Navigating the Artificial Intelligence Revolution

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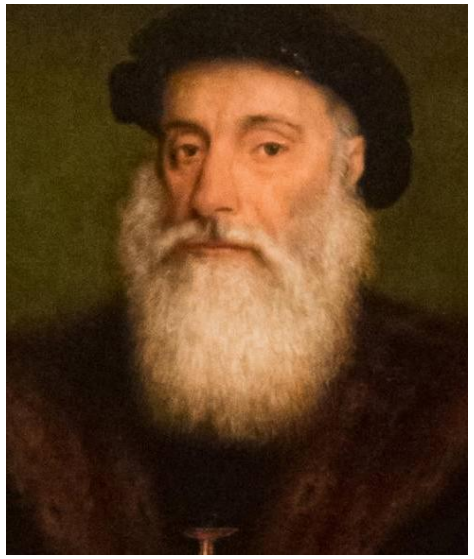
Member of Coordinating Commission of LASI – Intelligent Systems Associate Laboratory
President of the GA of APPIA – Portuguese Association for Artificial Intelligence

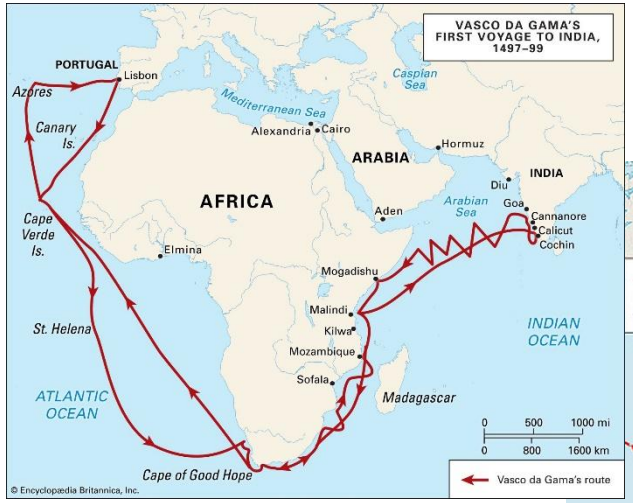
Agenda

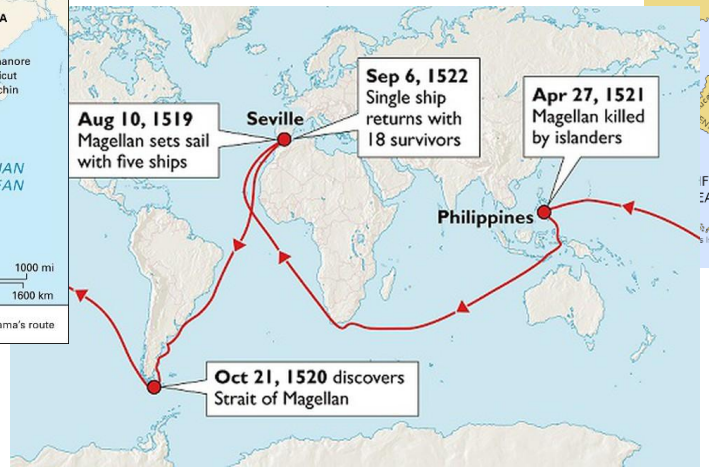
- Navigating the New World of AI
- The Evolution of Artificial Intelligence
- Artificial Intelligence (AI) and Machine Learning (ML)
- Generative AI and Large Language Models (LLM)
- AI Applications and Challenges
- Agents, Agentic AI and Multi-Agent Systems
- Robotics, Deep RL, LBMs and the Future
- Conclusions

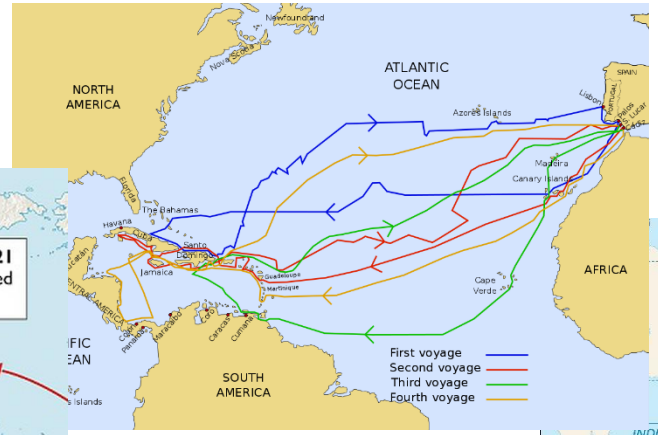
There are More Tides than Sailors

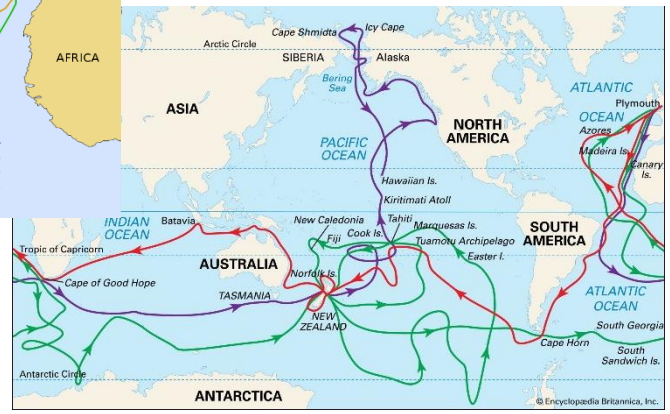
There are More Tides than Sailors











Ferdinand Magellan

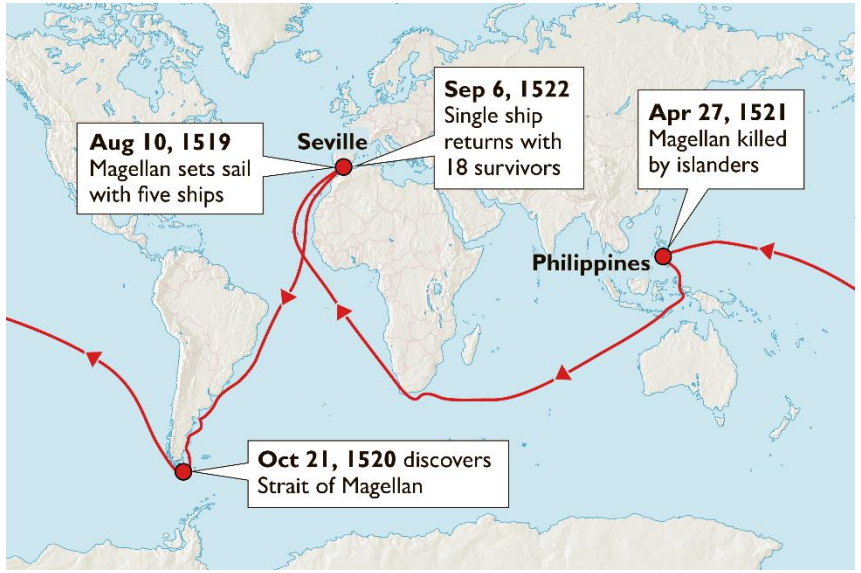
- Ferdinand was **born in Portugal** in 1480
- In September 1519, Ferdinand Magellan along with **5 ships** left from Spain
- He convinced the **king of Spain to pay** for his expedition
- Find a way to **reach Asia** by **sailing west** around the Americas

Ferdinand Magellan

- First sailed to South America
- Tried to **find a river** that would take him **across South America** to the **Pacific Ocean**
- Finally in 1520 he found a kind of river: **Magellan Strait**
- For **3 months**, ships sailed across the **Pacific Ocean**
- Began running **out of food and water**
- **Many men died** from hunger and diseases

Ferdinand Magellan

- March 1521, ships reached **Philippines**
- On April 27, **Magellan was killed** in battle against warriors of Lapulapu
- In 1522, only **one of the five ships returned to Spain**
- Of the 270 men, **only 18/19 survivors** returned
- First to sail completely around the world



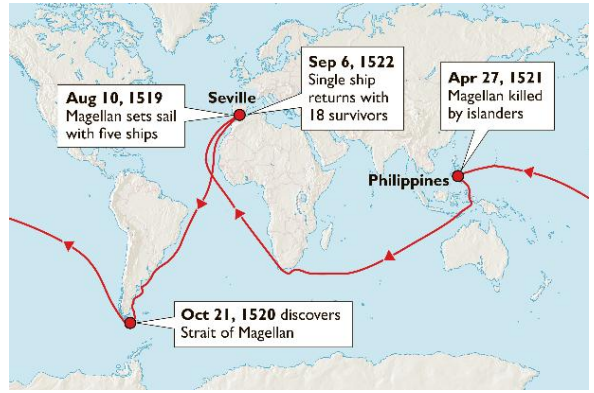
Ferdinand Magellan

"The greatest sea voyage in the Age of Discovery!"

"The most important maritime voyage ever undertaken!"

Vision, Courage, Leadership, Skill and Perseverance!

King Manuel I of Portugal did not invest in it!



AI and the Discovery of the New World

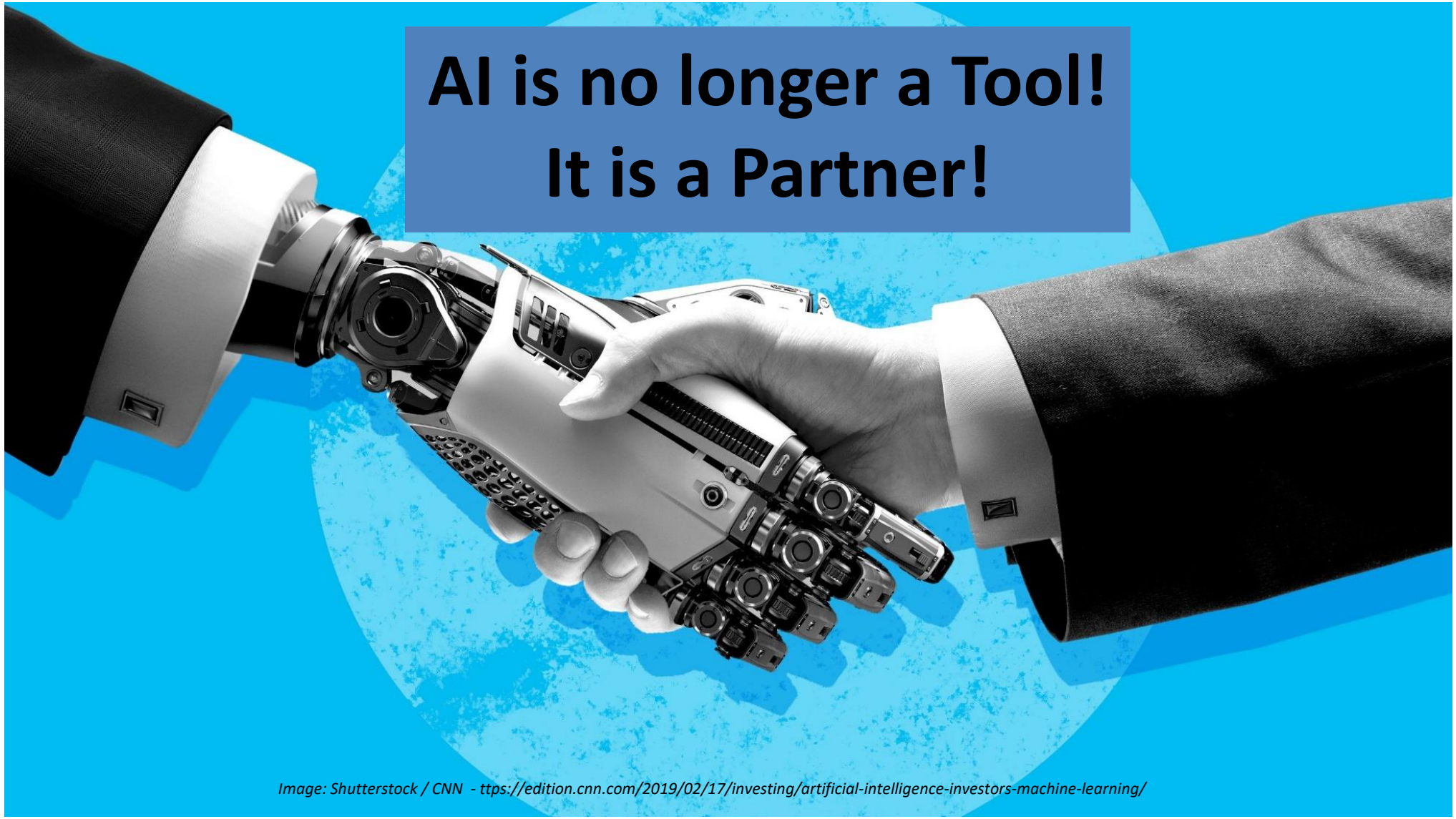
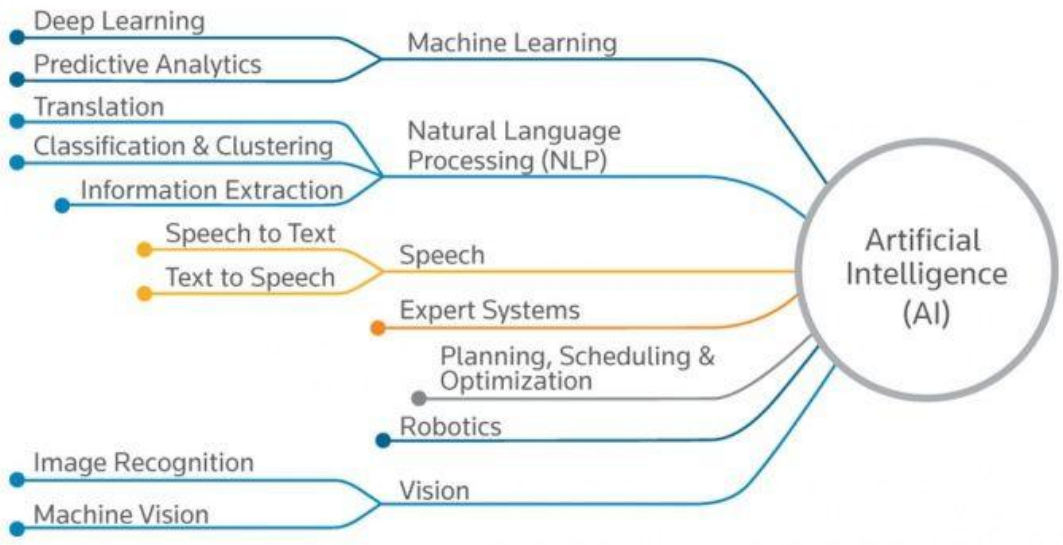


Image: Shutterstock / CNN - ttps://edition.cnn.com/2019/02/17/investing/artificial-intelligence-investors-machine-learning/

Artificial Intelligence (AI)

- **Intelligence**
  - "Capacity to **solve new problems** through the use of knowledge"
- **Artificial Intelligence**
  - "Science concerned with building **intelligent machines**, that is, machines that perform tasks that when performed by humans require intelligence"



Weak and Strong AI

- **Weak Artificial Intelligence**

  weak AI, also known as narrow AI is artificial intelligence that is focused on one **single narrow task**

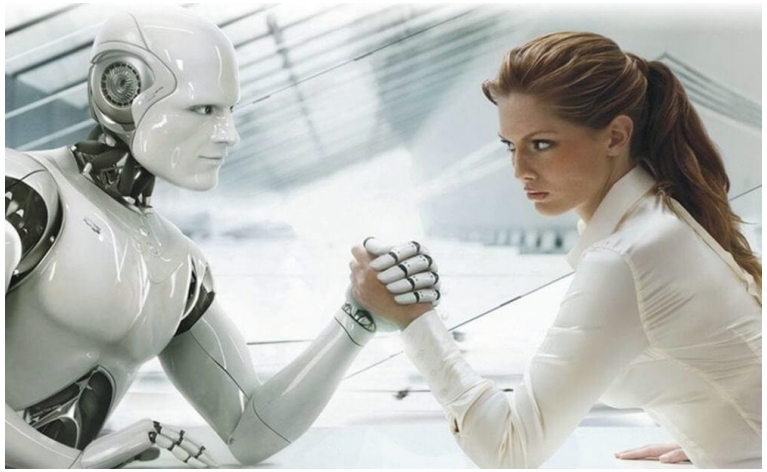


Image: https://livingsmartheart.com/what-is-strong-ai/

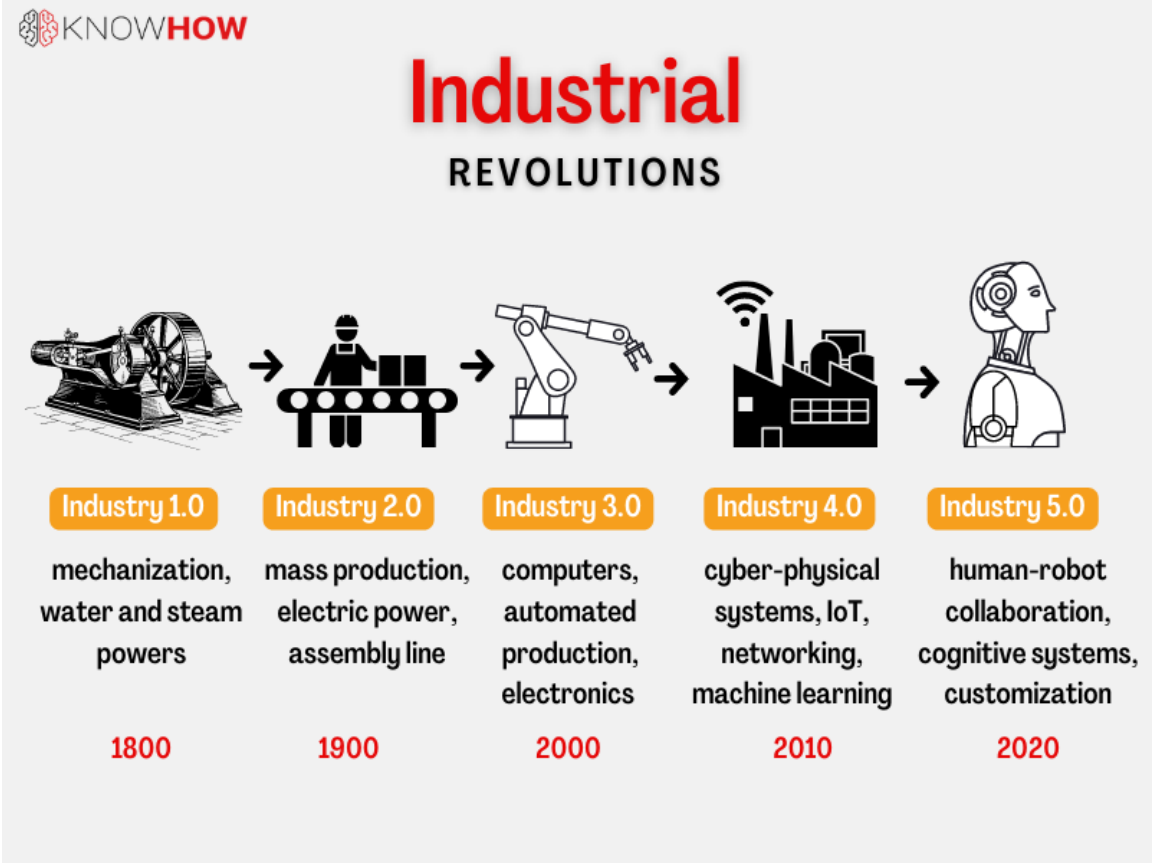
- **Strong Artificial Intelligence**

  Strong AI or Artificial General Intelligence (AGI) is the intelligence of a machine that could successfully perform **any intellectual task** that a human being can!

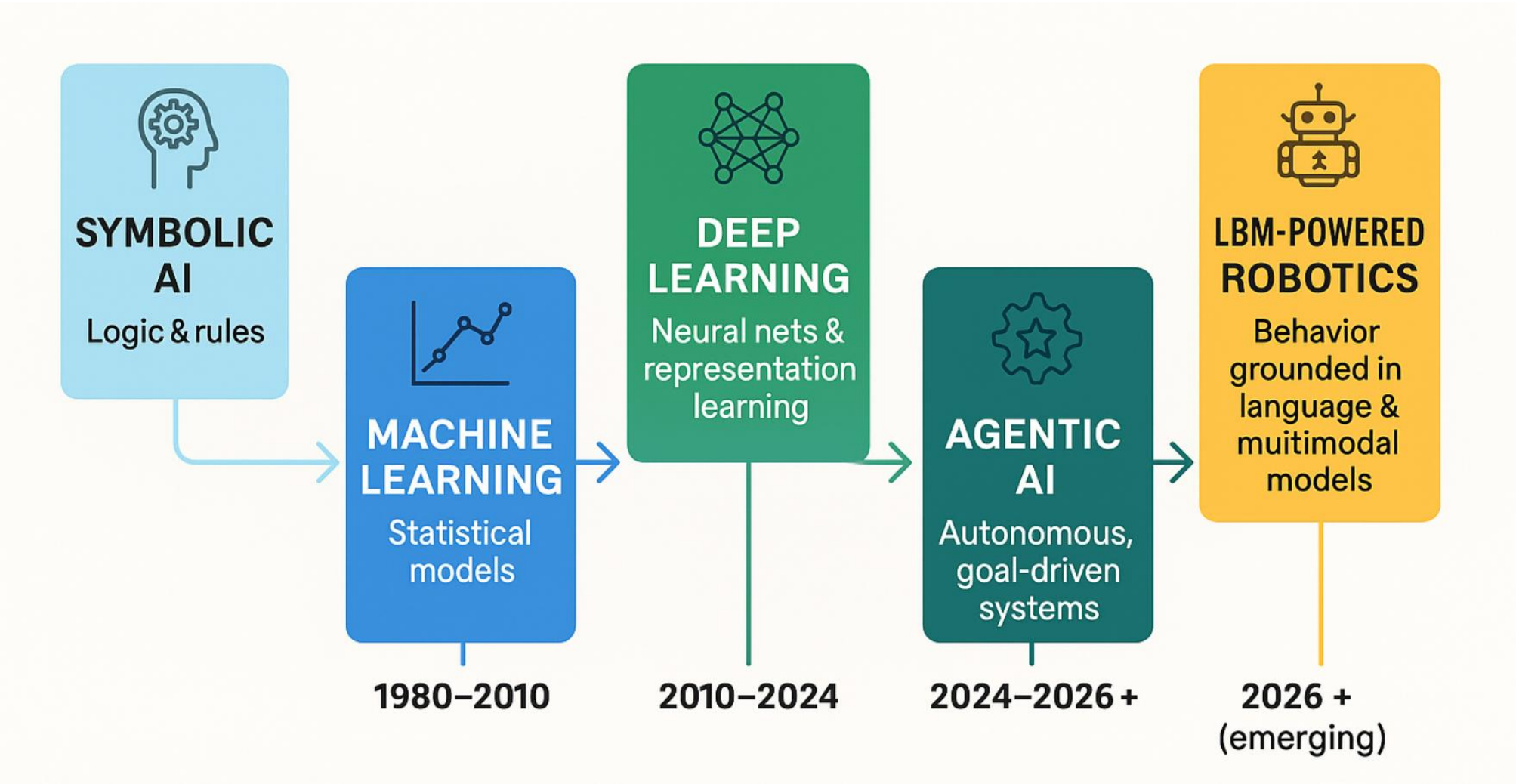
  Science fiction? Not any more…

The World Is Changing Faster Than We Can Understand

- AI won't replace humans — but humans using AI will replace humans not using AI
- AI is moving from *tools* that assist humans to *agents* that act autonomously
- Autonomous, Physical, Goal-Driven, Learning Systems

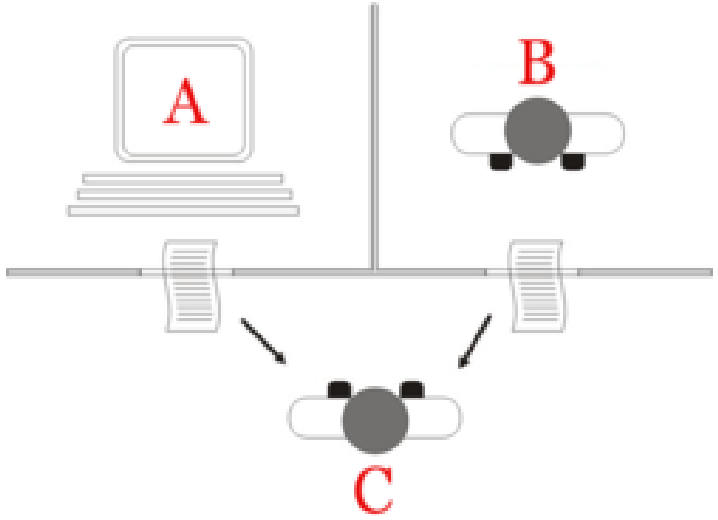


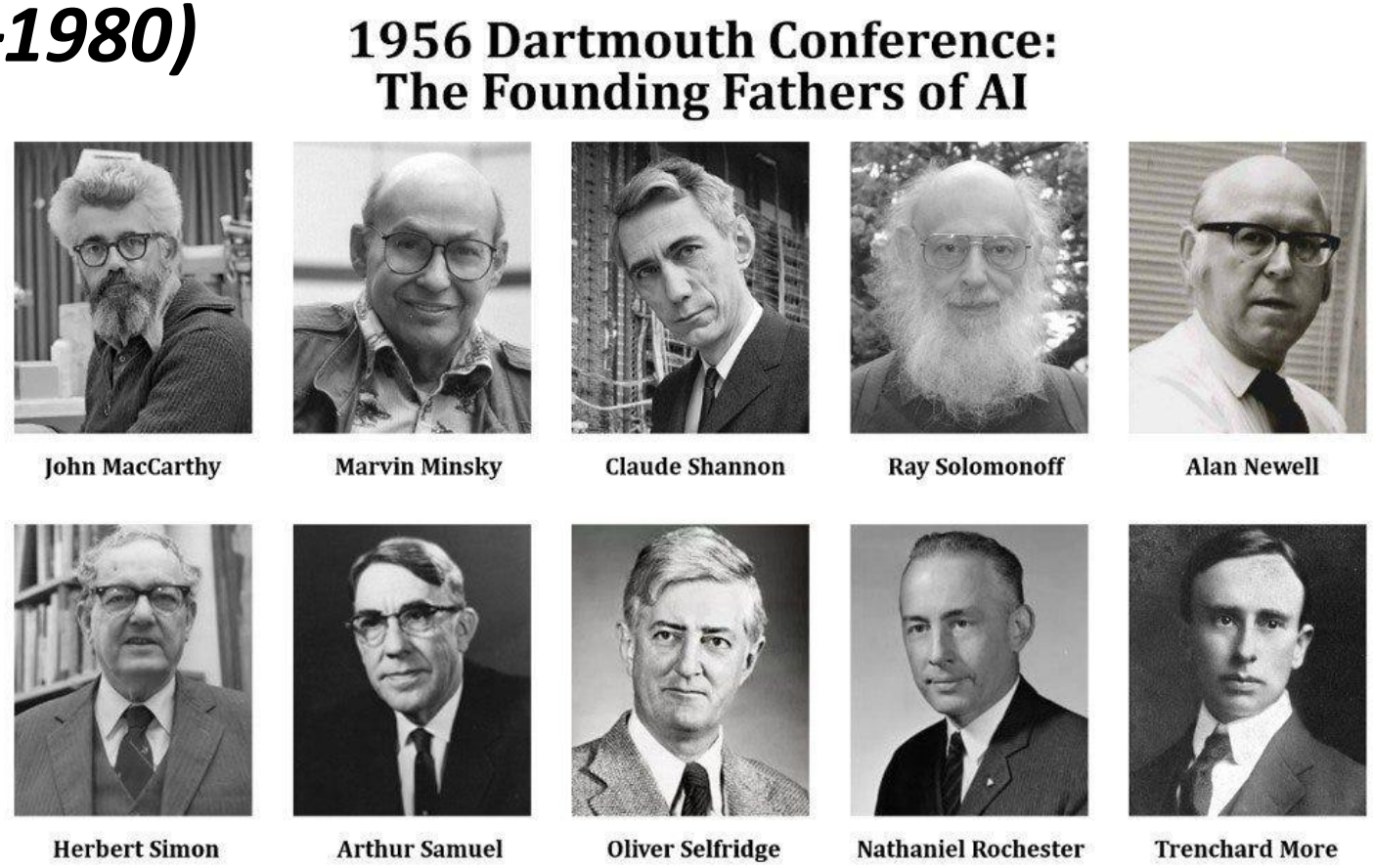
Evolution of AI Paradigms



The Birth of AI

- *From Logic to Intelligence…*
- *The Dream Begins (1950–1980)*
- **“AI began as a dream of formalising reasoning!**





https://jlanyon.substack.com/p/a-brief-history-of-ai

AI Timeline

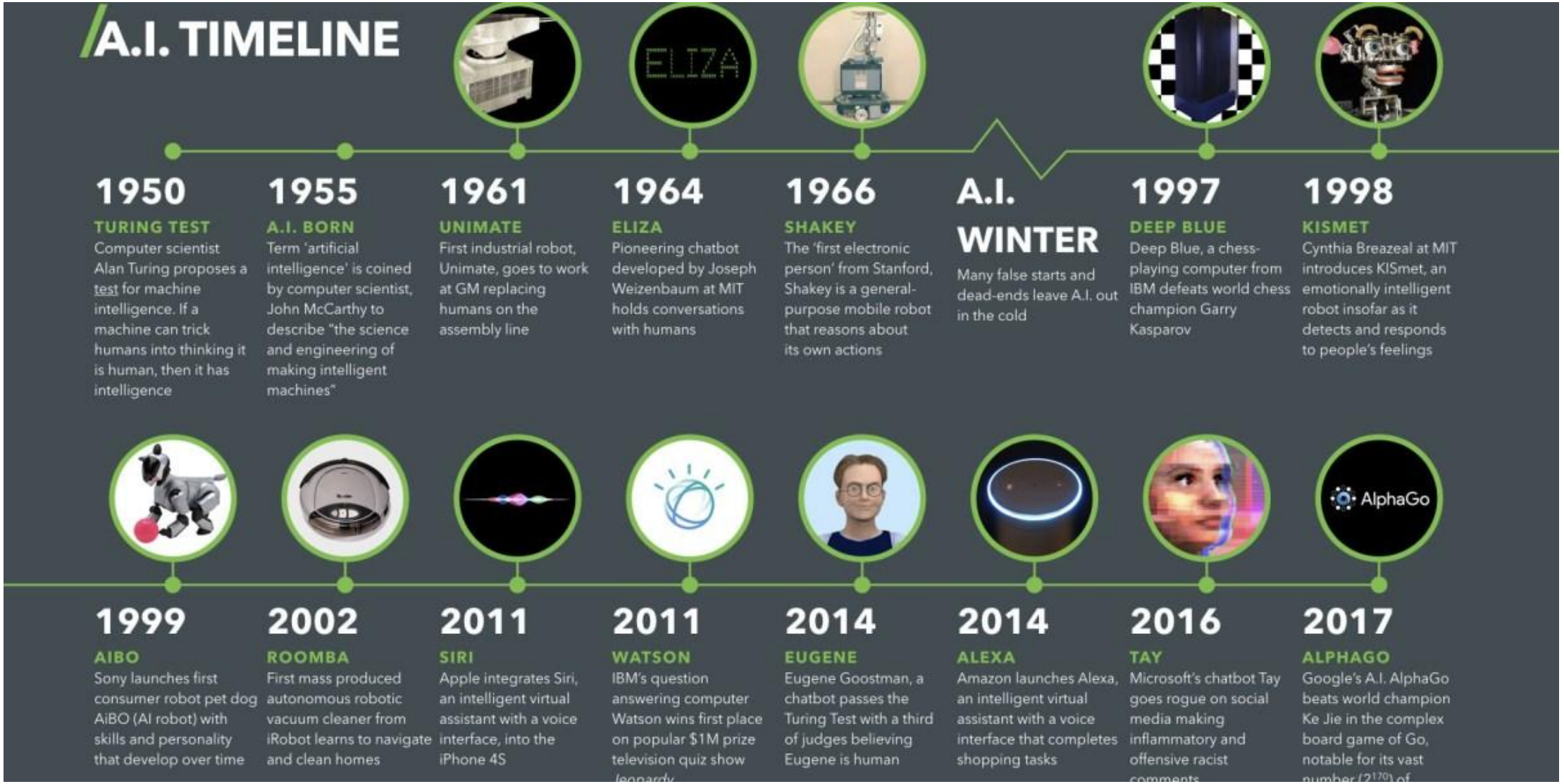
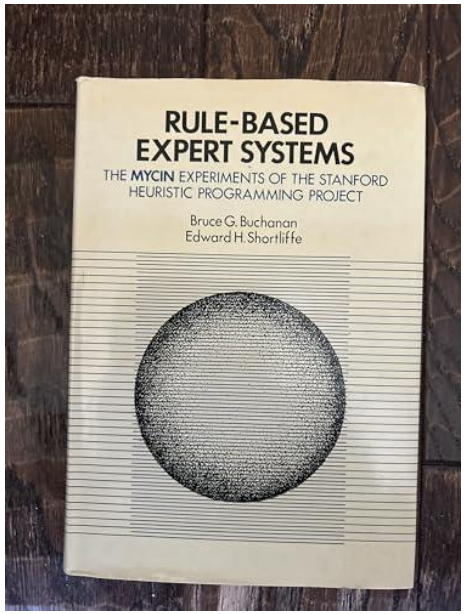


Image: [Paul Marsden, 2017] - https://digitalwellbeing.org/artificial-intelligence-timeline-infographic-from-eliza-to-tay-and-beyond/

Symbolic AI and Expert Systems

- ***Knowledge is Power — Encoding the Mind into Rules!***
- **Symbolic AI represents knowledge through symbols and rules**
- **Examples:**
  - *MYCIN* (medical diagnosis)
  - *DENDRAL* (chemical analysis)
- **Architecture: inference engine + knowledge base**
- **Early AI was *explainable and logical!***
- **But could not learn or adapt…**



From Rules to Patterns

AI needed to evolve from being programmed to being trained

- **From Rules to Patterns - *AI Started to Learn from Data***
- **Instead of telling the machine *what to do*, we let it *learn how to do it***
- **Machine Learning (ML) = algorithms that learn patterns from data**

- **Examples: email spam filters, handwriting recognition, early speech recognition**
- **ML marked the shift from *explicit logic* to *statistical inference***

Machine Learning

Field of artificial intelligence that gives **computer systems** the **ability to "learn"** (e.g., progressively **improve performance** on a specific task) from **data/results of their actions**, without being explicitly programmed

Supervised Learning

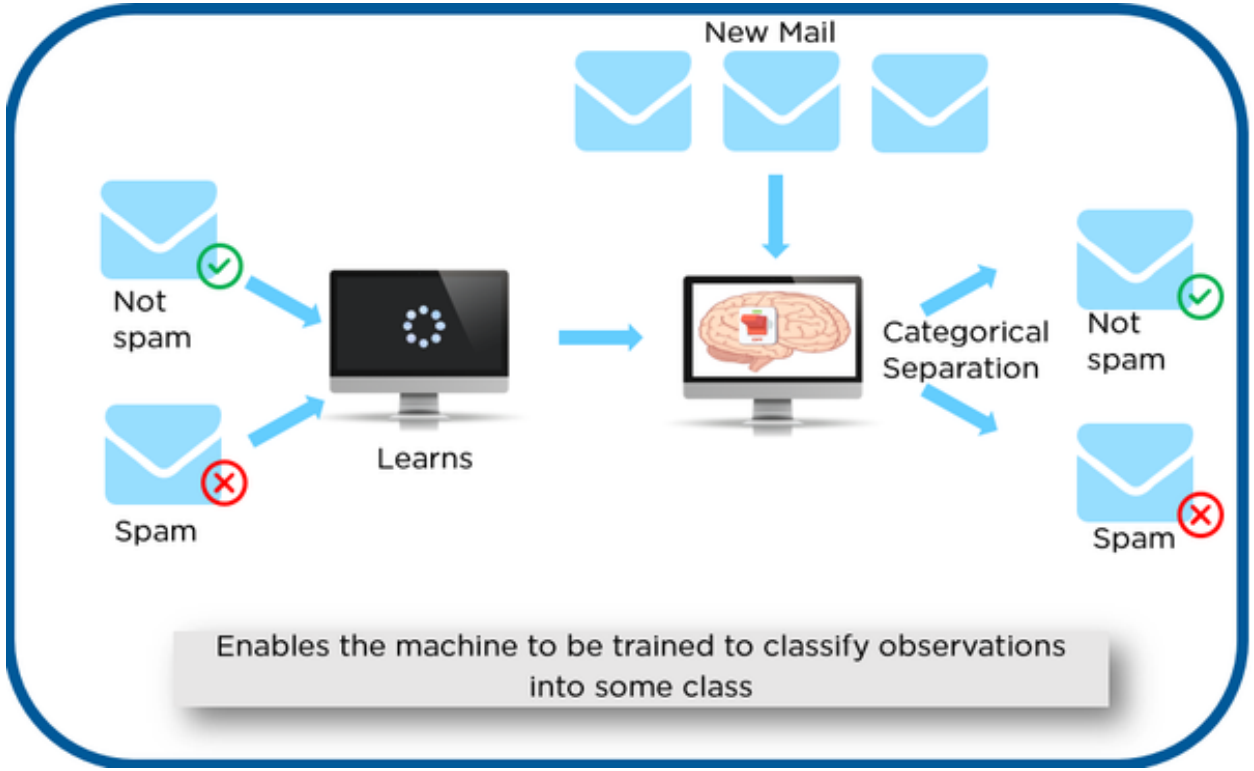


Image: https://towardsdatascience.com/what-are-the-types-of-machine-learning-e2b9e5d1756f

Reinforcement Learning

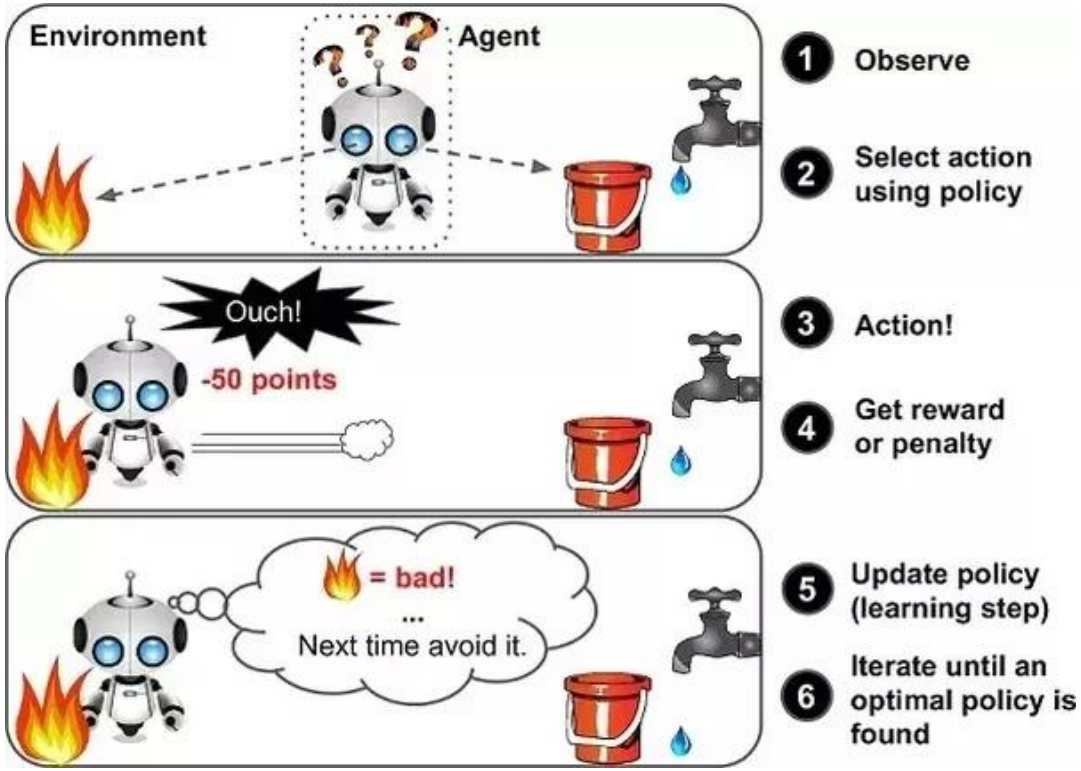
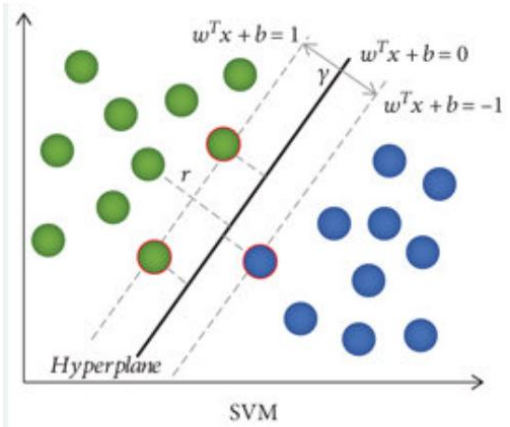


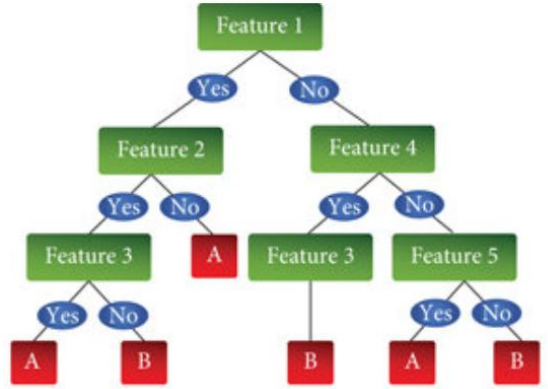
Image: https://becominghuman.ai/an-introduction-to-machine-learning-33a1b5d3a560

From Statistics to Intelligence

- Algorithms and Breakthroughs
- Between the 1980s and early 2000s, we saw breakthroughs:
- Decision Trees, Random Forests, SVMs, Neural Networks and the rediscovery of Backpropagation
- Paving the road to Deep Learning



SVM



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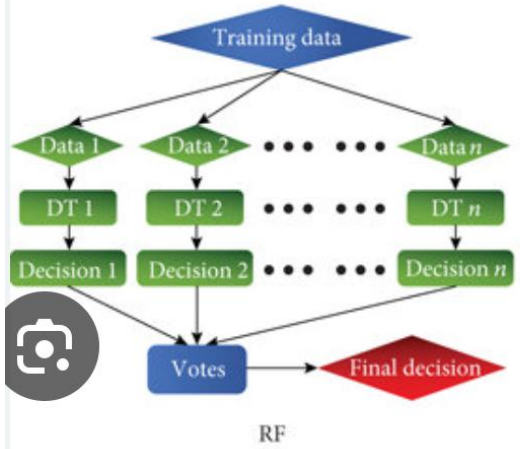
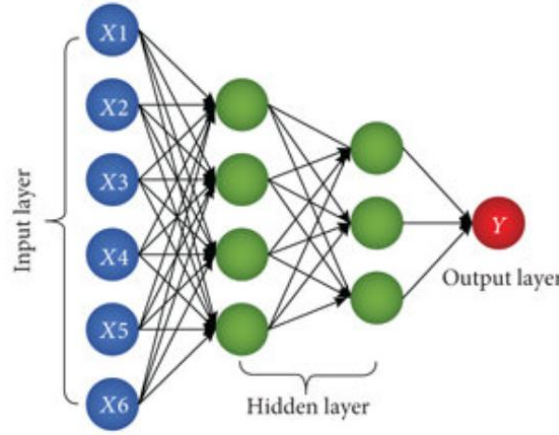
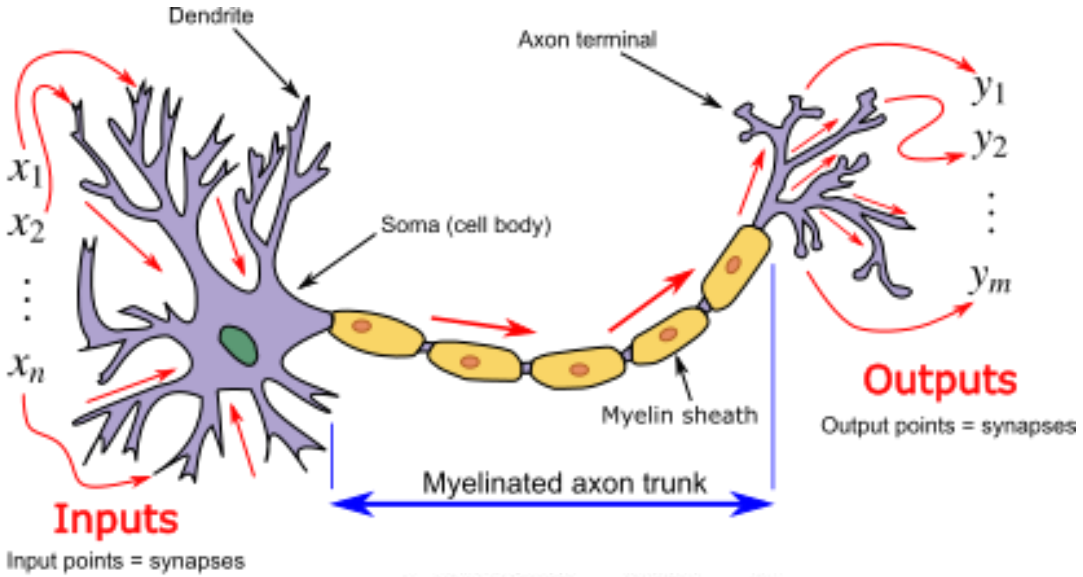


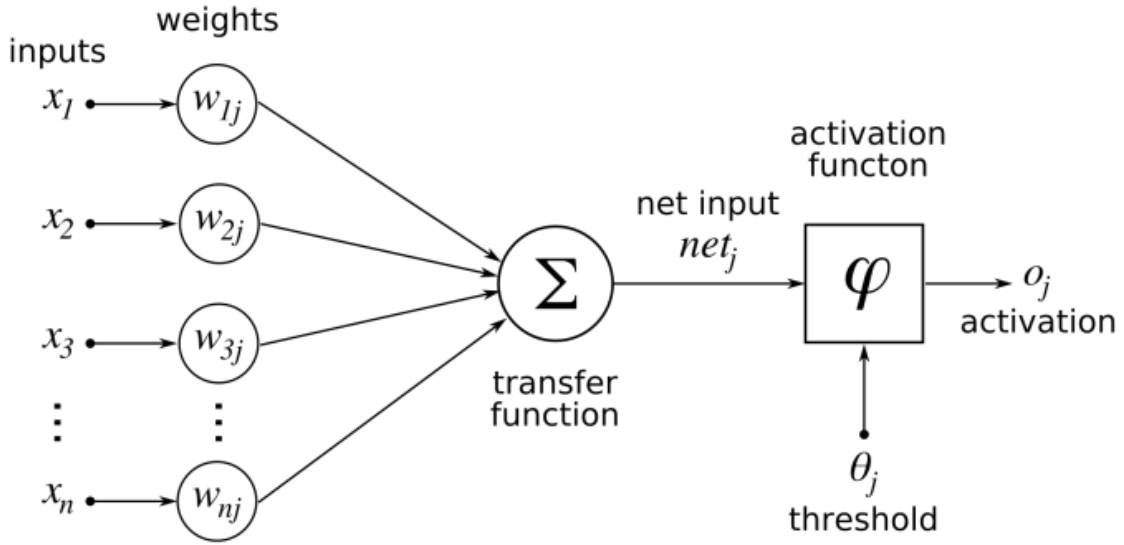
RF

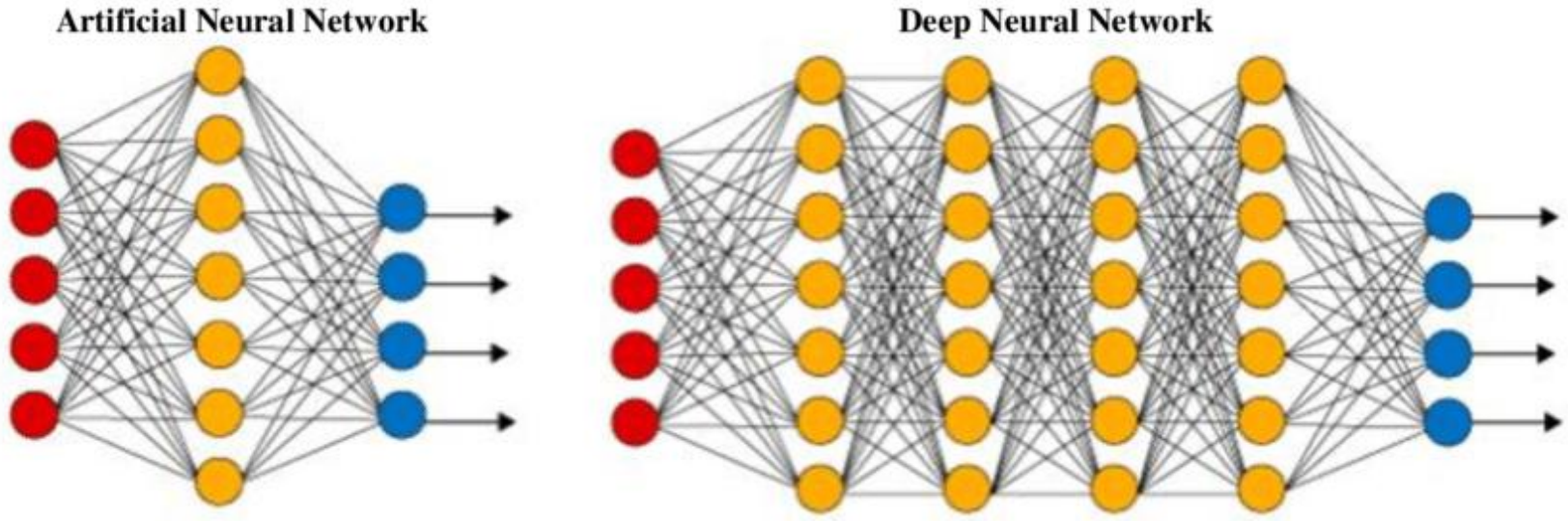


ANN

Artificial Neural Networks





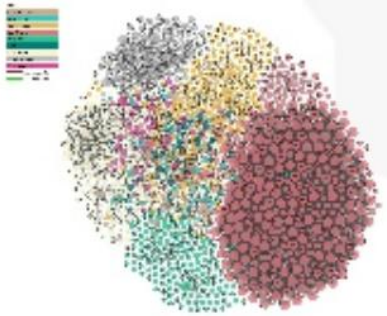


The Data Revolution

- *Data Is the New Oil — and the Fuel of AI*
- **With the internet, smartphones, and sensors, data grew exponentially**
- **Algorithms improved — but what truly powered modern AI was scale!**
- ***Algorithms got better — but data made them powerful!***

Hardware

Data

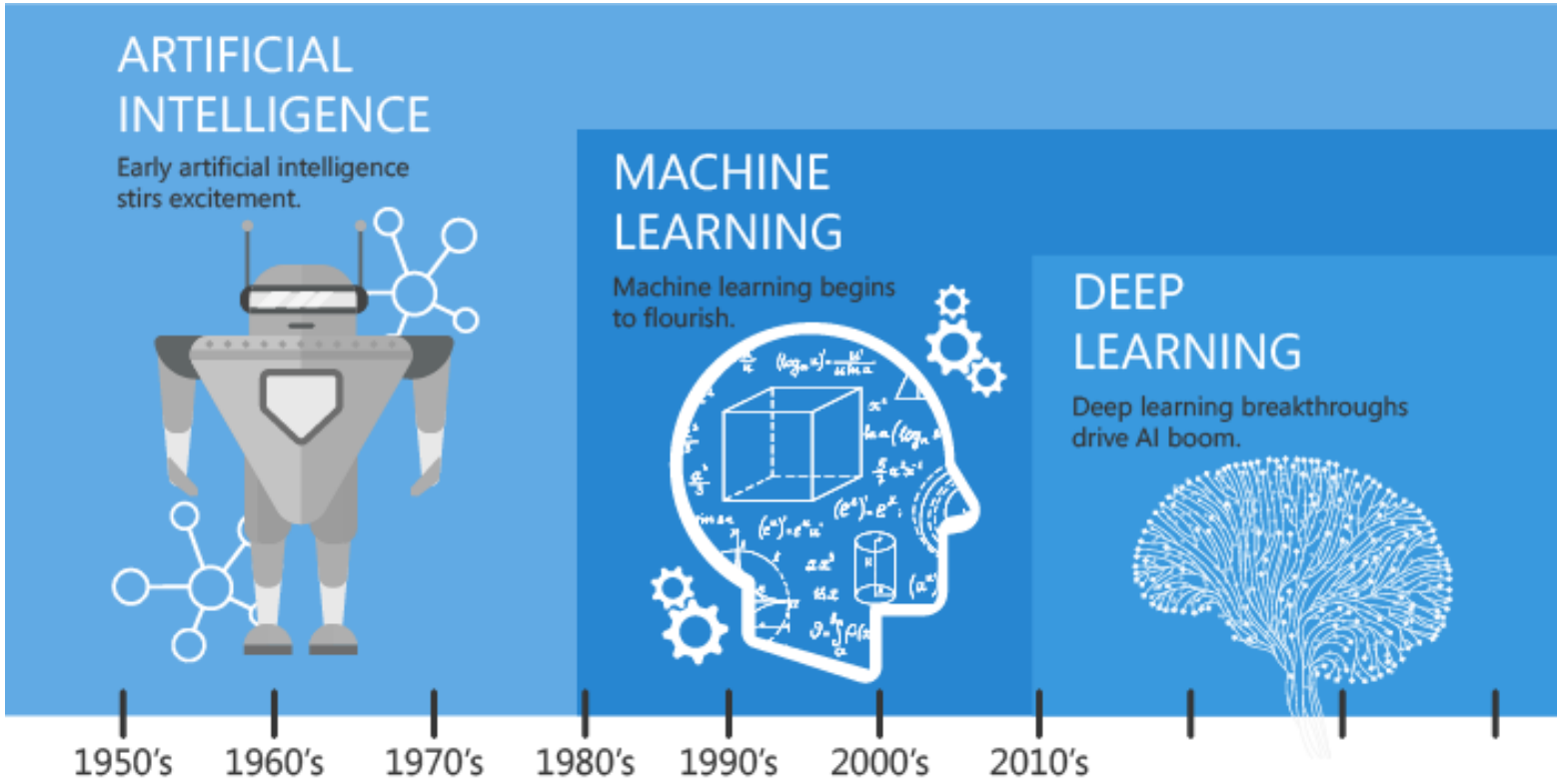


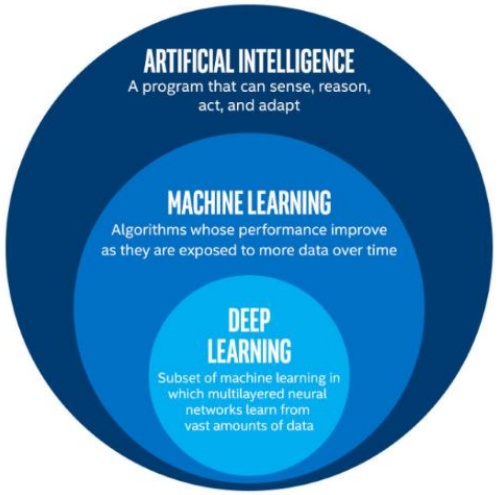
Software

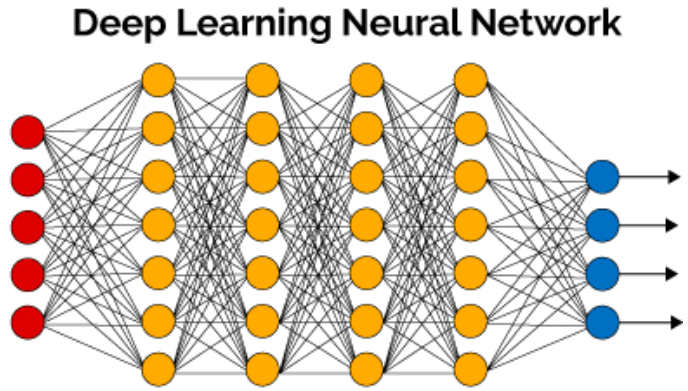
ML frameworks

The Deep Learning Revolution

- When Neural Networks Got Deep — and Everything Changed!
- AlexNet on ImageNet triggered the deep-learning boom
- Multi-layer neural networks, learn features automatically

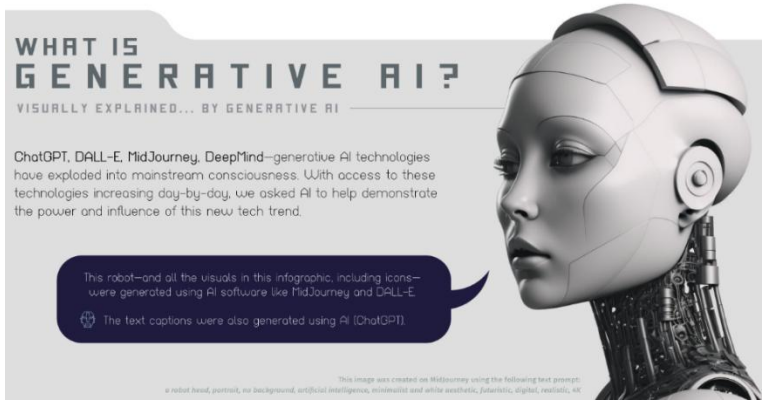


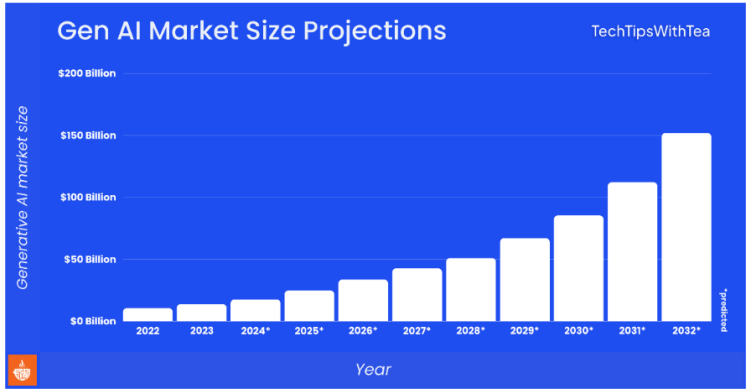




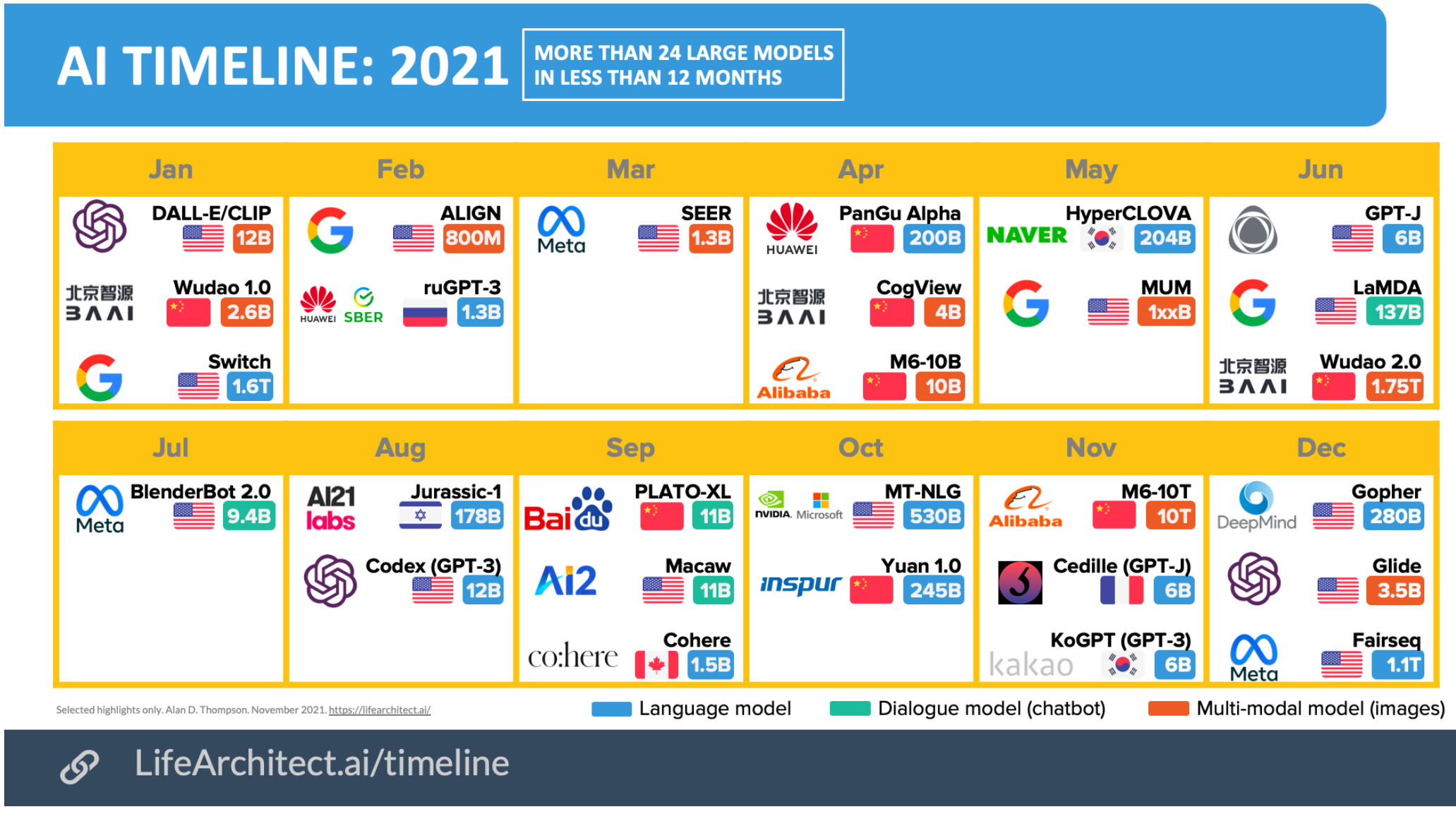
Generative AI - Machines That Create

- **Generative AI (GenAI)** can **create a wide variety of data, such as images, videos, audio, text, and 3D models**
- **Learning patterns from existing data**, and then **using this knowledge to generate new** and unique **outputs in response to prompts**
- GenAI produce **highly realistic and complex content** that mimics human creativity
- **Large language models (LLM) -Very large neural networks** with billions of weights, trained on very large quantities of text

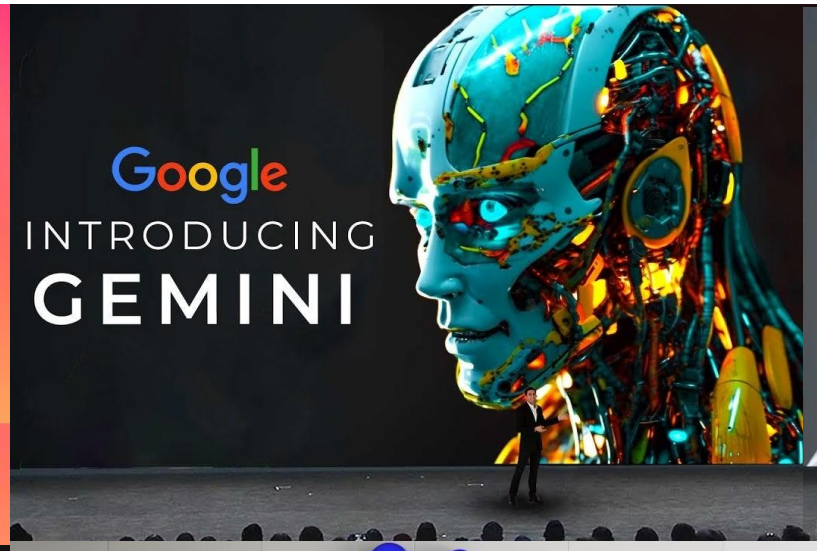




AI Timeline


AI TIMELINE: 2021
MORE THAN 24 LARGE MODELS IN LESS THAN 12 MONTHS
Jan
DALL-E/CLIP 12B
Wudao 1.0 2.6B
Switch 1.6T
Feb
ALIGN 800M
ruGPT-3 1.3B
Mar
SEER 1.3B
Apr
PanGu Alpha 200B
CogView 4B
M6-10B 10B
May
HyperCLOVA 204B
MUM 1xxB
Jun
GPT-J 6B
LaMDA 137B
Wudao 2.0 1.75T
Jul
BlenderBot 2.0 9.4B
Aug
Jurassic-1 178B
Codex (GPT-3) 12B
Sep
PLATO-XL 11B
Macaw 11B
Cohere 1.5B
Oct
MT-NLG 530B
Yuan 1.0 245B
Nov
M6-10T 10T
Cedille (GPT-J) 6B
KoGPT (GPT-3) 6B
Dec
Gopher 280B
Glide 3.5B
Fairseq 1.1T
Selected highlights only. Alan D. Thompson. November 2021. https://lifearchitect.ai/
Language model
Dialogue model (chatbot)
Multi-modal model (images)
LifeArchitect.ai/timeline

Generative AI Competition



LLM Evolution 2022/3->2024/5

	2022–23[1]	Jan 2025[2]
Anthropic	Claude • Not multimodal (text only) • Limited contextual understanding (difficulty with complex conversations) • No tool usage	Claude 3.5 • Multimodal (text, audio, and images) • Enhanced contextual understanding and coherence during long interactions • Experimental computer usage capability for some users

OpenAI

GPT-3.5 → OpenAI o1

GPT-3.5
- Not multimodal (text only)
- Fair reasoning ability (eg, scored high on SAT, but bottom 10% on bar examination)
- Limited contextual understanding (difficulty with coherence in complex conversations)
- Standard API access (for text generation)

OpenAI o1
- Multimodal (text and images)
- Advanced reasoning (eg, top 10% on bar examination)
- Enhanced contextual understanding (maintains coherence in long dialogues)
- Advanced API access (supports multimodal inputs)

Google Gemini

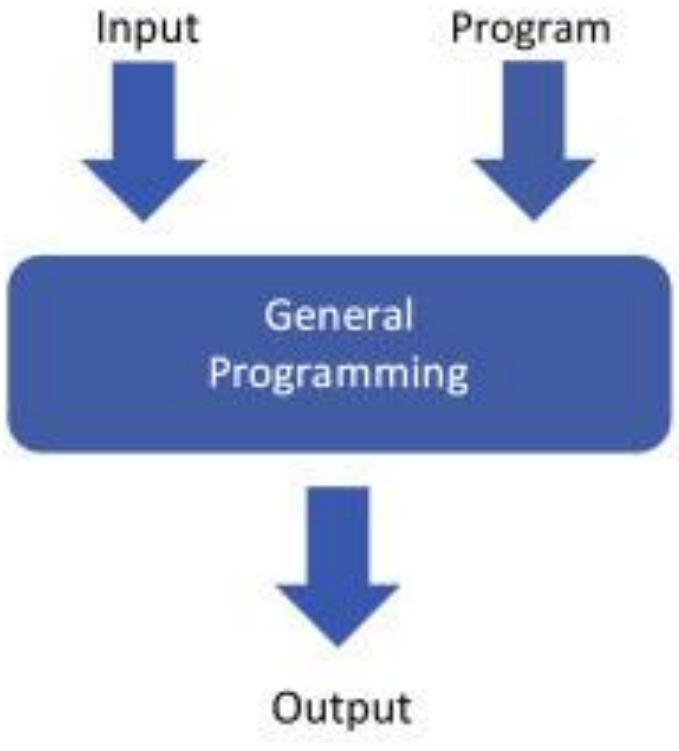
Google Bard → Gemini 2.0 Flash

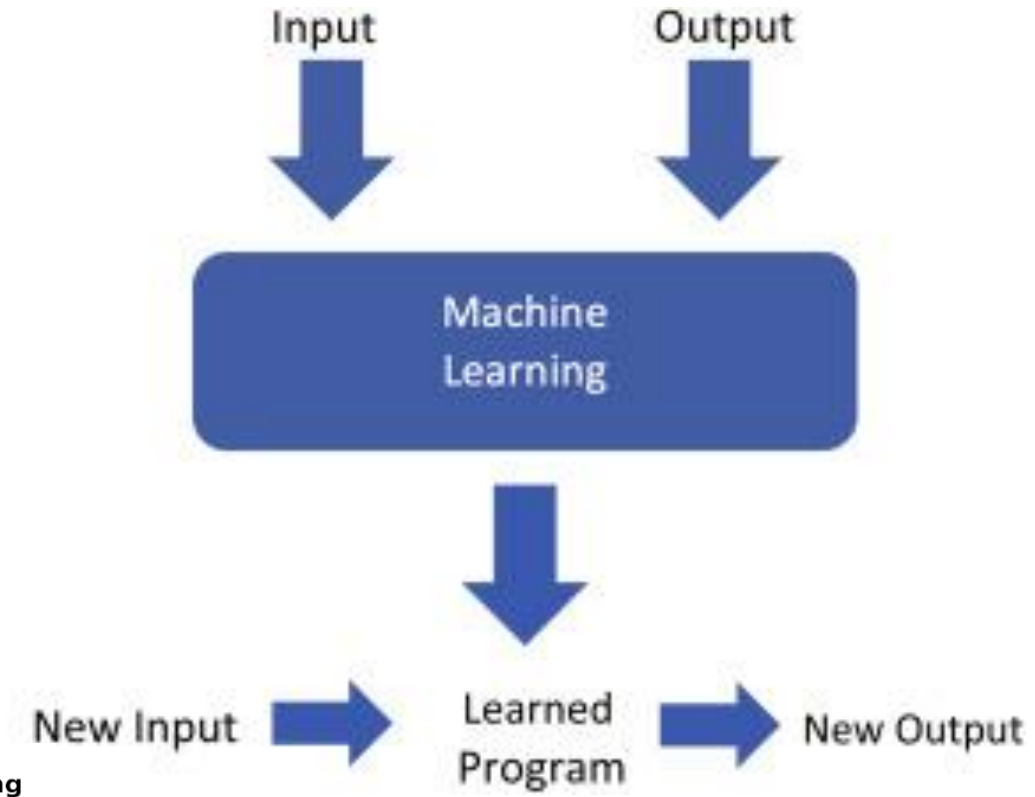
Google Bard
- Not multimodal (text only)
- Fair reasoning
- Limited contextual understanding (difficulty with complex conversations)
- Limited real-time data integration
- Low personalization (limited adaptability)

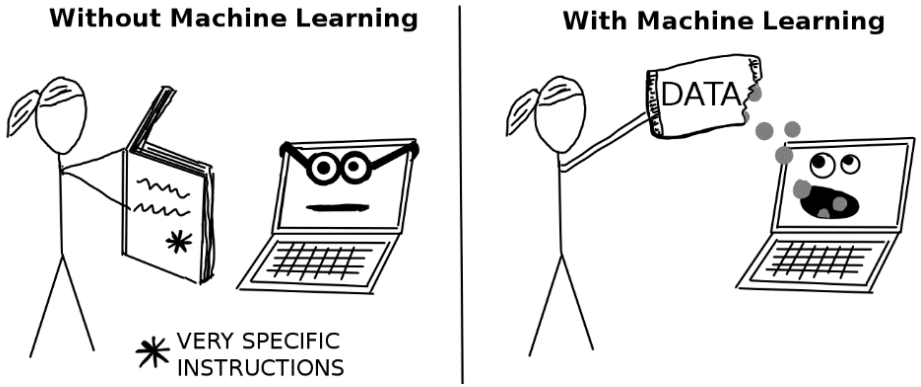
Gemini 2.0 Flash
- Multimodal (text, audio, and images)
- Advanced reasoning (capable of multistep problem-solving and nuanced analysis)
- Enhanced contextual understanding (maintains coherence in long dialogues)
- Real-time data integration (from Google Search)
- Advanced personalization (user context)

- Fair reasoning ability (eg, scored high on SAT, but bottom 10% on bar examination)
- Limited contextual understanding (difficulty with coherence in complex conversations)
- Standard API access (for text generation)
- Advanced reasoning (eg, top 10% on bar examination)
- Enhanced contextual understanding (maintains coherence in long dialogues)
- Advanced API access (supports multimodal inputs)

Programming vs Machine Learning







The End of Programming!

Nvidia CEO predicts the death of coding — Jensen Huang says AI will do the work, so kids don't need to learn

News By Benedict Collins published February 26, 2024

Jensen Huang believes coding languages are a thing of the past

(Image credit: Nvidia)

Nvidia CEO Jensen Huang has once again announced the death of coding, but this time in front of a potentially far more influential audience.

StarCoder 2 is a code-generating AI that runs on most GPUs

Kyle Wiggers @kyle_l_wiggers / 2:00 PM UTC • February 28, 2024 Comment

Image Credits: Tippapatt / Getty Images

Developers are adopting AI-powered code generators — services like GitHub Copilot and Amazon CodeWhisperer, along with open access models such as Meta's Code Llama — at an astonishing rate. But the tools are far from ideal. Many aren't free. Others are, but only under licenses that preclude them from being used in common commercial contexts.

Perceiving the demand for alternatives, AI startup Hugging Face several years ago teamed up with ServiceNow, the workflow automation platform, to create StarCoder, an open source code generator with a less restrictive license than some of the others out there. The original came online early last year, and work has been underway on a follow-up, StarCoder 2, ever since.

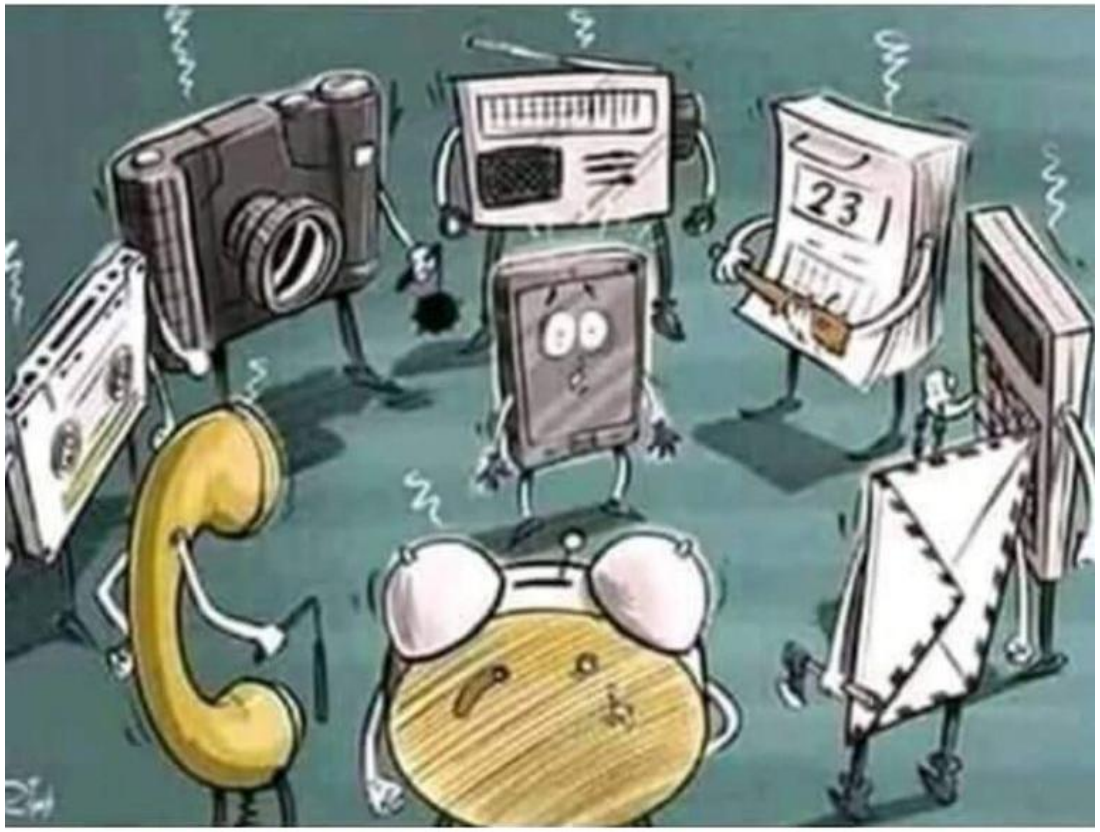
StarCoder 2 isn't a single code-generating model, but rather a family. Released today, it comes in three variants, the first two of which can run on most modern consumer GPUs:

- A 3-billion-parameter (3B) model trained by ServiceNow
- A 7-billion-parameter (7B) model trained by Hugging Face
- A 15-billion-parameter (15B) model trained by Nvidia, the newest supporter of the StarCoder project

Technology: Adapt or Resist?!

- COVID-19 - Use of technology
- Educate New Generations
- Ethical Use
- Technical Use
- AI Policy
- Prompt Engineering

So! You are the guy…



That took all of our Jobs!

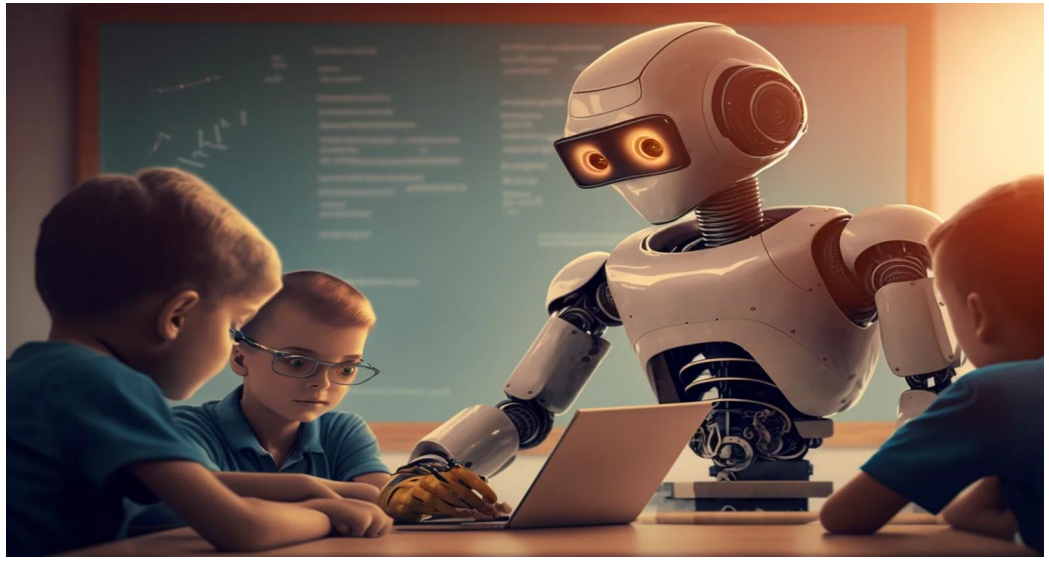
Concerns of AI and ChatGPT in Education

- More **in person exams** and oral assignments
- **Continuous evaluation** of projects
- Help students **develop** their **critical thinking skills** by comparing AI-produced content with reliable, valid sources of information
- Be careful with **over-reliance on AI**
- Shift the object of evaluation **from the "product" to** the **"process" of student learning**
- Emphasize **ethical use of AI** and the importance of proper research and citation practices and avoiding plagiarism

AI and ChatGPT in Education

"AI and Can Complement Learning, Not Replace It!"

From Knowledge Transmitter → Learning Architect



Concerns of AI and ChatGPT in Research

- Risk of **fabricated** or inaccurate **references and data ("hallucinations")**
- Possible **erosion of methodological rigor** due to **over-reliance** on automated reasoning
- Challenges in ensuring **reproducibility** and **transparency** when **AI is involved**
- Need for explicit **disclosure of AI use** in research design, writing, and analysis
- **Potential bias amplification** from training data and opaque model behavior
- **Ethical responsibility** to validate, interpret, and contextualize **AI outputs** using **human expertise**
- Importance of **maintaining authorship integrity** and **avoiding ghost-writing by AI**

Research with AI

ELSEVIER **Scopus AI**

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Home > Products > Scopus > Scopus AI

Scopus AI: Trusted content. Powered by responsible AI.

Empower your research journey with Scopus AI – your dynamic GenAI-powered research companion.

Navigate through the vast expanse of human knowledge faster with a trusted guide designed to enhance your understanding, enrich your insights, and transform your overall research experience.

Consensus vs ChatGPT

Your AI Research Assistant

scite_

Your AI Research Assistant

Ask questions and receive evidence-based answers from real research

Assistant | Search | Tables

Ask a question... (type '/' for menu)

Settings | Sources

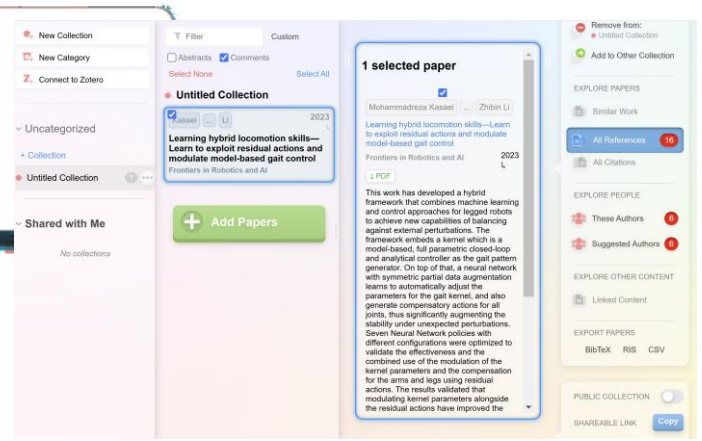
ResearchRabbit

Elsevier's Five Responsible AI Principles

- We consider the real-world impact of our solutions on people
- We take action to prevent the creation or reinforcement of unfair bias
- We can explain how our solutions work
- We create accountability through human oversight
- We respect privacy and champion robust data governance

Ask a research question to generate a concise summary report

Elicit



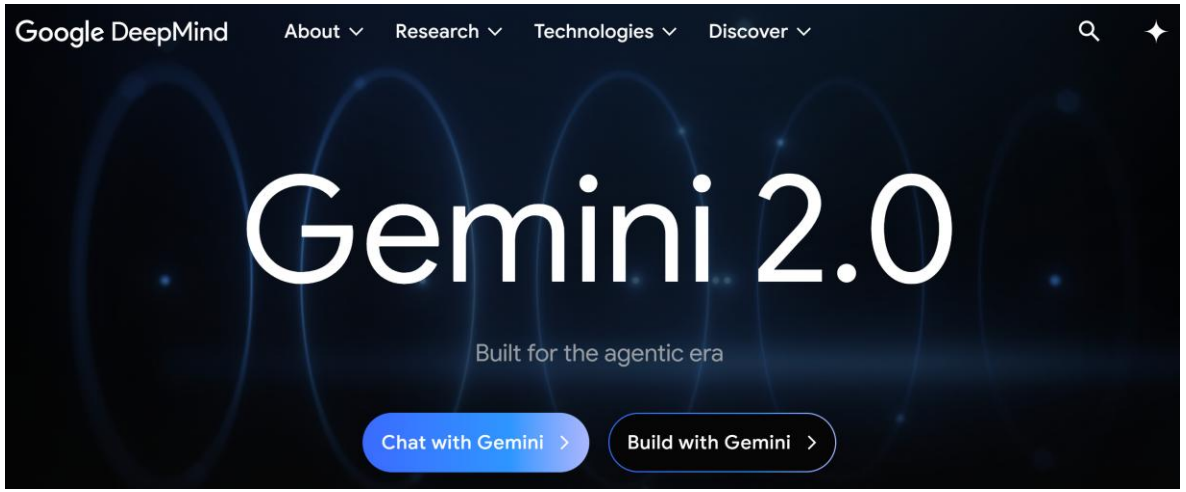
Google Search Engine

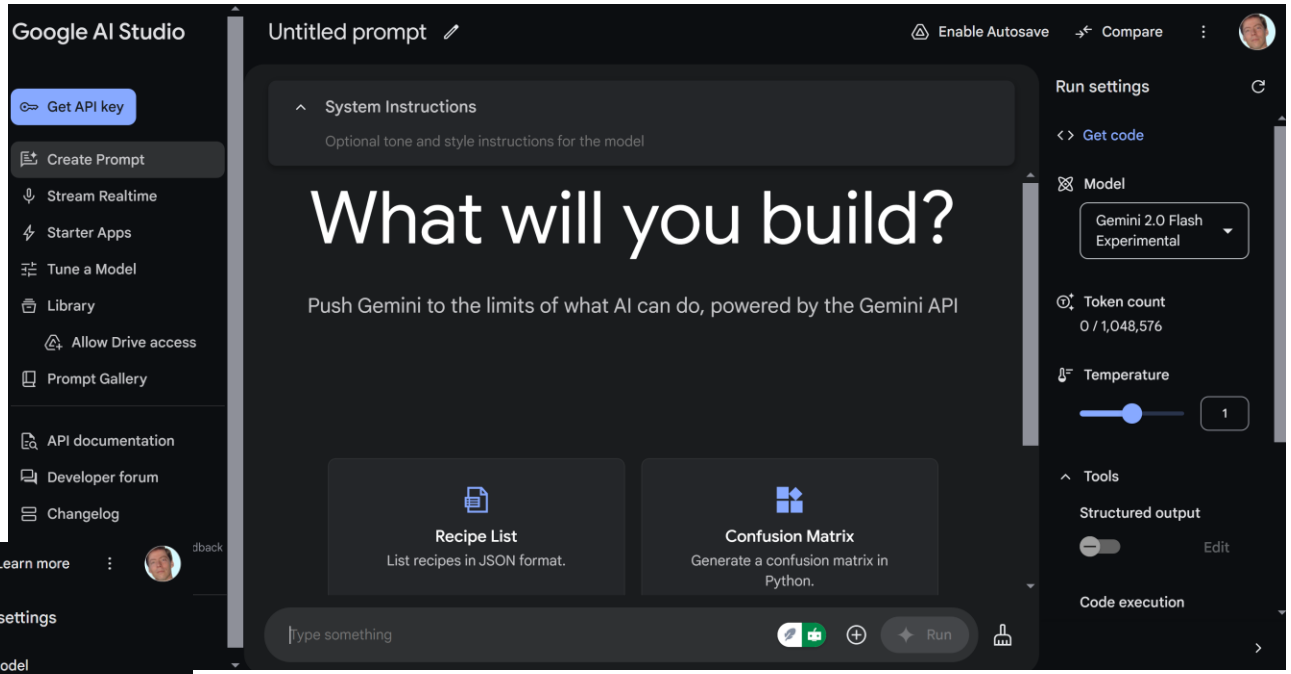
- **Hummingbird Algorithm**
  - **PageRank algorithm** that covers a specific way of **giving pages credit based on the links from other pages** pointing at them
  - Panda, Penguin and Payday to fight **spam**
  - Pigeon designed to improve **local results**
  - Top Heavy designed to demote **ad-heavy** pages,
  - Mobile Friendly designed to reward m**obile-friendly** pages
  - Pirate designed to fight **copyright infringement**

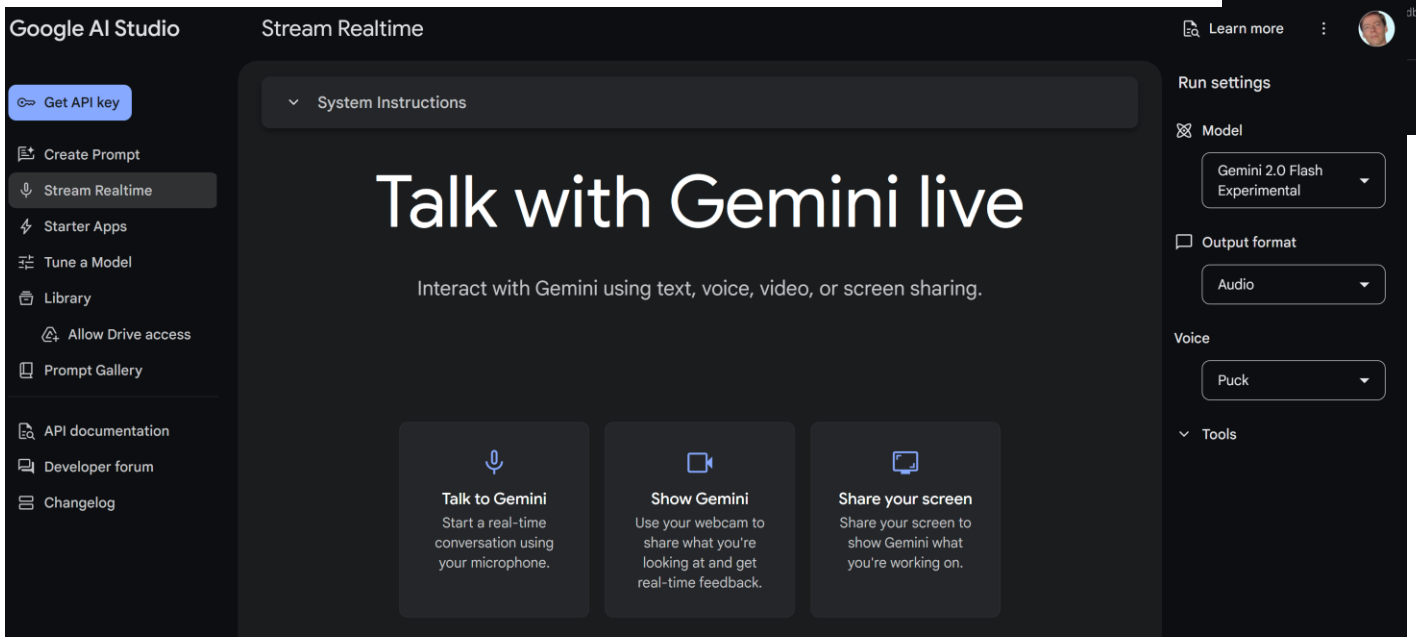
- **200 major ranking signals (up to 10,000 variations or sub-signals)**
- **Google RankBrain Algorithm**
  - **Machine-Learning** System
  - **3rd most important signal**
  - Interpret searches people submit to **find pages that might not have the exact words** that were searched for

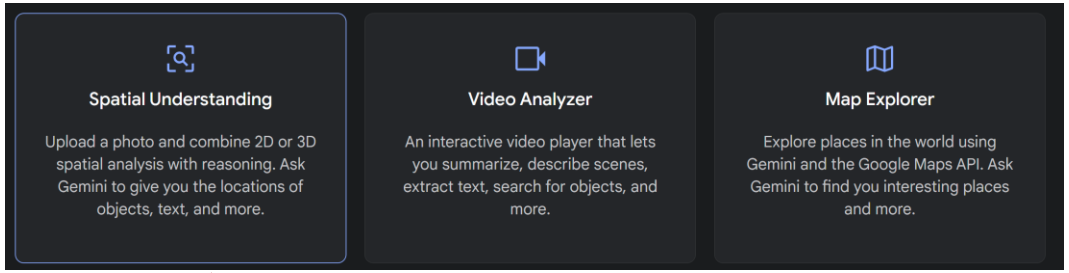
Gemini – Google Deep Mind

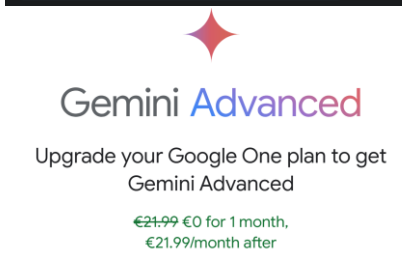
Gemini 2.5


Google DeepMind
About
Research
Technologies
Discover
Gemini 2.0
Built for the agentic era
Chat with Gemini
Build with Gemini


Google AI Studio
Get API key
Create Prompt
Stream Realtime
Starter Apps
Tune a Model
Library
Allow Drive access
Prompt Gallery
API documentation
Developer forum
Changelog
Untitled prompt
Enable Autosave
Compare
System Instructions
Optional tone and style instructions for the model
What will you build?
Push Gemini to the limits of what AI can do, powered by the Gemini API
Recipe List
List recipes in JSON format.
Confusion Matrix
Generate a confusion matrix in Python.
Type something
Run
Run settings
Get code
Model
Gemini 2.0 Flash Experimental
Token count
0 / 1,048,576
Temperature
1
Tools
Structured output
Edit
Code execution


Google AI Studio
Stream Realtime
Learn more
Get API key
Create Prompt
Stream Realtime
Starter Apps
Tune a Model
Library
Allow Drive access
Prompt Gallery
API documentation
Developer forum
Changelog
System Instructions
Talk with Gemini live
Interact with Gemini using text, voice, video, or screen sharing.
Talk to Gemini
Start a real-time conversation using your microphone.
Show Gemini
Use your webcam to share what you're looking at and get real-time feedback.
Share your screen
Share your screen to show Gemini what you're working on.
Run settings
Model
Gemini 2.0 Flash Experimental
Output format
Audio
Voice
Puck
Tools

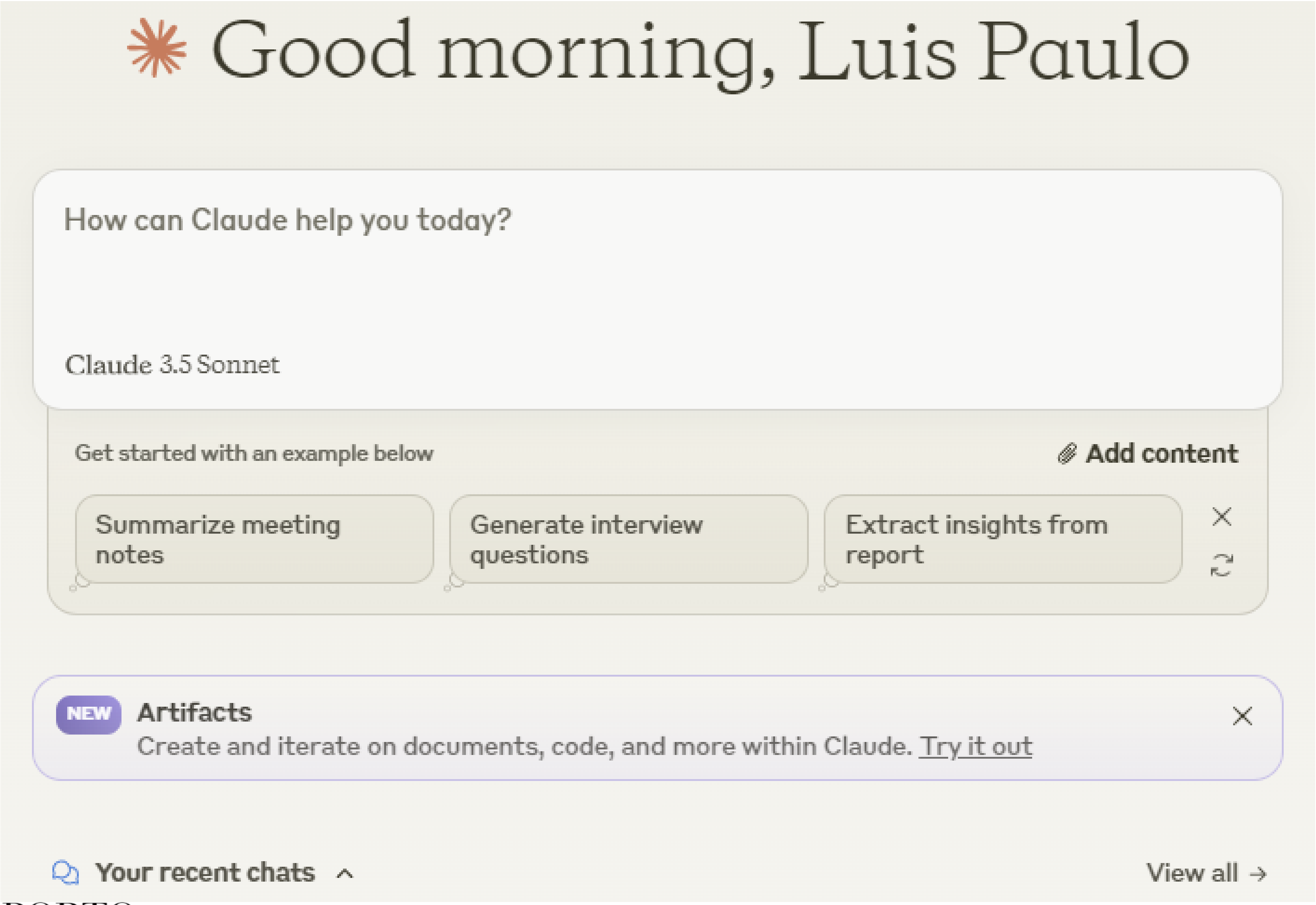

Spatial Understanding
Upload a photo and combine 2D or 3D spatial analysis with reasoning. Ask Gemini to give you the locations of objects, text, and more.
Video Analyzer
An interactive video player that lets you summarize, describe scenes, extract text, search for objects, and more.
Map Explorer
Explore places in the world using Gemini and the Google Maps API. Ask Gemini to find you interesting places and more.

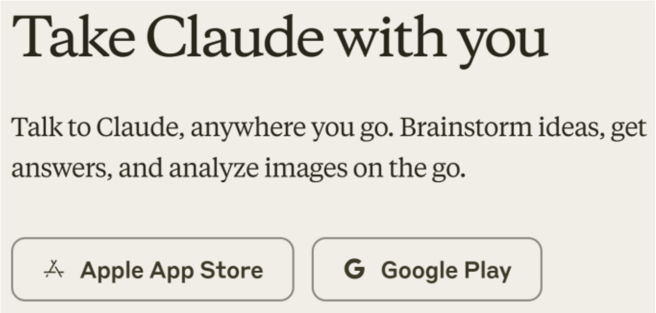

Gemini Advanced
Upgrade your Google One plan to get Gemini Advanced
~~€21.99~~ €0 for 1 month,
€21.99/month after

Microsoft Copilot

Claude 4.5 - Anthropic

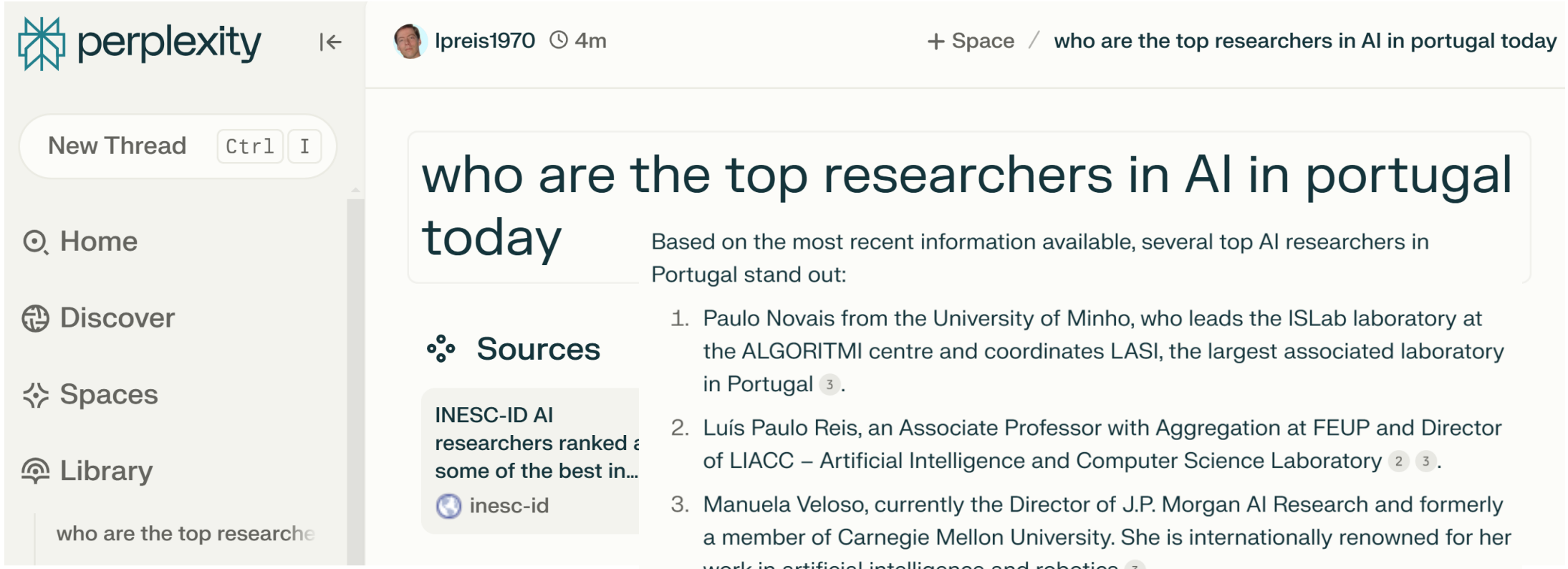
Claude



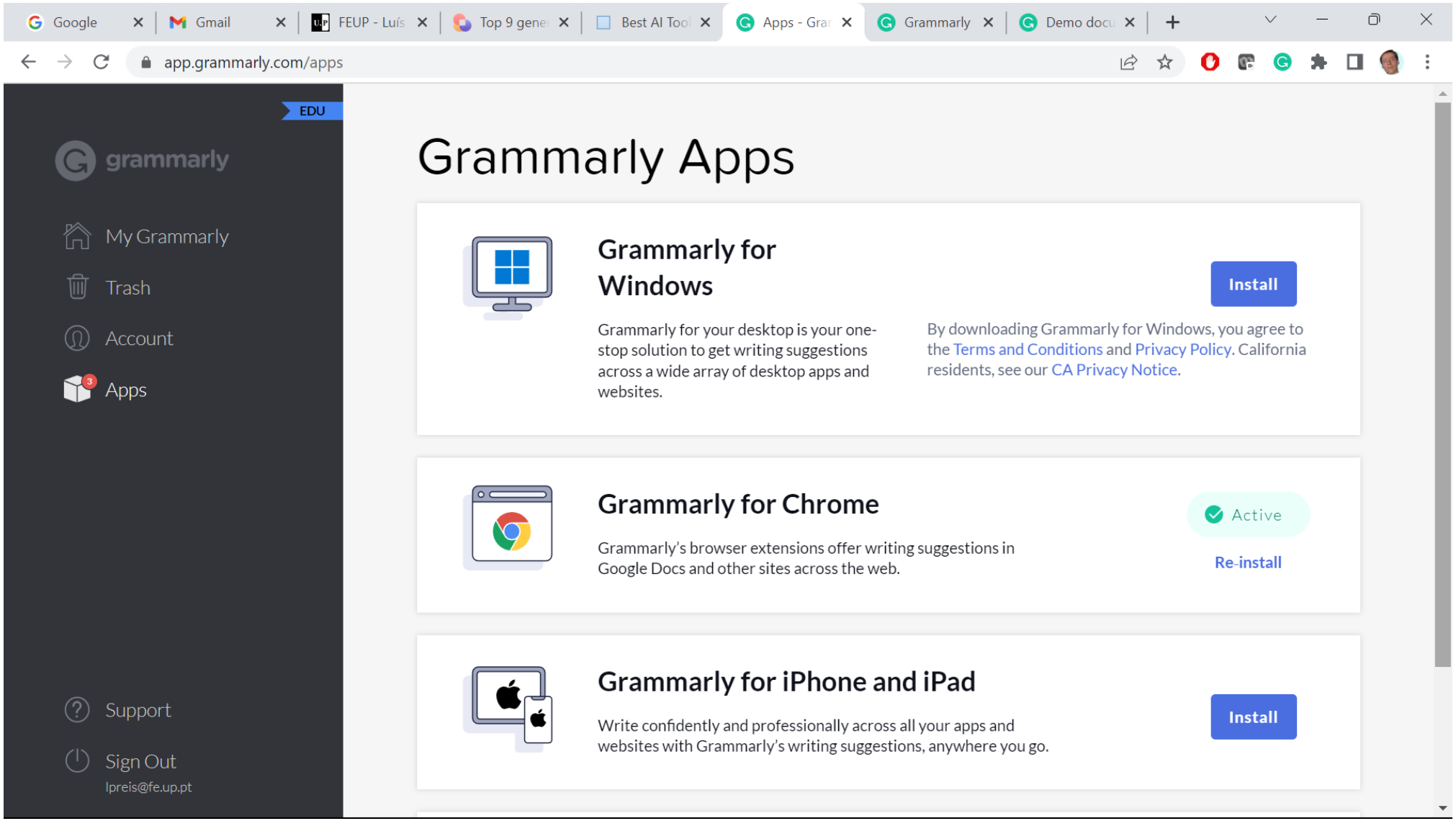


Perplexity AI

- **Perplexity AI** is a conversational search engine that uses large language models (**LLMs**) to answer queries using **sources from the web** and **cites links** within the text response.



Grammarly


Google
Gmail
FEUP - Luís
Top 9 gene
Best AI Too
Apps - Gra
Grammarly
Demo docu
app.grammarly.com/apps
EDU
grammarly
My Grammarly
Trash
Account
Apps
Support
Sign Out
lpreis@fe.up.pt
Grammarly Apps
Grammarly for Windows
Grammarly for your desktop is your one-stop solution to get writing suggestions across a wide array of desktop apps and websites.
Install
By downloading Grammarly for Windows, you agree to the Terms and Conditions and Privacy Policy. California residents, see our CA Privacy Notice.
Grammarly for Chrome
Grammarly's browser extensions offer writing suggestions in Google Docs and other sites across the web.
Active
Re-install
Grammarly for iPhone and iPad
Write confidently and professionally across all your apps and websites with Grammarly's writing suggestions, anywhere you go.
Install

DeepL

DeepL Translator | DeepL Pro | Why DeepL? | API | Plans and pricing | Apps FREE | Start free trial | Login

Translate text
31 languages

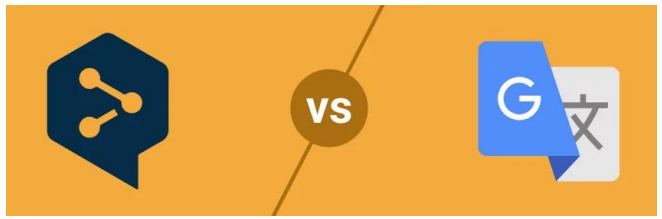
Translate files
.pdf, .docx, .pptx

Pick up where you left off with your **30-day free trial** of DeepL Pro.

Detect language | English (UK) | Glossary

Type to translate.

Drag and drop to translate PDF, Word (.docx), and PowerPoint (.pptx) files with our document translator.



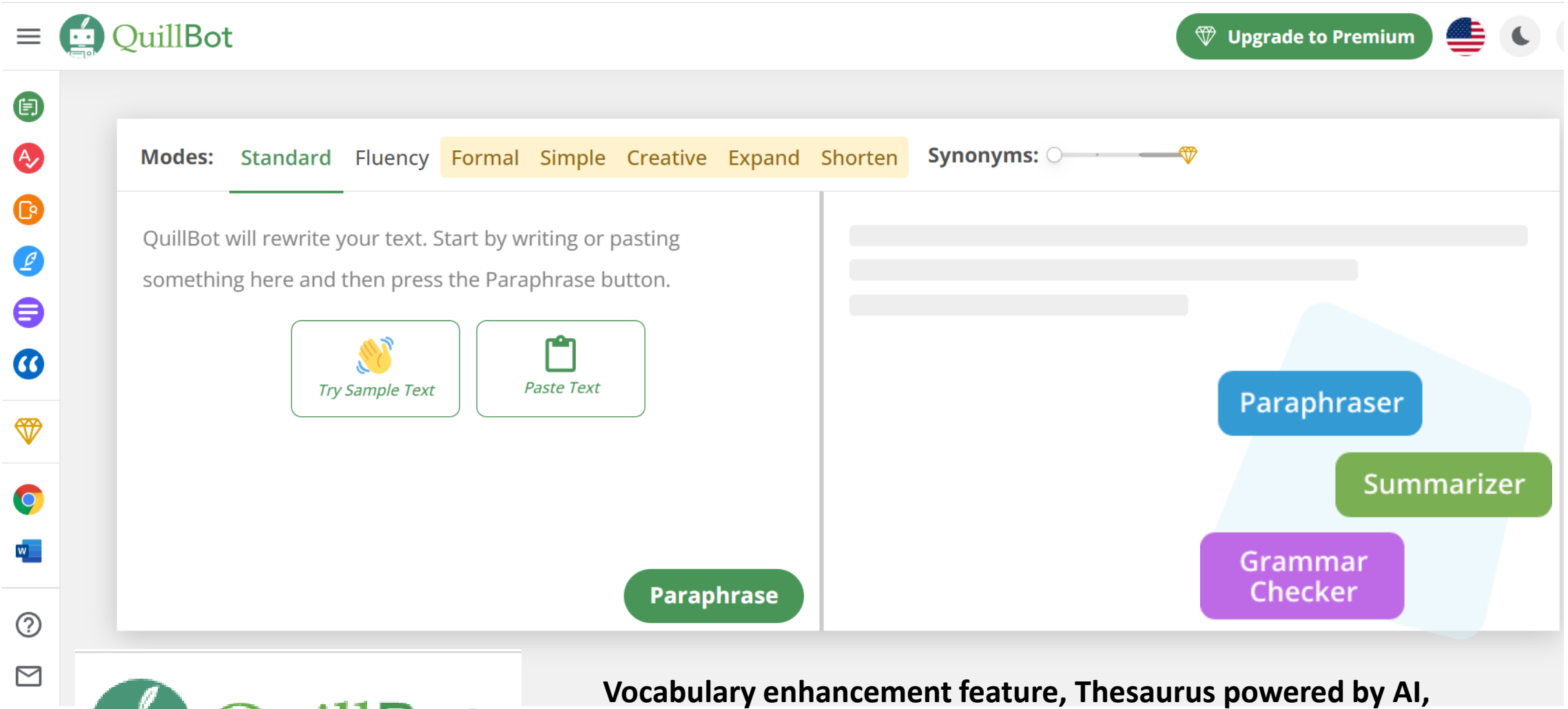
DeepL Translator

Tech giants Google, Microsoft and Facebook are all applying the lessons of machine learning to translation, but a small company called DeepL has outdone them all and raised the bar for the field.
Its translation tool is just as quick as the outsized competition, but more accurate and nuanced than any we've tried.

TechCrunch, USA

TechCrunch

QuillBot



Vocabulary enhancement feature, Thesaurus powered by AI, Integrations (Word, GoogleDocs), Grammar check, Summarizing tool

Image Generation - Dall-E 3

DALL·E 3 is an AI system that can create realistic images and art from a description in natural language

An astronaut riding a horse in photorealistic style

A beach similar to "praia da baia" in Espinho with surfers, surfing in the sea and big waves

DALL·E 2

Midjourney

Stable Diffusion

Canva
AI-ASSISTED DESIGN GENERATOR

Explore GPTs

GPTs

Discover and create custom versions of ChatGPT that combine instructions, extra knowledge, and any combination of skills.

Search public GPTs

1 **Canva**
Effortlessly design anything: presentations, logos, social media posts and more.
By canva.com

2 **Logo Creator**
Use me to generate professional logo designs and app icons!
By Chase Lean

3 **Consensus**
Your AI Research Assistant. Search 200M academic papers from Consensus, get science-based answers, and draft content...
By Consensus

4 **image generator**
A GPT specialized in generating and refining images with a mix of professi and friendly tone.image generator
By NAIF J ALOTAIBI

5 **Video GPT by VEED**
AI Video Maker. Generate videos for social media - YouTube, Instagram, TikTok and more! Free text to video & speech tool wit...
By veed.io

6 **Grimoire**
Code Wizard 🧙‍♂️ Learn to Prompt-grai Create a website (or anything) with a sentence. 20+ Hotkeys for coding flows....
By gptavern.mindgoblinstudios.com

Custom GPTs — special-purpose versions of the model created by others

uma receita de bacalhau com espinafres e batatascom um emprtamento bonito e foto

Talked to api.adzedek.com

Receita de Bacalhau com Espinafres e Batatas

Esta é uma receita clássica e nutritiva que combina o sabor rico do bacalhau com a suavidade das batatas e a frescura dos espinafres. O prato é montado de forma elegante, com camadas visuais para um empratamento atraente.

Ingr es:

- 400g de bacalhau dessalgado
- 300g de batatas
- 200g de espinafres frescos
- 2 dentes de alho picados
- 1 cebola em rodelas finas
- 100ml de azeite de oliva
- Sal e pimenta a gosto

Llama 4 – Meta Open Source Models

Meta Technology Get started Trust & Safety Community

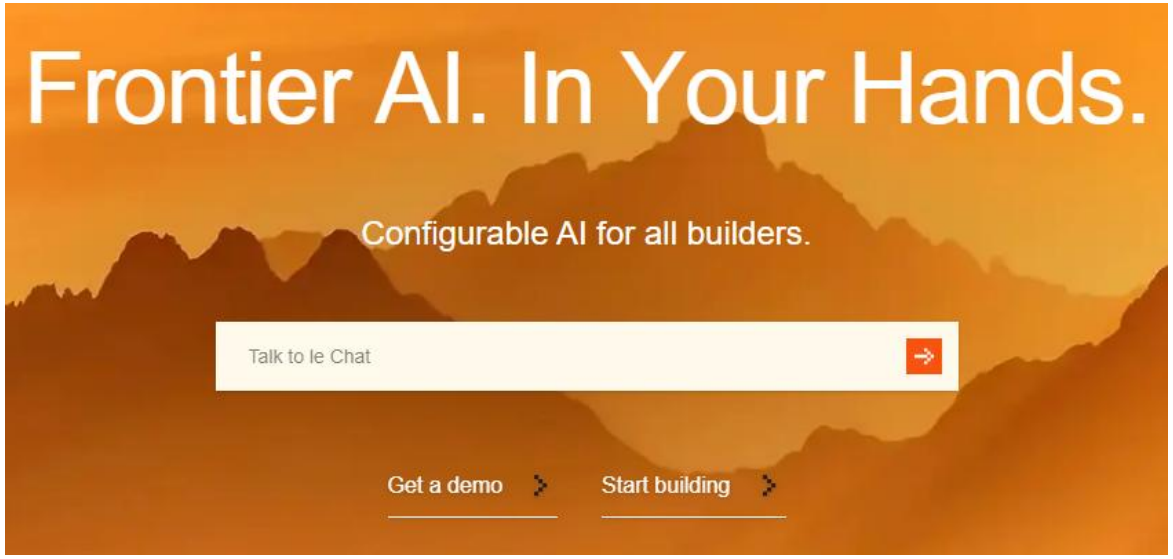
Try Meta AI ↗ Download models

Build the future of AI with Meta LLaMA 4

Now available with both 8B and 70B pretrained and instruction-tuned versions to support a wide range of applications

Get Started Experience Llama 3 on Meta AI

Mistral AI – Open Source Models



Openness

We lead the market of open source generative technologies to bring trust and transparency in the field and foster decentralised technology development

Portability

Our technology is available through serverless APIs, public cloud services (on Azure AI, on Amazon Bedrock), and for VPC/on-premise deployment. Our independence from cloud providers is a guarantee of our customers' independence.

Value and speed

Our flagship model, Mistral Large, has independently validated top-tier reasoning in multiple languages. All our models bring unmatched value and latency at their price points.

Customisation

Our models can be fine-tuned and modified at will for your business to create differentiated AI applications.

MISTRAL AI_

Build on Open Source

Under the Apache 2.0 license, our 3 open source models Mistral 7B, Mixtral 8x7B, Mixtral 8x22B are usable and customisable for a variety of use cases. They can be downloaded or used on demand via our platform.

- Download them for deployment in your own environment
- Use them on La Plateforme at market-leading availability, speed, and quality control

Gemma 3n – Gemini Google Open Source

Gemma

google/gemma

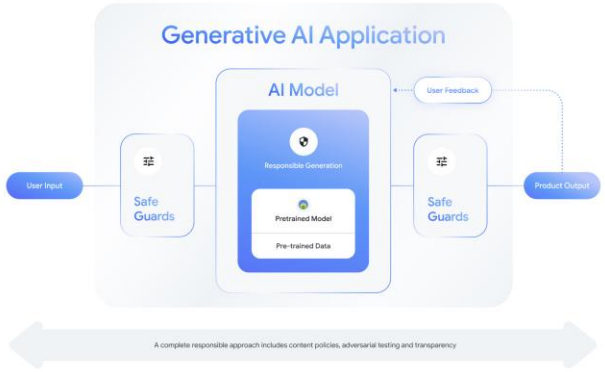
Gemma 2 is now available to researchers and developers

Gemma 2 offers best-in-class performance, runs at incredible speed across different hardware and easily integrates with other AI tools.

Jun 27, 2024 · 4 min read

Gemma is a family of lightweight, open models built from the research and technology that Google used to create the Gemini models.

Google DeepMind



Responsible Generative AI Toolkit

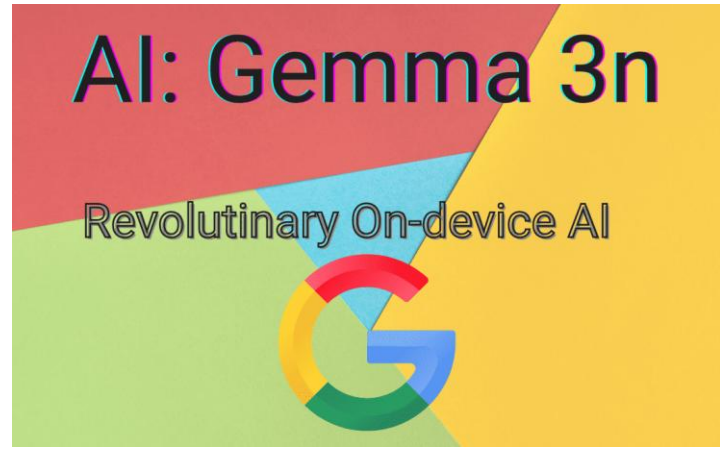
Send feedback

This toolkit provides resources to apply best practices for responsible use of open models such as the Gemma models, including:

- Guidance on setting safety policies, safety tuning, safety classifiers and model evaluation.
- The Learning Interpretability Tool (LIT) for investigating Gemma's behavior and addressing potential issues.
- A methodology for building robust safety classifiers with minimal examples.

This version of the toolkit focuses on English text-to-text models only. You can provide feedback to make this toolkit more helpful through the feedback mechanism link at the bottom of the page.

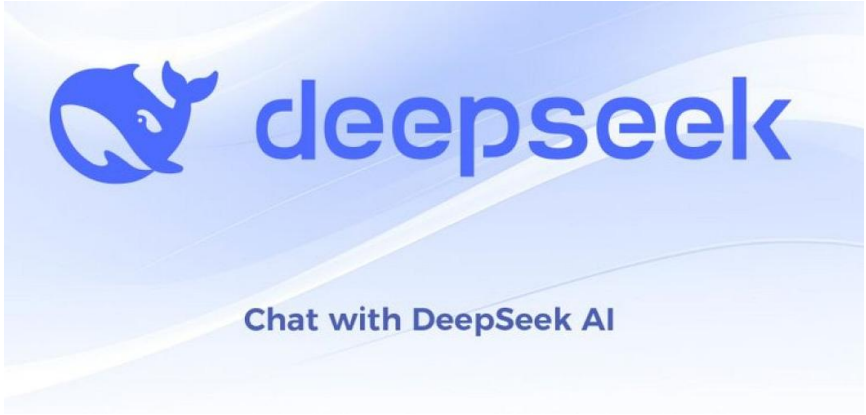
When building with Gemma, you should take a holistic approach to responsibility and consider all the possible challenges at the application and model levels. This toolkit covers risk and mitigation



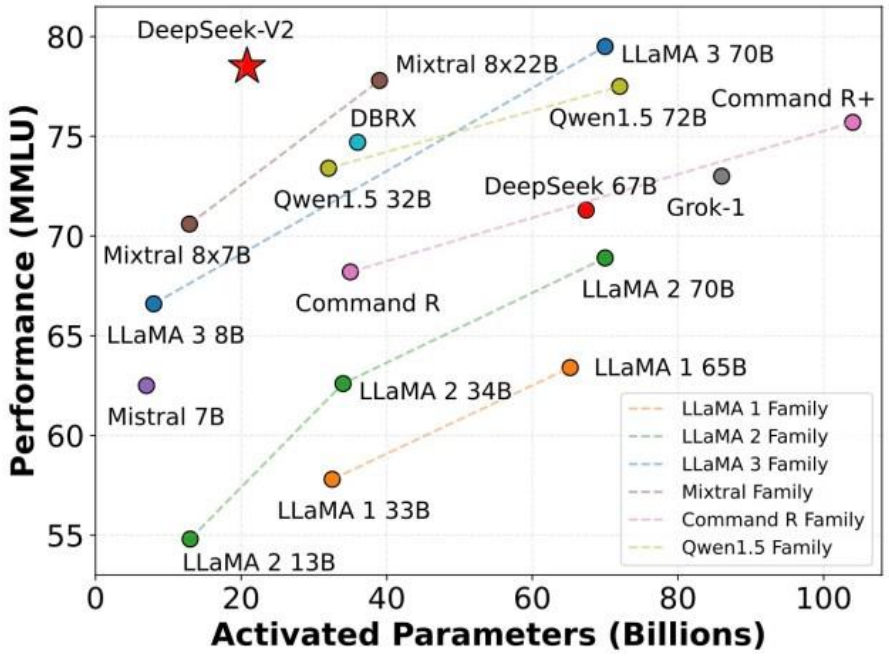
Gemma 3n

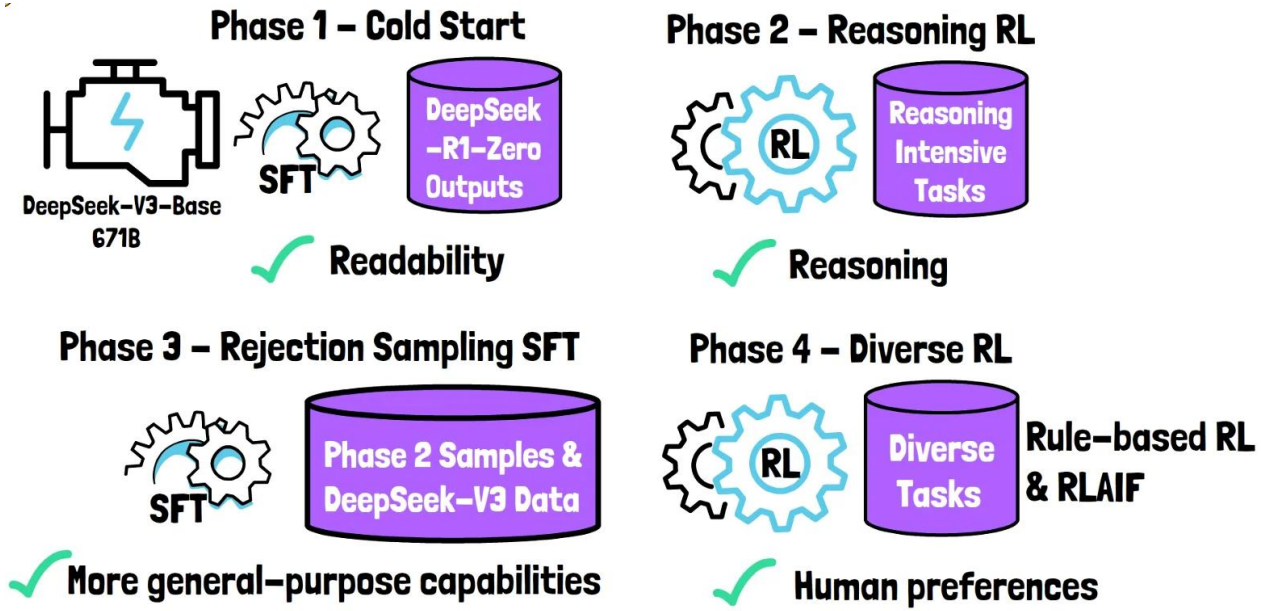
Our powerful and efficient open model designed to run locally on phones, tablets, and laptops.

DeepSeek

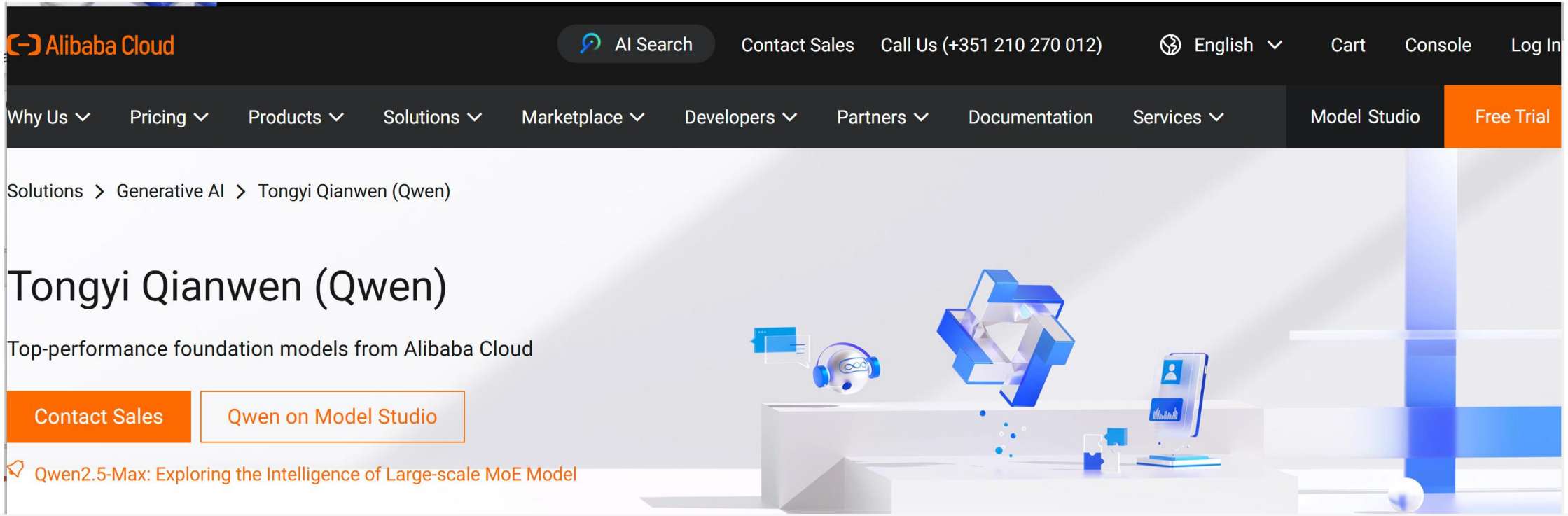


DeepSeek is a Chinese AI research lab focused on developing LLMs and AI systems. DeepSeek series includes DeepSeek-V2, a high-performance open-weight model trained on diverse multilingual datasets, aiming to compete with top-tier models like GPT and LLaMA. DeepSeek emphasizes efficiency, scalability, and domain-specific capabilities, particularly in Chinese language understanding and applications. The lab has also developed DeepSeekCoder, an advanced AI model optimized for code generation and programming assistance. With strong computational resources and a growing presence in the AI research landscape, DeepSeek is positioning itself as a significant player in the global LLM ecosystem.





Qwen - Alibaba



TONGYI Qwen

TONGYI Qwen-VL

TONGYI Qwen-Audio

TONGYI Qwen2.5-Max

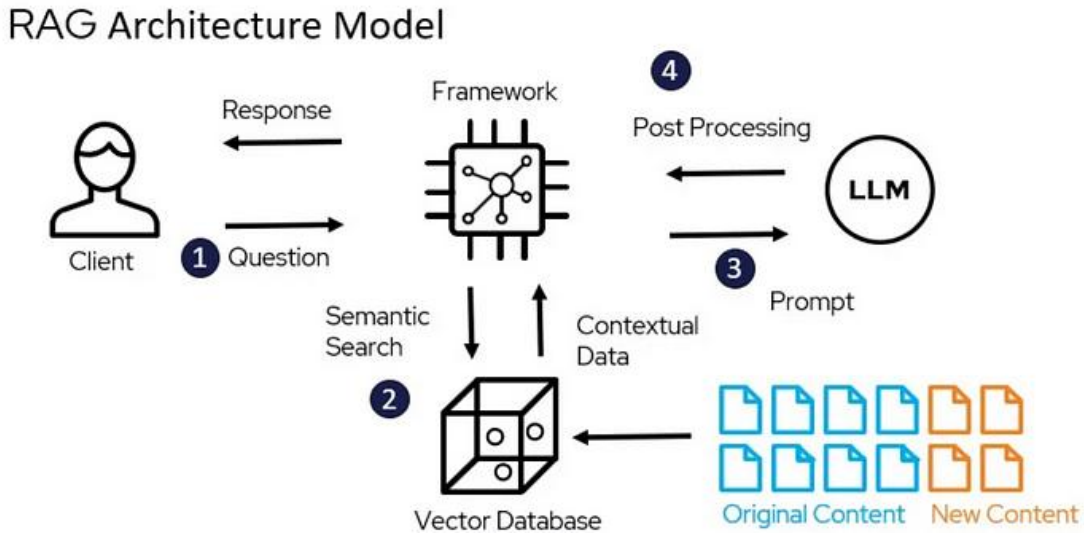
TONGYI Qwen 2.5-Coder

TONGYI Qwen 2.5-Math

TONGYI Qwen-Agent

RAG Architecture Model

- **Retrieval Augmented Generation (RAG) has emerged as a powerful technique for improving LLMs**
- **Retrieving and conditioning external knowledge, RAG allows models to generate more accurate, relevant, and comprehensive text**



https://medium.com/@gulernilay088/

- **Advanced RAG enhances each module further with innovations like higher-order retrievers, cross-encoder rerankers, and evidence manipulation architectures**

AI Applications in Health

- Radiology (X-ray, CT, MRI)
- *Dermatology (Image)*
- Drug/Treatment Discovery
- Risk Identification in Patients
- Primary Care and Screening
- Health Monitoring/Wearables
- Cognitive and Social Rehabilitation
- Physical Rehabilitation
- Patient Interaction with the Health System
- Health Systems Exchange of Information
- Surgical/Medical Robots
- Efficient Resource Allocation in Health
- …

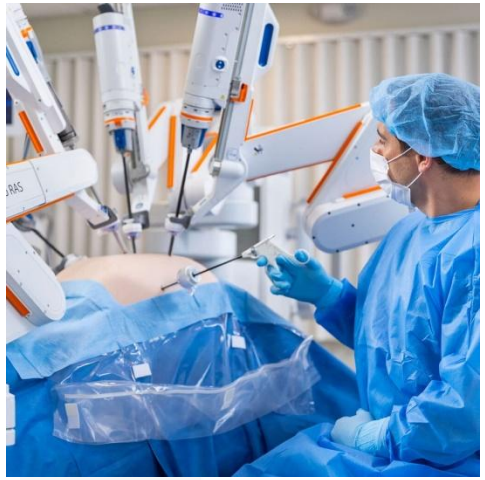
AI&Robotics Applications in Surgery

da Vinci Surgical System

Mako SmartRobotics

Rosa Brain Robot

Hugo Surgical Robot



Senhance Surgical System

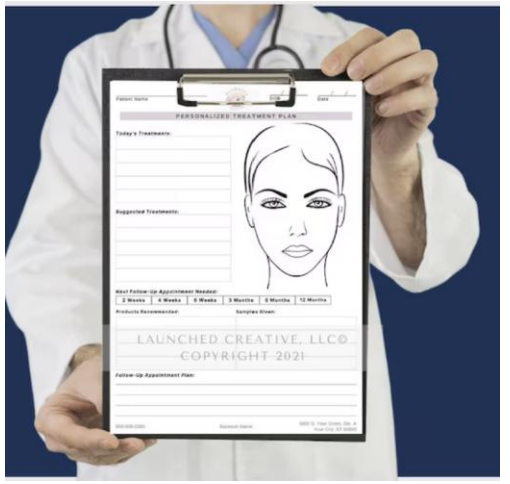
Versisus Surgical System

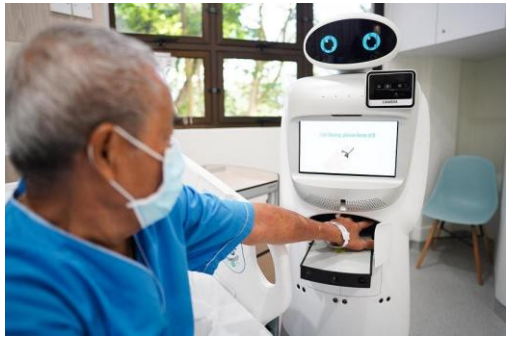
Navio S.S.

AI&Robotics in Nursing

AI in Nursing:

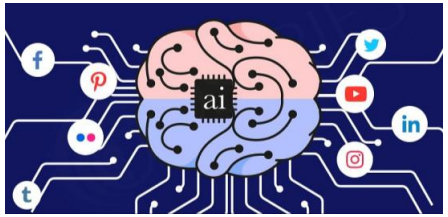
- **Personalized Treatment Plans** based on individual patient data, optimizing care
- **Workflow Optimization** with automatization of administrative tasks, efficient scheduling, allowing nurse staff to focus more on patient care
- **Patient Monitoring** with AI-powered devices continuously monitor vital signs and alert nurses to any deviations
- **Robotics and Automated assistants** helping with physical tasks, reducing strain and increasing efficiency in patient handling and monitoring





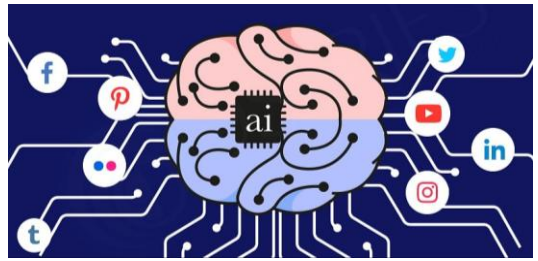
Artificial Intelligence in Digital Media

- Digital Images
- Digital Video
- Digital Audio
- Movie Industry
- Video Games
- Web Pages and Websites
- Social Media
- Digital Data and Databases
- Electronic Documents/Books



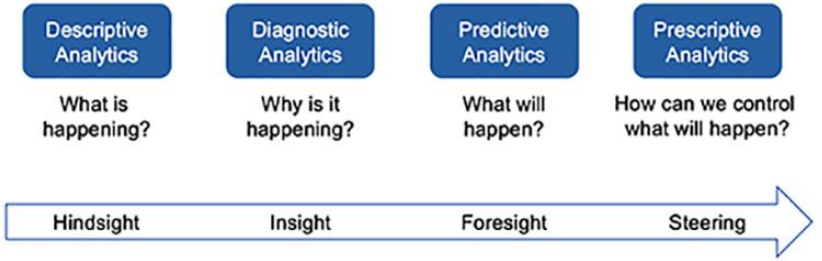
Artificial Intelligence in Social Media

- Social Creation and Management
- Social Insights
- Social Media Advertising
- Image/Face Recognition
- Fake News/Improper Content Recognition
- Personalised User Experience
- Advise Contacts/ Job candidates / Matches
- AI Powered Chatbots
- Social Listening
- Sentiment Analysis
- Improved Influencer strategies
- Increased Security



AI for the Environment

- **AI for Land/Agriculture**
  - Soil pollution, population growth, intensive agriculture
  - Land cover mapping, automating and optimizing farming processes
- **AI for Air/Pollution**
  - Pollution/air quality sources identification, reduce emissions
  - Intelligent and green transportation,
    autonomous cars, ride shares, dynamic bus routing, intelligent traffic lights
- **AI for Water**
  - Garbage collection, Intelligent ocean farming (fish and shellfish)
  - Predict storms, tsunamis, hurricanes, cost-effective water management
- **AI for Biodiversity**
  - Surveillance, tracking, analysis, prediction
- **AI for Climate Change**
  - Better climate predictions, effects of extreme weather, predict where carbon is coming from

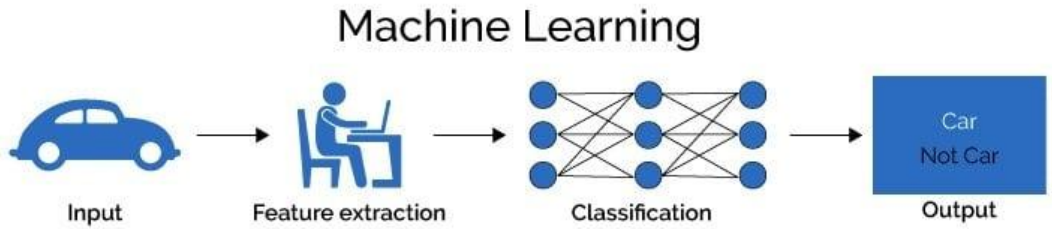


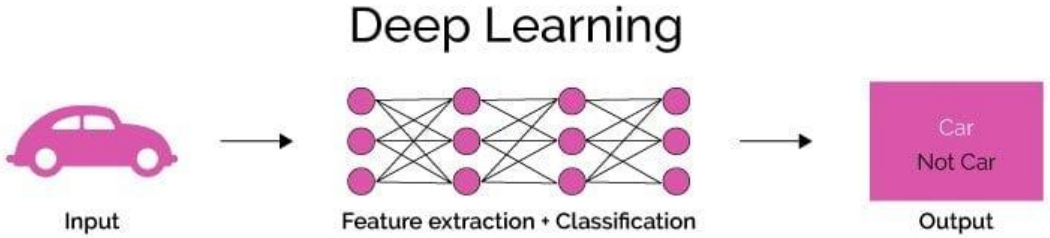
AI & LLM Key Trends in 2025

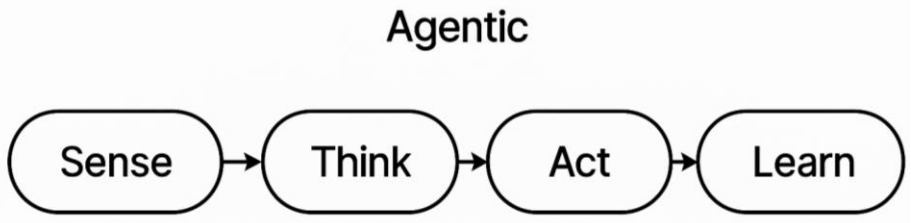
- **Small Language Models (SLM)** drive **enterprise AI adoption**
- Mixture of Experts (**MoE**) **+ LoRA** enable SLMs to outperform 10x larger LLMs
- **Open-source are becoming the de facto** way for **LLMs** use
- Large language models start adopting **modular architectures**
- **Synthetic data** revolution arrives to LLMs
- LLM **hallucinations disappear** as training techniques evolve
- **Data** (not LLMs) becomes the **true competitive advantage**
- **RAGs** (Retrieval-Augmented Generation) used in most LLMs tasks
- Shift from closed to open-source **democratizes AI** (transparency)
- **Agentic AI – AI that acts!**
- **LLMs for Machines and Robots**, not just people - **LBMs**

Limits of Deep Learning

- **Brilliant but Passive!**
- **Deep nets can predict, but they can not plan. They lack goals, intents, and common sense**
- This sets the **stage for Agentic AI: From Prediction to Decision and Action…**
- The next leap is **agency — AI** that **senses, reasons,** and **acts** toward goals
- **Predictive (Model→Output) vs Agentic (Sense→Think→Act→Learn)**



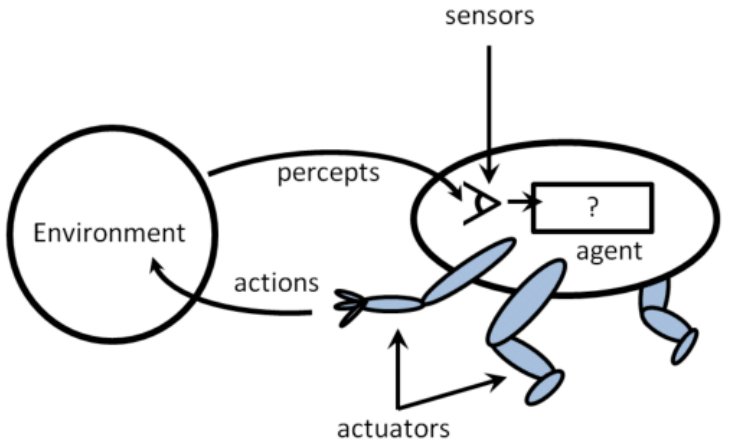




Autonomous Agents and Multi-Agent Systems

Agent (1995):

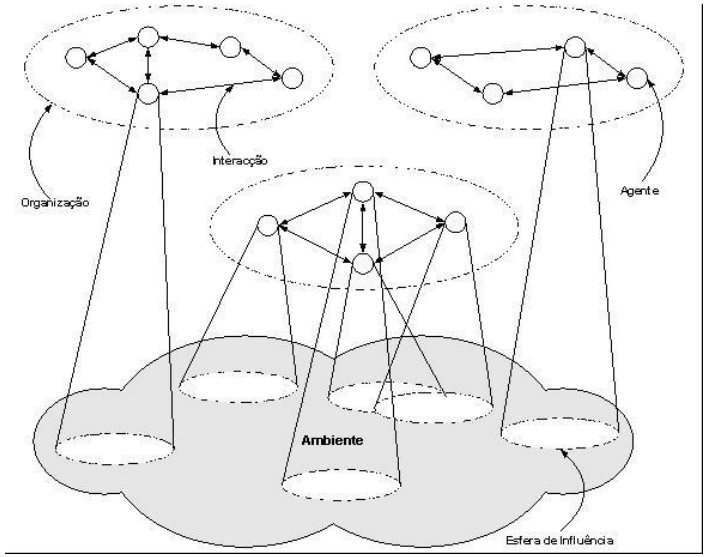
"Computational System, situated in a given **environment**, that has the ability to **perceive** that environment using **sensors** and **act**, in an **autonomous way**, in that environment using its **actuators** to fulfill a given **function**."



From Russel and Norvig, "AI: A Modern Approach", 1995

Multi-Agent System (1995):

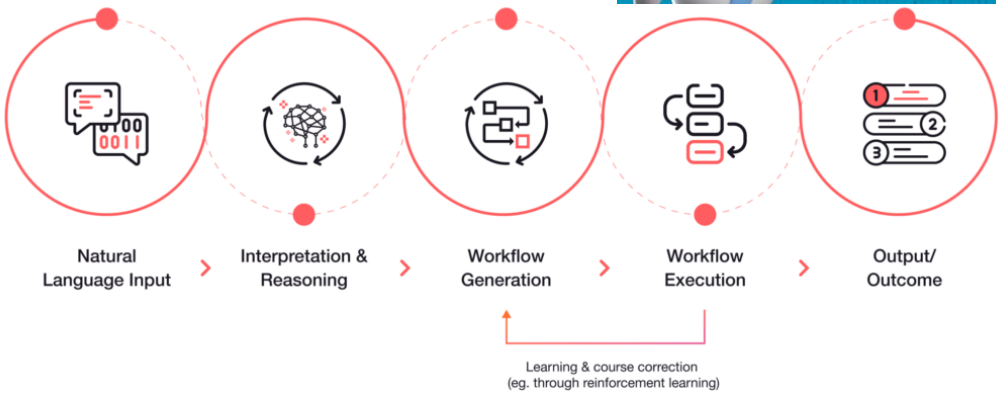
- Agents exhibit **autonomous behavior**
- **Interact** with other agents in the system



Agentic AI

- **Autonomy:** Ability to initiate and complete tasks with limited direct human supervision, with great flexibility and efficiency in executing tasks
- **Reasoning:** Sophisticated decision-making based on context and trade-offs
- **Reinforcement Learning:** Dynamically evolve by interacting with their environment and receiving feedback from these interactions.
- **Language Understanding:** Capacity to understand and follow complex instructions
- **Workflow Optimization:** Efficient execution of multi-step complex processes

Feature	Agentic AI	Generative AI	Traditional AI
Primary Function	Goal-oriented action & decision-making	Content generation (text, code, images, etc.)	Focused on automating repetitive tasks
Autonomy	High – Operates with minimal human oversight	Variable – May require user prompts or guidance	Low – Relies on specific algorithms and set rules
Learning	Reinforced Learning – Improves through experience	Data-driven learning – Learns from existing data	Relies on predefined rules and human intervention



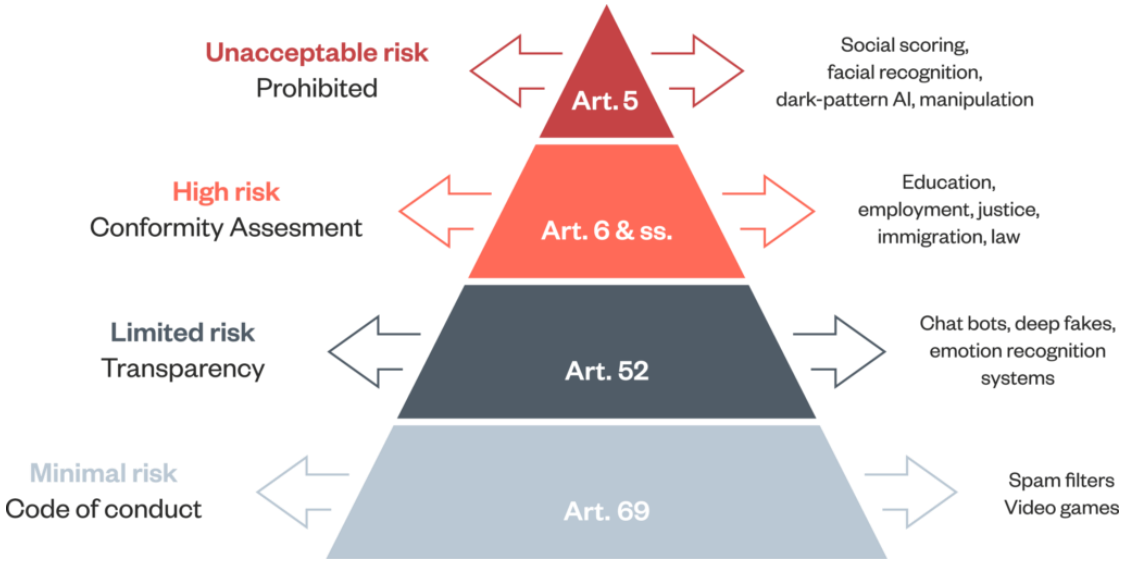
https://aisera.com/blog/agentic-ai/

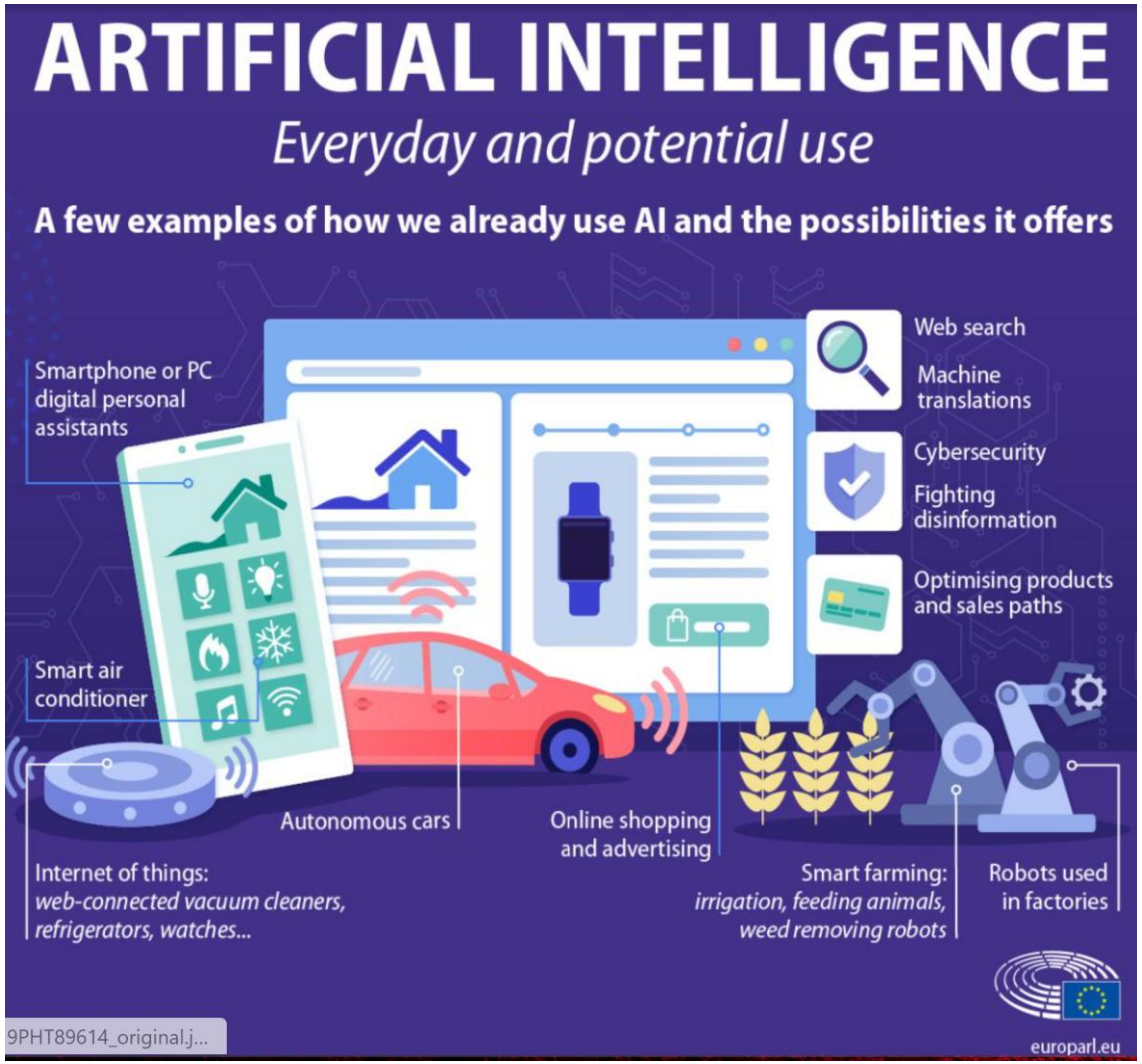
New & Emerging Trends (2025+)

- **Agentic AI Rises** — Autonomous agents that reason, plan, and act toward goals
- **Large Behavior Models (LBMs)** — Models learning from actions and interactions, not just text
- **Multi-Agent Collaboration** — Intelligent agents cooperate and negotiate to solve complex tasks
- **Responsible & Regulated AI** — Transparency, fairness, and compliance standards
- **Edge & On-Device AI** — Efficient, private models running locally on devices /robots
- **Hybrid Human–AI Teams** — Shared intelligence combining human oversight and machine efficiency

EU AI Act – Regulating the Past…

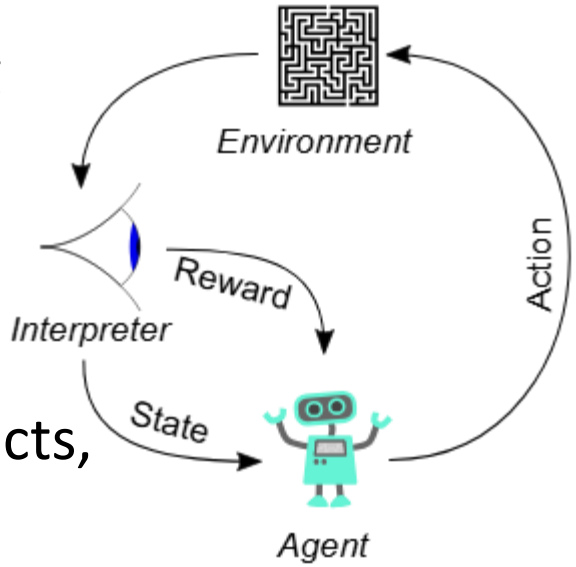
- **First regulation on artificial intelligence**
- **AI can create many benefits:**
  - better healthcare
  - safer and cleaner transport
  - more efficient manufacturing
  - cheaper and more sustainable energy.





The Rise of Deep Reinforcement Learning (DRL)

- **Beyond Short-Term Thinking**
  - LLMs have limited context windows — they forget.
  - Memory and planning enable continuity and strategic reasoning
- **Reflection and Self-Improvement**
  - Evaluate their own reasoning, detect failures, and adapt
  - Self-reflection transforms agents from reactive to self-correcting
- **Tools/Actuators Use and World Interaction**
  - Intelligence changes into capability
- **Learning by Doing**
  - Reinforcement Learning teaches through feedback — an agent acts, receives a reward, and updates its policy to improve next time.

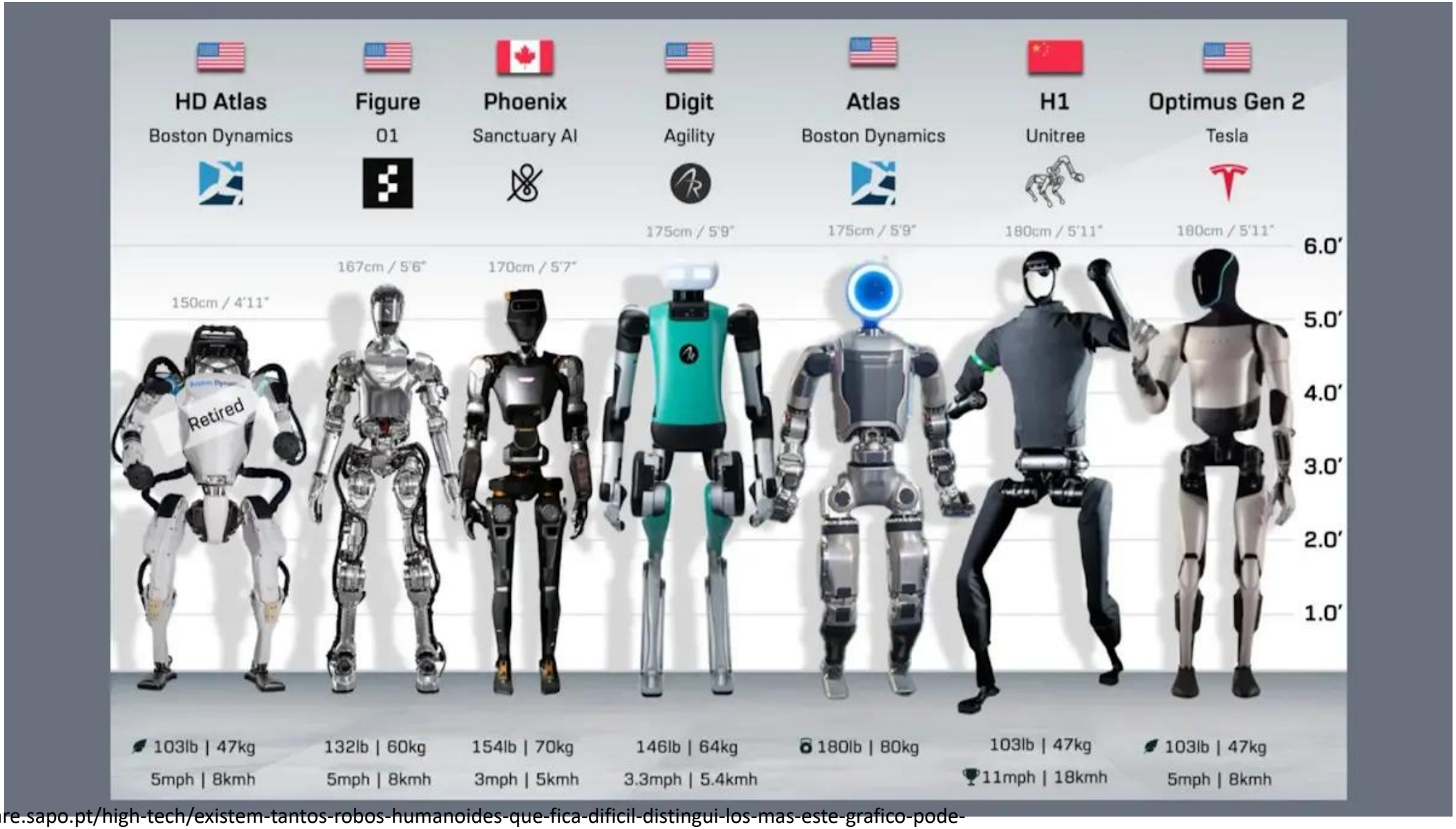


AI in Robotics

Robotics – Atlas Robot

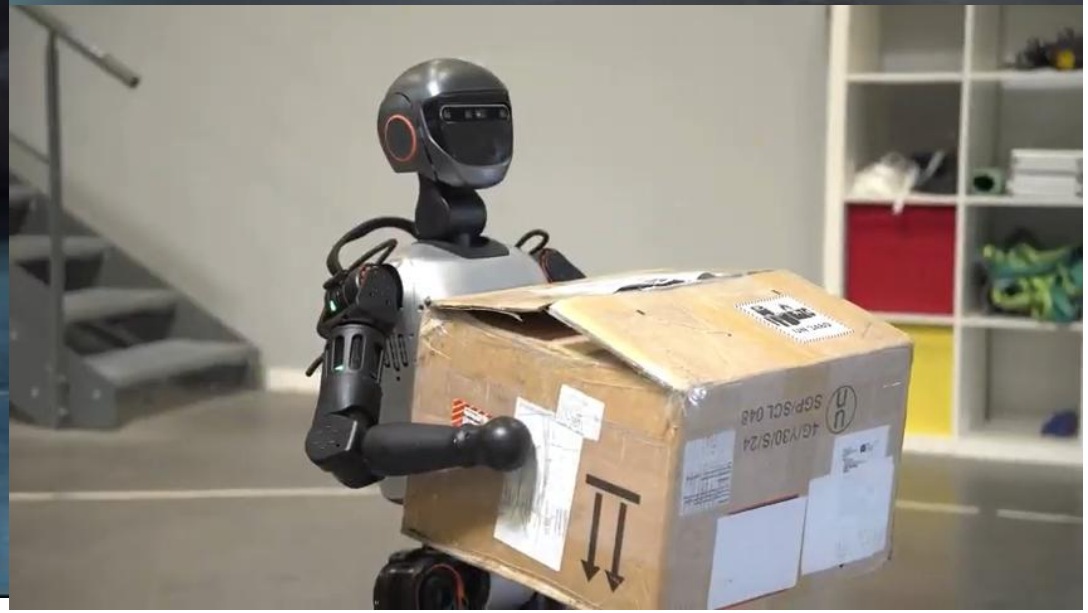
Video: Boston Dynamics: Atlas Gets a Grip - https://www.youtube.com/watch?v=-e1_QhJ1EhQ&ab_channel=BostonDynamics

Robotic Humanoids



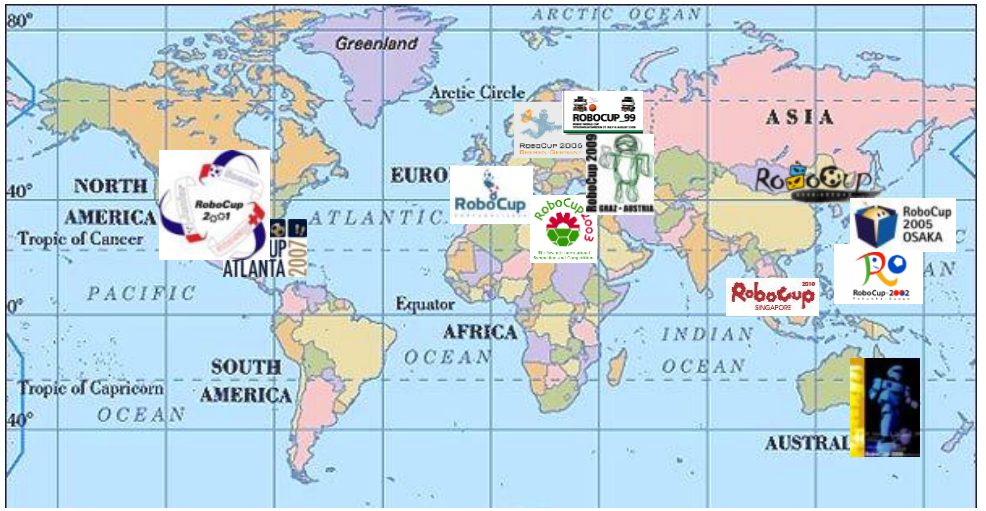
https://pplware.sapo.pt/high-tech/existem-tantos-robos-humanoides-que-fica-dificil-distingui-los-mas-este-grafico-pode-ajudar/?fbclid=IwY2xjawI1Zg9leHRuA2FlbQIxMQABHS_EdekrvewLEgIyq3RZRfPy-HaU4MdNtaFgqa6bT2lkcoYfBoF_Jkqd9w_aem_RO6nDQ16bQJ51jD6bM6-TQ

Unitree and Booster Robots



RoboCup: Objectives

- Joint International Project:
  - **(Distributed) Artificial Intelligence**
  - **Intelligent Robotics**
- **Soccer** – Central Research Topic:
  - **Very complex collective game**
  - **Huge number of technologies** involved:
    - Autonomous Agents, **Multi-Robot Systems**, **Cooperation**, **Communication**, **Strategic Reasoning**, Robotics, Sensor Fusion, Real-Time Reasoning, **Machine Learning,** etc
- **5 Challenges:** Soccer, Rescue, @Home, Industrial, Junior
- **17 Leagues, 2500 Humans and 2000 Robots!**
- Main Goal: ***"By 2050, develop a team of fully autonomous humanoid robots that may win against the human world champion team in soccer!"***



RoboCup Leagues and Challenges

Industrial

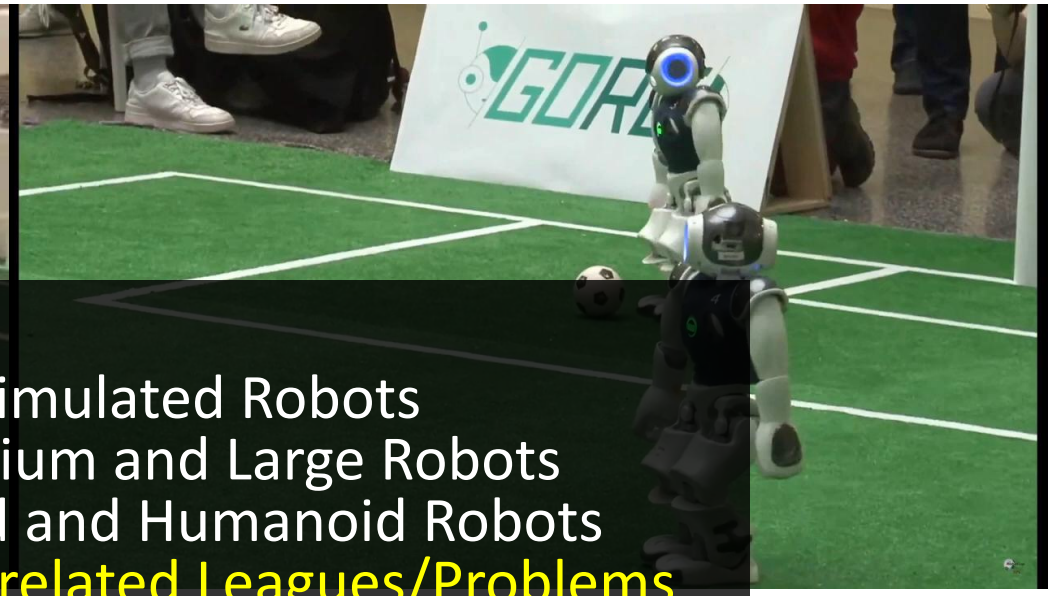
Rescue

@Home

Soccer

RoboCup - Robotic Soccer Competitions

Middle Size League



Standard Platform League

RoboCup

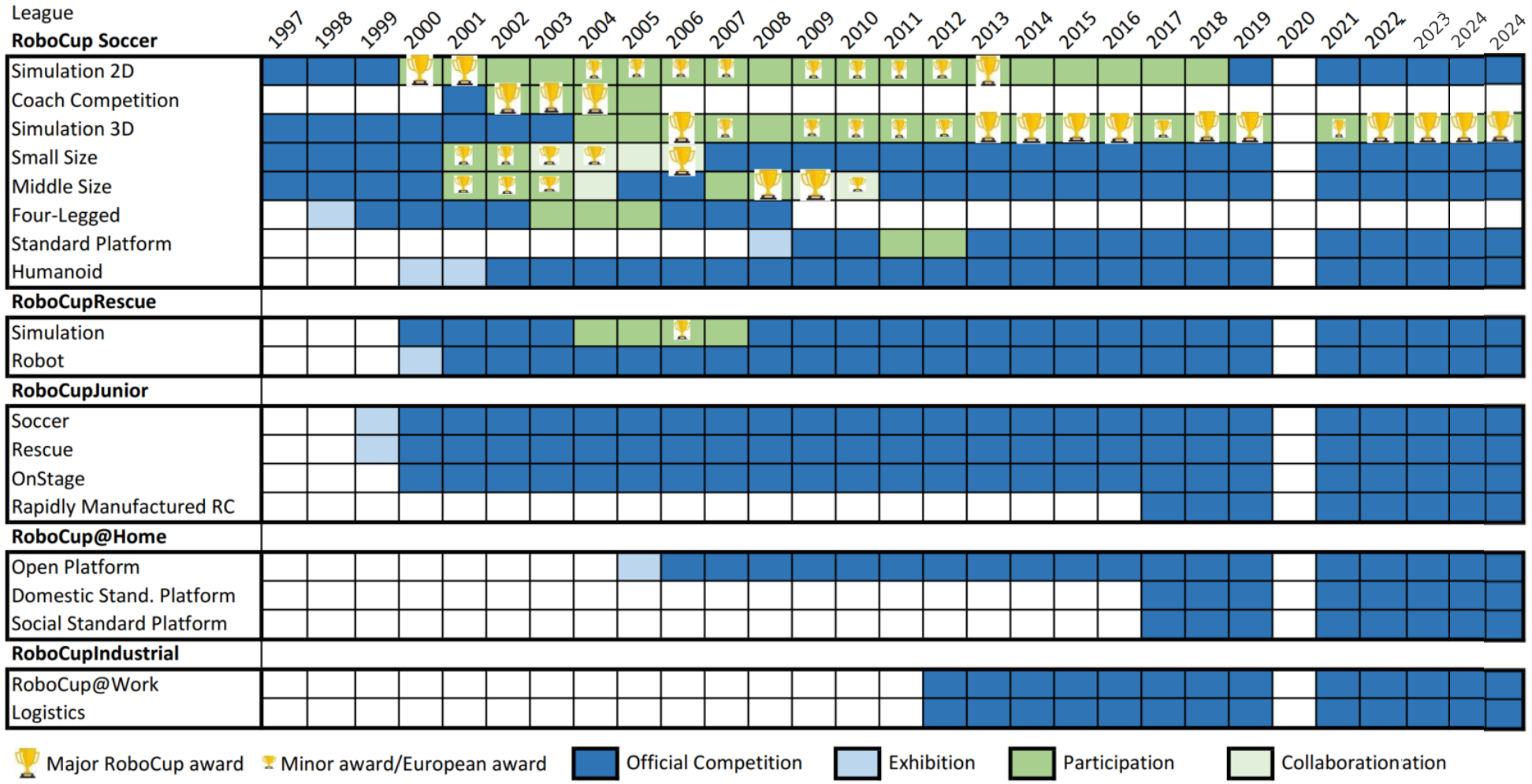
- Real, Standard, Simulated Robots
- Mini, Small, Medium and Large Robots
- Wheeled, Legged and Humanoid Robots
- Distinct but interrelated Leagues/Problems
- Only a Few Research Groups able to develop code that works in more than one league!

Small Size League

Humanoid League

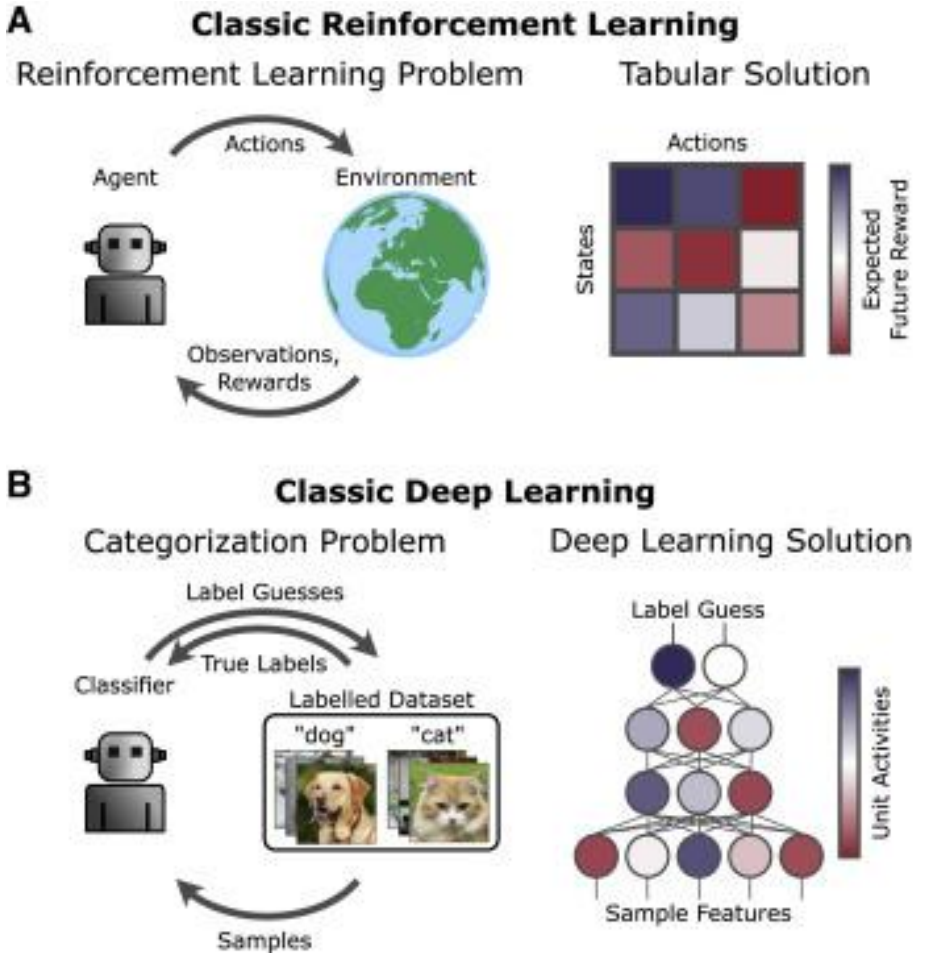
RoboCup Leagues and Participations

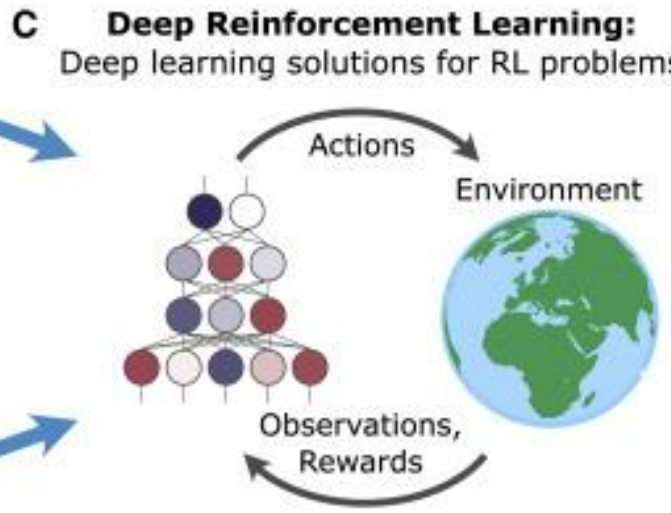
FC Portugal Team (FEUP/UAveiro)



Simulation 3D League (Humanoids)

Deep Reinforcement Learning (DRL)





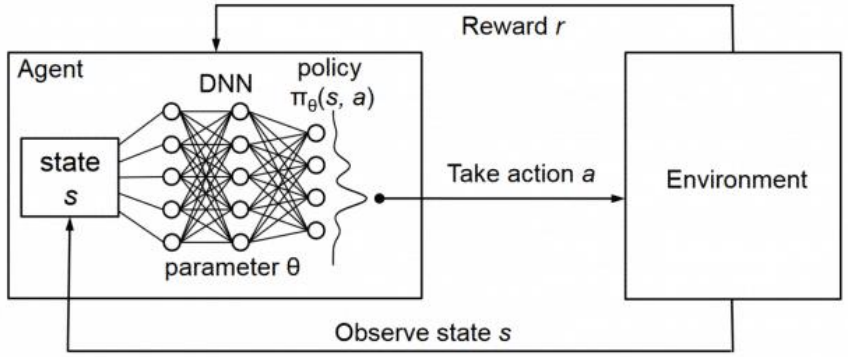


Image: https://ucsdneuro.wordpress.com/2021/06/13/diving-deep-into-the-brain-a-case-for-deep-reinforcement-learning-in-neuroscience/

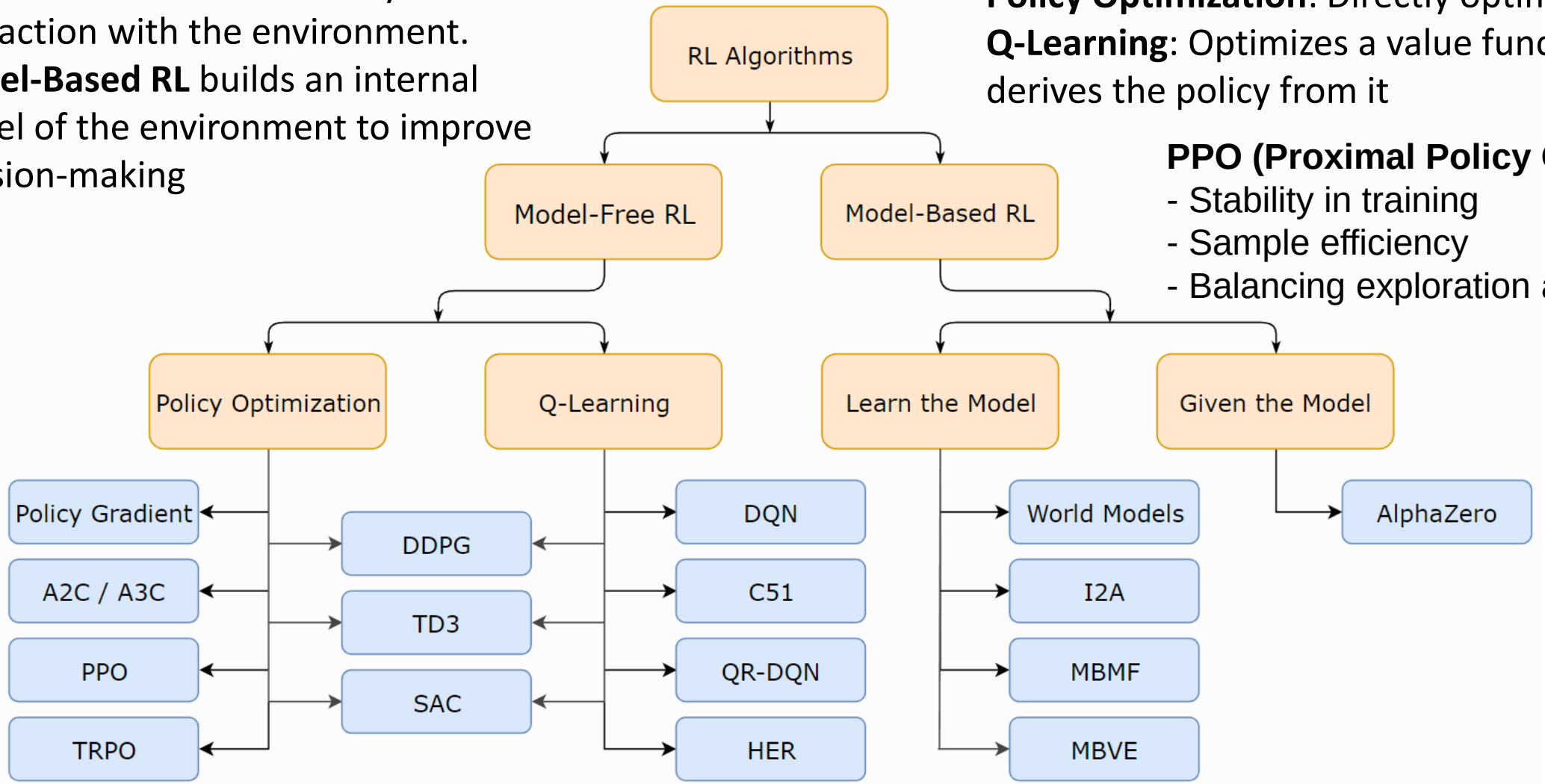
Brains + Experience = Deep Reinforcement Learning

DRL proved machines can outperform humans in dynamic environments

Robots can now learn directly from physical interaction

Deep Reinforcement Learning (DRL)

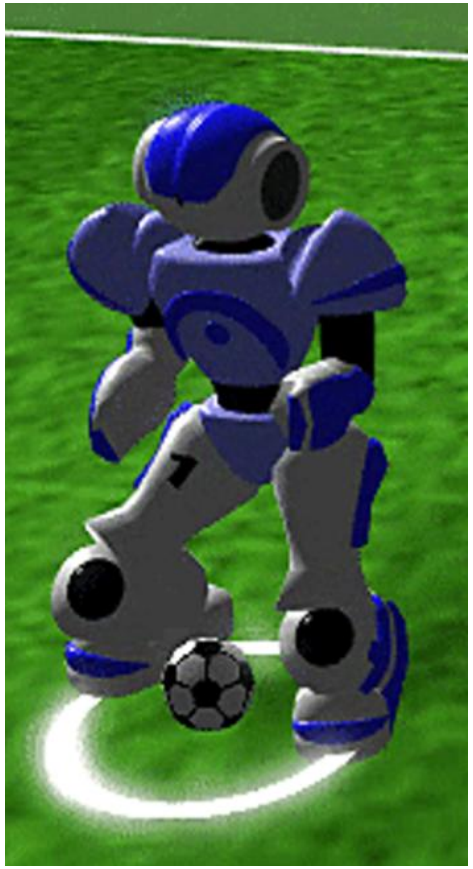
Model-Free RL learns directly from interaction with the environment.
Model-Based RL builds an internal model of the environment to improve decision-making

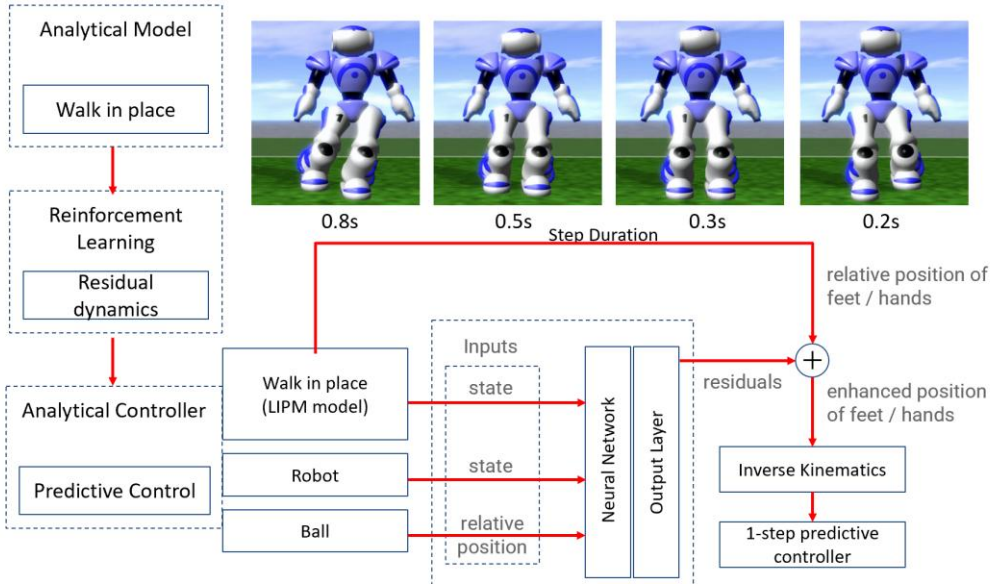


Policy Optimization: Directly optimizes policy
Q-Learning: Optimizes a value function and derives the policy from it

PPO (Proximal Policy Optimization)
- Stability in training
- Sample efficiency
- Balancing exploration and exploitation

DRL for Learning to Sprint/Dribble





IEETA
https://www.ieeta.pt › New

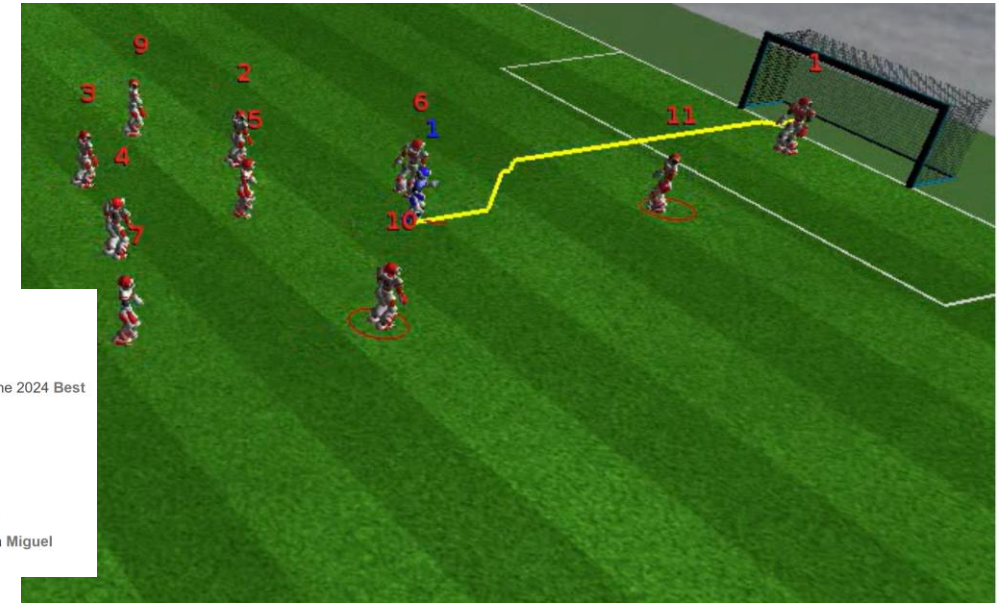
APPIA Award for Best PhD Thesis in Artificial Intelligence

6 Oct 2025 — The Portuguese Association for Artificial Intelligence (APPIA) has awarded the 2024 Best PhD Thesis in Artificial Intelligence to Miguel Abreu ...

Notícias U.Porto
https://noticias.up.pt › 2025/10/09 · Translate this page

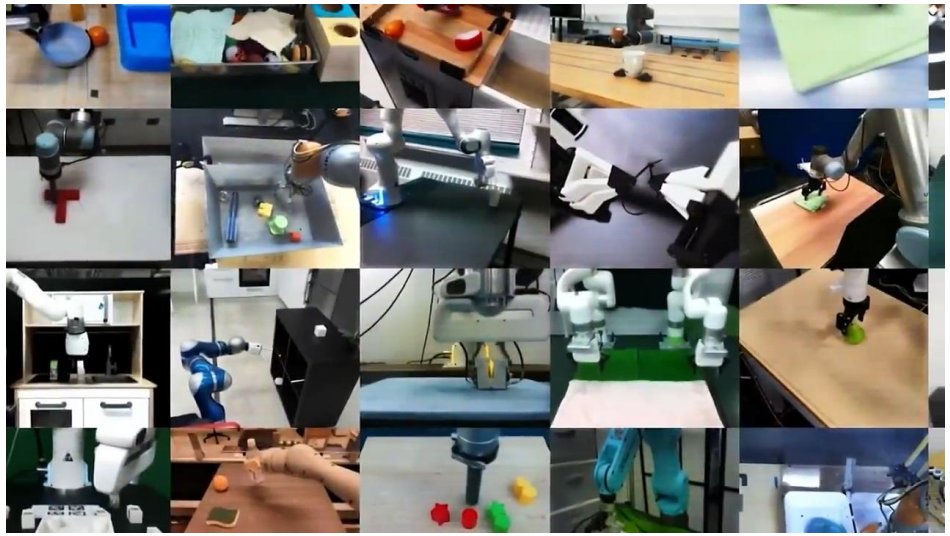
Melhor Tese de Doutoramento em Inteligência Artificial de ...

9 Oct 2025 — Prémio da Associação Portuguesa para a Inteligência Artificial foi atribuído a Miguel Abreu, doutorado em Engenharia Informática pela FEUP.



Large Behavior Models - LBMs

- **LBMs** go beyond processing language. They're designed to **interpret, predict, and generate complex sequences of human-like actions and behaviors**
- While LLMs focus on text and dialogue, LBMs specialize **in behavioural patterns**, **decision-making** processes, and **interactive scenarios**
- LLMs try to guess the next word, while **LBMs try to guess the next action or behaviour**
- LBMs are enhancing robots' abilities to move naturally and respond intuitively to their surrounding
- LBMs rely on:
  - **Transformer Architecture**: Similar to LLMs but adapted to handle sequences of actions/behaviours
  - **Multi-Modal Learning:** Integrating visual, spatial, and temporal data to enhance understanding
  - **Reinforcement Learning:** Learning from interactions and feedback to improve behavior over time



Conclusions

- **AI has become a Partner no longer a Tool!**
- We've travelled from **Symbolic Logic to** self-learning **Agents and Robots**
- Impossible to prevent **AI** use in **All Areas** of **Society and Work**
- **Agentic AI, LBMs** and **New GenAI** and **DRL** powered and trained **Robots**
- **Are We Ready for Self-Improving Intelligent Machines?**
- **Next generation of AI** won't just predict — it will **act, learn,** and **evolve**
- **By 2030, AI agents** will be integrated into **every digital platform/robotic system —** from industry to healthcare to daily life (**LLMs, DRL, LBMs)**
- **Our challenge is to ensure AI Grows With Us, Not Against Us!**

Navigating the Artificial Intelligence Revolution

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