Artificial Intelligence

Introduction to Artificial Intelligence

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

Institute of Information Management, **National Taipei University**

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

https://meet.google.com/
paj-zhhj-mya

2025-09-09
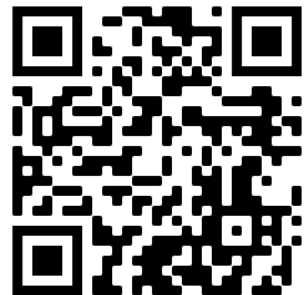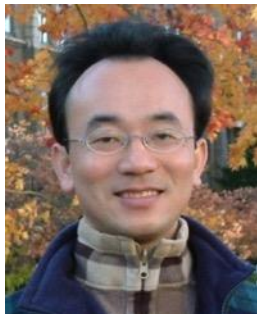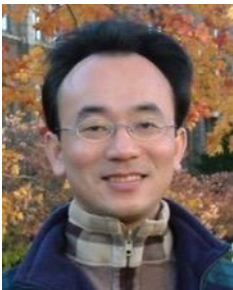
Prof. Min-Yuh Day

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, Financial Technology, Big Data Analytics, Data Mining and Text Mining, Electronic Commerce

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

- **Course Title: Artificial Intelligence**

- **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) (M5276)**

- **Time & Place: Tue, 2, 3, 4, (9:10-12:00) (B3F17)**

- **Google Meet: https://meet.google.com/paj-zhhj-mya**

https://meet.google.com/paj-zhhj-mya

Course Objectives

1. Understand the **fundamental concepts** and **research issues** of **Artificial Intelligence**.

2. Equip with **Hands-on practices** of **Artificial Intelligence**.

3. Conduct **information systems research** in the context of **Artificial Intelligence**.

Course Outline

- **This course introduces the fundamental concepts, research issues, and hands-on practices of Artificial Intelligence.**
- **Topics include:**
  1. **Introduction to Artificial Intelligence**
  2. **Artificial Intelligence and Intelligent Agents; Problem Solving**
  3. **Knowledge, Reasoning and Knowledge Representation**
  4. **Uncertain Knowledge and Reasoning**
  5. **Machine Learning: Supervised and Unsupervised Learning**
  6. **The Theory of Learning and Ensemble Learning**
  7. **NVIDIA Fundamentals of Deep Learning**
  8. **Natural Language Processing**
  9. **Computer Vision and Robotics**
  10. **Generative AI, Agentic AI, and Physical AI**
  11. **Philosophy and Ethics of AI and the Future of AI**
  12. **Case Study on AI**

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 2025/09/09 Introduction to Artificial Intelligence

**2 2025/09/16 Artificial Intelligence and Intelligent Agents;
           Problem Solving**

**3 2025/09/23 Knowledge, Reasoning and Knowledge Representation;
           Uncertain Knowledge and Reasoning**

4 2025/09/30 Case Study on Artificial Intelligence I

**5 2025/10/07 Machine Learning: Supervised and Unsupervised Learning;
           The Theory of Learning and Ensemble Learning**

Syllabus

Week   Date   Subject/Topics

6 2025/10/14 NVIDIA Fundamentals of Deep Learning I:
Deep Learning; Neural Networks

7 2025/10/21 NVIDIA Fundamentals of Deep Learning II:
Convolutional Neural Networks;
Data Augmentation and Deployment

8 2025/10/28 Self-Learning

9 2025/11/04 Midterm Project Report

10 2025/11/11 NVIDIA Fundamentals of Deep Learning III:
Pre-trained Models; Natural Language Processing

Syllabus

Week   Date   Subject/Topics

11 2025/11/18 Case Study on Artificial Intelligence II

12 2025/11/25 Computer Vision and Robotics

13 2025/12/02 Generative AI, Agentic AI, and Physical AI

14 2025/12/09 Philosophy and Ethics of AI and the Future of AI

15 2025/12/16 Final Project Report I

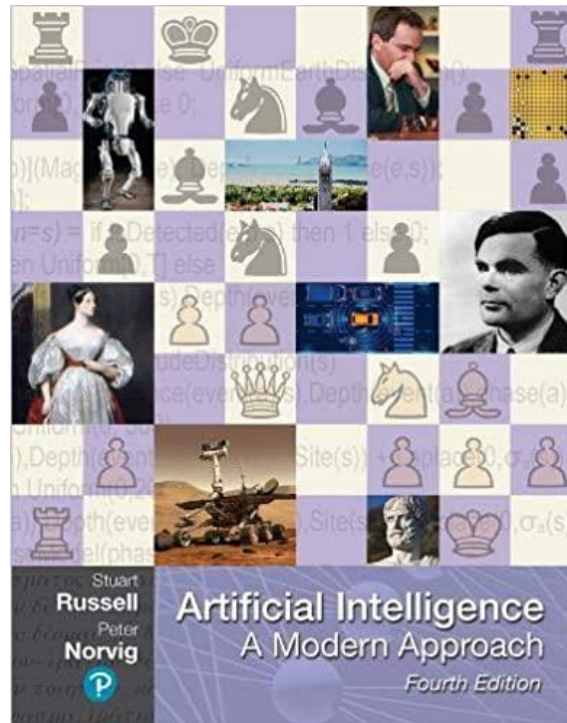16 2025/12/23 Final Project Report II

Teaching Methods and Activities

- **Lecture**

- **Discussion**

- **Practicum**

Evaluation Methods

- **Individual Presentation 60 %**

- **Group Presentation 10 %**

- **Case Report 10 %**

- **Class Participation 10 %**

- **Assignment 10 %**

Required Texts

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

Reference Books

- 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

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

- 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

- Ben Auffarth (2023), Generative AI with LangChain: Build large language model (LLM) apps with Python, ChatGPT and other LLMs, Packt Publishing.

- Aurélien Géron (2022), Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 3rd Edition, O'Reilly Media.

- Steven D'Ascoli (2022), Artificial Intelligence and Deep Learning with Python: Every Line of Code Explained For Readers New to AI and New to Python, Independently published.

- Nithin Buduma, Nikhil Buduma, Joe Papa (2022), Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, 2nd Edition, O'Reilly Media.
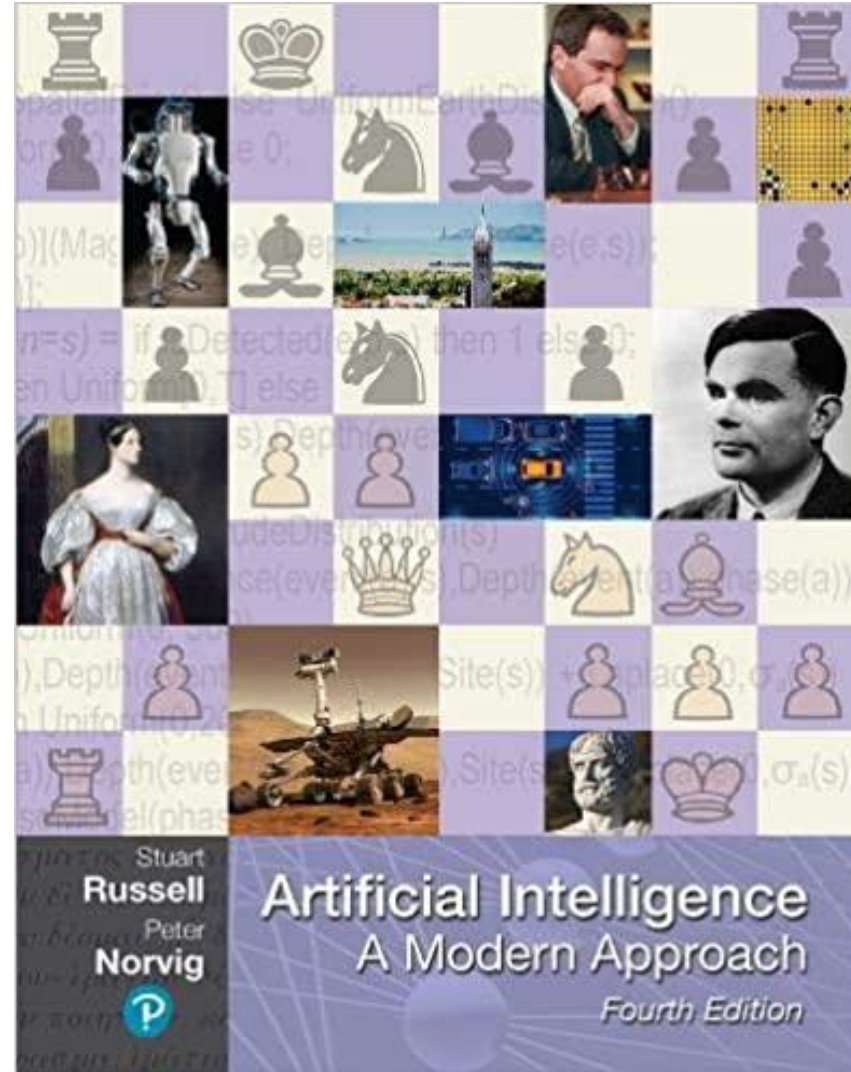
Stuart Russell and Peter Norvig (2020),
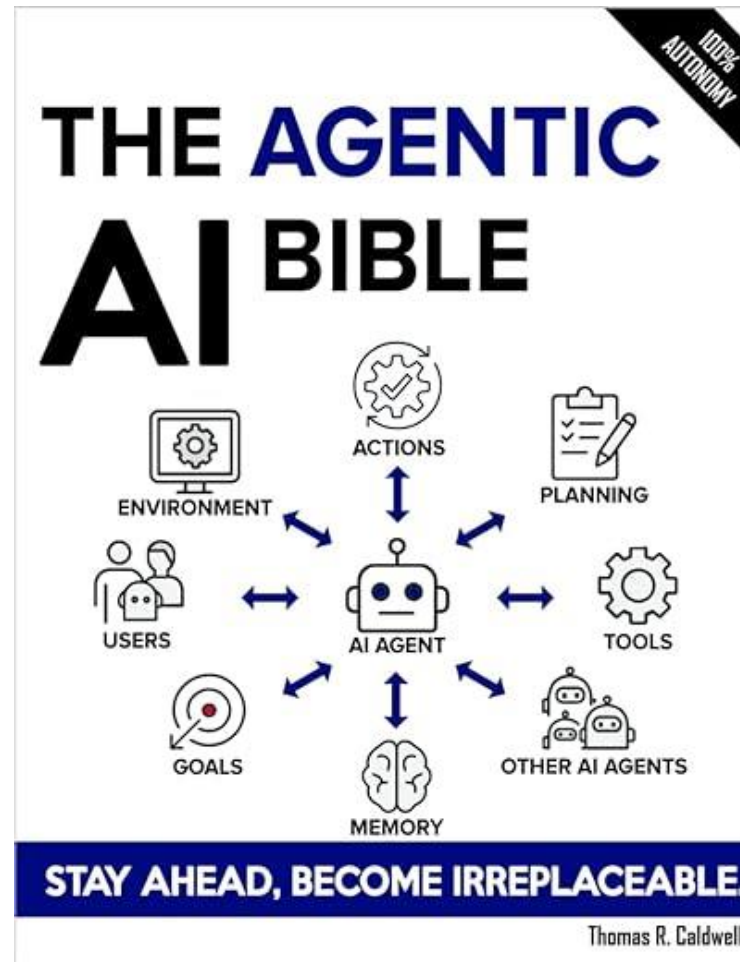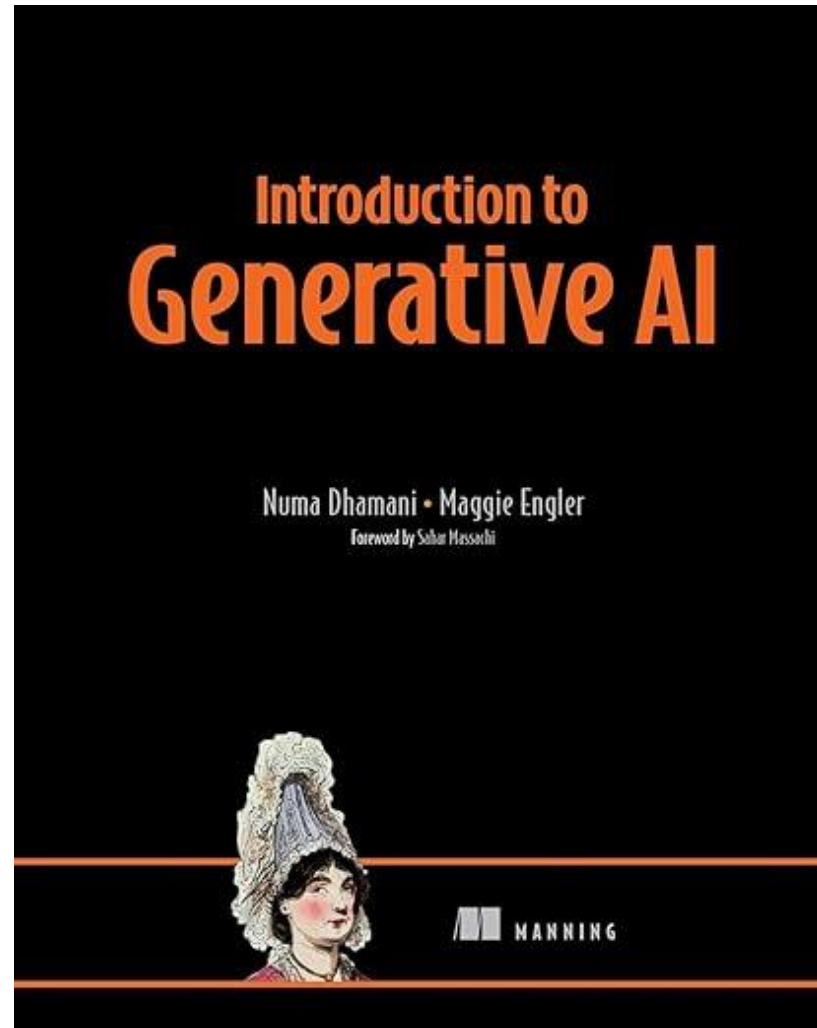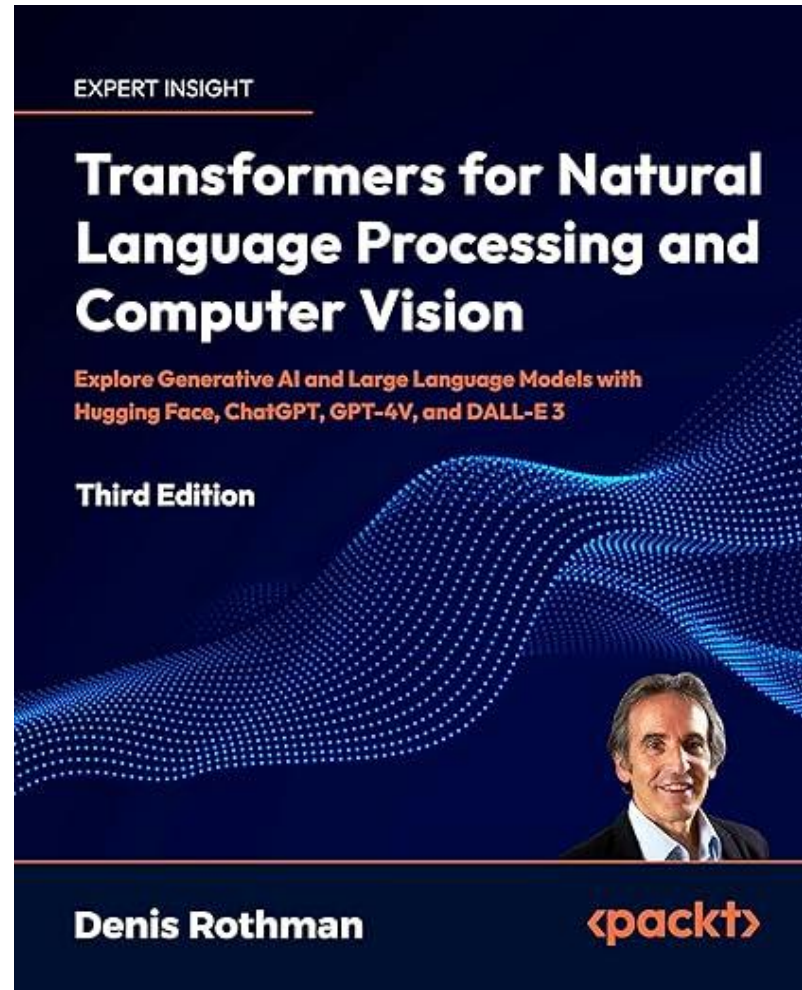# Artificial Intelligence: A Modern Approach,
4th Edition, Pearson

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The Complete and Up-to-Date Guide to Design, Build, and Scale Goal-Driven, LLM-Powered Agents that Think, Execute and Evolve,
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Numa Dhamani and Maggie Engler (2024),
Introduction to Generative AI,
Manning

Denis Rothman (2024),

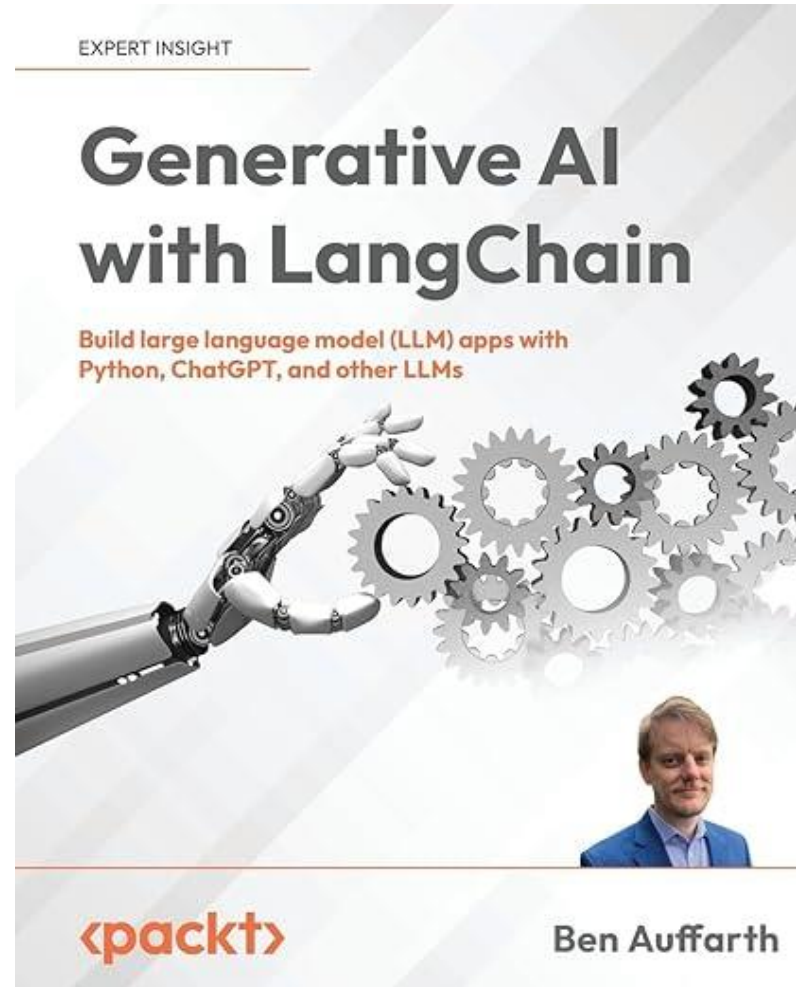# Transformers for Natural Language Processing and Computer Vision:
Explore Generative AI and Large Language Models with Hugging Face, ChatGPT, GPT-4V, and DALL-E 3,
**3rd Edition, Packt Publishing**

Ben Auffarth (2023),
Generative AI with LangChain:
Build large language model (LLM) apps with Python, ChatGPT and other LLMs,
Packt Publishing.

Aurélien Géron (2022),
Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow:
Concepts, Tools, and Techniques to Build Intelligent Systems,
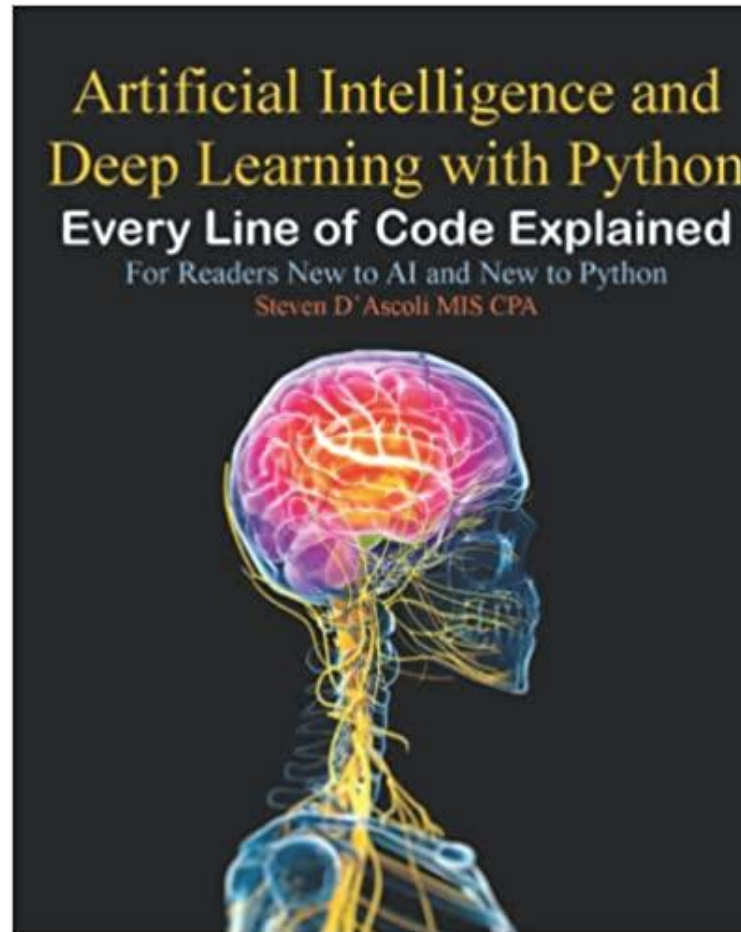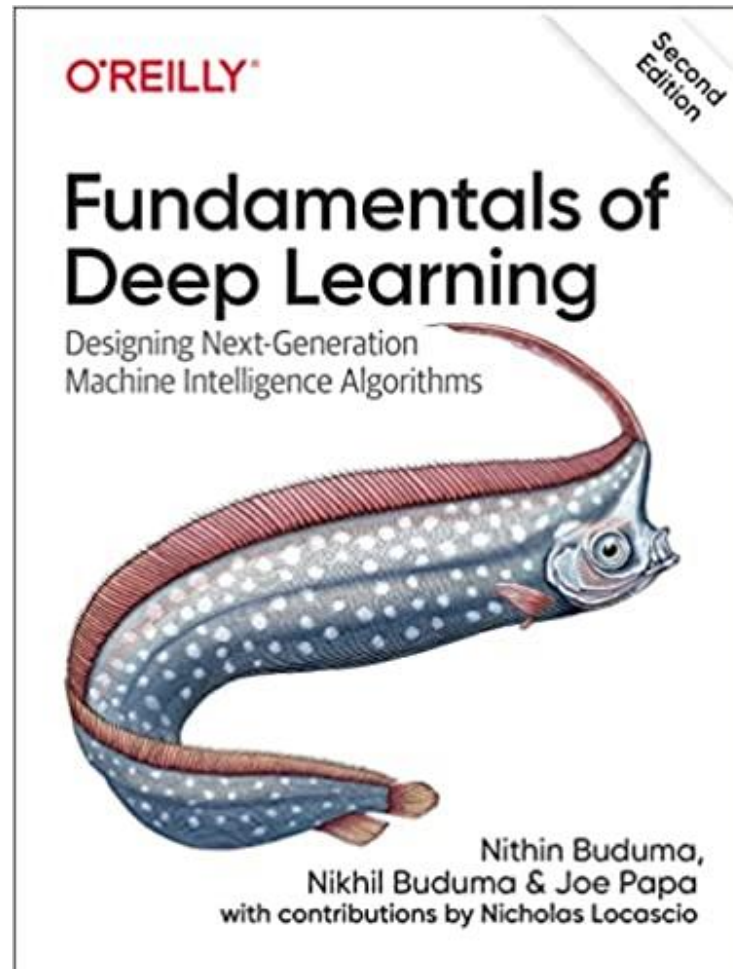**3rd Edition, O'Reilly Media**

https://github.com/ageron/handson-ml3
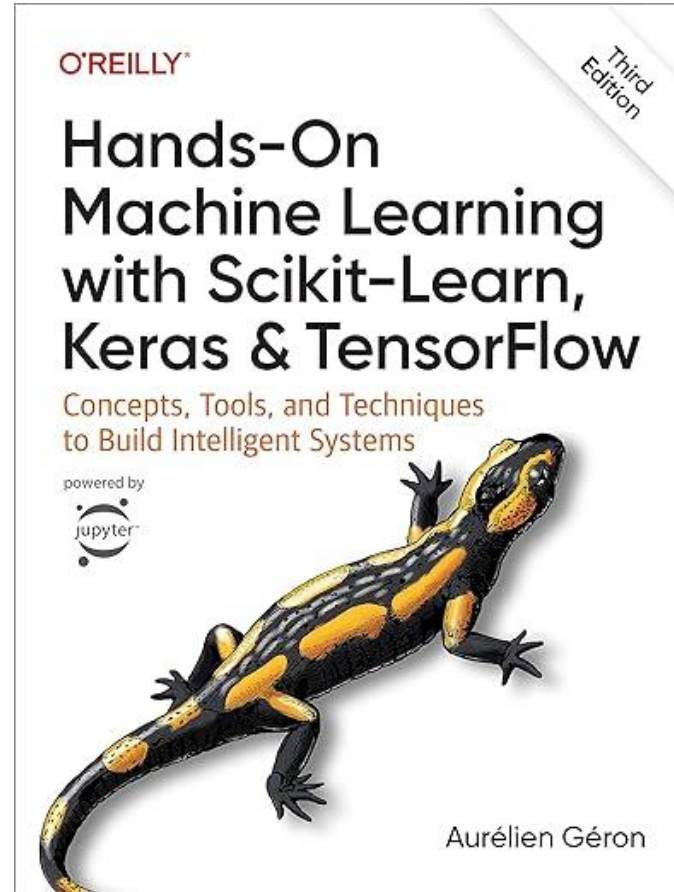
Steven D'Ascoli (2022),

Artificial Intelligence and Deep Learning with Python:

Every Line of Code Explained For Readers New to AI and New to Python,

Independently published.

Nithin Buduma, Nikhil Buduma, Joe Papa (2022),
Fundamentals of Deep Learning:
Designing Next-Generation Machine Intelligence Algorithms,
2nd Edition, O'Reilly Media.
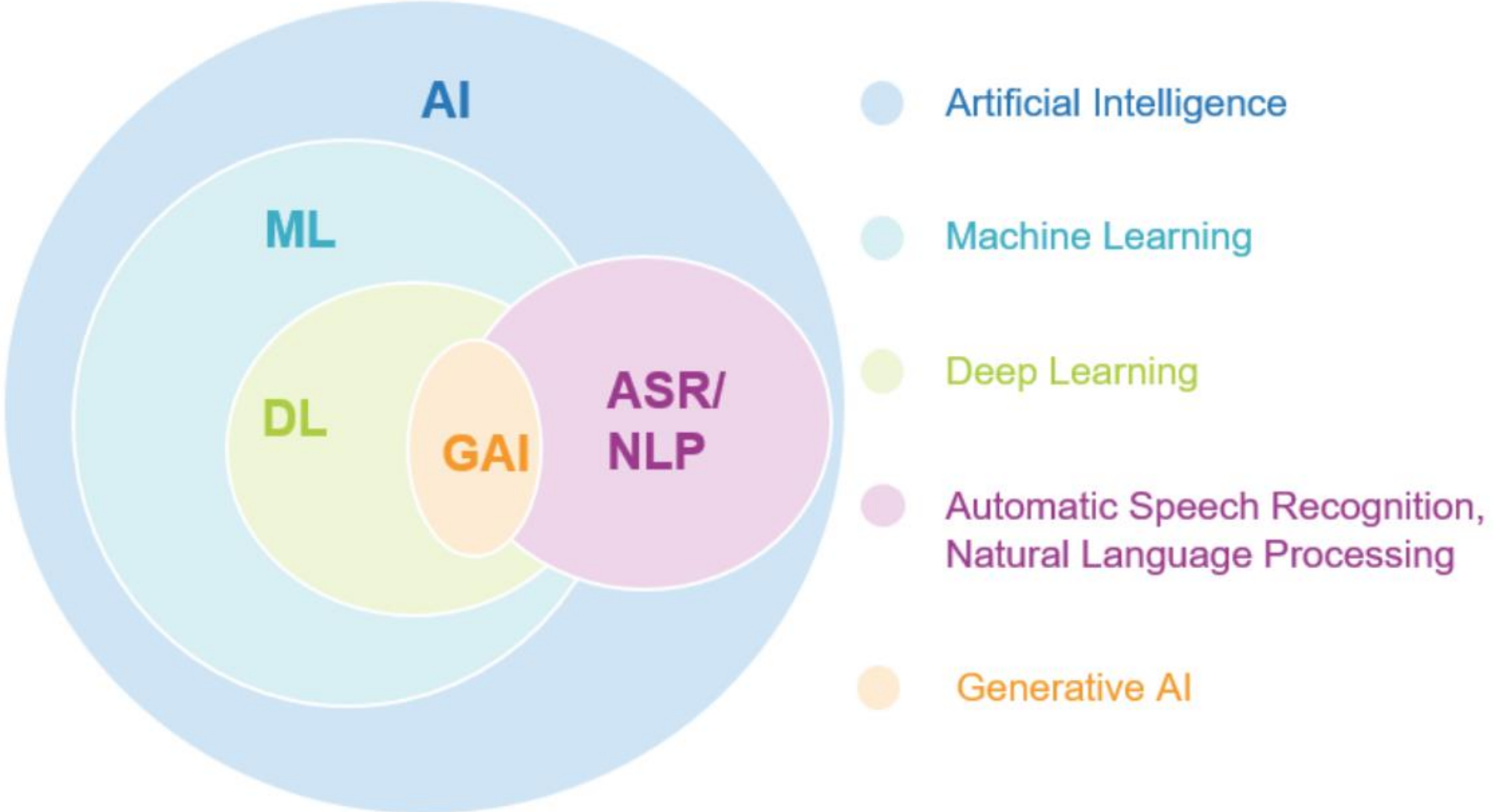
NVIDIA Developer Program

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

NVIDIA
Deep Learning Institute (DLI)

https://learn.nvidia.com/

Artificial Intelligence (AI)

AI, ML, DL, Generative AI

Generative AI, Agentic AI, Physical AI

Physical AI
Self-driving cars
General robotics

Agentic AI
Coding assistants
Customer service
Patient care

Generative AI
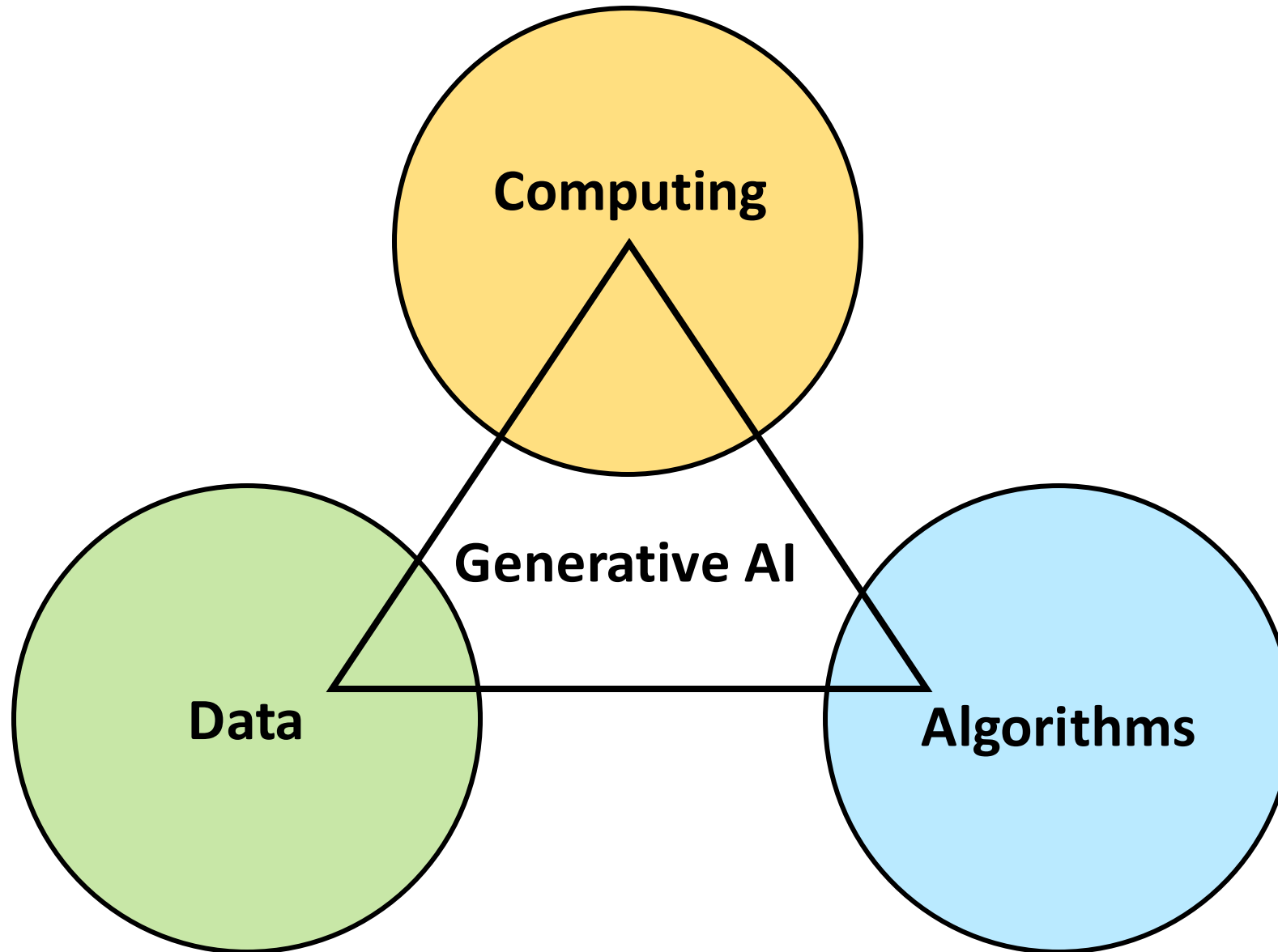Digital marketing
Content creation

Perception AI
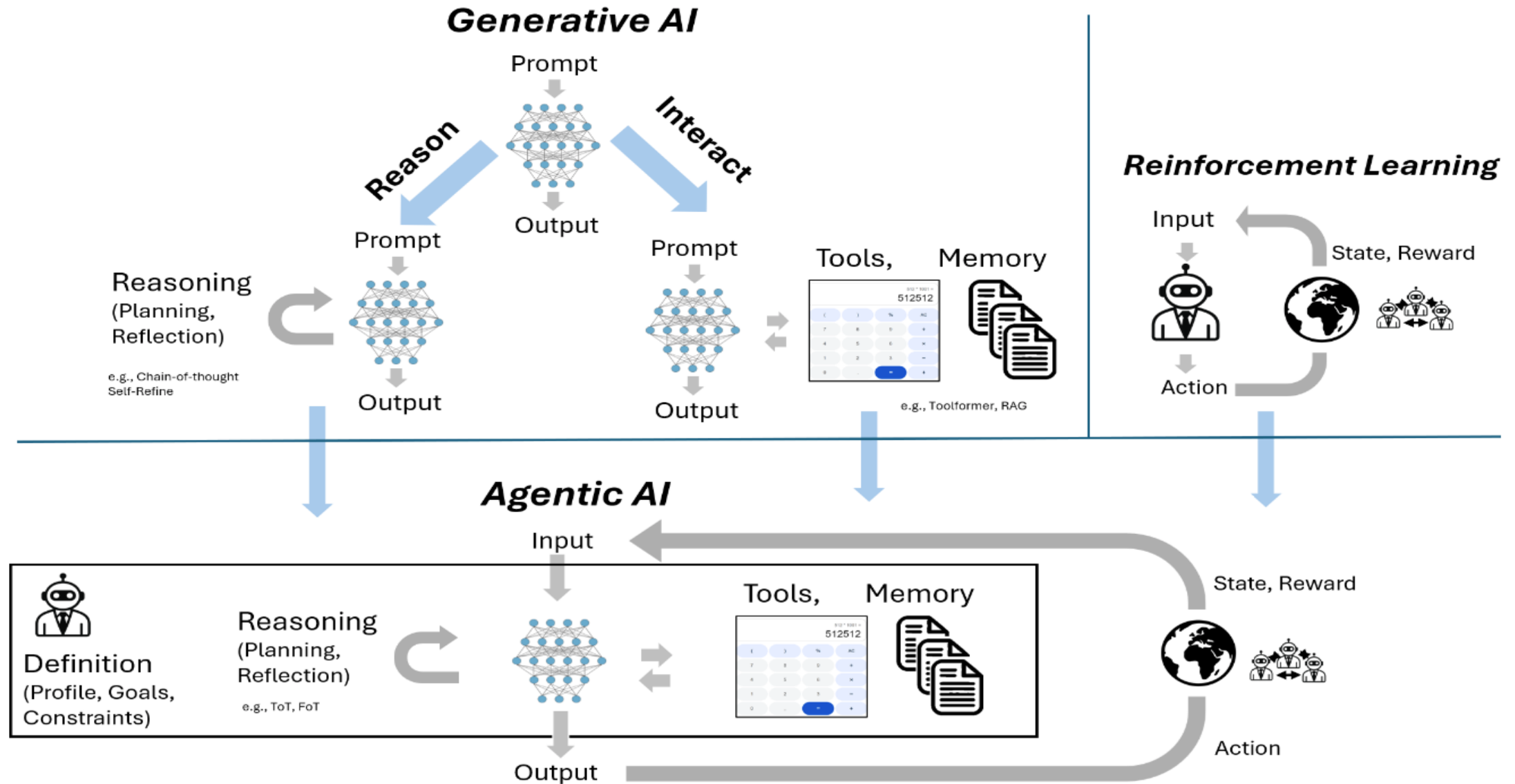Speech recognition
Deep recommender systems
Medical imaging
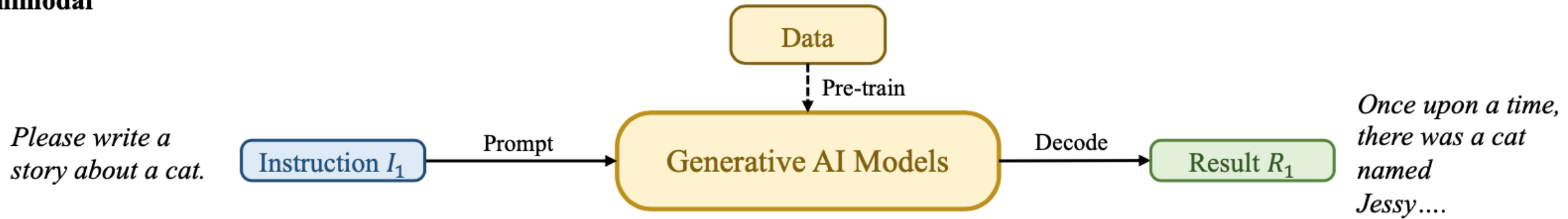
2012 AlexNet
Deep learning breakthrough

Generative AI
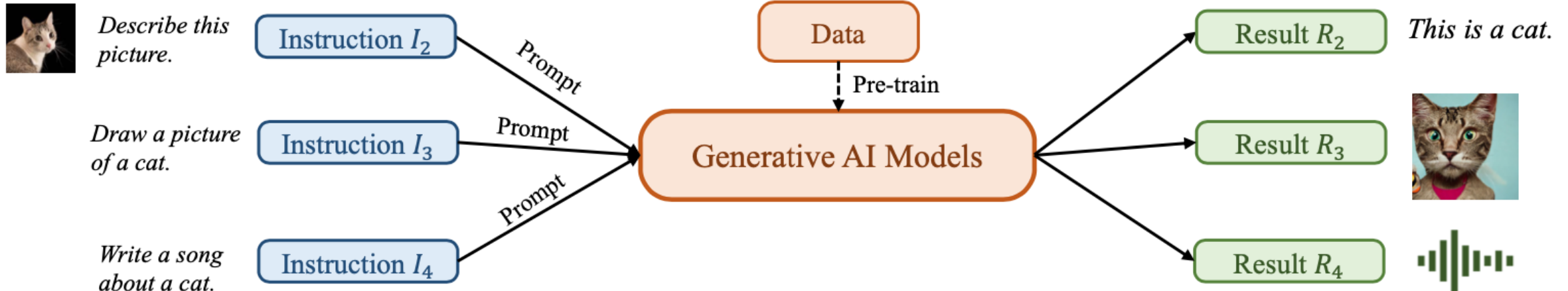
From Generative AI to Agentic AI

Generative AI (Gen AI)
AI Generated Content (AIGC)

Unimodal

Multimodal
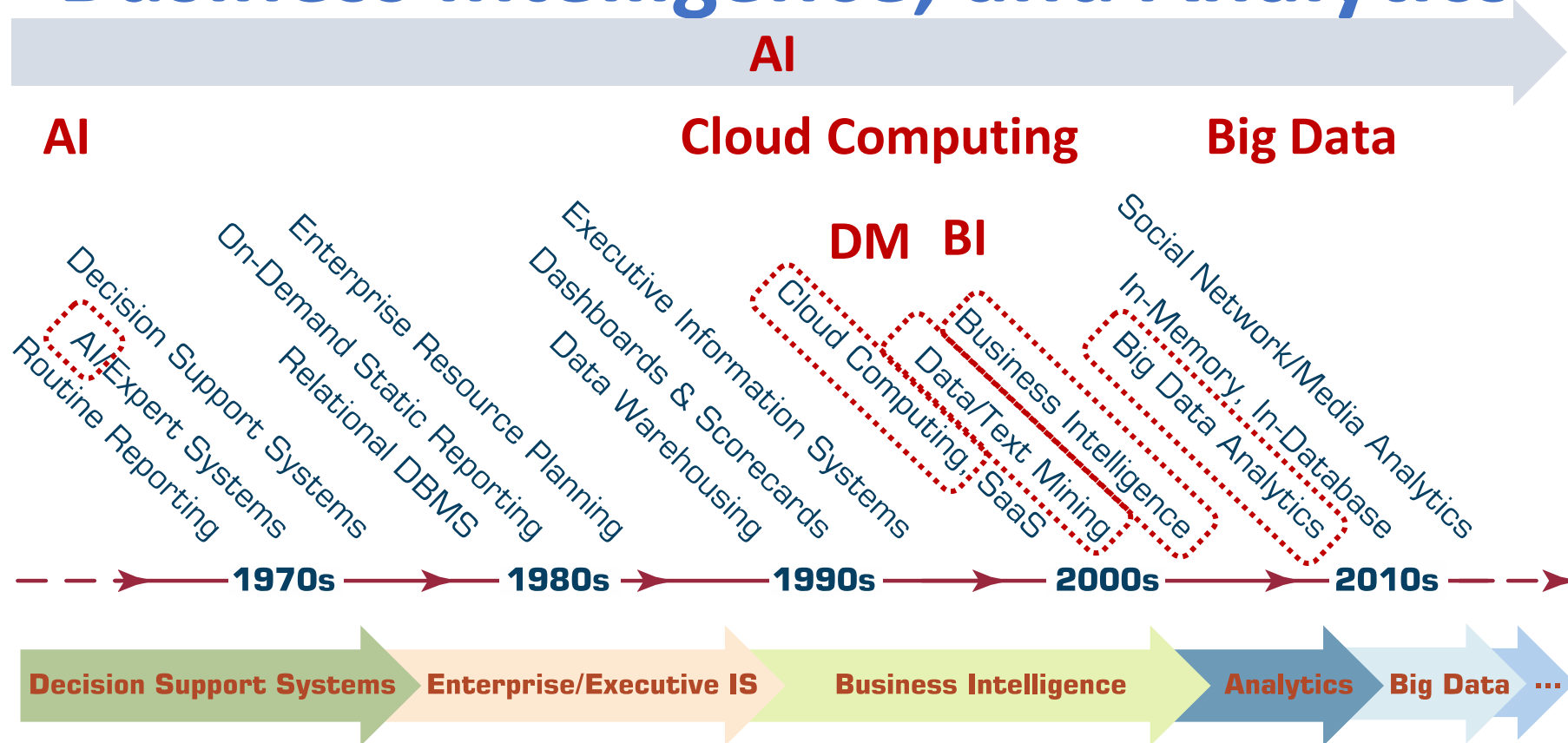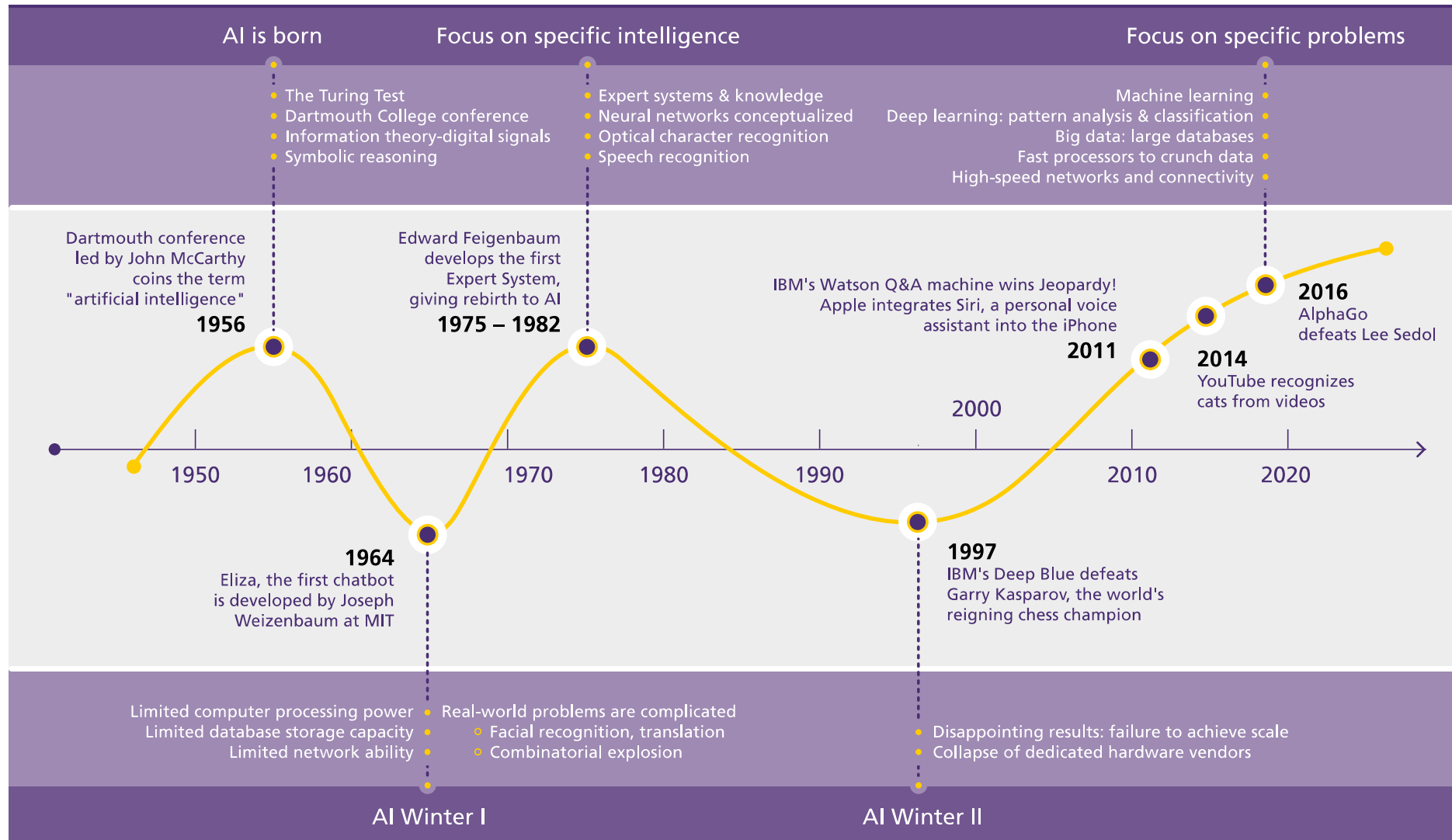

Source: Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.

AI, Big Data, Cloud Computing
Evolution of Decision Support, Business Intelligence, and Analytics

AI

AI

Cloud Computing

Big Data

DM BI

Decision Support Systems
AI/Expert Systems
Routine Reporting
On-Demand Static Reporting
Enterprise Resource Planning
Relational DBMS
Executive Information Systems
Dashboards & Scorecards
Data Warehousing
Cloud Computing, SaaS
Data/Text Mining
Business Intelligence
Social Network/Media Analytics
In-Memory, In-Database
Big Data Analytics

1970s → 1980s → 1990s → 2000s → 2010s

Decision Support Systems | **Enterprise/Executive IS** | **Business Intelligence** | **Analytics** | **Big Data** | ...

The Rise of AI

AI is born

Focus on specific intelligence

Focus on specific problems

- The Turing Test
- Dartmouth College conference
- Information theory-digital signals
- Symbolic reasoning

- Expert systems & knowledge
- Neural networks conceptualized
- Optical character recognition
- Speech recognition

- Machine learning
- Deep learning: pattern analysis & classification
- Big data: large databases
- Fast processors to crunch data
- High-speed networks and connectivity

Dartmouth conference led by John McCarthy coins the term "artificial intelligence"
1956

Edward Feigenbaum develops the first Expert System, giving rebirth to AI
1975 – 1982

IBM's Watson Q&A machine wins Jeopardy! Apple integrates Siri, a personal voice assistant into the iPhone
2011

2016
AlphaGo defeats Lee Sedol

2014
YouTube recognizes cats from videos

2000

1950 1960 1970 1980 1990 2010 2020

1964
Eliza, the first chatbot is developed by Joseph Weizenbaum at MIT

1997
IBM's Deep Blue defeats Garry Kasparov, the world's reigning chess champion

- Limited computer processing power
- Limited database storage capacity
- Limited network ability

- Real-world problems are complicated
  - Facial recognition, translation
  - Combinatorial explosion

- Disappointing results: failure to achieve scale
- Collapse of dedicated hardware vendors

AI Winter I

AI Winter II

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)

Definition
of
Artificial Intelligence
(A.I.)

Artificial Intelligence

"... the **science** and **engineering** of making **intelligent machines**"

(John McCarthy, 1955)

Artificial Intelligence

"... technology that thinks and acts like humans"

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Artificial Intelligence

"... **intelligence** exhibited by **machines** or **software**"

4 Approaches of AI

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

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**

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**

Artificial Intelligence: A Modern Approach

1. Artificial Intelligence

2. Problem Solving

3. Knowledge and Reasoning

4. Uncertain Knowledge and Reasoning

5. Machine Learning

6. Communicating, Perceiving, and Acting

7. Philosophy and Ethics of AI

Artificial Intelligence: Intelligent Agents

Artificial Intelligence:
2. Problem Solving

- **Solving Problems by Searching**
- **Search in Complex Environments**
- **Adversarial Search and Games**
- **Constraint Satisfaction Problems**

Artificial Intelligence:
3. Knowledge and Reasoning

- **Logical Agents**
- **First-Order Logic**
- **Inference in First-Order Logic**
- **Knowledge Representation**
- **Automated Planning**

Artificial Intelligence:
4. Uncertain Knowledge and Reasoning

- **Quantifying Uncertainty**
- **Probabilistic Reasoning**
- **Probabilistic Reasoning over Time**
- **Probabilistic Programming**
- **Making Simple Decisions**
- **Making Complex Decisions**
- **Multiagent Decision Making**

Artificial Intelligence:
5. Machine Learning

- **Learning from Examples**

- **Learning Probabilistic Models**

- **Deep Learning**

- **Reinforcement Learning**

Artificial Intelligence:
6. Communicating, Perceiving, and Acting

- **Natural Language Processing**
- **Deep Learning for Natural Language Processing**
- **Computer Vision**
- **Robotics**

Artificial Intelligence:

Philosophy and Ethics of AI
The Future of AI

Artificial Intelligence
Machine Learning & Deep Learning
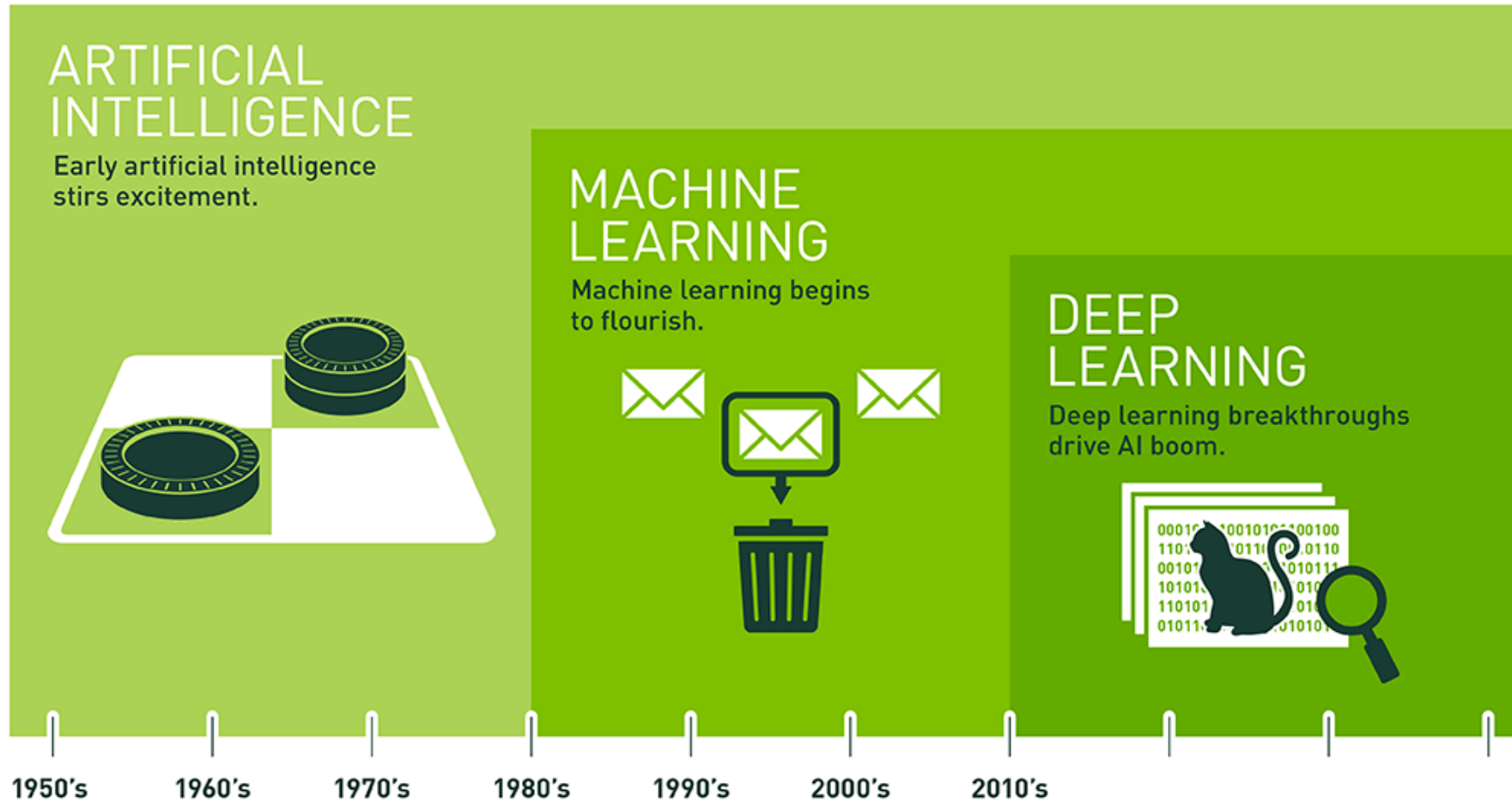
AI, ML, DL

Artificial Intelligence (AI)

Machine Learning (ML)

Supervised Learning

Unsupervised Learning

Deep Learning (DL)
CNN
RNN LSTM GRU
GAN

Semi-supervised Learning

Reinforcement Learning

3 Machine Learning Algorithms
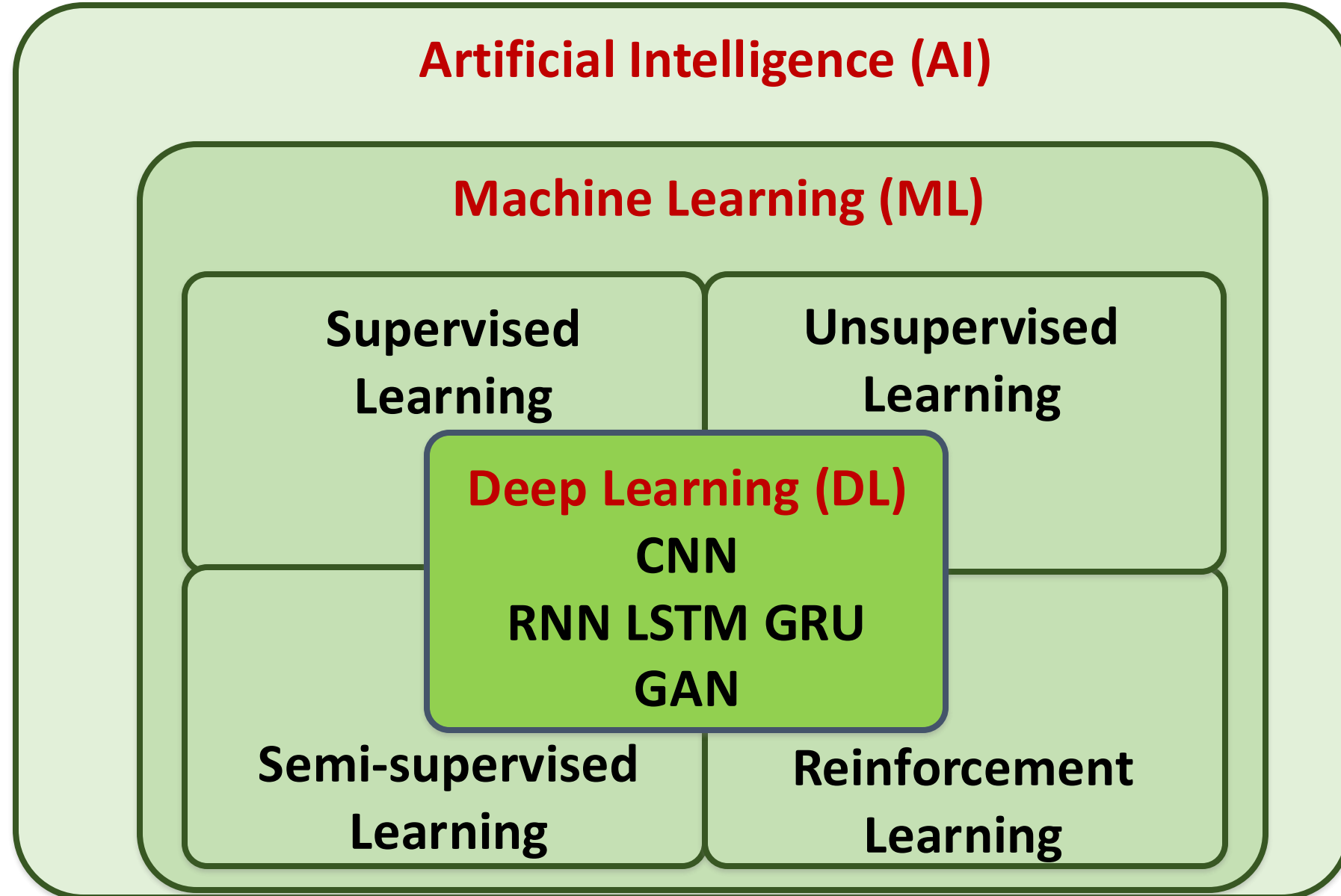
Source: Enrico Galimberti, http://blogs.teradata.com/data-points/tree-machine-learning-algorithms/

Machine Learning (ML)

Source: https://www.mactores.com/services/aws-big-data-machine-learning-cognitive-services/

Machine Learning (ML) / Deep Learning (DL)


```
Machine Learning (ML)
├── Supervised Learning
│   ├── Decision Tree Classifiers
│   ├── Linear Classifiers
│   │   ├── Support Vector Machine (SVM)
│   │   ├── Neural Network (NN)
│   │   └── Deep Learning (DL)
│   ├── Rule-based Classifiers
│   └── Probabilistic Classifiers
│       ├── Naïve Bayes (NB)
│       ├── Bayesian Network (BN)
│       └── Maximum Entropy (ME)
├── Unsupervised Learning
└── Reinforcement Learning
```
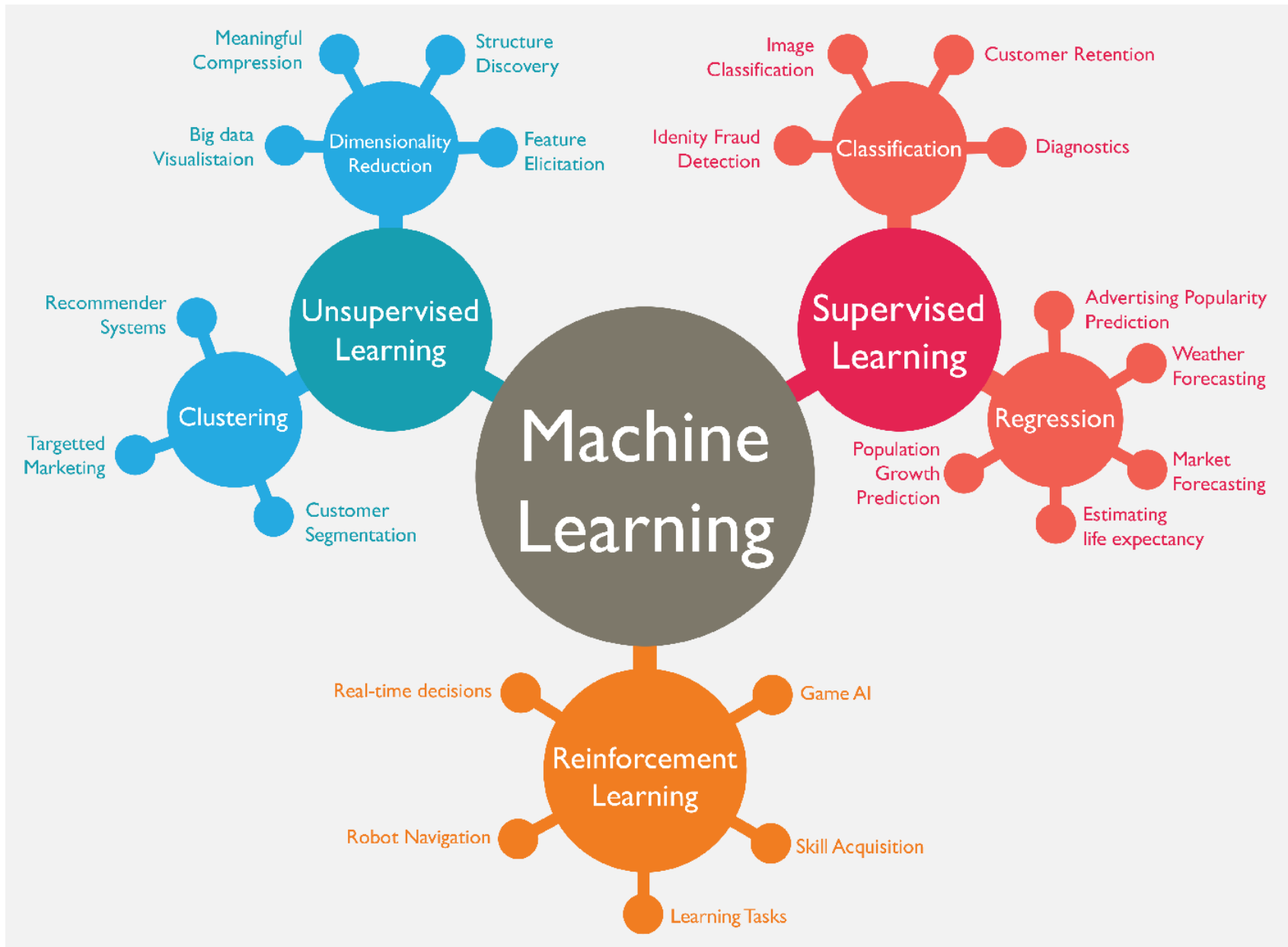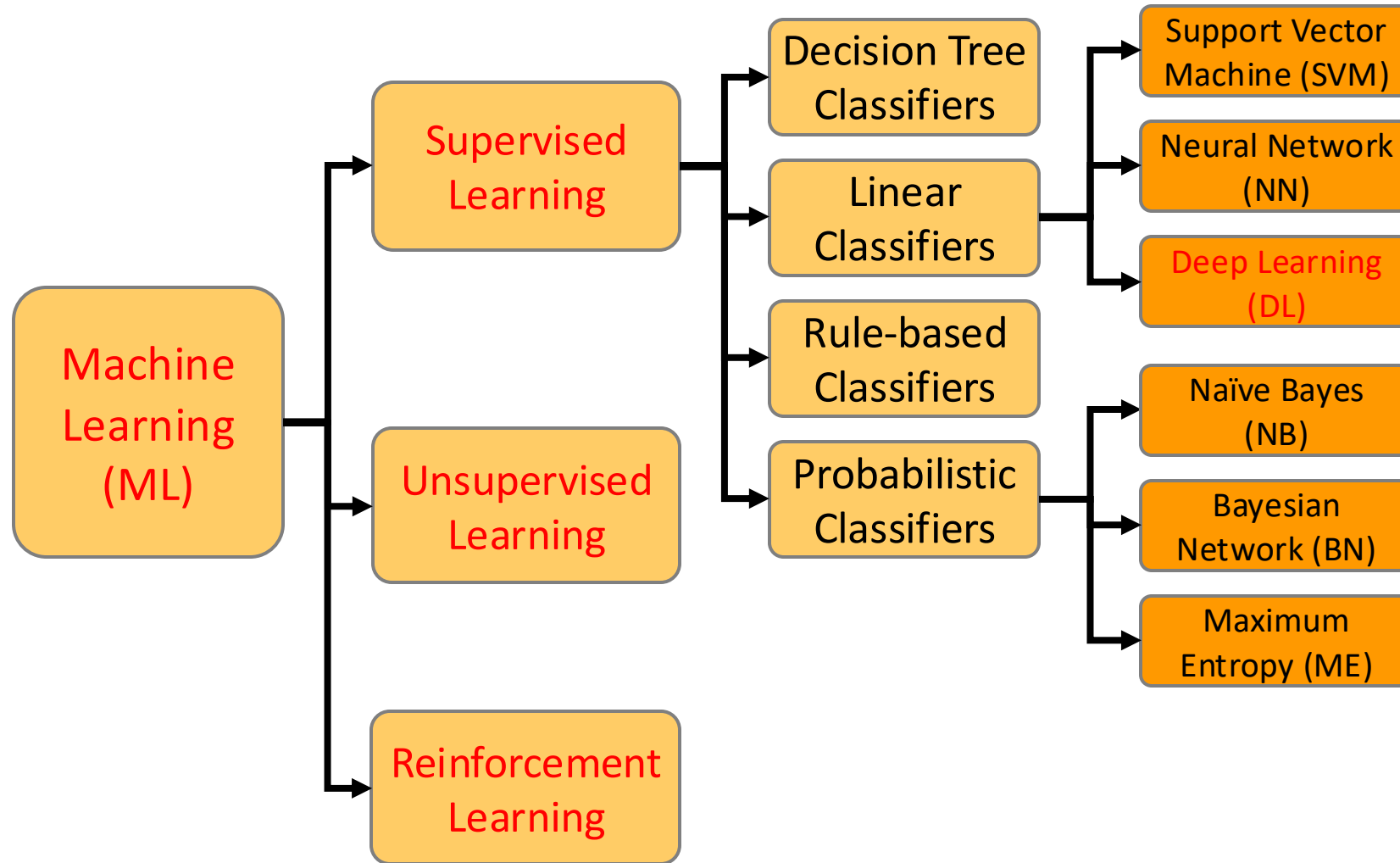
AI for Text Analytics
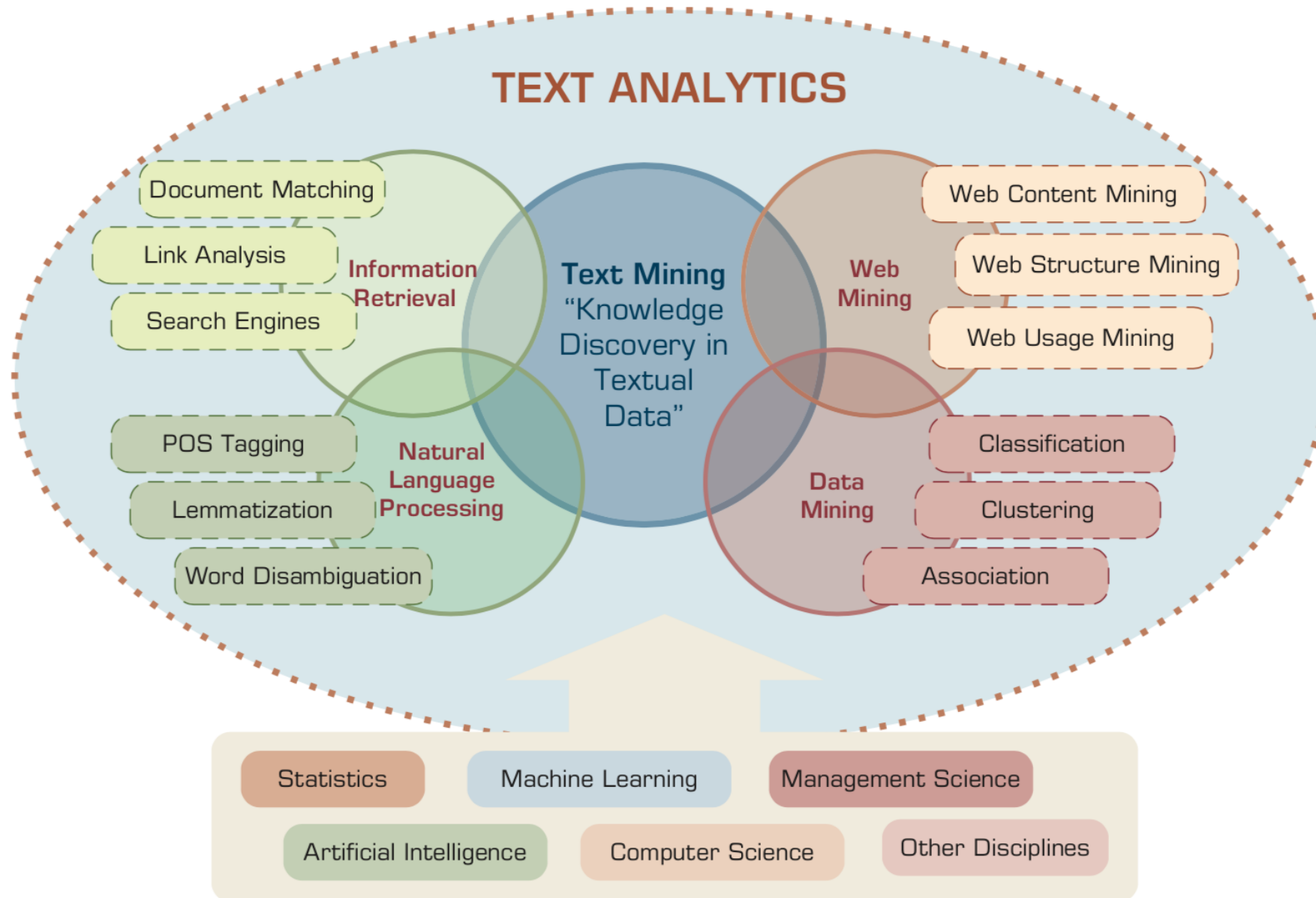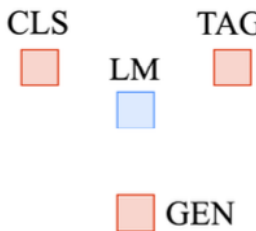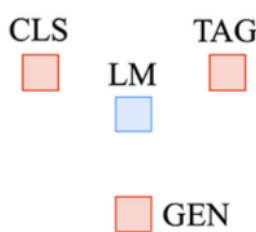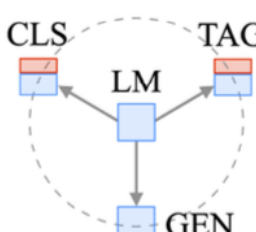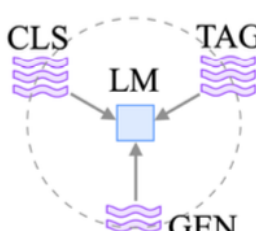
Transformer Models

Large Language Models (LLMs)

Source: Hadi, Muhammad Usman, Rizwan Qureshi, Abbas Shah, Muhammad Irfan, Anas Zafar, Muhammad Bilal Shaikh, Naveed Akhtar, Jia Wu, and Seyedali Mirjalili. "Large language models: a comprehensive survey of its applications, challenges, limitations, and future prospects." Authorea Preprints (2023).

57
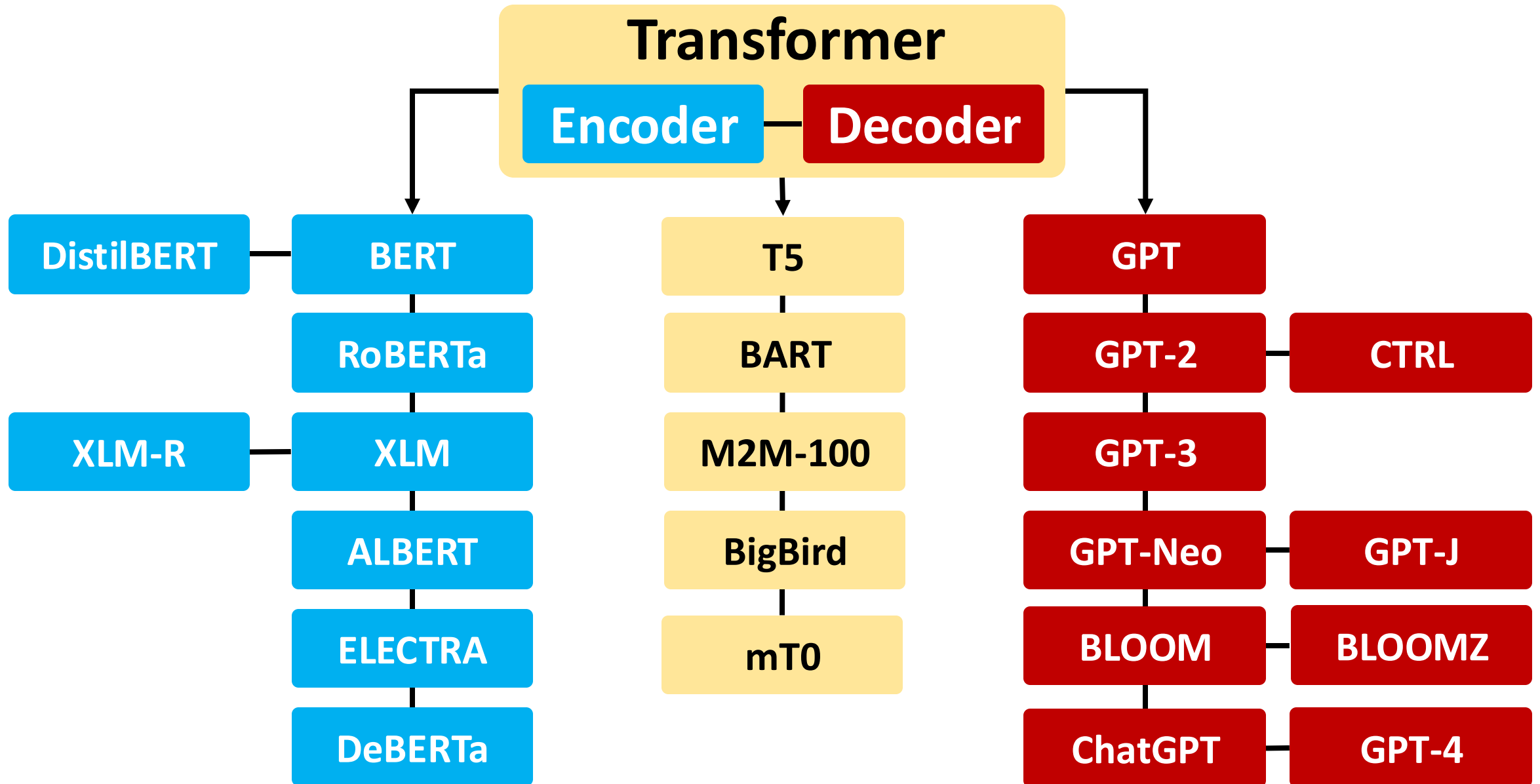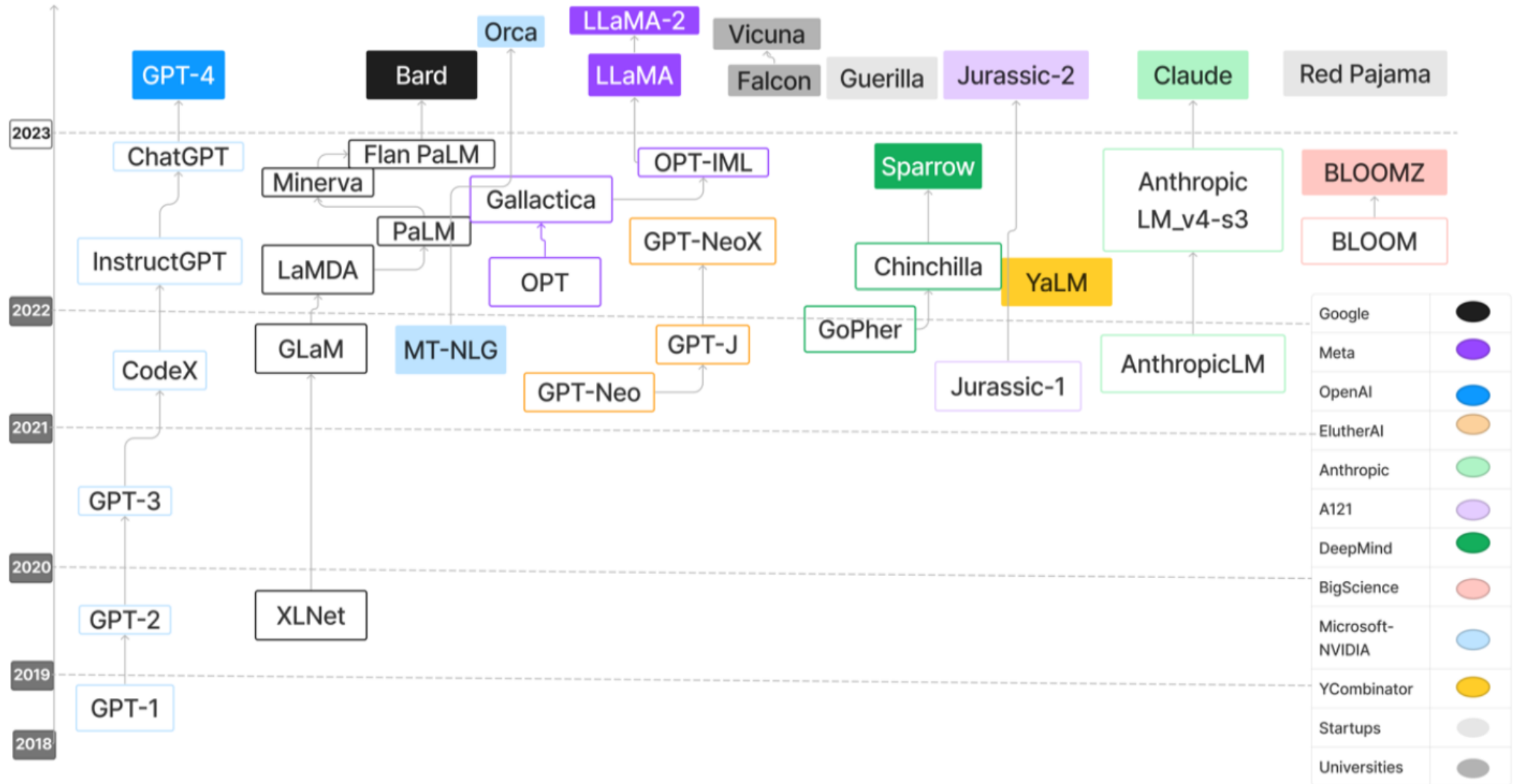
Four Paradigms in NLP (LM)

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)	

Generative AI
Text, Image, Video, Audio Applications

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**

LMArena Leaderboard

Rank (UB) ↑	Model ↕	Score ↕	95% CI (±) ↕	Votes ↕	Organization ↕	License ↕
1	G gemini-2.5-pro	1455	±5	41,731	Google	Proprietary
1	A\ 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	A\ 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	X 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

Artificial Analysis Intelligence Index
Intelligence, Speed, Price

INTELLIGENCE
Artificial Analysis Intelligence Index; Higher is better

Model	Value
GPT-5 (high)	67
GPT-5 (medium)	66
Grok 4	65
o3	65
Gemini 2.5 Pro	60
Claude 4.1 Opus	59
gpt-oss-120B (high)	58
Qwen3 235B 2507	57
Claude 4 Sonnet	57
DeepSeek V3.1	54
Gemini 2.5 Flash	51
GPT-4.1	43
Llama 4 Maverick	36
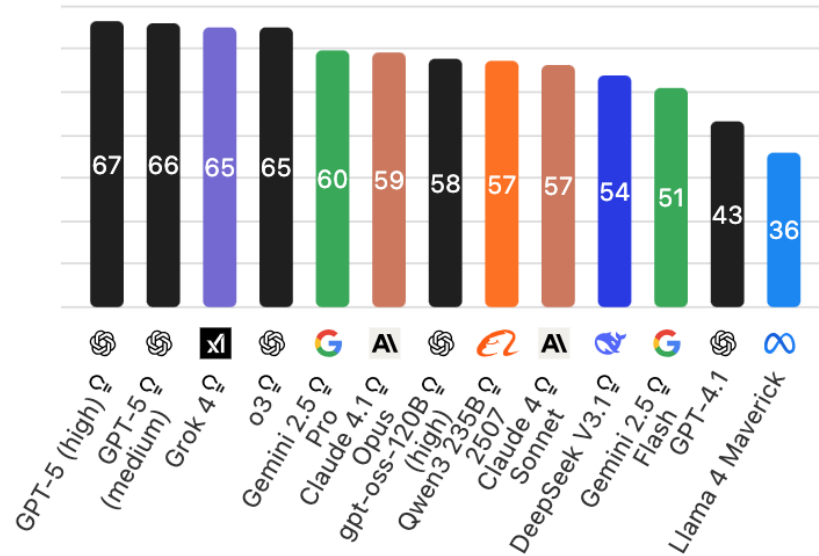
SPEED
Output Tokens per Second; Higher is better

Model	Value
Gemini 2.5 Flash	261
gpt-oss-120B (high)	225
o3	181
GPT-5 (medium)	178
Gemini 2.5 Pro	156
Llama 4 Maverick	142
GPT-4.1	117
GPT-5 (high)	65
Qwen3 235B 2507	51
Claude 4 Sonnet	46
Claude 4.1 Opus	46
Grok 4	44
DeepSeek V3.1	19
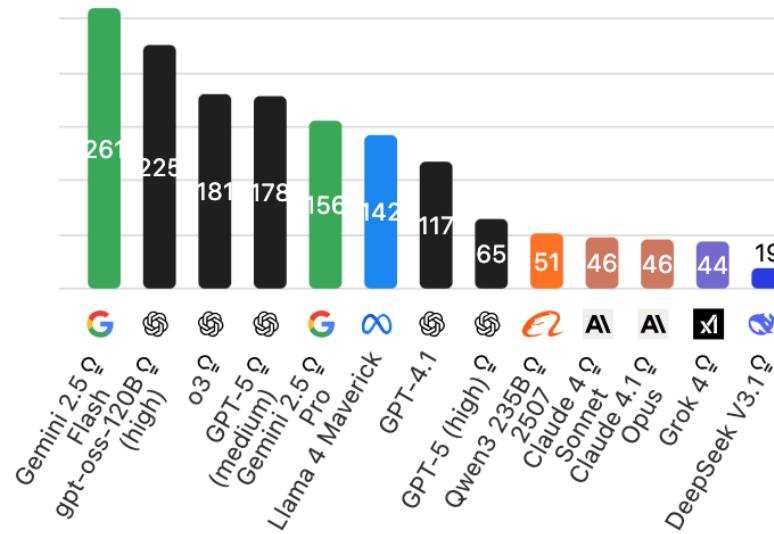
PRICE
USD per 1M Tokens; Lower is better

Model	Value
gpt-oss-120B (high)	0.3
Llama 4 Maverick	0.4
Gemini 2.5 Flash	0.8
DeepSeek V3.1	1
Qwen3 235B 2507	2.6
GPT-5 (high)	3.4
GPT-5 (medium)	3.4
Gemini 2.5 Pro	3.4
GPT-4.1	3.5
o3	3.5
Claude 4 Sonnet	6
Grok 4	6
Claude 4.1 Opus	30

Source: https://artificialanalysis.ai/
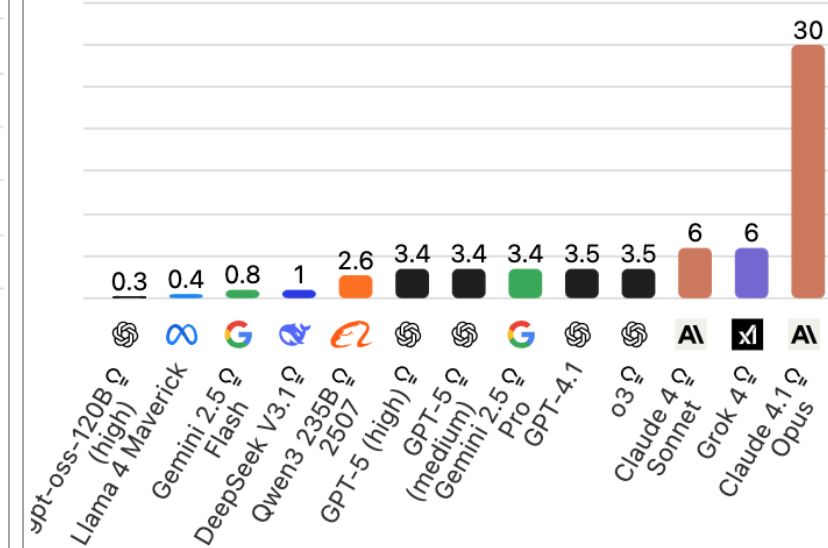
Artificial Analysis Intelligence Index 2022-2025

Frontier Language Model Intelligence, Over Time

Artificial Analysis Intelligence Index v3.0 incorporates 10 evaluations: MMLU-Pro, GPQA Diamond, Humanity's Last Exam, LiveCodeBench, SciCode, AIME 2025, IFBench, AA-LCR, Terminal-Bench Hard, τ^2-Bench Telecom

Legend: ■ Alibaba ■ Anthropic ■ DeepSeek ■ Google ■ LG AI Research ■ Meta ■ Mistral ■ Moonshot AI ■ OpenAI ■ Upstage ■ xAI ■ Z AI
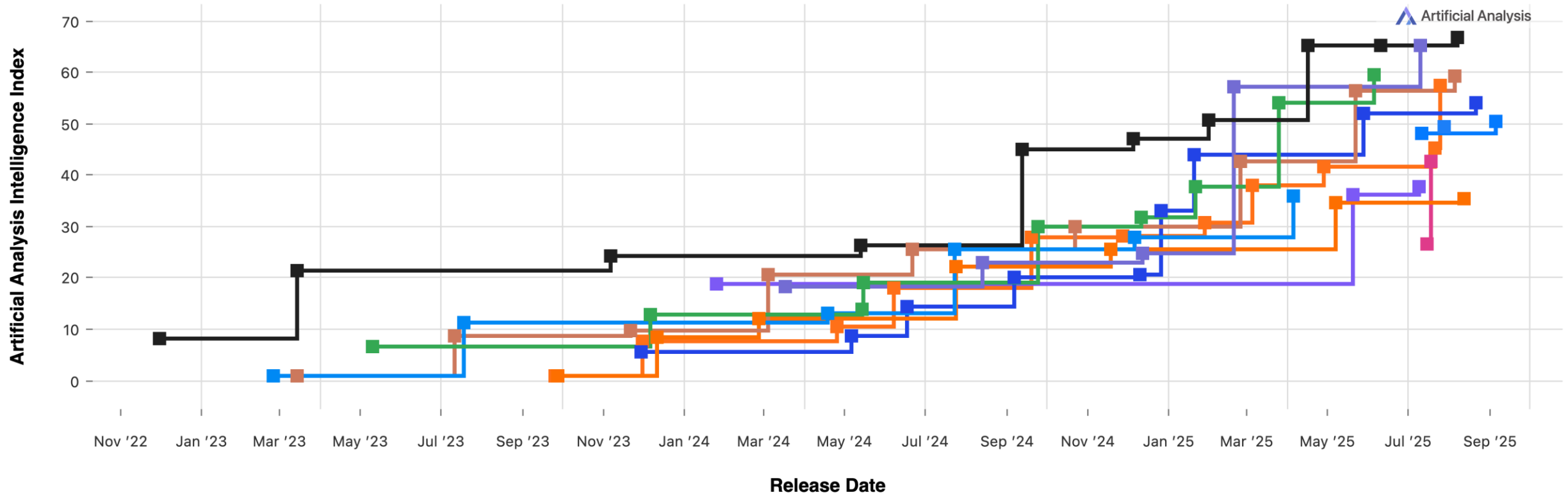
Google Gemma 3 27B
The most capable model you can run on a single GPU or TPU

Chatbot Arena Elo Score

- DeepSeek R1 (671B): 1363
- Gemma 3 27B[1] (27B): 1338
- Deepseek v3 (671B): 1318
- o3-mini (Proprietary): 1304
- Llama3-405B (405B): 1269
- Mistral Large (123B): 1251
- Gemma 2 27B (27B): 1220

NVIDIA H100 GPUs required @bf16[2]

[1] Gemma 3 27B preliminary elo score +8/-9
[2] estimated GPUs
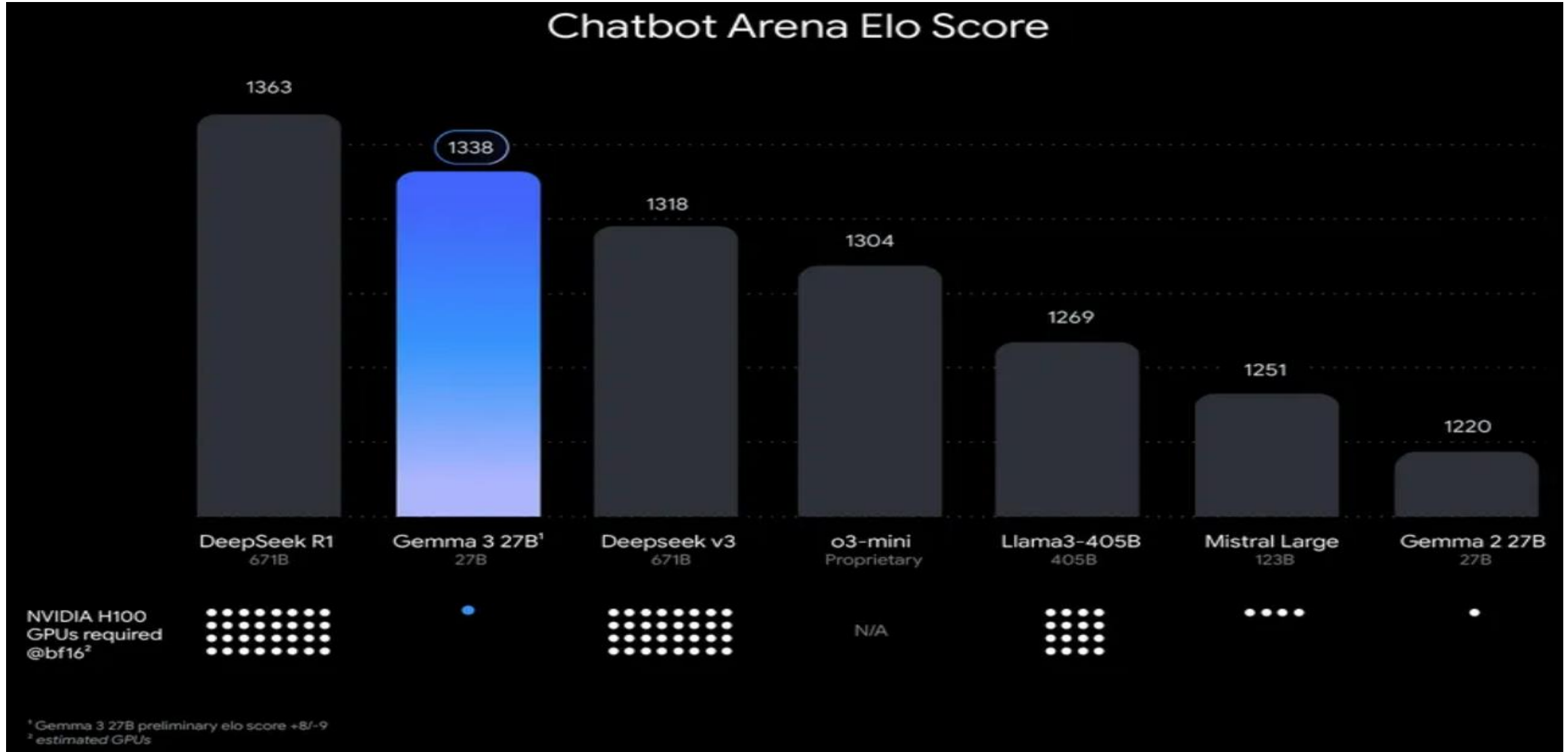
Google Gemma 3 Multimodality (vision-language input and text outputs)

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

Google Gemma 3: Pre-training and Post-training
(distillation, reinforcement learning, and model merging)

Model Performance vs. Size

Source: https://developers.googleblog.com/en/introducing-gemma3/
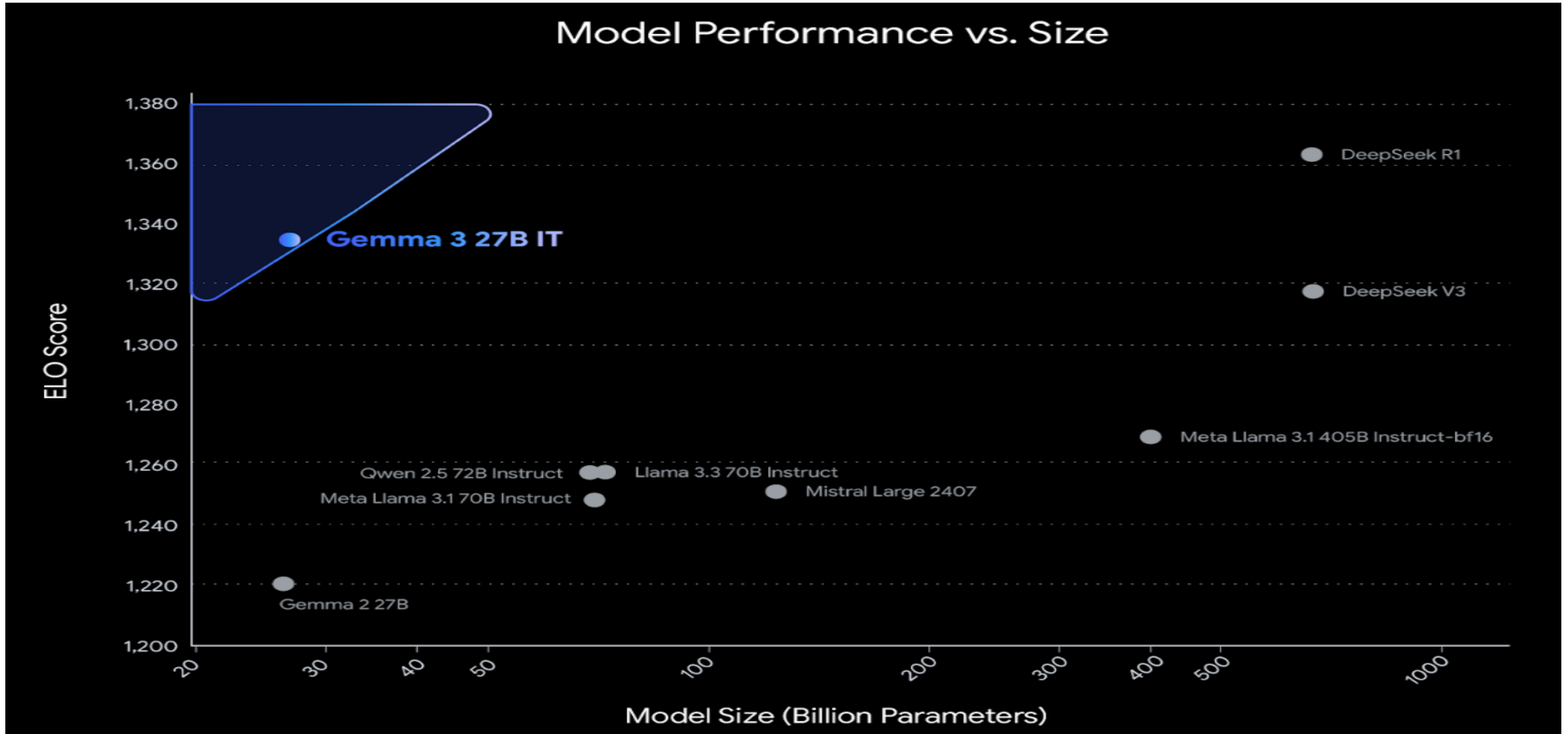
Google AI Studio (Gemma 3 27B)

Grok 3 Deep Search

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 assistant<|im_end|><|im_start|>user<|im_sep|><|im_end|><|im_start|>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

Word	Word Embedding							Dimensionality reduction	Visualization of Word embeddings in 2D
	living being	*feline*	*human*	*gender*	*royalty*	*verb*	*plural*		
cat →	0.6	0.9	0.1	0.4	-0.7	-0.3	-0.2		
kitten →	0.5	0.8	-0.1	0.2	-0.6	-0.5	-0.1		
dog →	0.7	-0.1	0.4	0.3	-0.4	-0.1	-0.3		
houses →	0.8	-0.4	-0.5	0.1	-0.9	0.3	0.8		
man →	0.6	-0.2	0.8	0.9	-0.1	-0.9	-0.7		
women →	0.7	0.3	0.9	-0.7	0.1	-0.5	-0.4		
king →	0.5	-0.4	0.7	0.8	0.9	-0.7	-0.6		
queen →	0.8	-0.1	0.8	-0.9	0.8	-0.5	-0.9		

Dimensionality reduction of word embeddings from 7D to 2D

Transformer (Attention is All You Need)
(Vaswani et al., 2017)
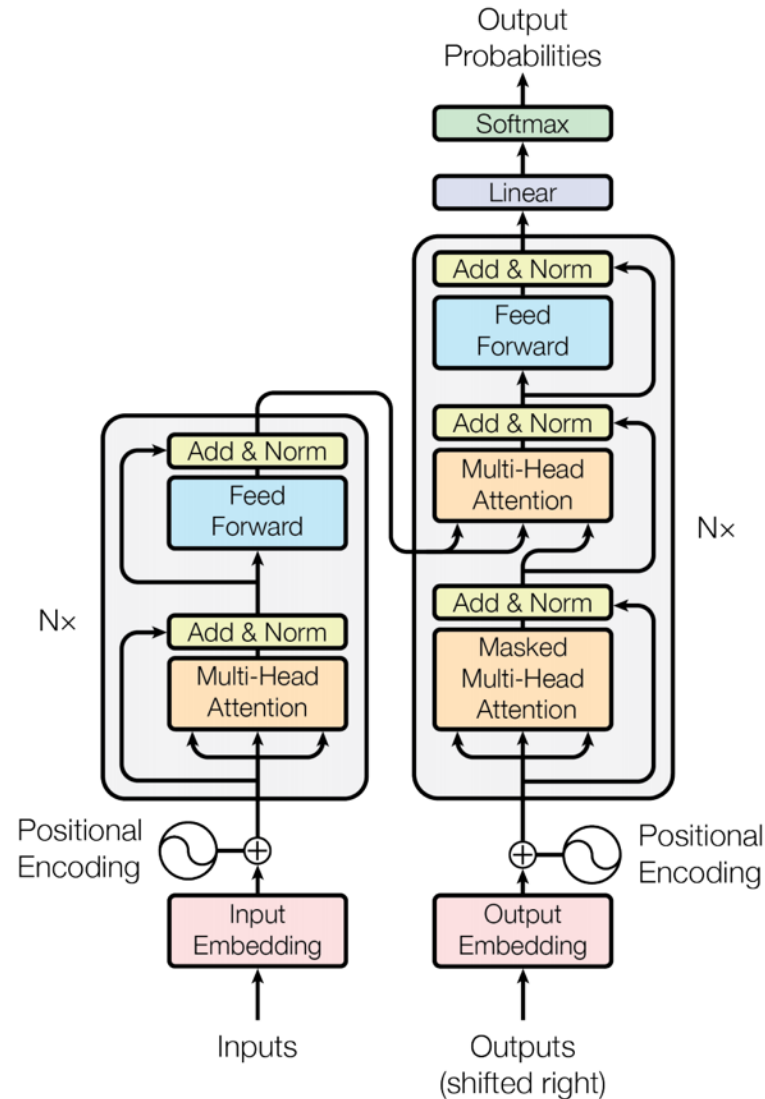
BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding

BERT (Bidirectional Encoder Representations from Transformers)

Overall pre-training and fine-tuning procedures for BERT

Source: Devlin, Jacob, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova (2018).
"Bert: Pre-training of deep bidirectional transformers for language understanding." arXiv preprint arXiv:1810.04805.
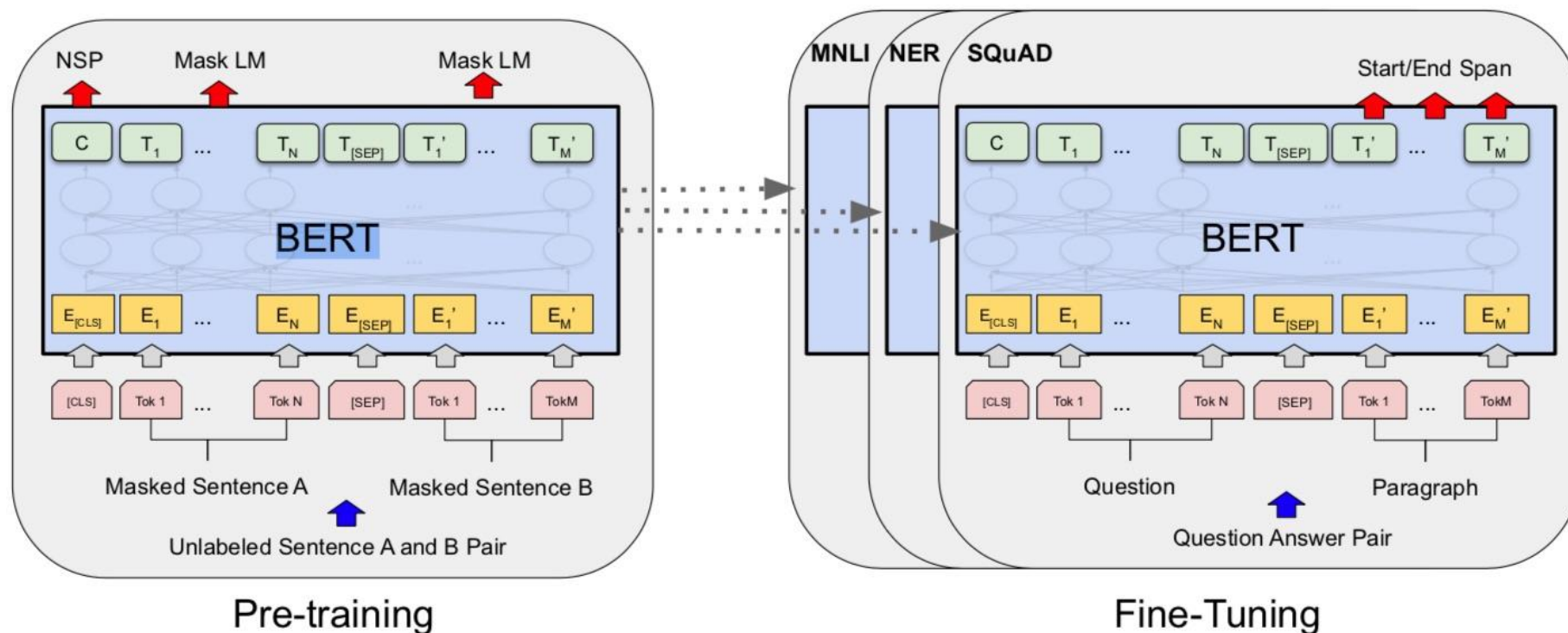
Fine-tuning BERT on Different Tasks
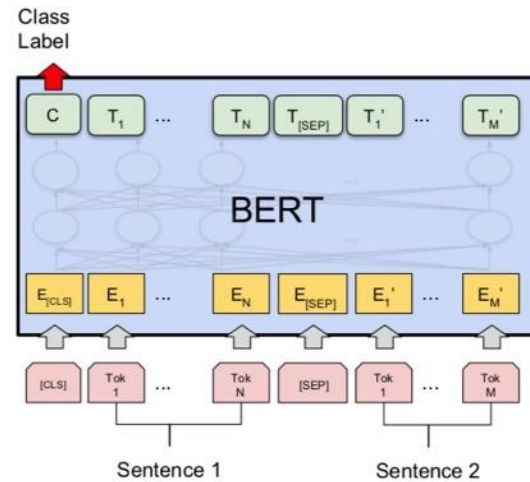
(a) Sentence Pair Classification Tasks:
MNLI, QQP, QNLI, STS-B, MRPC,
RTE, SWAG
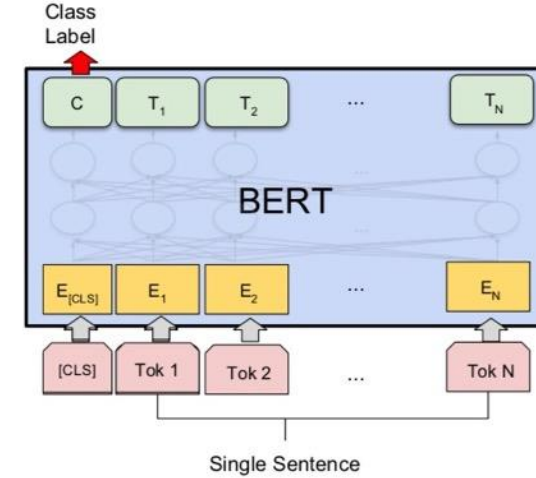
(b) Single Sentence Classification Tasks:
SST-2, CoLA
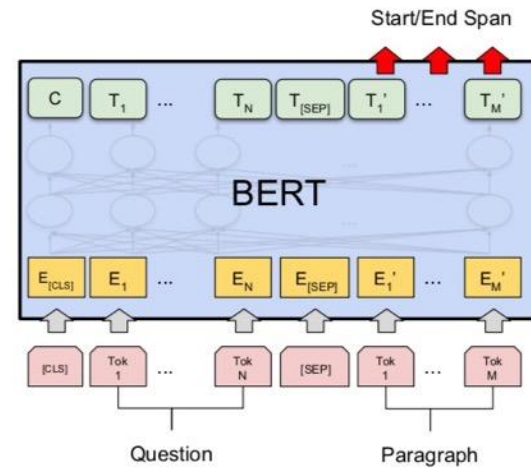
(c) Question Answering Tasks:
SQuAD v1.1

(d) Single Sentence Tagging Tasks:
CoNLL-2003 NER

Sentiment Analysis:
Single Sentence Classification

(b) Single Sentence Classification Tasks:
SST-2, CoLA

Source: Devlin, Jacob, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova (2018).
"BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding." arXiv preprint arXiv:1810.04805
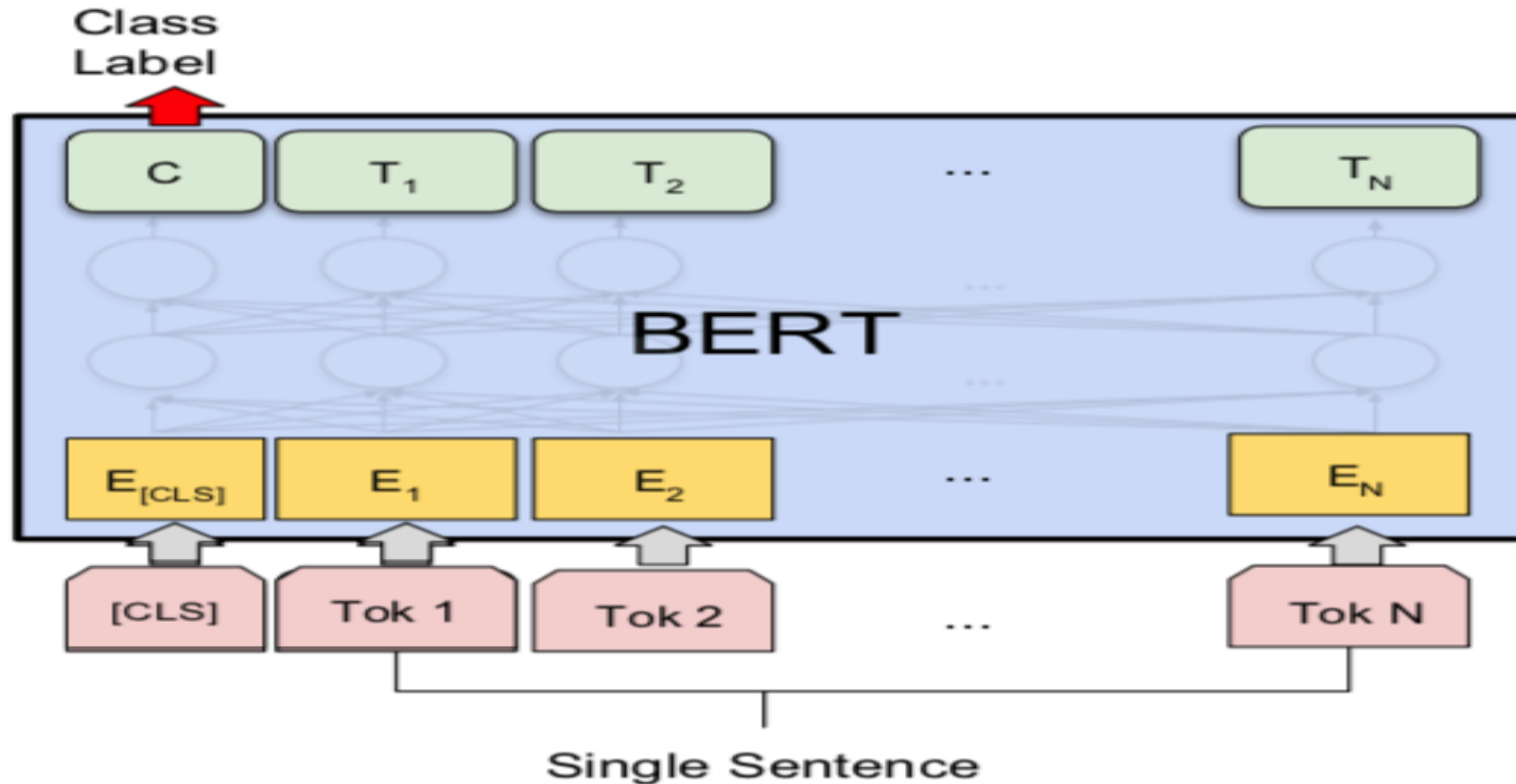
Fine-tuning BERT on Question Answering (QA)

Start/End Span
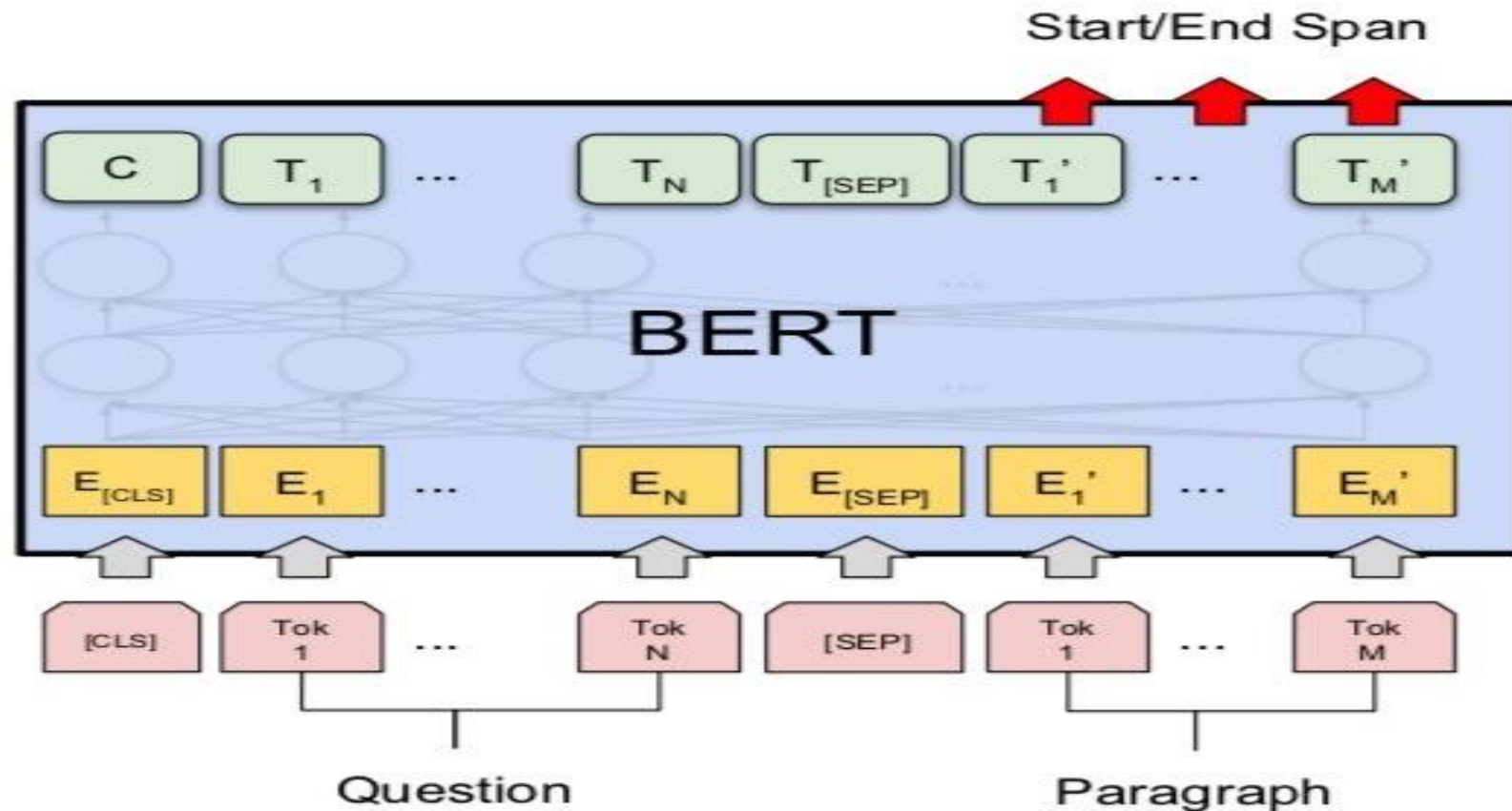
BERT

(c) Question Answering Tasks:
SQuAD v1.1

Fine-tuning BERT on Dialogue
Intent Detection (ID; Classification)

(b) Single Sentence Classification Tasks: SST-2, CoLA

Source: Devlin, Jacob, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova (2018). "Bert: Pre-training of deep bidirectional transformers for language understanding." arXiv preprint arXiv:1810.04805.
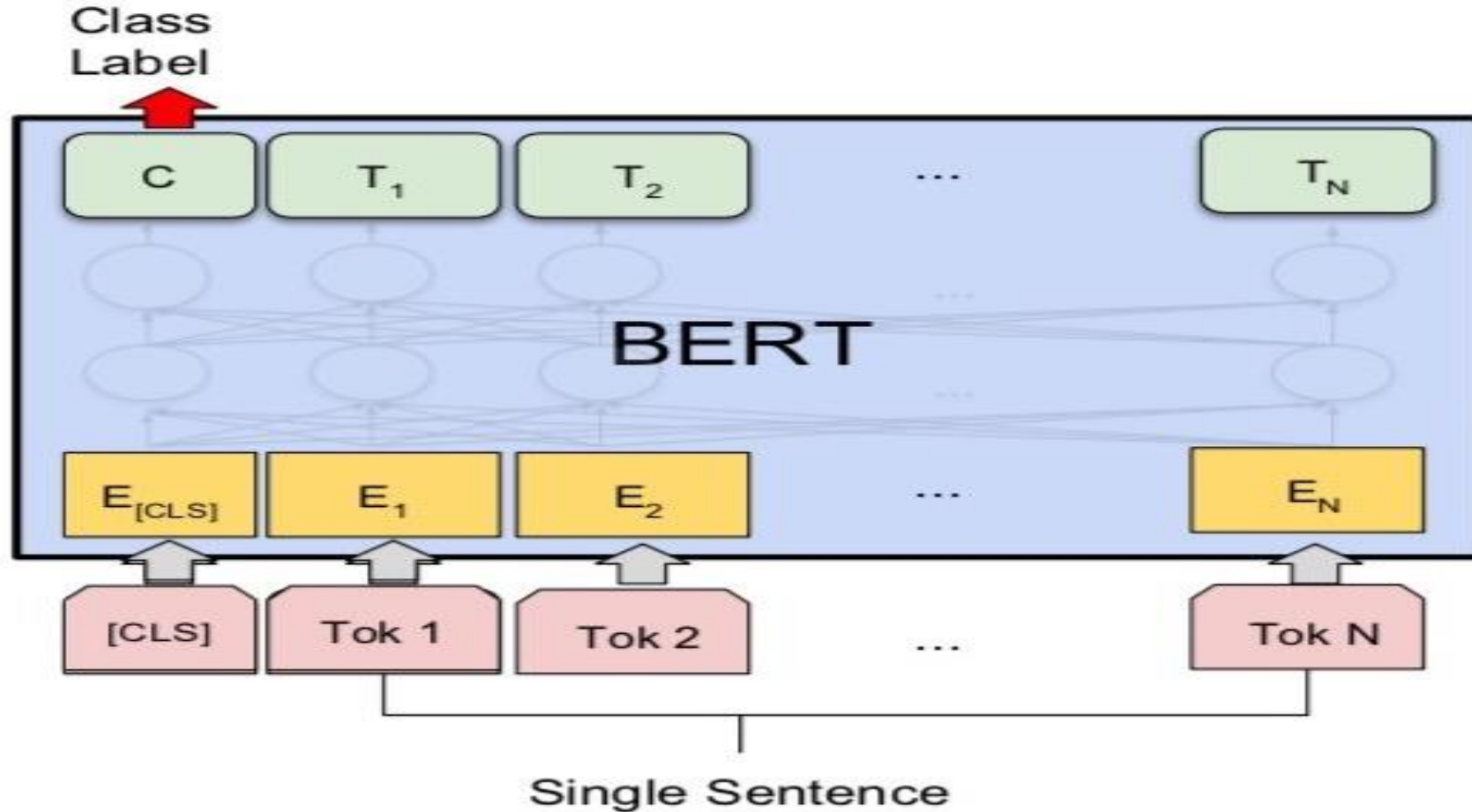
Fine-tuning BERT on Dialogue Slot Filling (SF)

(d) Single Sentence Tagging Tasks: CoNLL-2003 NER

Source: Devlin, Jacob, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova (2018).
"Bert: Pre-training of deep bidirectional transformers for language understanding." arXiv preprint arXiv:1810.04805.
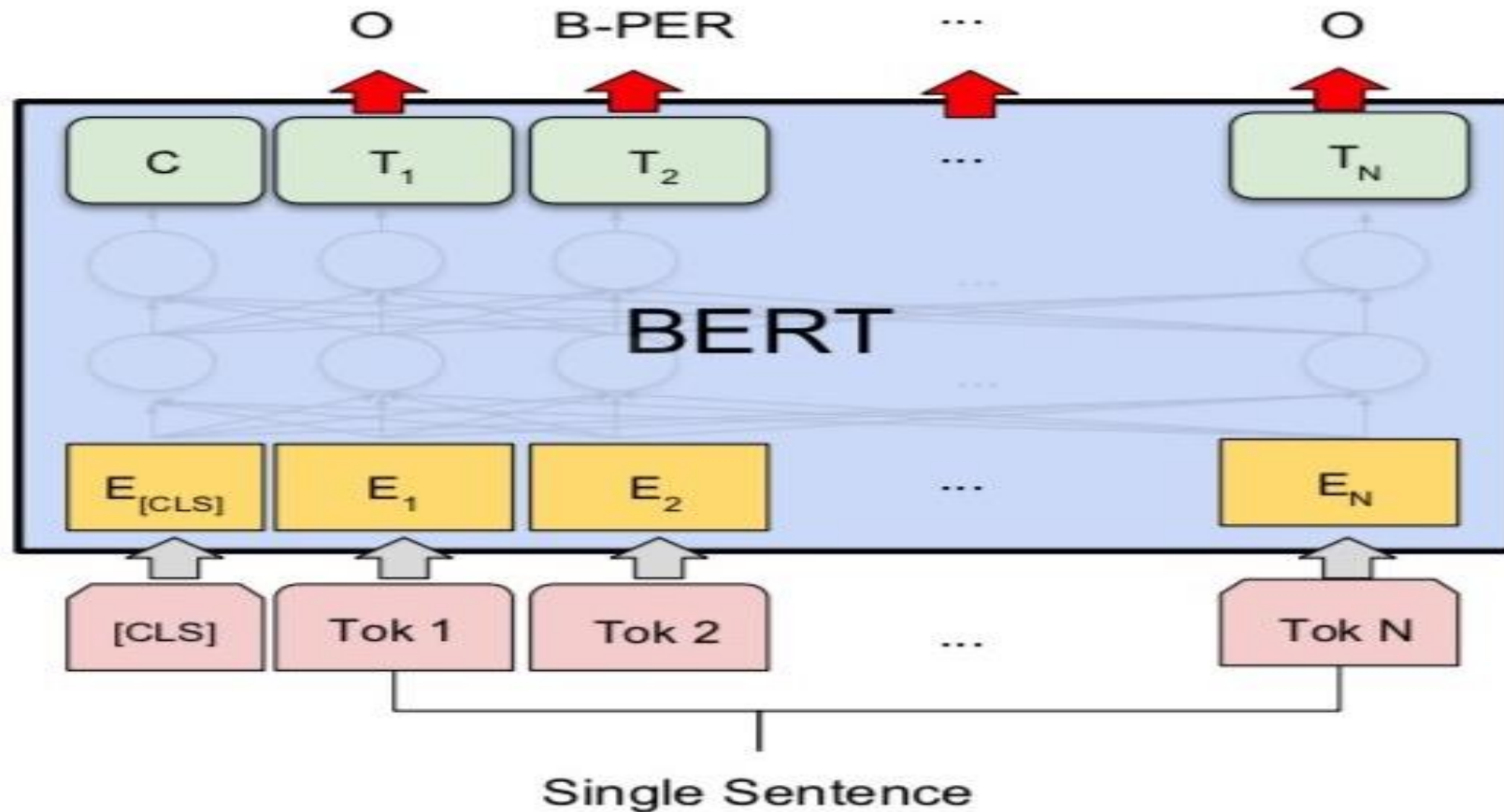
Task-Oriented Dialogue (ToD) System
Speech, Text, NLP
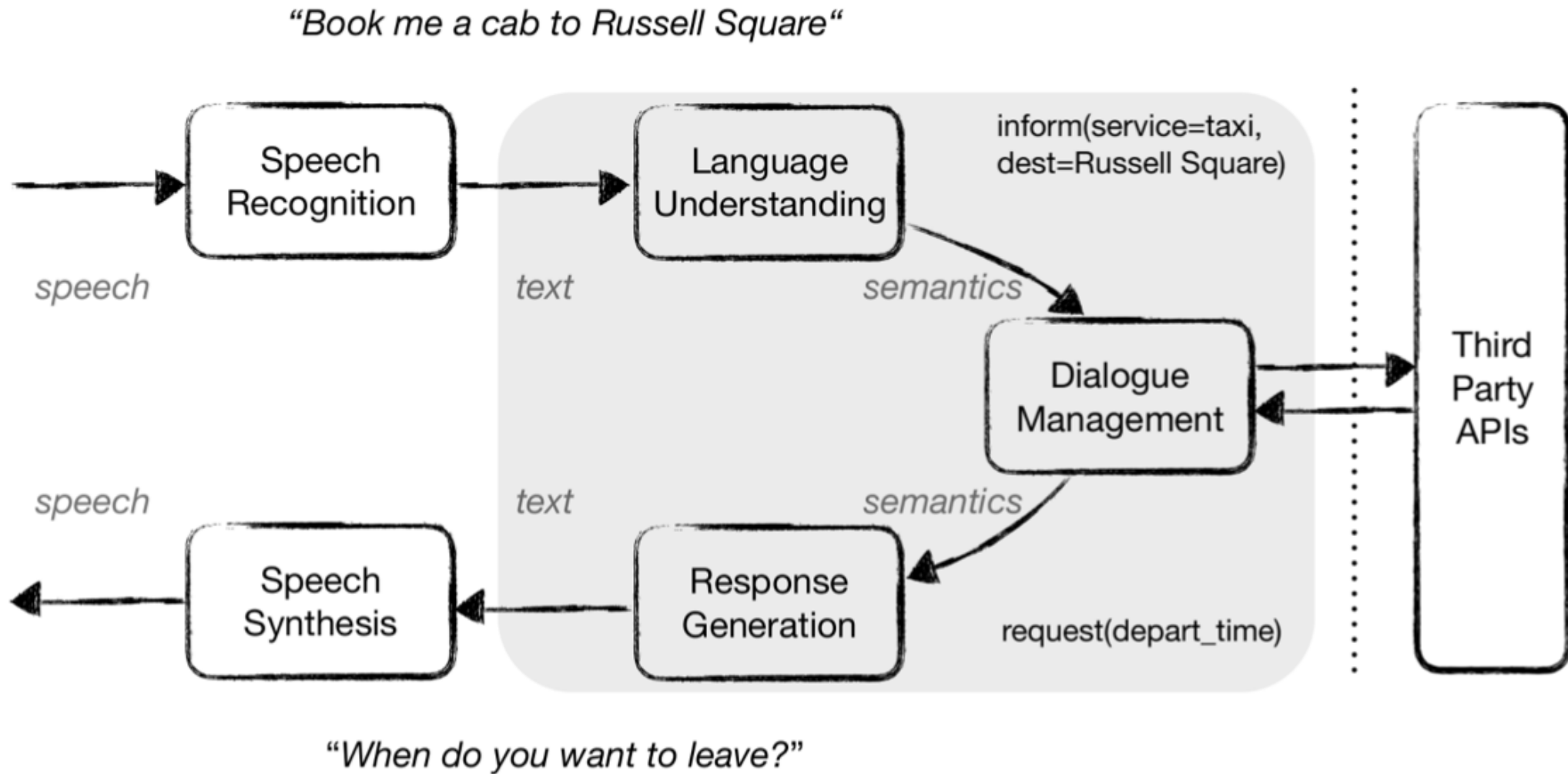
"Book me a cab to Russell Square"

"When do you want to leave?"

Conversational AI
to deliver contextual and personal experience to users

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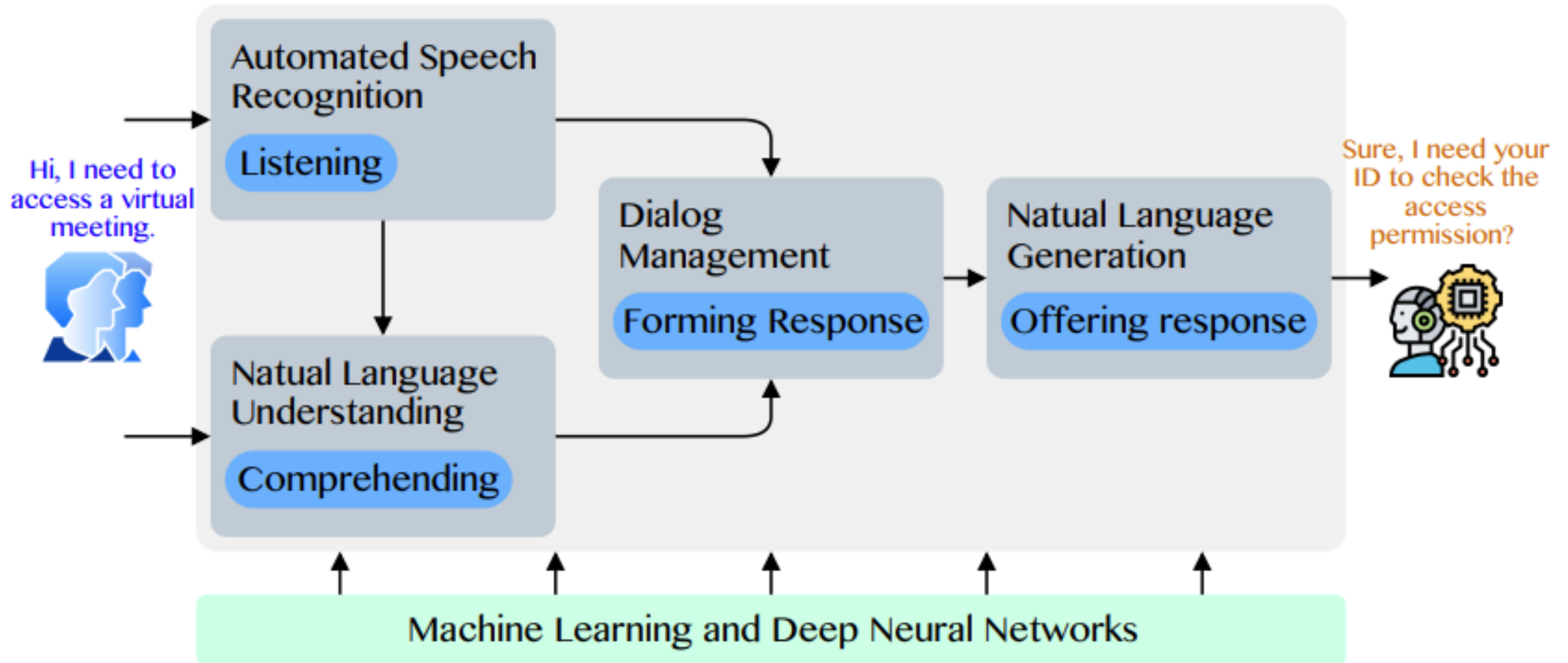
Technological Integration for Multimodal AI

Video content analysis
Video captioning
Video indexing

Speech recognition
Audio captioning
Content-based audio retrieval

Video

Audio

Multimodal AI

Human computer interactions

Image

Facial expression
Touch sensing
Biometric recognition

Visual recognition
Image captioning
Image based search
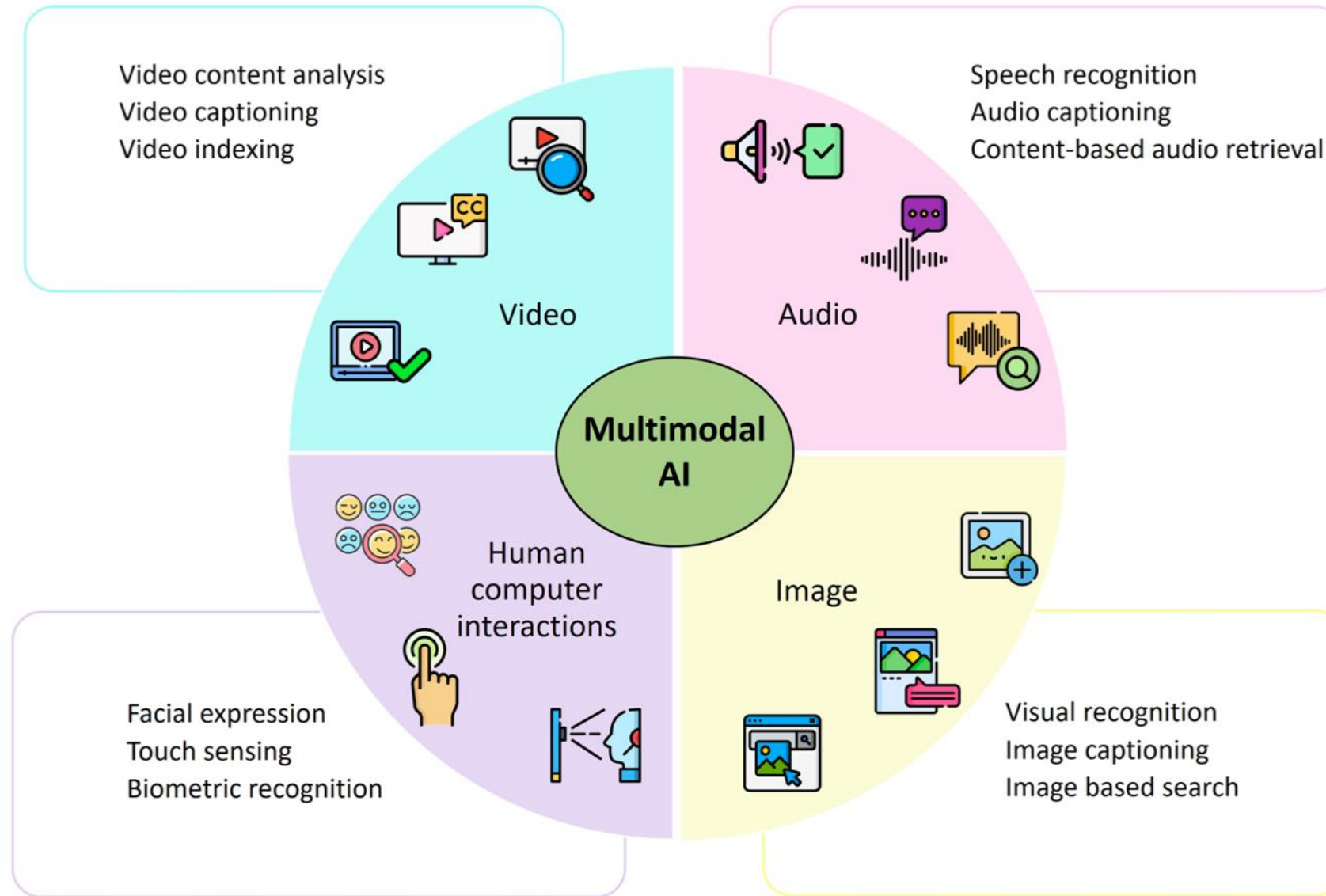
Large Language Model (LLM) based Agents
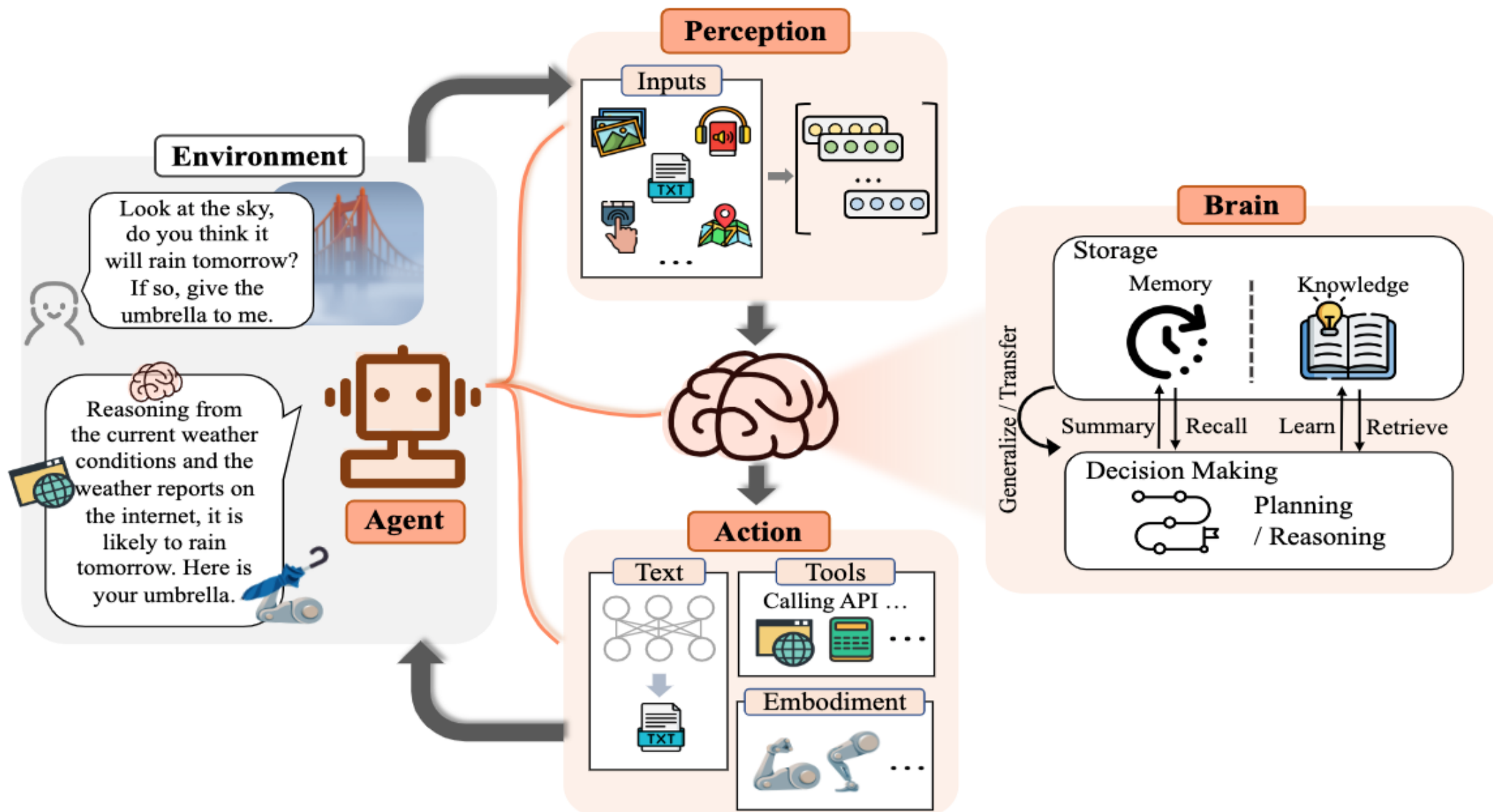
Large Multimodal Agents (LMA)

(a)

(b)

(c)

(d)

Large Multimodal Agents (LMA)

Source: Xie, J., Chen, Z., Zhang, R., Wan, X., & Li, G. (2024). Large Multimodal Agents: A Survey. ArXiv, abs/2402.15116.
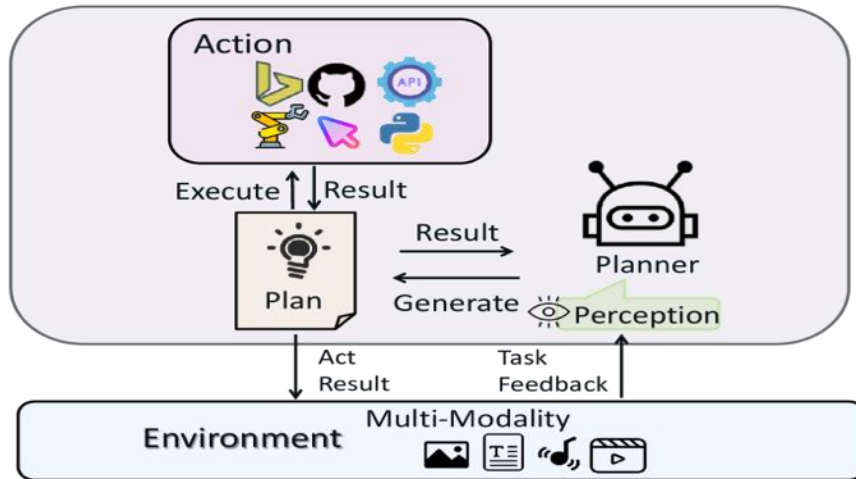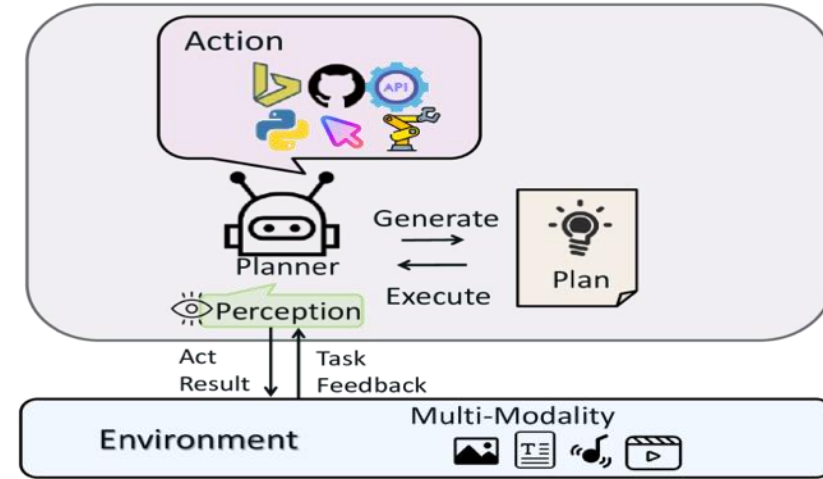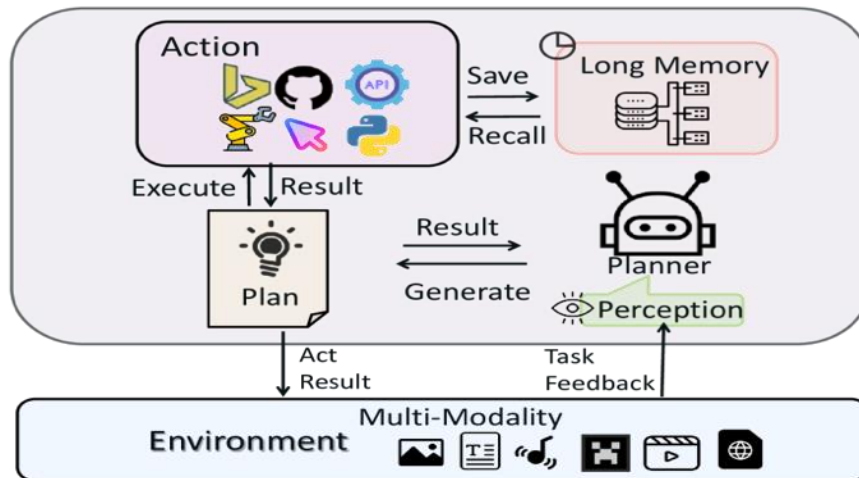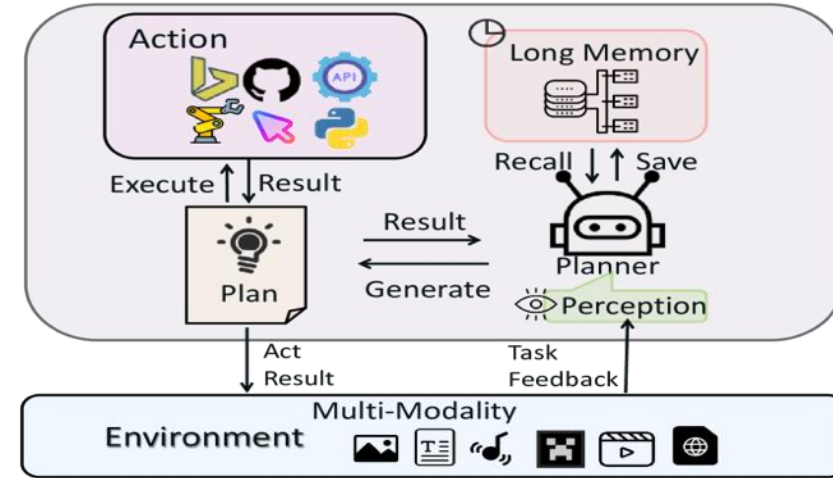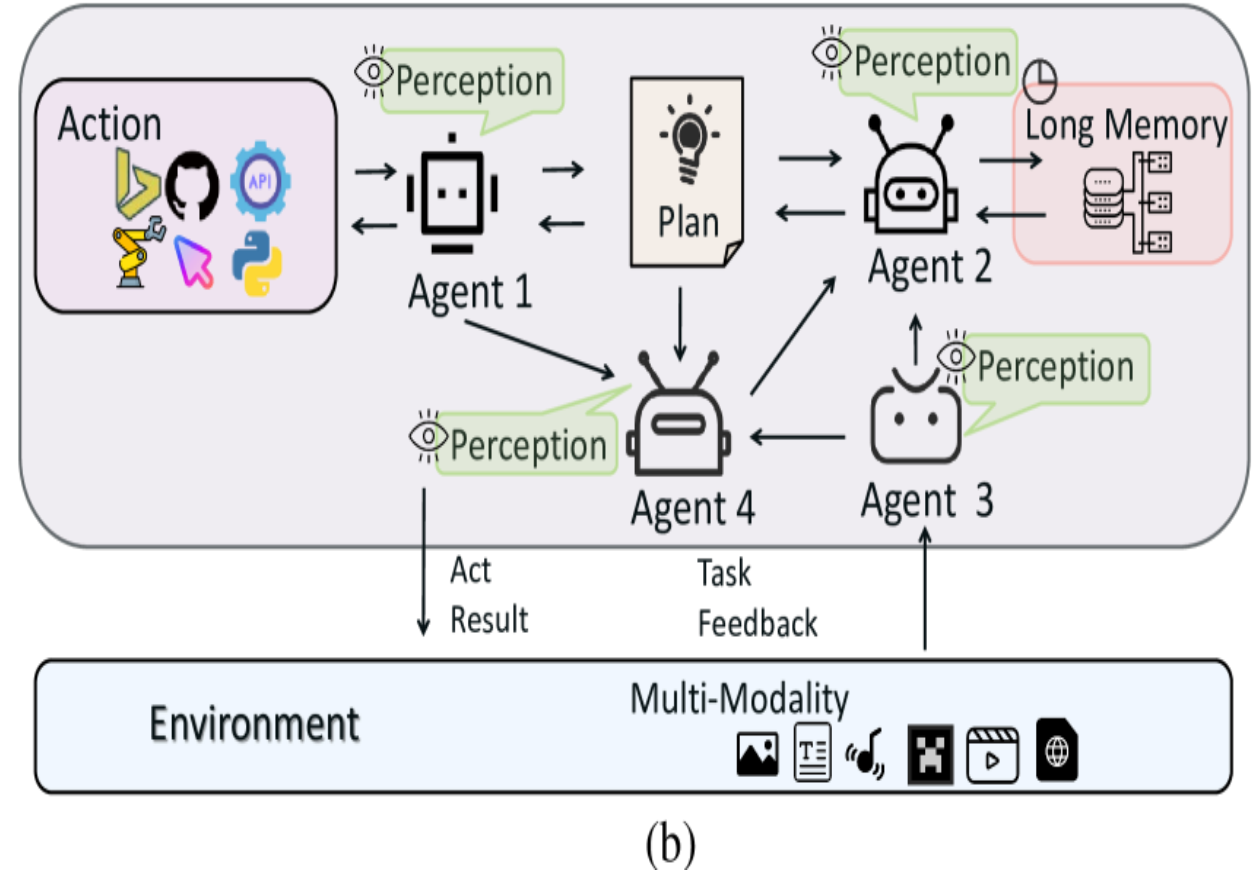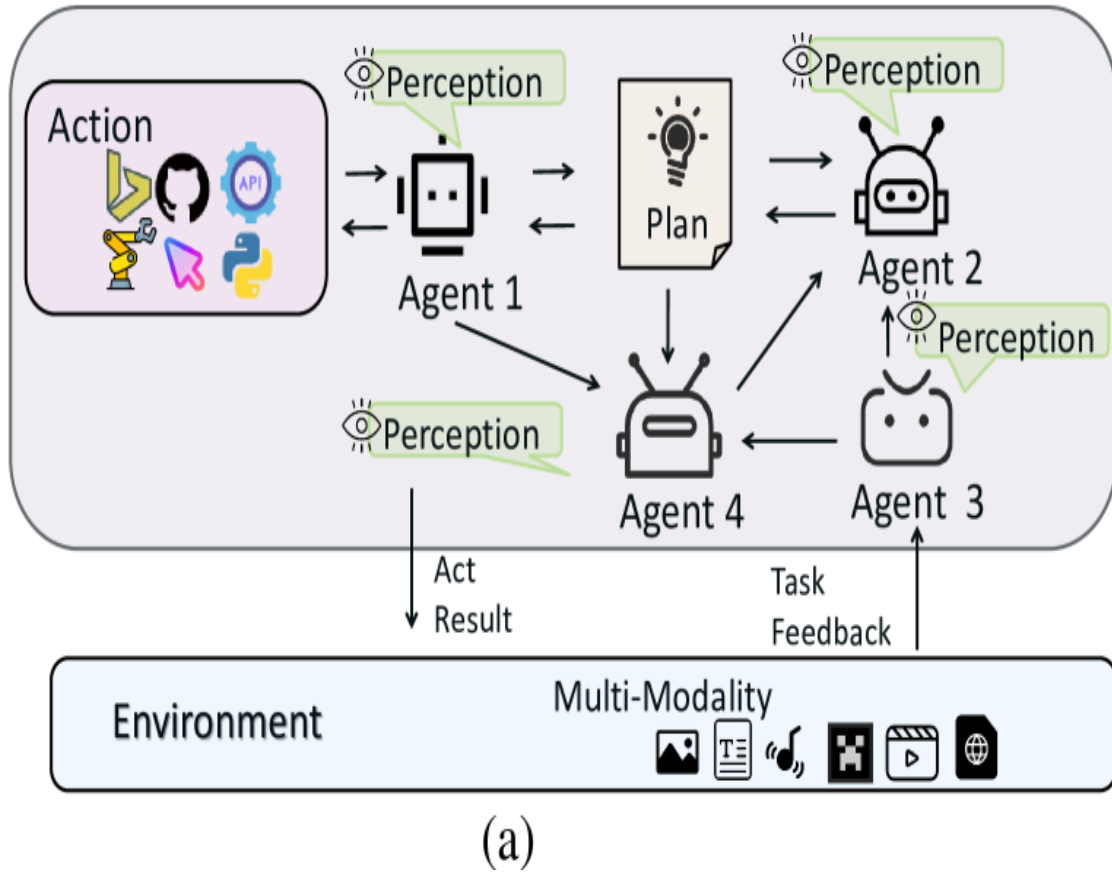
FinBrain: when Finance meets AI 2.0

(Zheng et al., 2019)

Financial Intelligence

Products and services

Wealth management	Risk management	Business security	Smart customer service	Blockchain
Robo-Advisor	Intelligent marketing	Financial product recommendation	Intelligent credit	Risk assessment
Financial identity authentication	AI customer service	Intelligent agent	Blockchain	...

Algorithms and models

Graph algorithm	Combinatorial optimization	Rule engine	Risk monitoring	Face recognition	Speech recognition
Machine learning	Deep learning	Reinforcement learning	Transfer learning	Knowledge graph	...

Financial big data

Text	Speech	Image	Video
Media websites, forums ...	Business platform (electricity supplier, payment, financial management ...)	Government agencies (social security, civil affairs, public security, industry and commerce, taxation, court ...)	Financial institutions (bank, insurance ...)

Technology-driven Financial Industry Development

Development stage	Driving technology	Main landscape	Inclusive finance	Relationship between technology and finance
Fintech 1.0 (financial IT)	Computer	Credit card, ATM, and CRMS	Low	Technology as a tool
Fintech 2.0 (Internet finance)	Mobile Internet	Marketplace lending, third-party payment, crowdfunding, and Internet insurance	Medium	Technology-driven change
Fintech 3.0 (financial intelligence)	AI, Big Data, Cloud Computing, Blockchain	Intelligent finance	High	Deep fusion

Deep learning for financial applications: A survey

Applied Soft Computing (2020)

Financial
time series forecasting with deep learning:
A systematic literature review: 2005–2019

Applied Soft Computing (2020)

Deep learning for financial applications: Topic-Model Heatmap

Source: Ahmet Murat Ozbayoglu, Mehmet Ugur Gudelek, and Omer Berat Sezer (2020). "Deep learning for financial applications: A survey." Applied Soft Computing (2020): 106384.

Deep learning for financial applications: Topic-Feature Heatmap

	algorithmic trading	risk assessment	fraud detection	portfolio management	asset pricing and derivatives market	cryptocurrency and blockchain studies	financial sentiment analysis	financial text mining
price data	35	3	0	16	10	7	10	22
technical indicator	15	0	0	7	1	4	3	7
index data	5	1	0	0	0	0	1	1
market characteristics	6	2	2	0	9	0	0	0
fundamental	2	0	0	2	3	0	0	0
market microstructure data	8	4	3	0	0	1	0	1
sentiment	1	1	0	0	0	1	7	5
text	2	7	2	1	1	0	21	36
news	0	1	0	0	0	0	4	22
company/personal financial data	0	21	5	2	1	0	2	3
macroeconomic data	1	2	2	0	0	1	0	0
risk measuring features	0	3	2	0	0	0	0	0
blockchain/cryptocurrency specific features	0	0	0	0	0	6	0	0
human inputs	0	0	0	0	0	0	0	2

Deep learning for financial applications: Topic-Dataset Heatmap

	algorithmic trading	risk assessment	fraud detection	portfolio management	asset pricing and derivatives market	cryptocurrency and blockchain studies	financial sentiment analysis	financial text mining	theoretical or conceptual studies	other financial applications
Stock Data	15	2	0	11	3	0	7	20	2	3
Index/ETF Data	35	0	0	3	3	0	9	14	0	1
Cryptocurrency	9	0	0	2	0	15	2	0	0	0
Forex Data	5	0	0	1	0	0	0	0	0	2
Commodity Data	6	0	0	1	0	0	0	0	0	2
Options Data	1	0	0	0	4	0	0	0	0	0
Transaction Data	2	3	2	0	0	0	0	1	0	0
News Text	4	3	0	0	0	0	13	36	0	0
Tweet/microblog	1	0	0	0	0	1	8	10	0	1
Credit Data	0	10	1	0	0	0	0	0	0	0
Financial Reports	0	6	2	3	2	0	4	3	0	3
Consumer Data	0	8	6	0	0	0	0	1	0	1
Macroeconomic Data	0	2	1	0	0	0	0	0	0	1
Other	5	3	1	1	3	0	0	3	1	0

Financial time series forecasting with deep learning: Topic-model heatmap

	stock price forecasting	index forecasting	commodity price forecasting	volatility forecasting	forex price forecasting	cryptocurrency price prediction	trend forecasting	forex industry
RNN	30	19	3	4	6	2	18	5
CNN	11	3	1	1	2	1	8	2
DMLP	13	9	2	0	4	1	6	3
DBN	2	0	0	0	4	0	3	4
AE	2	1	1	0	2	0	0	2
RL	0	2	1	0	0	0	0	0
RBM	1	0	0	0	1	0	2	1
Other	5	3	0	2	3	0	8	2

Source: Omer Berat Sezer, Mehmet Ugur Gudelek, and Ahmet Murat Ozbayoglu (2020), "Financial time series forecasting with deep learning: A systematic literature review: 2005–2019." Applied Soft Computing 90 (2020): 106181.
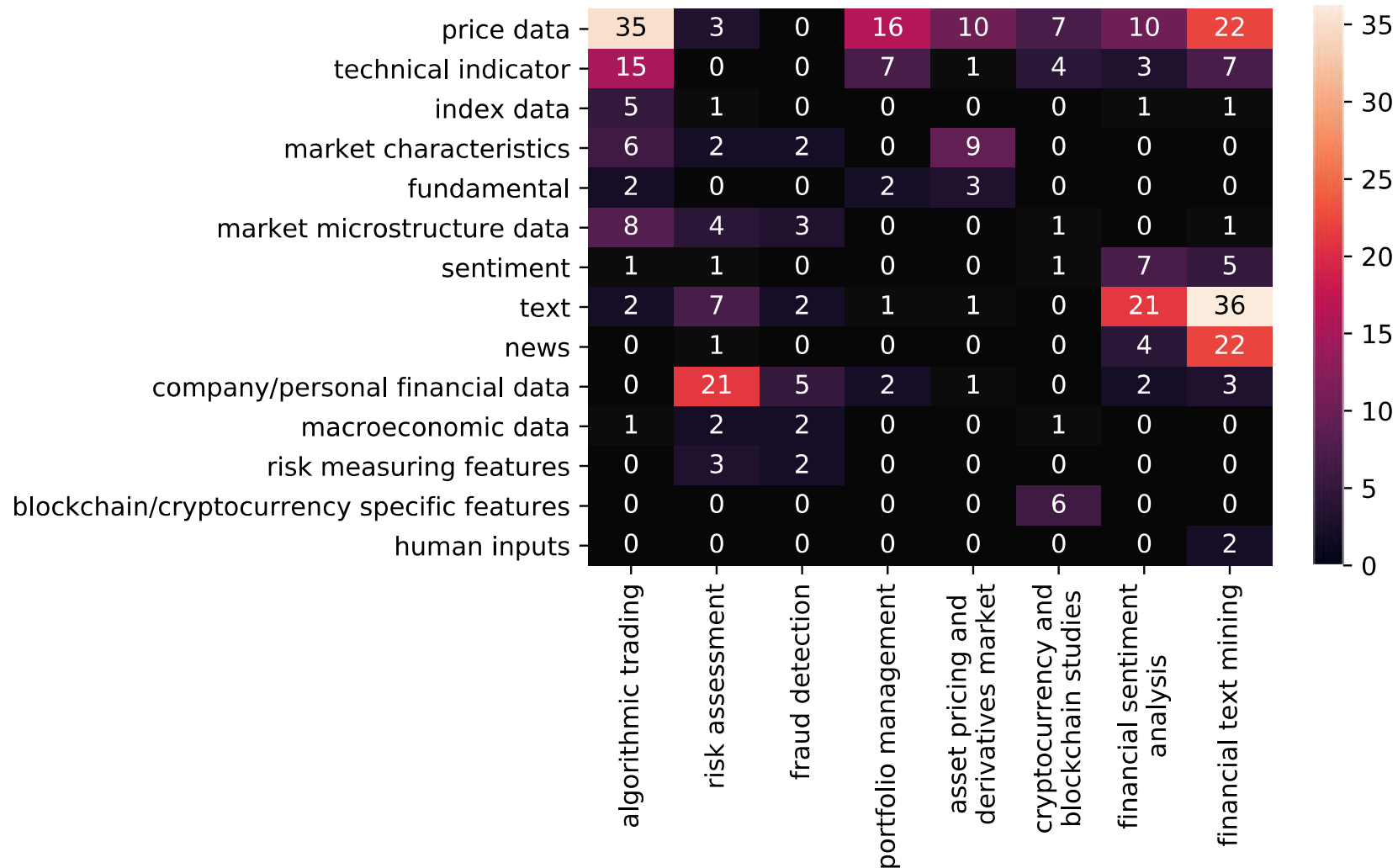
Papers with Code
State-of-the-Art (SOTA)

https://paperswithcode.com/sota

Python in Google Colab (Python101)

```python
# Future Value
pv = 100
r = 0.1
n = 7
fv = pv * ((1 + (r)) ** n)
print(round(fv, 2))
```
    194.87

```python
amount = 100
interest = 10 #10% = 0.01 * 10
years = 7

future_value = amount * ((1 + (0.01 * interest)) ** years)
print(round(future_value, 2))
```
    194.87

```python
# Python Function def
def getfv(pv, r, n):
    fv = pv * ((1 + (r)) ** n)
    return fv
fv = getfv(100, 0.1, 7)
print(round(fv, 2))
```
    194.87

```python
# Python if else
score = 80
if score >=60 :
    print("Pass")
else:
    print("Fail")
```
    Pass

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

Summary

- **This course introduces the fundamental concepts, research issues, and hands-on practices of Artificial Intelligence.**
- **Topics include:**
  1. **Introduction to Artificial Intelligence**
  2. **Artificial Intelligence and Intelligent Agents; Problem Solving**
  3. **Knowledge, Reasoning and Knowledge Representation**
  4. **Uncertain Knowledge and Reasoning**
  5. **Machine Learning: Supervised and Unsupervised Learning**
  6. **The Theory of Learning and Ensemble Learning**
  7. **NVIDIA Fundamentals of Deep Learning**
  8. **Natural Language Processing**
  9. **Computer Vision and Robotics**
  10. **Generative AI, Agentic AI, and Physical AI**
  11. **Philosophy and Ethics of AI and the Future of AI**
  12. **Case Study on AI**

Artificial Intelligence

Contact Information

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Professor and Director

Institute of Information Management, **National Taipei University**

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Email: myday@gm.ntpu.edu.tw

Web: http://web.ntpu.edu.tw/~myday/