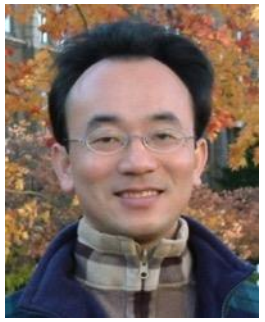
Sustainability and ESG Data Analytics

Introduction to Sustainability and ESG Data Analytics

1141ESGDA01
MBA, IM, NTPU (M5265) (Fall 2025)
Wed 2, 3, 4 (9:10-12:00) (B3F17)

https://meet.google.com/miy-fbif-max



Min-Yuh Day, Ph.D,
Professor and Director

Institute of Information Management, National Taipei University

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

2025-09-10

NTPU
國立臺北大學
National Taipei University

AACSB ACCREDITED

aws educate | Cloud Ambassador
2020 Cohort

aws academy
Accredited Educator

aws certified
Solutions Architect
Associate

aws certified
Cloud Practitioner

Prof. Min-Yuh Day

NVIDIA
University Ambassador
Certified Instructor

Director, 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

Artificial Intelligence, Agentic AI, ESG and Green Financial Technology, Big Data Analytics, Electronic Commerce

NTPU
國立臺北大學
National Taipei University

中央研究院 ACADEMIA SINICA 1928

Course Syllabus
National Taipei University
Academic Year 114, 1st Semester (Fall 2025)

- **Course Title: Sustainability and ESG Data Analytics**
- **Instructor: Min-Yuh Day**
- **Course Class: MBA, IM, NTPU (3 Credits, Elective)**
- **Details**
  - **In-Class and Distance Learning EMI Course (3 Credits, Elective, One Semester) (M5265)**
- **Time & Place: Wed, 2, 3, 4, (9:10-12:00) (B3F17)**
- **Google Meet:** https://meet.google.com/miy-fbif-max

https://meet.google.com/miy-fbif-max

Course Objectives

1. Understand the fundamental concepts of sustainability and ESG data analytics.
2. Equip with Hands-on practices of sustainability and ESG data analytics.
3. Integrate innovative thinking of big data analysis to enhance the operational model of sustainable development.
4. In the context of sustainability, use data analysis to formulate responses to sustainable issues and cultivate students' ability to extract management-relevant data analysis skills from the data.

The Course Includes Sustainable Development Goals (SDGs)

1. SDG4 | Quality Education
2. SDG7 | Affordable and Clean Energy
3. SDG8 | Decent Work and Economic Growth
4. SDG9 | Industry, Innovation and Infrastructure
5. SDG11 | Sustainable Cities and Communities
6. SDG12 | Responsible Consumption and Production
7. SDG13 | Climate Action
8. SDG17 | Partnerships for the Goals

Course Outline

- This course introduces the fundamental concepts and hands-on practices of Sustainability and ESG Data Analytics.
- Topics include
  1. Introduction Sustainability and ESG Data Analytics
  2. Environmental, Social, and Governance (ESG) in Net-Zero Digital Transformation
  3. Data Science for Sustainability and ESG
  4. Web 3.0 and Big Data Analysis in Fintech, Green Finance, Sustainable Finance
  5. ESG Data Gathering, Analysis, and Visualization
  6. NVIDIA Building RAG Agents with LLMs
  7. Artificial Intelligence of things (AIoT) in ESG and Sustainability Applications
  8. Generative AI for ESG Rating and Reporting Generation
  9. Case Study on Sustainability and ESG Data Analytics

Core Competence

- **Exploring new knowledge in information technology, system development and application 80 %**
- **Internet marketing planning ability 10 %**
- **Thesis writing and independent research skills 10 %**

Four Fundamental Qualities

- Professionalism
  - Creative thinking and Problem-solving 40 %
  - Comprehensive Integration 40 %
- Interpersonal Relationship
  - Communication and Coordination 10 %
  - Teamwork 5 %
- Ethics
  - Honesty and Integrity 0 %
  - Self-Esteem and Self-reflection 0 %
- International Vision
  - Caring for Diversity 0 %
  - Interdisciplinary Vision 5 %

College Learning Goals

- Ethics/Corporate Social Responsibility
- Global Knowledge/Awareness
- Communication
- Analytical and Critical Thinking

Department Learning Goals

- **Information Technologies and System Development Capabilities**
- **Internet Marketing Management Capabilities**
- **Research capabilities**

Syllabus

Week	Date	Subject/Topics
1	2025/09/10	Introduction Sustainability and ESG Data Analytics
2	2025/09/17	Environmental, Social, and Governance (ESG) in Net-Zero Digital Transformation
3	2025/09/24	Data Science for Sustainability and ESG
4	2025/10/01	Case Study on Sustainability and ESG Data Analytics I
5	2025/10/08	Web 3.0 and Big Data Analysis in Fintech, Green and Sustainable Finance
6	2025/10/15	ESG Data Gathering, Analysis, and Visualization

Syllabus

Week	Date	Subject/Topics
7	2025/10/22	NVIDIA Building RAG Agents with LLMs Part I: LLM Services and AI Foundation Models
8	2025/10/29	Self-Learning
9	2025/11/05	Midterm Project Report
10	2025/11/12	NVIDIA Building RAG Agents with LLMs Part II: Document Loading, Chunking, and Embeddings
11	2025/11/19	NVIDIA Building RAG Agents with LLMs Part III: Retrieval-Augmented Generation with Vector Stores and RAG Evaluation

Syllabus

Week	Date	Subject/Topics
12	2025/11/26	Case Study on Sustainability and ESG Data Analytics II
13	2025/12/03	Artificial Intelligence of things (AIoT) in ESG and Sustainability Applications
14	2025/12/10	Generative AI for ESG Rating and Reporting Generation
15	2025/12/17	Final Project Report I
16	2025/12/24	Final Project Report II

Course and Teaching Features

1. Combine Web3.0 to introduce basic concepts of big data analysis, research topics, and practical operations.
2. Provide theories and tools for data integration and communication planning.
3. Apply to analyze data from various domains and present analysis results through data visualization.

Expected Social Impact:

1. Learn from data analysis, cultivating the ability to analyze responses when facing sustainable issues and risks.
2. Train talents who possess basic concepts of big data analysis, research topics, practical operations, and practical abilities in sustainable data analysis.

Innovative Teaching Strategies

1. USR (University Social Responsibility) Local Connection and Collaboration
2. Group Learning
3. Problem-Based Learning (PBL)
4. Thematic Teaching
5. Learning by Thinking Teaching Method

Evaluation Methods

- Individual Presentation 60 %
- Group Presentation 10 %
- Case Report 10 %
- Class Participation 10 %
- Assignment 10 %

Required Texts

- **Cino Robin Castelli, Cyril Shmatov (2022), Quantitative Methods for ESG Finance, Wiley**

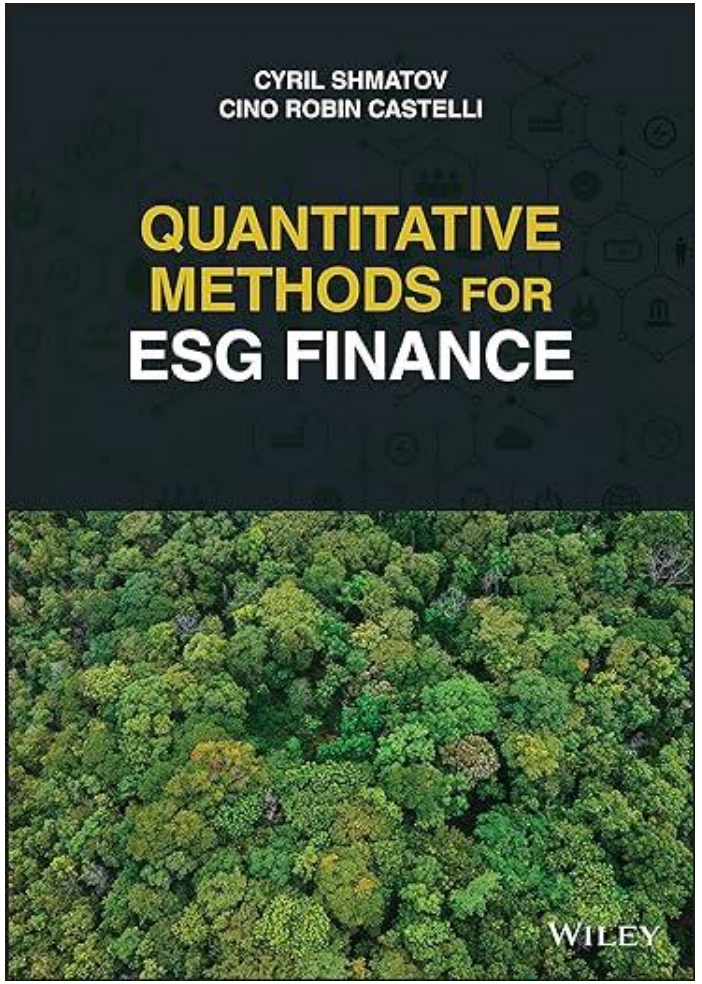
Reference Books

1. Simon Thompson (2023), Green and Sustainable Finance: Principles and Practice in Banking, Investment and Insurance, 2nd Edition, Kogan Page.
2. Chrissa Pagitsas (2023), Chief Sustainability Officers At Work: How CSOs Build Successful Sustainability and ESG Strategies, Apress.
3. Hariom Tatsat, Sahil Puri, Brad Lookabaugh (2020), Machine Learning and Data Science Blueprints for Finance: From Building Trading Strategies to Robo-Advisors Using Python, O'Reilly Media
4. 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.
5. Numa Dhamani and Maggie Engler (2024), Introduction to Generative AI, Manning.
6. 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.
7. Thomas R. Caldwell (2025), The Agentic AI Bible: The Complete and Up-to-Date Guide to Design, Build, and Scale Goal-Driven, LLM-Powered Agents that Think, Execute and Evolve, Independently published.

Other References

1. **GRI (Global Report Initiative):** https://www.globalreporting.org/
2. **CDP (Carbon Disclosure Project):** https://www.cdp.net/
3. **SASB (Sustainability Accounting Standards Board):** https://sasb.org/
4. **ISSB (International Sustainability Standards Board):** https://www.ifrs.org/groups/international-sustainability-standards-board/
5. **TCFD (Task Force on Climate-related Financial Disclosures):** https://www.fsb-tcfd.org/
6. **Research Papers**

Cino Robin Castelli, Cyril Shmatov (2022), Quantitative Methods for ESG Finance, Wiley



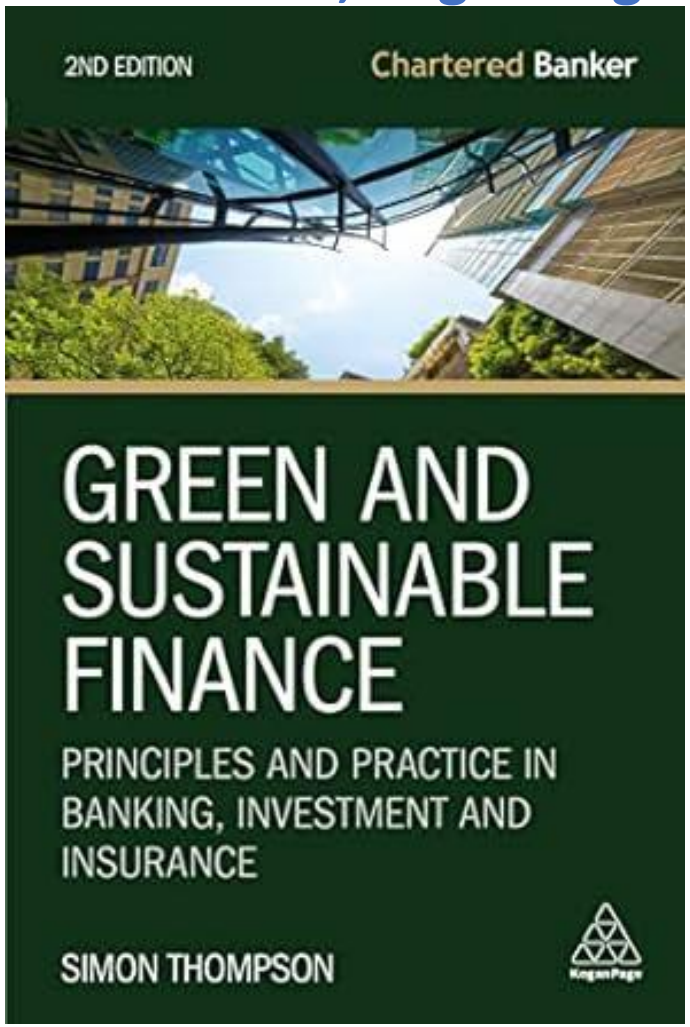
Source: https://www.amazon.com/Quantitative-Methods-Finance-Robin-Castelli/dp/1119903807/

Simon Thompson (2023),

Green and Sustainable Finance:

Principles and Practice in Banking, Investment and Insurance,

2nd Edition, Kogan Page.



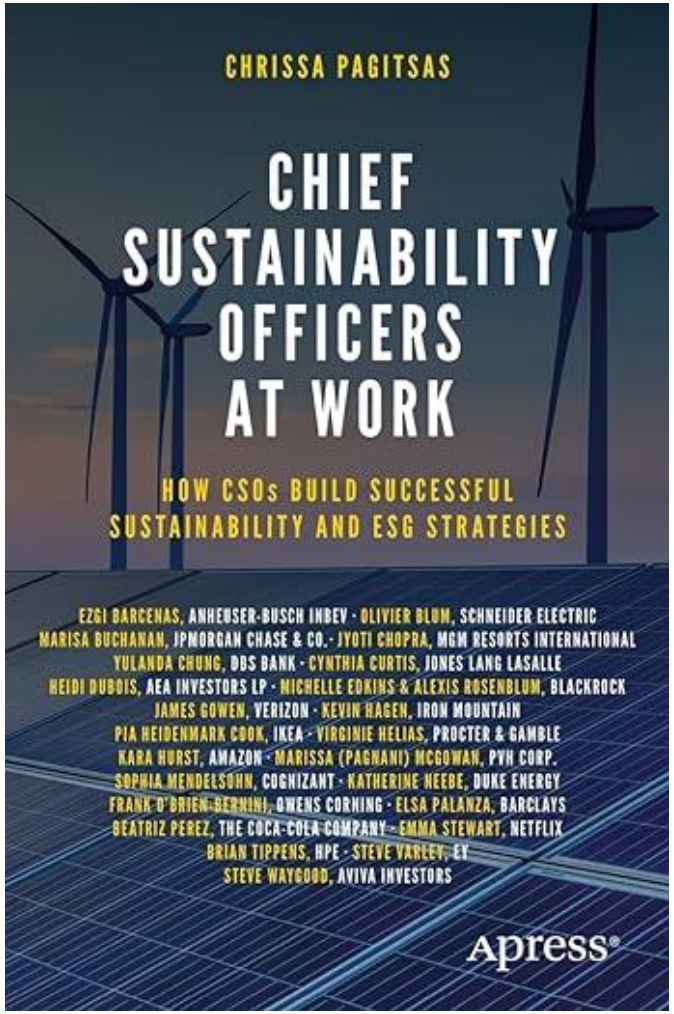
Source: https://www.amazon.com/Green-Sustainable-Finance-Principles-Investment/dp/1398609242/

Chrissa Pagitsas (2023),

Chief Sustainability Officers At Work:

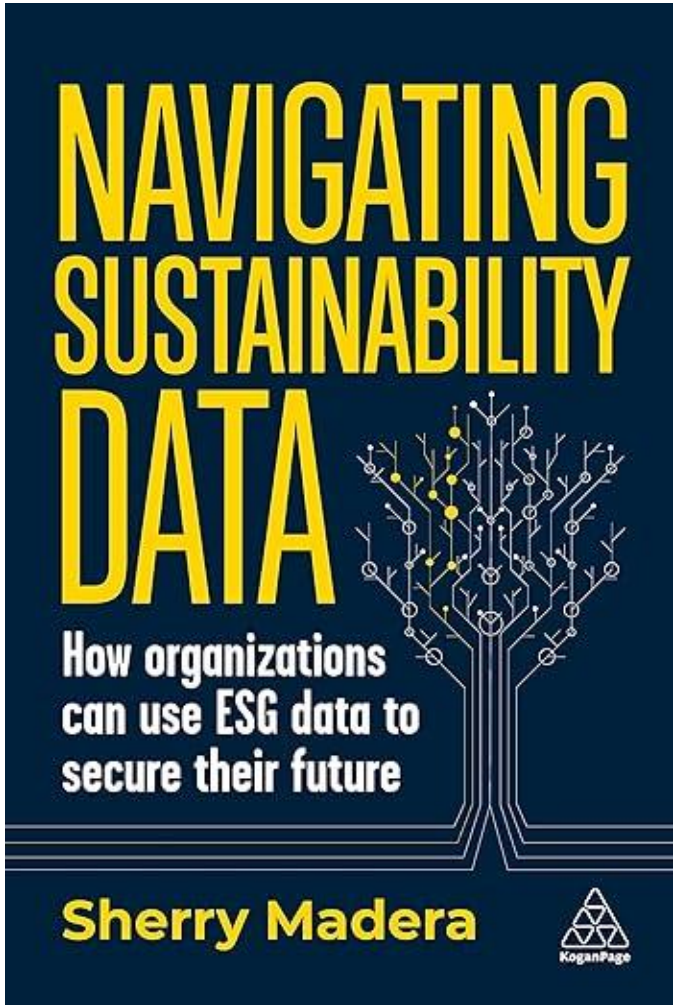
How CSOs Build Successful Sustainability and ESG Strategies,

Apress.



Source: https://www.amazon.com/Chief-Sustainability-Officers-Work-Successful/dp/1484278658/

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



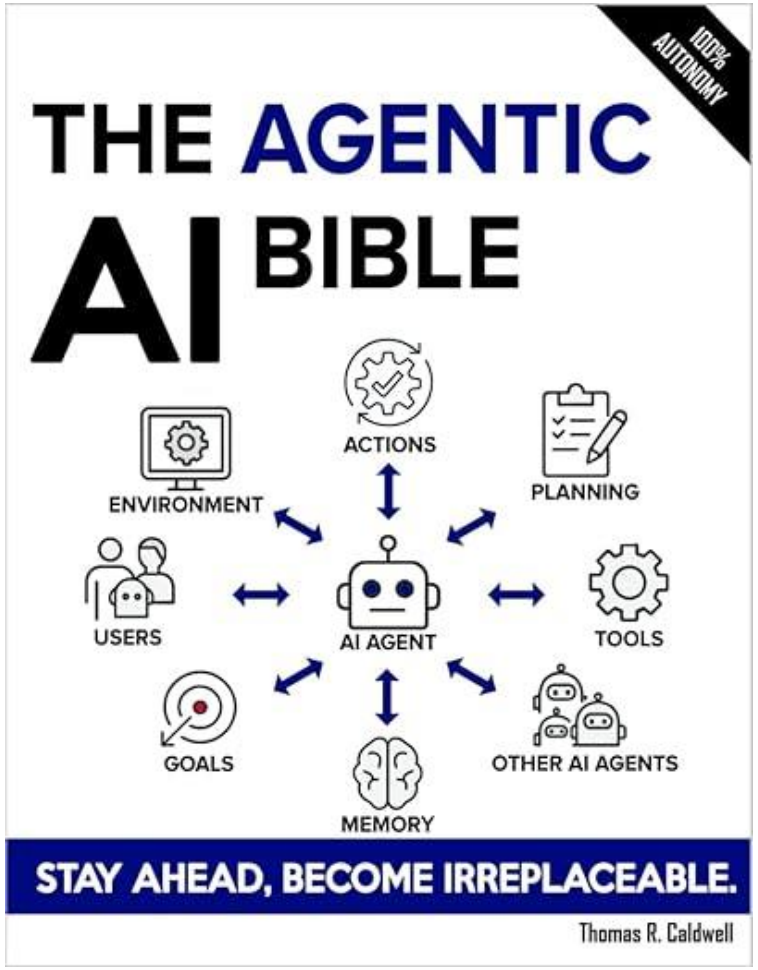
Source: https://www.amazon.com/Navigating-Sustainability-Data-Organizations-Secure/dp/1398612243/

Thomas R. Caldwell (2025),

The Agentic AI Bible:

The Complete and Up-to-Date Guide to Design, Build, and Scale Goal-Driven, LLM-Powered Agents that Think, Execute and Evolve,

Independently published

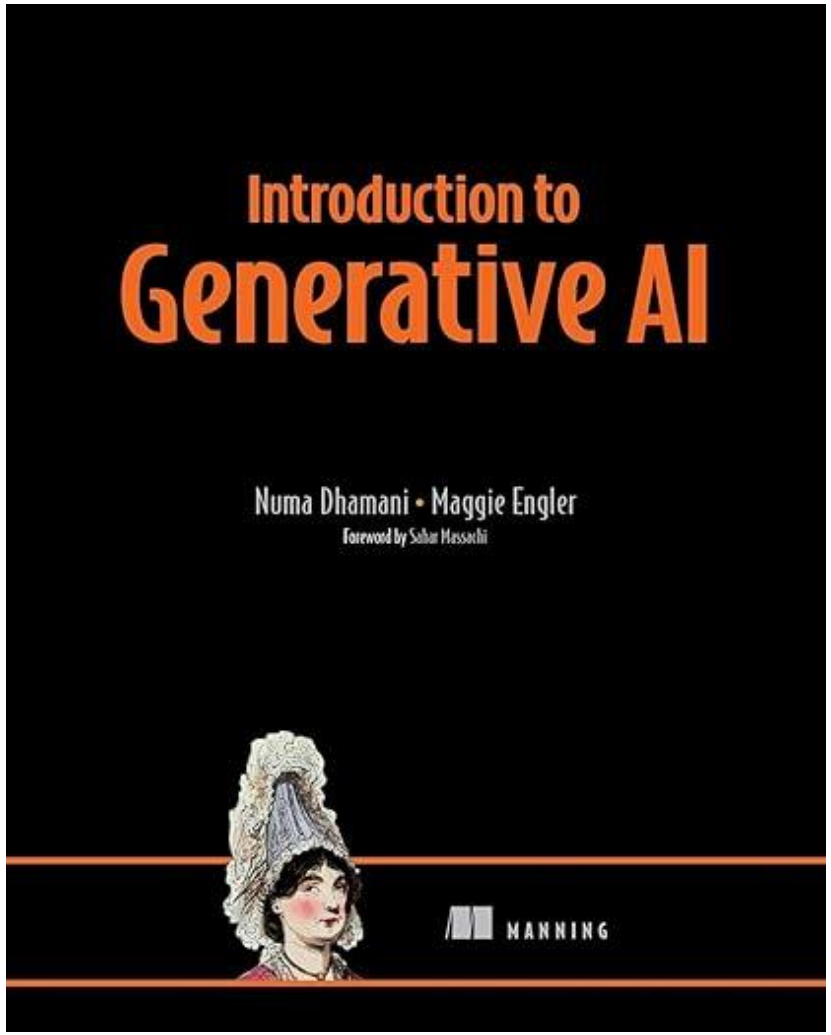


Source: https://www.amazon.com/Agentic-Bible-Up-Date-Goal-Driven/dp/B0FL21R86Q

Numa Dhamani and Maggie Engler (2024),

Introduction to Generative AI,

Manning



Source: Numa Dhamani and Maggie Engler (2024), Introduction to Generative AI, Manning
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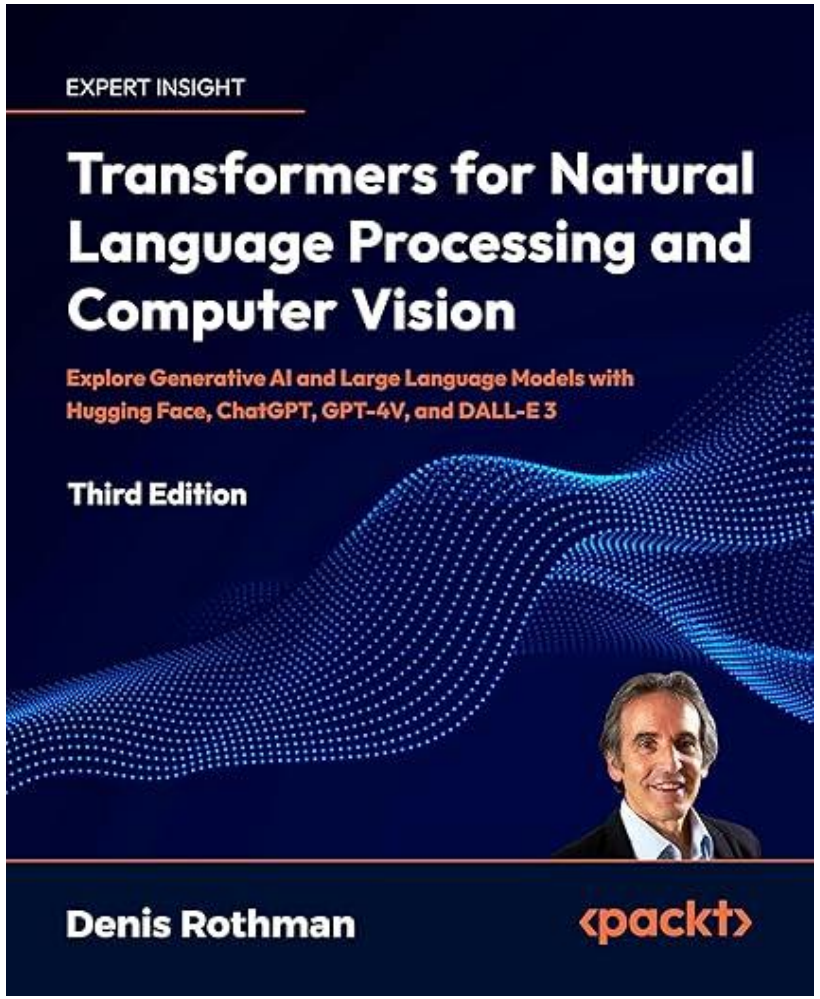


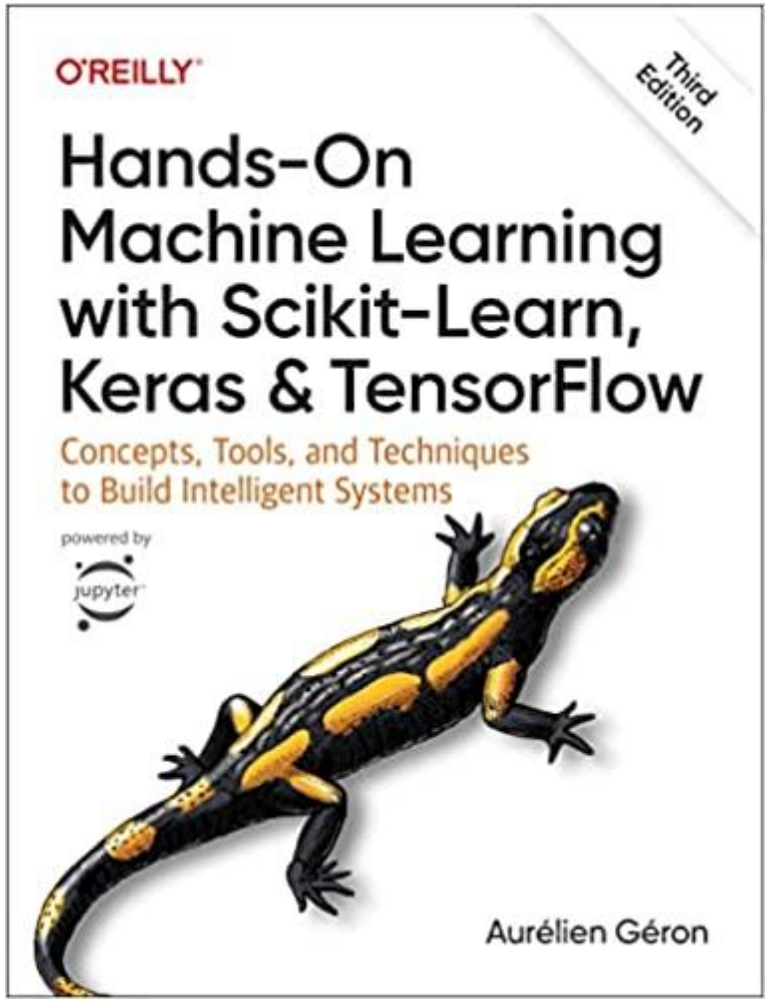
Source: https://www.amazon.com/Transformers-Natural-Language-Processing-Computer/dp/1805128728

Aurélien Géron (2022),

Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow:

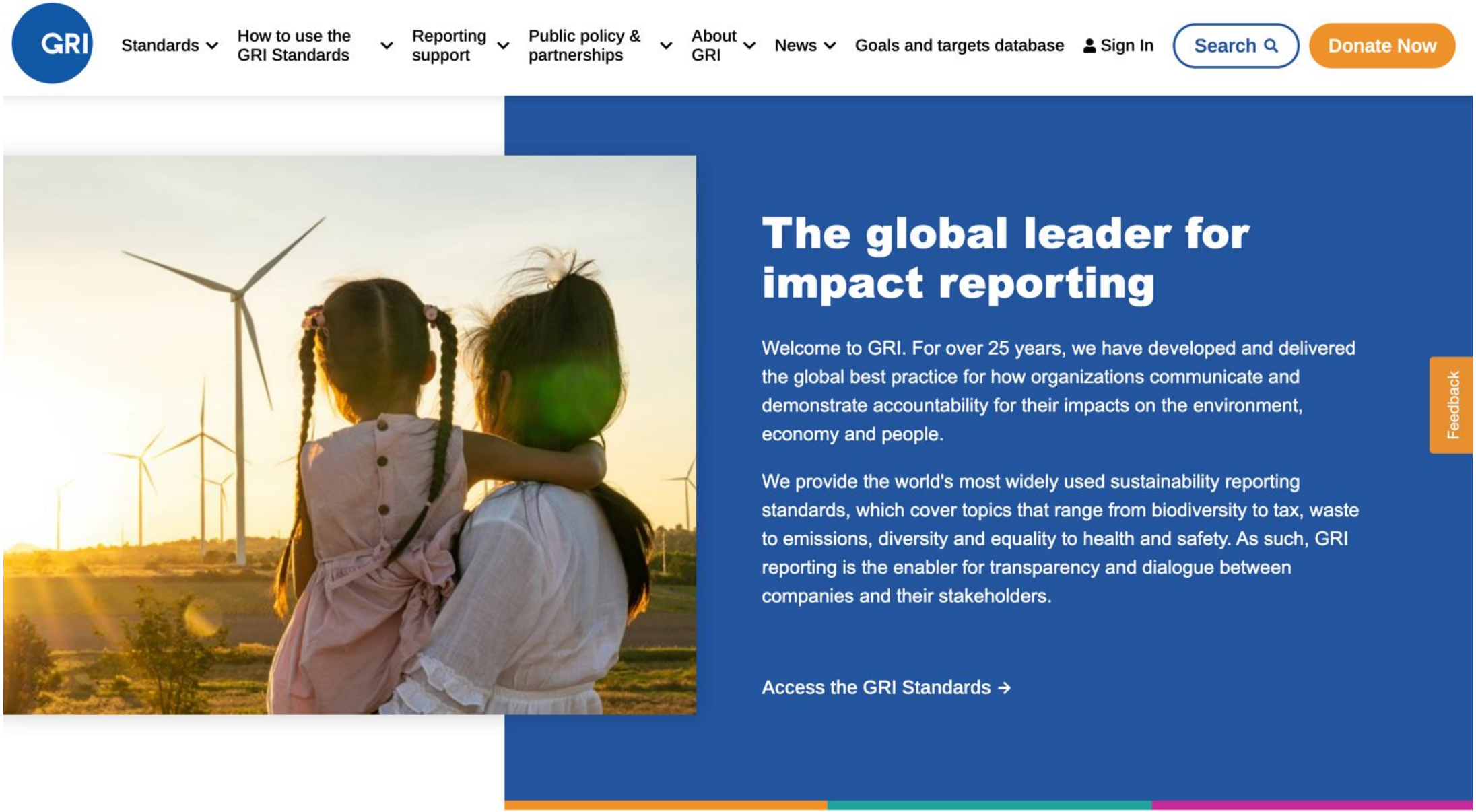
Concepts, Tools, and Techniques to Build Intelligent Systems,

3rd Edition, O'Reilly Media.



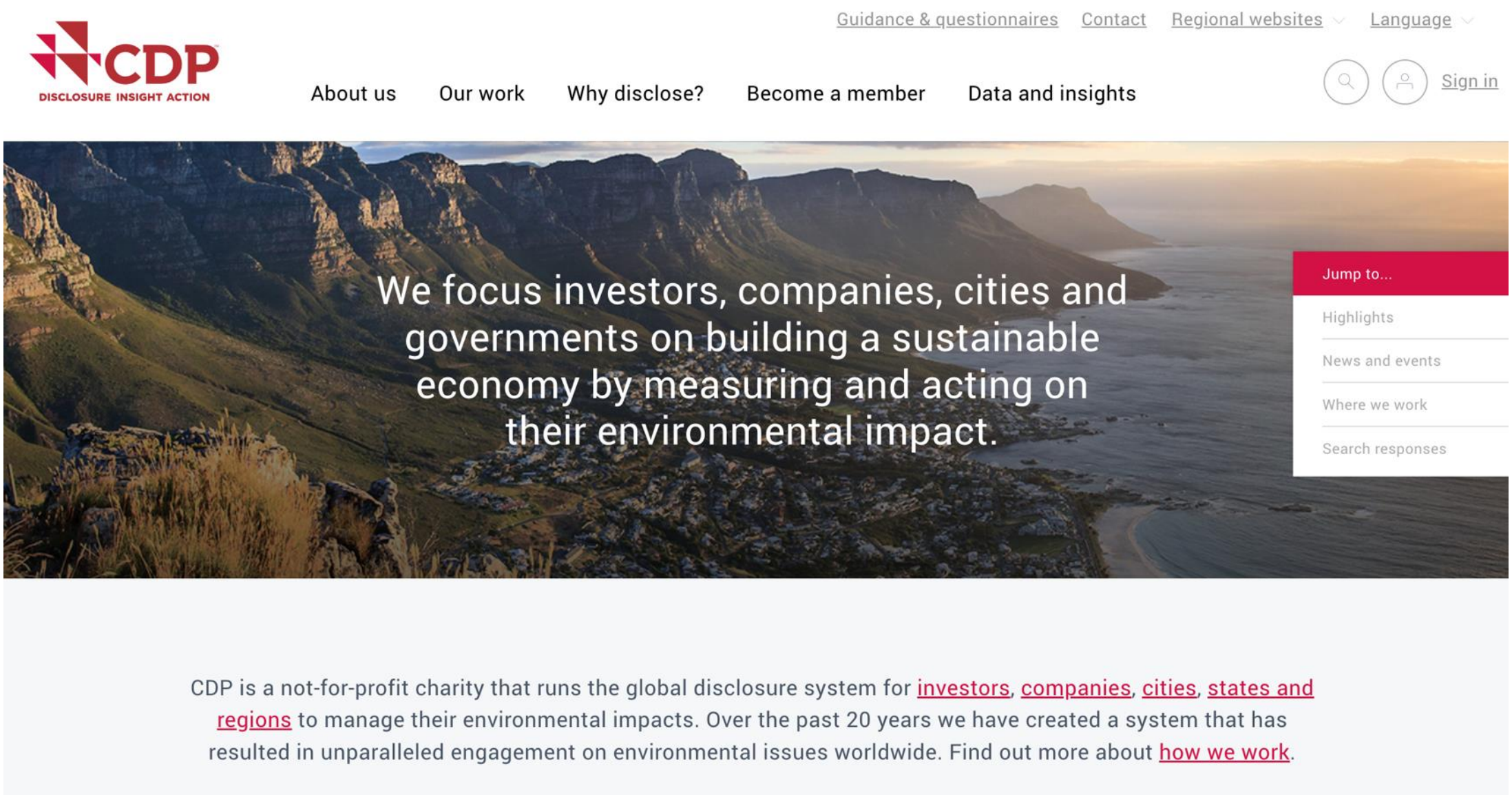
Source: https://www.amazon.com/Hands-Machine-Learning-Scikit-Learn-TensorFlow/dp/1098125975

GRI (Global Report Initiative)



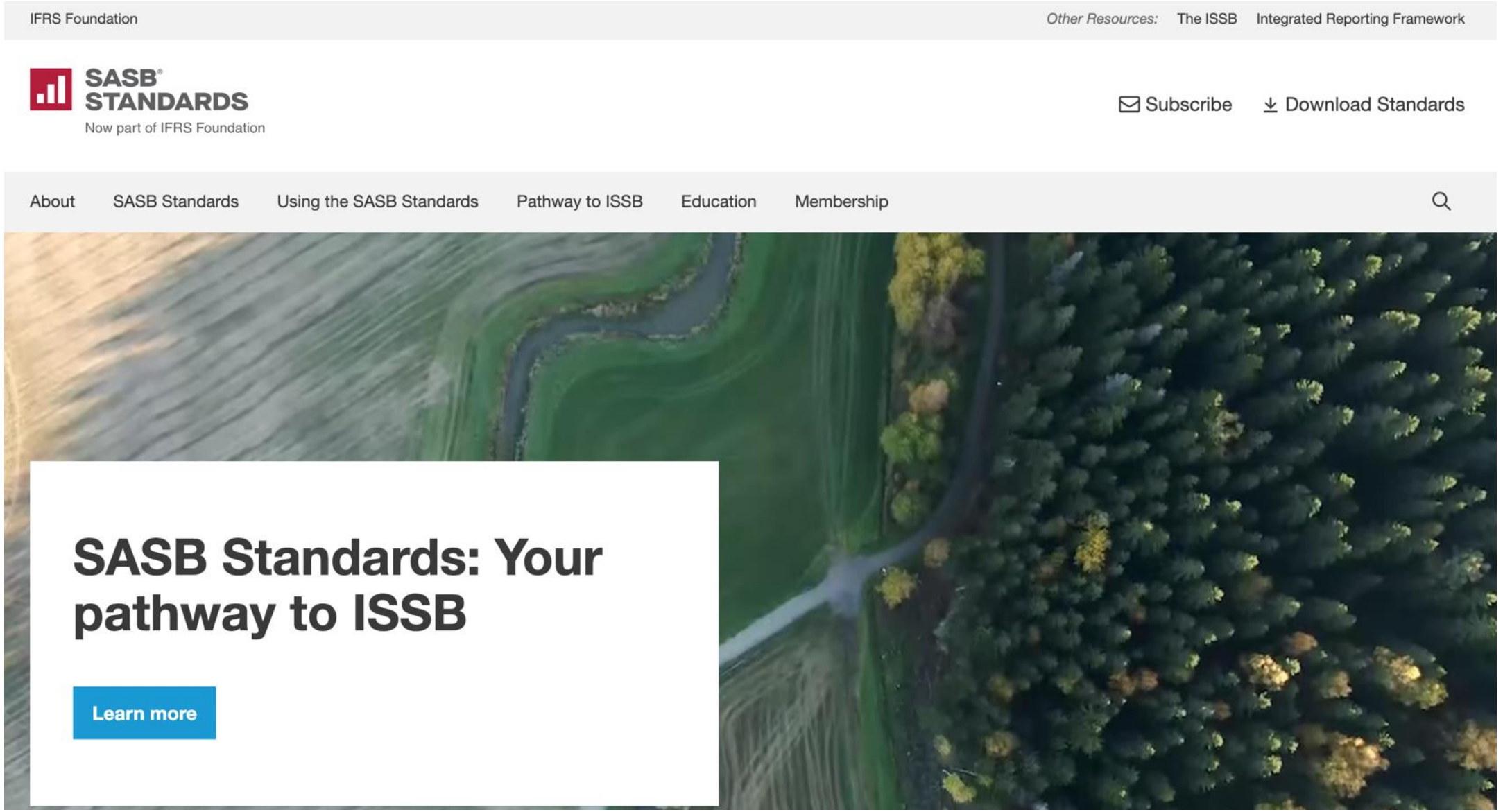
https://www.globalreporting.org/

CDP (Carbon Disclosure Project)



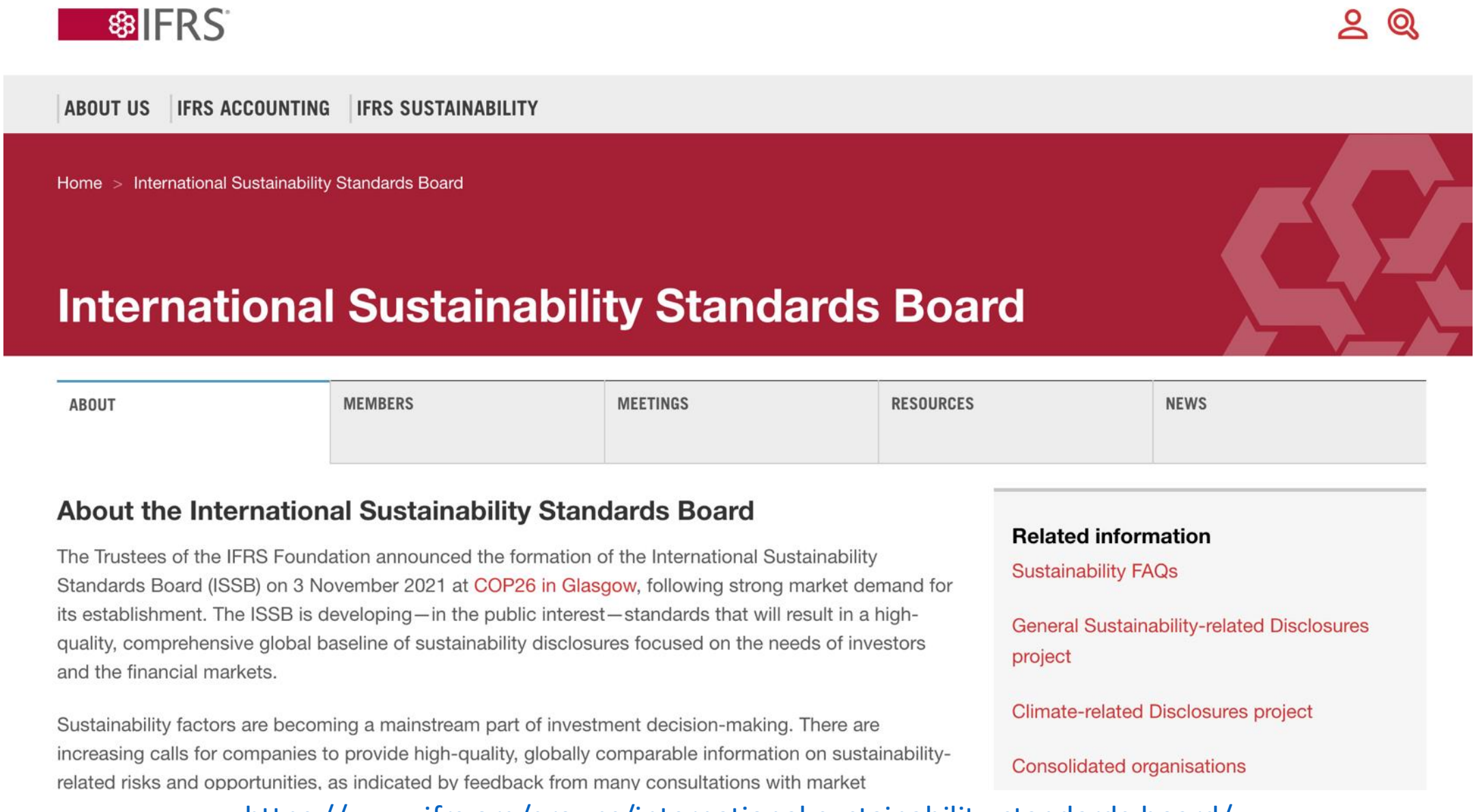
https://www.cdp.net/

SASB (Sustainability Accounting Standards Board)



https://sasb.org/

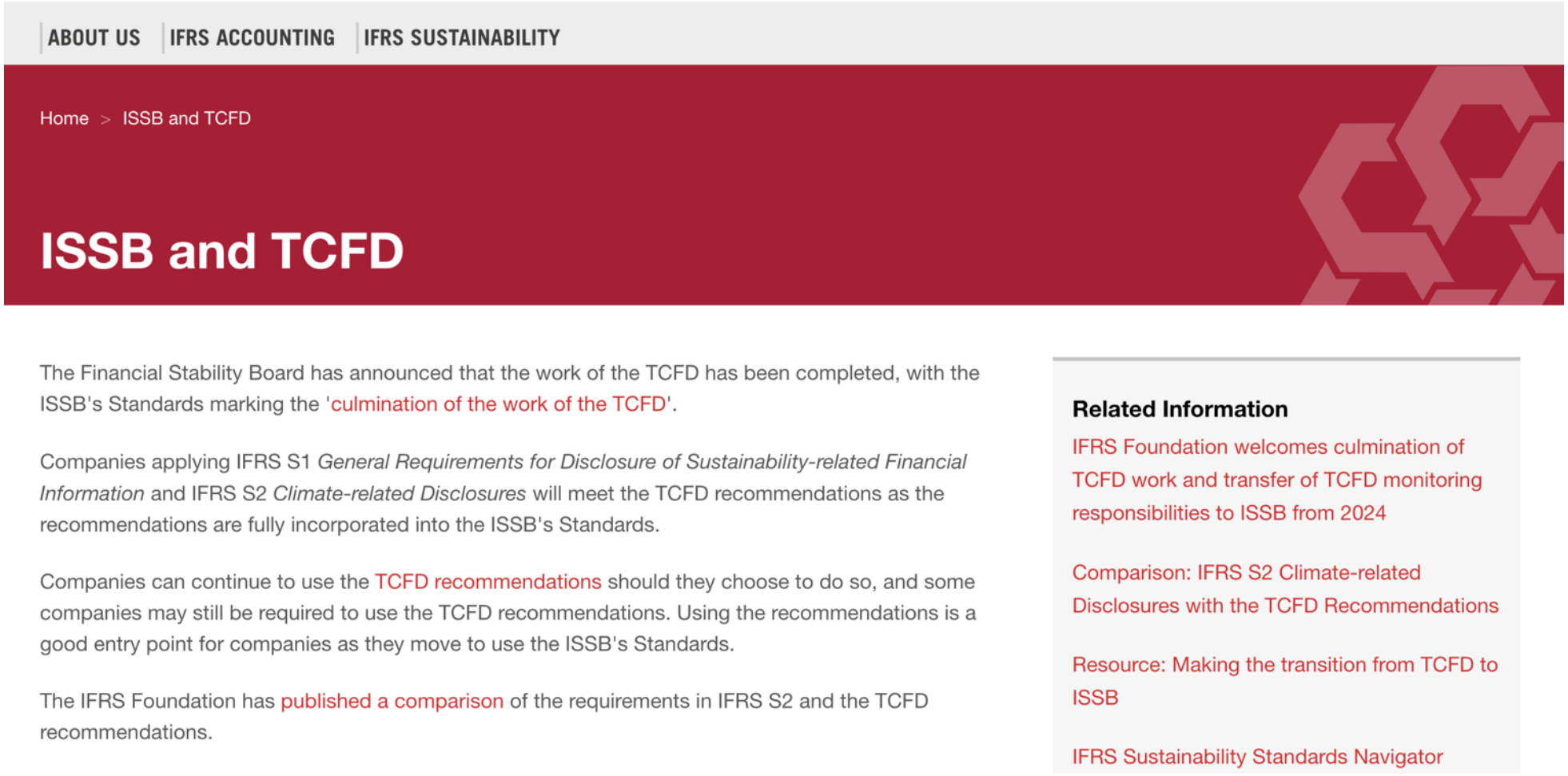
ISSB (International Sustainability Standards Board)



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/

CSRD
(Corporate Sustainability Reporting Directive)

Corporate sustainability reporting

EU rules require large companies and listed companies to publish regular reports on the social and environmental risks they face, and on how their activities impact people and the environment.

PAGE CONTENTS

What the EU is doing and why

EU law requires companies above a certain size to disclose information on what they see as the risks and opportunities arising from social and environmental issues, and on the impact of their activities on people and the environment.

This helps investors, civil society organisations, consumers and other stakeholders to evaluate the sustainability performance of companies, as part of the European green deal.

The first companies subject to the Corporate Sustainability Reporting Directive (CSRD) have to apply the new rules for the first time in the 2024 financial year, for reports published in 2025.

Companies subject to the CSRD have to report according to European Sustainability Reporting Standards (ESRS). The standards are developed in a draft form by the EFRAG, previously known as the European Financial Reporting Advisory Group, an independent body bringing together various different stakeholders.

https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

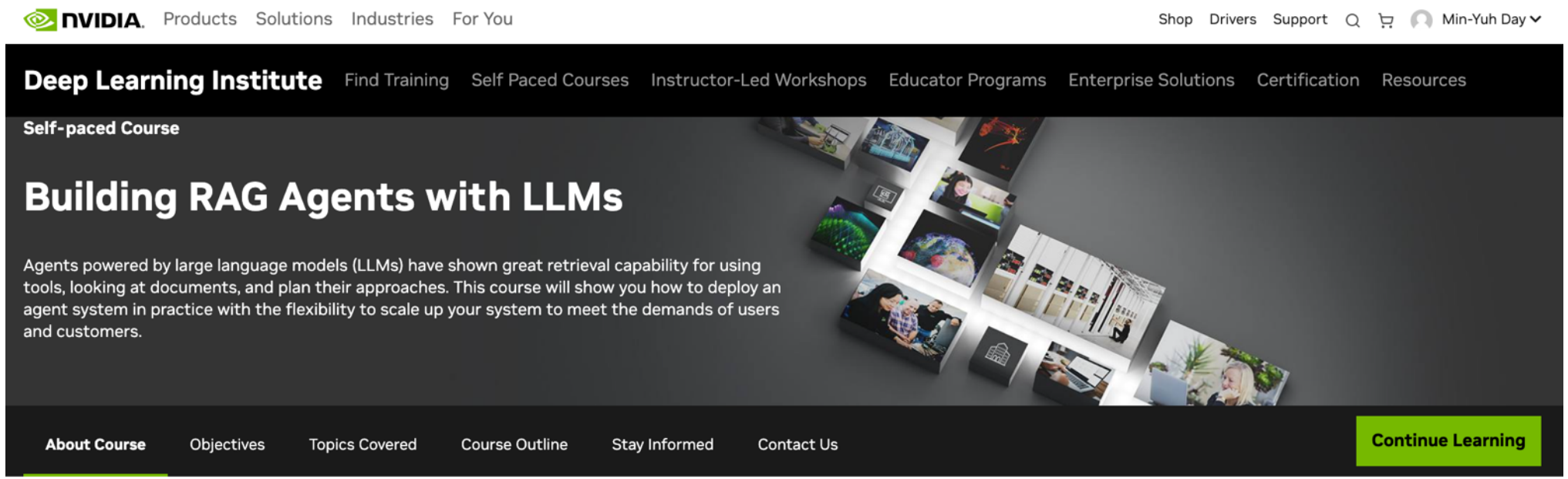
NVIDIA Developer Program

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

NVIDIA Deep Learning Institute (DLI)

https://learn.nvidia.com/

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

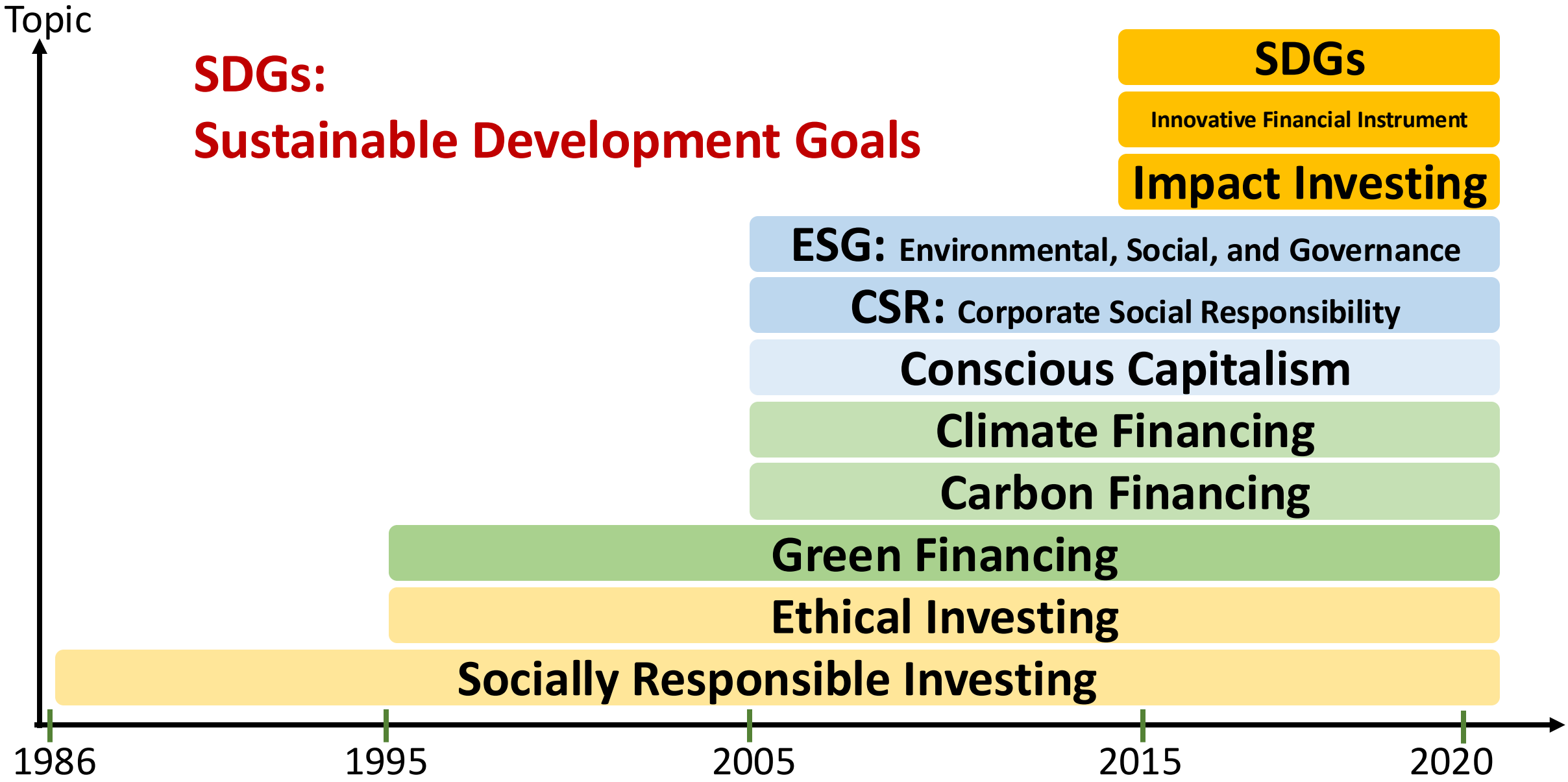
https://learn.nvidia.com/courses/course-detail?course_id=course-v1:DLI+S-FX-15+V1

Sustainability and ESG Data Analytics

Sustainable Development Goals (SDGs)

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

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) and 5P

Partnership

Peace

Prosperity

People

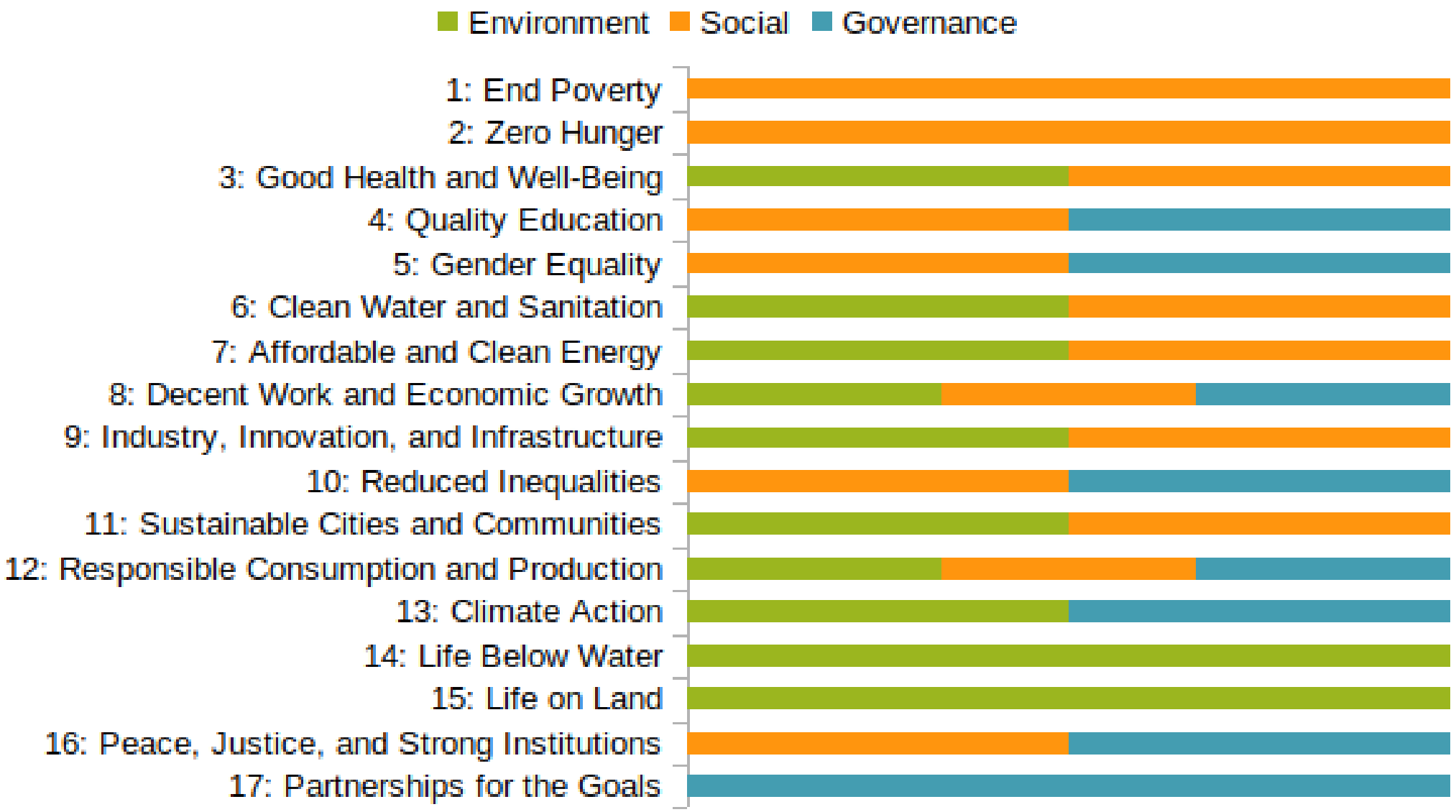
Planet

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.

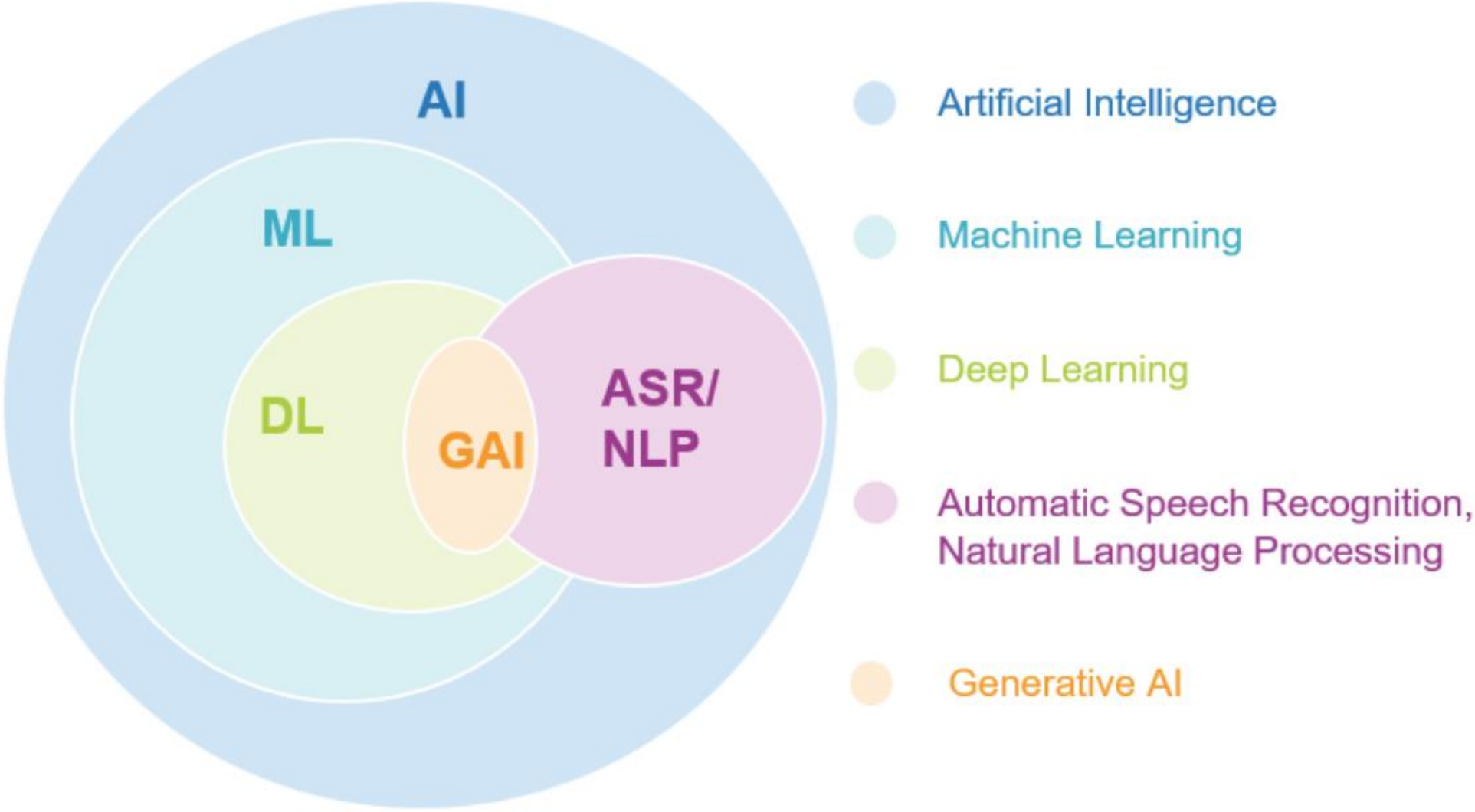
ESG to 17 SDGs



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

Agentic AI for ESG Applications

AI, ML, DL, 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).

Generative AI, Agentic AI, Physical AI

2012 AlexNet
Deep learning breakthrough

Perception AI
Speech recognition
Deep recommender systems
Medical imaging

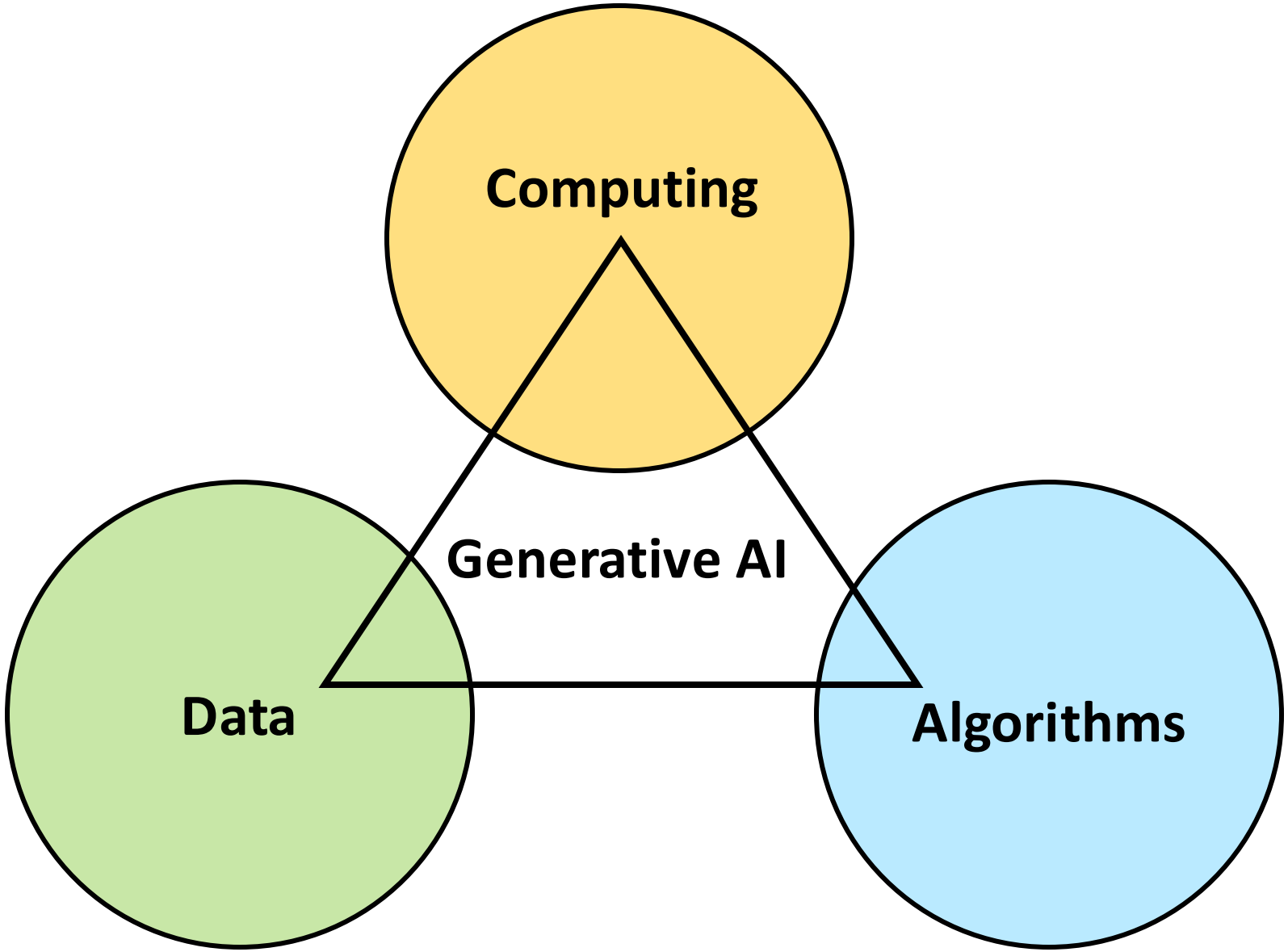
Generative AI
Digital marketing
Content creation

Agentic AI
Coding assistants
Customer service
Patient care

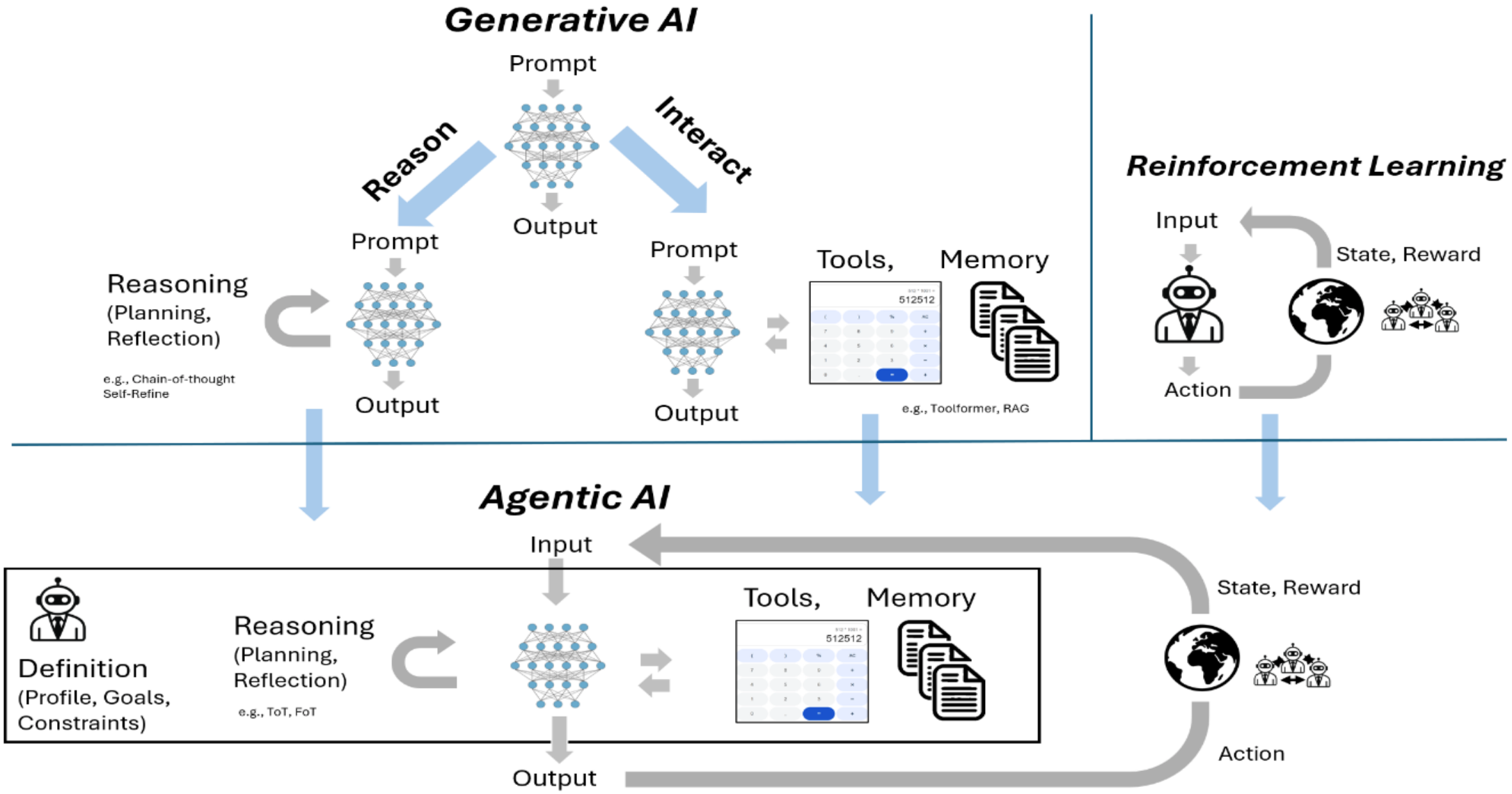
Physical AI
Self-driving cars
General robotics

Source: NVIDIA (2025), GTC March 2025 Keynote with NVIDIA CEO Jensen Huang, https://www.youtube.com/watch?v=_waPvOwL9Z8

Generative AI

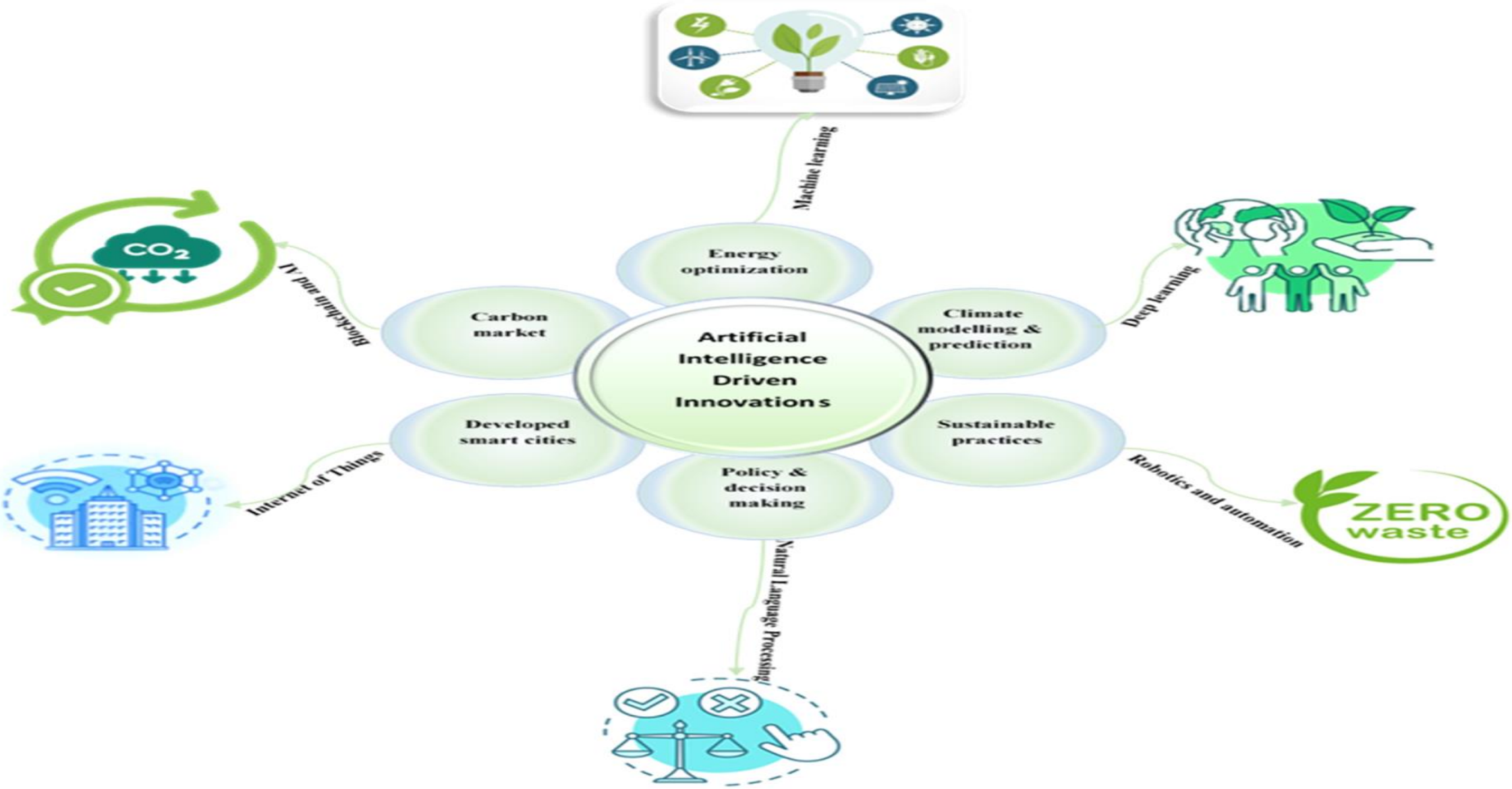


From Generative AI to Agentic AI



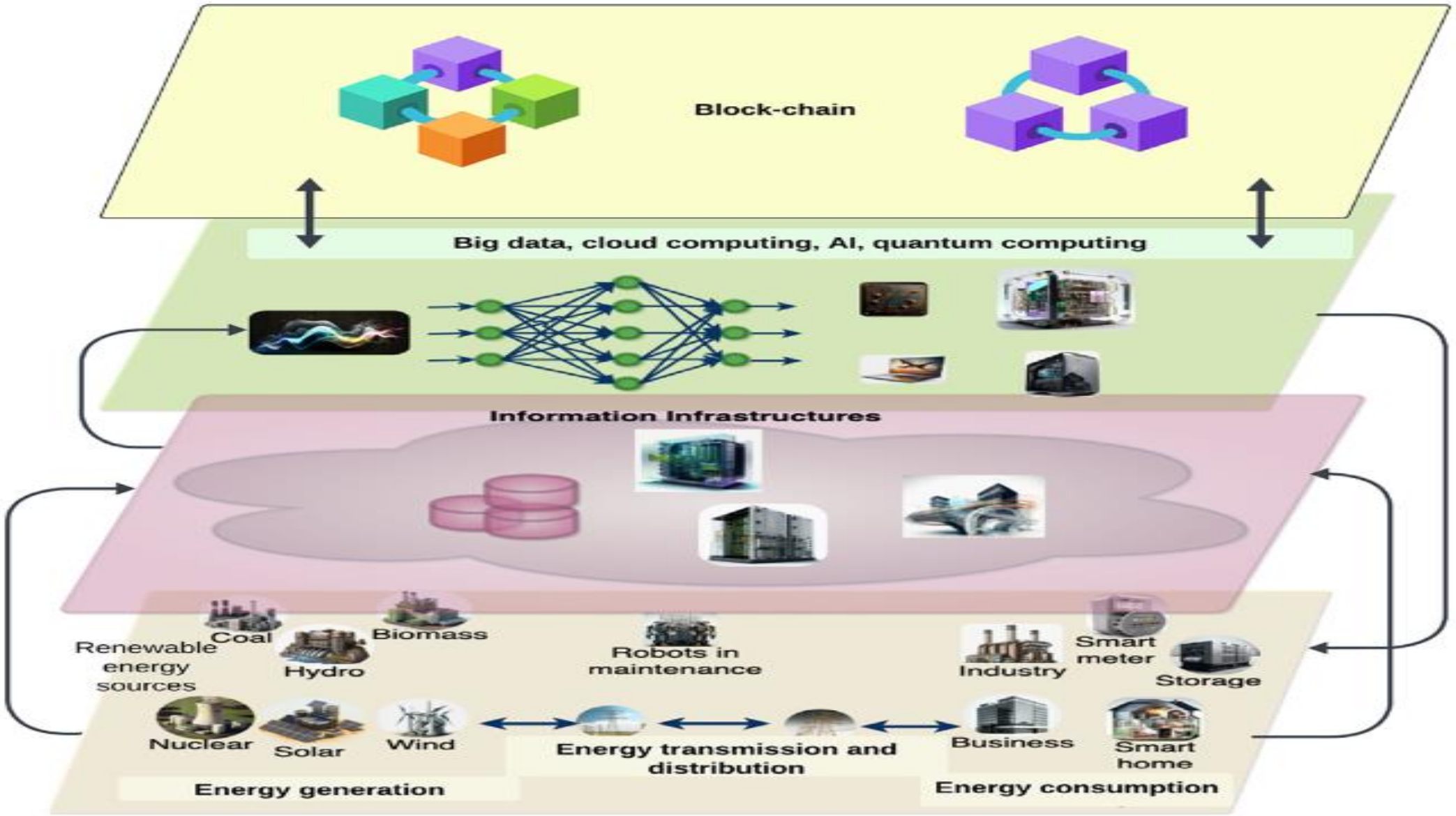
Source: Schneider, Johannes. "Generative to Agentic AI: Survey, Conceptualization, and Challenges." arXiv preprint arXiv:2504.18875 (2025).

AI Innovations for Net-Zero Transformation



Source: Olawade, D. B., Wada, O. Z., David-Olawade, A. C., Fapohunda, O., Ige, A. O., & Ling, J. (2024). Artificial intelligence potential for net zero sustainability: Current evidence and prospects. Next Sustainability, 4, 100041.

AI Technology for Net-Zero Energy Transition



Source: Ferdaus, M. M., Dam, T., Anavatti, S., & Das, S. (2024). Digital technologies for a net-zero energy future: A comprehensive review. Renewable and Sustainable Energy Reviews, 202, 114681.

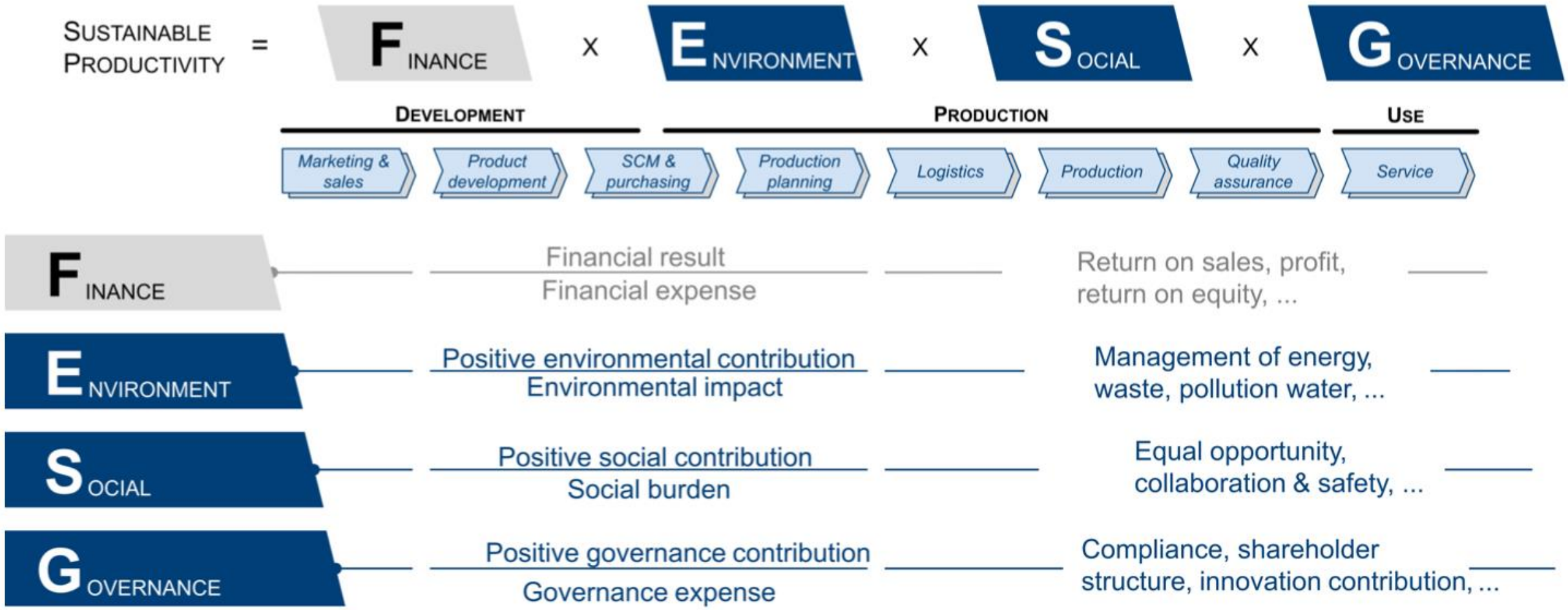
Net-Zero Transformation

- **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

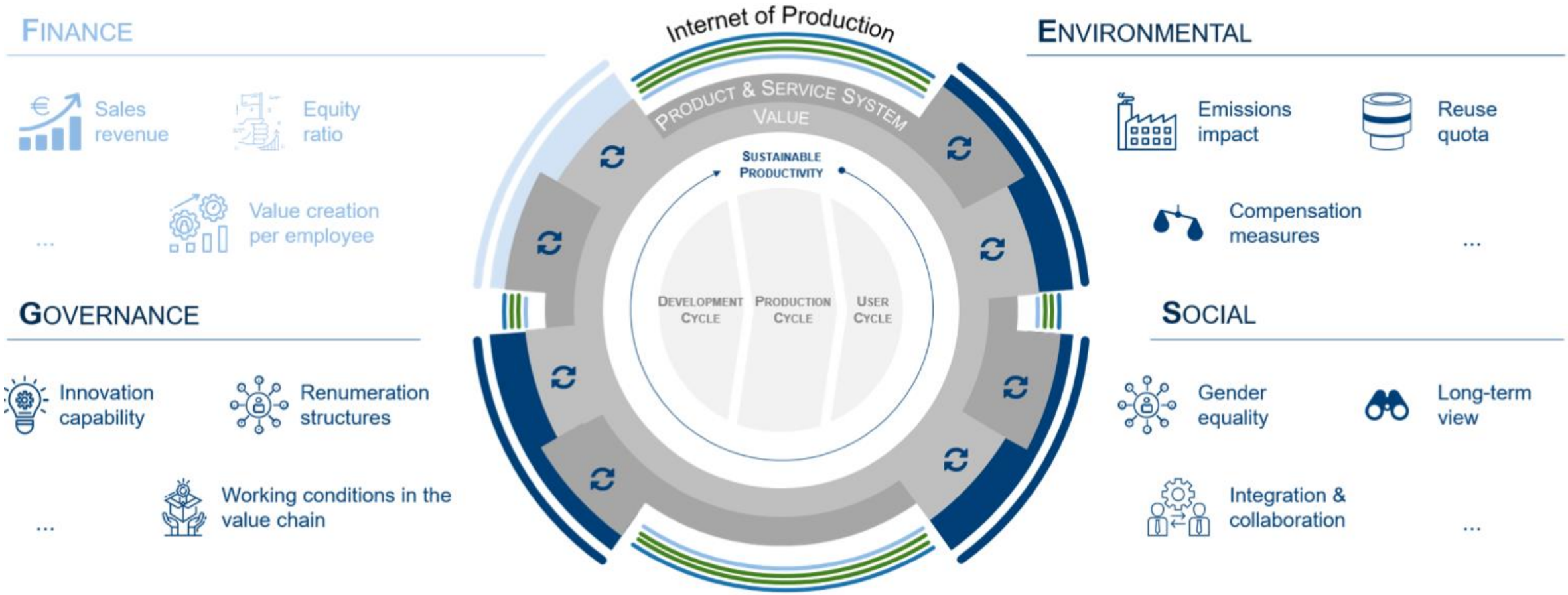
Source: https://www.pwc.com/us/en/services/esg/library/building-blocks-for-net-zero-transformation.html

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

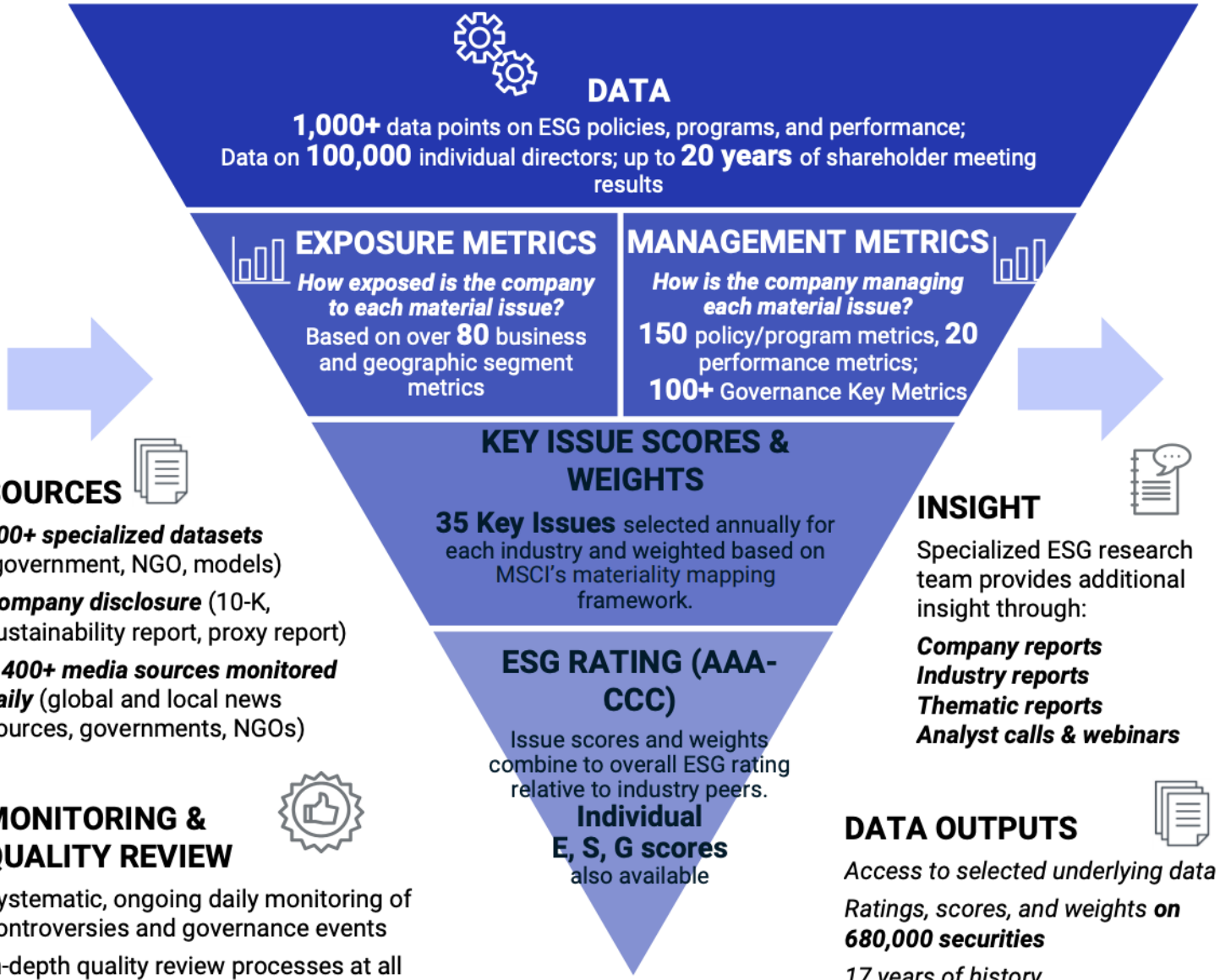


Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.

ESG Indexes

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

MSCI ESG Rating Framework



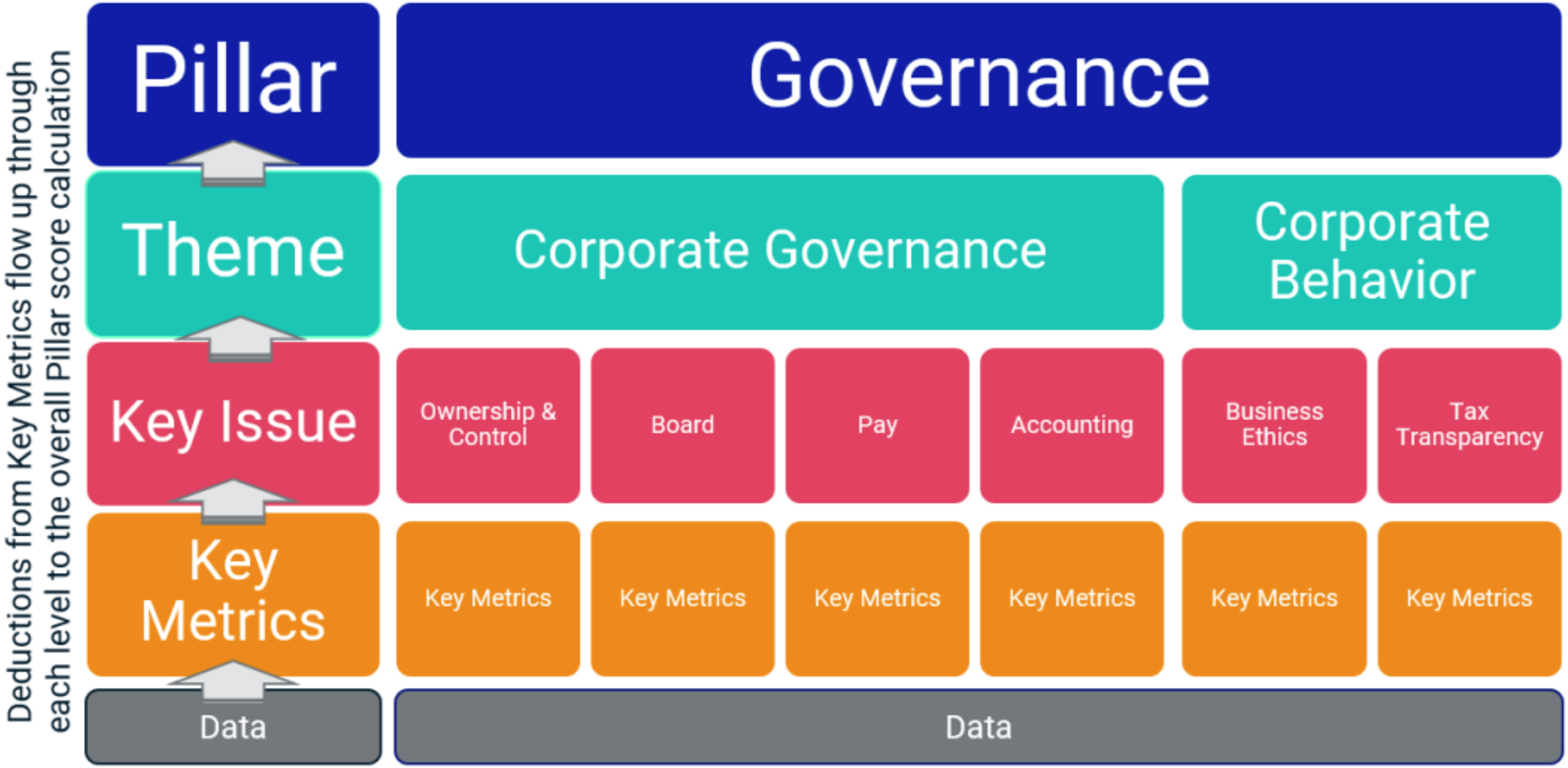
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

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	

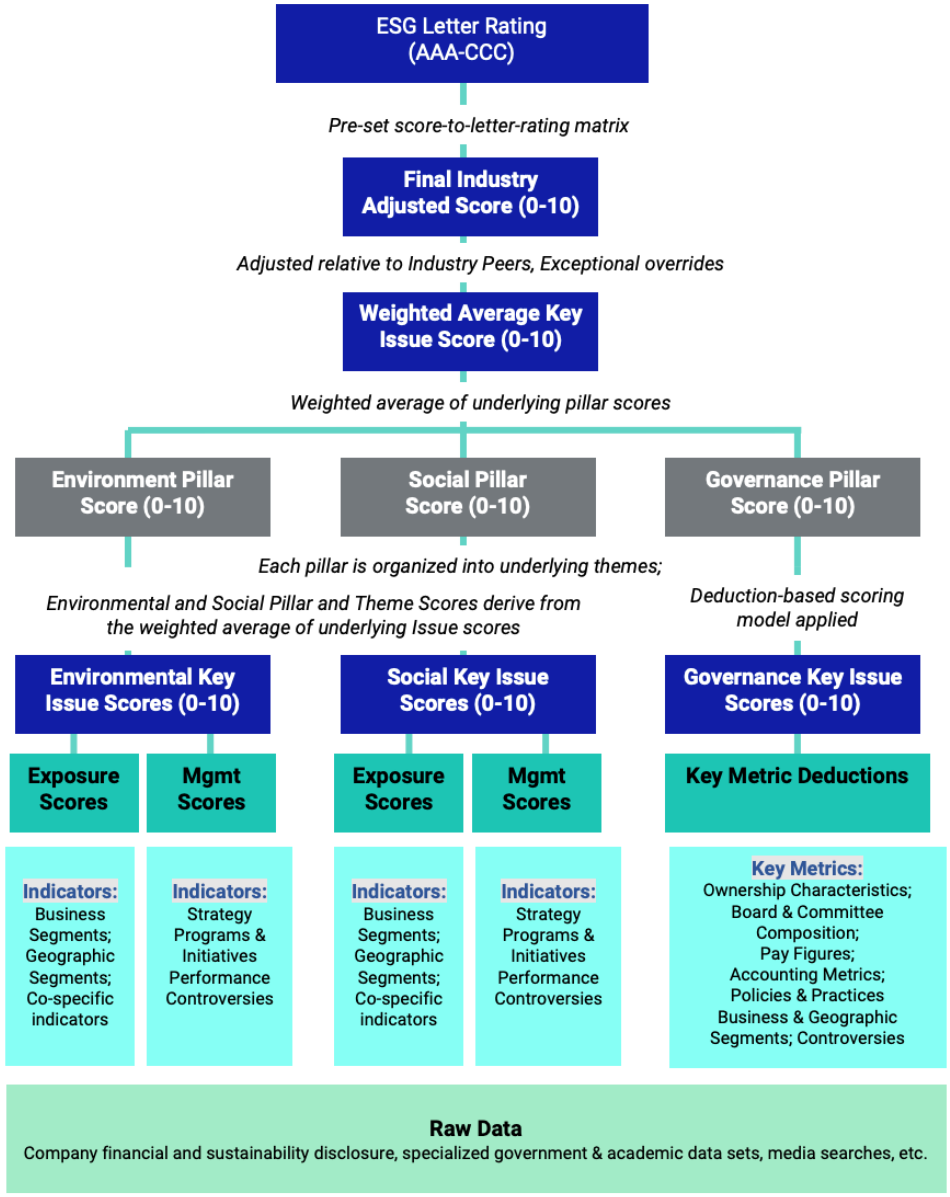
Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

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

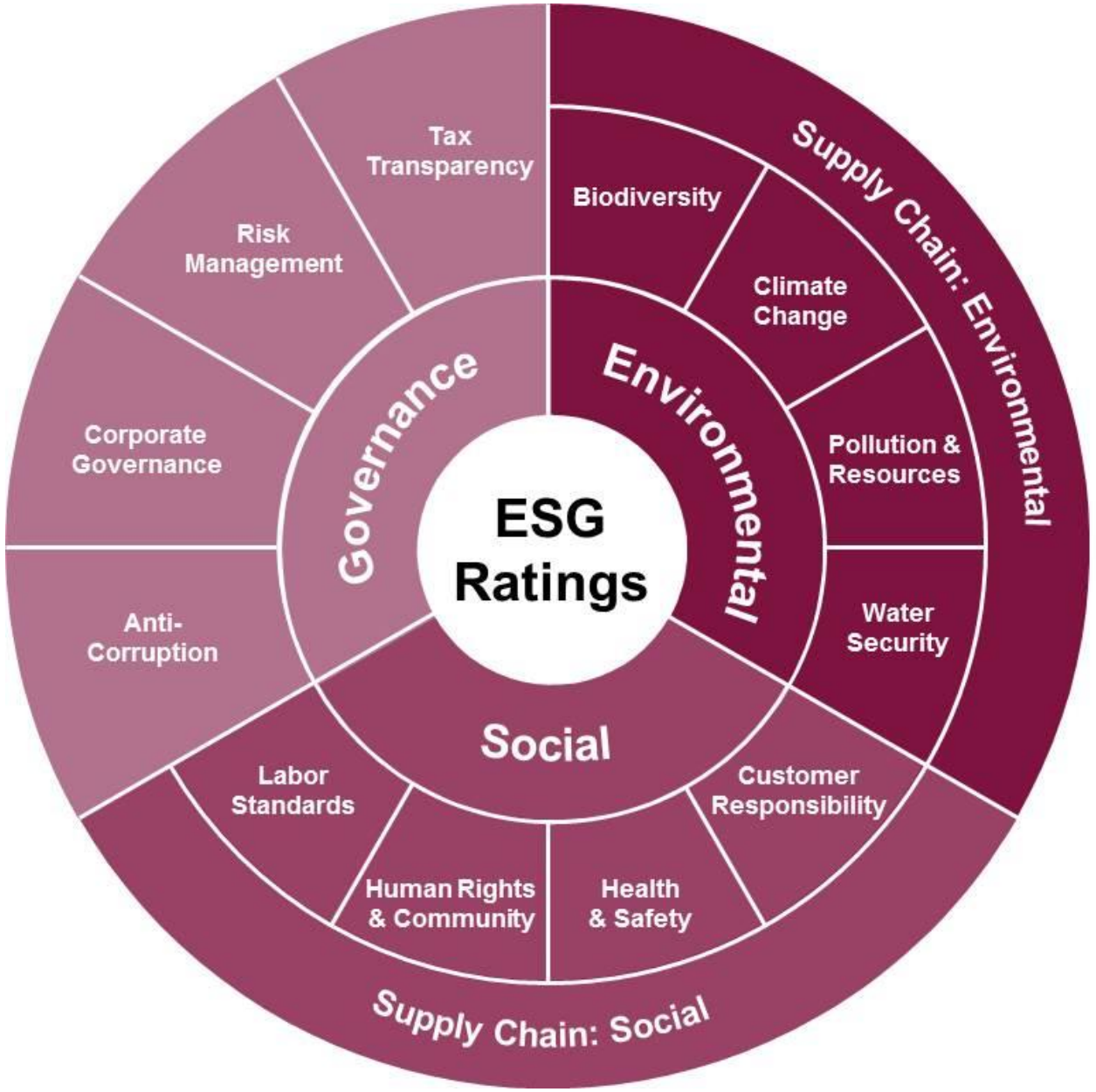
Weighted criteria scores
Adjusted for corporate ESG controversies where applicable

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
a Morningstar company

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

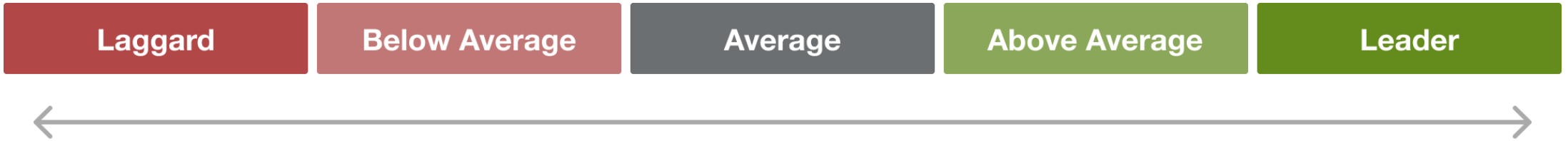
TruValue Labs

FACTSET

Truvalue ESG Ranks

Machine-based approach

- **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

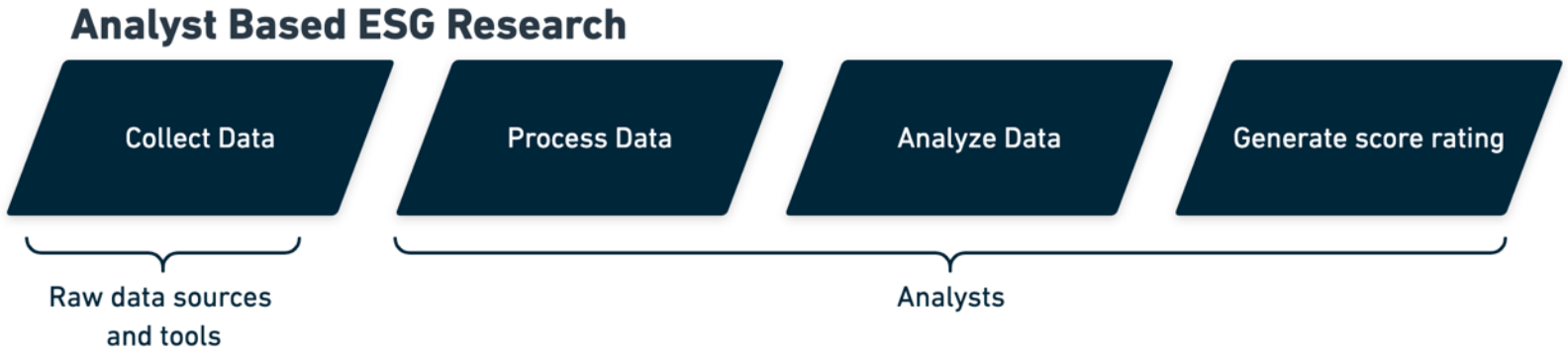
Truvalue Labs

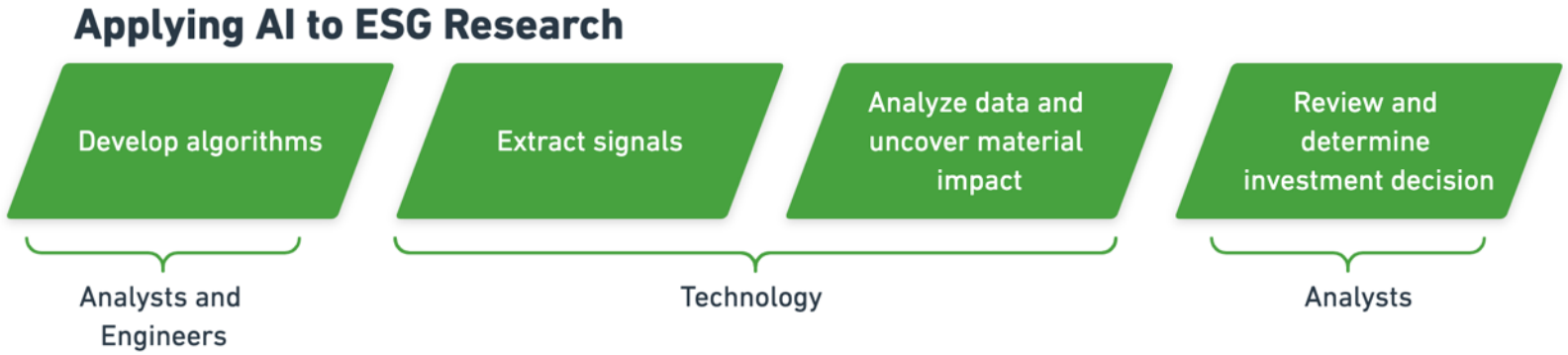
Analyst expertise at the beginning of the process produces consistent results

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

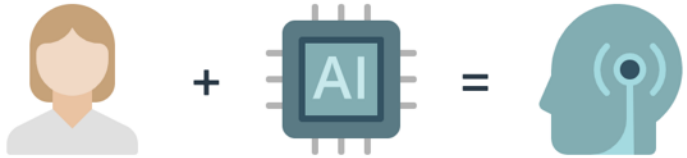
AI based ESG Research





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

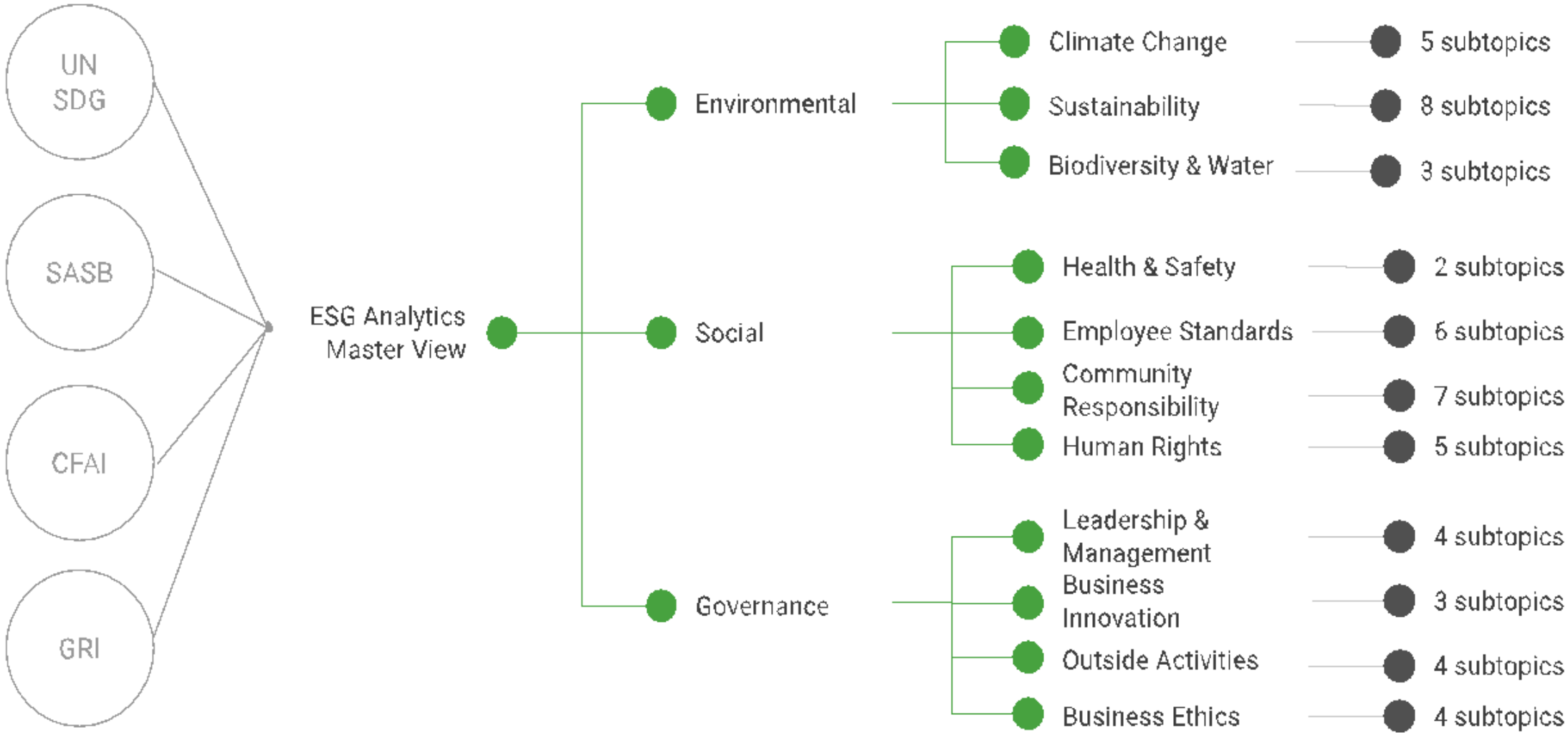
Combining analysts with AI creates gives you the full picture



ESG ANALYTICS
Invest where it matters.

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

ESG Analytics: NLP Taxonomy

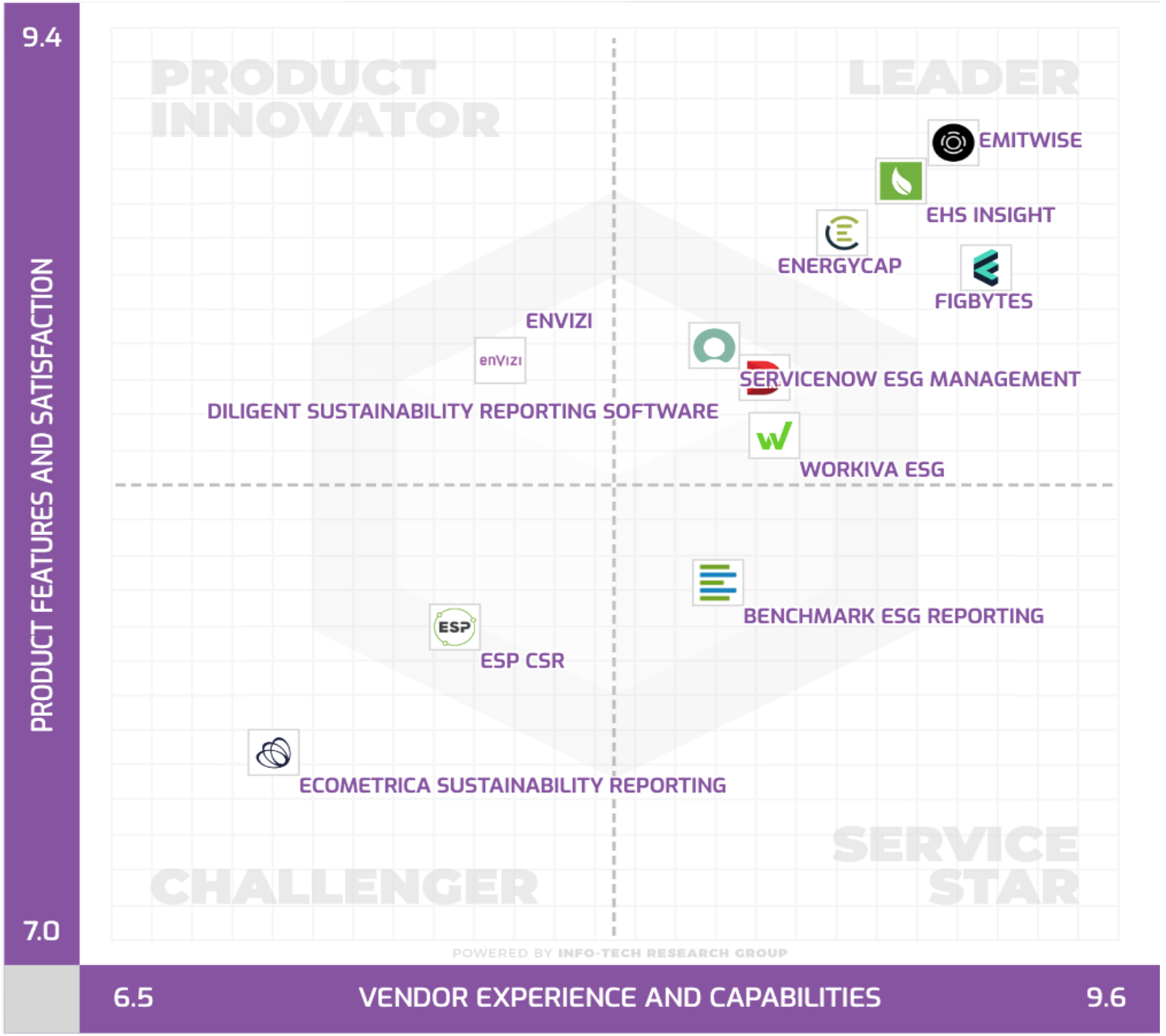


ESG ANALYTICS

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

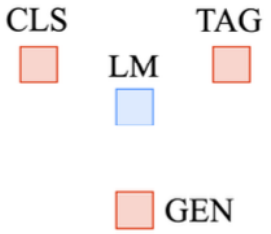
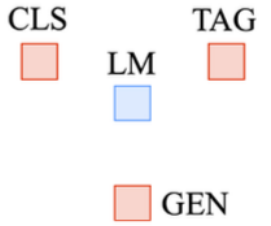
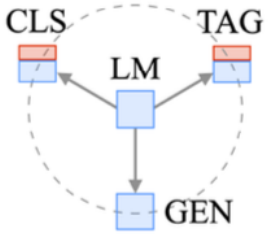
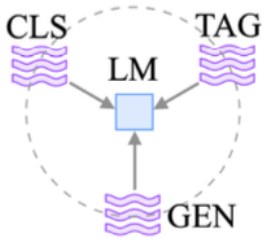
Top ESG Reporting Software

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

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.

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

LMArena Leaderboard

Rank (UB) ↑	Model ⇅	Score ⇅	95% CI (±) ⇅	Votes ⇅	Organization ⇅	License ⇅
1	gemini-2.5-pro	1455	±5	41,731	Google	Proprietary
1	claude-opus-4-1-20250805-thinking-16k	1451	±6	11,750	Anthropic	Proprietary
2	o3-2025-04-16	1444	±4	43,898	OpenAI	Proprietary
2	gpt-5-high	1442	±6	15,076	OpenAI	Proprietary
2	chatgpt-4o-latest-20250326	1441	±4	36,426	OpenAI	Proprietary
3	gpt-4.5-preview-2025-02-27	1439	±6	15,271	OpenAI	Proprietary
3	claude-opus-4-1-20250805	1438	±6	18,341	Anthropic	Proprietary
5	gpt-5-chat	1430	±6	11,808	OpenAI	Proprietary
6	qwen3-max-preview	1428	±7	8,781	Alibaba	Proprietary
8	grok-4-0709	1422	±5	21,446	xAI	Proprietary

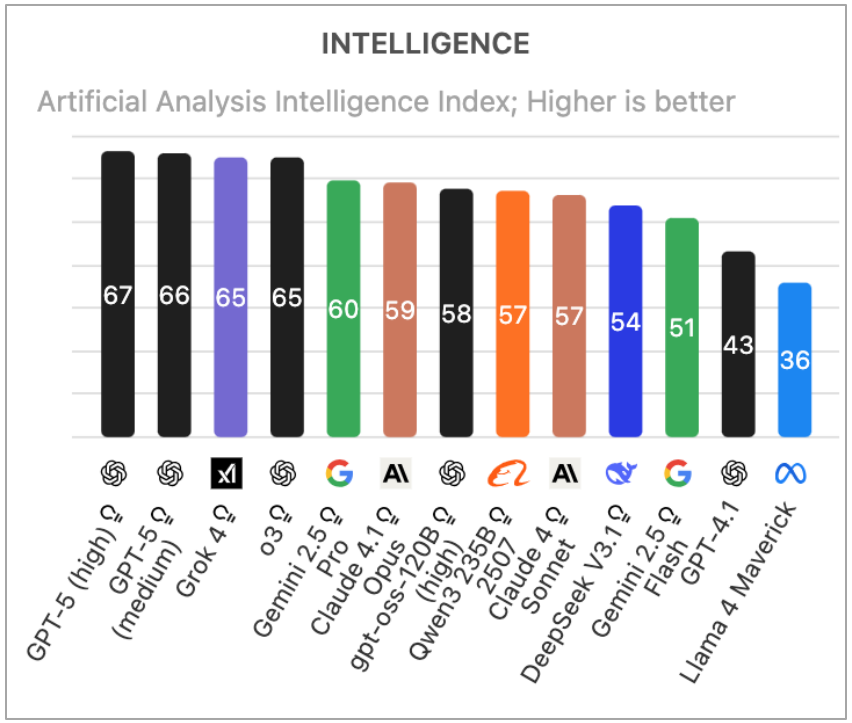
https://lmarena.ai/

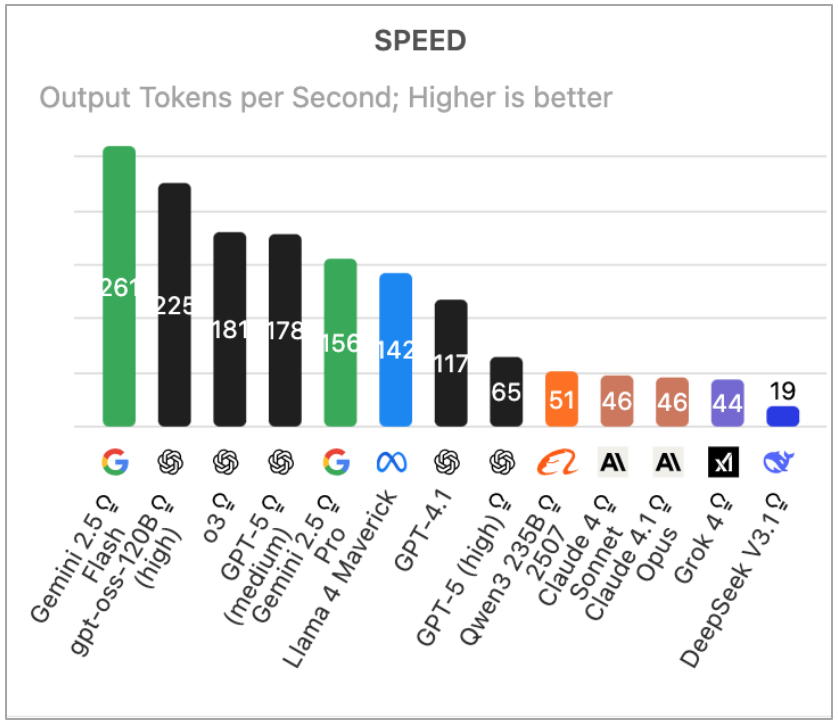
LMArena Leaderboard

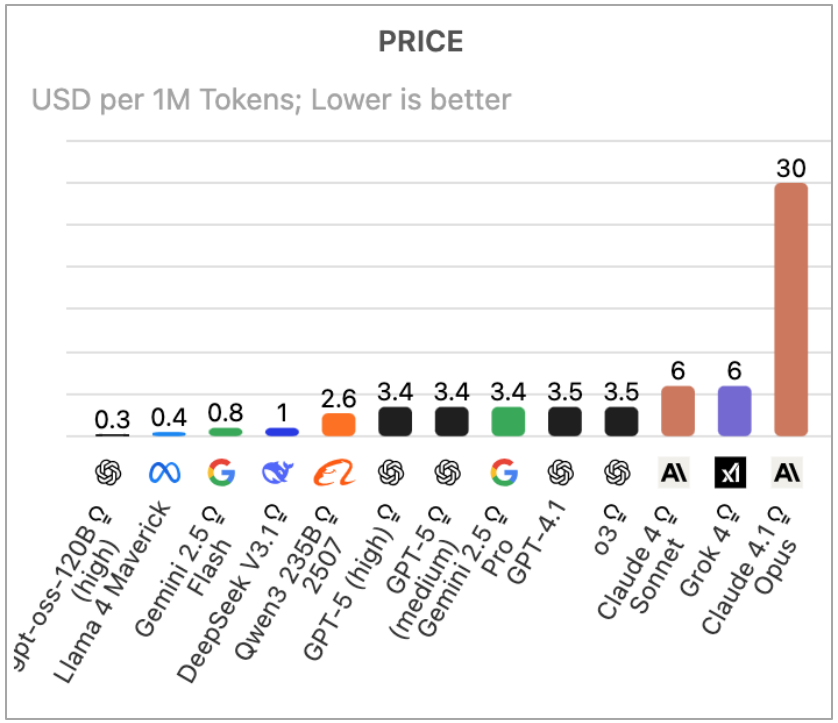
Model 239 / 239	Overall	Hard Prompts	Coding	Math	Creative Writing	Instruction Following	Longer Query	Multi-Turn
claude-opus-4-1-…	1	1	1	1	1	1	1	1
gemini-2.5-pro	1	2	3	1	1	1	1	1
chatgpt-4o-lates…	2	4	3	13	2	5	4	1
gpt-5-high	2	2	3	1	7	5	11	6
o3-2025-04-16	2	4	3	1	8	6	13	7
claude-opus-4-1-…	3	2	1	1	1	1	1	1
gpt-4.5-preview-…	3	5	4	8	1	4	3	1
gpt-5-chat	5	3	3	8	3	5	3	1
qwen3-max-preview	6	4	2	1	7	4	4	3
claude-opus-4-20…	8	4	3	6	2	2	2	7
deepseek-r1-0528	8	8	4	10	8	15	13	14
deepseek-v3.1	8	6	4	1	7	6	5	9
deepseek-v3.1-th…	8	4	3	1	2	4	1	7
grok-4-0709	8	10	12	1	4	6	8	7
kimi-k2-0711-pre…	8	10	7	13	16	24	22	7
kimi-k2-0905-pre…	8	5	3	-	6	16	12	7
qwen3-235b-a22b-…	8	4	3	2	9	6	4	7
glm-4.5	10	7	4	7	14	7	8	10

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

Artificial Analysis Intelligence Index
Intelligence, Speed, Price

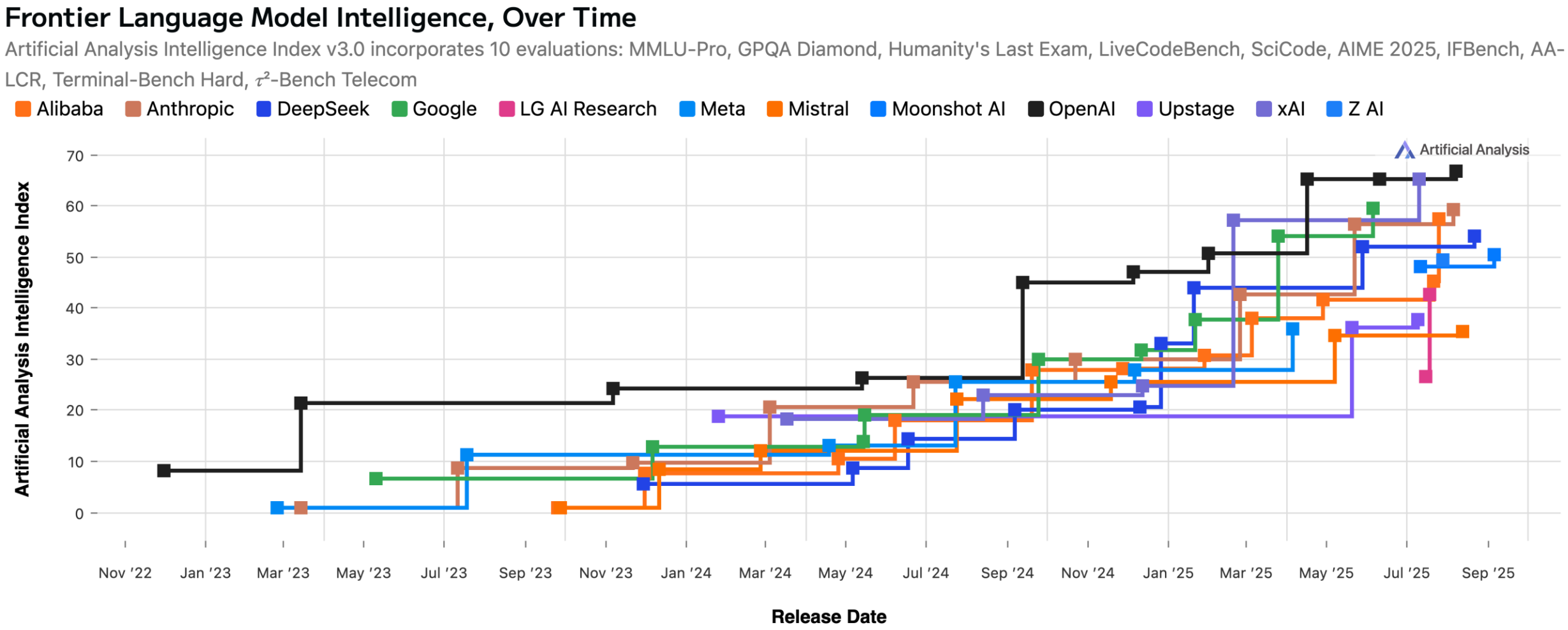






Source: https://artificialanalysis.ai/

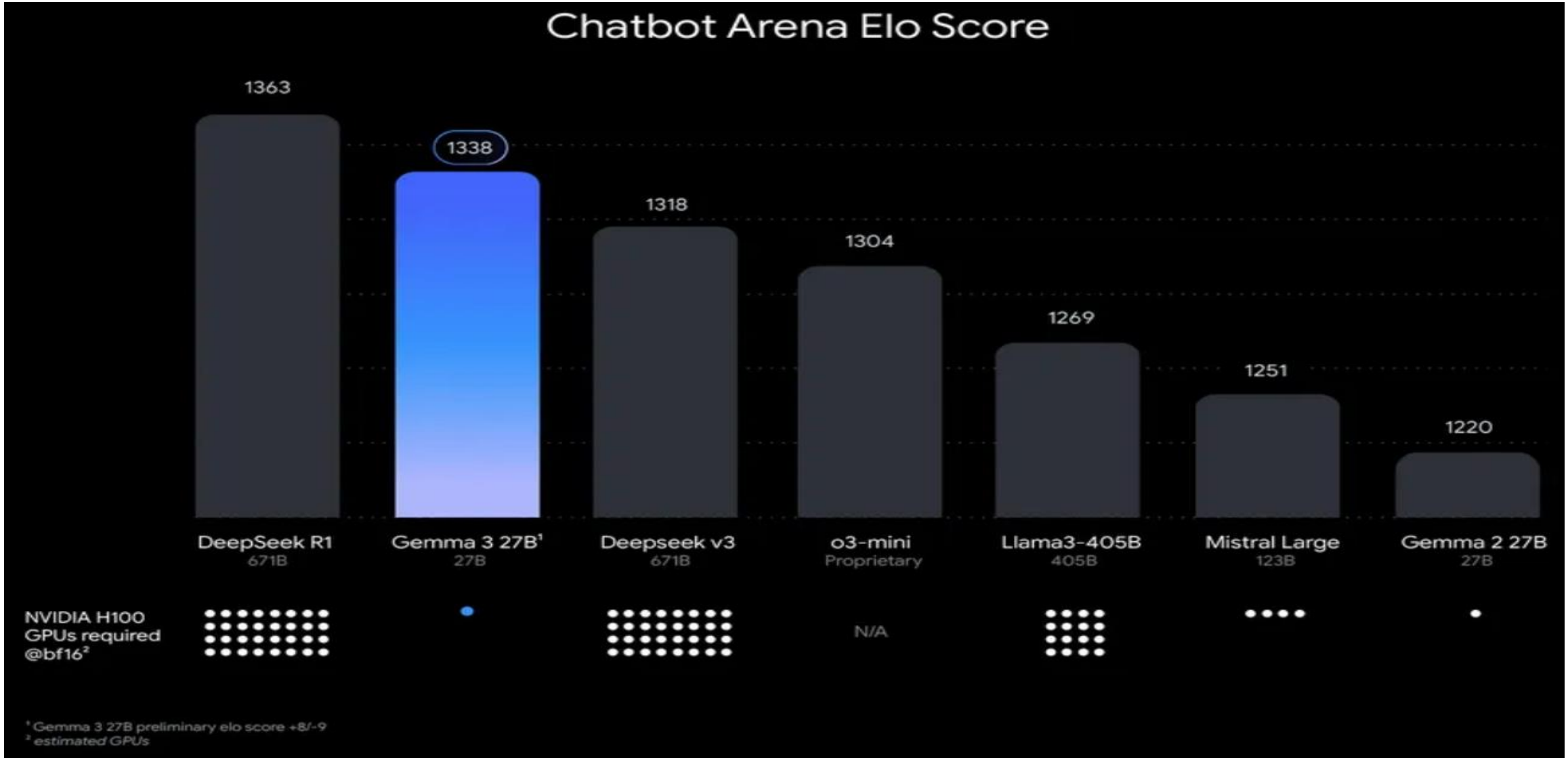
Artificial Analysis Intelligence Index 2022-2025



Source: https://artificialanalysis.ai/

Google Gemma 3 27B

The most capable model you can run on a single GPU or TPU



Source: https://blog.google/technology/developers/gemma-3/

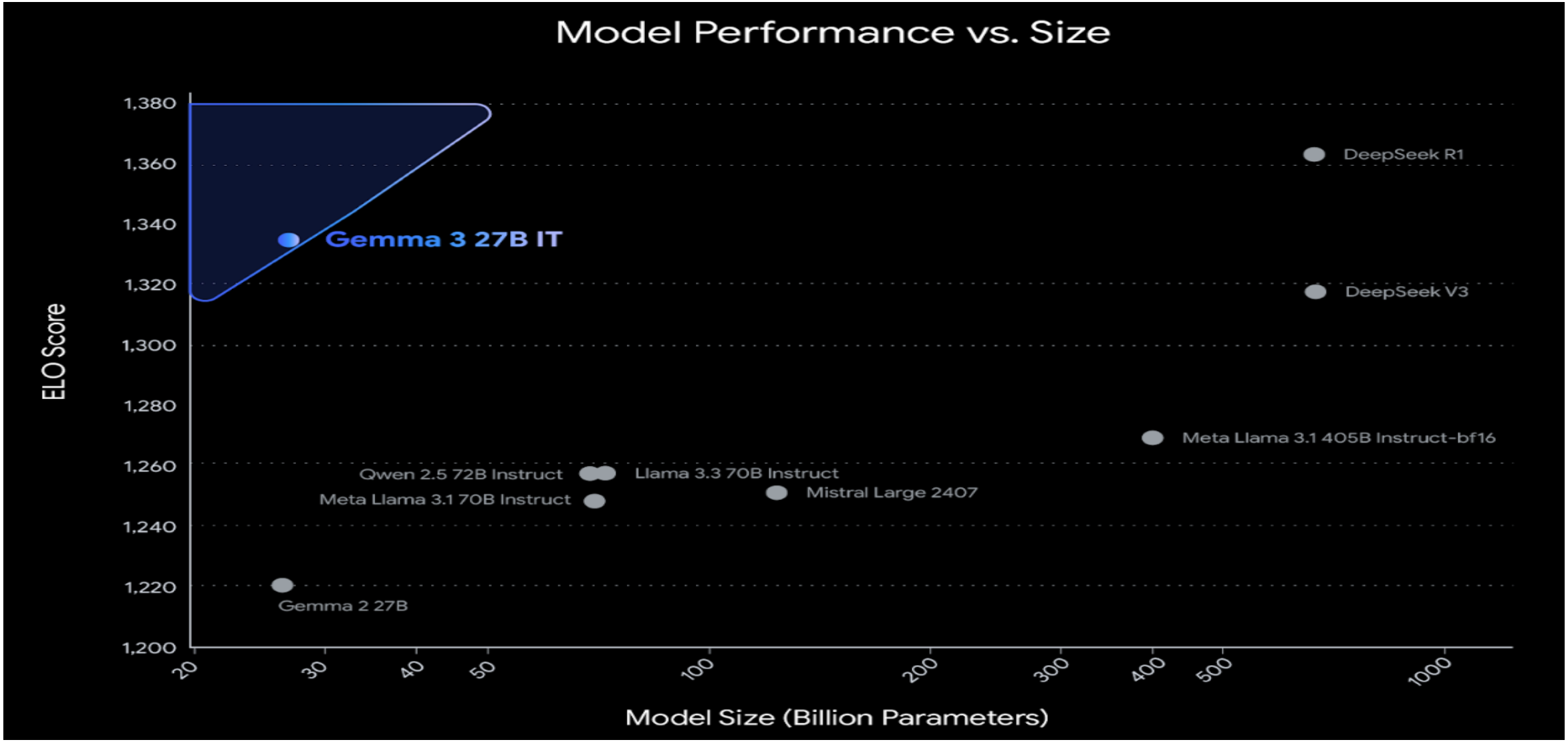
Google Gemma 3 Multimodality (vision-language input and text outputs)

MODEL	SIZE (in billion parameter)	CONTEXT LENGTH	LANGUAGES	INPUT MODALITIES
Gemma 3 1B (IT)	1B	32k	English	Input: Text Output: Text
Gemma 3 4B (IT)	4B	128k	+140 Languages	Input: Text, Image Output: Text
Gemma 3 12B (IT)	12B	128k	+140 Languages	Input: Text, Image Output: Text
Gemma 3 27B (IT)	27B	128k	+140 Languages	Input: Text, Image Output: Text
Shield Gemma 2	4B	8k	+140 Languages	Input: Text, Image Output: Text

Source: https://developers.googleblog.com/en/introducing-gemma3/

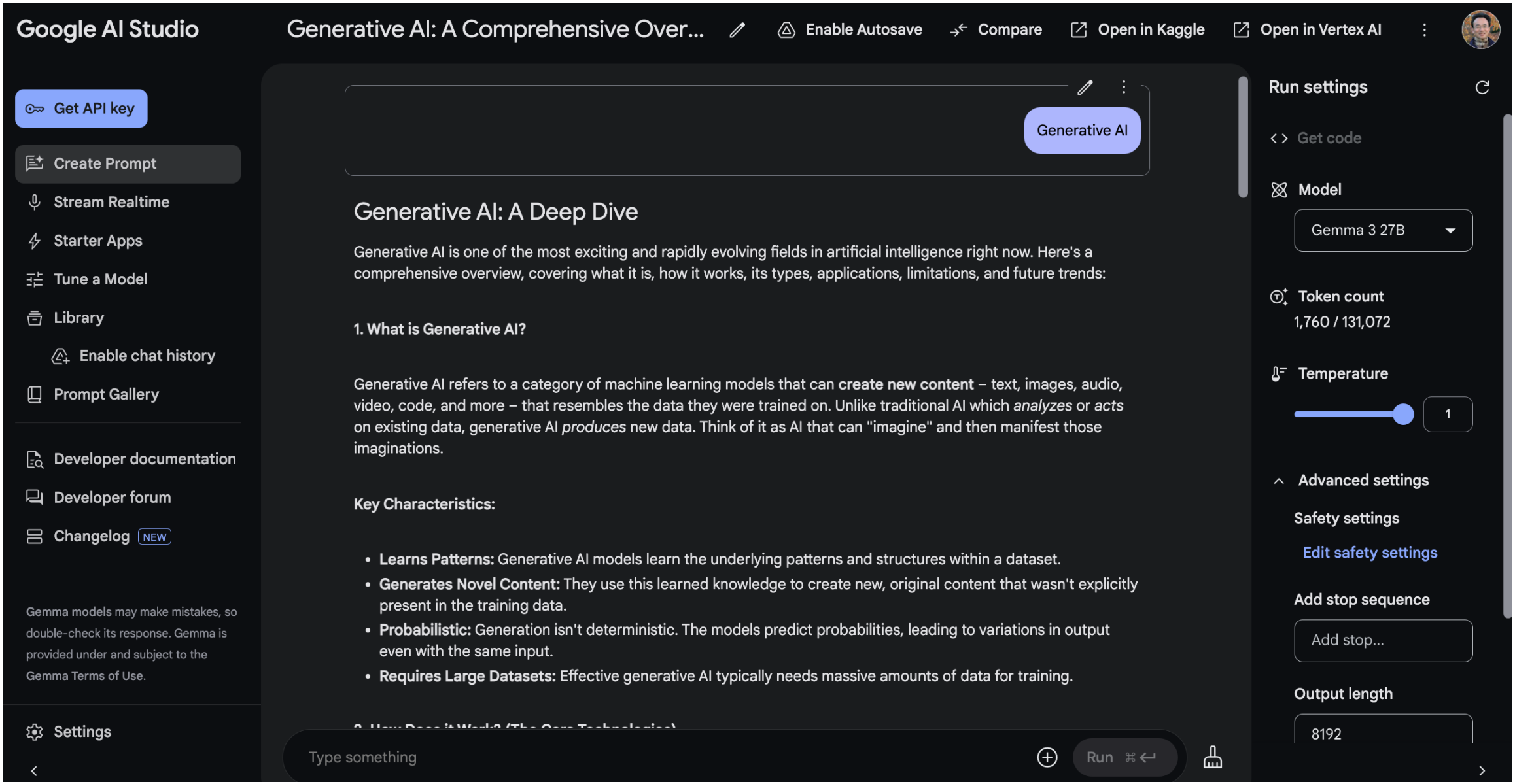
Google Gemma 3: Pre-training and Post-training

(distillation, reinforcement learning, and model merging)



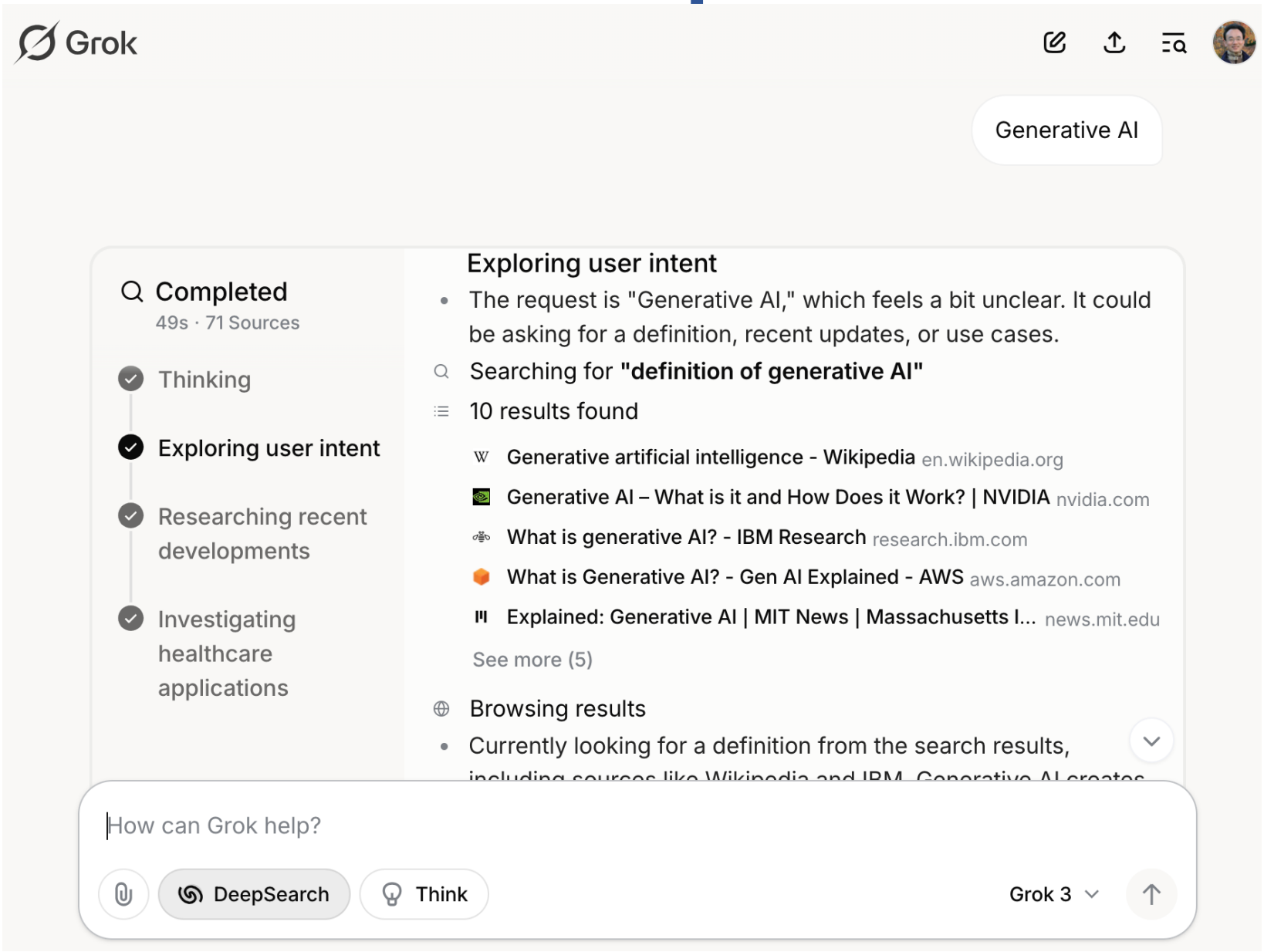
Source: https://developers.googleblog.com/en/introducing-gemma3/

Google AI Studio (Gemma 3 27B)



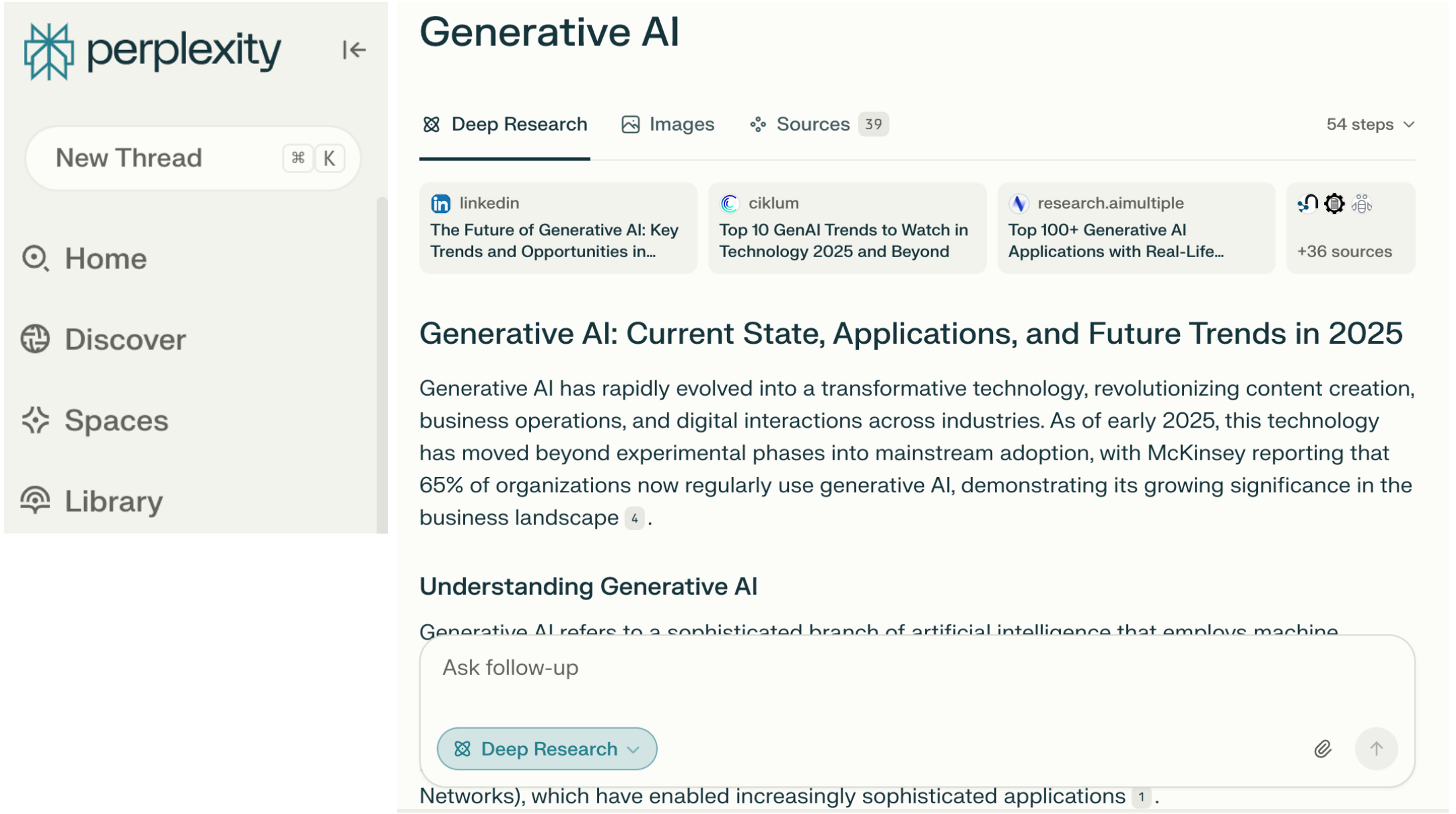
Source: https://aistudio.google.com/

Grok 3 Deep Search



Source: https://grok.com/chat

Perplexity.ai Deep Research



Source: https://www.perplexity.ai/

Token

Tiktokenizer

gpt-4o

System | You are a helpful assistant

User | Content

Add message

```
<|im_start|>system<|im_sep|>You are a helpful
assistant<|im_end|><|im_start|>user<|im_sep|><|im_end|>
<|im_start|>assistant<|im_sep|>
```

Token count
16

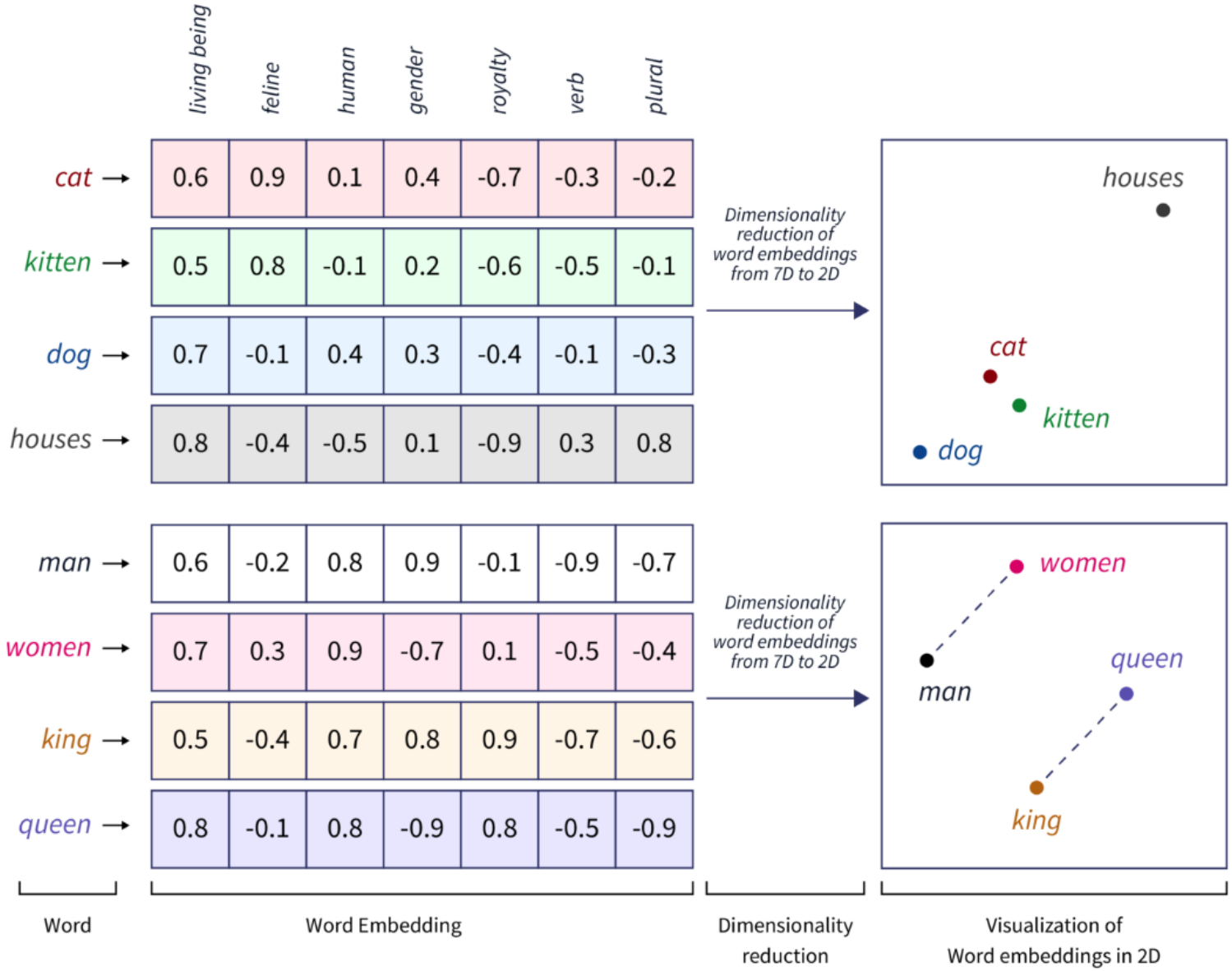
```
<|im_start|>system<|im_sep|>You are a helpful assistan
t<|im_end|><|im_start|>user<|im_sep|><|im_end|><|im_st
art|>assistant<|im_sep|>
```

```
200264, 17360, 200266, 3575, 553, 261, 10297, 29186, 2
00265, 200264, 1428, 200266, 200265, 200264, 173781, 2
00266
```

Show whitespace

https://tiktokenizer.vercel.app/

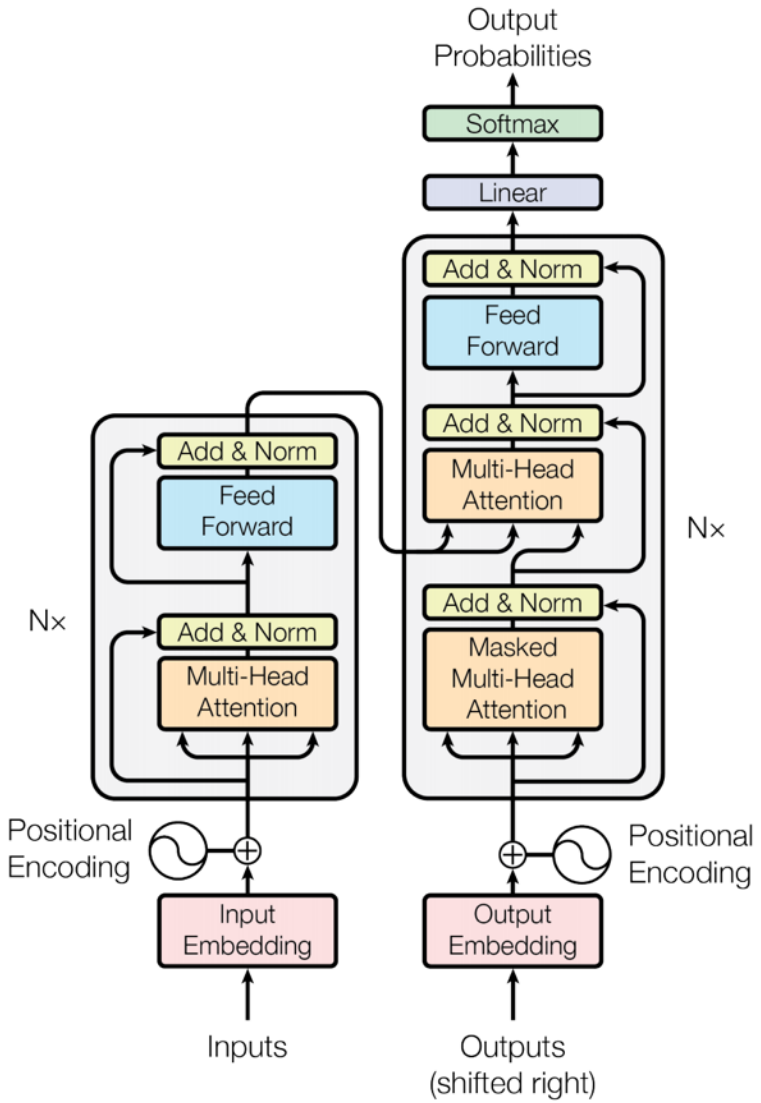
Word Embeddings



Source: https://www.scaler.com/topics/tensorflow/tensorflow-word-embeddings/

Transformer (Attention is All You Need)

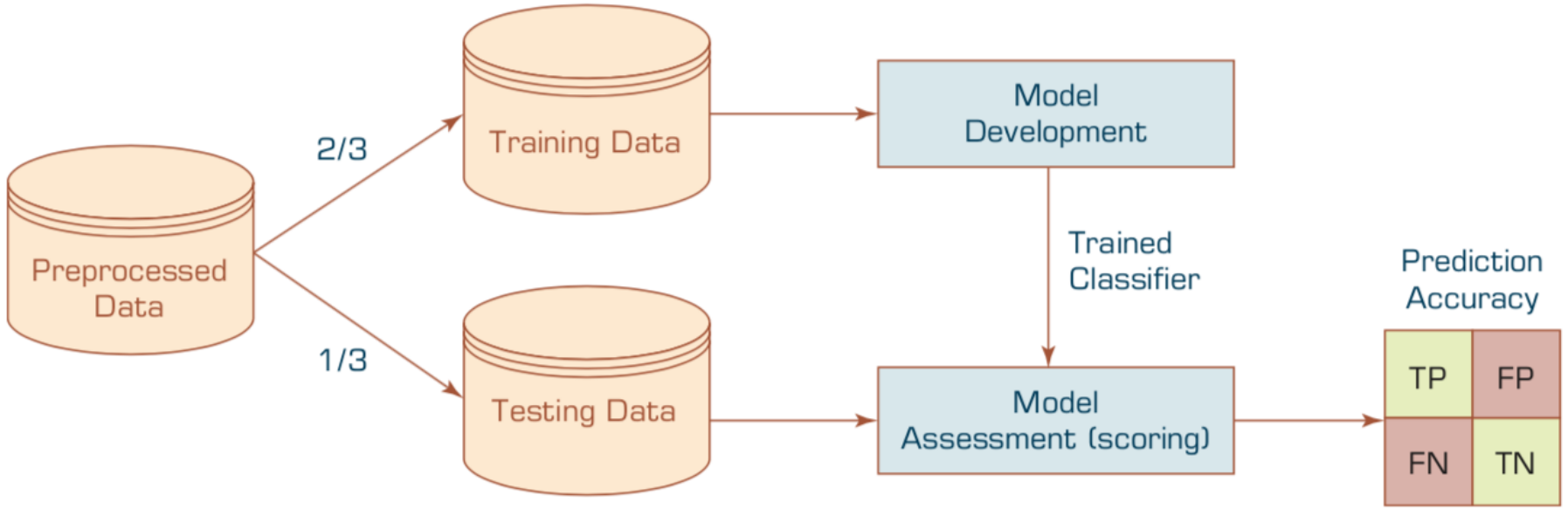
(Vaswani et al., 2017)



Source: Vaswani, Ashish, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin. "Attention is all you need." In *Advances in neural information processing systems*, pp. 5998-6008. 2017.

Estimation Methodologies for Machine Learning Classification Tasks

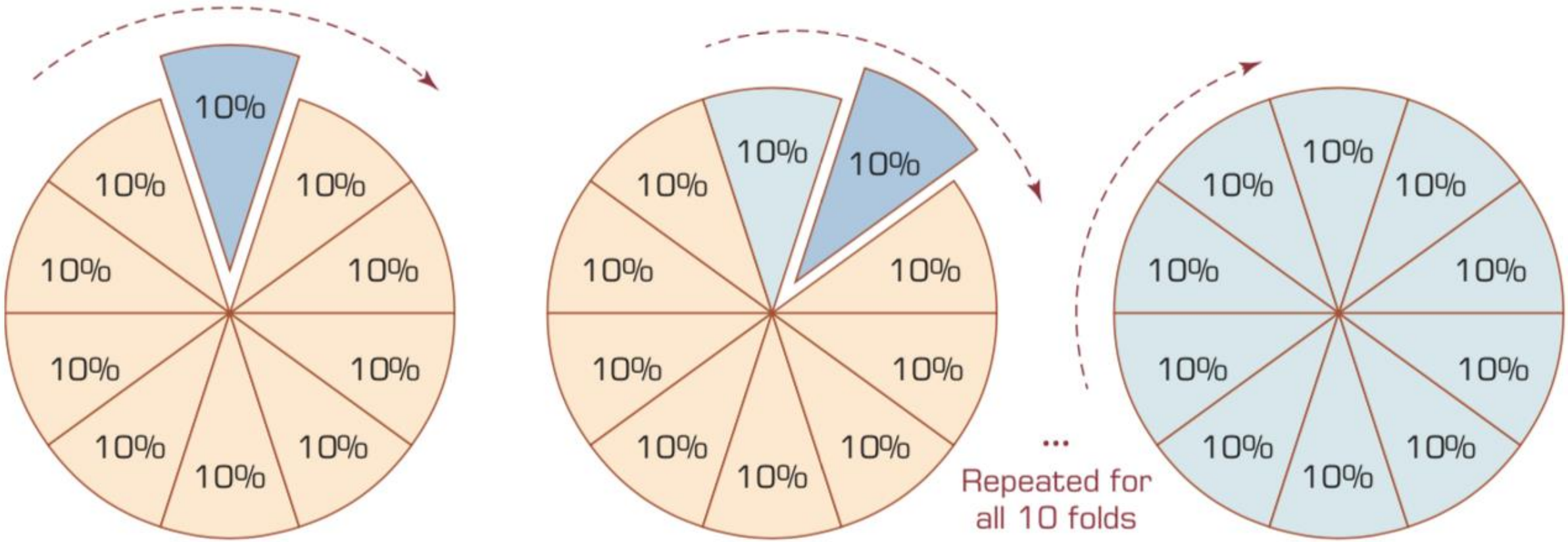
- **Simple split (or holdout or test sample estimation)**
  - **Split the data into 2 mutually exclusive sets training (~70%) and testing (30%)**



  - **For ANN, the data is split into three sub-sets (training [~60%], validation [~20%], testing [~20%])**

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

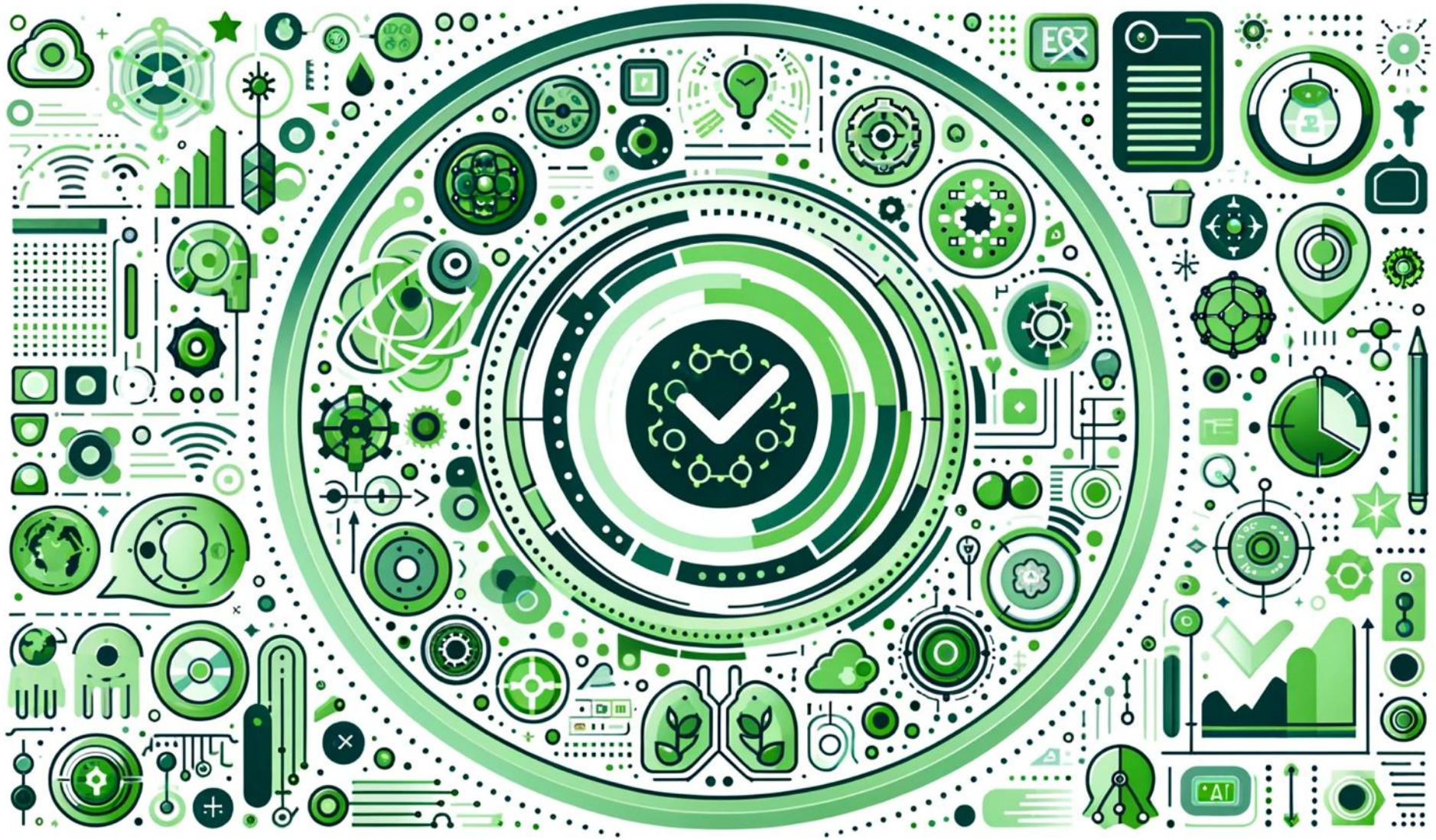
k-Fold Cross-Validation:
Machine Learning Data Splitting and Model Assessment



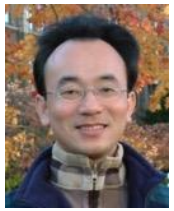
Generative AI and LLMs for Sustainability and ESG Data Analytics

Sustainability and ESG Data Analytics

Generative AI for ESG Rating and Reporting Generation



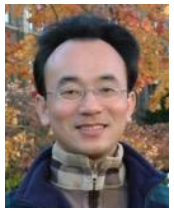
Teaching



- **Artificial Intelligence**
  - Spring 2021, Fall 2022, Fall 2024, Fall 2025
- **Sustainability and ESG Data Analytics**
  - Spring 2024, Fall 2024, Fall 2025
- **Software Engineering**
  - Fall 2020, Fall, 2021, Spring 2022, Spring 2023, Spring 2024, Spring 2025
- **Generative AI Innovative Applications**
  - Spring 2025
- **Artificial Intelligence in Finance and Quantitative**
  - Fall 2021, Fall 2022, Fall 2023, Spring 2025
- **Big Data Analytics**
  - Fall 2020, Spring 2023, Spring 2024
- **Artificial Intelligence for Text Analytics**
  - Spring 2022, Fall 2023
- **Python for Accounting Applications**
  - Fall 2023, Fall 2024, ,Fall 2025
- **Foundation of Business Cloud Computing**
  - Spring 2021, Spring 2022, Spring 2023, Spring 2024

https://web.ntpu.edu.tw/~myday/teaching.htm

Research Projects

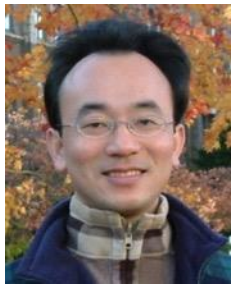


1. **Generative AI Multi-Agent Systems with LLM-Based RAG for ESG Reporting Automation**
   - NSTC (E4104), NSTC 114-2221-E-305-002-, 2025/08/01~2026/07/31
2. **Innovative Agentic AI Technology for Autonomous ESG Report Generation**
   - Industrial Technology Research Institute (ITRI), Fintech and Green Finance Center (FGFC, NTPU), NTPU-114A513E01, 2025/03/01~2025/12/31
3. **Digital Support, Unimpeded Communication: The Development, Support and Promotion of AI-assisted Communication Assistive Devices for Speech Impairment(3/3), Sub-project 3: Multimodal Cross-lingual Task-Oriented Dialogue System for Inclusive Communication Support,**
   - NSTC (HZZ22), NSTC 114-2425-H-305-003-, 3 Years (2023/05/01-2026/04/30) Year 3: 2025/05/01~2026/04/30
4. **Research on speech processing, synthesis, recognition, and sentence construction of people with language disabilities, Sub-project 3: Multimodal Cross-lingual Task-Oriented Dialogue System**
   - NTPU, 114-NTPU_ORDA-F-004, 3 Years (2023/01/01-2025/12/31) Year 3: 2025/01/01~2025/12/31
5. **Development of a Deep Learning for Dental Implant Detection in Panoramic Radiographs,**
   - University System of Taipei Joint Research Program (NTPU, TMU), USTP-NTPU-TMU-114-02, 2025/01/01~2025/12/31

https://web.ntpu.edu.tw/~myday/cindex.htm#projects

Summary

- This course introduces the fundamental concepts and hands-on practices of Sustainability and ESG Data Analytics.
- Topics include
  1. Introduction Sustainability and ESG Data Analytics
  2. Environmental, Social, and Governance (ESG) in Net-Zero Digital Transformation
  3. Data Science for Sustainability and ESG
  4. Web 3.0 and Big Data Analysis in Fintech, Green Finance, Sustainable Finance
  5. ESG Data Gathering, Analysis, and Visualization
  6. NVIDIA Building RAG Agents with LLMs
  7. Artificial Intelligence of things (AIoT) in ESG and Sustainability Applications
  8. Generative AI for ESG Rating and Reporting Generation
  9. Case Study on Sustainability and ESG Data Analytics



Sustainability and ESG Data Analytics

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