國立臺北大學 商學院碩士在職專班
企業倫理與永續發展
(Business Ethics and Sustainable Development)

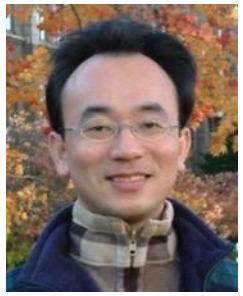
Generative AI for ESG and Sustainable Development
(生成式 AI 於 ESG 與永續發展)

Time: 18:50-21:30, Tuesday, March, 11, 2025
企業倫理與永續發展 (Business Ethics and Sustainable Development)
任課教師：陳宥杉， 戴敏育

戴敏育 教授 (Prof. Min-Yuh Day)
國立臺北大學 資訊管理研究所 教授
金融科技暨綠色金融研究中心 主任
永續辦公室 永續發展組 組長

2025-03-11

國立臺北大學
National Taipei University



戴敏育 教授

Prof. Min-Yuh Day

NVIDIA
University Ambassador
Certified Instructor

aws educate | Cloud Ambassador
2020 Cohort

aws academy Accredited Educator

aws certified Solutions Architect Associate

aws certified Cloud Practitioner

Professor, Information Management, NTPU

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

Director, Fintech and Green Finance Center (FGFC), NTPU

Division Director, Sustainable Development, Sustainability Office, NTPU

Visiting Scholar, IIS, Academia Sinica

Ph.D., Information Management, NTU

Publications Co-Chairs, 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
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中央研究院 ACADEMIA SINICA 1928

Outline

1. Generative AI
2. ESG
3. Sustainable Development

衡量企業永續關鍵指標
臺北大學獨創ESG永續評鑑系統

社會(S)	經濟(E)	環境(E)	揭露(D)
1.人權 2.員工溝通與福利 3.人力資本發展 4.多元組成與包容性 5.供應鏈社會面向控管 6.客戶關係管理 7.產品安全 8.企業公民與慈善	1.股東權益 2.董事會結構與運作 3.行為準則與內控 4.風險及危機管理 5.永續金融 6.ESG創新	1.環境系統與治理 2.空氣管理 3.能源與氣候變遷 4.水管理 5.原物料與廢棄物管理/資源與廢棄物管理 6.生物多樣性 7.供應商及產品生命週期管理/供應鏈環境面向管理	1.ESG 揭露

Source: https://www.aacsb.ntpu.edu.tw/twsvi/view.php?id=Nzc=

國立臺北大學
National Taipei University

國立臺北大學商學院
企業永續發展研究中心
Center for Corporate Sustainability

SEED
台灣永續評鑑

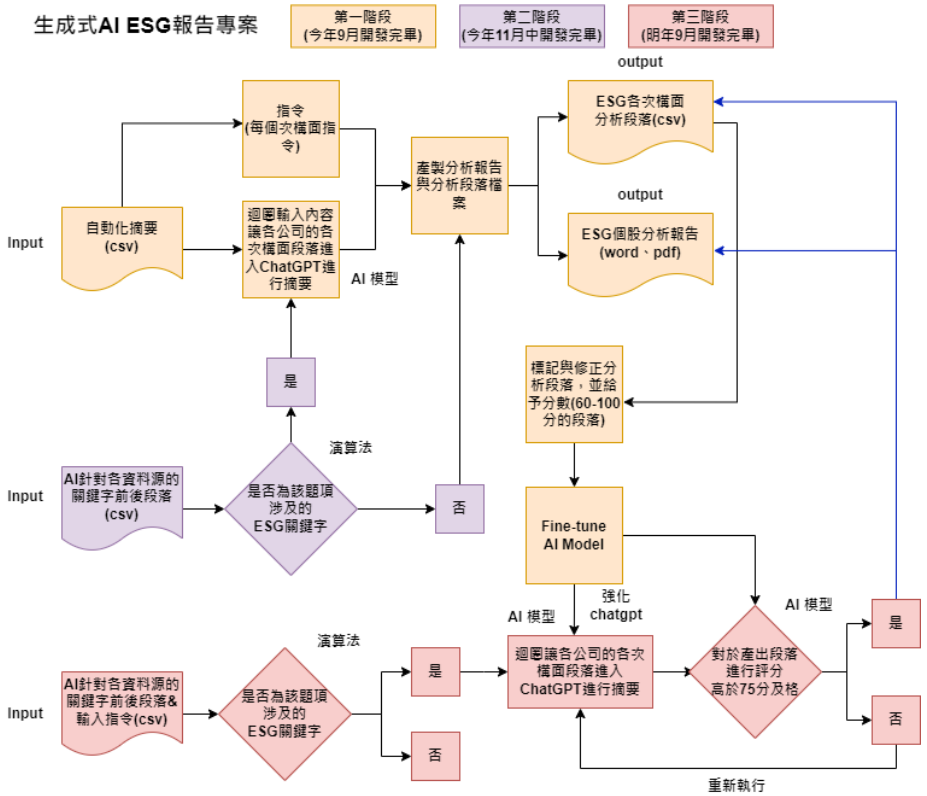
台灣永續評鑑

國立臺北大學商學院企業永續發展研究團隊

透過 AI SEED 提升評鑑效率

國立臺北大學 National Taipei University
國立臺北大學商學院 企業永續發展研究中心 Center for Corporate Sustainability

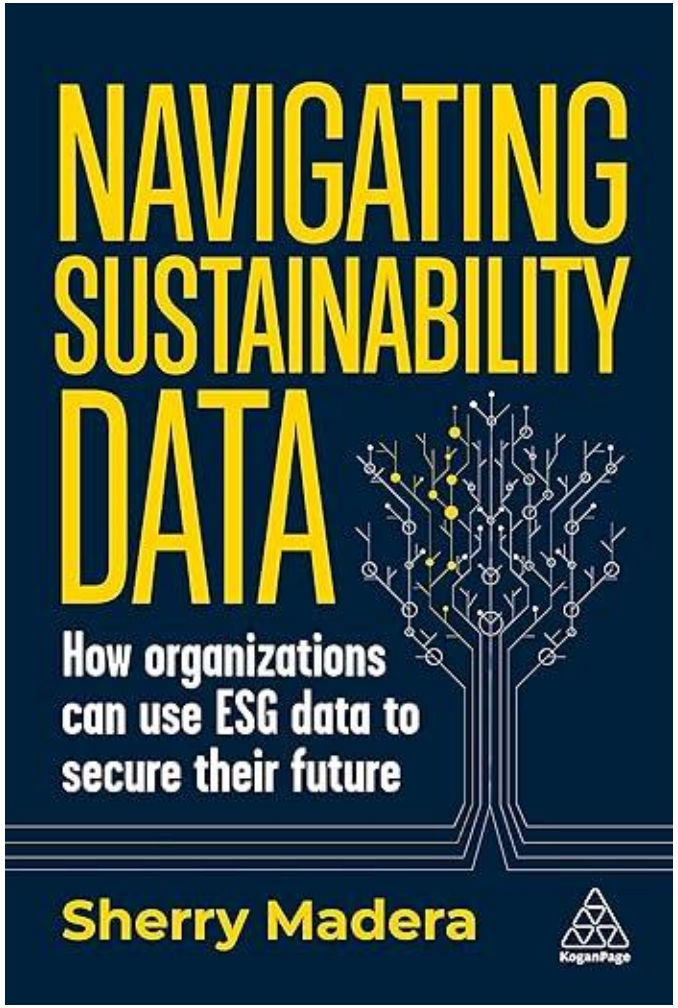
為使評鑑效率提升，與國立臺北大學資管所及資工所合作，開發相關程式，
已有25%題項自動或半自動化，大幅提升評鑑效率，並持續開發機械學習，持續透過AI 輔助評鑑進行。
另也透過AI SEED團隊持續將部分流程自動化，提升評鑑正確性，減少人力出錯可能。



題號	題目關鍵字	完成度
2-1-15	僅分派董監酬勞未分派股利	100%
2-2-3	獨董達董事席次1/2以上	100%
2-2-4	至少兩名獨董任期不超過9年	100%
2-2-14	設提名委員會且半數以上為獨董	100%
2-2-30	董事長兼任總經理	100%
2-2-31	1/3以上董事任期超過15年	100%
2-3-8	破產 / 面臨下市	100%
2-3-15	資安長或資訊安全委員會	100%
2-4-7	無保留意見	100%

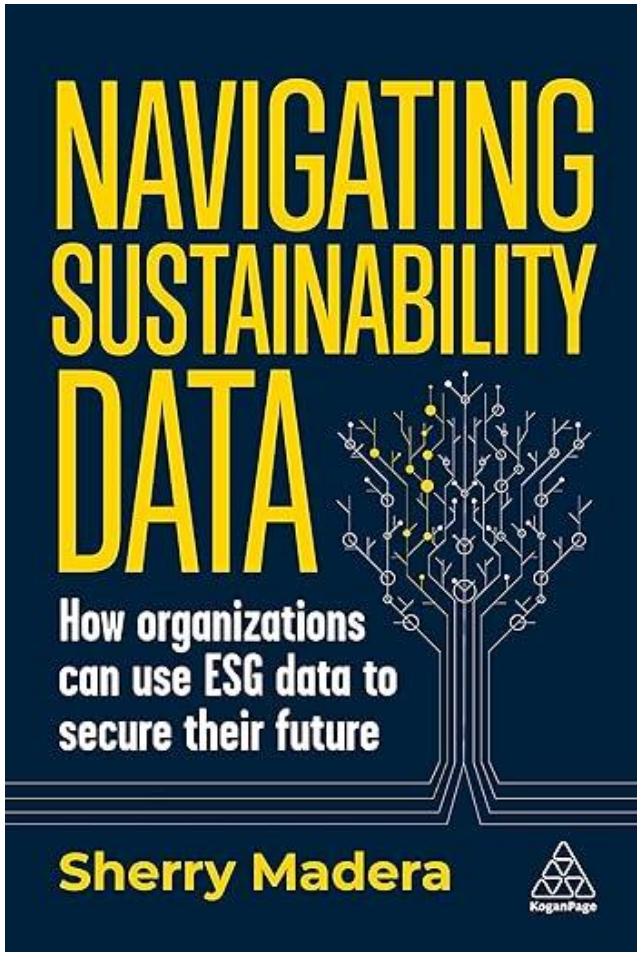
SEED 台灣永續評鑑

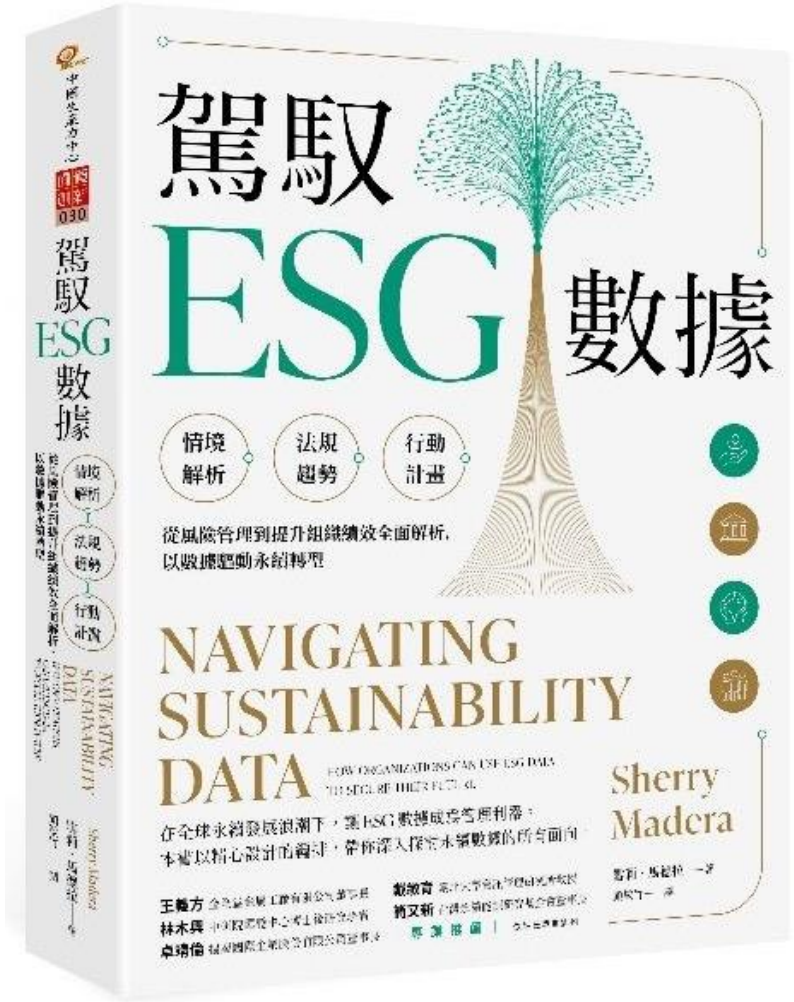
Sherry Madera (2024),
Navigating Sustainability Data: How Organizations can use ESG Data to Secure Their Future, Kogan Page



Source: https://www.amazon.com/Navigating-Sustainability-Data-Organizations-Secure/dp/1398612243/

雪莉．馬德拉 (Sherry Madera) (顏敏竹 譯) (2024),
駕馭ESG數據 (Navigating Sustainability Data),
財團法人中國生產力中心





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（台灣永續能源研究基金會董事長）

Source: https://www.eslite.com/product/1001201176268268892900 2

Generative AI-Driven ESG Report Generation Technology

Industrial Technology Research Institute (ITRI),
Fintech and Green Finance Center (FGFC, NTPU),
NTPU-113A513E01, 2024/03/01~2024/12/31

Generative AI

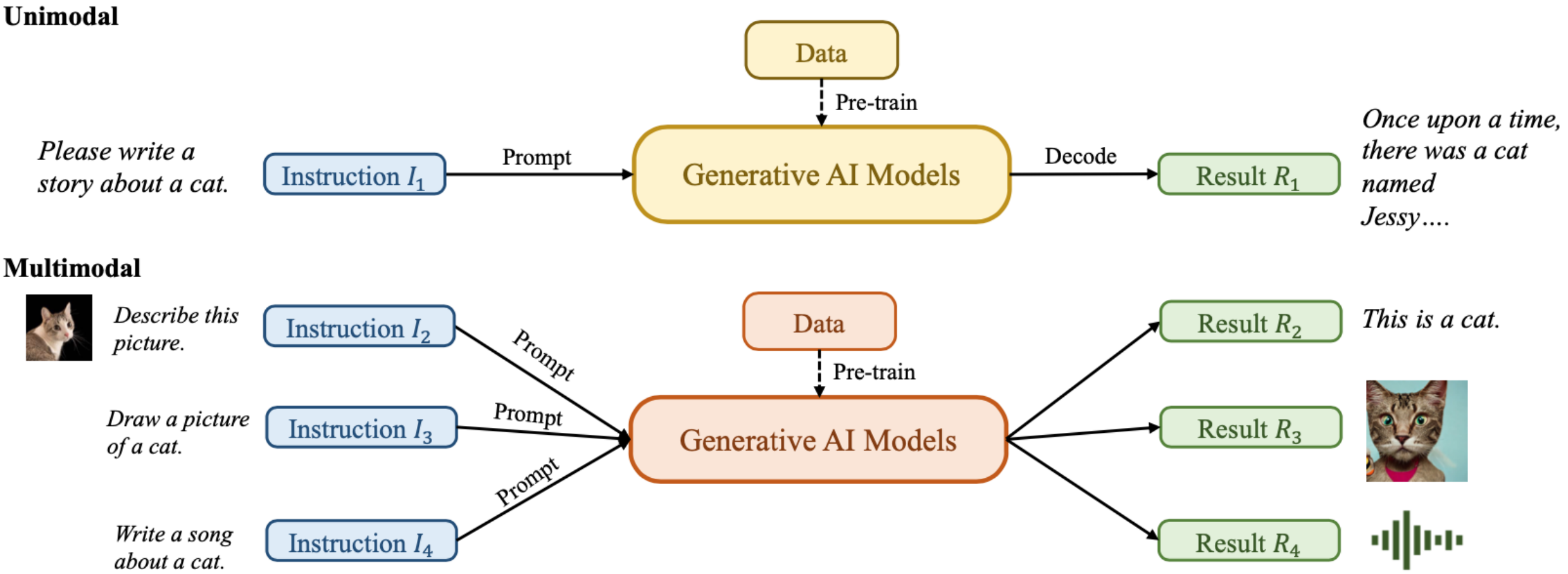
Powering Digital Sustainability Transformation

Generative AI (Gen AI)

AI Generated Content (AIGC)

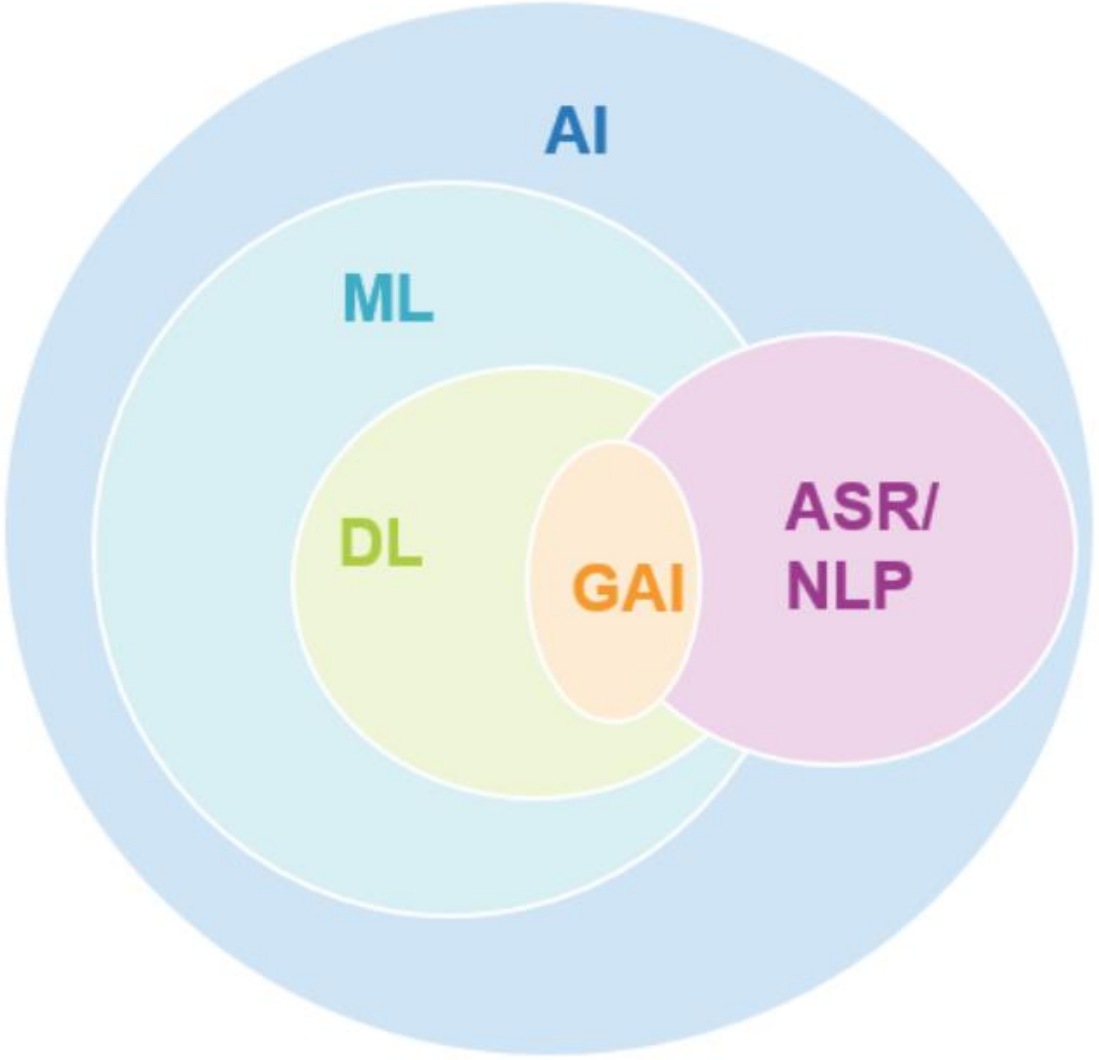
Generative AI (Gen AI)

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.

AI, ML, DL, Generative AI



- Artificial Intelligence
- Machine Learning
- Deep Learning
- Automatic Speech Recognition, Natural Language Processing
- Generative AI

Source: Jeong, Cheonsu. "A Study on the Implementation of Generative AI Services Using an Enterprise Data-Based LLM Application Architecture." arXiv preprint arXiv:2309.01105 (2023).

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

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**

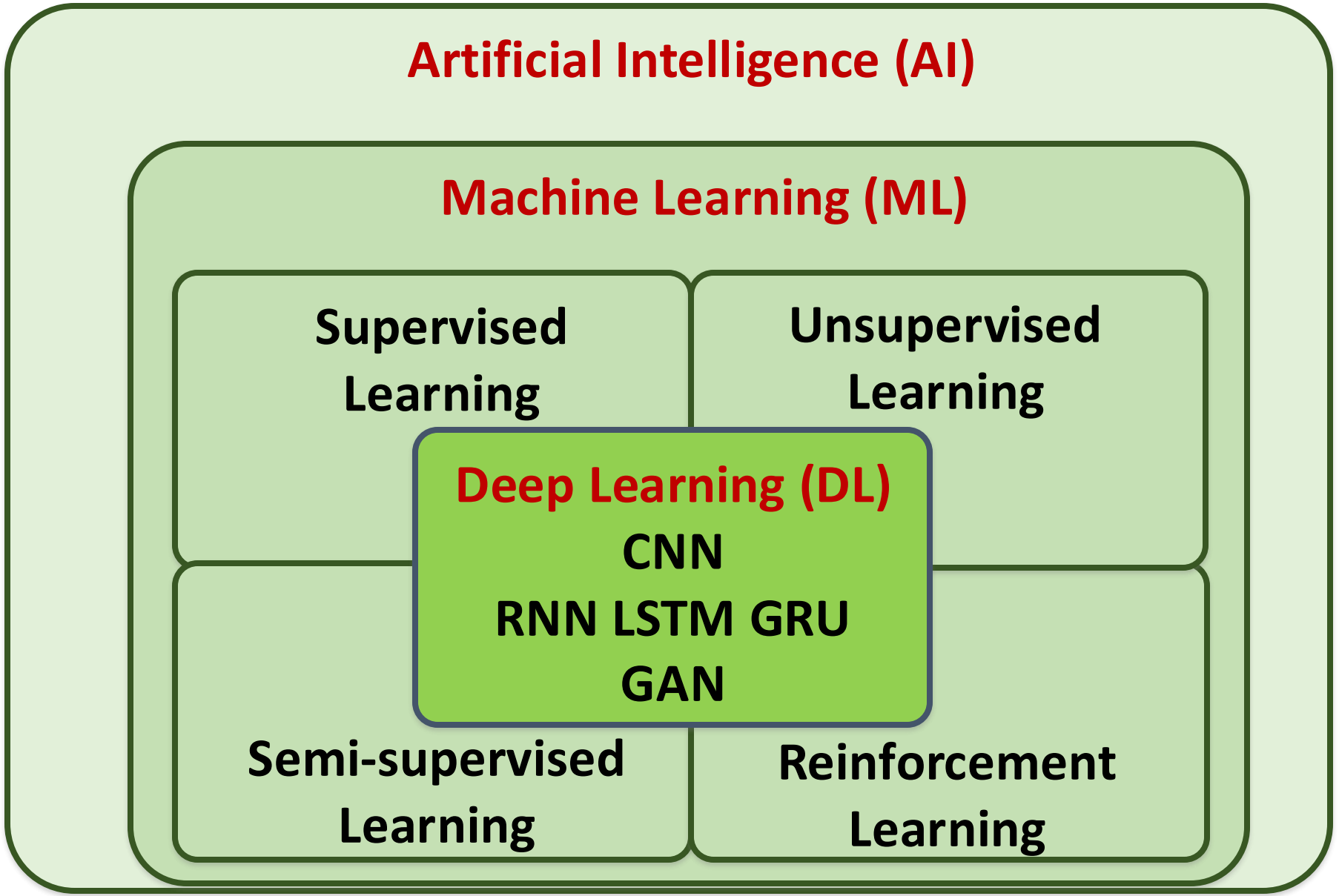
Source: Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson

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

AI, ML, DL



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

Comparison of Generative AI and Traditional AI

Feature	Generative AI	Traditional AI
Output type	New content	Classification/Prediction
Creativity	High	Low
Interactivity	Usually more natural	Limited

Generative AI

- Generative AI: The Art of Creation
- Definition: AI systems capable of creating new content
- Characteristics: Creativity, interactivity

Generative AI and Large Language Models (LLMs): Popular Generative AI Applications

Generative AI
Large Language Models (LLMs)
Foundation Models

Spring 2025

Generative AI Innovative Applications

NVIDIA

University Ambassador

This certificate acknowledges that

Min-Yuh Day

has been certified to deliver NVIDIA instructor-led workshop for academia

Greg Estes

Vice President, NVIDIA

Issue Date: : March 7, 2025

Ambassador Certification ID: cCFh1ZWWTvqKTq7dcKkEWw

https://learn.nvidia.com/certificates?id=cCFh1ZWWTvqKTq7dcKkEWw

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Building RAG Agents with LLMs

Greg Estes

Vice President, NVIDIA

Issue Date: : March 7, 2025

Certification ID: OVmqY4cSSya0BdMQBWHxzw

https://learn.nvidia.com/certificates?id=OVmqY4cSSya0BdMQBWHxzw

NVIDIA Developer Program

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

NVIDIA Deep Learning Institute (DLI)

https://learn.nvidia.com/

Get NVIDIA DLI Certificate

- Welcome to NVIDIA DLI "Building RAG Agents with LLMs" workshop scheduled for March 11th-25th, 2025 at NTPU.
- Step 1. Visit https://learn.nvidia.com/dli-event
- Step 2. Enter the event code: NTPU_RAG_AMBASSADOR_MA25
- Step 3. Complete the NVIDIA DLI course and review the course datasheet (on March 25, 2025) at https://developer.nvidia.com/dli/getready

Get NVIDIA DLI Certificate Before the NVIDIA Workshop

- **Step 1. Join NVIDIA Developer Program (Free)**
  https://developer.nvidia.com/join-nvidia-developer-program
- **Step 2. Visit NVIDIA Deep Learning Institute (DLI)**
  https://learn.nvidia.com/
- **Step 3. Enroll "Building RAG Agents with LLMs" Self-Paced Course (Free)**
  https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-15+V1

NVIDIA Deep Learning Institute (DLI)

Building RAG Agents with LLMs workshop

March 11th-25th, 2025 at NTPU

Self-Paced Course	Instructor-Led Workshop
Building RAG Agents With LLMs	**Building RAG Agents With LLMs**
Certificate available Free 8 hours	Certificate available $500 8 hours

Step 1.
Visit
https://learn.nvidia.com/dli-event

Step 2.
Enter the event code:
NTPU_RAG_AMBASSADOR_MA25

https://www.nvidia.com/en-us/learn/learning-path/generative-ai-llm/

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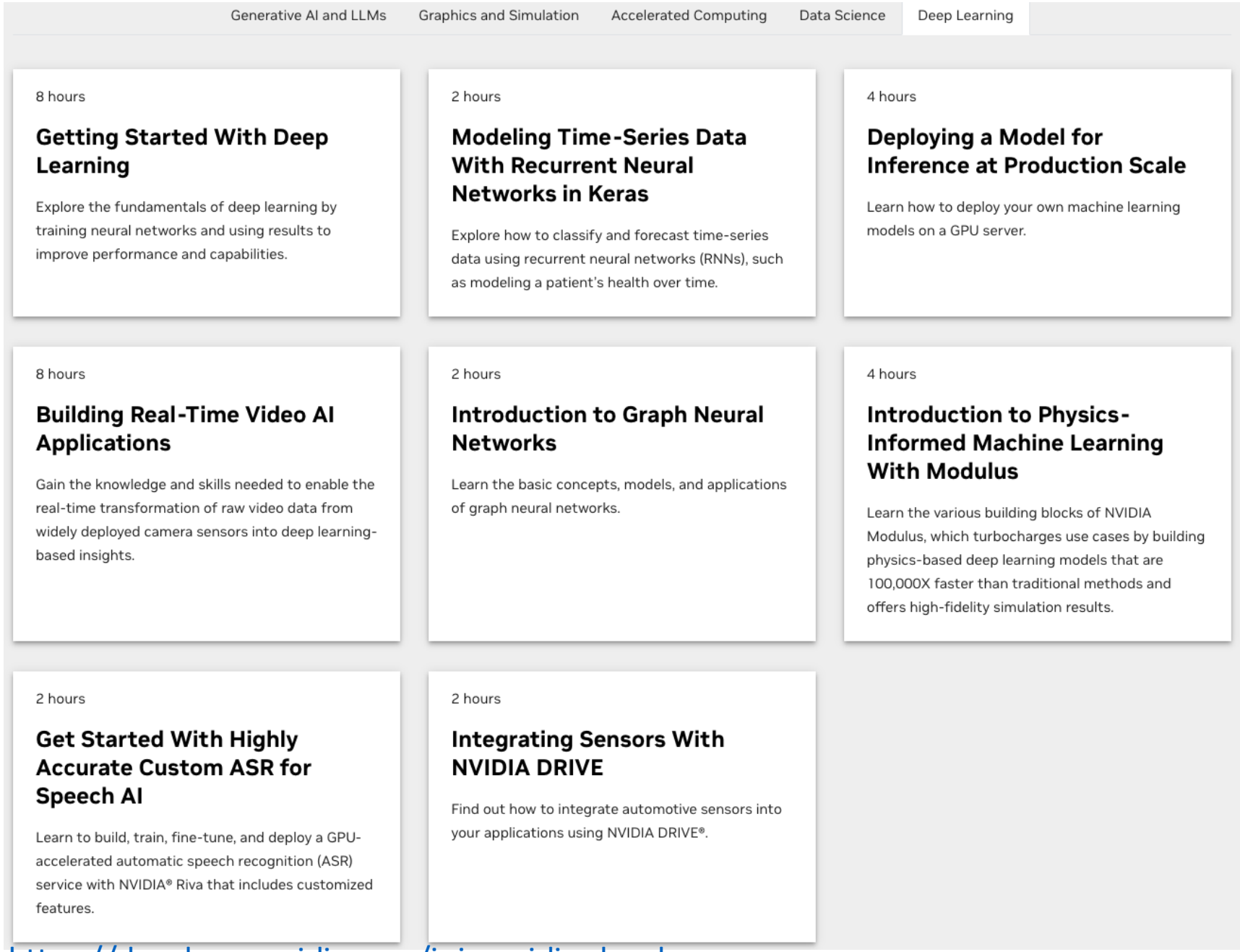

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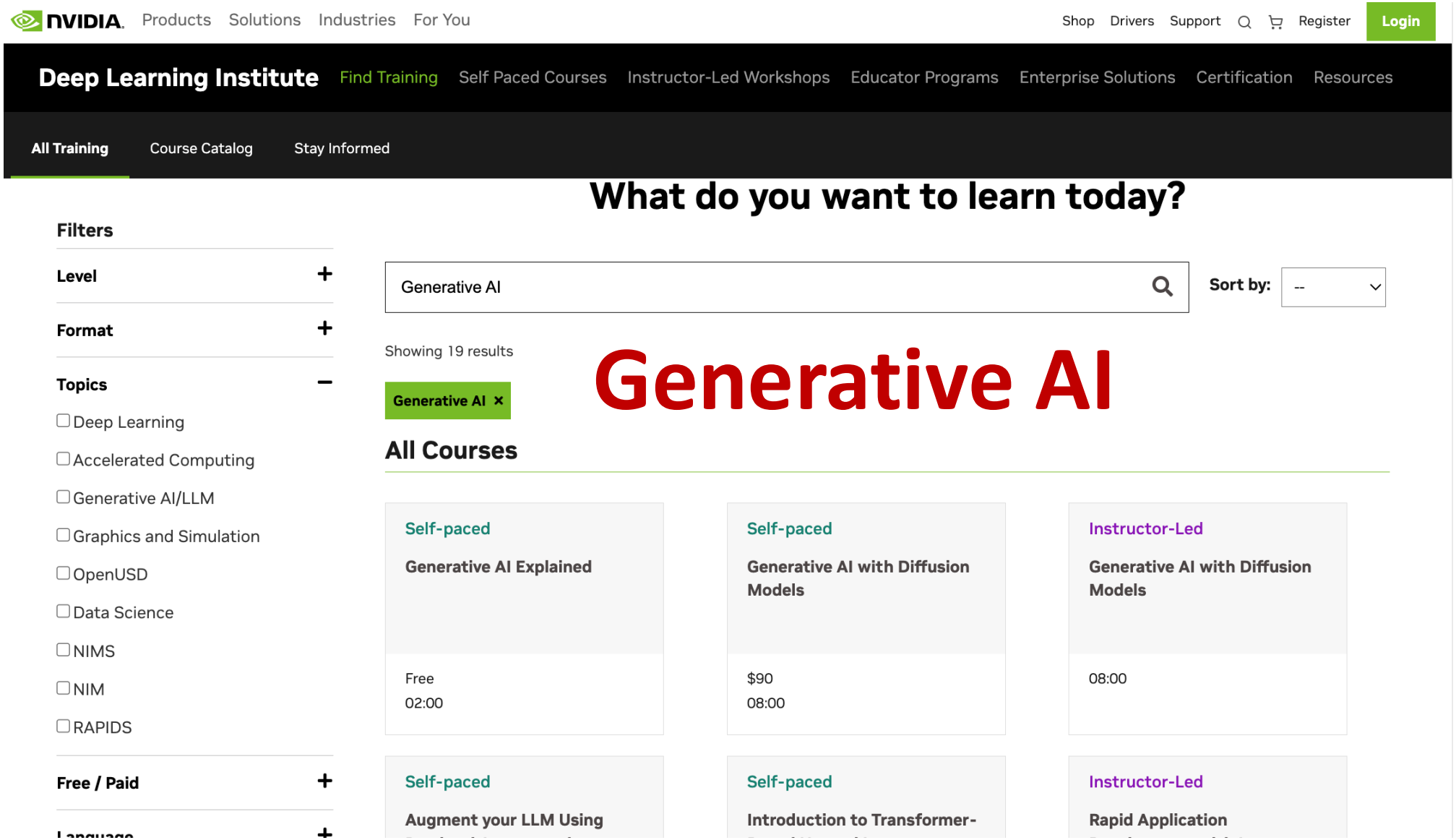
NVIDIA Deep Learning Institute (DLI)

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

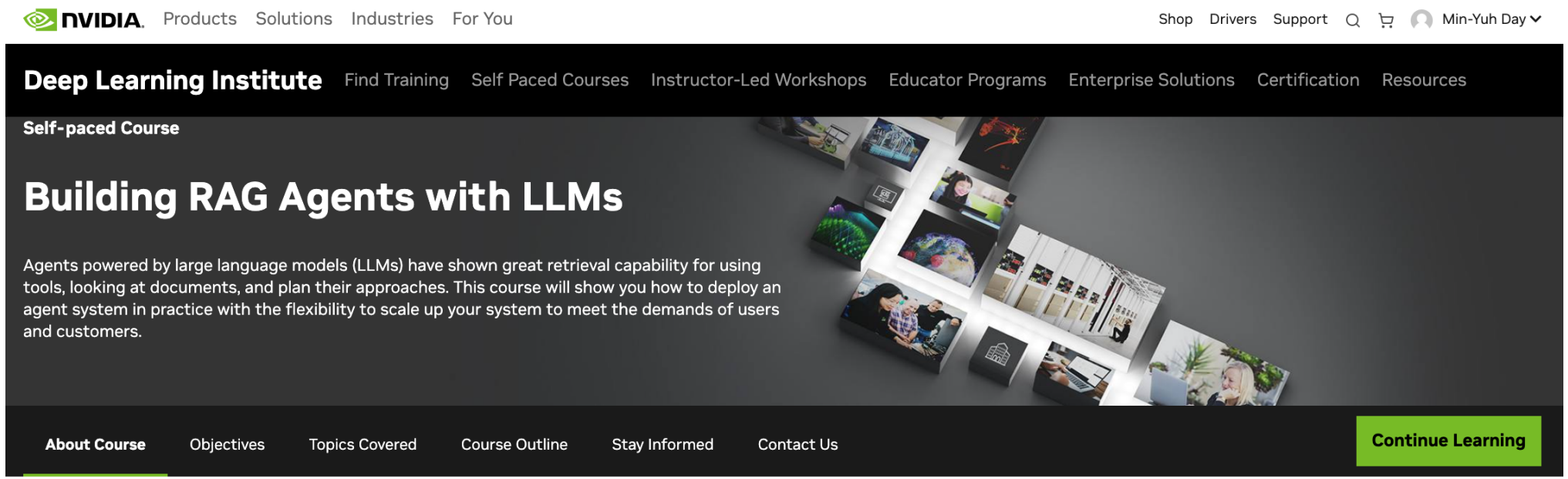
https://www.nvidia.com/en-us/learn/learning-path/generative-ai-llm/

NVIDIA Deep Learning Institute (DLI)



https://learn.nvidia.com/en-us/training/find-training?q=Generative+AI

Building RAG Agents with LLMs



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

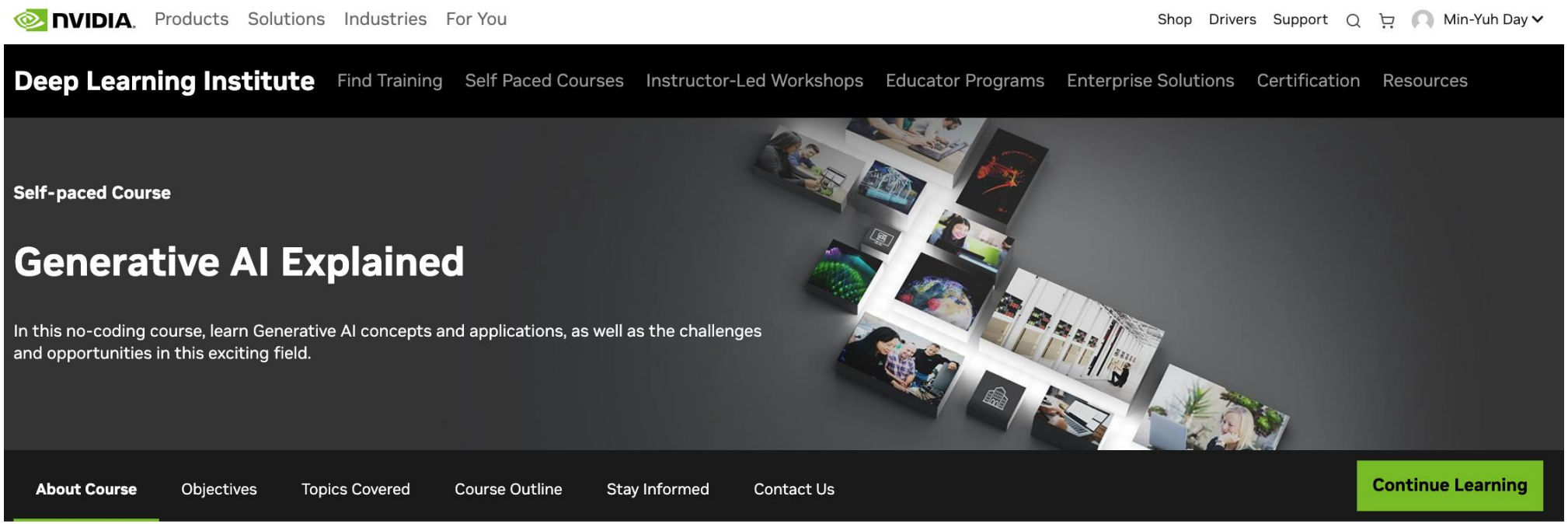
Subject: Generative AI/LLM

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

Generative AI Explained



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

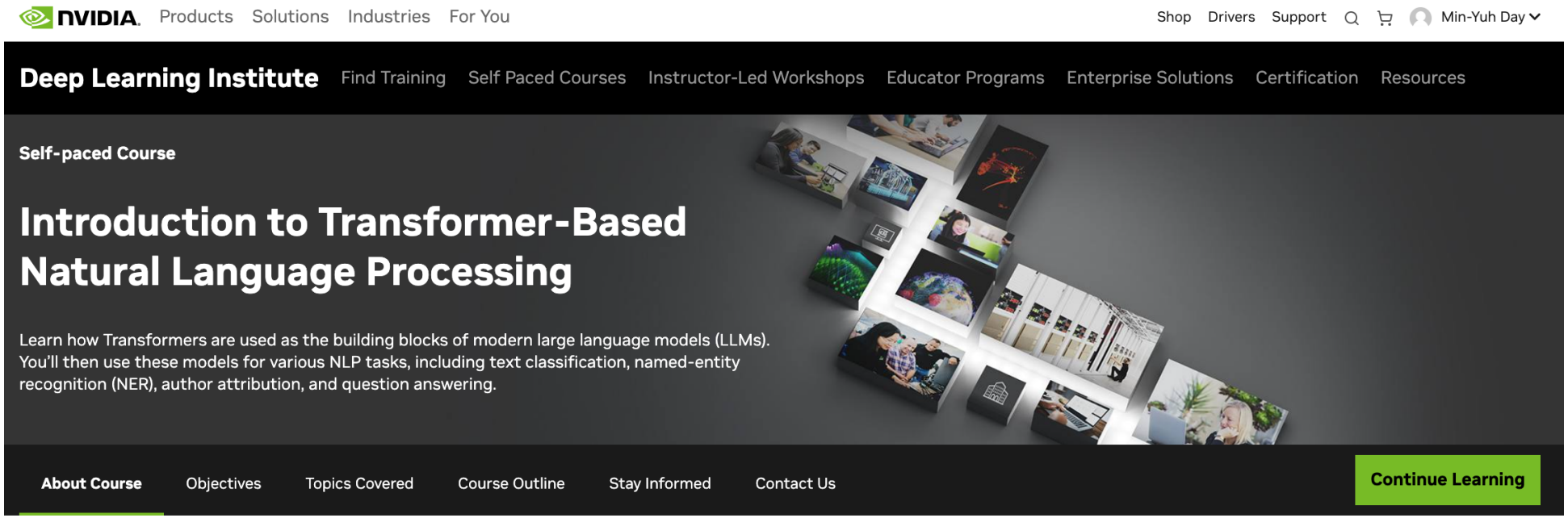
Level: Technical - Beginner

Subject: Generative AI/LLM

Language: English

https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-15+V1

Introduction to Transformer-Based Natural Language Processing



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

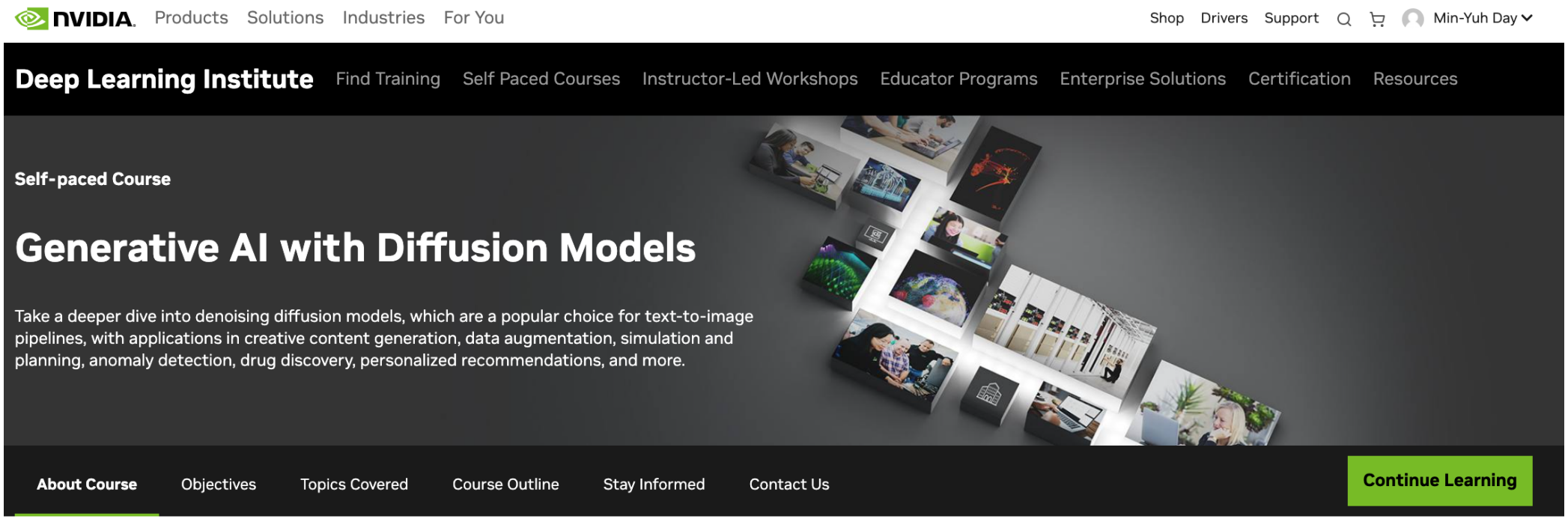
Level: Technical - Beginner

Subject: Generative AI/LLM

Language: English

https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-08+V1

Generative AI with Diffusion Models



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

Course Details

Duration: 08:00

Price: $90

Subject: Generative AI/LLM

Language: English

Course Prerequisites:
A basic understanding of Deep Learning Concepts.

https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-14+V1

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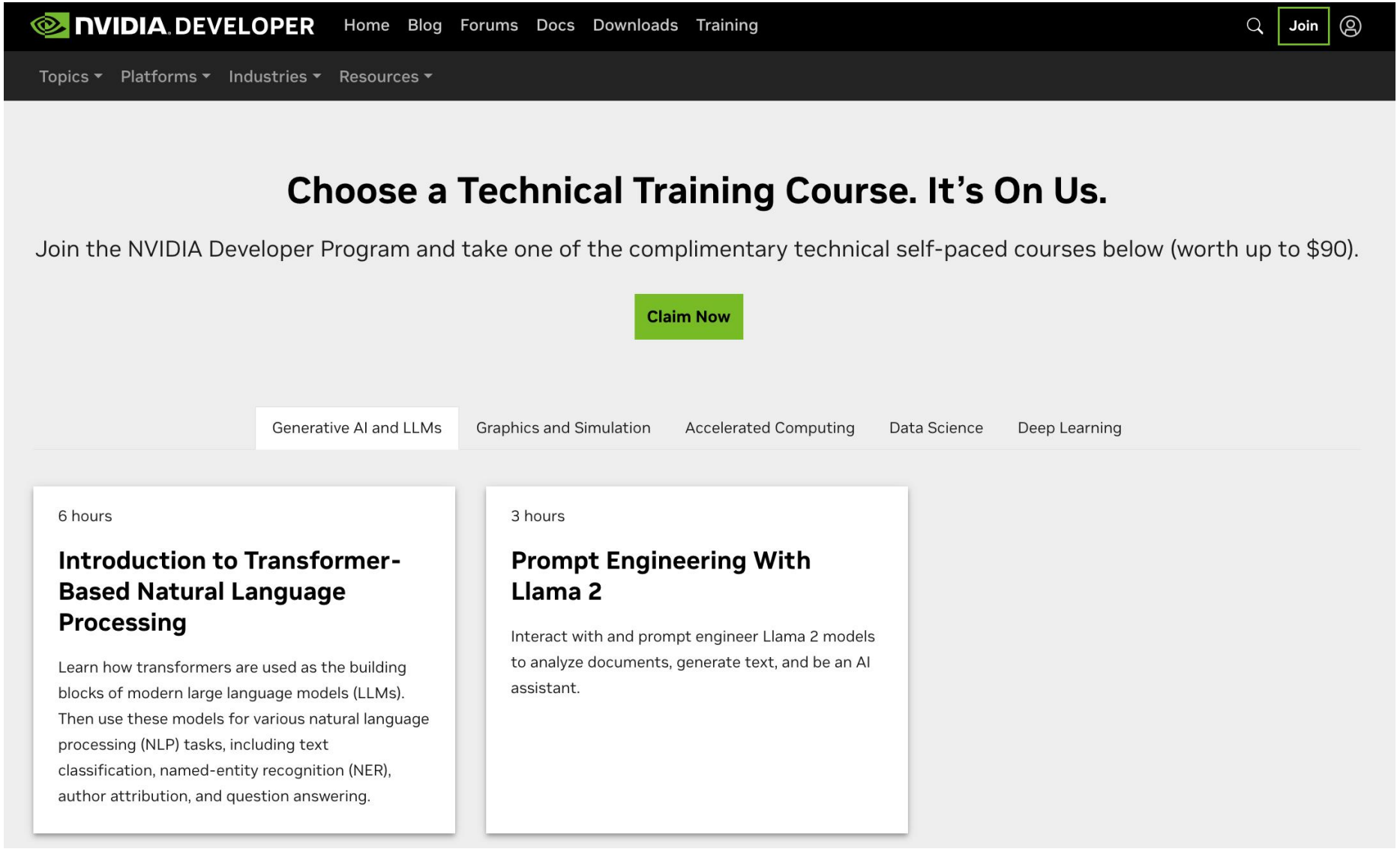

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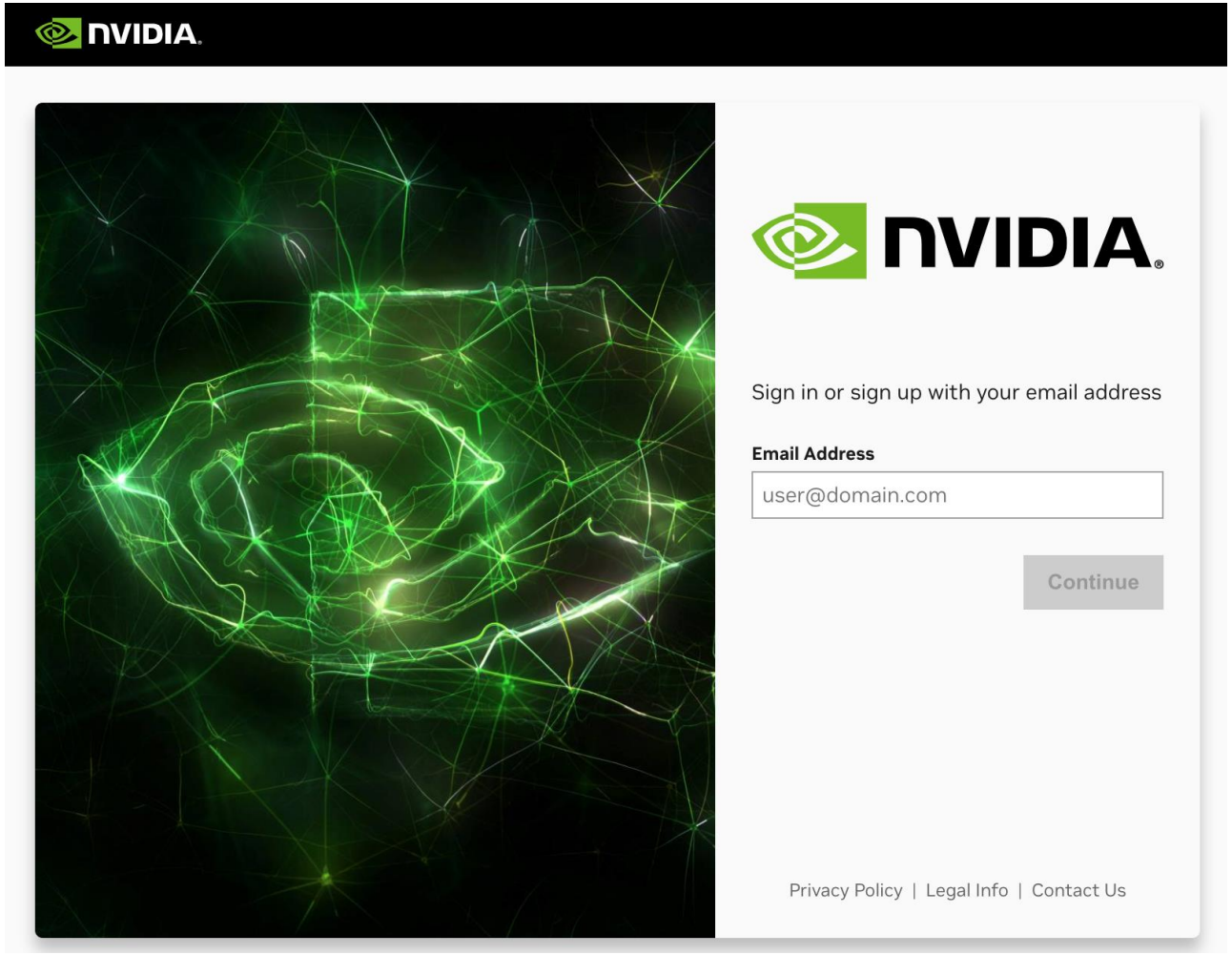

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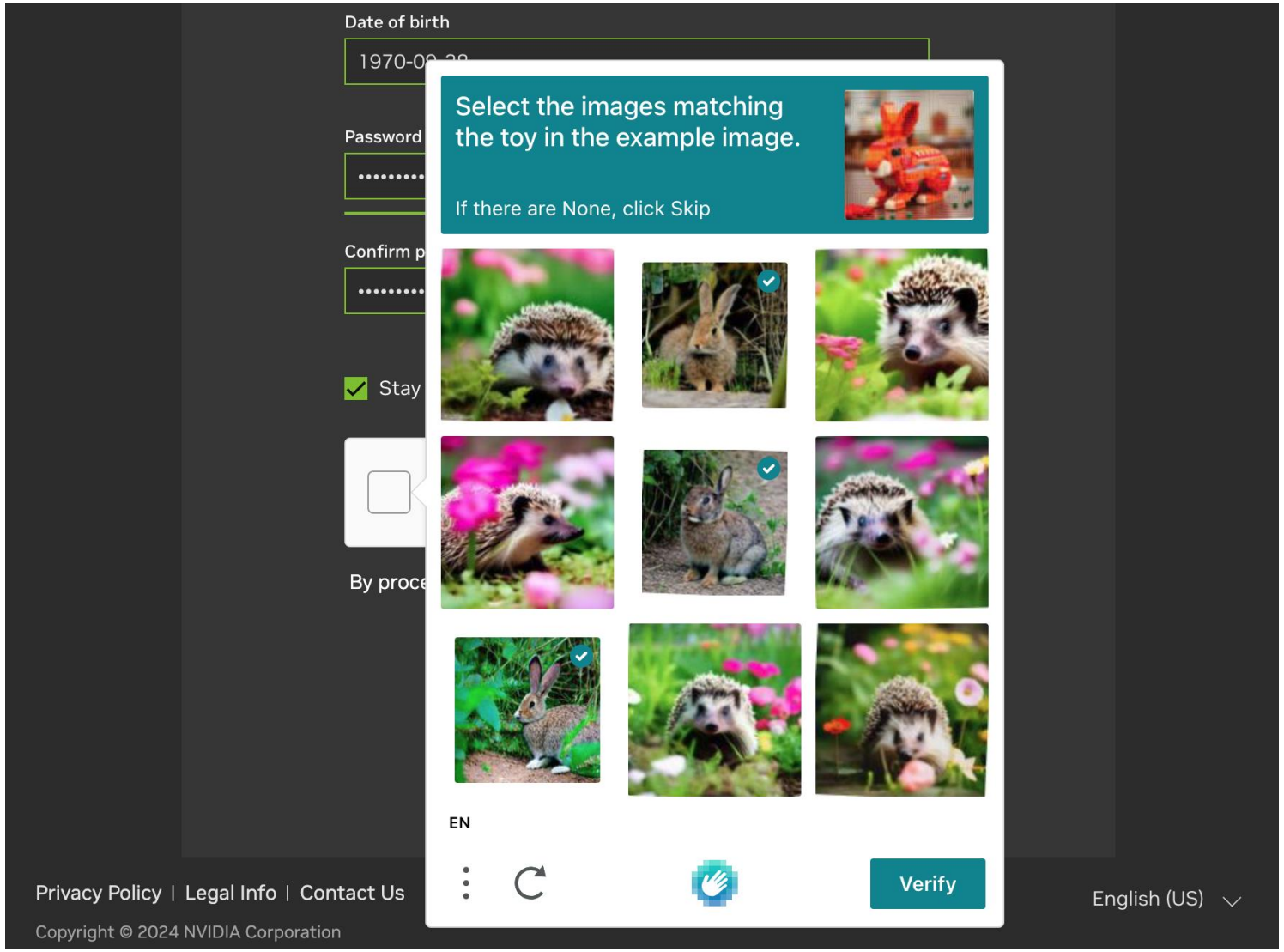

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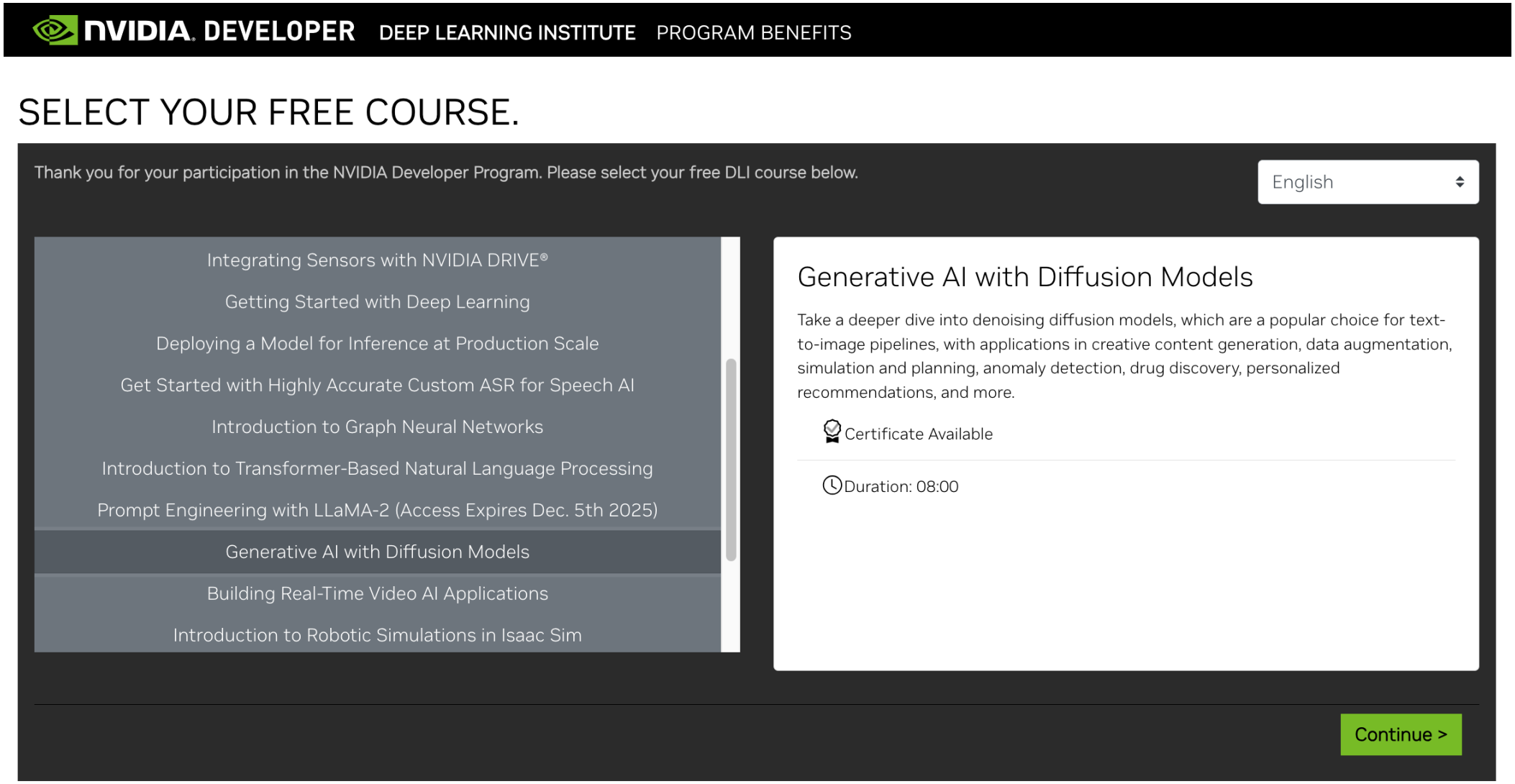

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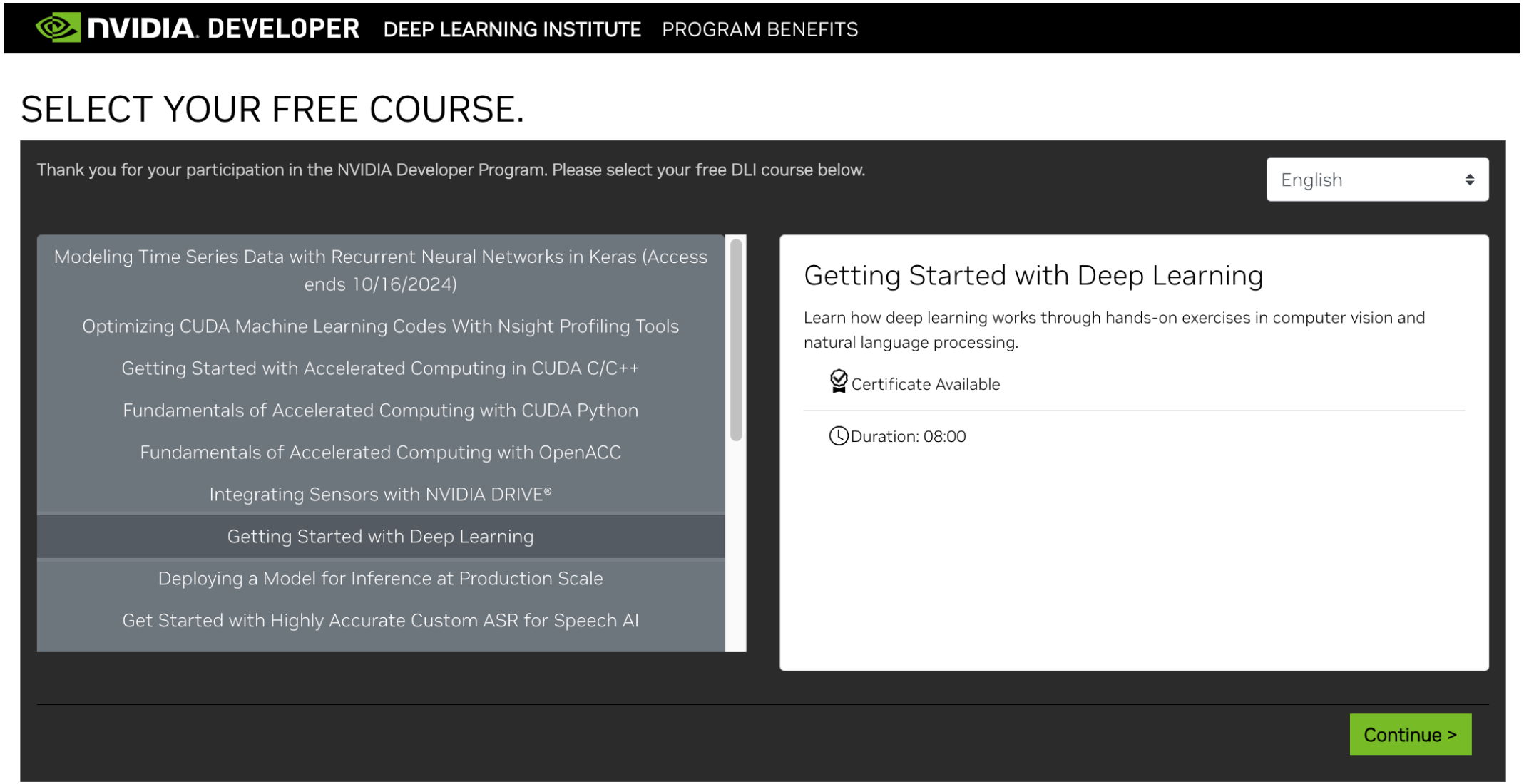

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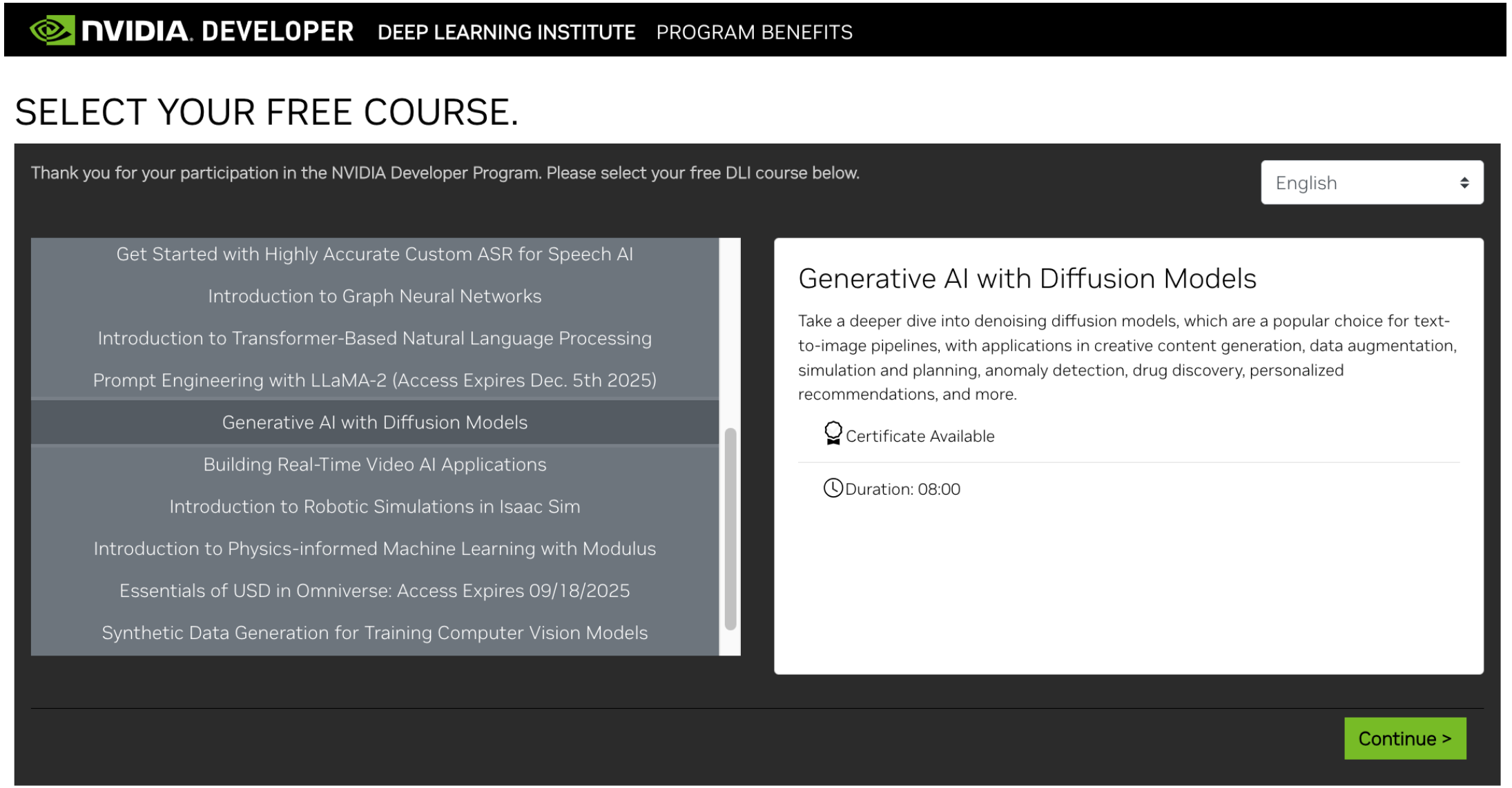

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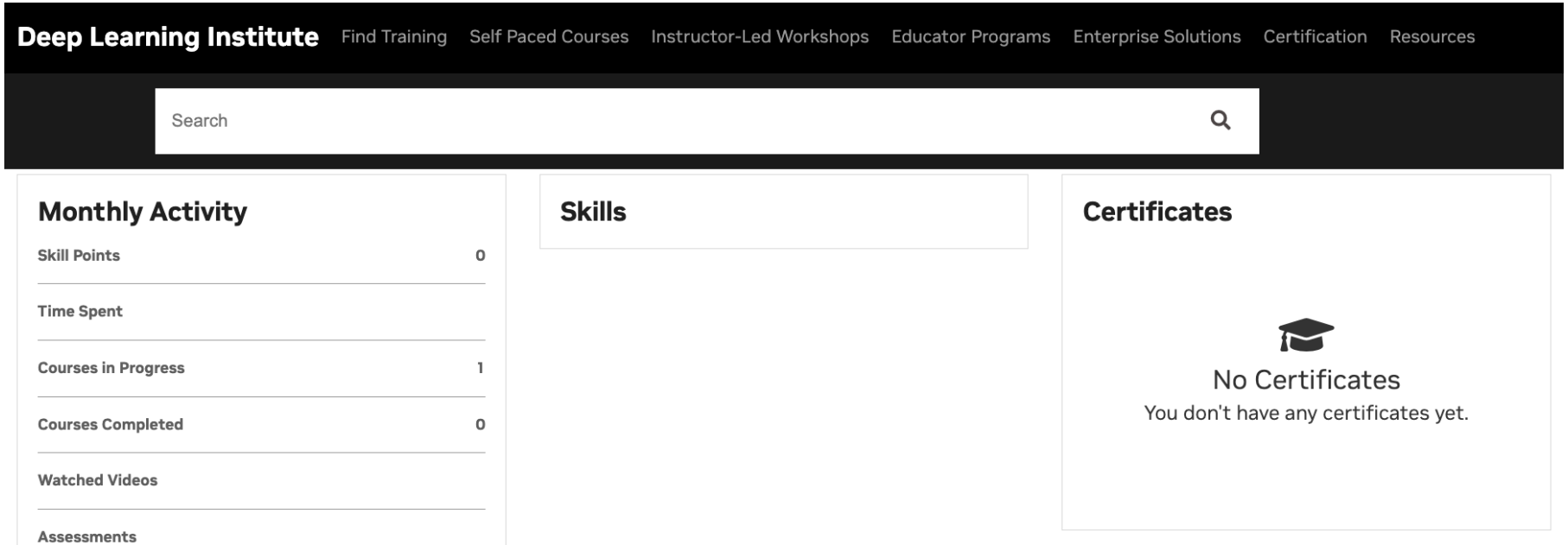

https://learn.nvidia.com/my-learning

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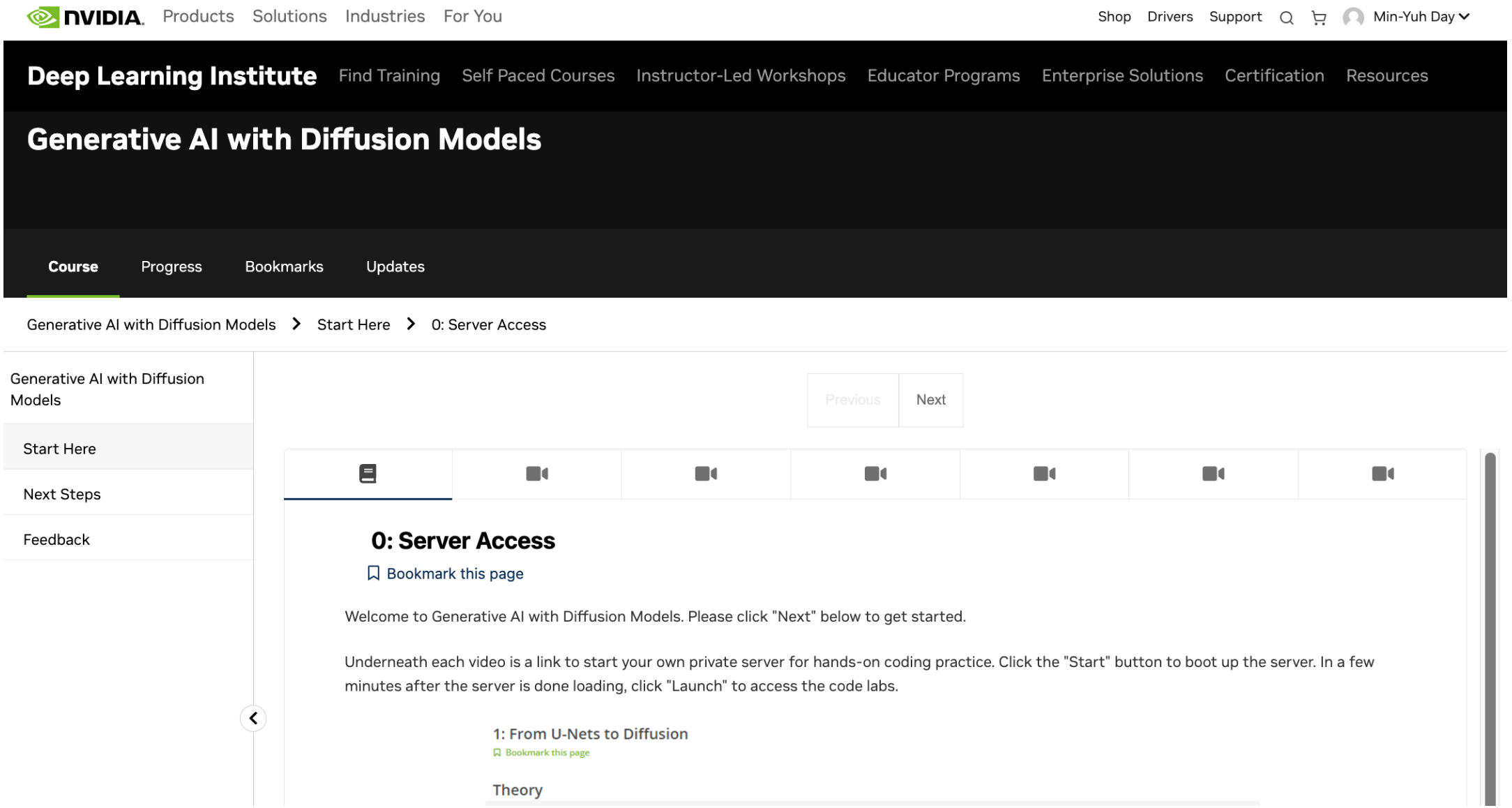

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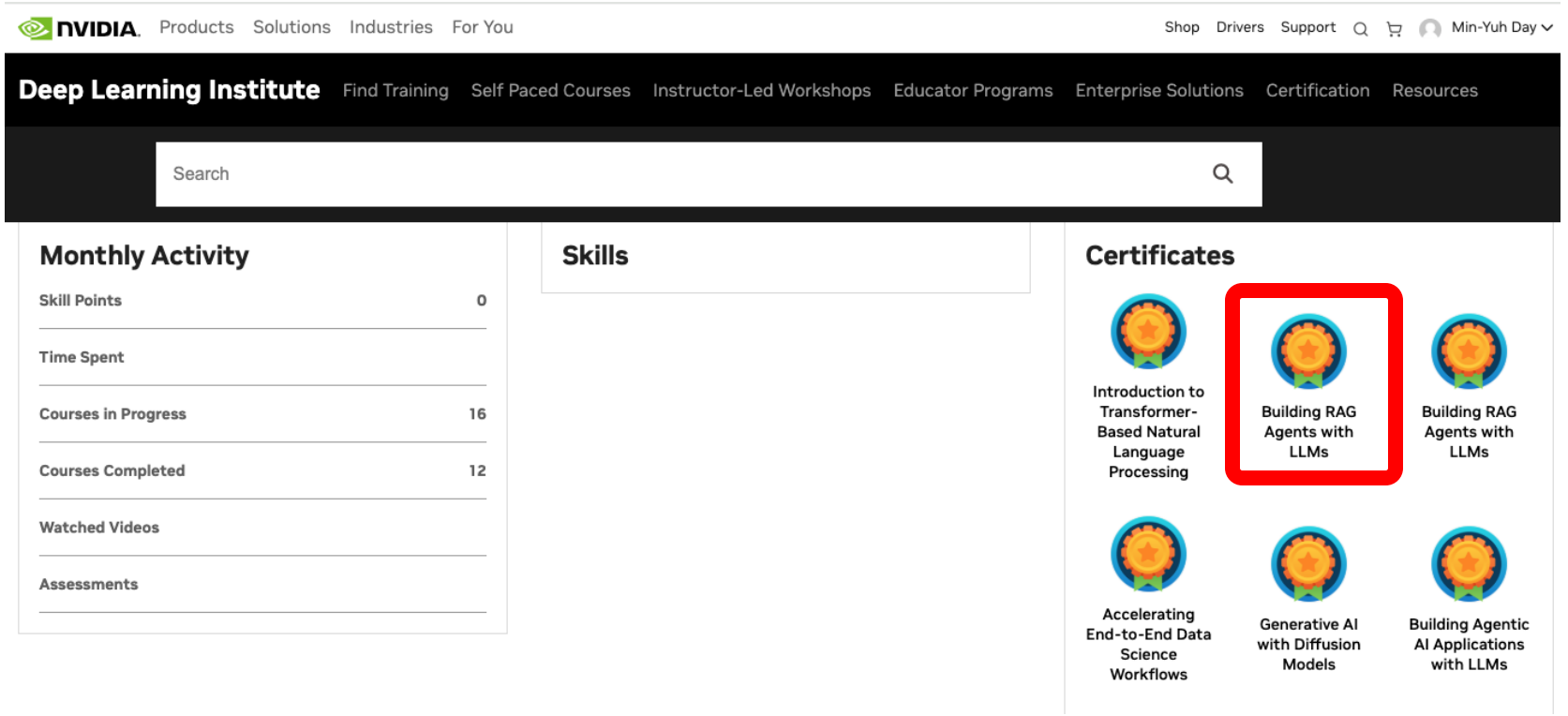
Deep Learning Institute (DLI)



Completed Courses

View more

Self-paced	Self-paced	Self-paced	Self-paced	Self-paced
Sizing LLM Inference Systems	Augment your LLM Using Retrieval Augmented Generation	Building RAG Agents with LLMs	Generative AI Explained	Introduction to Transform Based Natural Language Processing
100% Completed 03:00	100% Completed 01:00	100% Completed 08:00	100% Completed 02:00	100% Completed 06:00

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NVIDIA

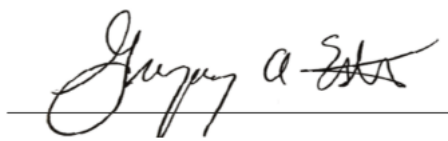
Certificate of Completion

This certificate is awarded to

Min-Yuh Day

for successfully completing

Building RAG Agents with LLMs



Greg Estes

Vice President, NVIDIA

Issue Date: : December 8, 2024

Certification ID: ed-qOCIMQaatzU8SNUNxgw |

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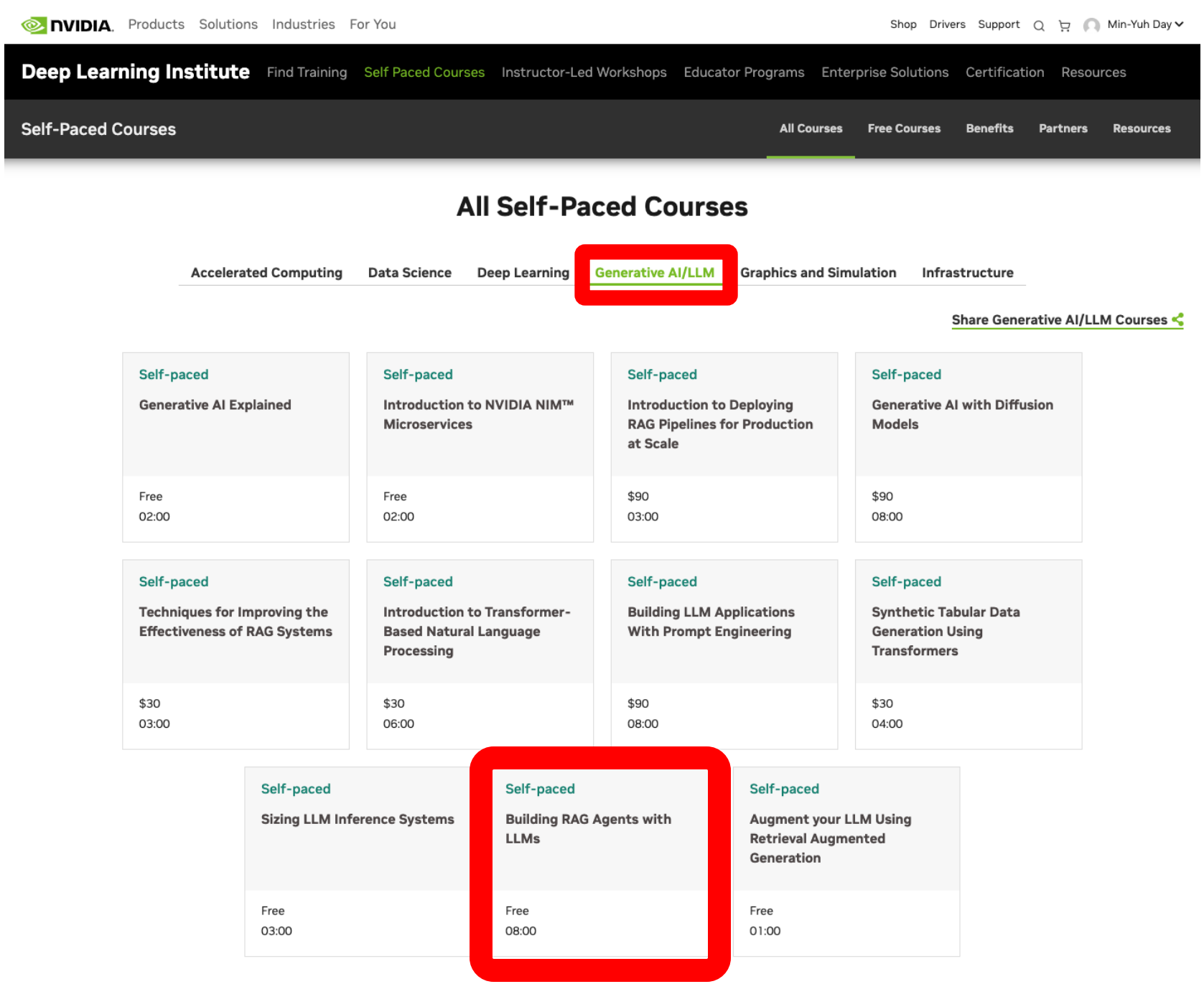
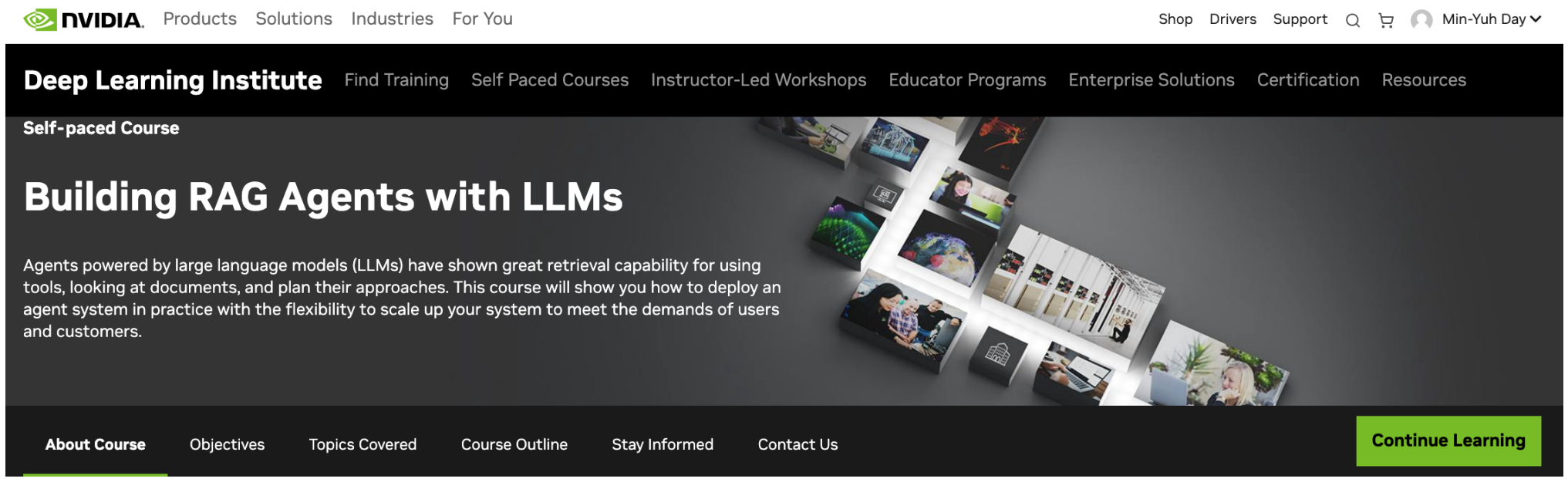
NVIDIA Deep Learning Institute (DLI)



https://learn.nvidia.com/en-us/training/self-paced-courses

Building RAG Agents with LLMs



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

Building RAG Agents with LLMs

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Building RAG Agents with LLMs

Course Progress Bookmarks Updates

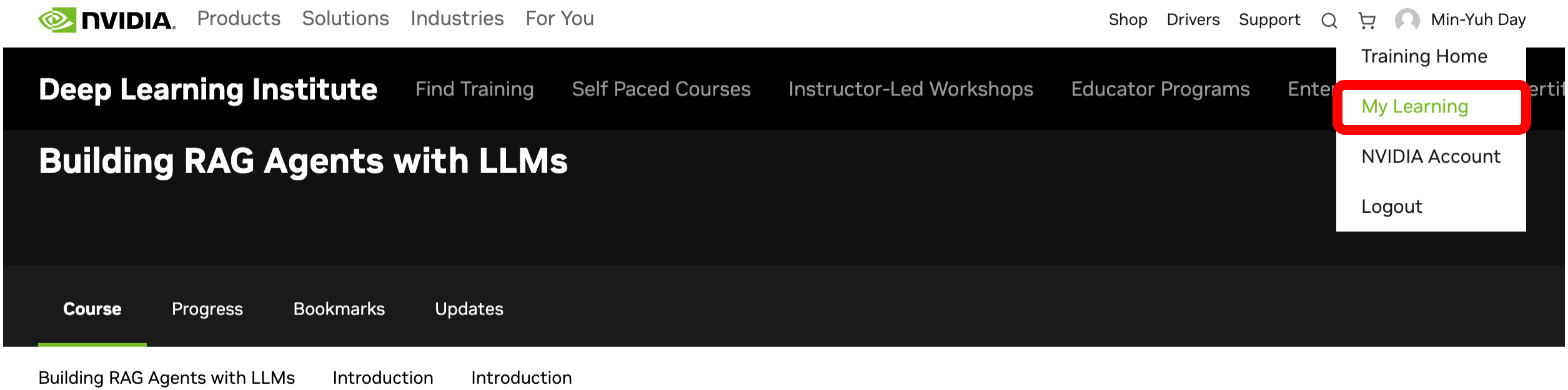
Building RAG Agents with LLMs Introduction Introduction

- Building RAG Agents with LLMs
- Introduction
- Environment and LLMs
- LangChain
- Documents and Embeddings
- Retrieval-Augmented Generation
- Next Steps
- Feedback

Previous Next

Source: NVIDIA DLI (2024), Building RAG Agents with LLMs, https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-15+V1

Building RAG Agents with LLMs



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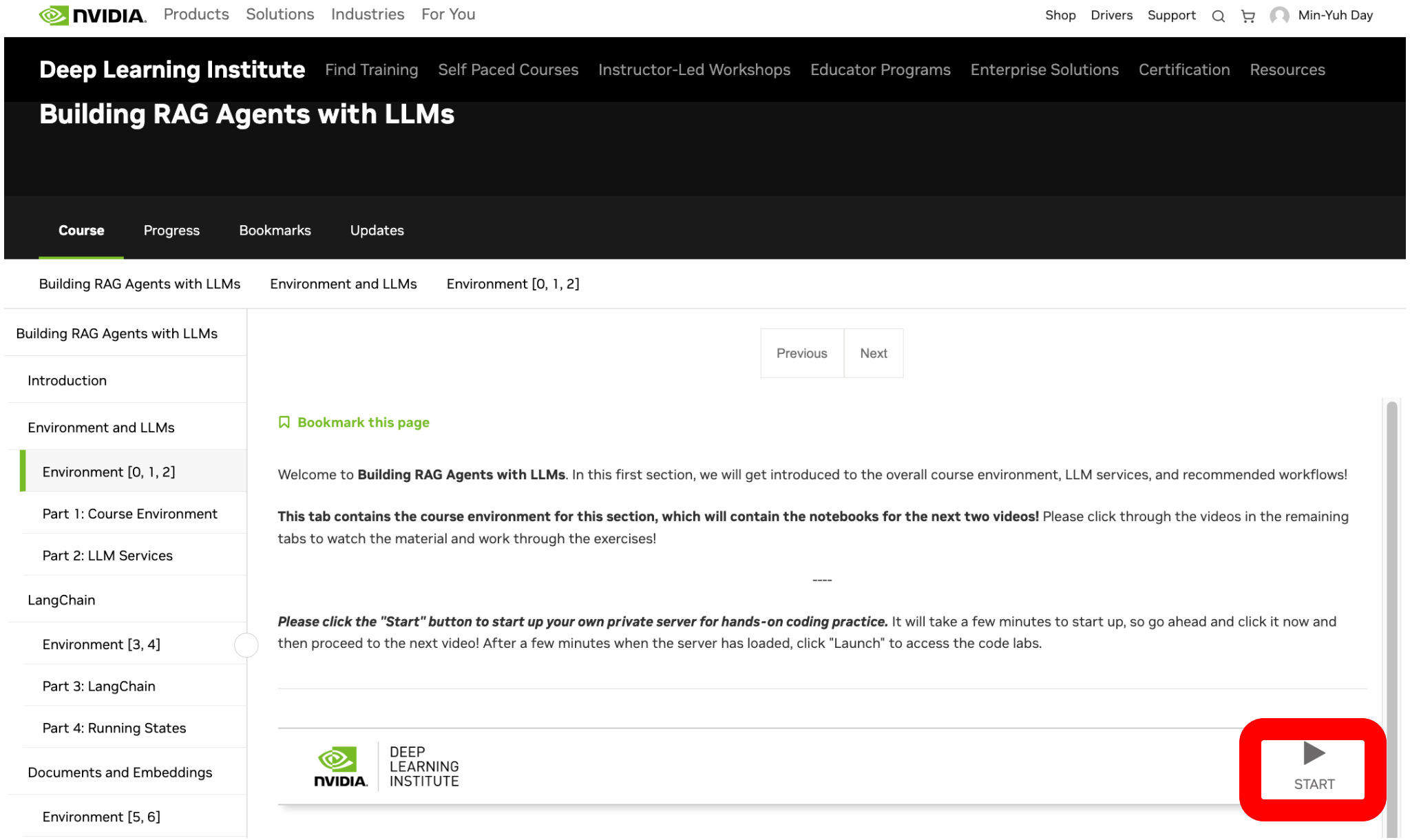
Building RAG Agents with LLMs



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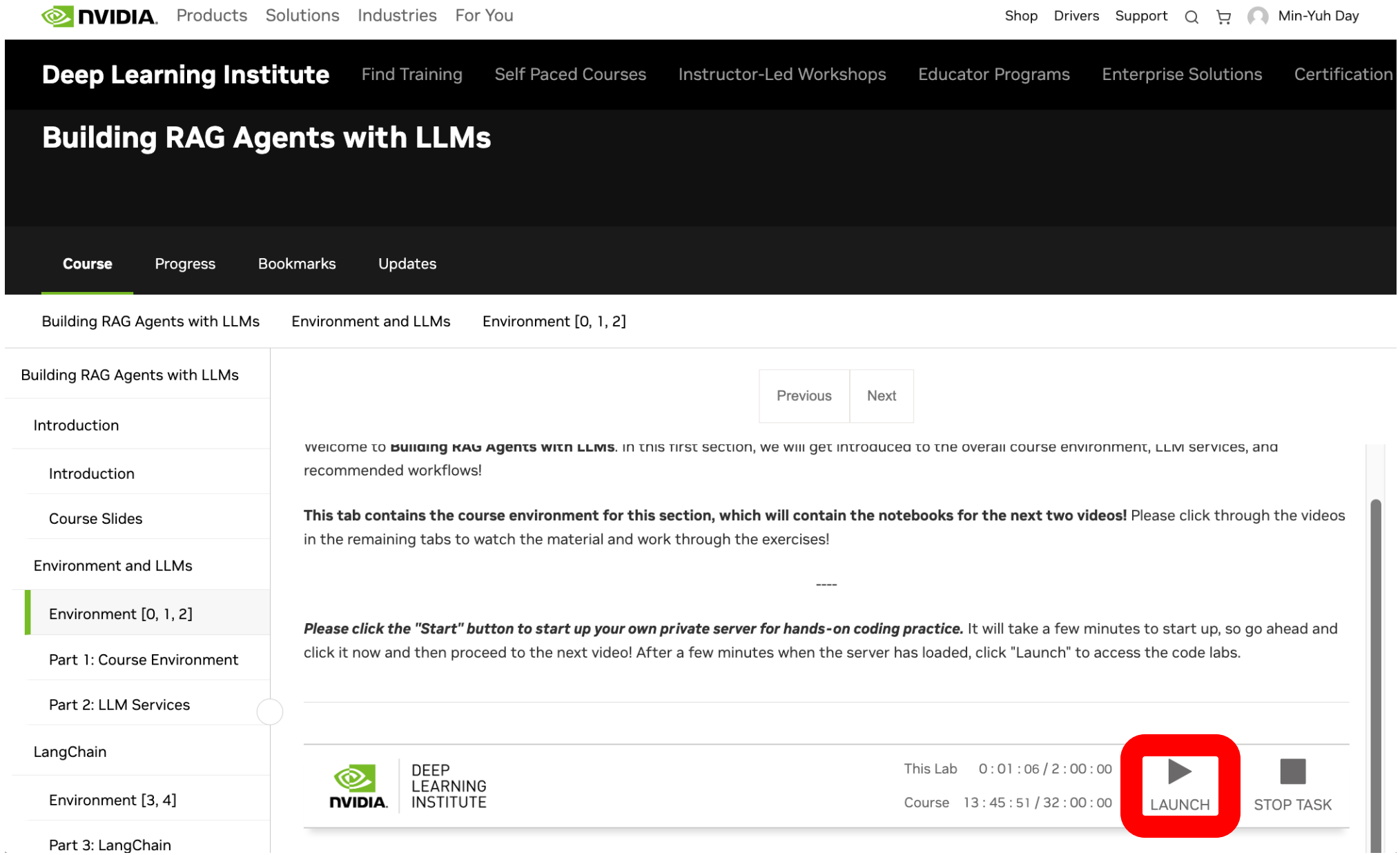
Building RAG Agents with LLMs



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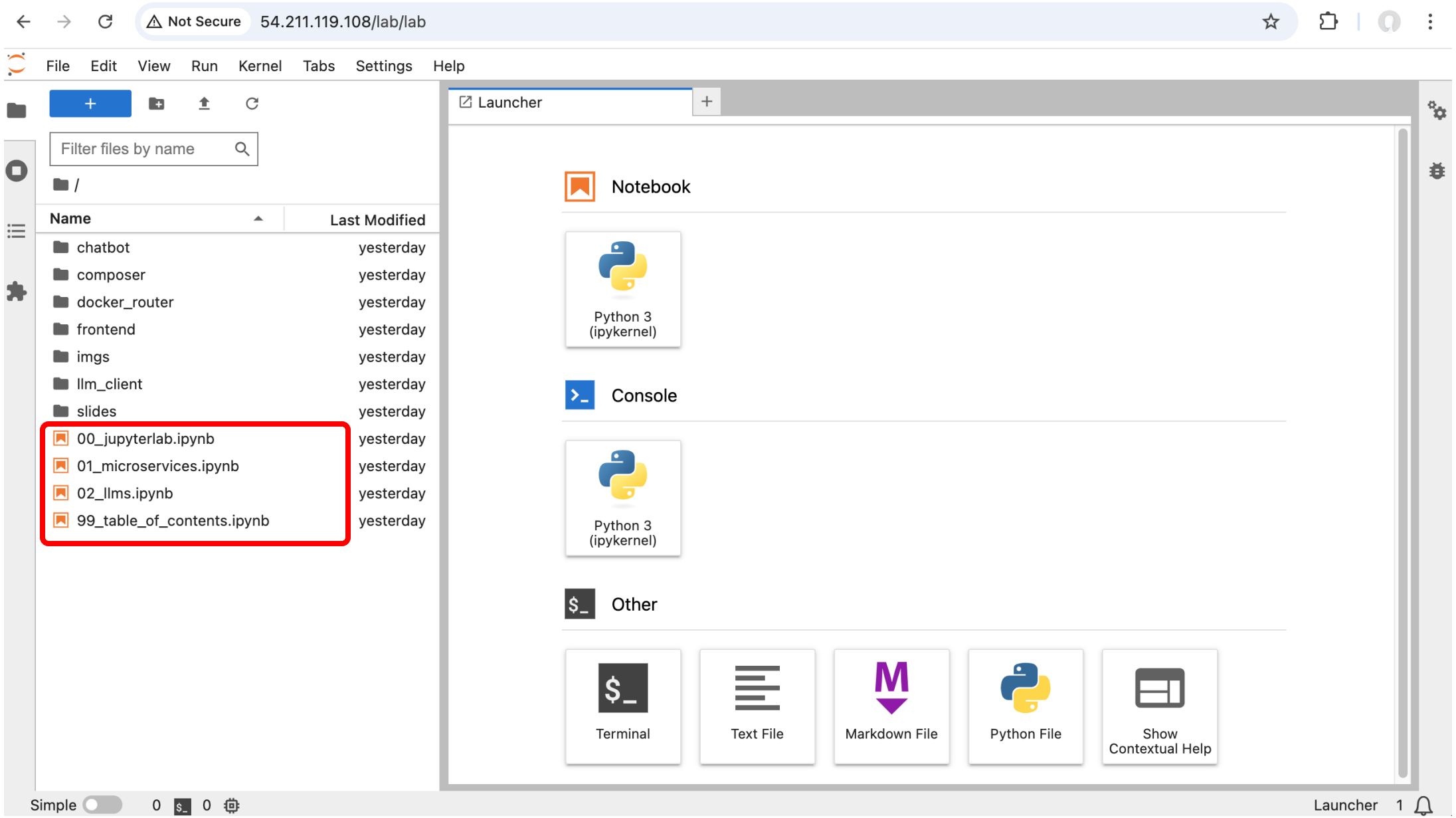
Building RAG Agents with LLMs



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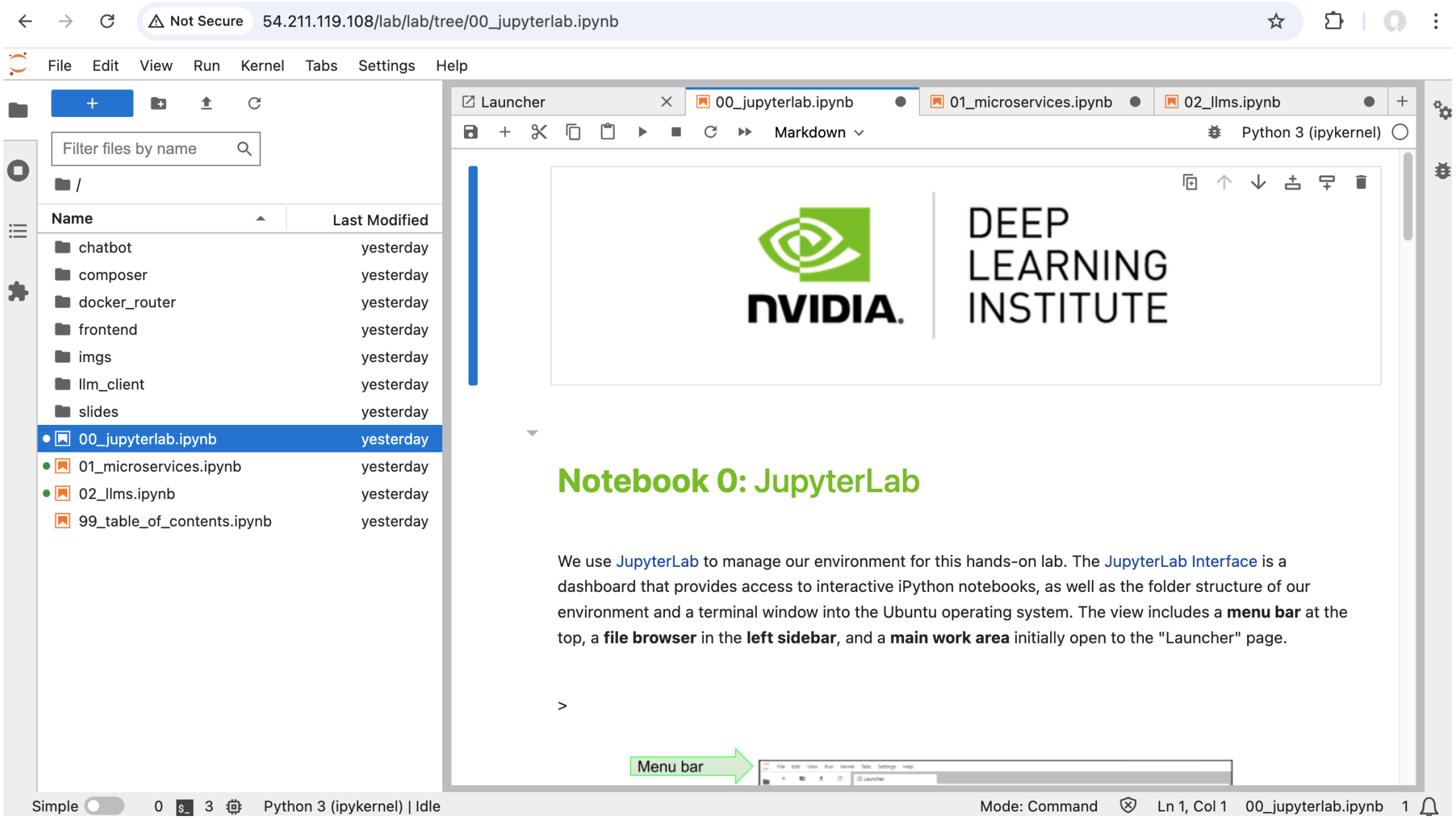
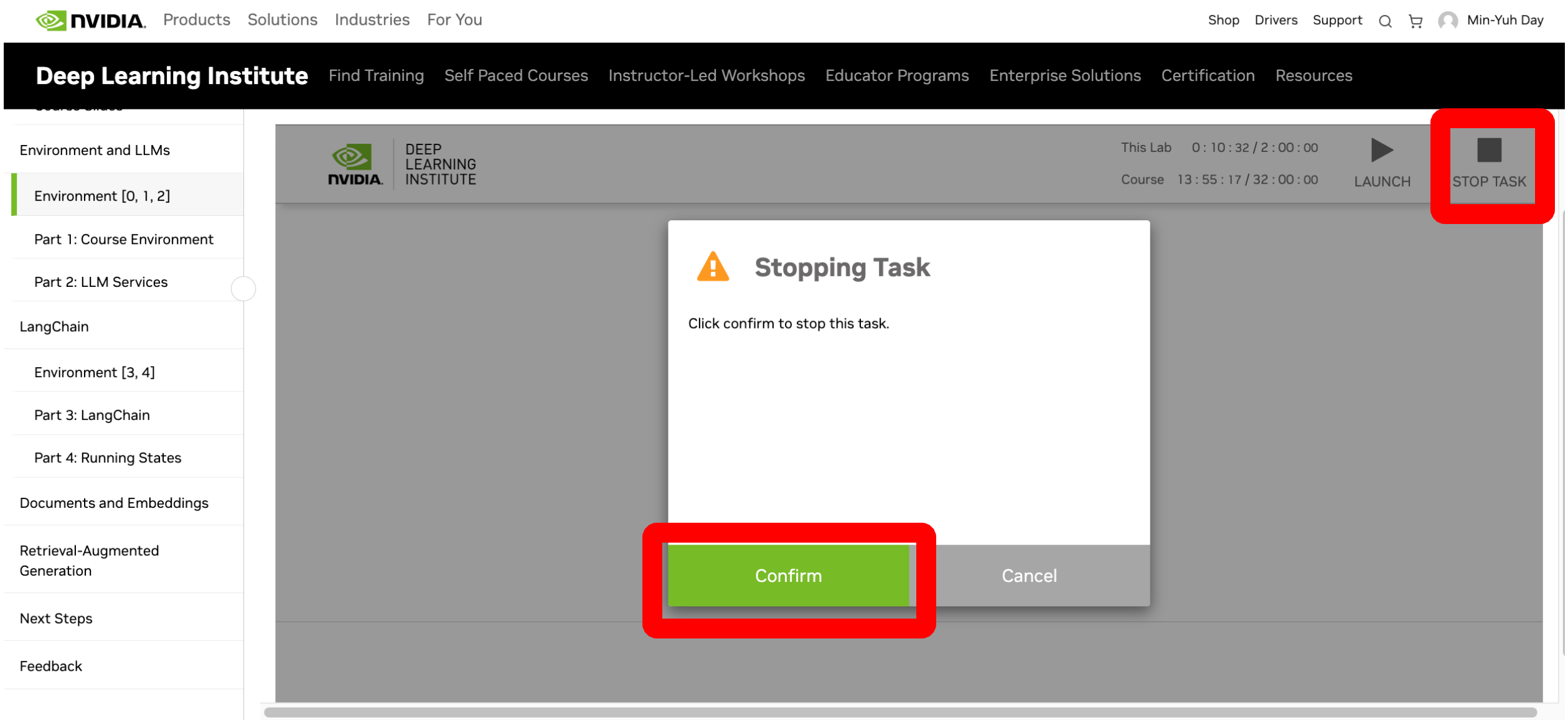
Building RAG Agents with LLMs



https://learn.nvidia.com/courses/course?course_id=course-v1:DLI+S-FX-15+V1

Building RAG Agents with LLMs



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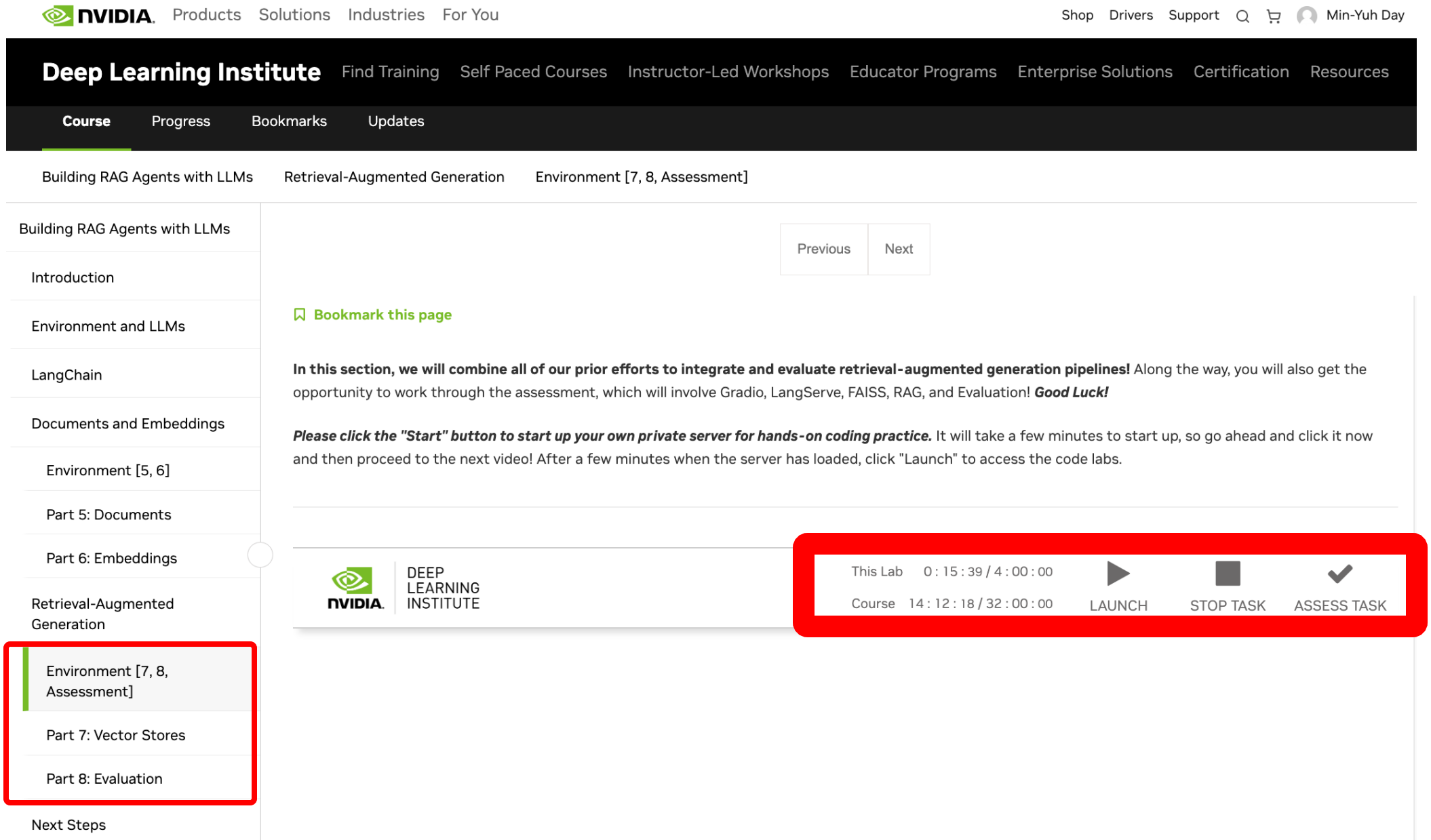
Building RAG Agents with LLMs



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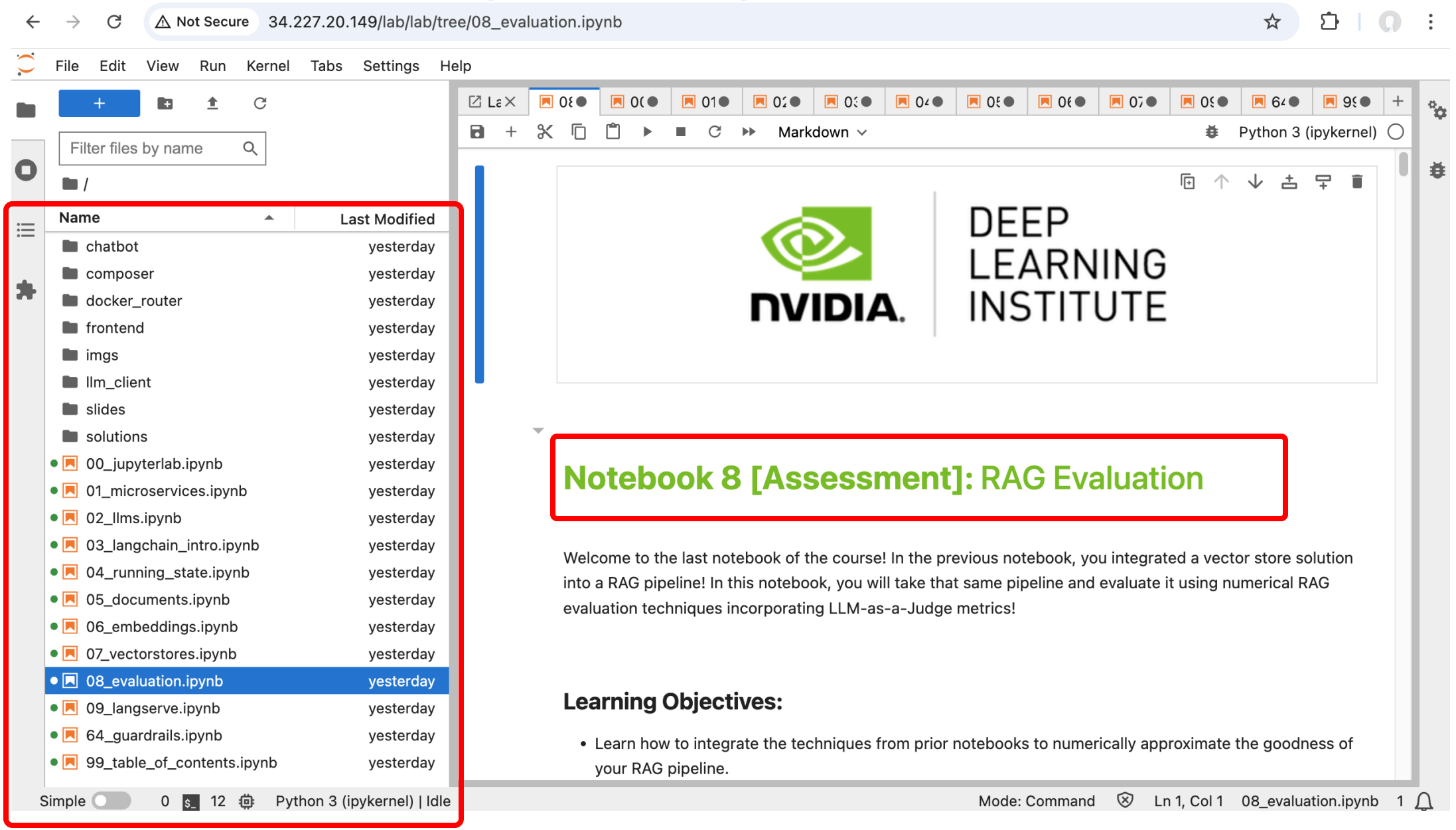
Building RAG Agents with LLMs



https://learn.nvidia.com/courses/course?course_id=course-v1:DLI+S-FX-15+V1

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.

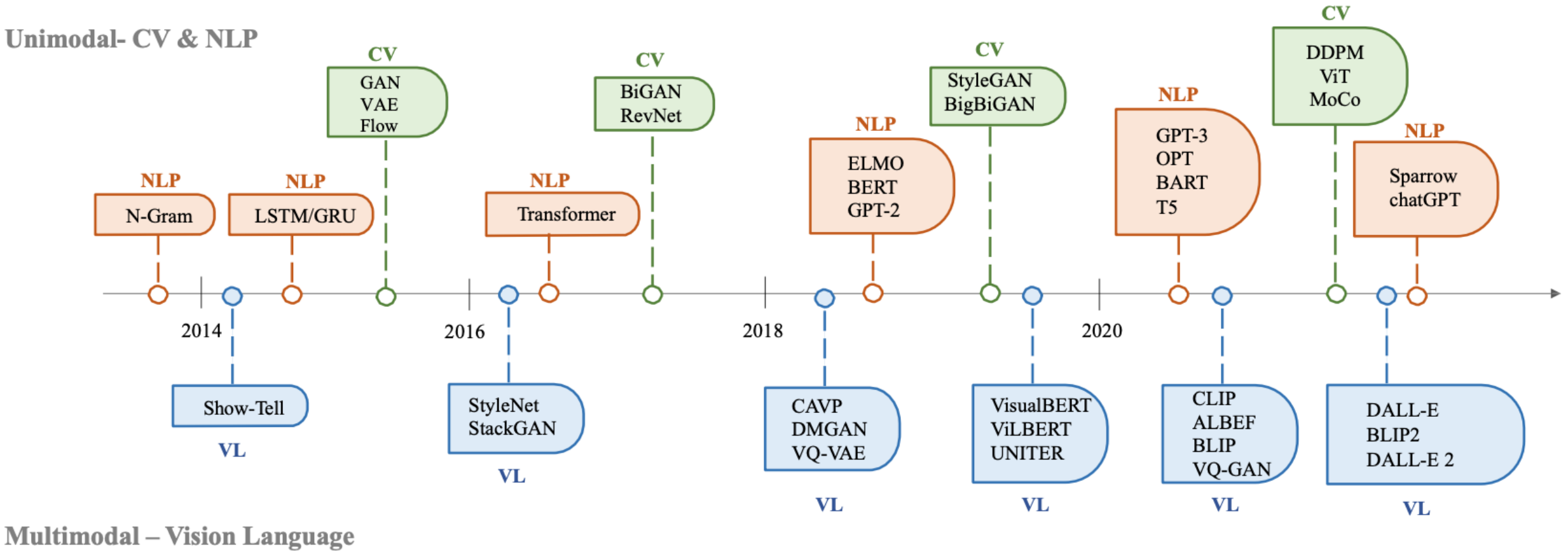
Figure 1

Figure 2

OpenAI DALL·E 2

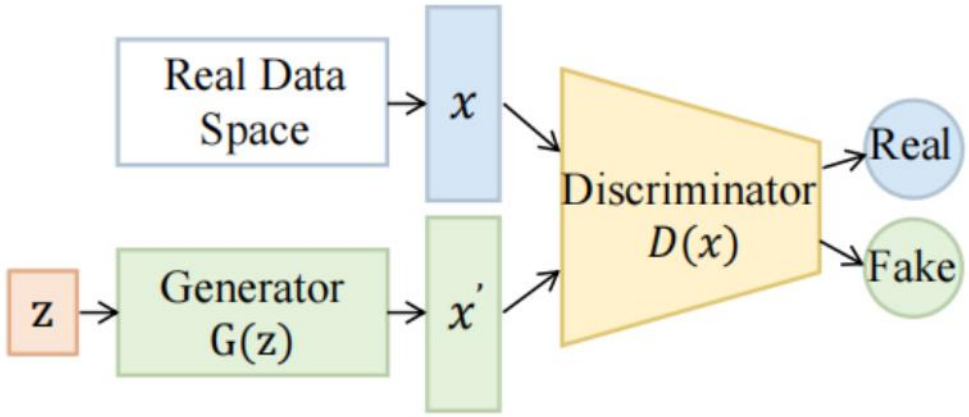
Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

The history of Generative AI in CV, NLP and VL

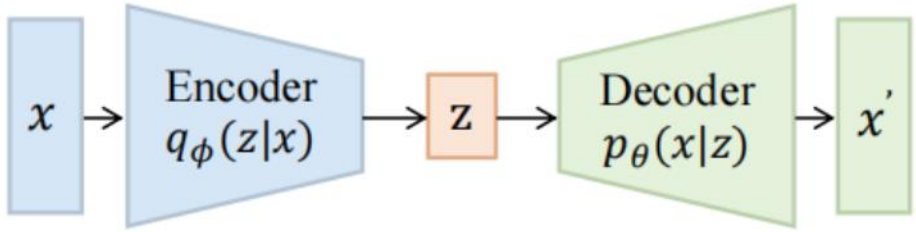


Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

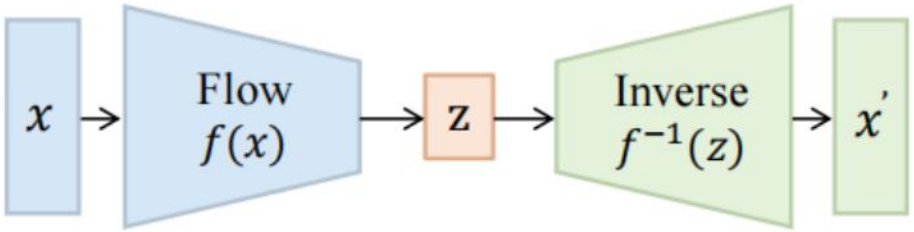
Categories of Vision Generative Models



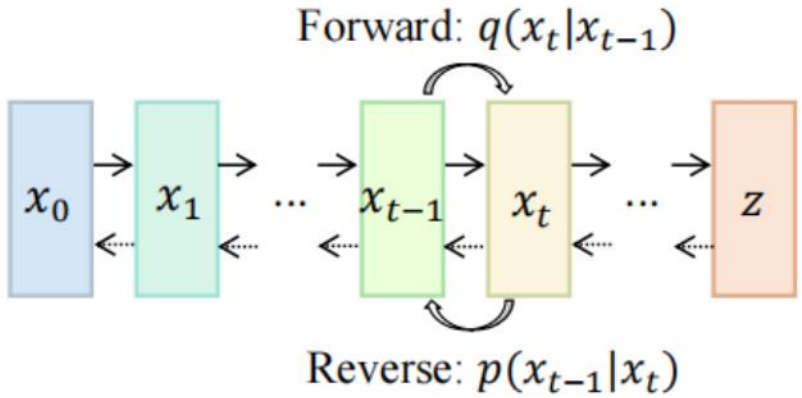
(1) Generative adversarial networks



(2) Variational autoencoders



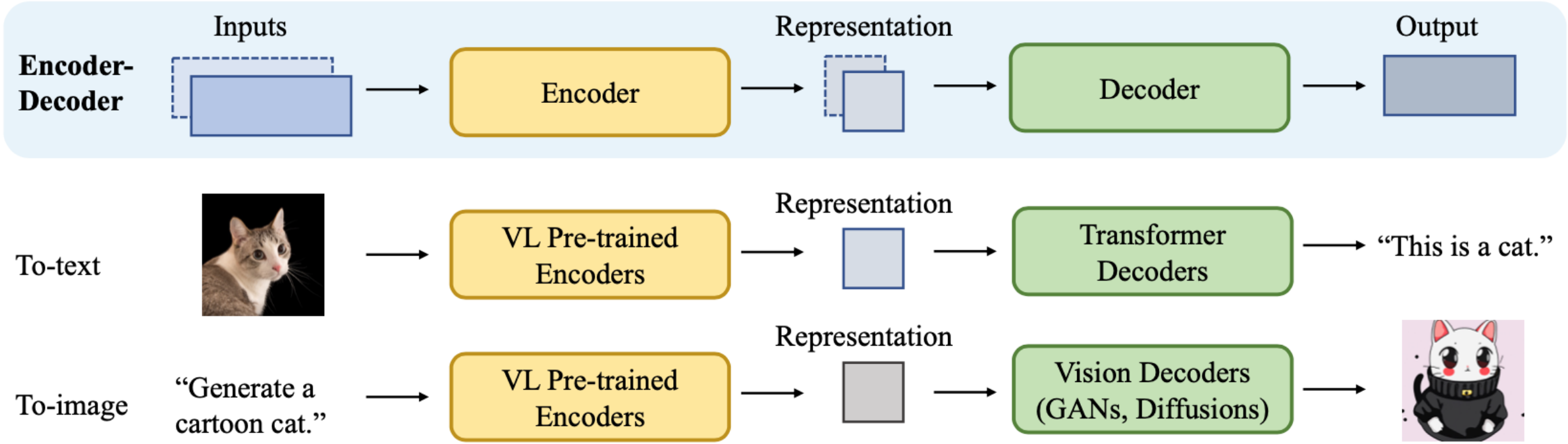
(3) Normalizing flows



(4) Diffusion models

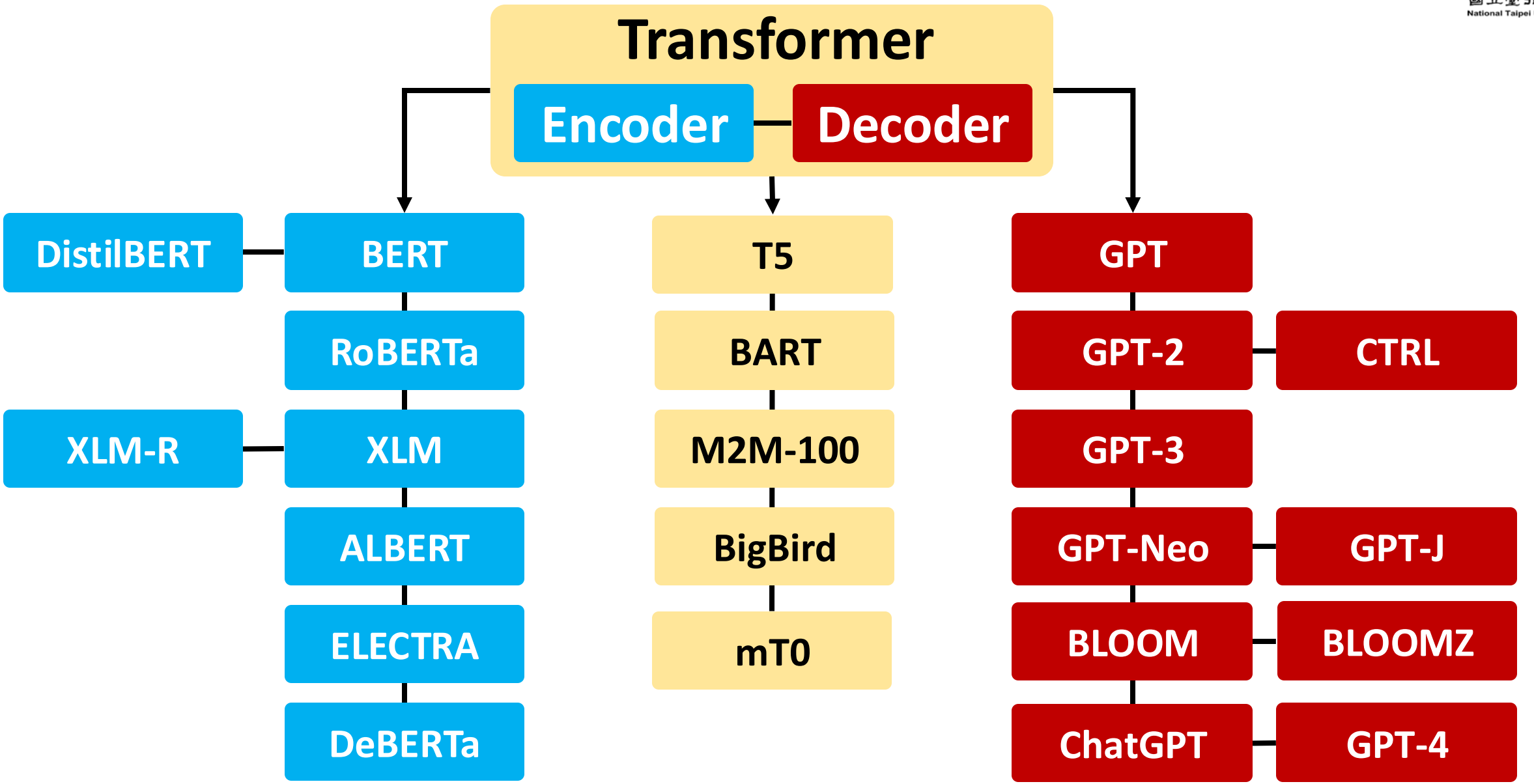
Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

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.

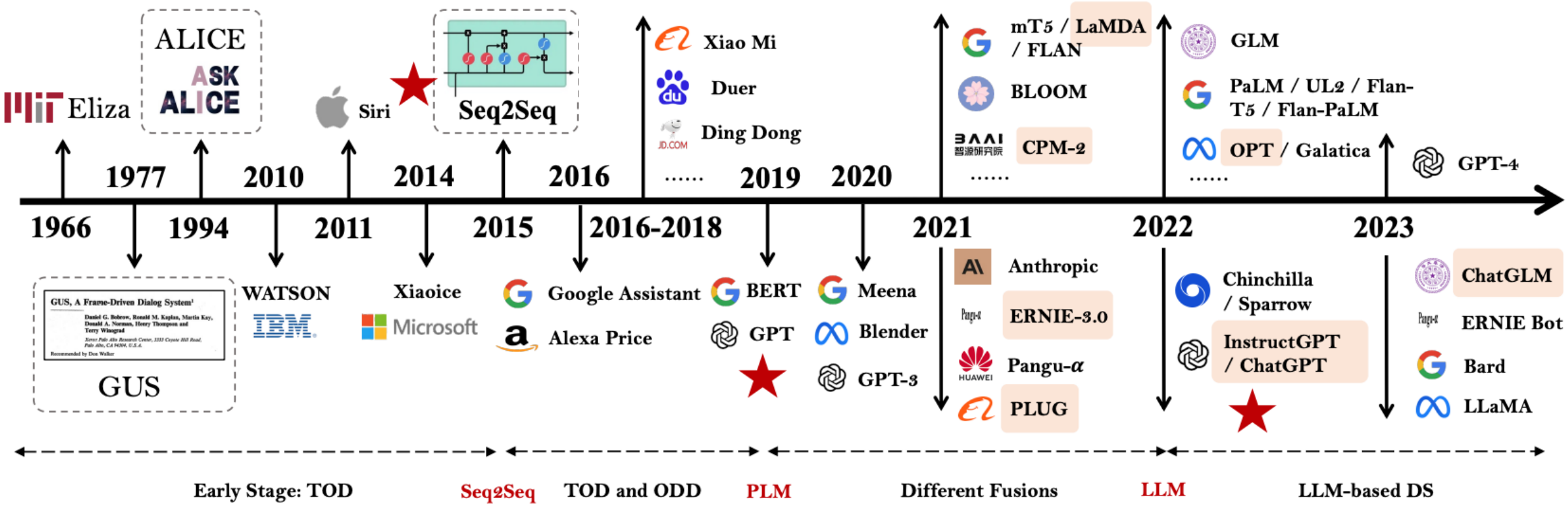
Transformer Models



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

The Development of LM-based Dialogue Systems

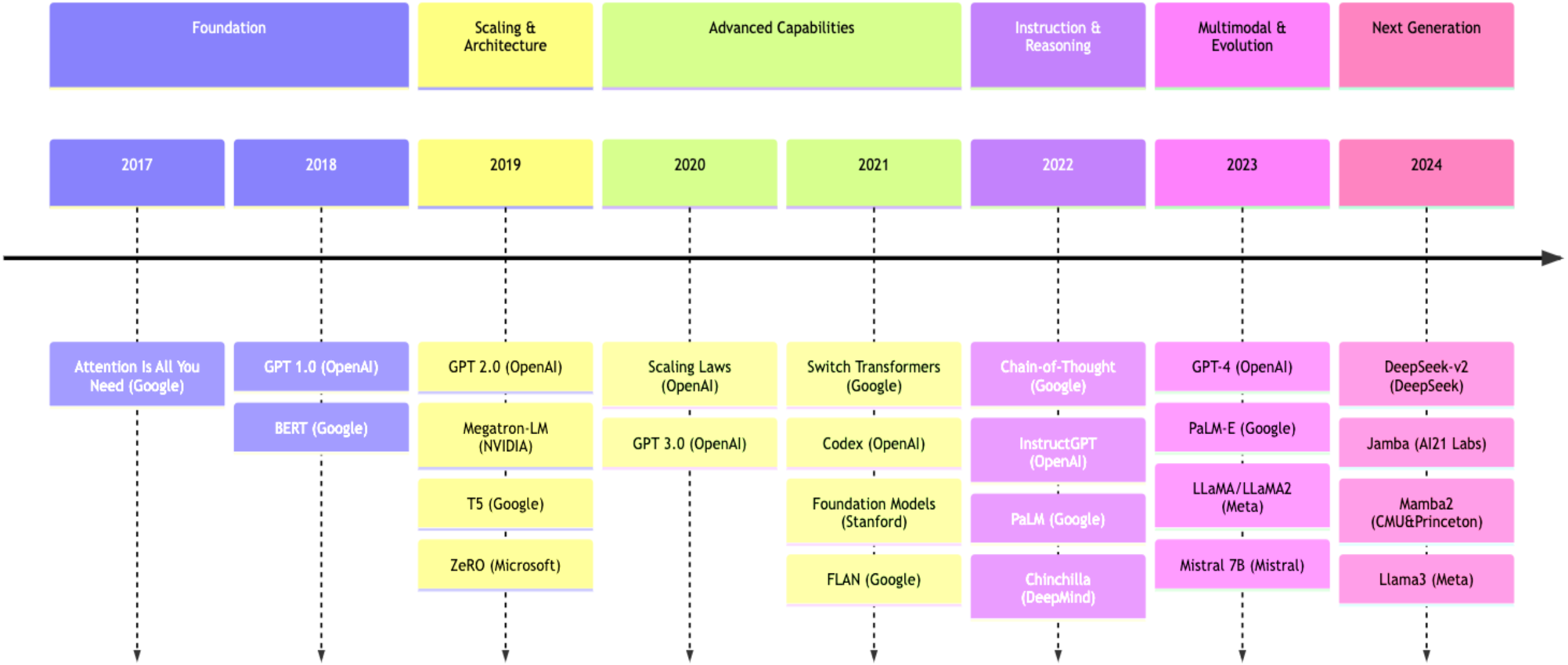
1) Early Stage (1966 - 2015)
2) The Independent Development of TOD and ODD (2015 - 2019)
3) Fusions of Dialogue Systems (2019 - 2022)
4) LLM-based DS (2022 - Now)



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

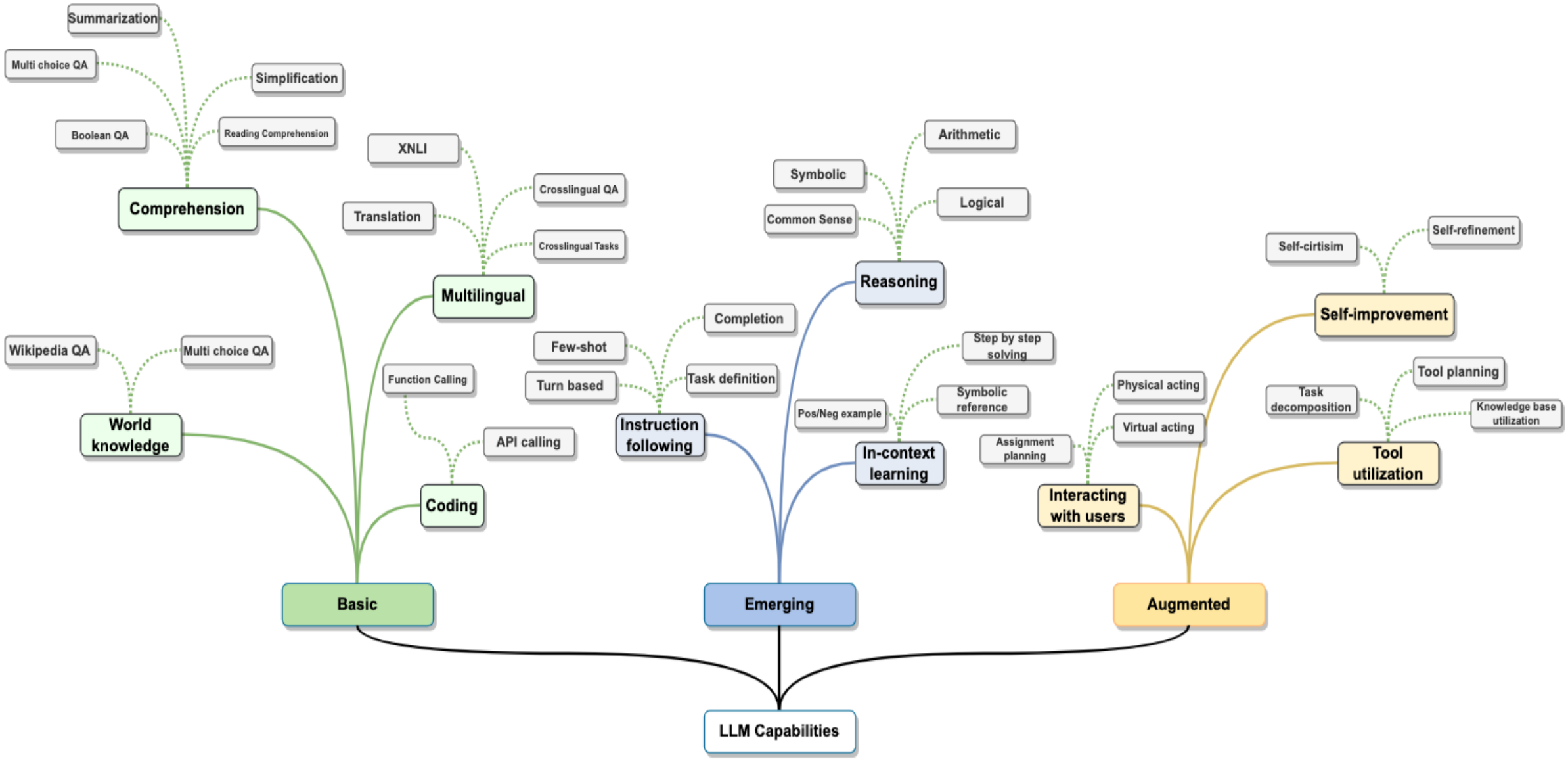
Source: Wang, Hongru, Lingzhi Wang, Yiming Du, Liang Chen, Jingyan Zhou, Yufei Wang, and Kam-Fai Wong. "A Survey of the Evolution of Language Model-Based Dialogue Systems." arXiv preprint arXiv:2311.16789 (2023).

Major GenAI LLMs Research Milestones (2017-2024)



Source: https://github.com/Hannibal046/Awesome-LLM

LLM Capabilities



Source: Minaee, Shervin, Tomas Mikolov, Narjes Nikzad, Meysam Chenaghlu, Richard Socher, Xavier Amatriain, and Jianfeng Gao. (2024) "Large language models: A survey." arXiv preprint arXiv:2402.06196 (2024).

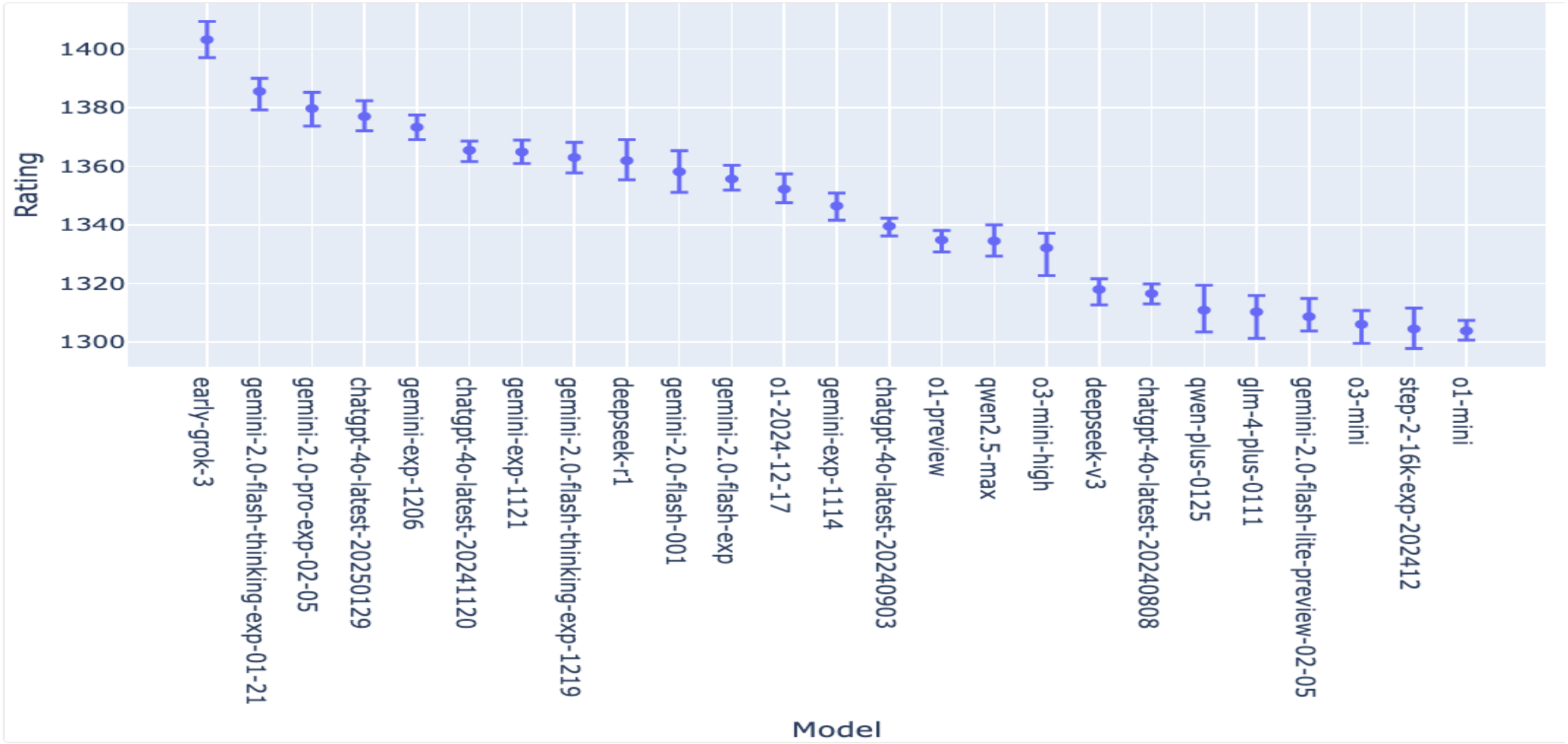
lmarena.ai Chatbot Arena Leaderboard

Rank* (UB)	Rank (StyleCtrl)	Model	Arena Score	95% CI	Votes	Organization	License
1	1	chocolate (Early Grok-3)	1403	+6/-6	9992	xAI	Proprietary
2	3	Gemini-2.0-Flash-Thinking-Exp-01-21	1385	+4/-6	15083	Google	Proprietary
2	3	Gemini-2.0-Pro-Exp-02-05	1380	+5/-6	13000	Google	Proprietary
2	1	ChatGPT-4o-latest (2025-01-29)	1377	+5/-5	13470	OpenAI	Proprietary
5	3	DeepSeek-R1	1362	+7/-7	6581	DeepSeek	MIT
5	8	Gemini-2.0-Flash-001	1358	+7/-7	10862	Google	Proprietary
5	3	o1-2024-12-17	1352	+5/-5	17248	OpenAI	Proprietary
8	7	o1-preview	1335	+3/-4	33169	OpenAI	Proprietary
8	8	Qwen2.5-Max	1334	+5/-5	9282	Alibaba	Proprietary
8	7	o3-mini-high	1332	+5/-9	5954	OpenAI	Proprietary
11	11	DeepSeek-V3	1318	+4/-5	19461	DeepSeek	DeepSeek
11	13	Qwen-Plus-0125	1311	+9/-7	5112	Alibaba	Proprietary
11	14	GLM-4-Plus-0111	1310	+6/-9	5134	Zhipu	Proprietary
11	13	Gemini-2.0-Flash-Lite-Preview-02-05	1309	+6/-5	10262	Google	Proprietary
12	12	o3-mini	1306	+5/-6	12179	OpenAI	Proprietary

https://huggingface.co/spaces/lmarena-ai/chatbot-arena-leaderboard

lmarena.ai Chatbot Arena Leaderboard

Confidence Intervals on Model Strength (via Bootstrapping)



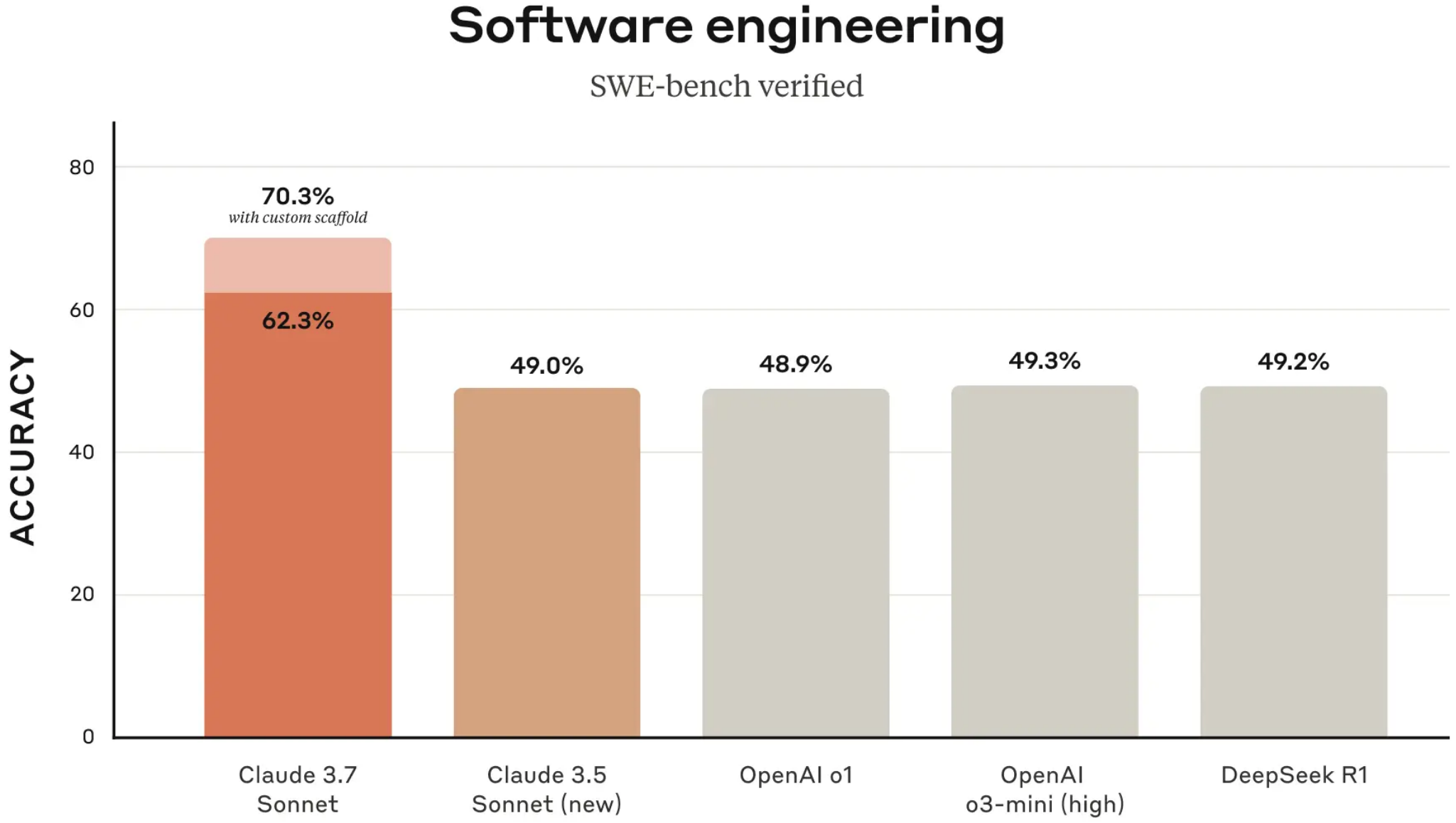
https://huggingface.co/spaces/lmarena-ai/chatbot-arena-leaderboard

Claude 3.7 Sonnet, Claude 3.5 Sonnet, OpenAI, DeepSeek, and Grok

	Claude 3.7 Sonnet *64K extended thinking*	Claude 3.7 Sonnet *No extended thinking*	Claude 3.5 Sonnet (new)	OpenAI o1[1]	OpenAI o3-mini[1] *High*	DeepSeek R1 *32K extended thinking*	Grok 3 Beta *Extended thinking*
Graduate-level reasoning *GPQA Diamond*[3]	78.2% / 84.8%	68.0%	65.0%	75.7% / 78.0%	79.7%	71.5%	80.2% / 84.6%
Agentic coding *SWE-bench Verified*[2]	—	62.3% / 70.3%	49.0%	48.9%	49.3%	49.2%	—
Agentic tool use *TAU-bench*	—	Retail 81.2%	Retail 71.5%	Retail 73.5%	—	—	—
	—	Airline 58.4%	Airline 48.8%	Airline 54.2%	—	—	—
Multilingual Q&A *MMMLU*	86.1%	83.2%	82.1%	87.7%	79.5%	—	—
Visual reasoning *MMMU (validation)*	75%	71.8%	70.4%	78.2 %	—	—	76.0% / 78.0%
Instruction-following *IFEval*	93.2%	90.8%	90.2%	—	—	83.3%	—
Math problem-solving *MATH 500*	96.2%	82.2%	78.0%	96.4%	97.9%	97.3%	—
High school math competition *AIME 2024*[3]	61.3% / 80.0%	23.3%	16.0%	79.2% / 83.3%	87.3%	79.8%	83.9% / 93.3%

Source: https://www.anthropic.com/news/claude-3-7-sonnet

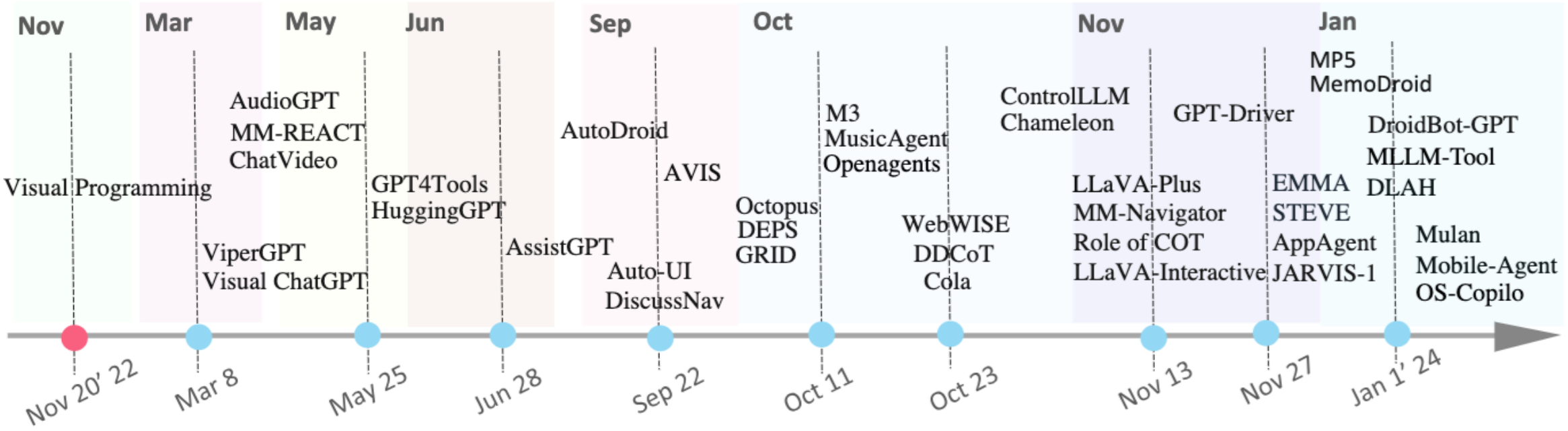
Claude 3.7 Sonnet and Claude Code



Source: https://www.anthropic.com/news/claude-3-7-sonnet

LLM-powered Multimodal Agents

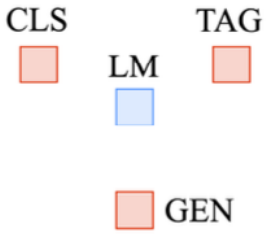
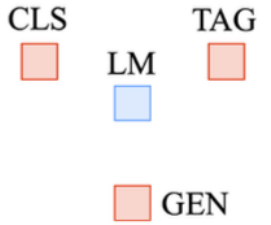
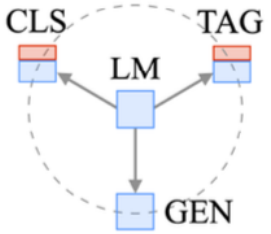
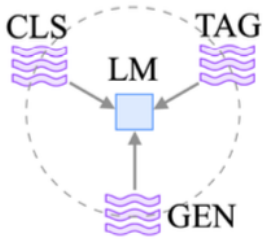
Large Multimodal Agents (LMAs)



2022 2023 2024

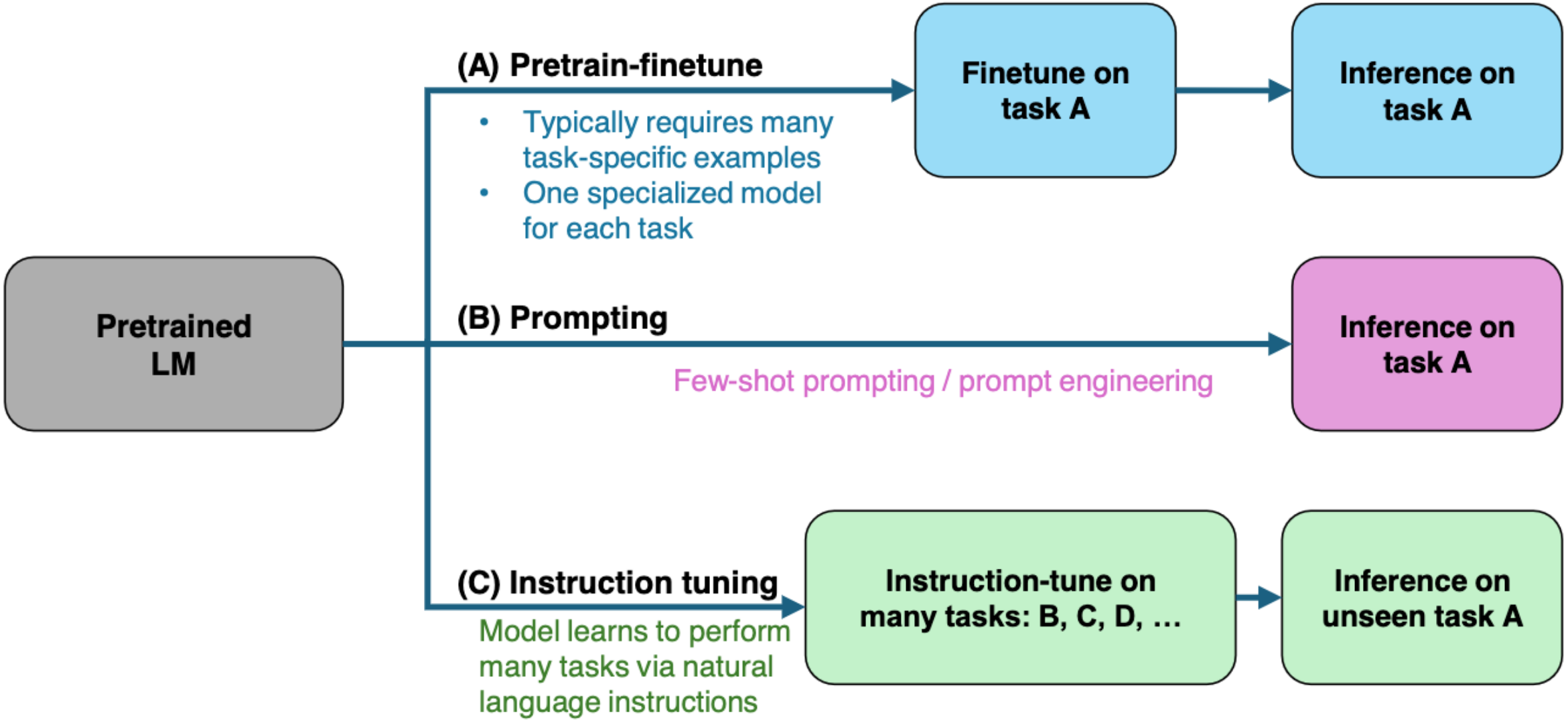
Source: Xie, Junlin, Zhihong Chen, Ruifei Zhang, Xiang Wan, and Guanbin Li. "Large Multimodal Agents: A Survey." arXiv preprint arXiv:2402.15116 (2024).

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

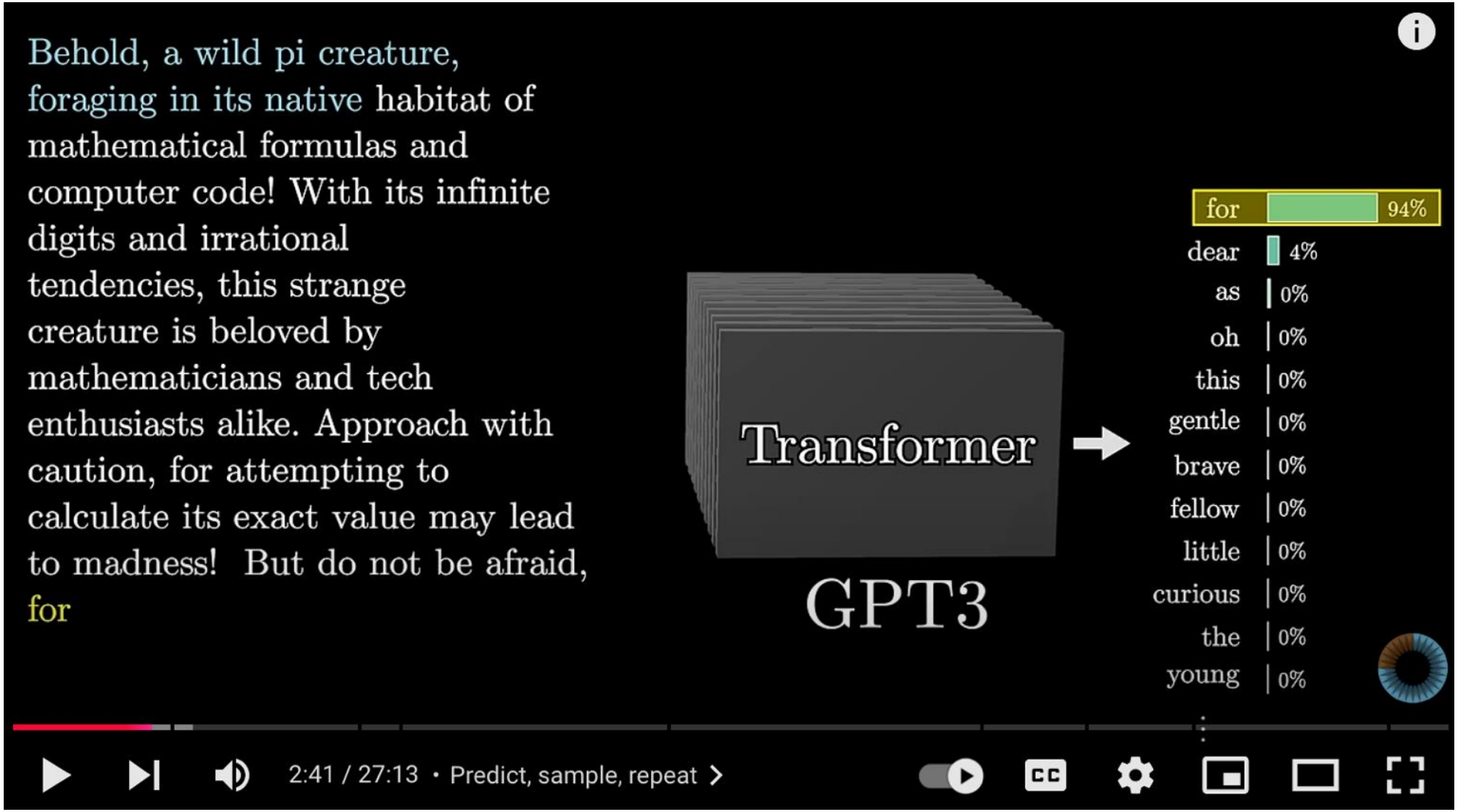
Source: Pengfei Liu, Weizhe Yuan, Jinlan Fu, Zhengbao Jiang, Hiroaki Hayashi, and Graham Neubig. (2023) "Pre-train, prompt, and predict: A systematic survey of prompting methods in natural language processing." ACM Computing Surveys 55, no. 9 (2023): 1-35.

Large Language Models (LLM)
Three typical learning paradigms



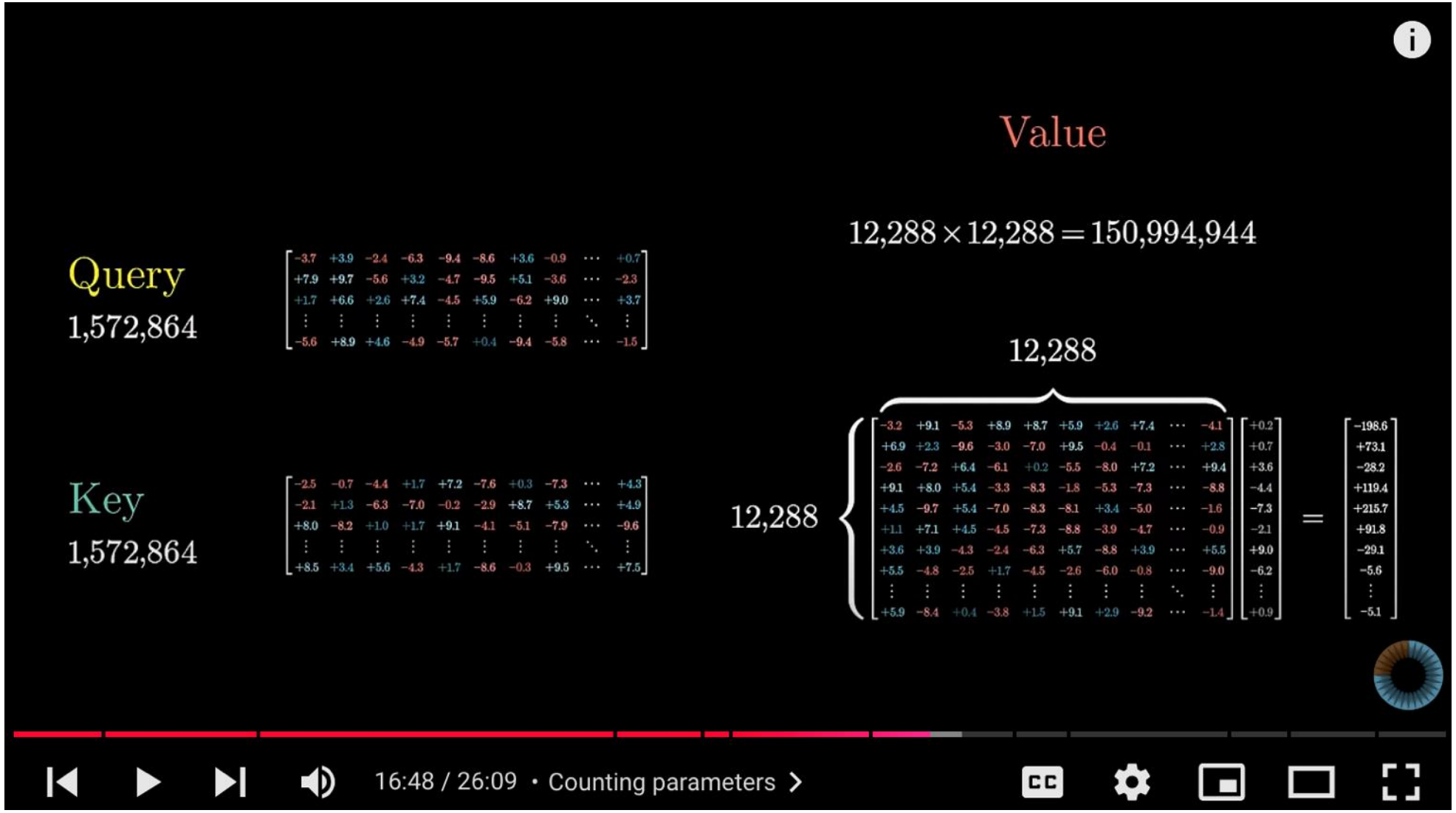
Source: Shukang Yin, Chaoyou Fu, Sirui Zhao, Ke Li, Xing Sun, Tong Xu, and Enhong Chen. (2024) "A survey on multimodal large language models." National Science Review (2024): nwae403.

Transformers (how LLMs work)



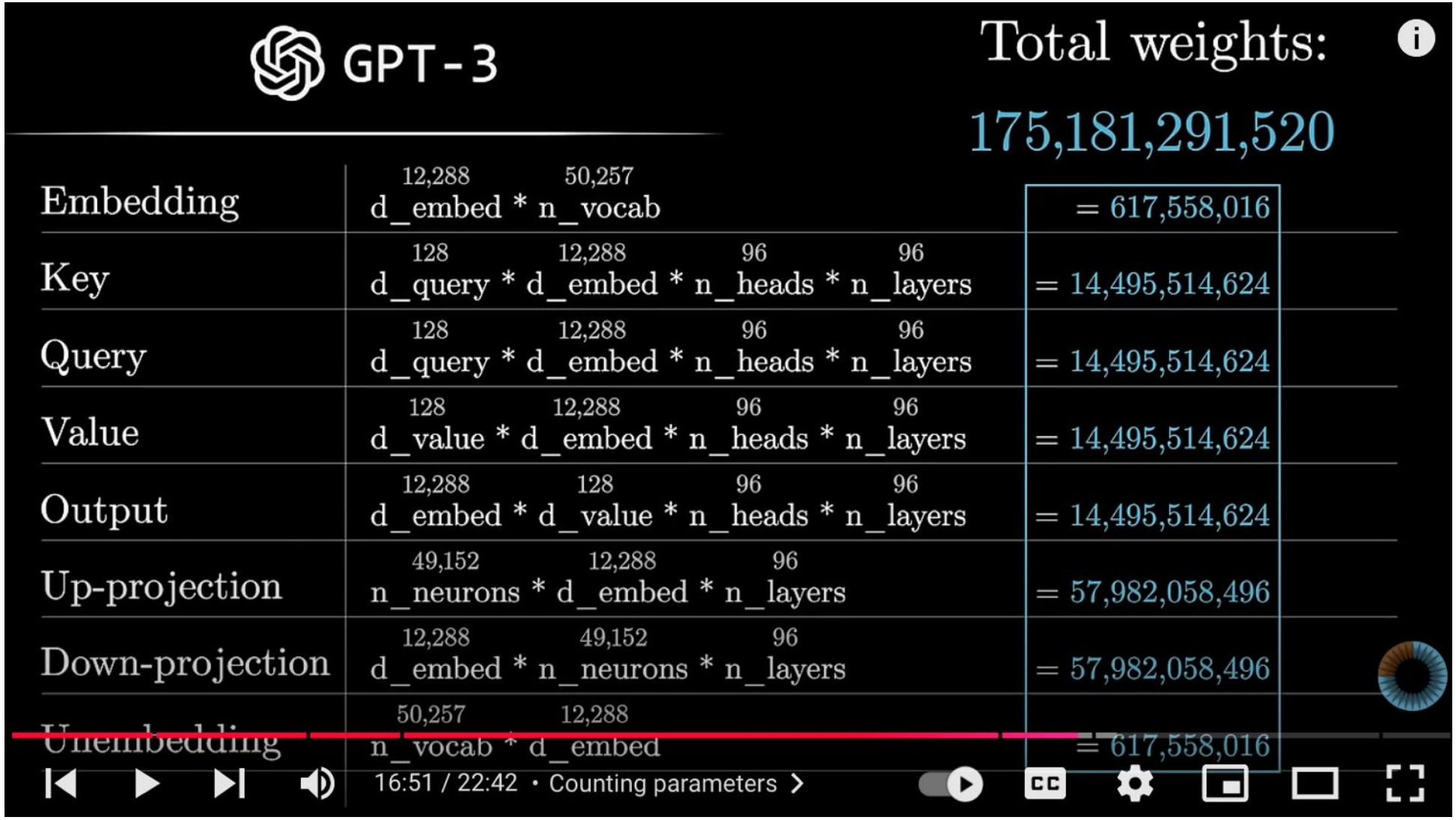
Source: 3Blue1Brown (2024), Transformers (how LLMs work) explained visually | DL5, https://www.youtube.com/watch?v=wjZofJX0v4M

Attention in Transformers



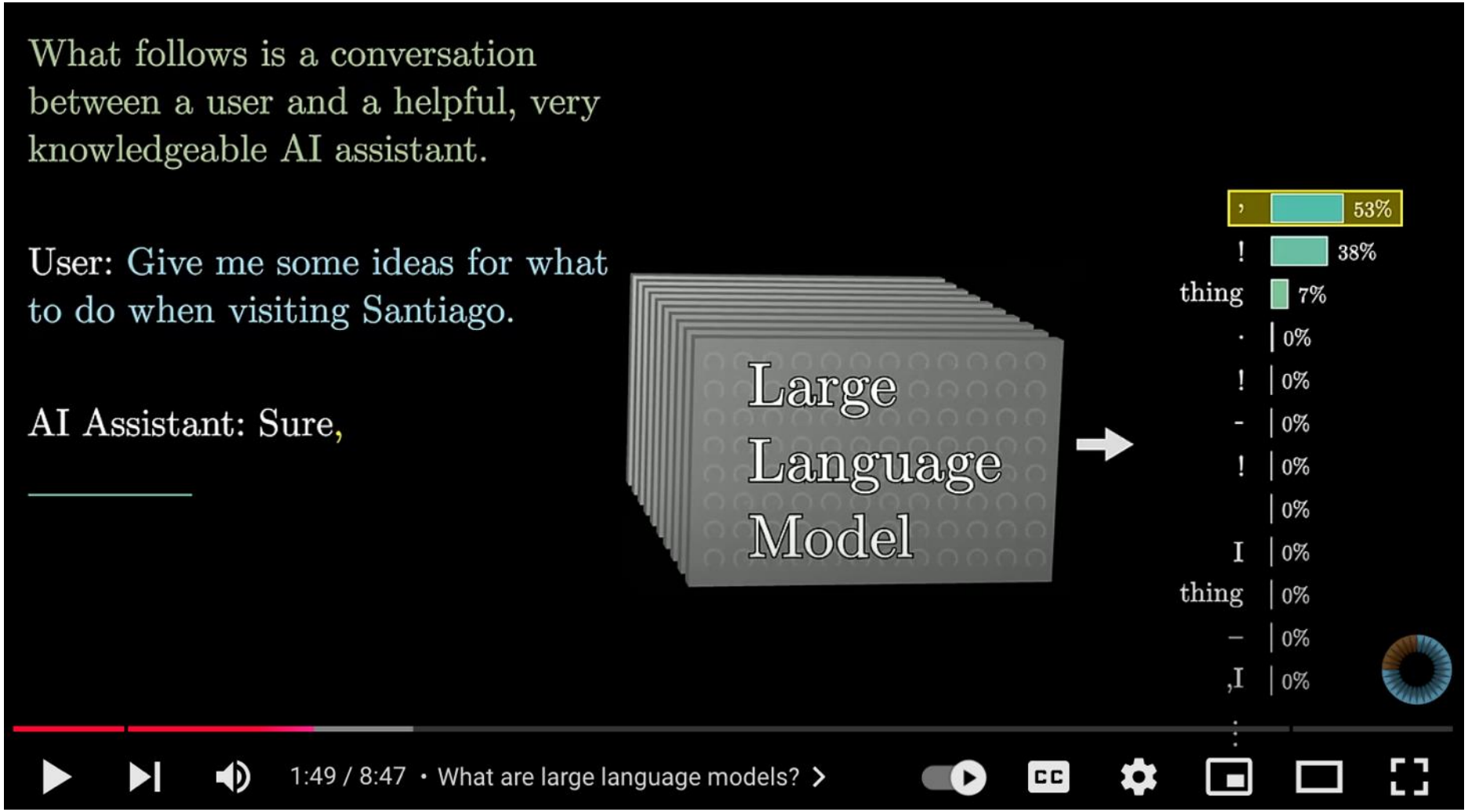
Source: 3Blue1Brown (2024), Attention in transformers, visually explained | DL6, https://www.youtube.com/watch?v=eMlx5fFNoYc

How might LLMs store facts



Source: 3Blue1Brown (2024), How might LLMs store facts | DL7, https://www.youtube.com/watch?v=9-Jl0dxWQs8

Large Language Models explained briefly

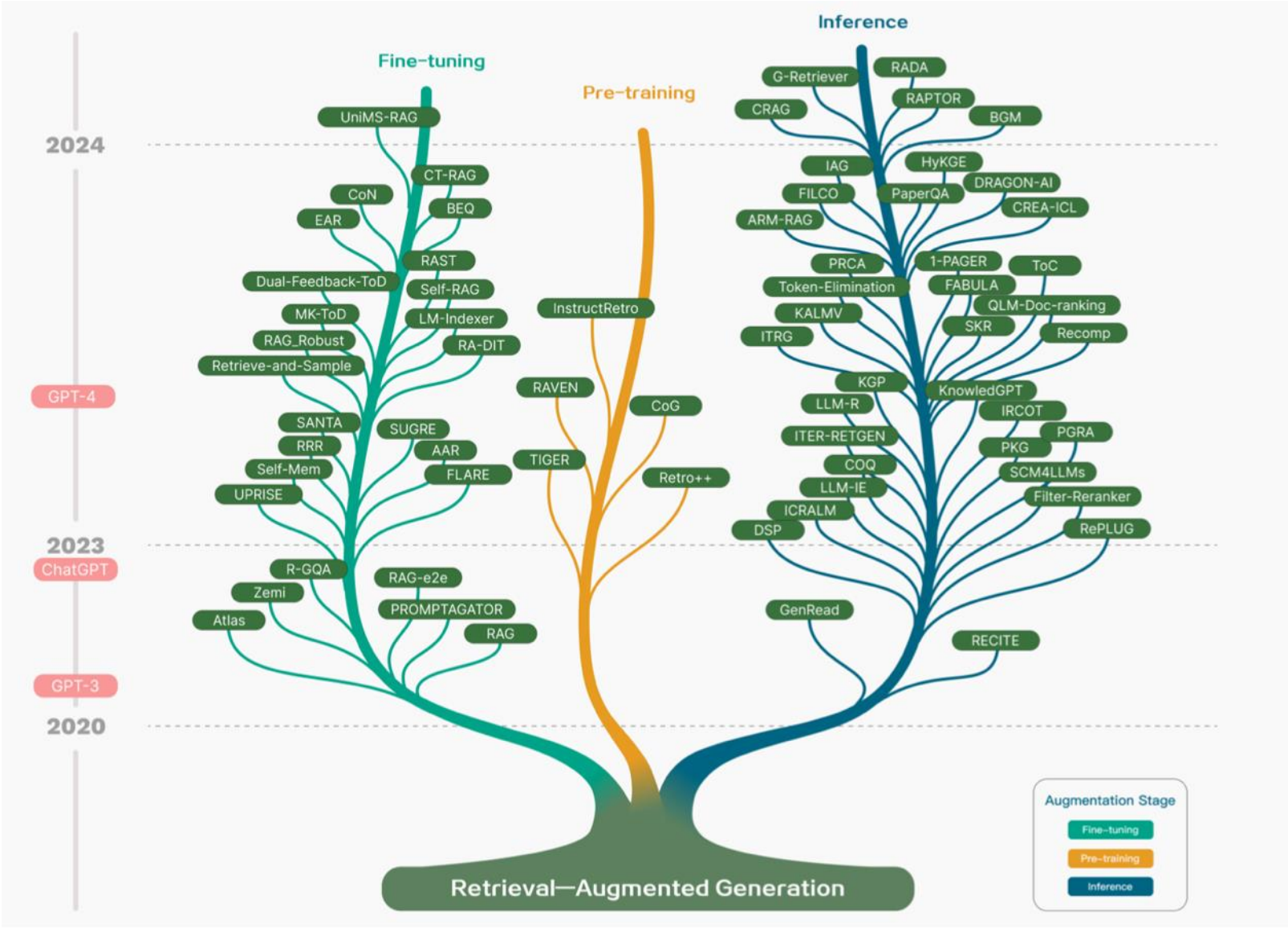


Source: 3Blue1Brown (2024), Large Language Models explained briefly, https://www.youtube.com/watch?v=LPZh9BOjkQs

RAG LLM
Dialogue Systems

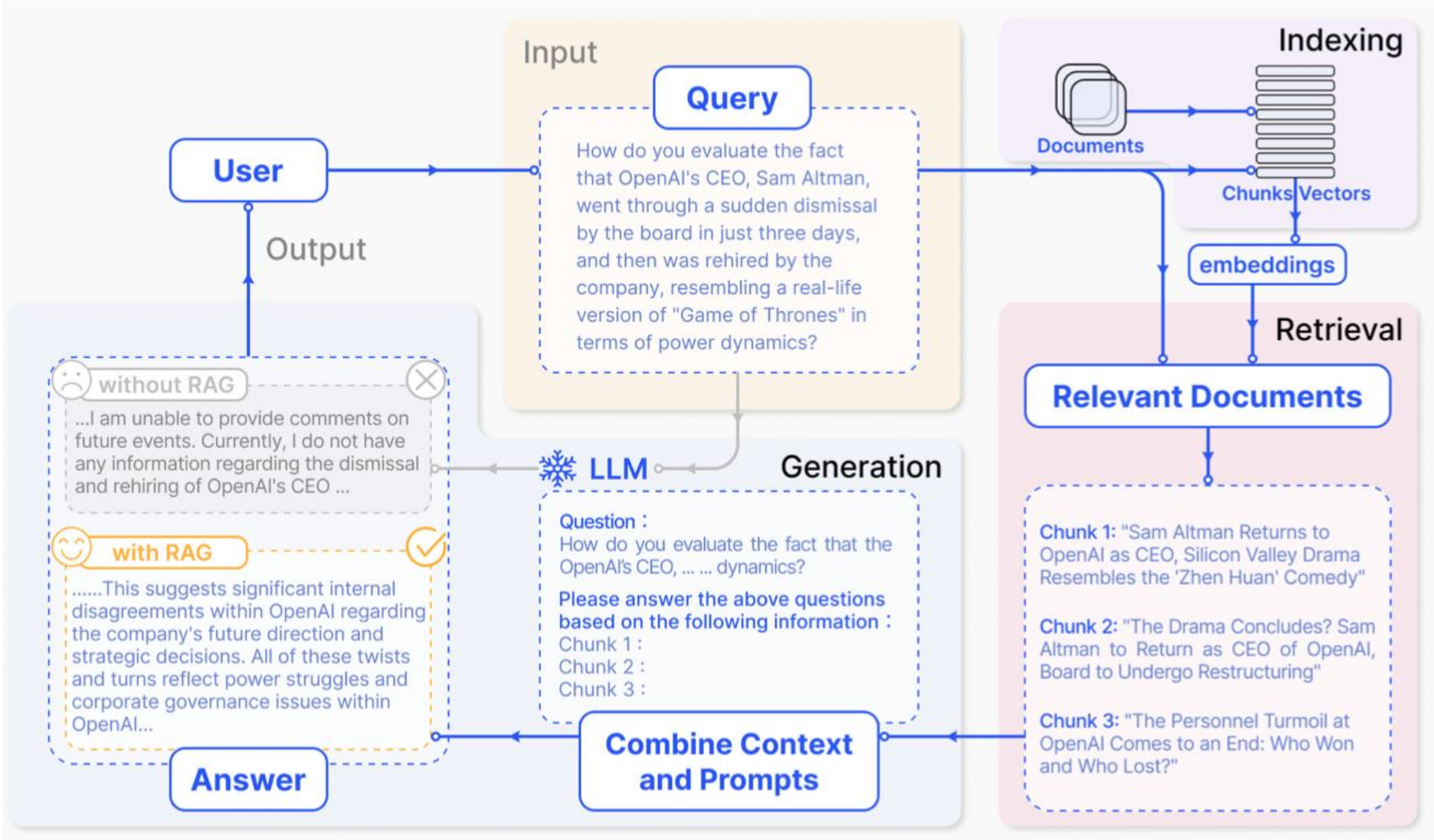
Technology Tree of RAG Research

Retrieval-Augmented Generation (RAG) for Large Language Models (LLMs)



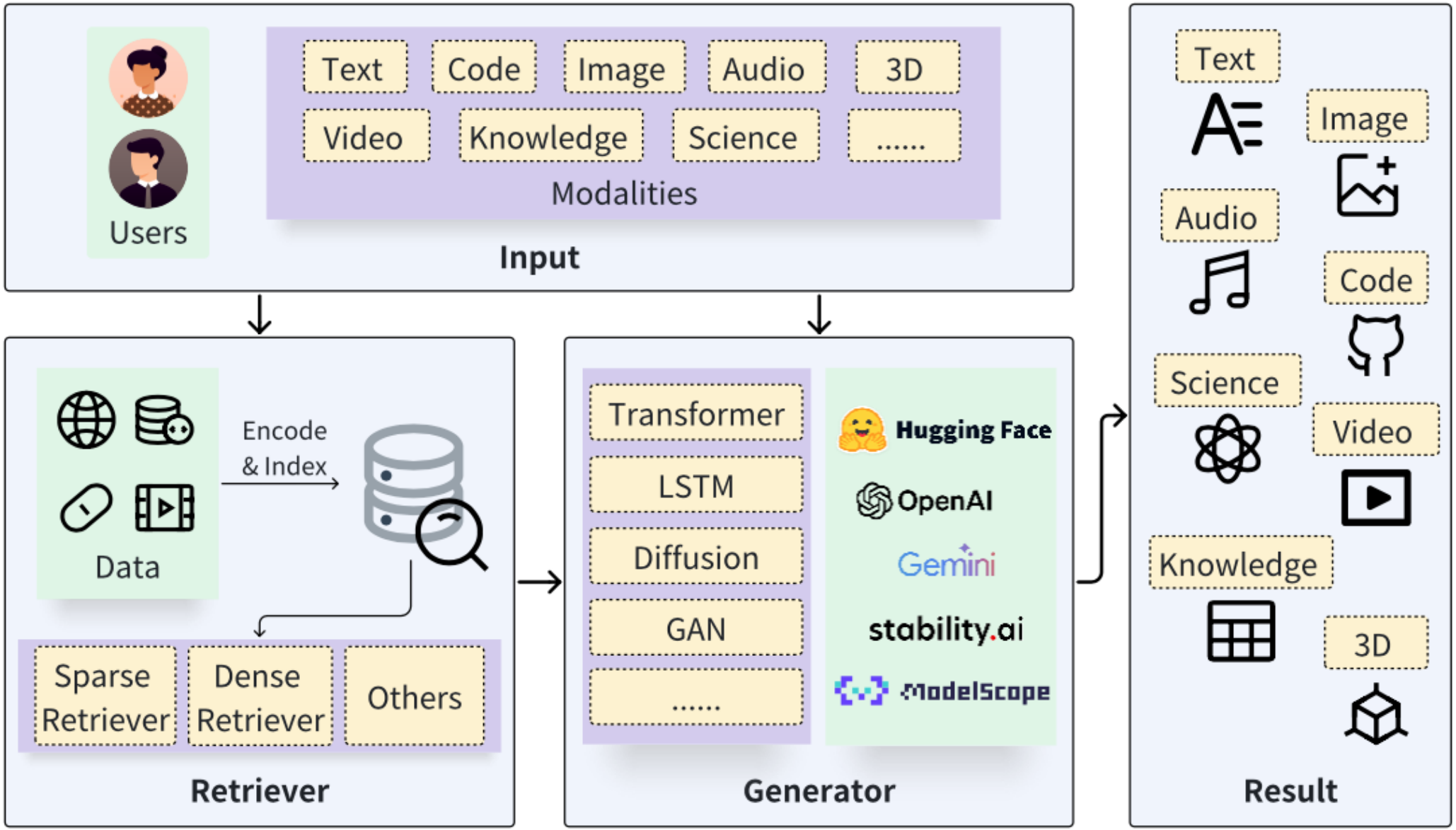
Source: Gao, Y., Xiong, Y., Gao, X., Jia, K., Pan, J., Bi, Y., ... & Wang, H. (2023). Retrieval-augmented generation for large language models: A survey. arXiv preprint arXiv:2312.10997.

Retrieval-Augmented Generation (RAG) for Large Language Models (LLMs)



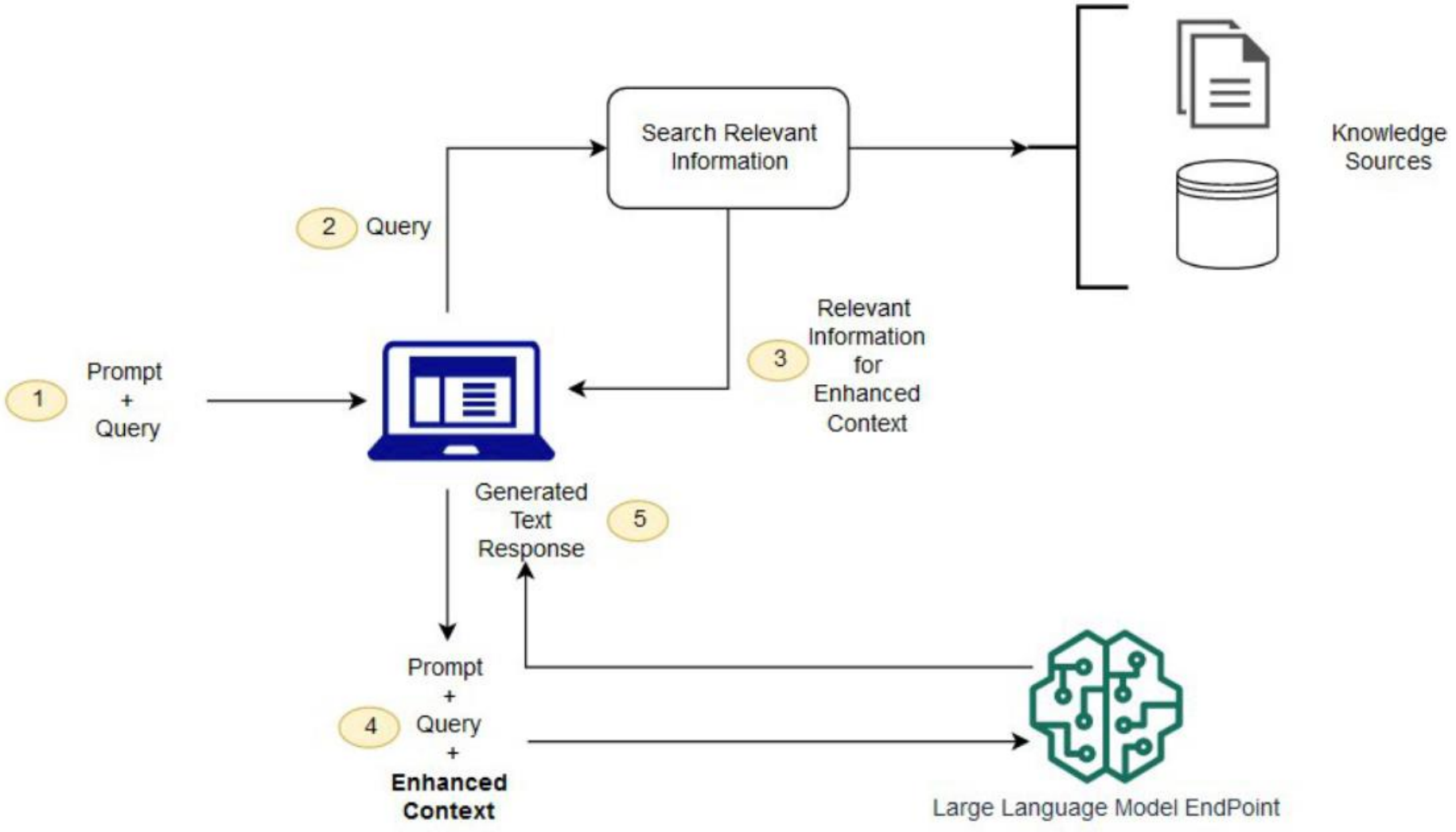
Source: Gao, Y., Xiong, Y., Gao, X., Jia, K., Pan, J., Bi, Y., ... & Wang, H. (2023). Retrieval-augmented generation for large language models: A survey. arXiv preprint arXiv:2312.10997.

Retrieval-Augmented Generation (RAG) Architecture



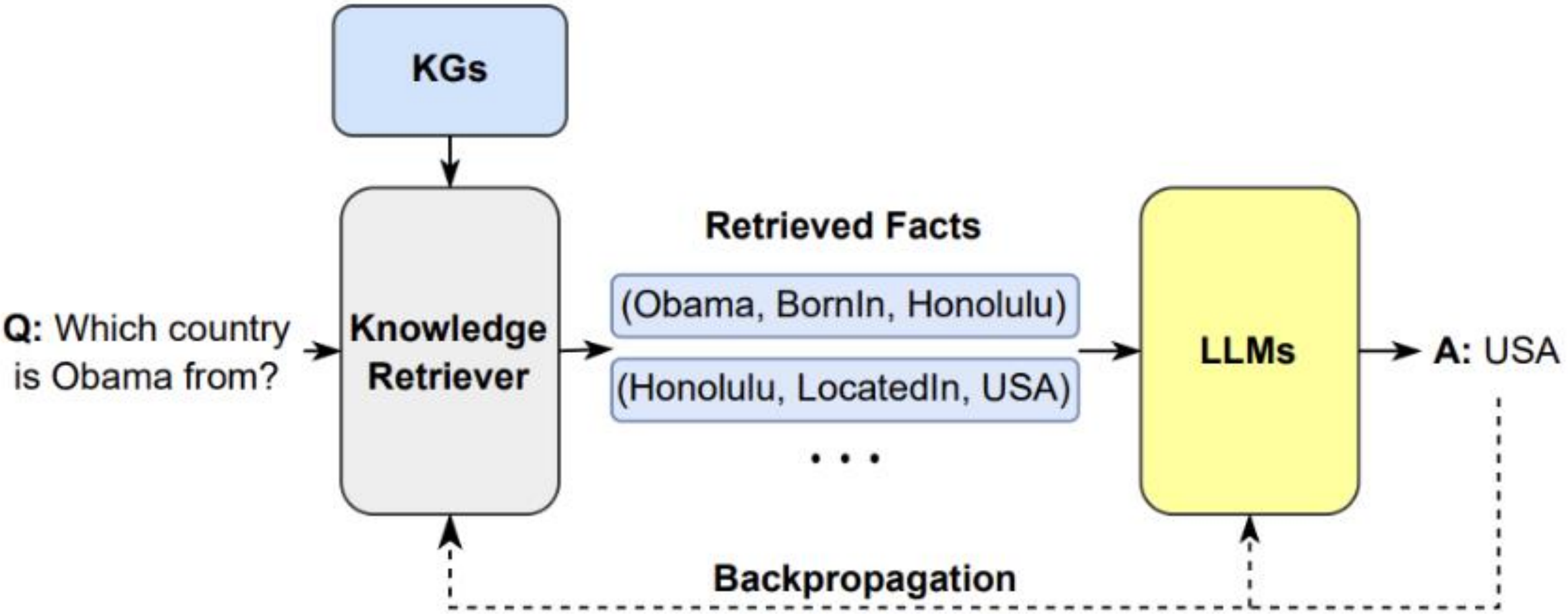
Source: Zhao, P., Zhang, H., Yu, Q., Wang, Z., Geng, Y., Fu, F., ... & Cui, B. (2024). Retrieval-augmented generation for ai-generated content: A survey. arXiv preprint arXiv:2402.19473.

Synthesizing RAG with LLMs for Question Answering Application



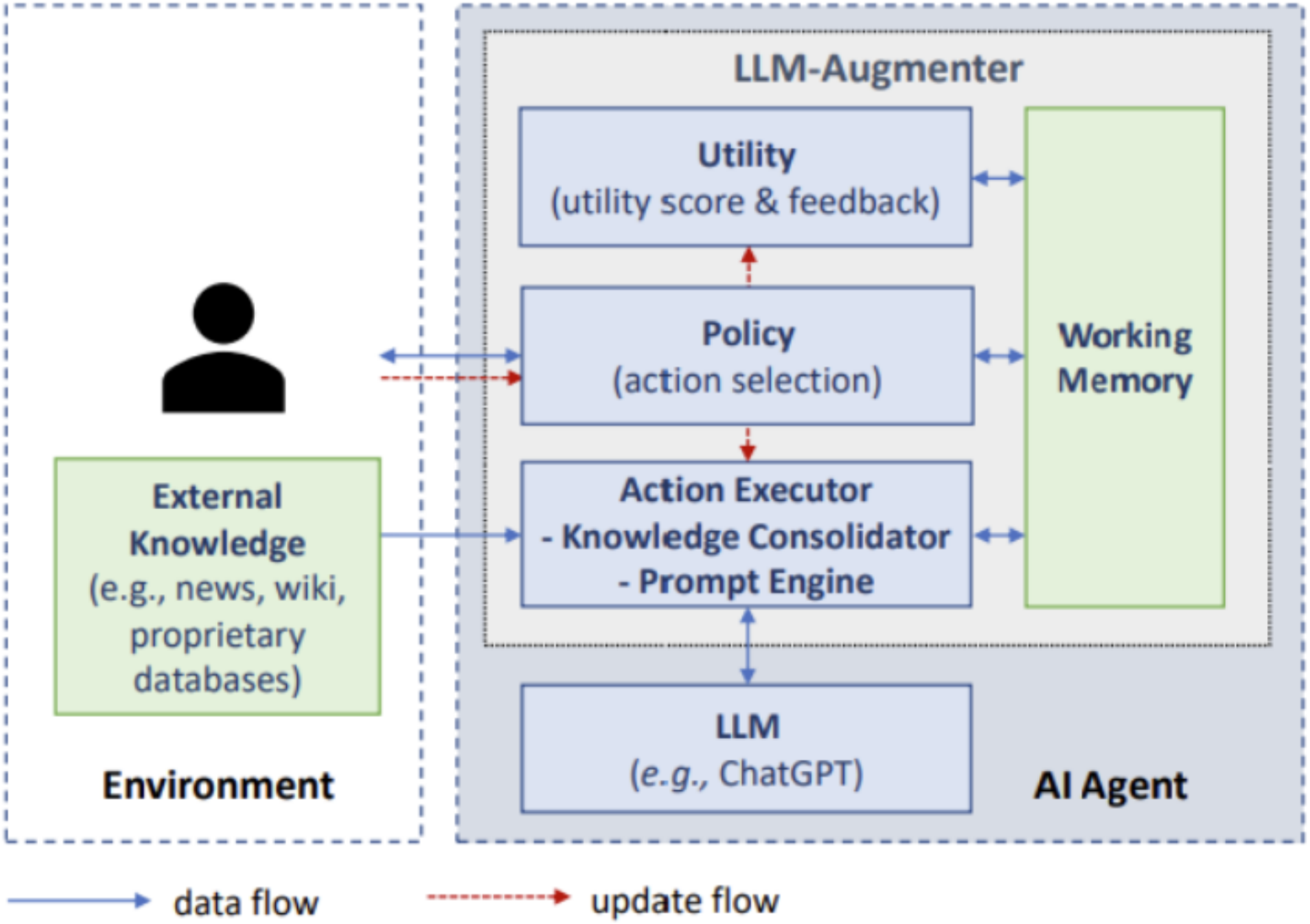
Source: Minaee, S., Mikolov, T., Nikzad, N., Chenaghlu, M., Socher, R., Amatriain, X., & Gao, J. (2024). Large language models: A survey. arXiv preprint arXiv:2402.06196.

Synthesizing the KG as a Retriever with LLMs



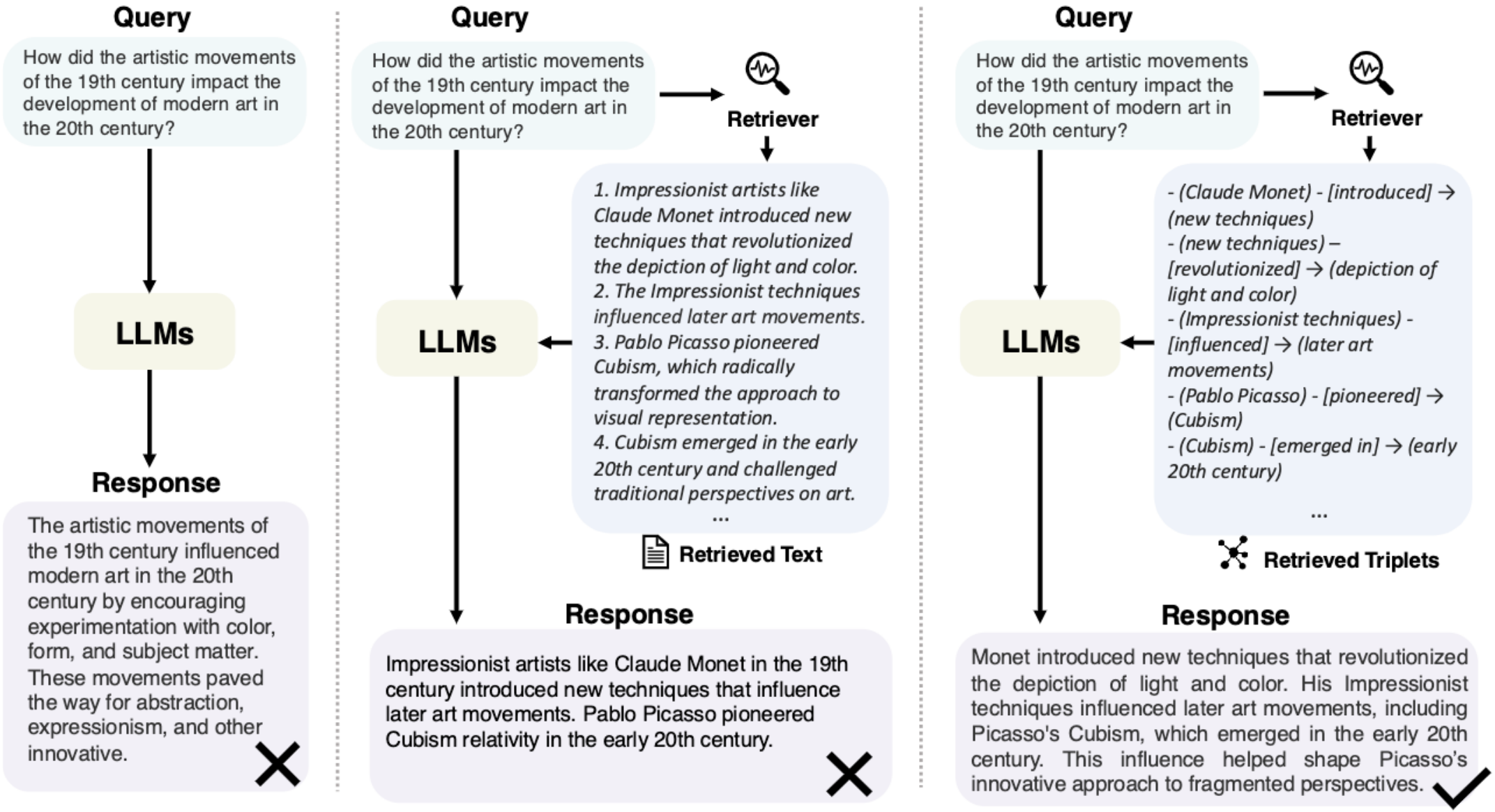
Source: Minaee, S., Mikolov, T., Nikzad, N., Chenaghlu, M., Socher, R., Amatriain, X., & Gao, J. (2024). Large language models: A survey. arXiv preprint arXiv:2402.06196.

A LLM-based Agent for Conversational Information Seeking



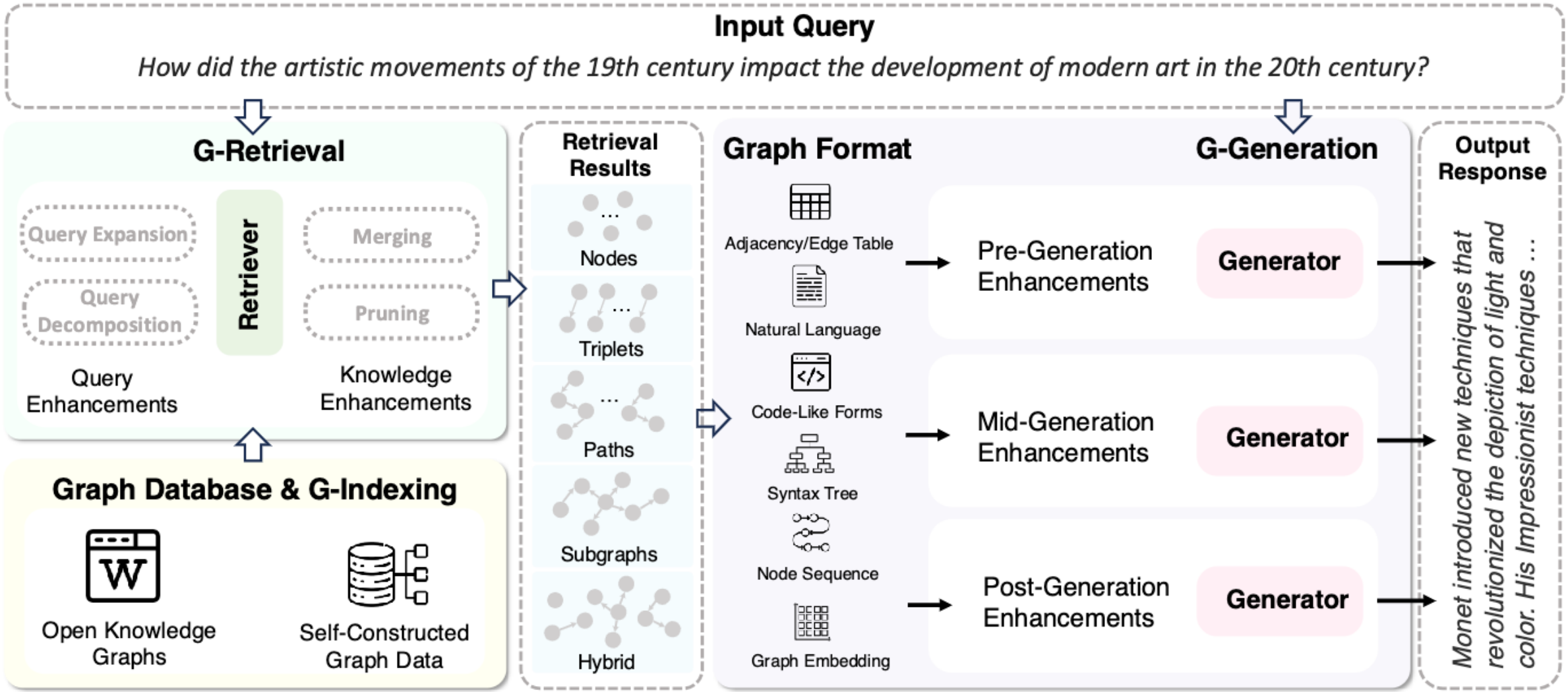
Source: Minaee, S., Mikolov, T., Nikzad, N., Chenaghlu, M., Socher, R., Amatriain, X., & Gao, J. (2024). Large language models: A survey. arXiv preprint arXiv:2402.06196.

Direct LLM, RAG, and GraphRAG



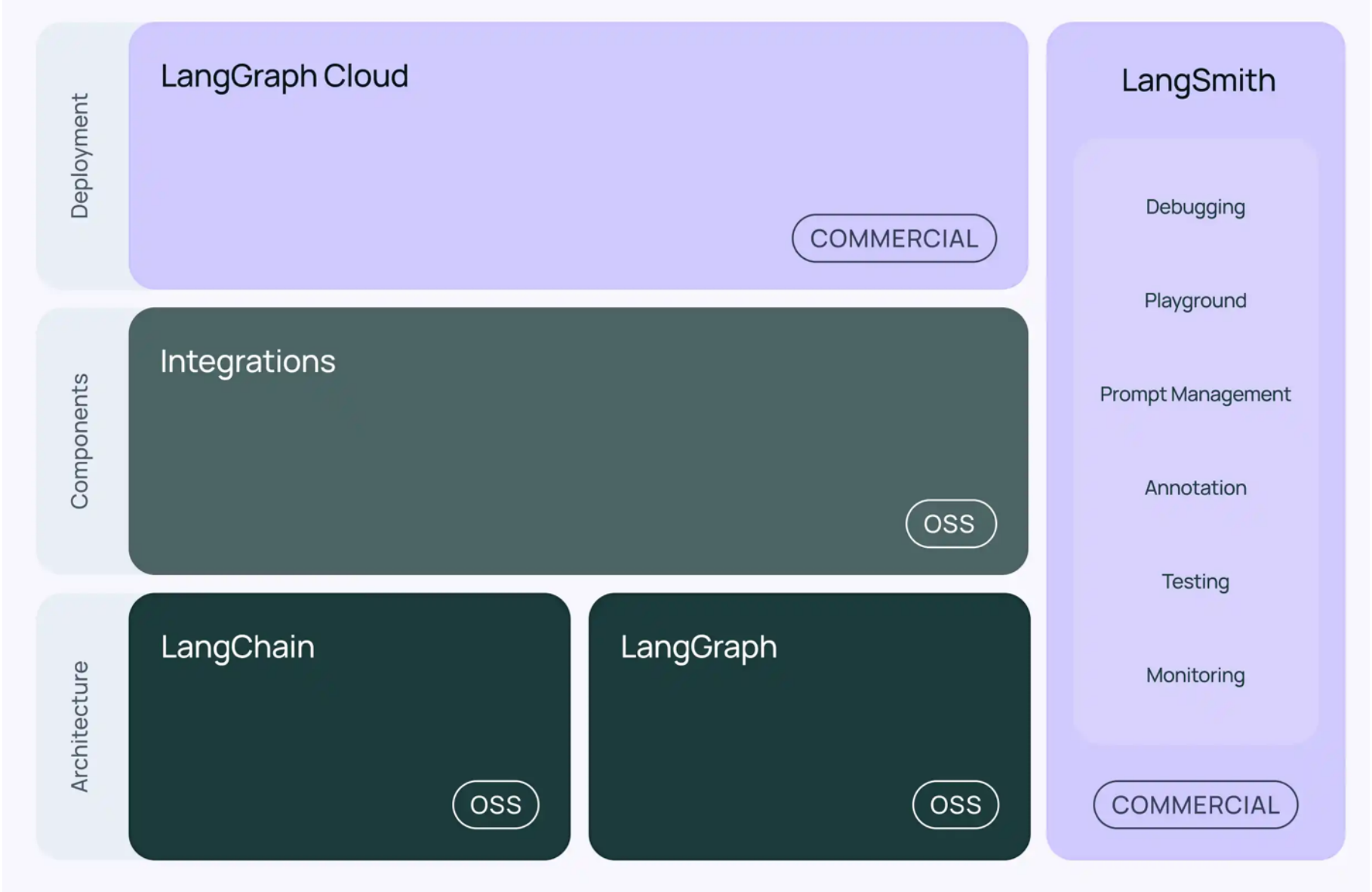
Source: Peng, B., Zhu, Y., Liu, Y., Bo, X., Shi, H., Hong, C., ... & Tang, S. (2024). Graph retrieval-augmented generation: A survey. arXiv preprint arXiv:2408.08921.

GraphRAG Framework for Question Answering



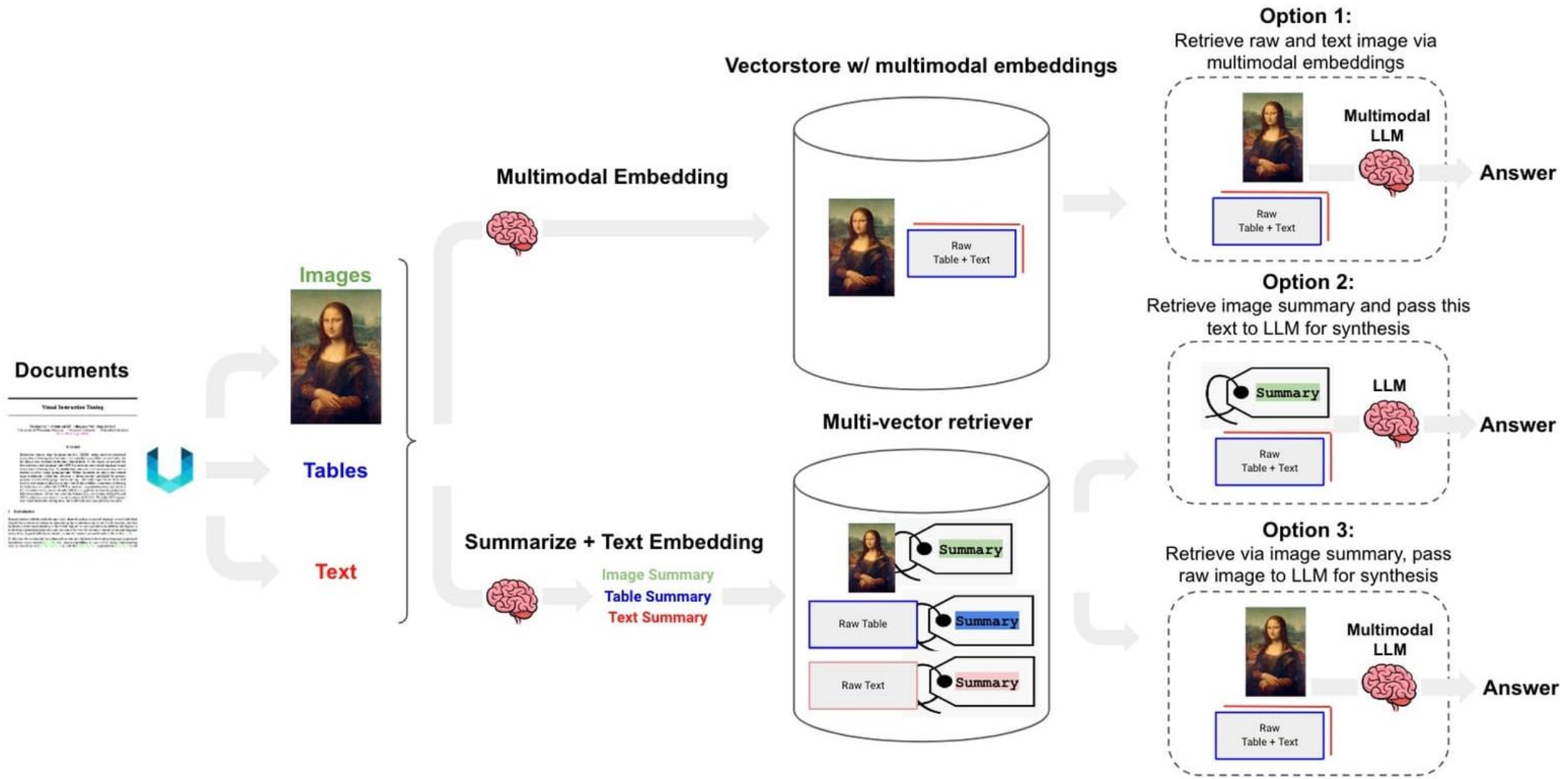
Source: Peng, B., Zhu, Y., Liu, Y., Bo, X., Shi, H., Hong, C., ... & Tang, S. (2024). Graph retrieval-augmented generation: A survey. arXiv preprint arXiv:2408.08921.

LangChain Architecture



Source: https://www.langchain.com/

Multimodal LLM RAG
Multi-Vector Retriever for RAG



Source: https://blog.langchain.dev/deconstructing-rag/

Evaluating RAG with Ragas Metrics

ragas score

generation

faithfulness

how factually acurate is
the generated answer

answer relevancy

how relevant is the generated
answer to the question

retrieval

context precision

the signal to noise ratio of retrieved
context

context recall

can it retrieve all the relevant information
required to answer the question

Source: https://blog.langchain.dev/evaluating-rag-pipelines-with-ragas-langsmith/

ESG

ESG:

Environmental

Social

Governance

CSR: Corporate Social Responsibility

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.

Sustainable Development Goals (SDGs)

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

Sustainable Development Goals (SDGs) and 5P

Partnership

Peace

Prosperity

People

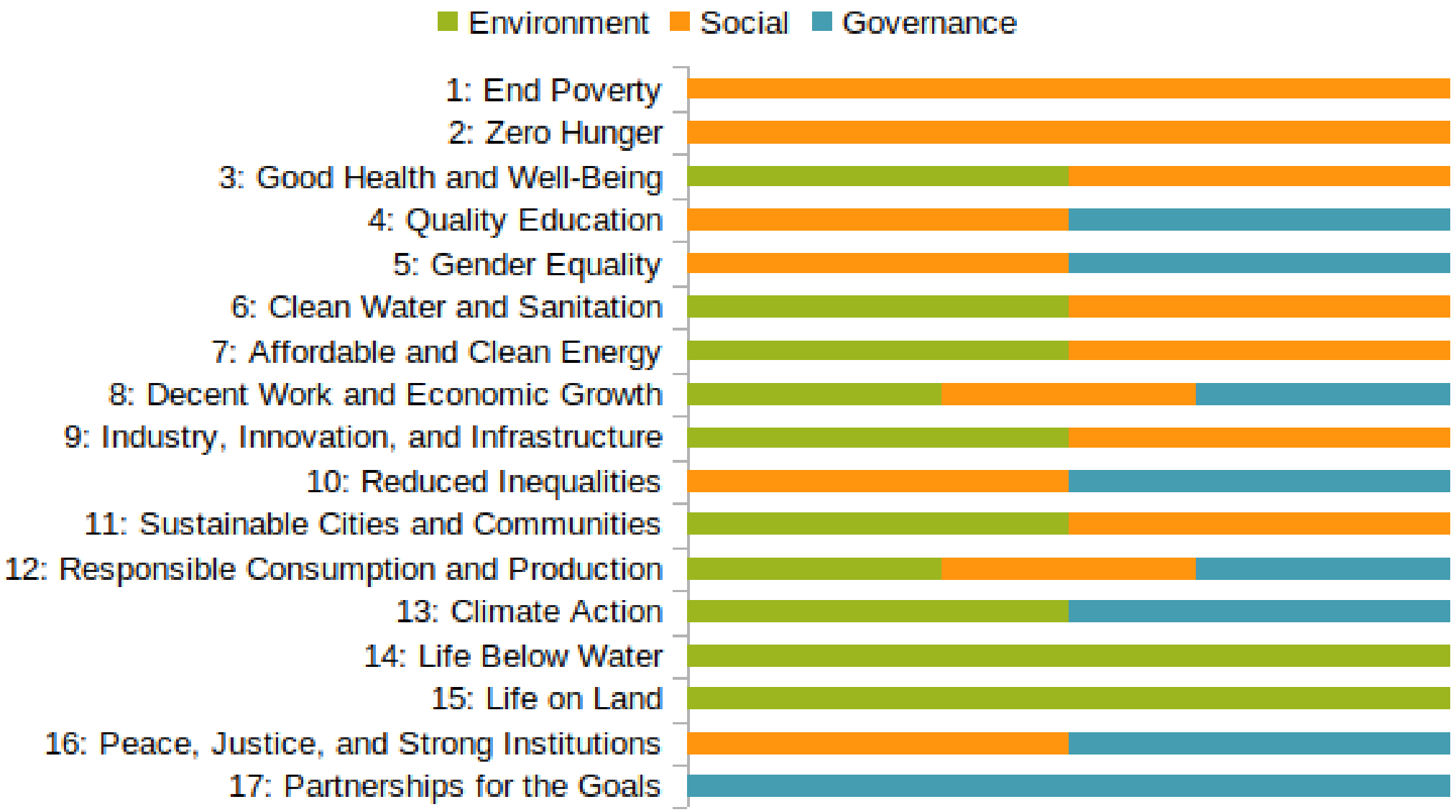
Planet

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).

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/

Sustainable Development

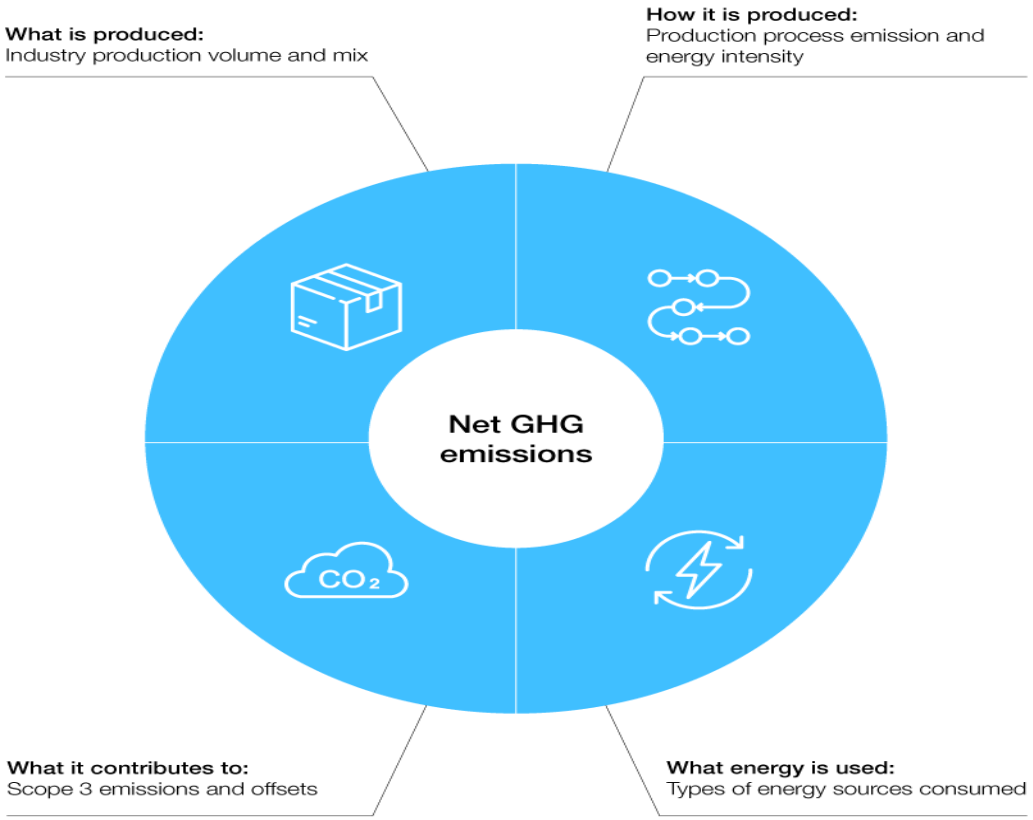
Net-Zero Transformation

- **Ambition**
  - Aligned to achieving global net zero by no later than 2050 & to limit warming to 1.5° C
- **Governance**
  - Accountability driven from the top
- **Strategy**
  - Embedded and aligned net zero into company strategy
- **Enterprise**
  - Key operating model changes in support of transformation
- **Supply chains**
  - Transformed net zero supply chains
- **Innovation**
  - Developed innovation and technologies to deliver net zero
- **Finance**
  - Financing the net zero transformation
- **Transparency**
  - Communicating action
- **Engagement**
  - Enhancing the pace and scale of net zero action

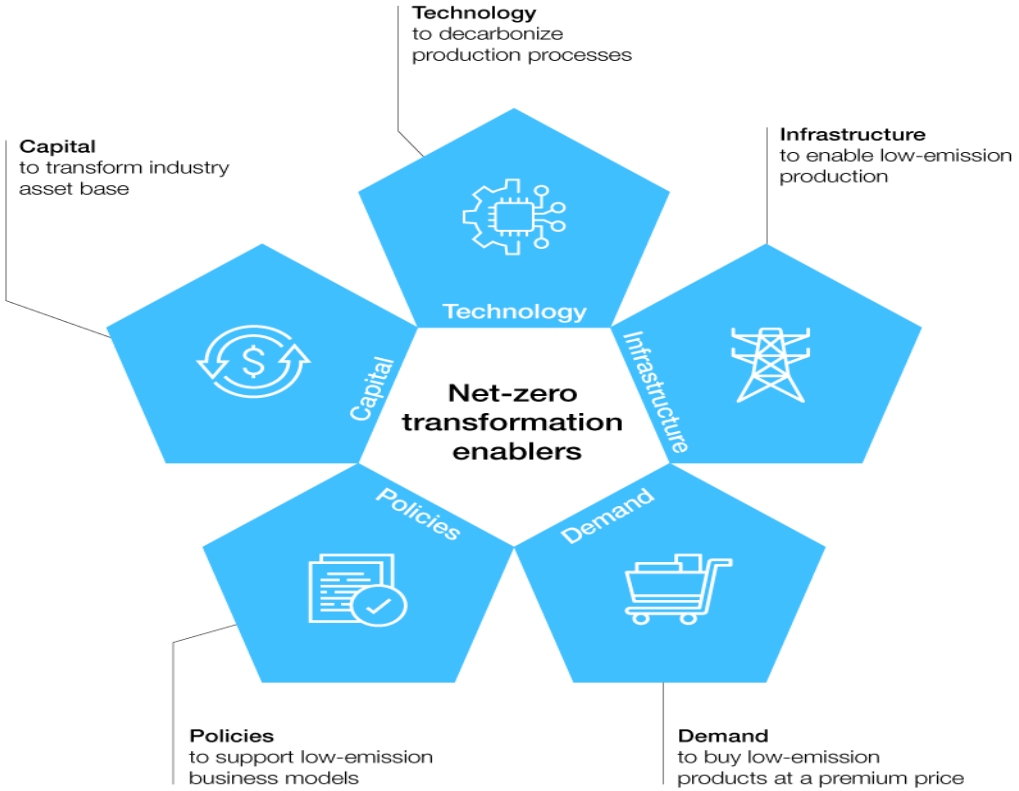
Source: https://www.pwc.com/us/en/services/esg/library/building-blocks-for-net-zero-transformation.html

Net-Zero Transformation Enablers

Net-zero industry performance
The four drivers of industry net greenhouse gas (GHG) emissions:

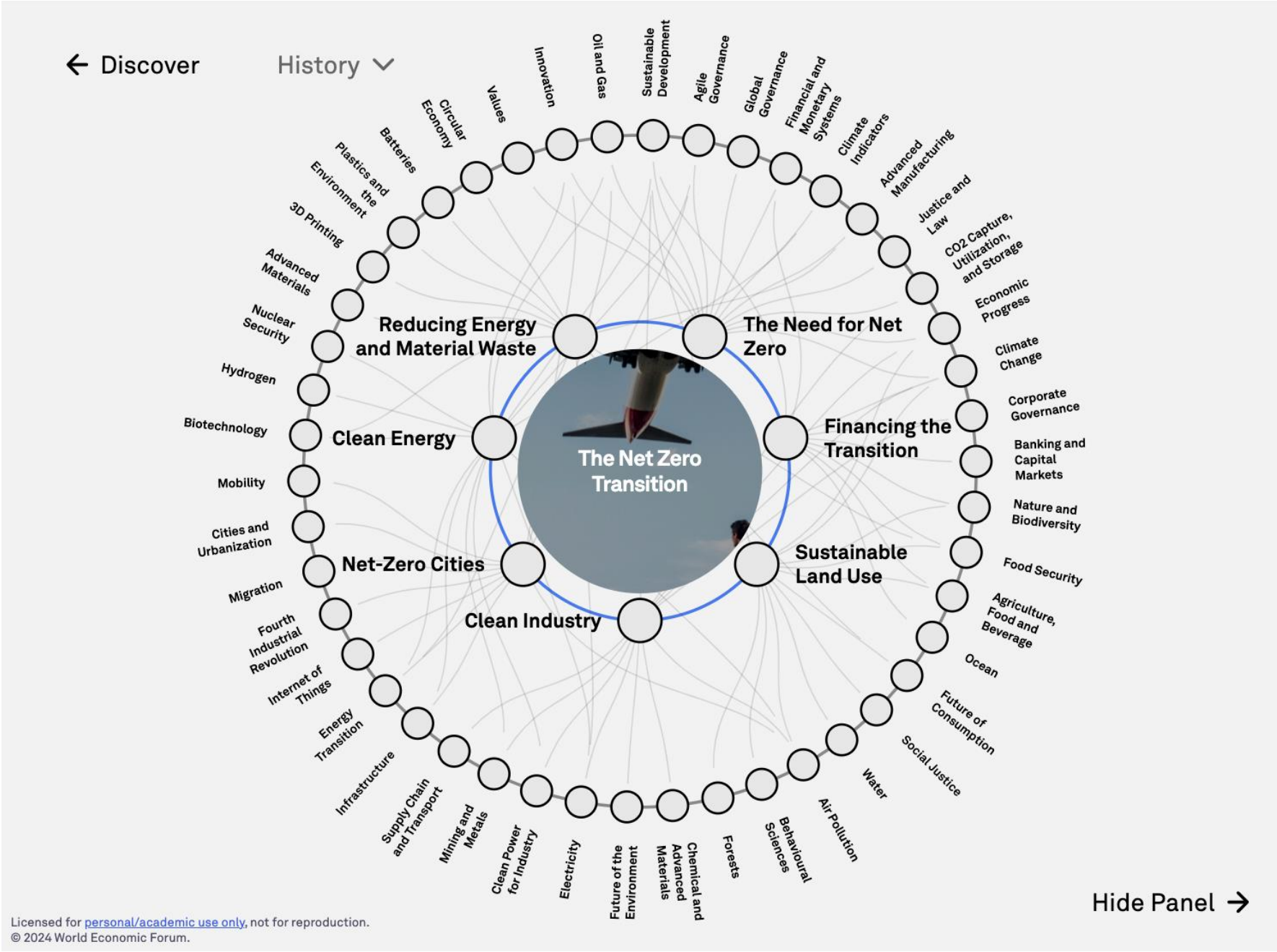


Net-zero industry readiness
The five enabling dimensions of industry net-zero transformation:



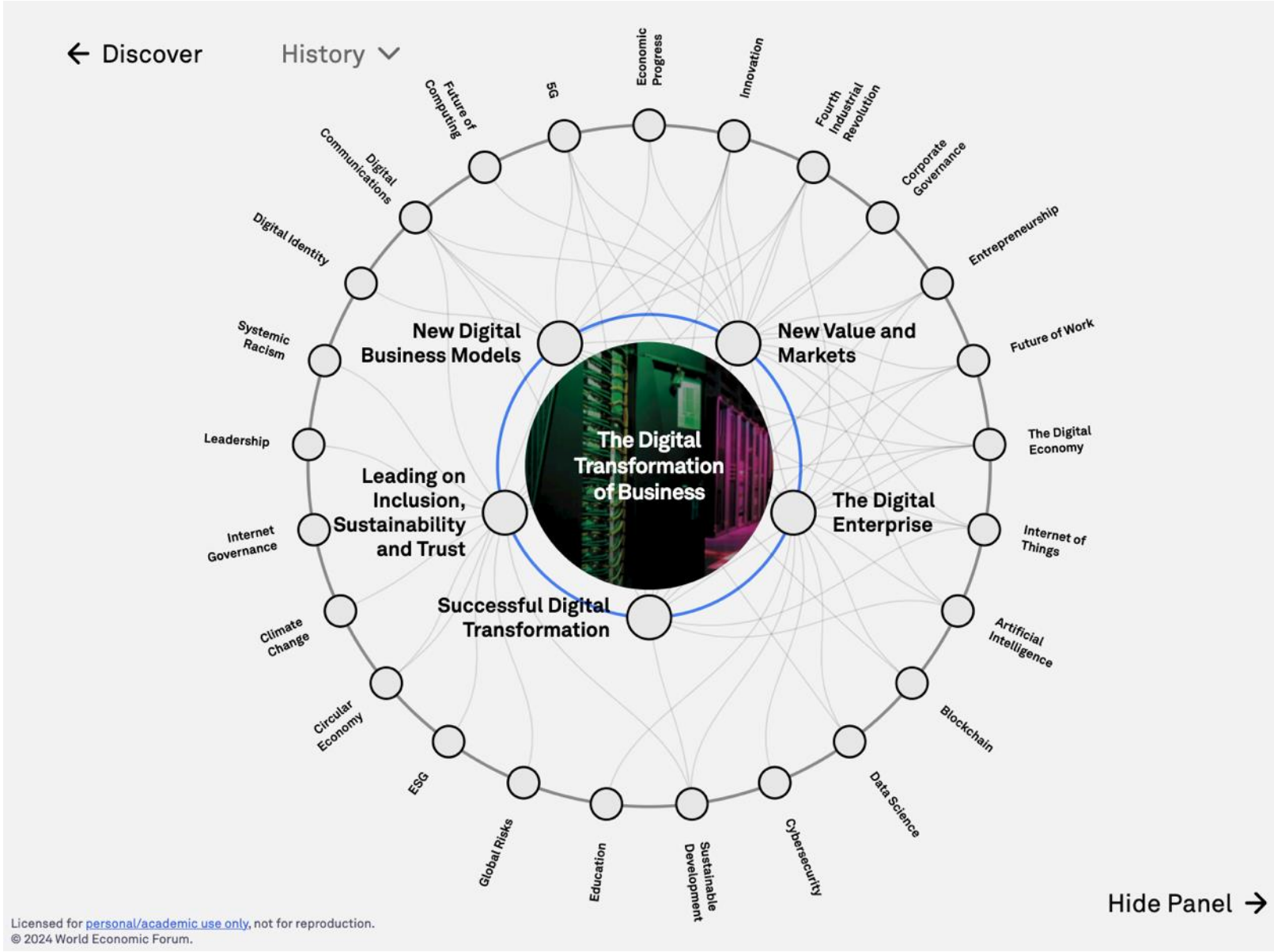
Source: https://www.weforum.org/agenda/2022/07/net-zero-tracker/

The Net Zero Transition



Source: https://intelligence.weforum.org/topics/a1G680000004C93EAE

The Digital Transformation of Business



Source: https://intelligence.weforum.org/topics/a1G0X000006DIDZUA4

Digital Transformation

Dimensions	Categories
A. BUSINESS MODELS	Business Process Innovation Business Strategy
B. DIGITAL BUSINESS	Digital Culture, Literacy and Skills Digital Economy Innovation and Socio-technical Shared Values
C. TECHNOLOGIES	Technology and Innovation Management Artificial Intelligence Big Data Internet of Things Industry 4.0
D. SUSTAINABILITY	Sustainable Business Sustainable Competitive Advantage Sustainable Development Sustainable Innovation
E. HUMAN RESOURCES	Employee Experience Career Dynamics
F. SMART CITIES	Sustainable Smart Manufacturing Digital Manufacturing

Source: Reis, João, and Nuno Melão (2023). "Digital transformation: A meta-review and guidelines for future research." Heliyon (2023).

ESG Challenges and Opportunities

- Challenges
  - Fragmented and unstructured ESG data.
  - Lack of standardization and transparency.
  - Timeliness of data availability.
- Opportunities
  - Rising demand for actionable ESG insights.
  - Innovation in sustainable solutions and policies.
  - Generative AI as a tool for transformation.

Sustainability and ESG Data Analytics

Generative AI for ESG Data Analytics

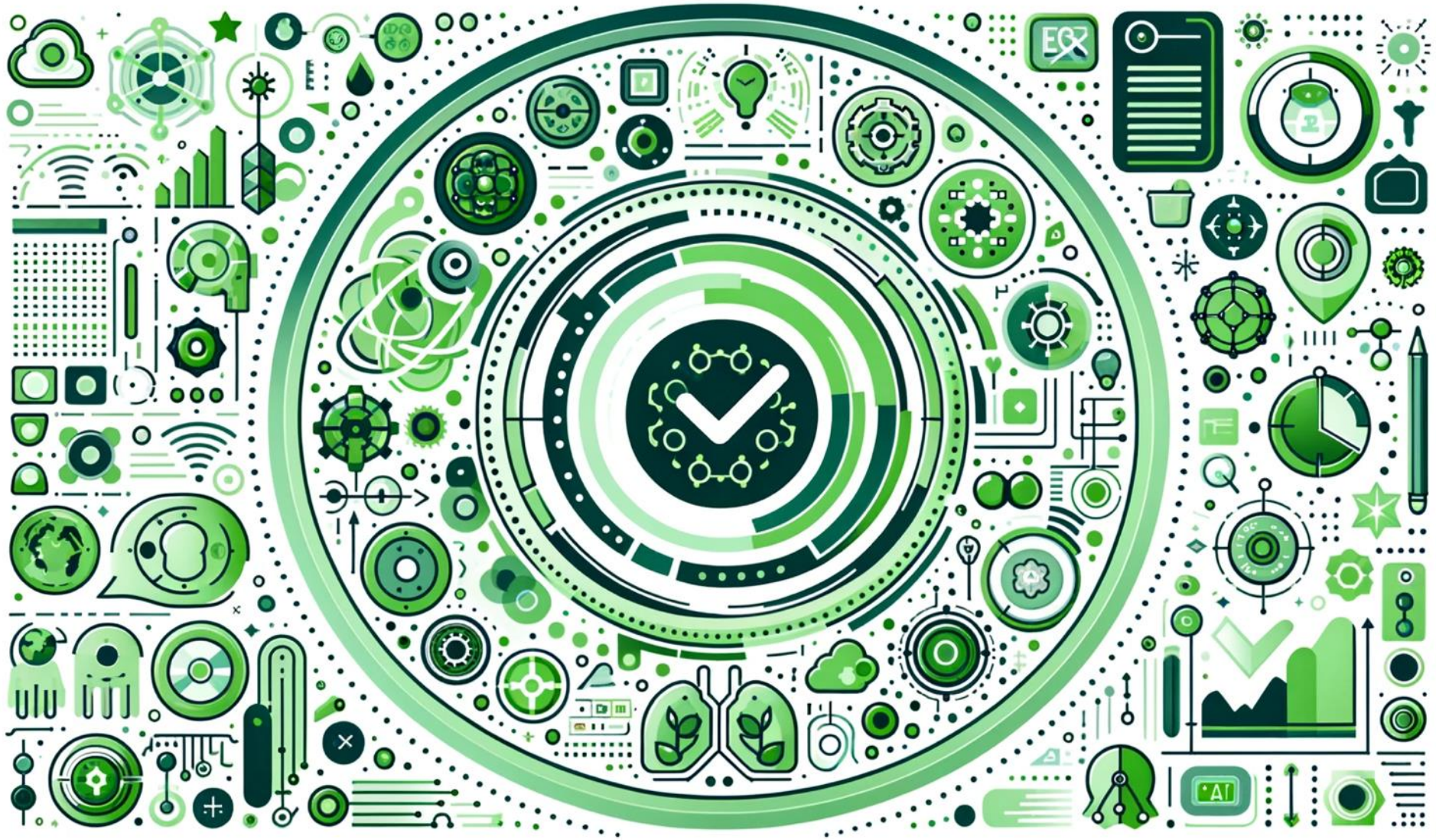
- Data Integration and Enrichment:
  - Synthesizing structured and unstructured ESG data.
- Automated Reporting and Insight Generation:
  - Tailored ESG reports and insights for stakeholders.
- Scenario Modeling and Forecasting:
  - Simulating potential risks and opportunities.
- Addressing Bias and Ensuring Accountability:
  - Transparent, fair, and ethical AI deployment.

Generative AI and LLMs for Sustainability and ESG Data Analytics

Sustainability Innovation with Generative AI

- Sustainable Product Design:
  - Eco-friendly designs minimizing waste and energy.
- Policy Formulation and Implementation:
  - AI-driven simulations for effective policies.
- Stakeholder Engagement and Awareness:
  - Communicating ESG strategies with compelling AI-driven visuals.

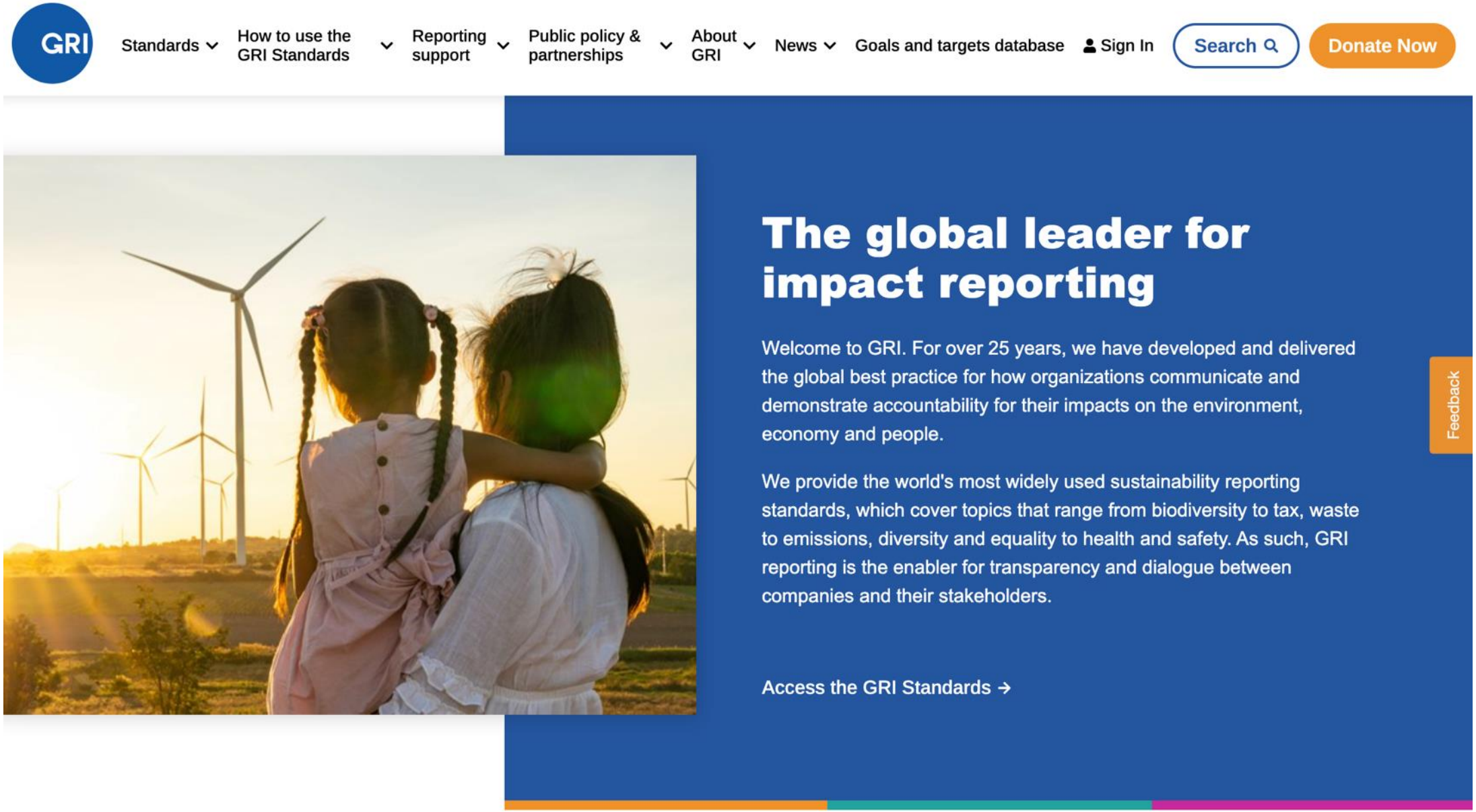
Generative AI for ESG Rating and Reporting Generation



Mapping the ESG Standards Landscape

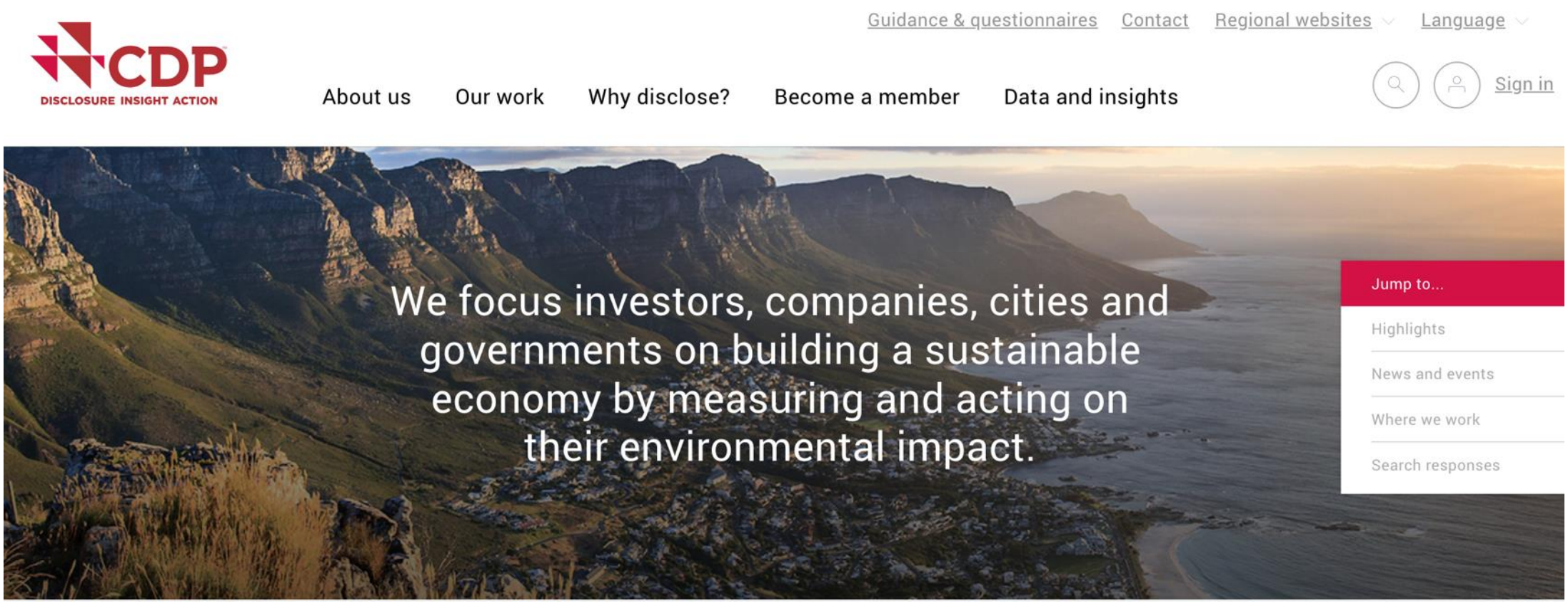
- The most prevalent ESG reporting frameworks
  - GRI (Global Report Initiative)
  - CDP (Carbon Disclosure Project)
  - SASB (Sustainability Accounting Standards Board
  - ISSB (International Sustainability Standards Board)
  - TCFD (Task Force on Climate-related Financial Disclosures
- How companies choose
  - Materiality, industry-specific standards, investor alignment

GRI (Global Report Initiative)



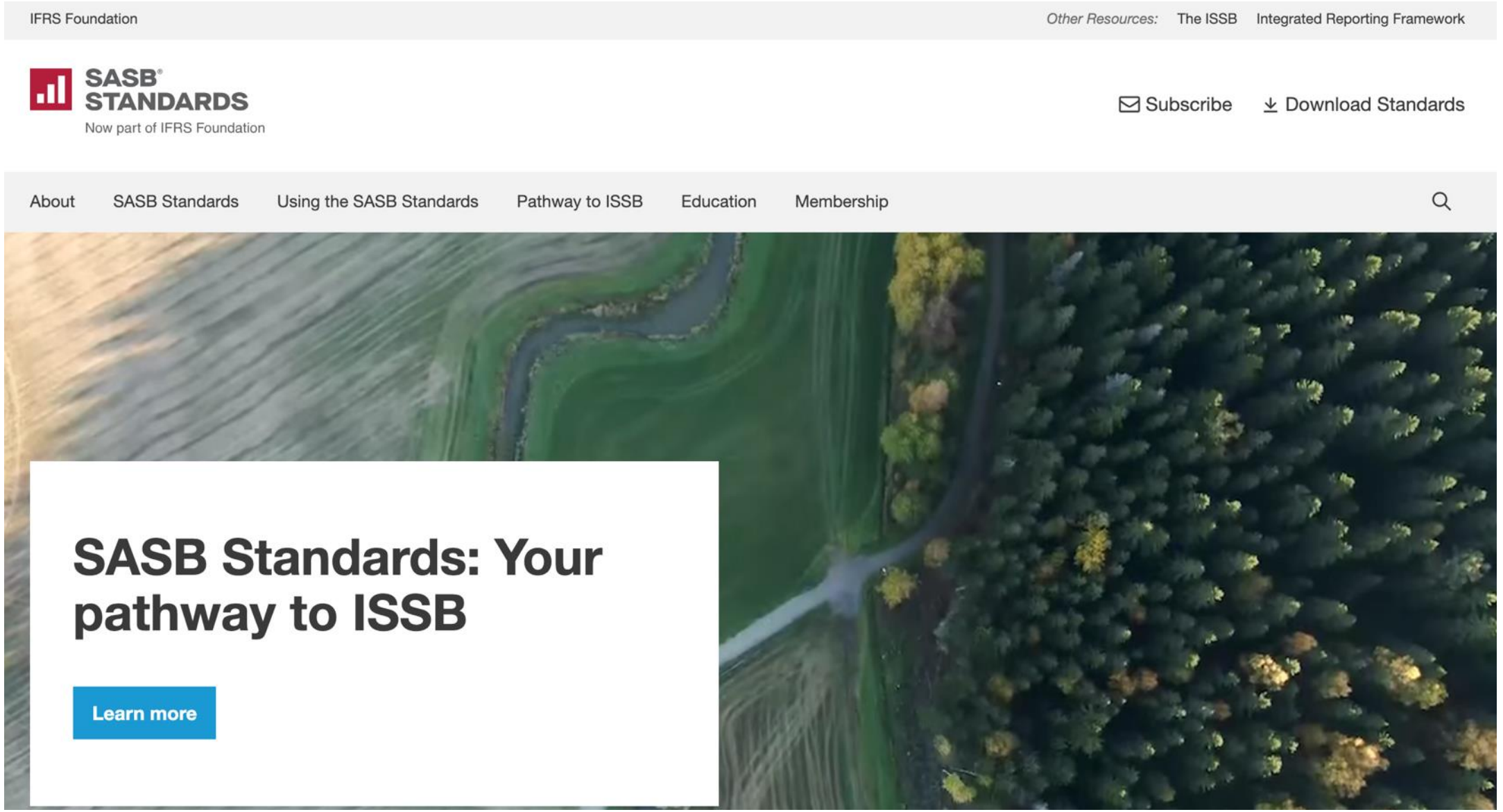
https://www.globalreporting.org/

CDP (Carbon Disclosure Project)



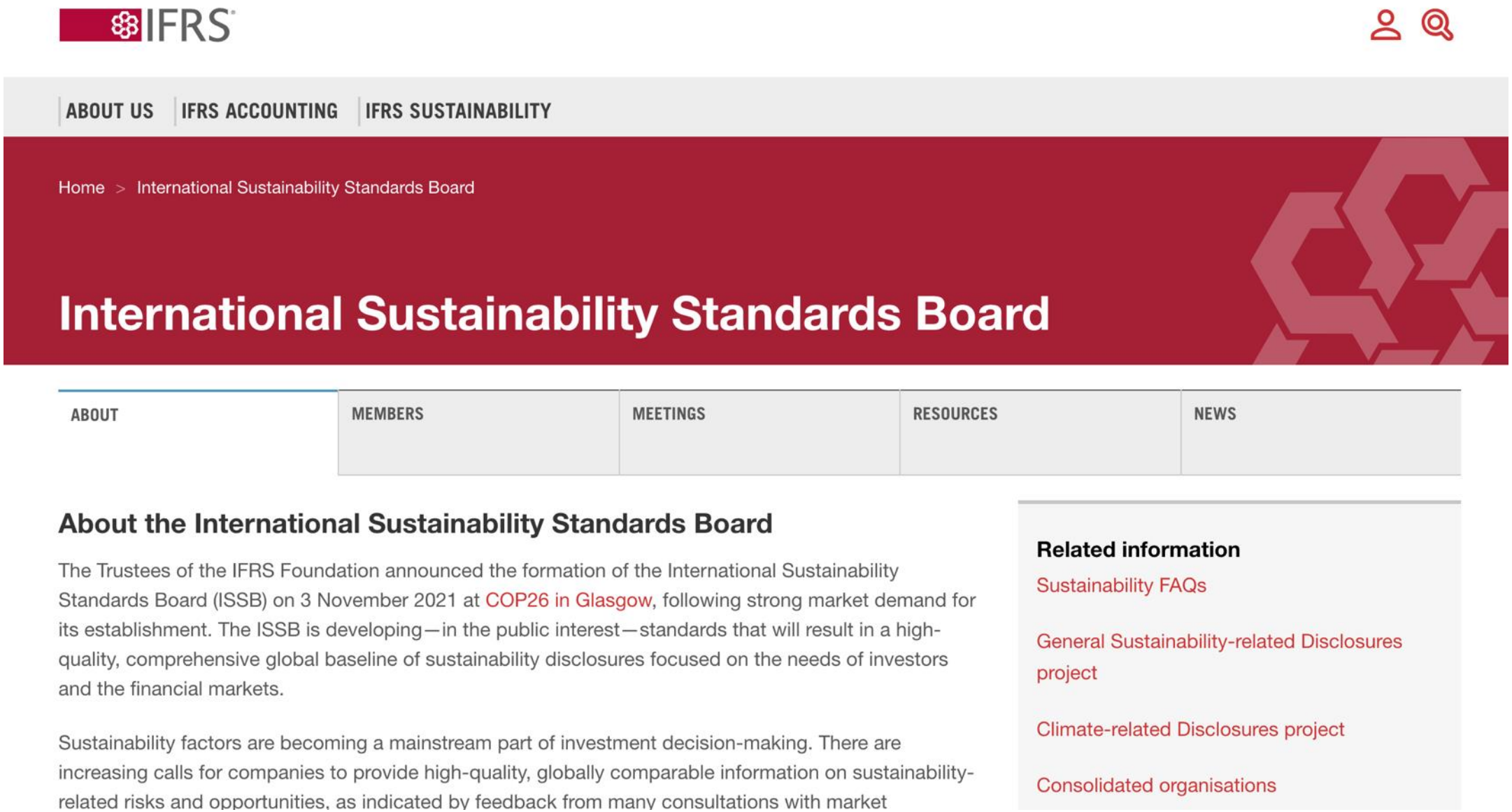
https://www.cdp.net/

SASB (Sustainability Accounting Standards Board)



https://sasb.org/

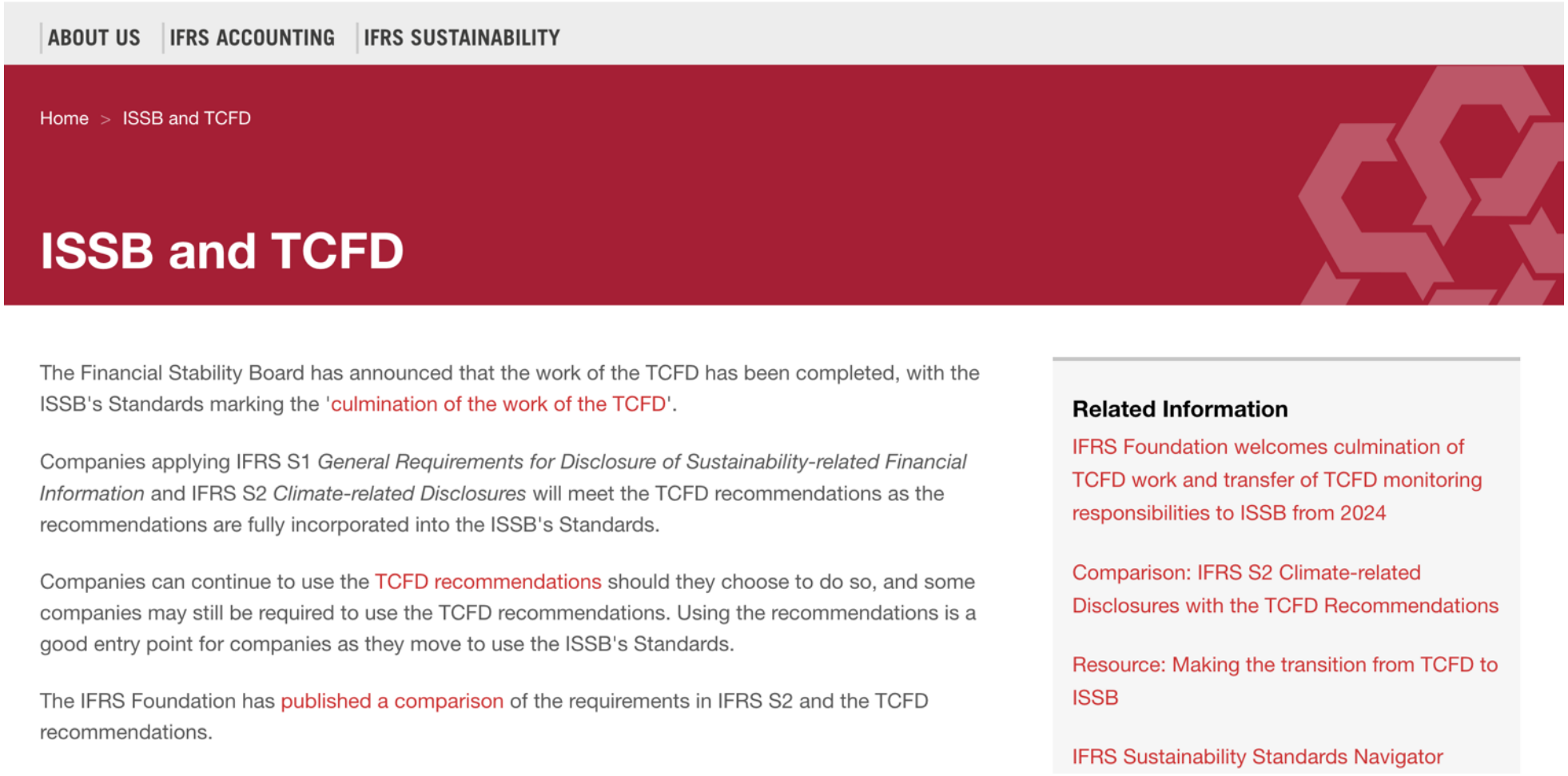
ISSB (International Sustainability Standards Board)



https://www.ifrs.org/groups/international-sustainability-standards-board/

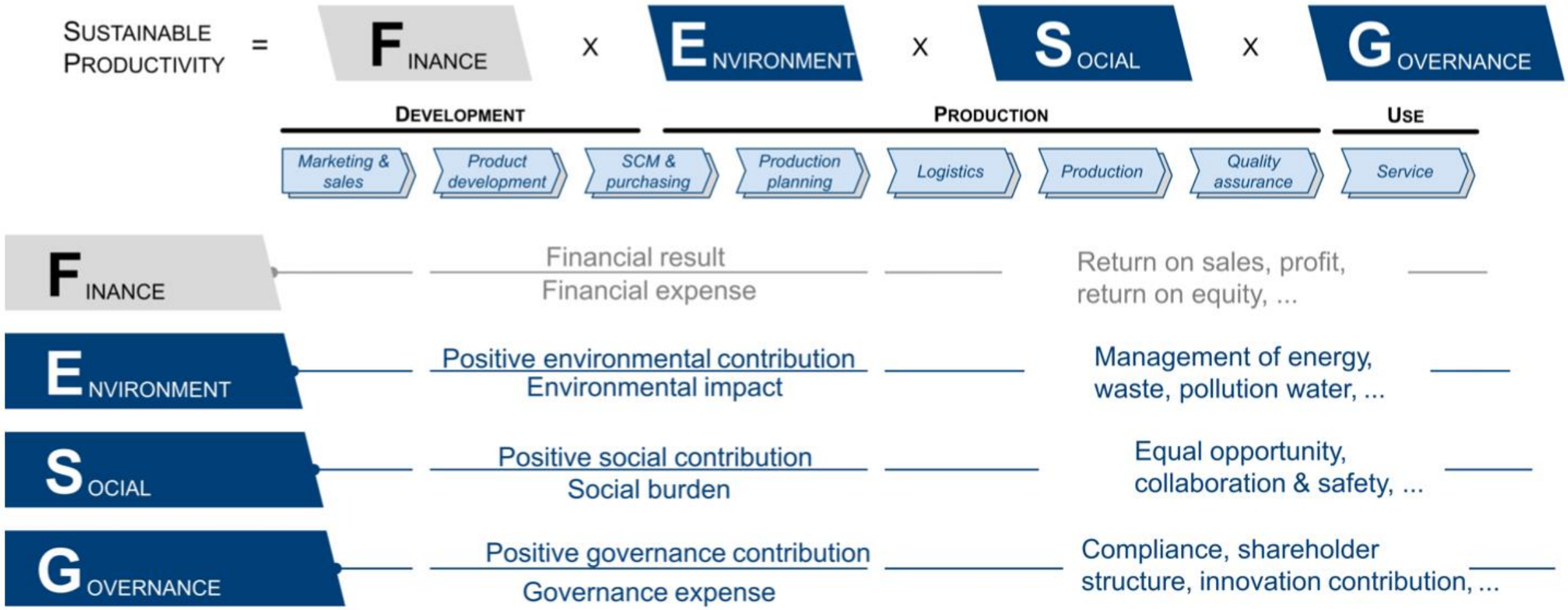
TCFD
(Task Force on Climate-related Financial Disclosures)

https://www.ifrs.org/sustainability/tcfd/



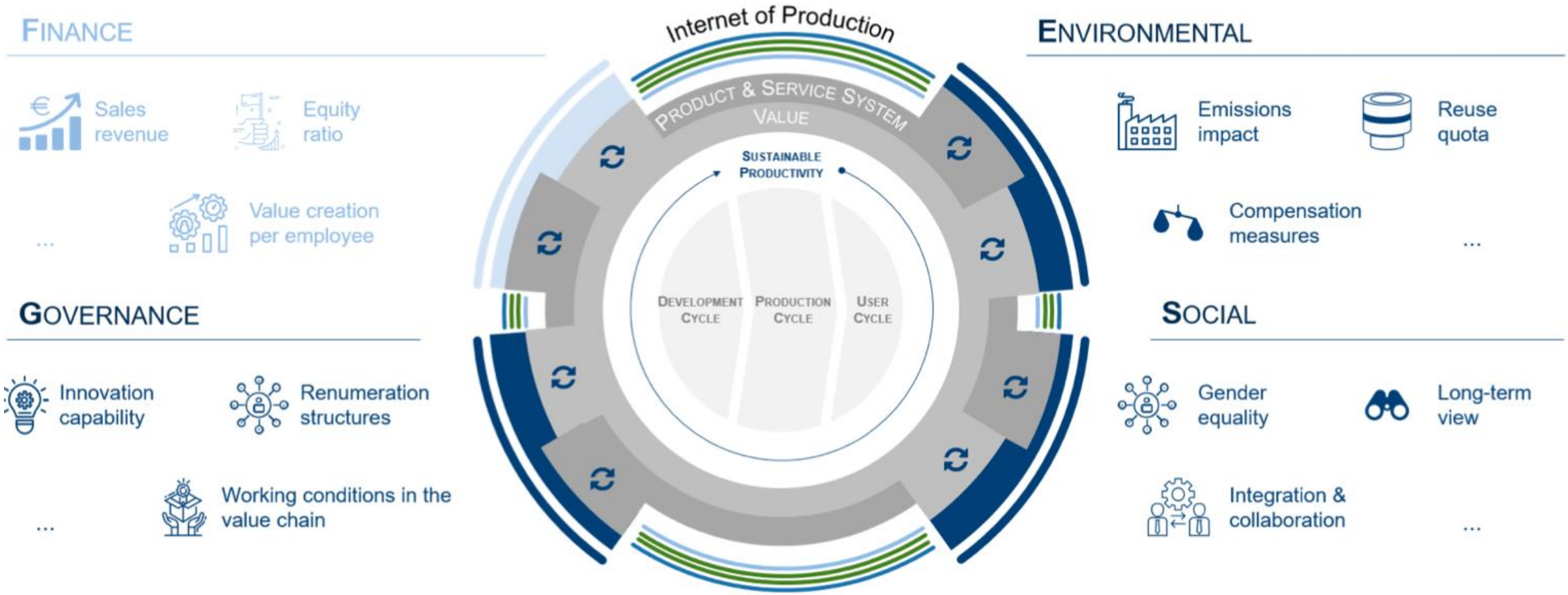
https://www.fsb-tcfd.org/

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

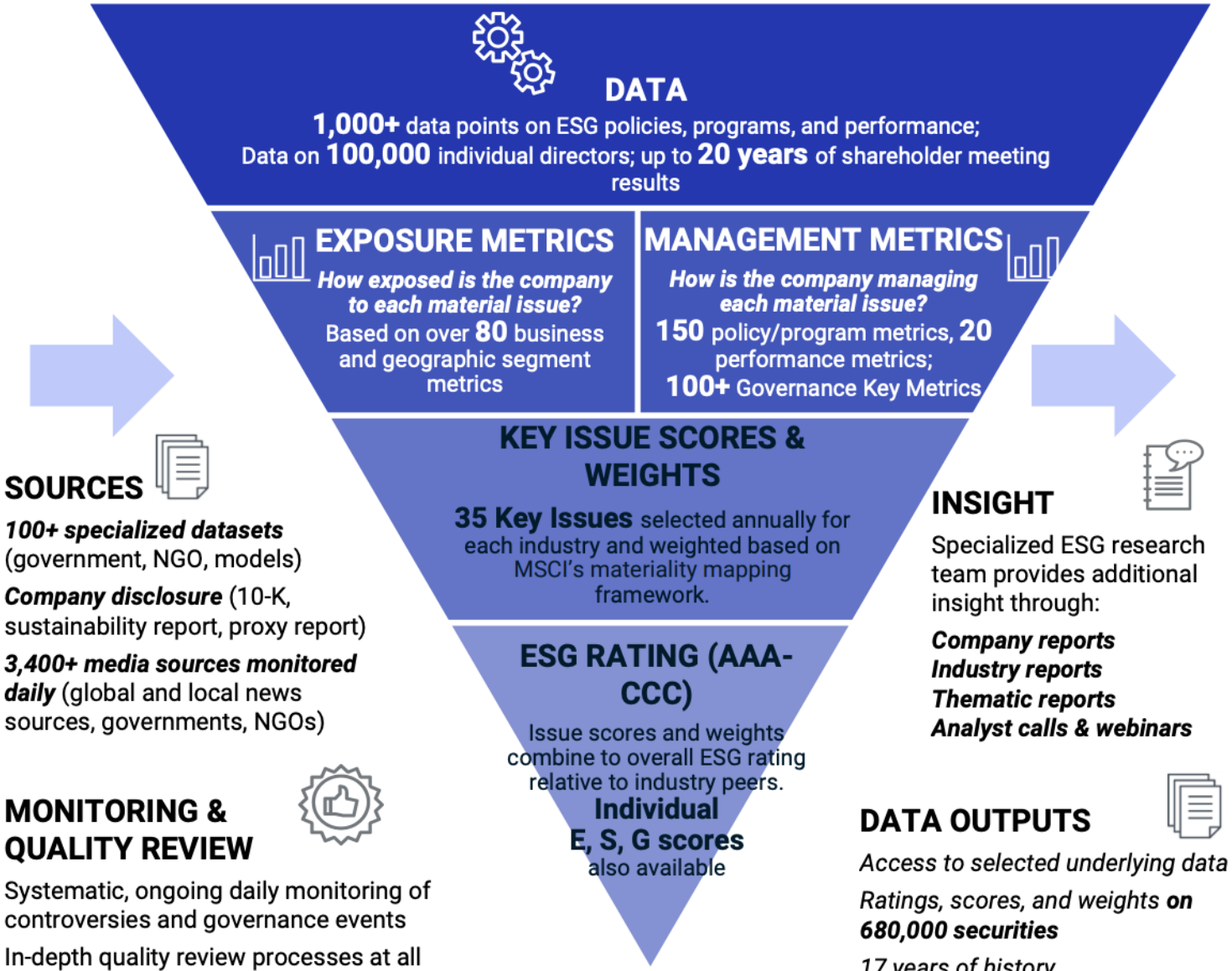


Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.

ESG Indexes

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

MSCI ESG Rating Framework



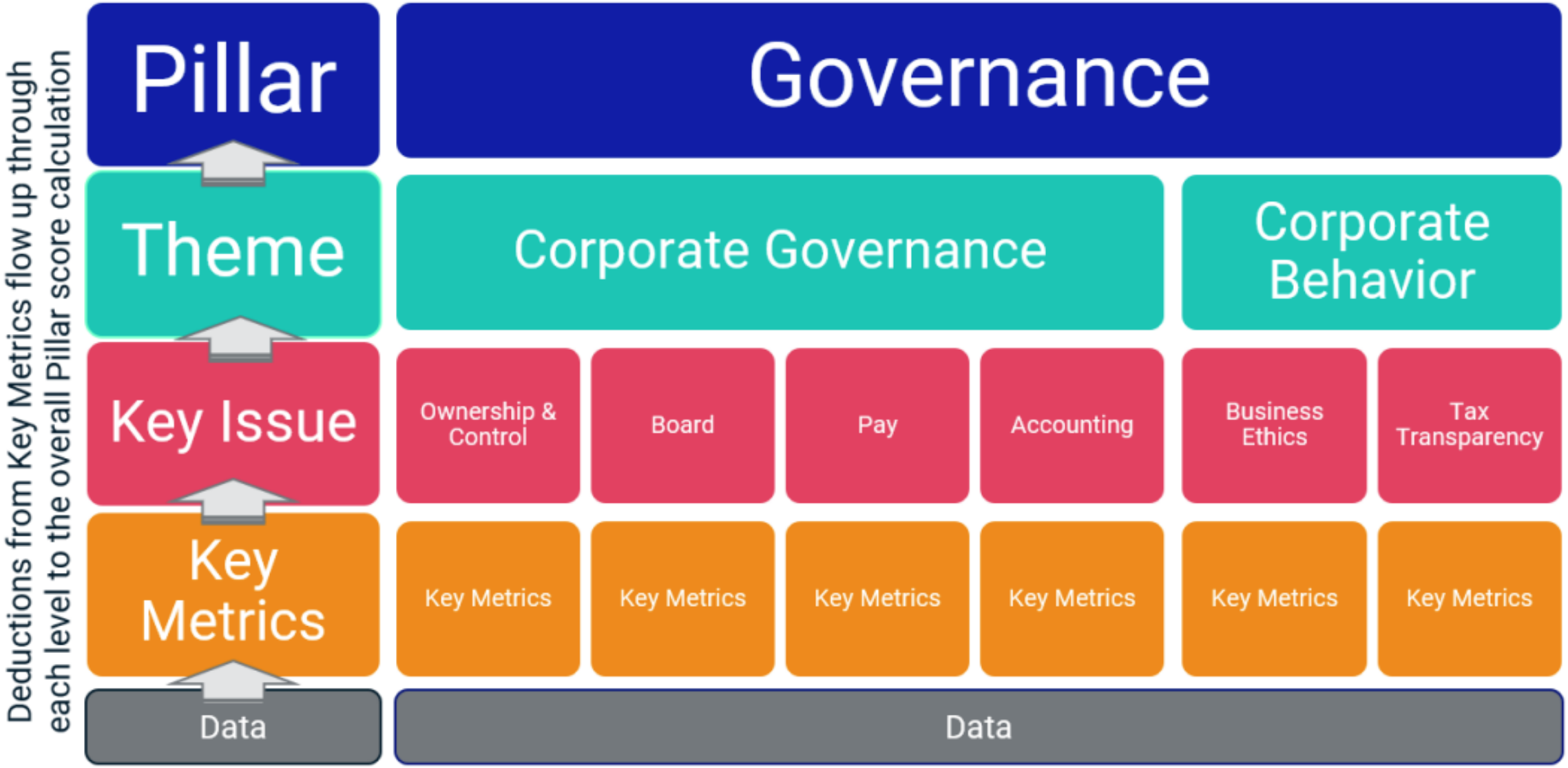
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

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	

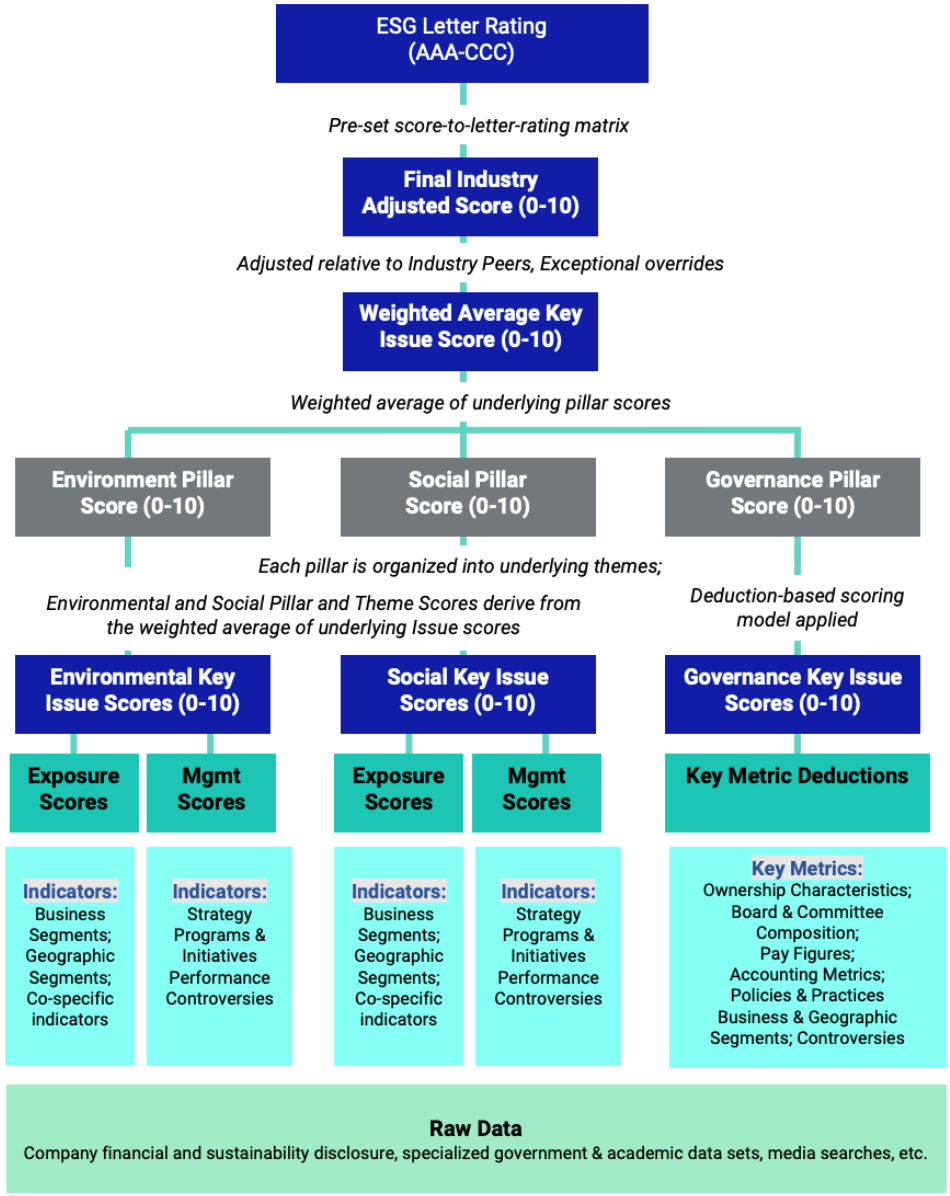
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

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

DJSI S&P Global ESG Score

8,000
Companies

90%
Global market capitalization

340,000+
Current Research Universe and Active Securities

Approx.
1,000
Datapoints

Assessed values, text, checkboxes, documents
Sources: Web-based questionnaire and company documents

130+
Questions

Weighted data point scores
Up to 50% industry-specific

Ave.
30+
Criteria scores

Weighted question scores
61 industry specific approaches, with tailored questions, criteria and related weightings

3
Dimension scores

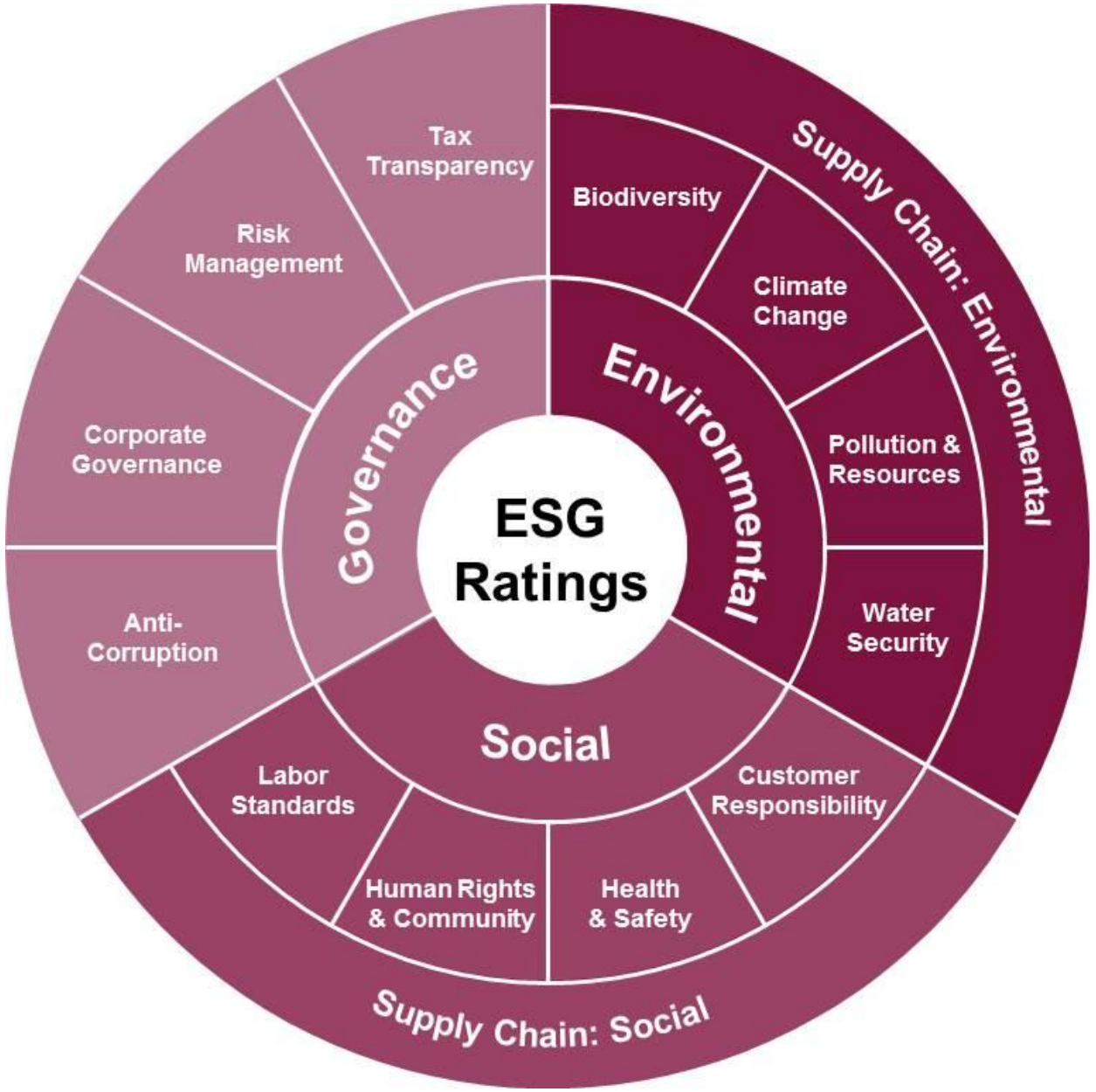
Weighted criteria scores
Adjusted for corporate ESG controversies where applicable

1
S&P Global ESG Score

Sum of weighted dimension scores

Source: DJSI, S&P Global Corporate Sustainability Assessment (CSA), https://www.spglobal.com/esg/solutions/data-intelligence-esg-scores

FTSE Russell ESG Ratings



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

Sustainalytics ESG Risk Ratings

Analyst-based approach

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

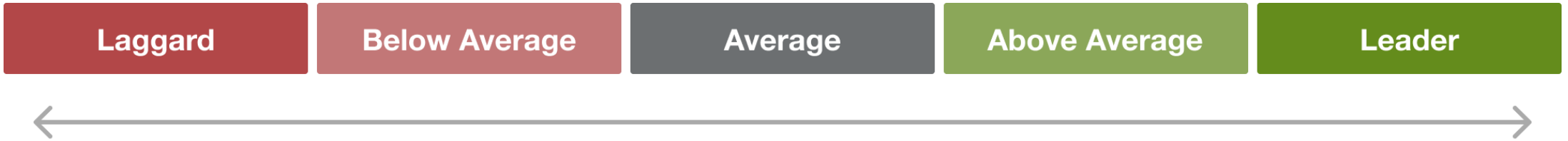
TruValue Labs

FACTSET

Machine-based approach

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

Analyst-driven vs. AI-driven ESG

Analyst-driven ESG research

Derives ratings in a structured data model

Sustainalytics

Analyst role at the end of the process allows subjectivity to color results

AI-driven ESG research

Derives signals from unstructured data

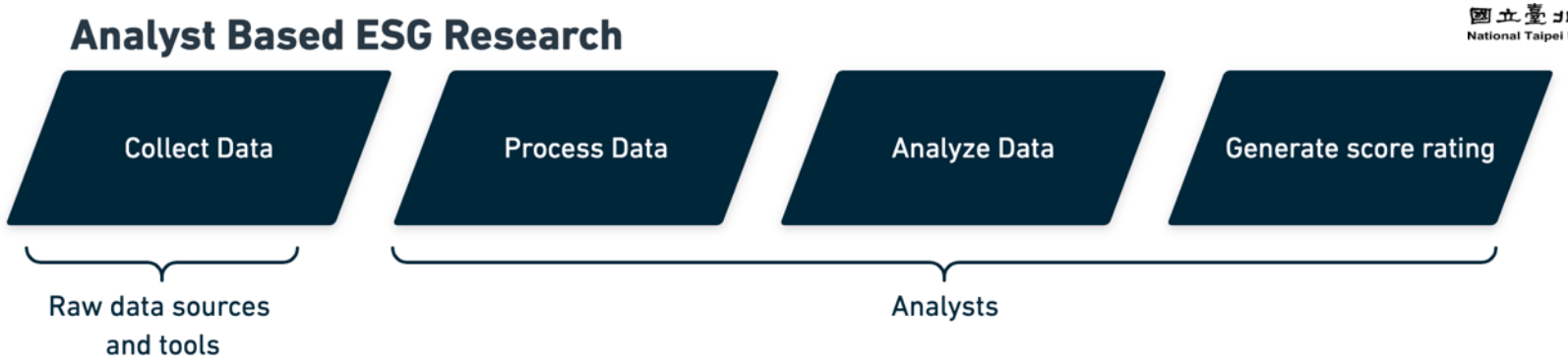
Truvalue Labs

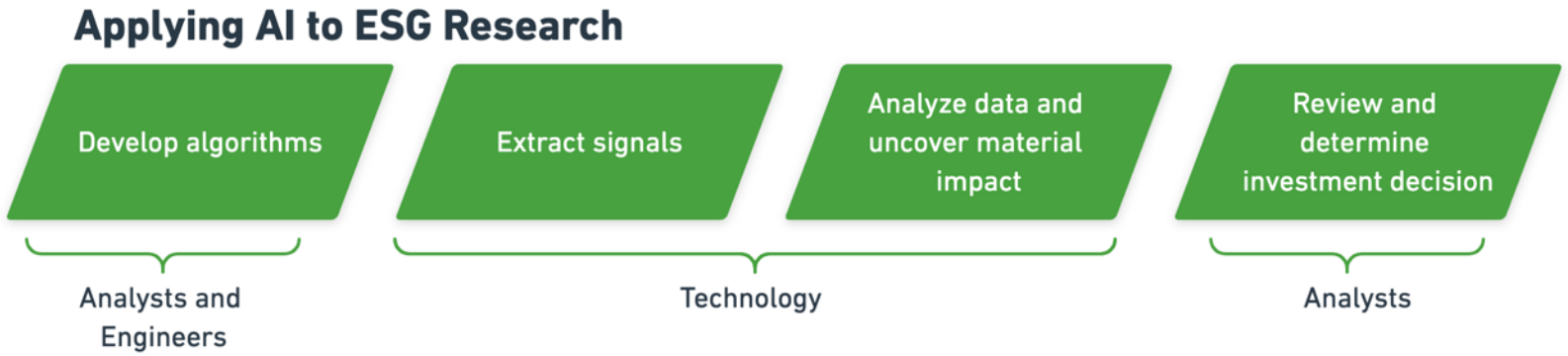
Analyst expertise at the beginning of the process produces consistent results

Source: Mark Tulay (2020), Man vs. machine: A tale of two sustainability ratings systems, GreenBiz, https://www.greenbiz.com/article/man-vs-machine-tale-two-sustainability-ratings-systems

Analyst based ESG Research

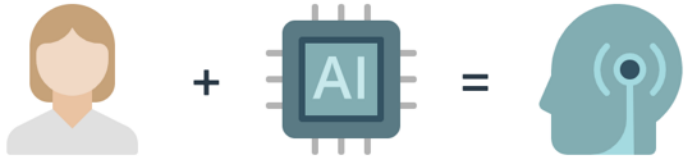
AI based ESG Research





It would take an analyst over 5 years to do what our AI can in 1 week

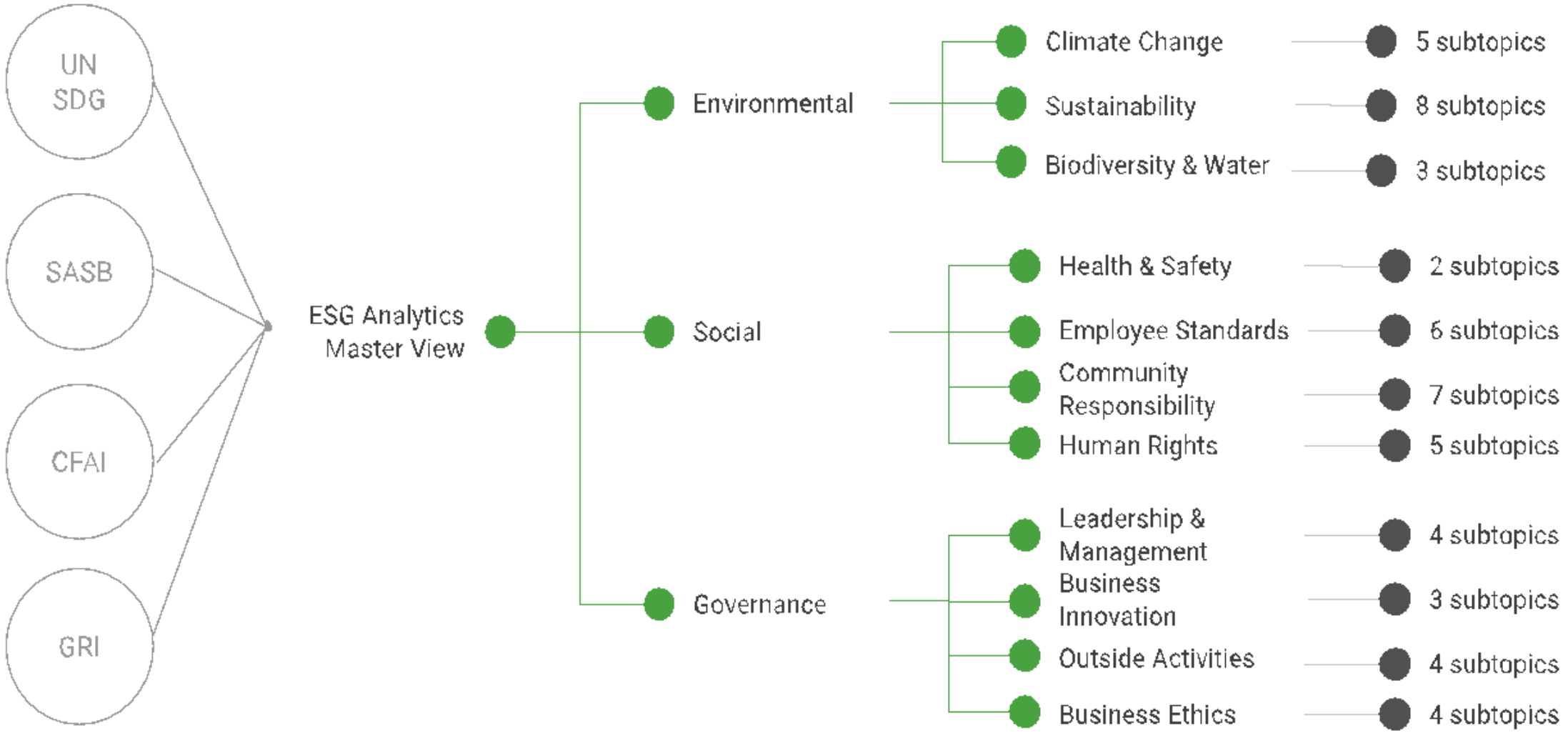
Combining analysts with AI creates gives you the full picture



ESG ANALYTICS
Invest where it matters.

Source: https://www.esganalytics.io/insights/how-data-is-accelerating-esg

ESG Analytics: NLP Taxonomy

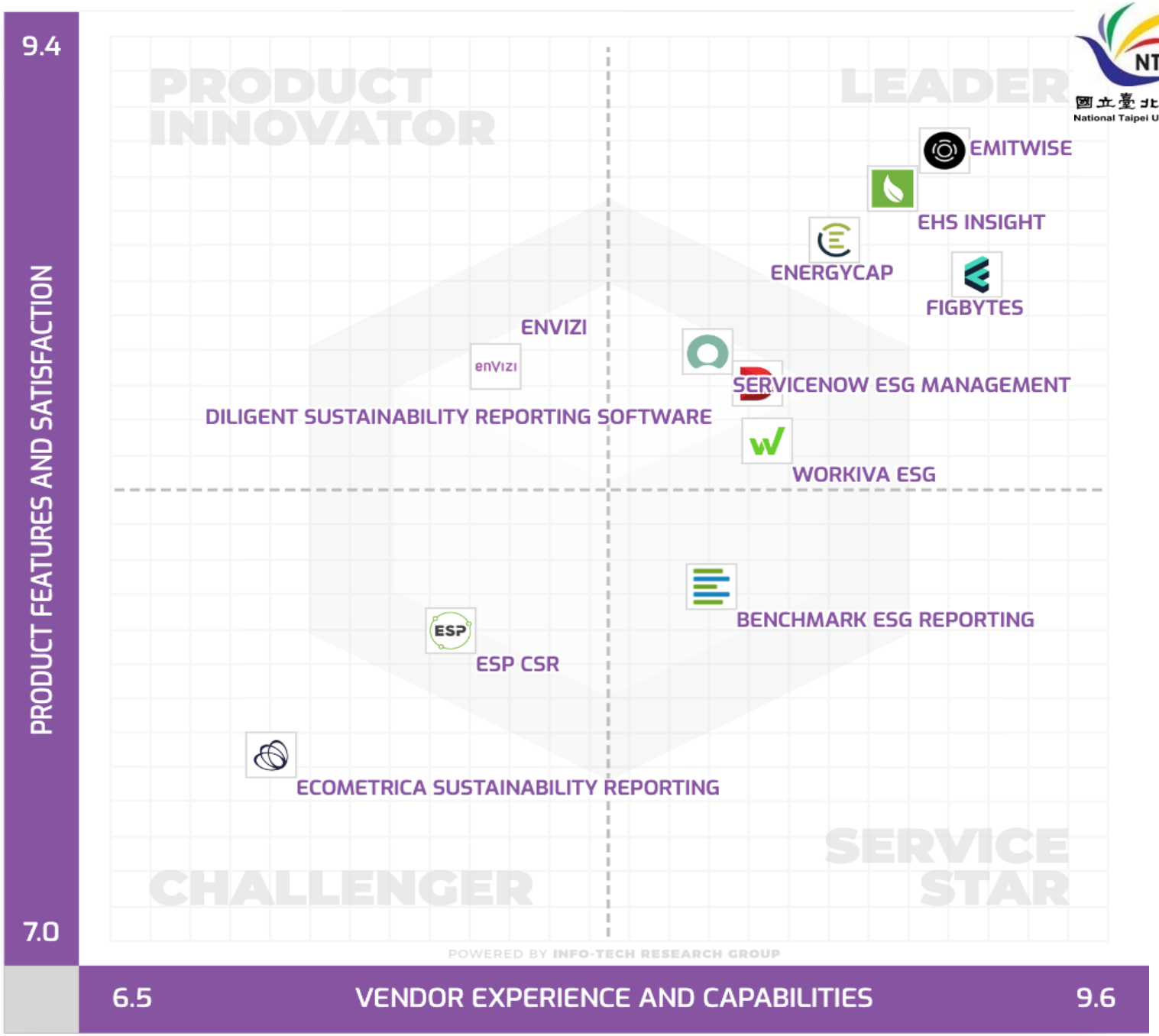


ESG ANALYTICS

Source: https://www.esganalytics.io/insights/how-data-is-accelerating-esg

Top ESG Reporting Software

Environmental, Social and Governance (ESG) Reporting software or **Sustainability software** helps organizations manage their operational data, evaluate their impact on the environment and provide reporting to perform audits.



Source: https://www.softwarereviews.com/categories/environmental-social-and-governance-reporting

Future Directions

- Integrating blockchain, IoT, and digital twins.
- Democratizing AI tools for all stakeholders.
- Promoting collaboration among experts and communities.

Conclusion

- Generative AI is transforming ESG analytics and sustainability innovation.
- Collaboration among researchers, policymakers, and innovators is key.
- Generative AI to build a sustainable future.

Summary

1. Generative AI
2. ESG
3. Sustainable Development

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國立臺北大學 商學院碩士在職專班

企業倫理與永續發展

(Business Ethics and Sustainable Development)

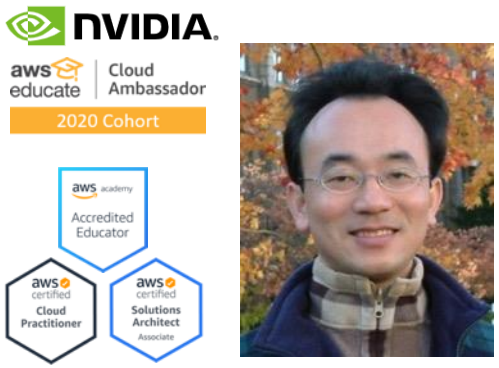
Q & A

Generative AI for ESG and Sustainable Development (生成式 AI 於 ESG 與永續發展)

Time: 18:50-21:30, Tuesday, March, 11, 2025

企業倫理與永續發展 (Business Ethics and Sustainable Development)

任課教師：陳宥杉， 戴敏育



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2025-03-11