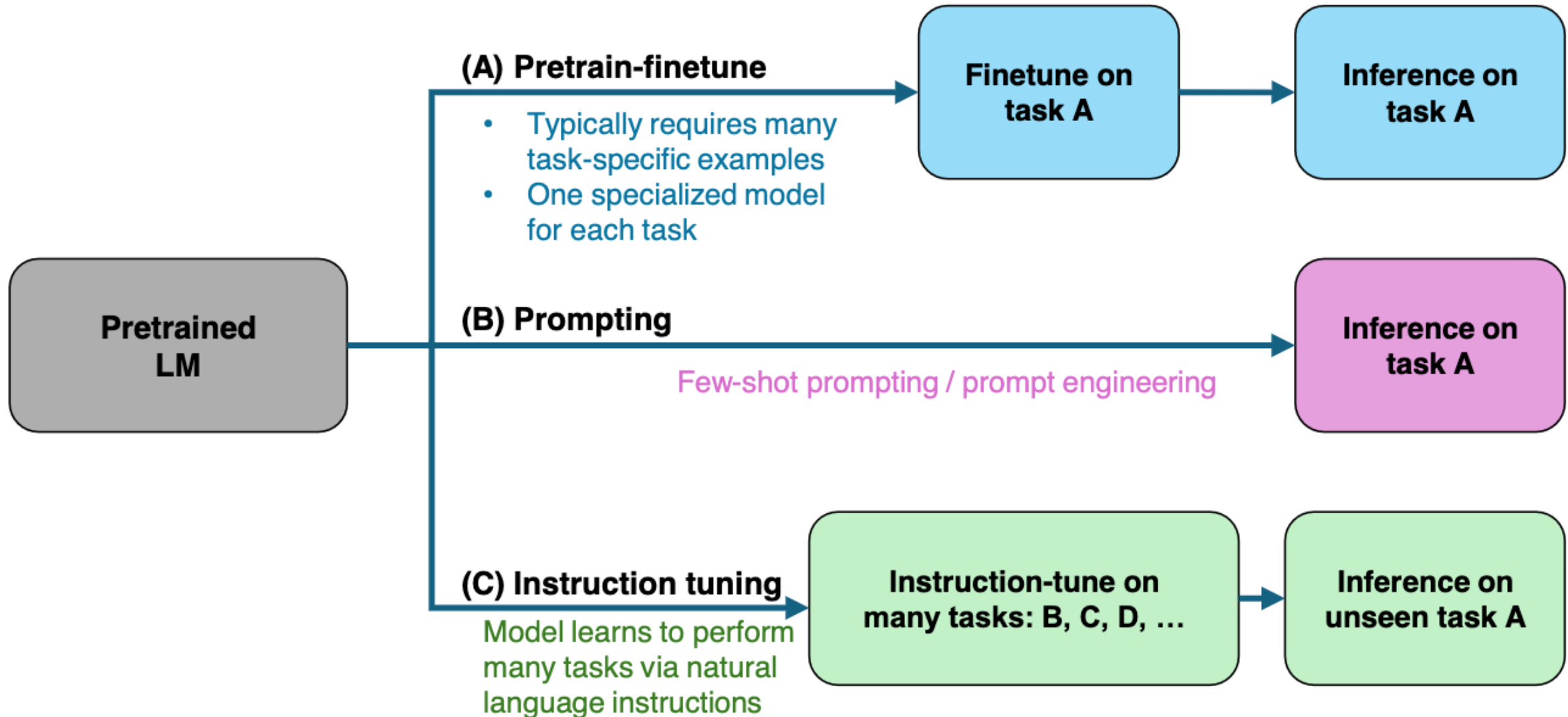


# Four Paradigms in NLP (LM)

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)	
<b>Transfer Learning: Pre-training, Fine-Tuning (FT)</b>		
c. Pre-train, Fine-tune	Objective (e.g. masked language modeling, next sentence prediction)	
<b>GAI: Pre-train, Prompt, and Predict (Prompting)</b>		
d. Pre-train, Prompt, Predict	Prompt (e.g. cloze, prefix)	

# Large Language Models (LLM)

## Three typical learning paradigms



# Popular Generative AI

- **OpenAI ChatGPT (GPT-o1, GPT-4o, GPT-4)**
- **Claude.ai (Claude 3.5)**
- **Google Gemini**
- **Meta Llama 3.3, Llama 3.2 Vision**
- **Mixtral Pixtral (mistral.ai)**
- **Chat.LMSys.org (lmarena.ai)**
- **Perplexity.ai**
- **Stable Diffusion**
- **Video: D-ID, Synthesia**
- **Audio: Speechify**

# LMSYS Chatbot Arena Leaderboard

Rank* (UB)	Rank (StyleCtrl)	Model	Arena Score	95% CI	Votes	Organization	License
1	1	<a href="#">Gemini-Exp-1206</a>	1379	+10/-5	5052	Google	Proprietary
2	<b>1</b>	<a href="#">ChatGPT-4o-latest (2024-11-20)</a>	1366	+4/-5	21929	OpenAI	Proprietary
2	<b>4</b>	<a href="#">Gemini-Exp-1121</a>	1364	+4/-5	15004	Google	Proprietary
4	<b>3</b>	<a href="#">o1-preview</a>	1334	+5/-4	30448	OpenAI	Proprietary
5	<b>7</b>	<a href="#">o1-mini</a>	1307	+4/-3	37176	OpenAI	Proprietary
5	<b>6</b>	<a href="#">Gemini-1.5-Pro-002</a>	1302	+5/-3	32758	Google	Proprietary
7	<b>10</b>	<a href="#">Grok-2-08-13</a>	1289	+3/-3	55616	xAI	Proprietary
7	<b>11</b>	<a href="#">Yi-Lightning</a>	1287	+4/-4	29193	01 AI	Proprietary
7	<b>6</b>	<a href="#">GPT-4o-2024-05-13</a>	1285	+3/-3	116858	OpenAI	Proprietary
7	<b>4</b>	<a href="#">Claude 3.5 Sonnet (20241022)</a>	1283	+3/-3	34846	Anthropic	Proprietary
8	<b>17</b>	<a href="#">Athene-v2-Chat-72B</a>	1278	+6/-6	8700	NexusFlow	NexusFlow
11	<b>16</b>	<a href="#">GLM-4-Plus</a>	1274	+4/-5	28006	Zhipu AI	Proprietary
11	<b>18</b>	<a href="#">GPT-4o-mini-2024-07-18</a>	1273	+3/-3	54539	OpenAI	Proprietary
11	<b>21</b>	<a href="#">Gemini-1.5-Flash-002</a>	1271	+4/-4	26276	Google	Proprietary
11	<b>28</b>	<a href="#">Llama-3.1-Nemotron-70B-Instruct</a>	1269	+6/-6	7676	Nvidia	Llama 3.1

GPT-4o

Claude 3.5

# Claude 3.5 Sonnet state-of-the-art vision

	Claude 3.5 Sonnet (new)	Claude 3.5 Haiku	Claude 3.5 Sonnet	GPT-4o*	GPT-4o mini*	Gemini 1.5 Pro	Gemini 1.5 Flash
Graduate level reasoning <i>GPQA (Diamond)</i>	<b>65.0%</b> 0-shot CoT	<b>41.6%</b> 0-shot CoT	<b>59.4%</b> 0-shot CoT	<b>53.6%</b> 0-shot CoT	<b>40.2%</b> 0-shot CoT	<b>59.1%</b> 0-shot CoT	<b>51.0%</b> 0-shot CoT
Undergraduate level knowledge <i>MMLU Pro</i>	<b>78.0%</b> 0-shot CoT	<b>65.0%</b> 0-shot CoT	<b>75.1%</b> 0-shot CoT	—	—	<b>75.8%</b> 0-shot CoT	<b>67.3%</b> 0-shot CoT
Code <i>HumanEval</i>	<b>93.7%</b> 0-shot	<b>88.1%</b> 0-shot	<b>92.0%</b> 0-shot	<b>90.2%</b> 0-shot	<b>87.2%</b> 0-shot	—	—
Math problem-solving <i>MATH</i>	<b>78.3%</b> 0-shot CoT	<b>69.2%</b> 0-shot CoT	<b>71.1%</b> 0-shot CoT	<b>76.6%</b> 0-shot CoT	<b>70.2%</b> 0-shot CoT	<b>86.5%</b> 4-shot CoT	<b>77.9%</b> 4-shot CoT
High school math competition <i>AIME 2024</i>	<b>16.0%</b> 0-shot CoT	<b>5.3%</b> 0-shot CoT	<b>9.6%</b> 0-shot CoT	<b>9.3%</b> 0-shot CoT	—	—	—
Visual Q/A <i>MMMU</i>	<b>70.4%</b> 0-shot CoT	—	<b>68.3%</b> 0-shot CoT	<b>69.1%</b> 0-shot CoT	<b>59.4%</b> 0-shot CoT	<b>65.9%</b> 0-shot CoT	<b>62.3%</b> 0-shot CoT
Agentic coding <i>SWE-bench Verified</i>	<b>49.0%</b>	<b>40.6%</b>	<b>33.4%</b>	—	—	—	—
Agentic tool use <i>TAU-bench</i>	Retail <b>69.2%</b> Airline <b>46.0%</b>	Retail <b>51.0%</b> Airline <b>22.8%</b>	Retail <b>62.6%</b> Airline <b>36.0%</b>	—	—	—	—

\* Our evaluation tables exclude OpenAI's o1 model family as they depend on extensive pre-response computation time, unlike typical models. This fundamental difference makes performance comparisons difficult.

# Llama 3.2 90B vision LLMs

Modality	Category Benchmark	Llama 3.2 11B	Llama 3.2 90B	Claude 3 – Haiku	GPT-4o-mini
Image	College-level Problems and Mathematical Reasoning MMMU (val, 0-shot CoT, micro avg accuracy)	50.7	60.3	50.2	59.4
	MMMU-Pro, Standard (10 opts, test)	33.0	45.2	27.3	42.3
	MMMU-Pro, Vision (test)	23.7	33.8	20.1	36.5
	MathVista (testmini)	51.5	57.3	46.4	56.7
	Charts and Diagram Understanding ChartQA (test, 0-shot CoT relaxed accuracy)*	83.4	85.5	81.7	—
	AI2 Diagram (test)*	91.1	92.3	86.7	—
	DocVQA (test, ANLS)*	88.4	90.1	88.8	—
	General Visual Question Answering VQAv2 (test)	75.2	78.1	—	—
Text	General MMLU (0-shot, CoT)	73.0	86.0	75.2 (5-shot)	82.0
	Math MATH (0-shot, CoT)	51.9	68.0	38.9	70.2
	Reasoning GPQA (0-shot, CoT)	32.8	46.7	33.3	40.2
	Multilingual MGSM (0-shot, CoT)	68.9	86.9	75.1	87.0

# Llama 3.3 70B instruction-tuned

Category Benchmark	Llama 3.1 70B	Llama 3.3 70B	Amazon Nova Pro	Llama 3.1 405B	Gemini Pro 1.5	GPT-4o	Claude 3.5 Sonnet
General							
MMLU Chat (0-shot, CoT)	86.0	<b>86.0</b>	85.9	<b>88.6</b>	87.1	87.5	<b>88.9</b>
MMLU PRO (5-shot, CoT)	66.4	<b>68.9</b>	-	<b>73.4</b>	76.1	73.8	<b>77.8</b>
Instruction Following							
IFEval	87.5	<b>92.1</b>	<b>92.1</b>	<b>88.6</b>	81.9	84.6	<b>89.3</b>
Code							
HumanEval (0-shot)	80.5	<b>88.4</b>	<b>89.0</b>	<b>89.0</b>	89.0	86.0	<b>93.7</b>
MBPP EvalPlus (base) (0-shot)	86.0	<b>87.6</b>	-	<b>88.6</b>	87.8	83.9	86.8
Math							
MATH (0-sho, CoT)	67.8	<b>77.0</b>	76.6	<b>73.9</b>	<b>82.9</b>	76.9	78.3
Reasoning							
GPQA Diamond (0-shot, CoT)	48.0	<b>50.5</b>	-	<b>49.0</b>	53.5	47.5	<b>65.0</b>
Tool use							
BFCL v2 (0-shot)	77.5	<b>77.3</b>	-	<b>81.1</b>	80.3	74.0	79.3
Long context							
NIH/Multi-needle	97.5	<b>97.5</b>	-	<b>98.1</b>	94.7	-	<b>99.4</b>
Multilingual							
Multilingual MGSM (0-shot)	86.9	<b>91.1</b>	-	<b>91.6</b>	89.6	90.6	<b>92.8</b>
Pricing*							
1M Input tokens (Cheapest among providers)*	\$0.1	<b>\$0.1</b>	\$0.80	<b>\$1.0</b>	\$1.30	2.5\$	\$3.0
1M Output tokens (Cheapest among providers)*	\$0.4	<b>\$0.4</b>	\$3.20	<b>\$1.8</b>	\$5.0	10.0\$	\$15.0

<https://www.llama.com/>

# Mistral Pixtral Large (124B)

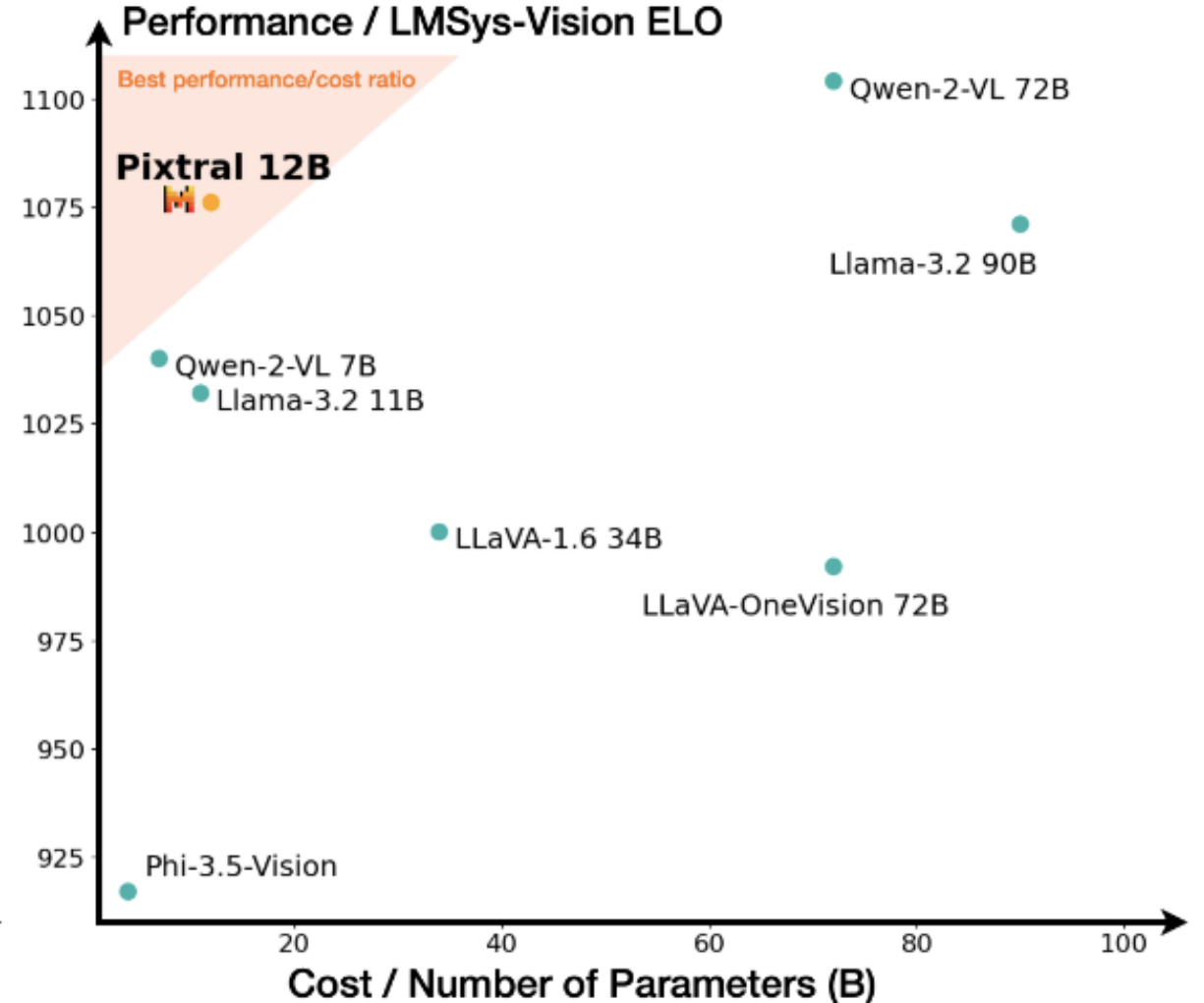
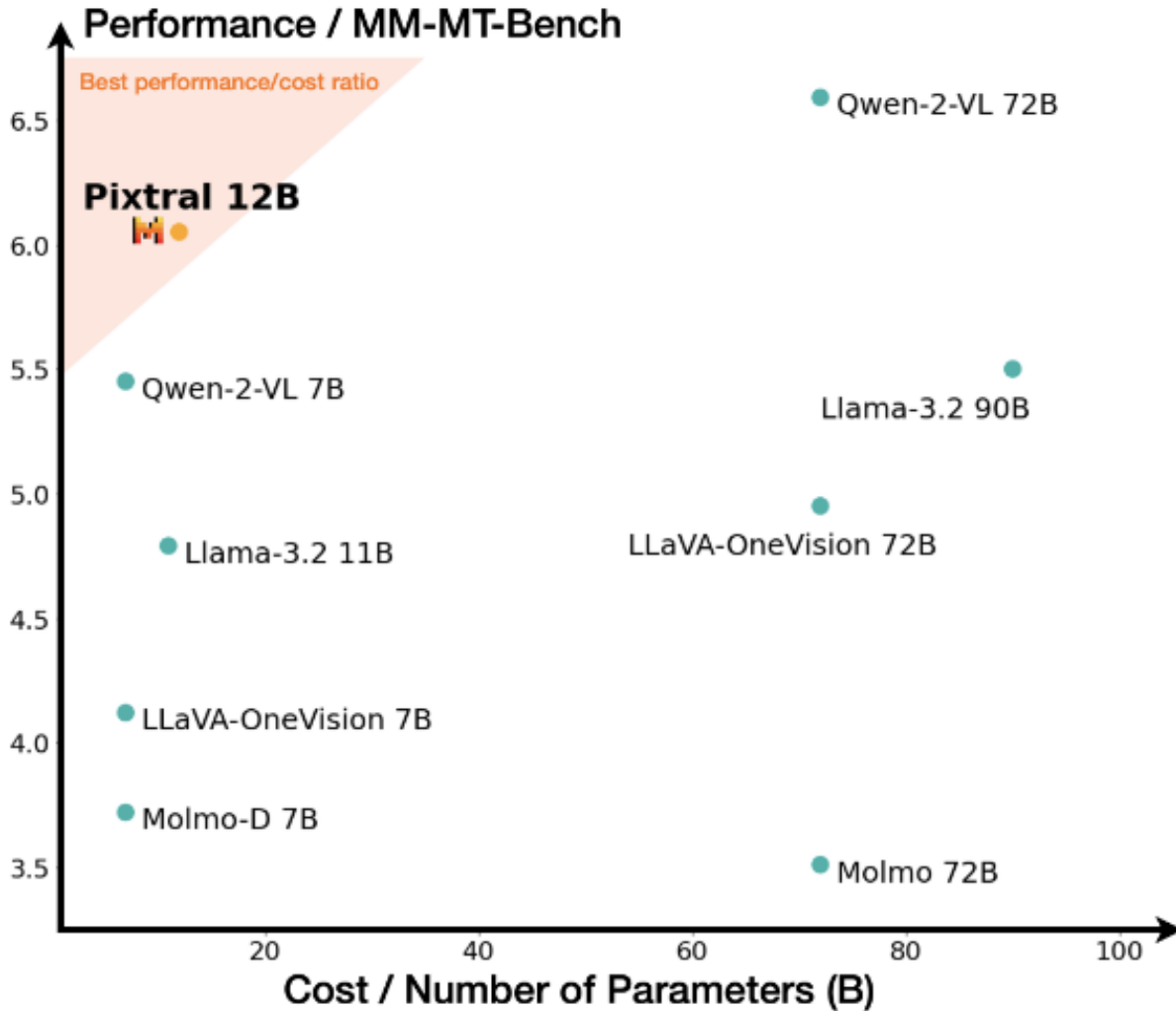
## Frontier-class multimodal performance

Model	Mathvista (CoT)	MMMU (CoT)	ChartQA (CoT)	DocVQA (ANLS)	VQAv2 (VQA Match)	AI2D (BBox)	MM MT-Bench	
Open Weights	Pixtral Large (124B)	<b>69.4</b>	64.0	88.1	<b>93.3</b>	<b>80.9</b>	93.8	<b>7.4</b>
	Llama-3.2 90B (measured)	49.1	53.7	70.8	85.7	67.0	-	5.5
	Llama-3.2 90B (reported)	57.3	60.3	85.8	90.1	80.2	92.3	-
Closed	Gemini-1.5 Pro (measured)	<b>67.8</b>	<b>66.3</b>	<b>83.8</b>	<b>92.3</b>	<b>70.6</b>	<b>94.6</b>	<b>6.8</b>
	Gemini-1.5 Pro (reported)	68.1	65.9	-	-	-	-	-
	GPT-4o (measured)	<b>65.4</b>	<b>68.6</b>	<b>85.2</b>	<b>88.5</b>	<b>76.4</b>	<b>93.2</b>	<b>6.7</b>
	GPT-4o (reported)	63.8	69.1	85.7	92.8	-	-	-
	Claude-3.5 Sonnet (measured)	<b>67.1</b>	<b>68.4</b>	<b>89.1</b>	<b>88.6</b>	<b>69.5</b>	<b>76.9</b>	<b>7.3</b>
	Claude-3.5 Sonnet (reported)	70.7	70.4	90.8	94.2	-	95.3	-
Unreleased	Llama-3.1 505B (reported)	-	64.5	85.8	92.6	80.2	94.1	-
	Grok-2 (reported)	69.0	66.1	-	93.6	-	-	-

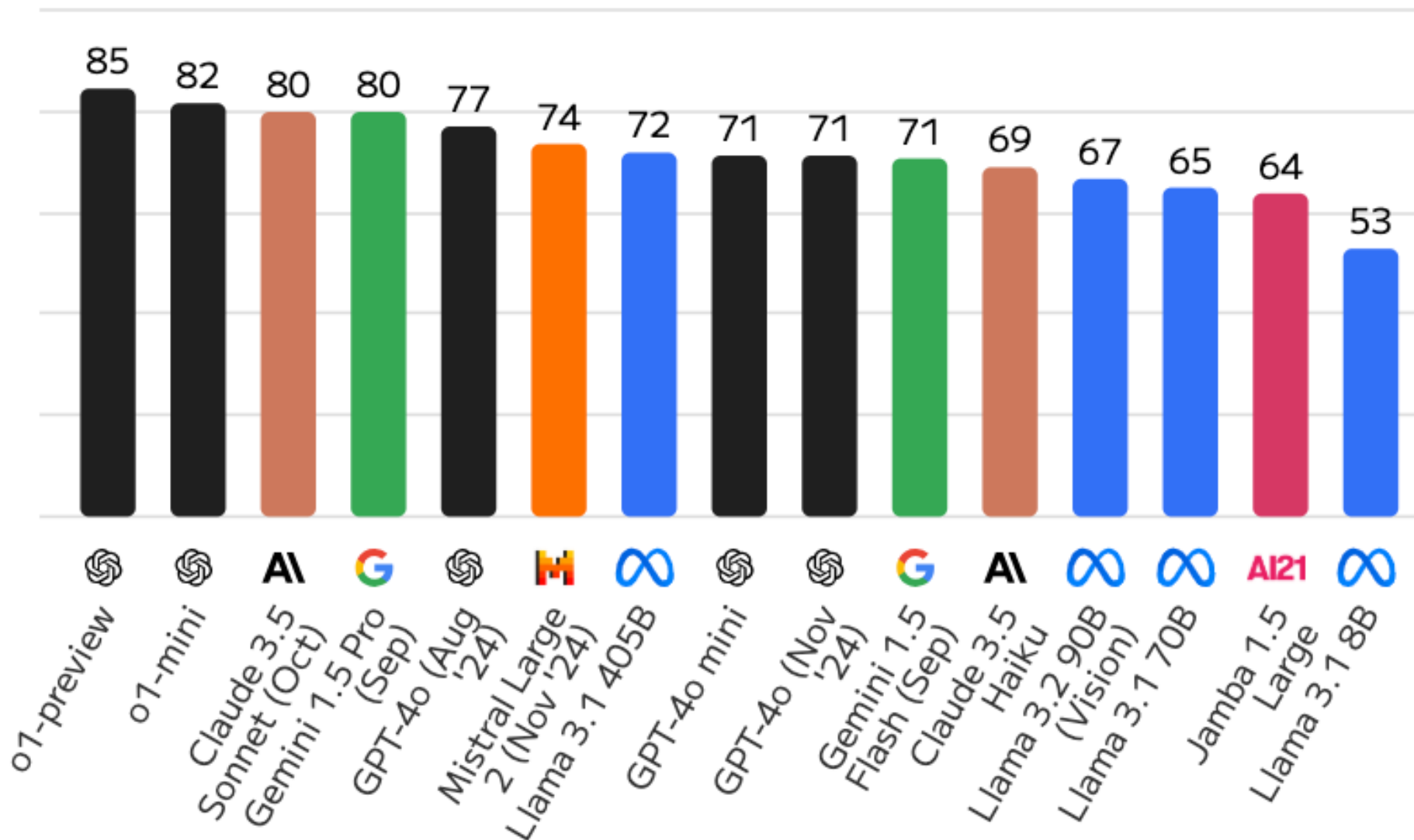
Specific model versions evaluated: Claude-3.5 Sonnet (new) [Oct 24], Gemini-1.5 Pro (002) [Sep 24], GPT-4o (2024-08-06) [Aug 24]

Source: <https://mistral.ai/news/pixtral-large/>

# Mistral Pixtral 12B



# Large Language Models (LLMs) Artificial Analysis Quality Index



# Large Language Models (LLMs)

## Quality vs. Price

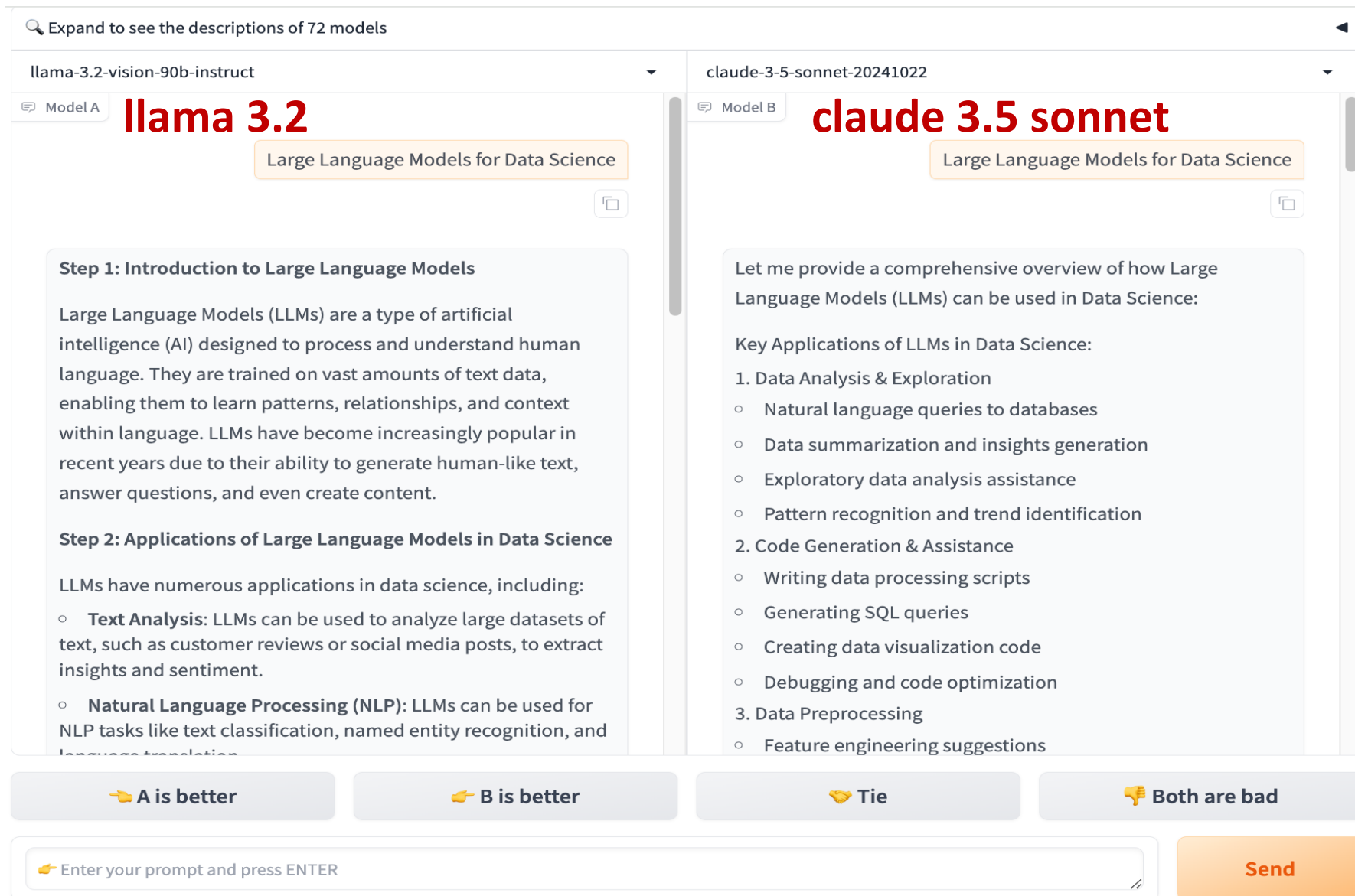
Artificial Analysis Quality Index, Price: USD per 1M Tokens

Most attractive quadrant

- o1-preview
- o1-mini
- GPT-4o (Aug '24)
- GPT-4o mini
- GPT-4o (Nov '24)
- Llama 3.1 405B
- Llama 3.2 90B (Vision)
- Llama 3.1 70B
- Llama 3.1 8B
- Gemini 1.5 Pro (Sep)
- Gemini 1.5 Flash (Sep)
- Claude 3.5 Sonnet (Oct)
- Claude 3.5 Haiku
- Mistral Large 2 (Nov '24)
- Jamba 1.5 Large



# Chat with Open Large Language Models: Chatbot Arena



Expand to see the descriptions of 72 models

llama-3.2-vision-90b-instruct      claude-3-5-sonnet-20241022

Model A **llama 3.2**      Model B **claude 3.5 sonnet**

Large Language Models for Data Science

**Step 1: Introduction to Large Language Models**

Large Language Models (LLMs) are a type of artificial intelligence (AI) designed to process and understand human language. They are trained on vast amounts of text data, enabling them to learn patterns, relationships, and context within language. LLMs have become increasingly popular in recent years due to their ability to generate human-like text, answer questions, and even create content.

**Step 2: Applications of Large Language Models in Data Science**

LLMs have numerous applications in data science, including:

- **Text Analysis:** LLMs can be used to analyze large datasets of text, such as customer reviews or social media posts, to extract insights and sentiment.
- **Natural Language Processing (NLP):** LLMs can be used for NLP tasks like text classification, named entity recognition, and language translation.

Let me provide a comprehensive overview of how Large Language Models (LLMs) can be used in Data Science:

Key Applications of LLMs in Data Science:

1. Data Analysis & Exploration
  - Natural language queries to databases
  - Data summarization and insights generation
  - Exploratory data analysis assistance
  - Pattern recognition and trend identification
2. Code Generation & Assistance
  - Writing data processing scripts
  - Generating SQL queries
  - Creating data visualization code
  - Debugging and code optimization
3. Data Preprocessing
  - Feature engineering suggestions

👉 A is better      👉 B is better      👉 Tie      👉 Both are bad

👉 Enter your prompt and press ENTER      Send

<https://lmarena.ai/>

# Perplexity.ai



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Upgrade to Claude-2 or GPT-4, boost Copilot uses, and upload more files.  
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## Large Language Models for Data Science

### Sources

- What Is a Large Language Model and What Can... snowflake · 1
- What are Large Language Models? | NVIDIA nvidia · 2
- Catch Up On Large Language Models | by... towardsdatascien... · 3
- View 3 more

### Answer

Large Language Models (LLMs) are advanced AI systems designed to understand human language intricacies and generate intelligent, creative responses to queries <sup>1</sup>. They are deep learning algorithms that can recognize, summarize, translate, predict, and generate content using very large datasets <sup>2</sup>. LLMs are trained on enormous data sets typically measured in petabytes, sourced from books, articles, websites, and other text-based sources <sup>1</sup>. They are dynamic tools that are continuously updated and refined as new data becomes available <sup>1</sup>.

In the field of data science, LLMs can potentially transform how teams source, manage, and analyze data <sup>1</sup>. They are used in numerous data science applications, and their ability to process and interpret vast amounts of text data has made them an indispensable part of

Ask follow-up... Copilot

social media posts or customer reviews, to determine whether the overall sentiment is

<https://www.perplexity.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

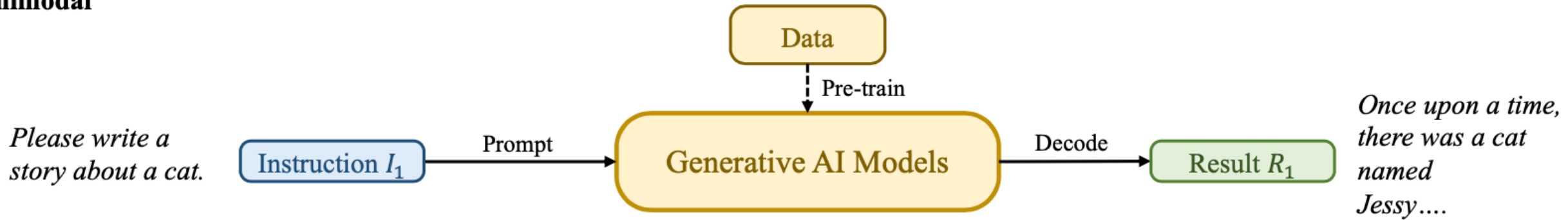


 **OpenAI DALL·E 2**

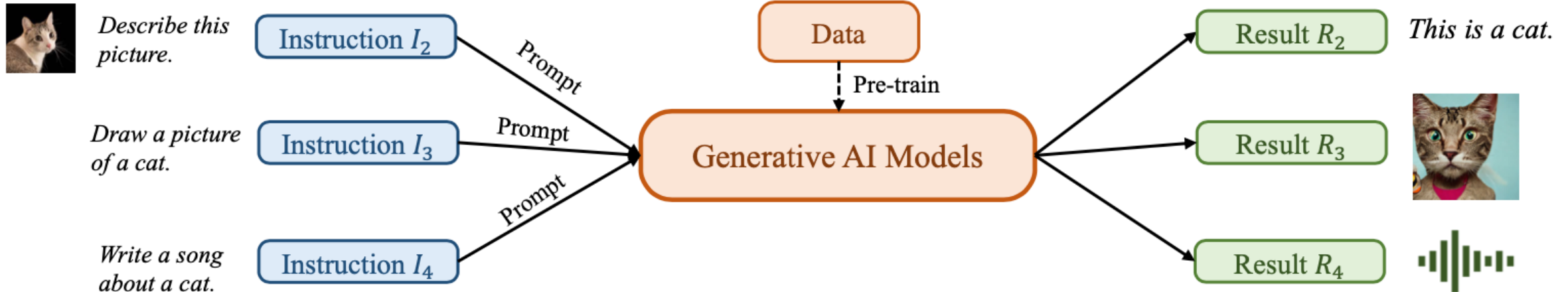
# Generative AI (Gen AI)

## AI Generated Content (AIGC)

### Unimodal

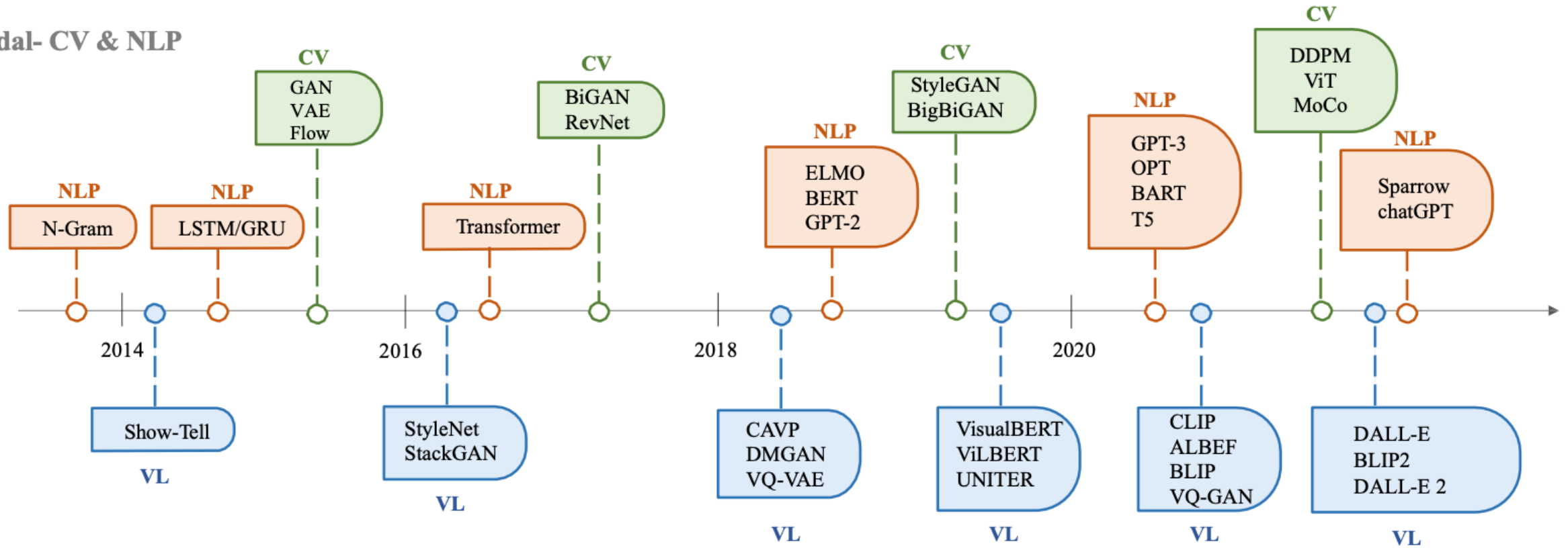


### Multimodal



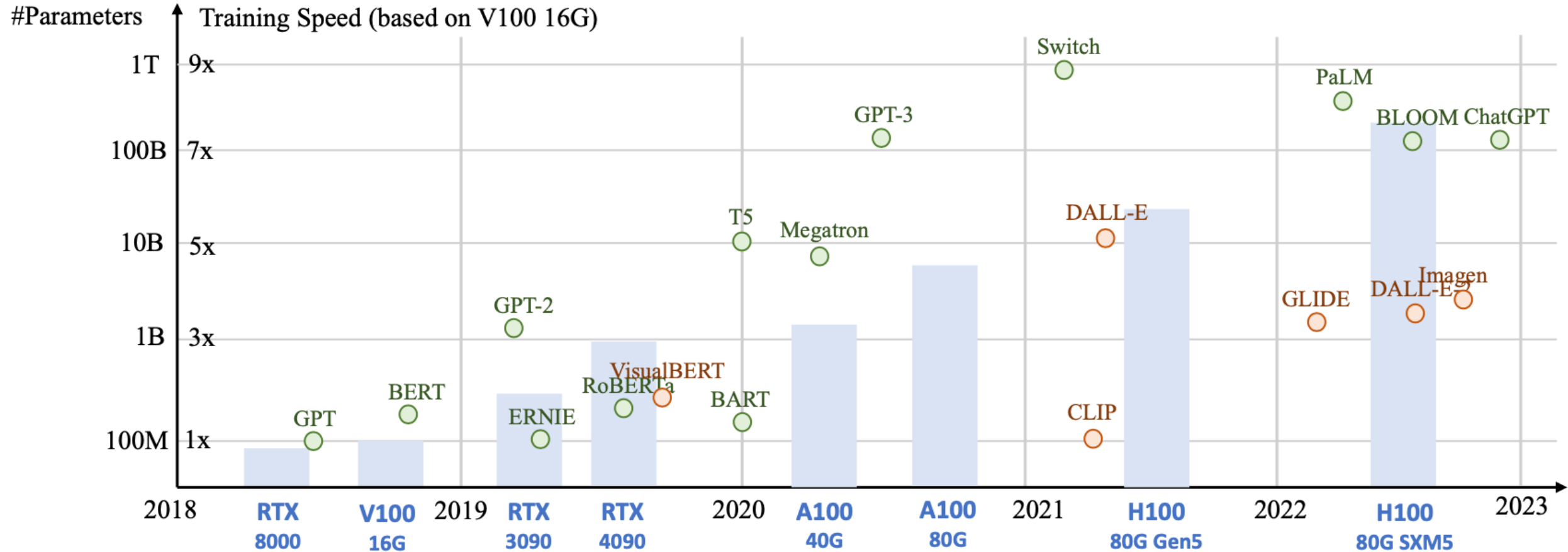
# The history of Generative AI in CV, NLP and VL

## Unimodal- CV & NLP

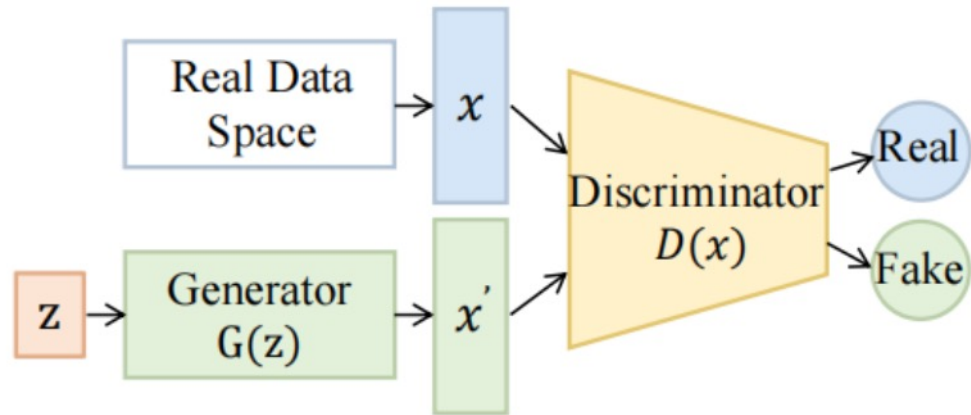


## Multimodal – Vision Language

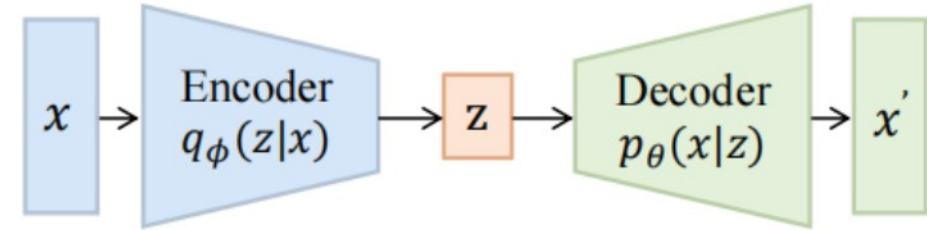
# Generative AI Foundation Models



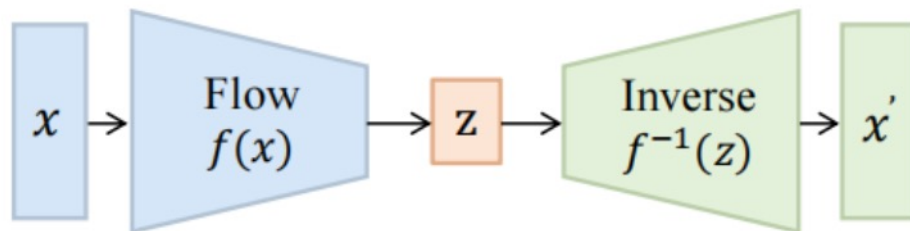
# Categories of Vision Generative Models



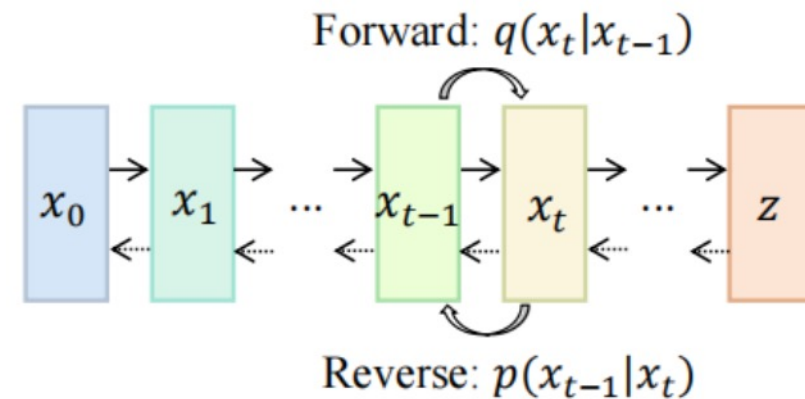
(1) Generative adversarial networks



(2) Variational autoencoders

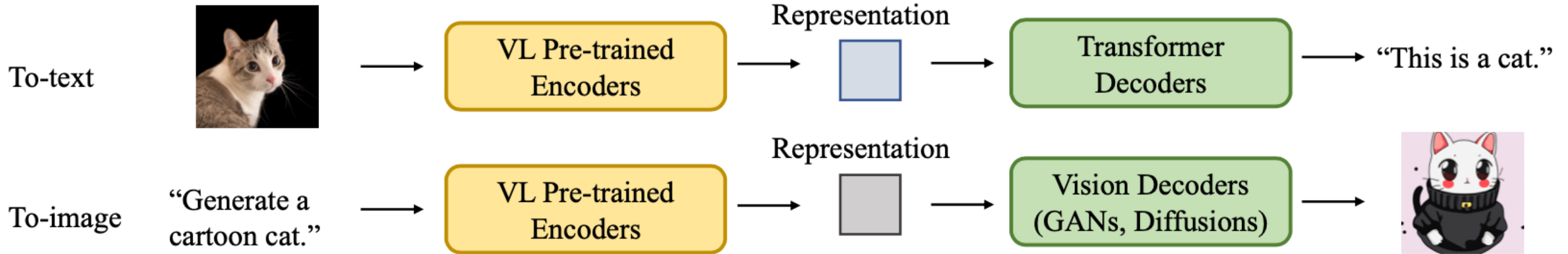
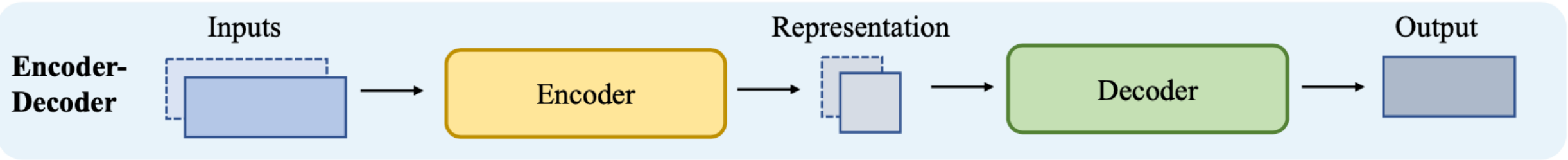


(3) Normalizing flows



(4) Diffusion models

# The General Structure of Generative Vision Language



# Philosophy and Ethics of AI

# Philosophy, Ethics, and Safety of AI

- **The Limits of AI**
- **Can Machines Really Think?**
- **The Ethics of AI**

# Philosophy of AI

- Philosophers use the term
  - **weak AI** for the hypothesis that machines could possibly behave intelligently
  - **strong AI** for the hypothesis that such machines would count as having actual minds (as opposed to simulated minds)

# 4 Approaches of AI

<b>Thinking Humanly</b>	<b>Thinking Rationally</b>
<b>Acting Humanly</b>	<b>Acting Rationally</b>

# 4 Approaches of AI

<p><b>2.</b> <b>Thinking Humanly: The Cognitive Modeling Approach</b></p>	<p><b>3.</b> <b>Thinking Rationally: The “Laws of Thought” Approach</b></p>
<p><b>1.</b> <b>Acting Humanly: The Turing Test Approach</b> (1950)</p>	<p><b>4.</b> <b>Acting Rationally: The Rational Agent Approach</b></p>

# 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

# 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.**

# The Ethics of AI

- Given that AI is a **powerful** technology, we have a **moral obligation** to use it well, to promote the **positive aspects** and avoid or mitigate the negative ones.

# Principles of Robotics and AI

- **Ensure safety**
- **Ensure fairness**
- **Respect privacy**
- **Promote collaboration**
- **Provide transparency**
- **Limit harmful uses of AI**

# Principles of Robotics and AI

- **Establish accountability**
- **Uphold human rights and values**
- **Reflect diversity/inclusion**
- **Avoid concentration of power**
- **Acknowledge legal/policy implications**
- **Contemplate implications for employment**

# Safety of AI

- AI is a **powerful** technology, and as such it poses **potential dangers**, through lethal autonomous weapons, security and privacy breaches, unintended side effects, unintentional errors, and malignant misuse.
- Those who work with AI technology have an **ethical imperative to responsibly reduce those dangers**.

# Robot Ethics

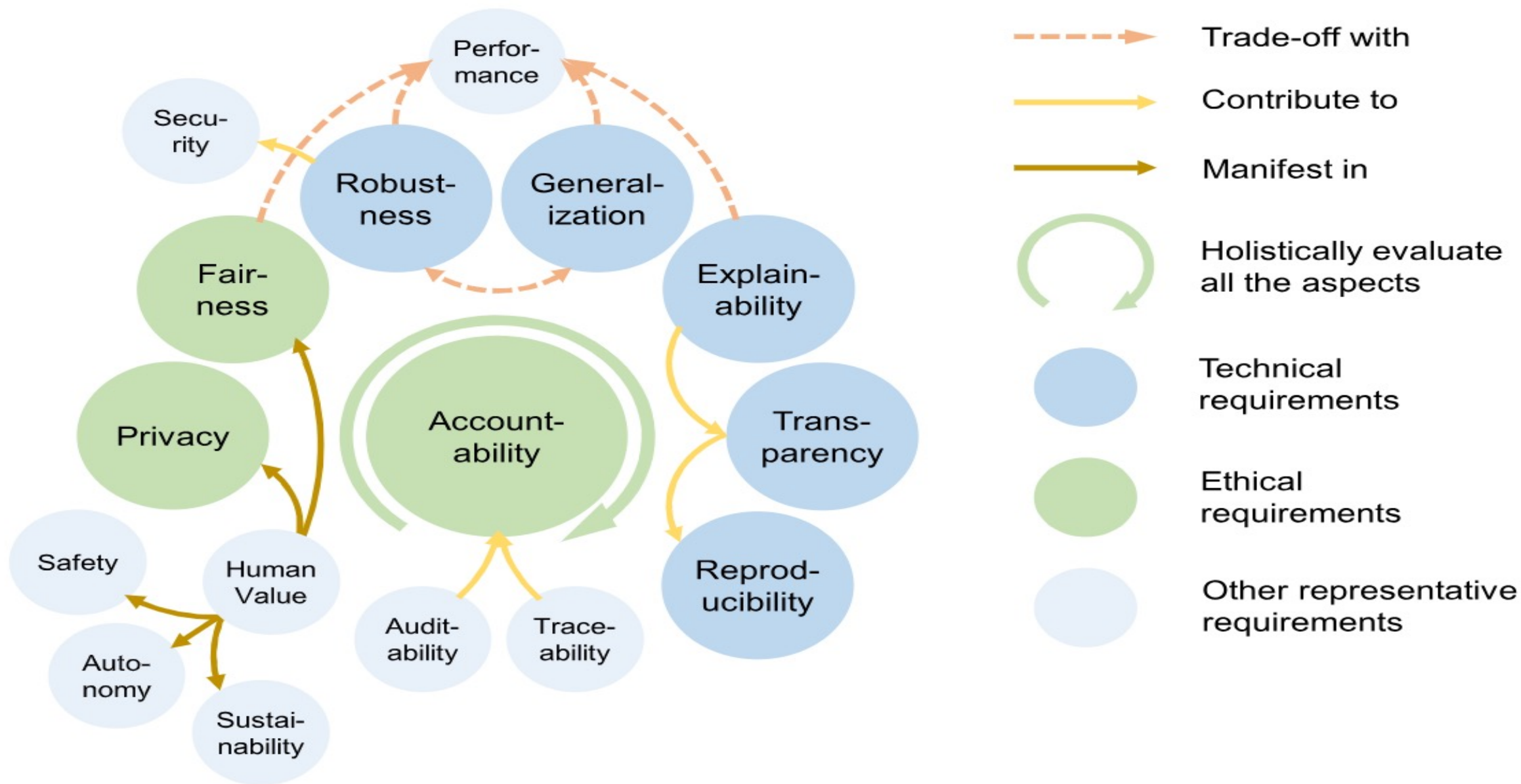
## Laws of Robotics (Isaac Asimov, 1942, 1950)

- 1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.**
- 2. A robot must obey orders given to it by human beings, except where such orders would conflict with the First Law.**
- 3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.**

# Fair, trustworthy, and transparent of AI

- AI systems must be able to demonstrate they are **fair, trustworthy, and transparent**.
- There are multiple aspects of fairness, and it is impossible to maximize all of them at once.
- So a first step is to decide what counts as fair.

# Trustworthy AI



# Explainable AI (XAI)

- **When an AI system turns you down for a loan, you deserve an explanation.**
  - **In Europe, the GDPR enforces this for you.**
  - **An AI system that can explain itself is called **explainable AI (XAI)**.**

# Explainable AI (XAI)

- A good explanation properties of XAI
  - it should be **understandable** and **convincing** to the user
  - it should accurately reflect the **reasoning** of the system
  - it should be **complete**
  - it should be **specific** in that different users with different conditions or different outcomes should get different explanations

# Automation

- **Automation is already changing the way people work.**
- **As a society, we will have to deal with these changes.**

# The Future of AI

# The Future of AI

- **AI Components**
- **AI Architectures**

# AI Components

- Sensors and actuators
- Representing the state of the world
- Selecting actions
- Deciding what we want
- **Learning**
- Resources
  - Shared data
  - **Shared model**

# Learning

- **Deep learning**
- **Data science**
- **Big data**
- **Transfer learning**
- **Apprenticeship learning**
- **Differentiable programming**
- **Weakly supervised learning**
- **Predictive learning**

# AI Architectures

- Which of the **agent architectures** should an agent use?
  - **All of them!**
- **Real-time AI**
- **Anytime algorithm**
- **Decision-theoretic metareasoning**
- **Reflective architecture**
- **Agent = Architecture + Program**
- **Bounded optimality**

# Real-time AI

- **As AI systems move into more complex domains, all problems will become **real-time**, because the agent will never have long enough to solve the decision problem exactly.**

# General AI

- **Narrow tasks AI**
  - **DARPA Grand Challenge for autonomous cars**
  - **ImageNet object recognition competition**
  - **For each separate task, we build a separate AI system**
  - **A separate machine learning model trained from scratch with data collected specifically for this task.**
- **Human-level AI (HLAI)**

# AI Engineering

- **Powerful tools and frameworks**
  - **TensorFlow, Keras, PyTorch, CAFFE, Scikit-Learn and SCIPY.**
- **Promising approaches**
  - **GANs**
  - **Deep reinforcement learning**
  - **Train properly in a new domain**

# Generative AI: Proprietary & Confidential

- **Valuable data needs to be private.**
- **Need to maintain confidentiality with private data.**
- **Need to consider industry-specific data norms.**

# Challenges of Generative AI

- **IP ownership**
  - Does the model have the right to reproduce and extrapolate from this data
- **IP attribution**
  - Can the output of the model be attributed to the proper sources
  - Important for many businesses
- **Harmful application**
  - Is the output of the model used to manipulate or mislead
- **Harmful outputs**
  - Is the output of the model offensive

# Training Generative AI Efficiently at Scale

- **NVIDIA NeMo enables efficient training of large language models at scale.**
- **Full-stack optimization from networking to compute to frameworks and libraries.**
- **Extraordinary throughput and flexibility.**
- **NVIDIA invests heavily in the most important frameworks: JAX, PyTorch, TensorFlow and more.**

# The Future of AI

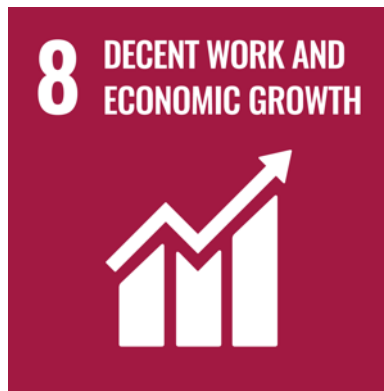
- AI has made great progress in its short history.
- We can see only a short distance ahead, but we can see that much remains to be done.  
(Alan Turing, 1950)  
[Computing Machinery and Intelligence]

# The Future of AI

- **Past: Build each new system from scratch**
- **Future: Start with a single huge system**
  - For each new task, extract from it the parts that are relevant to the task.
- **Transformer language models (e.g., BERT, GPT-2, GPT-3, ChatGPT) with billions of parameters**
  - An “outrageously large” ensemble neural network architecture that scales up to 175 billion parameters in one experiment.
  - **GPT-3 (175B), BLOOM (176B), PaLM (540B)**

# AI for Social Good (AI4SG)

# Sustainable Development Goals (SDGs)



# Sustainable Development Goals (SDGs) and 5P

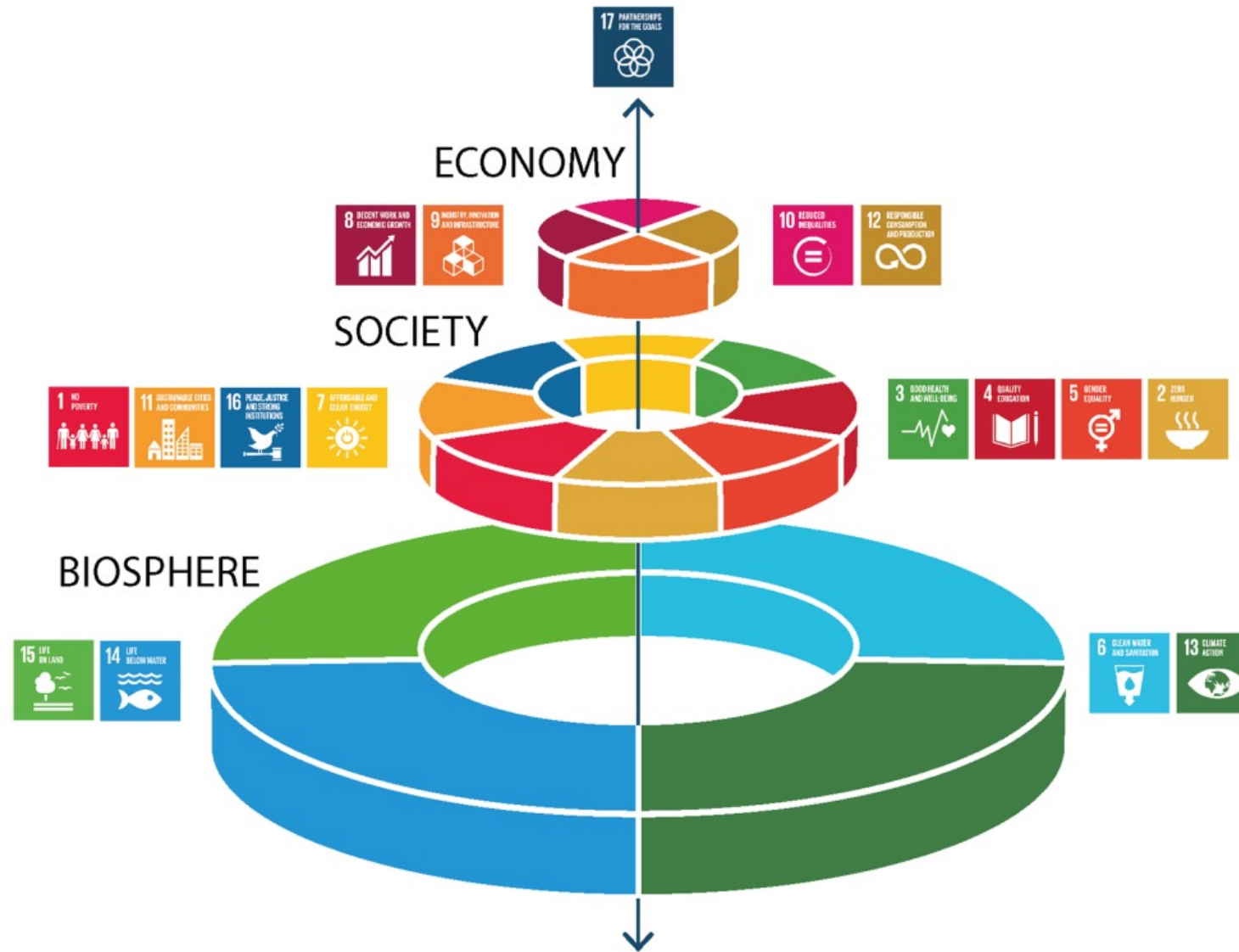
Partnership

Peace

Prosperity

People

Planet



# ESG to 17 SDGs

## ENVIRONMENT

6 CLEAN WATER AND SANITATION	7 AFFORDABLE AND CLEAN ENERGY	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION
14 LIFE BELOW WATER	15 LIFE ON LAND	

## SOCIAL

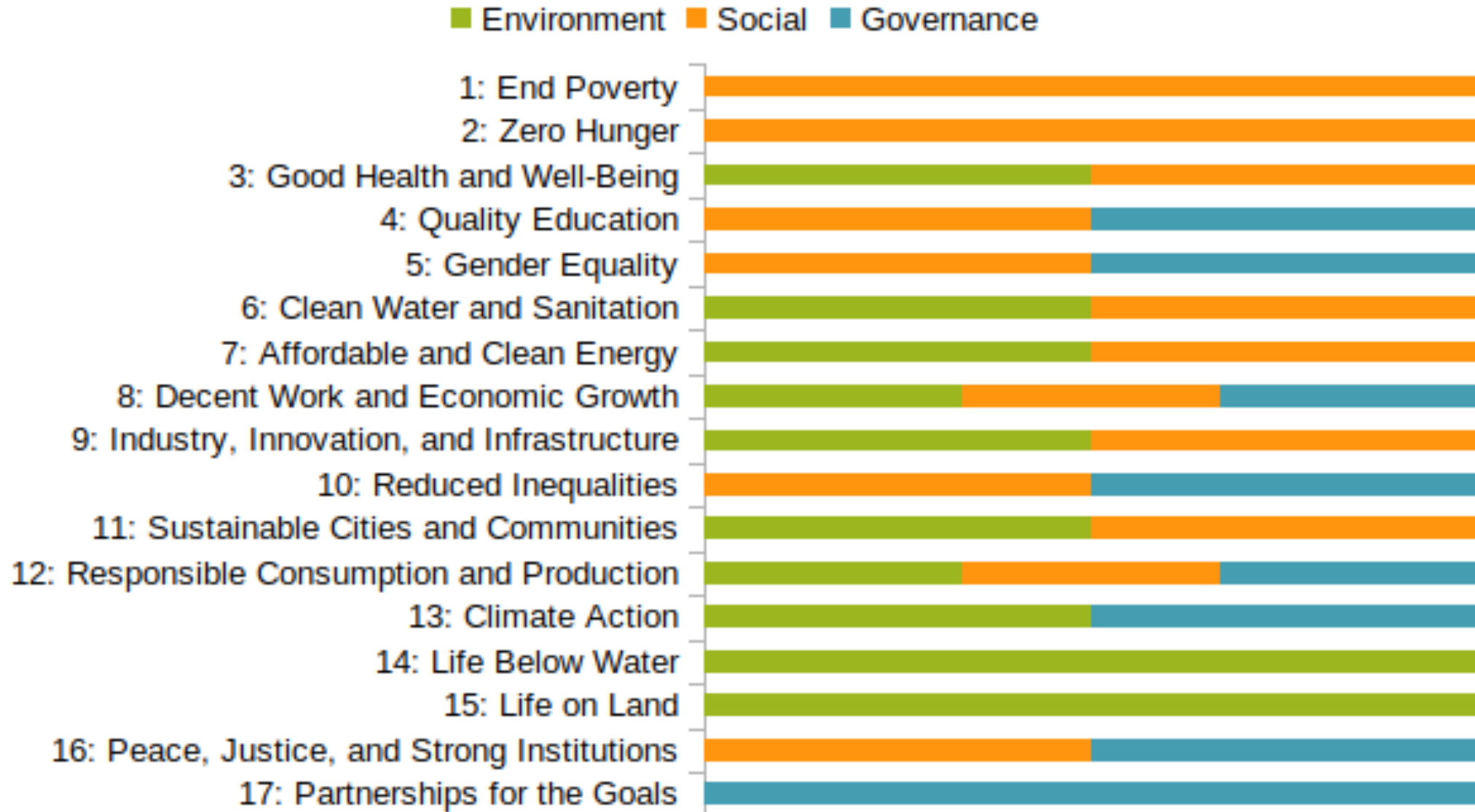
1 NO POVERTY	2 ZERO HUNGER	3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION	5 GENDER EQUALITY	6 CLEAN WATER AND SANITATION
8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	10 REDUCED INEQUALITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	16 PEACE, JUSTICE AND STRONG INSTITUTIONS	

## GOVERNANCE

5 GENDER EQUALITY	8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION
16 PEACE, JUSTICE AND STRONG INSTITUTIONS	17 PARTNERSHIPS FOR THE GOALS	

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



# 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)**

# 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.**

# 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.**

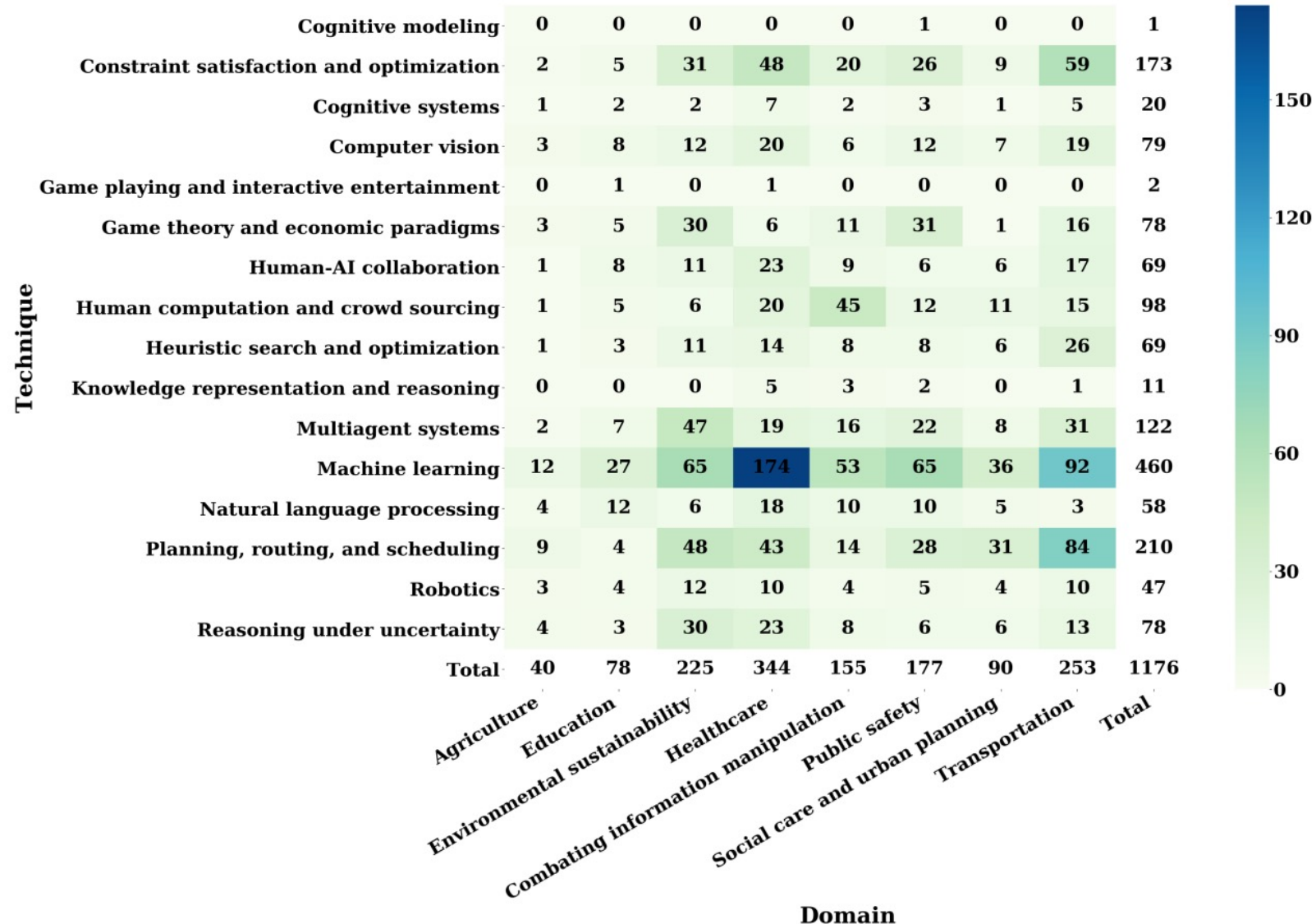
# AI4SG 10 Guidelines

## Data Handling (G9, G10)

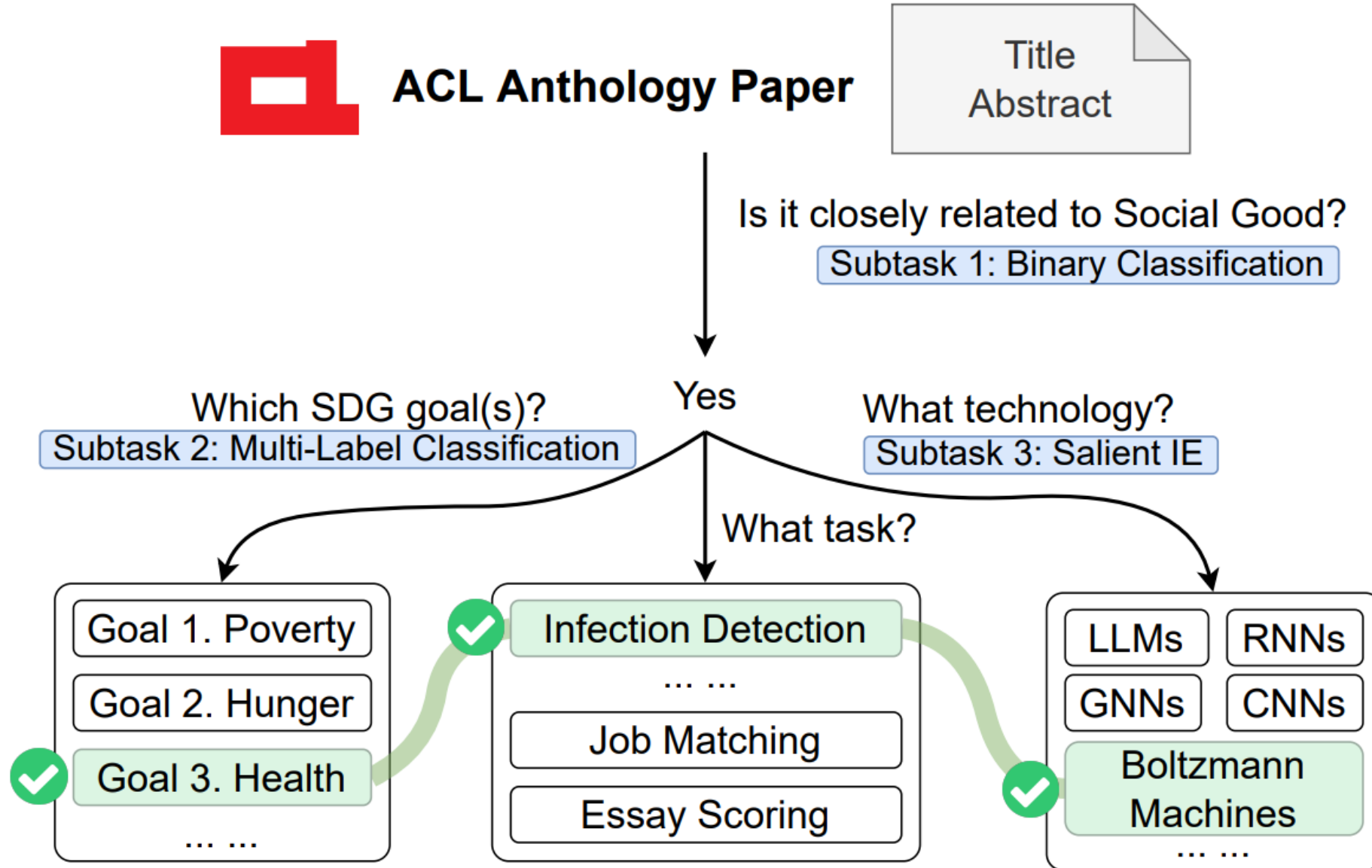
- **G9: Improving data readiness is key.**
- **G10: Data must be processed securely, with utmost respect for human rights and privacy.**

# AI for Social Good (AI4SG)

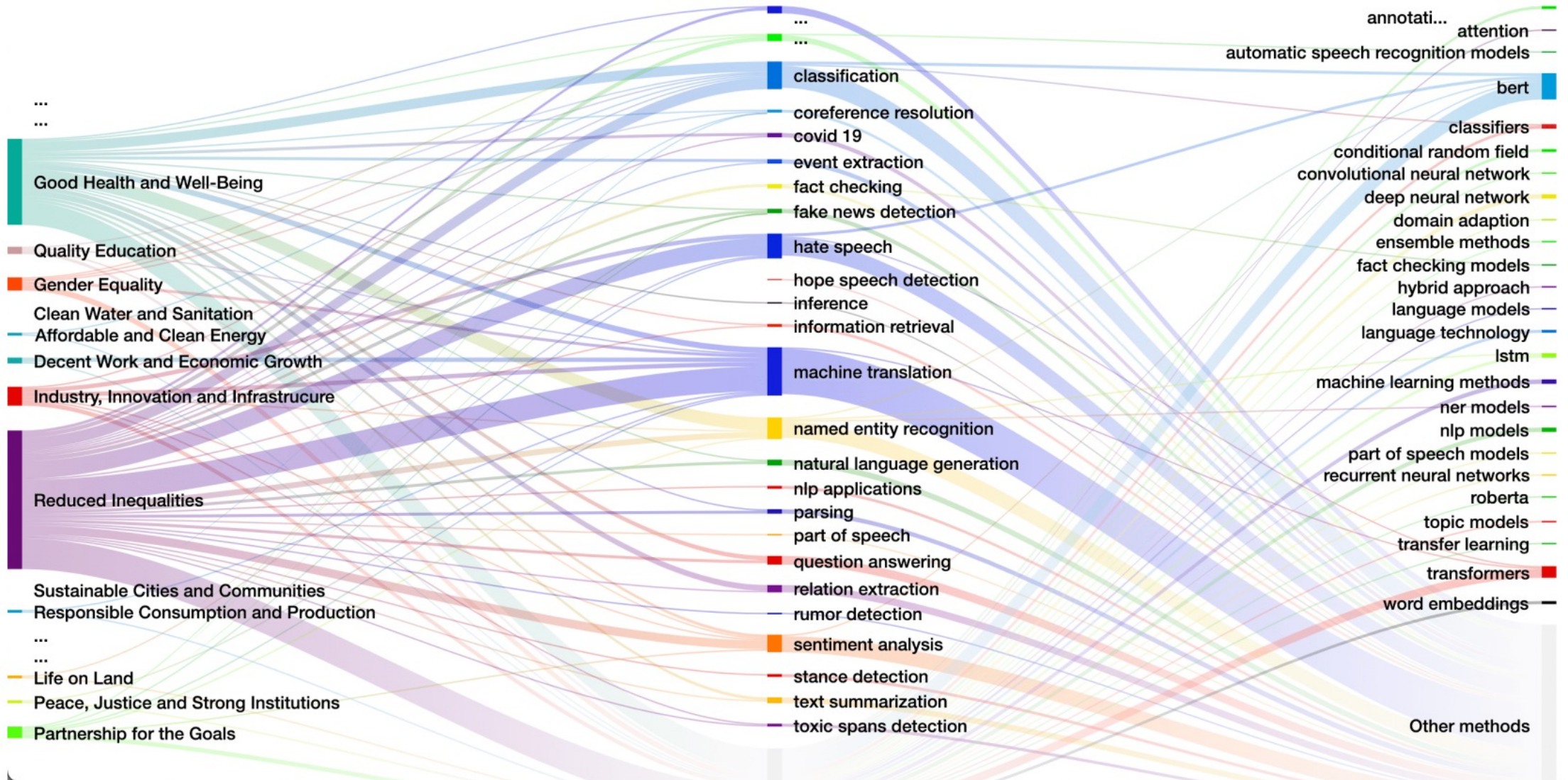
## Domains and Techniques



# NLP for Social Good (NLP4SG)



# 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."

# Papers with Code State-of-the-Art (SOTA)

## Computer Vision



▶ See all 1415 tasks

## Natural Language Processing



▶ See all 664 tasks

Spring 2025

**Generative AI**  
**Innovative Applications**

# Summary

- **Generative AI**
- **Philosophy, Ethics, and Safety of AI**
  - **The Limits of AI**
  - **Can Machines Really Think?**
  - **The Ethics of AI**
- **The Future of AI**
  - **AI Components**
  - **AI Architectures**

# References

- Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson.
- Denis Rothman (2024), Transformers for Natural Language Processing and Computer Vision - Third Edition: Explore Generative AI and Large Language Models with Hugging Face, ChatGPT, GPT-4V, and DALL-E 3, 3rd ed. Edition, Packt Publishing
- Aurélien Géron (2022), Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 3rd Edition, O'Reilly Media.
- Steven D'Ascoli (2022), Artificial Intelligence and Deep Learning with Python: Every Line of Code Explained For Readers New to AI and New to Python, Independently published.
- 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.
- 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."
- Shukang Yin, Chaoyou Fu, Sirui Zhao, Ke Li, Xing Sun, Tong Xu, and Enhong Chen. (2024) "A survey on multimodal large language models." National Science Review (2024): nwae403.
- Jiayi Kuang, Jingyou Xie, Haohao Luo, Ronghao Li, Zhe Xu, Xianfeng Cheng, Yinghui Li, Xika Lin, and Ying Shen. (2024) "Natural Language Understanding and Inference with MLLM in Visual Question Answering: A Survey." arXiv preprint arXiv:2411.17558.
- Bo Li, Peng Qi, Bo Liu, Shuai Di, Jingen Liu, Jiquan Pei, Jinfeng Yi, and Bowen Zhou. (2023) "Trustworthy AI: From principles to practices." ACM Computing Surveys 55, no. 9 (2023): 1-46.
- NVIDIA DLI (2024), Generative AI Explained, [https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-07+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-07+V1)
- NVIDIA DLI (2024), Introduction to Transformer-Based Natural Language Processing, [https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-08+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-08+V1)
- NVIDIA DLI (2024), Building RAG Agents with LLMs, [https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-15+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-15+V1)
- NVIDIA DLI (2024), Generative AI with Diffusion Models, [https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-14+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-14+V1)
- NVIDIA DLI (2024), Introduction to NVIDIA NIM™ Microservices, [https://learn.nvidia.com/courses/course-detail?course\\_id=course-v1:DLI+S-FX-23+V1](https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-23+V1)
- Min-Yuh Day (2024), Python 101, <https://tinyurl.com/aintpupython101>