GENERATIVE AI
Technologies at a Glance

August 2025

"TECHNOLOGIES AT A GLANCE" REPORT

ANALYSING KEY TRENDS FOR INFORMED DECISION-MAKING

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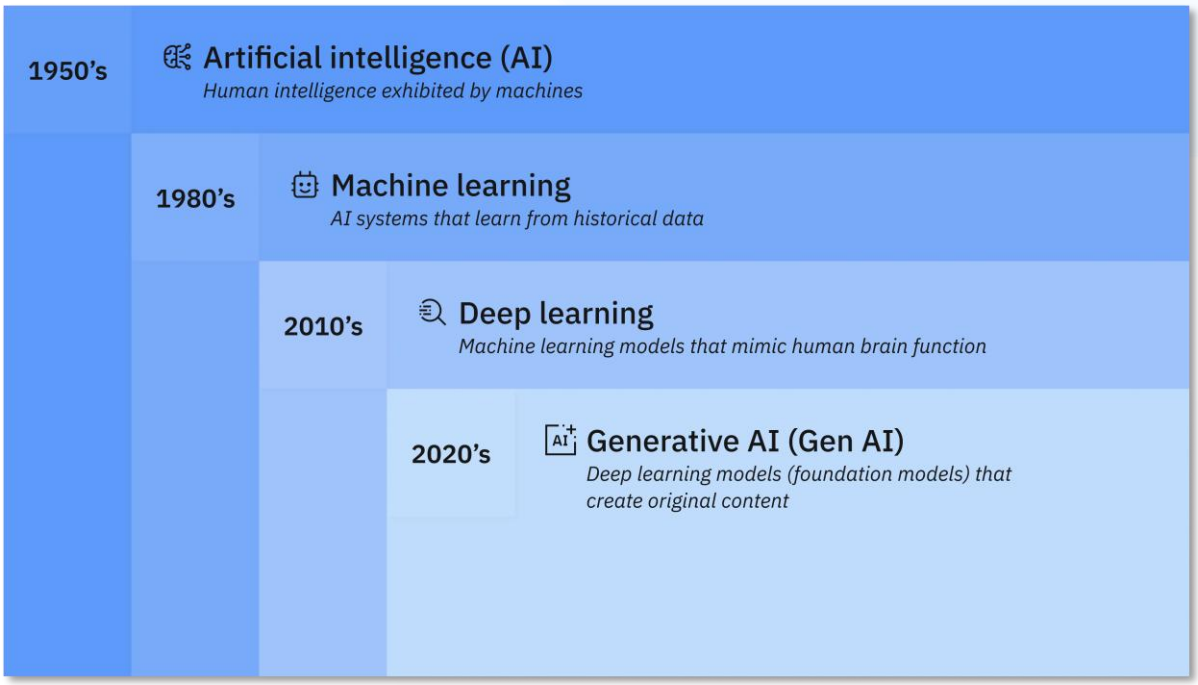
Agenda

01 Generative AI

What is Generative AI (GenAI)?

Today, when we talk about Artificial Intelligence, we usually refer to Generative AI, a technology capable of producing text, images, videos, and other types of content. The main feature of GenAI is its ability to generate original content based on vast amounts of data.

To fully understand Generative AI, it is important to first understand the underlying technologies: machine learning and deep learning.



IBM, « How artificial intelligence, machine learning, deep learning and generative AI are related. »

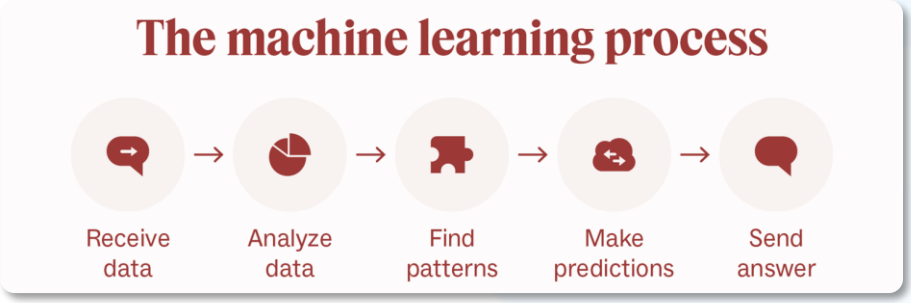
01 Generative AI

Machine Learning & Deep Learning

What is Machine Learning?

Machine learning is a branch of artificial intelligence (AI) that enables computers to learn from data and improve their performance on specific tasks without being explicitly programmed for each scenario.

Machine Learning models do not follow a given instruction, such as classical algorithms, but identifies patterns and adapt to make predictions, or take decisions based on experience.

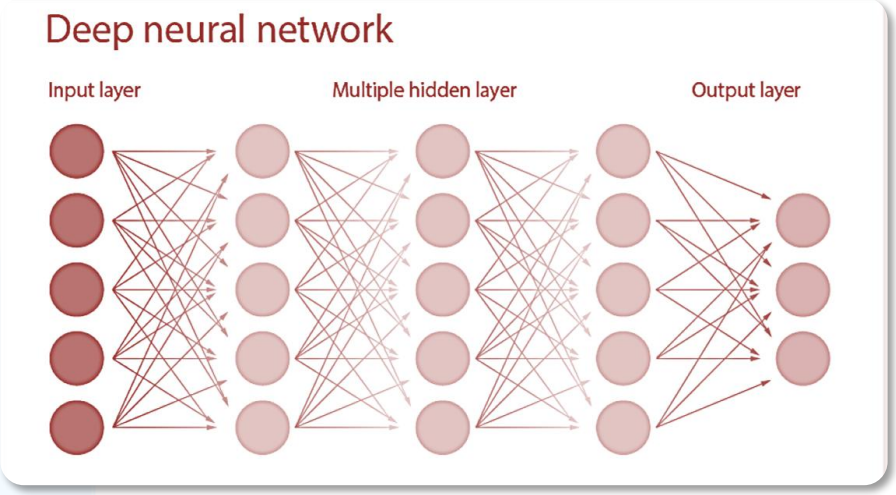


Credit image: Zendesk

What is Deep Learning?

Deep Learning is a branch of Machine Learning that uses multilayered machine learning programs or models (called neural networks), to learn complex patterns of data, and simulate complex decision-making power of the human brain.

The main difference with machine learning is that classical machine learning uses simple neural networks, with or two computational layers, while deep learning models use at least three layers.



Credit image: IBM

01 Generative AI

So, what is Generative AI (GenAI)?

In short, GenAI consists of deep learning models that have the ability to create complex original content such as long-form texts, images, video and audio, etc., according to a user's request (prompt).

Why now?

Generative models are not new, they have been used of years in statistics for instance. But the real revolution that happened in the last decade is their ability to analyse and generate more complex data types. This evolution has coincided with the emergence of three significant deep models:

- The variational autoencoders, introduced in 2013, can generate multiple variations of content in response to a single prompt.
- Diffusion models, introduced in 2014, allow the generation of original images in response to prompts.
- Transformer models generate extended sequences of content (for example, shapes in an image, words in sentences, etc.). They are the basis of today's most famous generative AI tools.

Next to those three major revolutions, the emergence of Large Language Models in 2018 has been the premise for GenAI as we know it today. LLMs are a type of deep learning model trained on massive amounts of text data to understand, generate, and manipulate human language.

01 Generative AI

Simplified timeline of emergence of modern LLMs

2017
Release of the « Attention is All You Need » paper by several experts, setting the architecture foundation for all modern LLMs.

2018
OpenAI introduces its first GPT (Generative Pretrained Transformer).

2019
OpenAI introduces GPT-2, including 1.5 billion parameters.

2020
OpenAI GPT-3 now includes 175 billion parameters.

2022
Stable Diffusion democratized AI-generated visuals.

2023
Launch of ChatGPT-4.
Meta release LLaMA.
Google launch Bard.
Foundation of Mistral AI.

2024
Launch of Gemini by Google (under which Bard was integrated).
Launch of OpenAI GPT-4o.

2025
GenAI race: ChatGPT-5, Anthropic Claude - 4, Deepseek R-1, MistralAI, etc.

01 Generative AI

How does GenAI work?

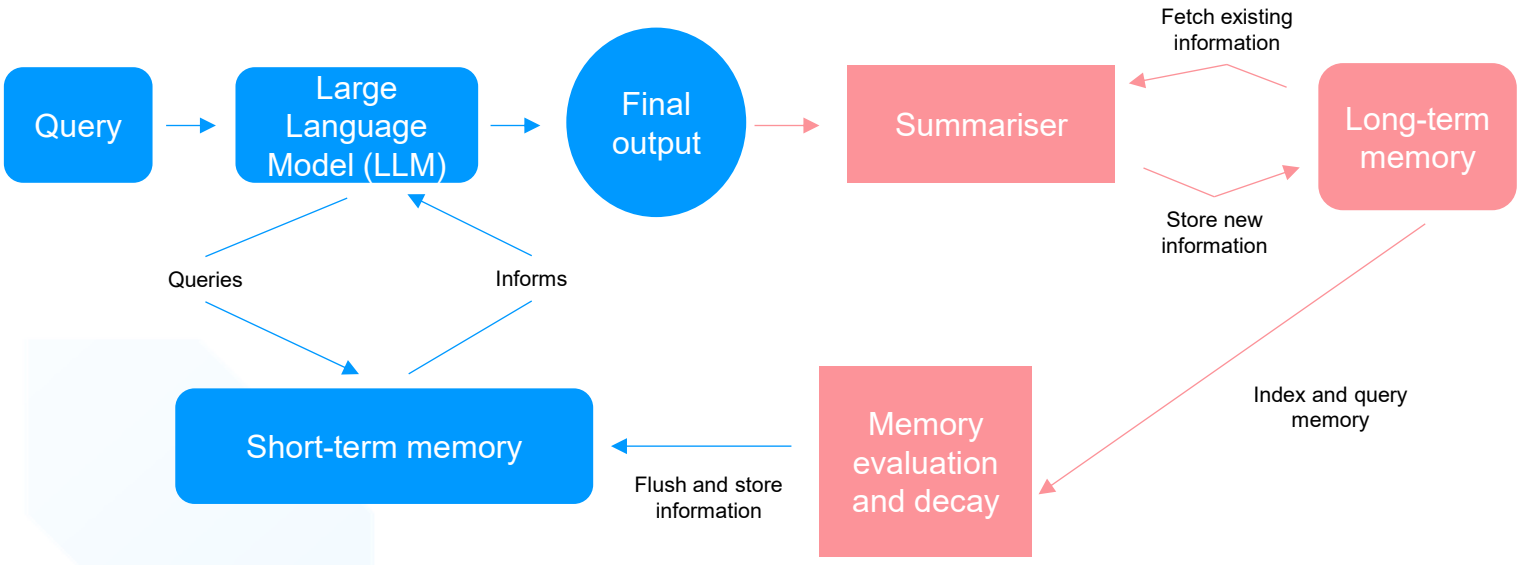
When a user enters a query (prompt), generative AI uses large language models (LLMs) to understand the question and generate a smart final output.

The LLM also checks short-term memory to see if there's any recent information that might help answer the query better. After generating the response, it may update the short-term memory with new information for future use.

How are the models trained?

Once the LLM has given you an answer to your query, it then uses a summariser to save important information. It stores that information in a long-term memory, which is checked once and then by the memory evaluation on what to keep and what to forget. If an information is deemed important, it save it again in the short-term memory.

Apart from this classical schema, users can improve the capabilities of LLMs by allowing them to access external, up-to-date information from a knowledge base. That technique is called RAG, Retrieval-Augmented Generation.



Source for graphics: Arya.ai

02 Generative AI

Drivers & obstacles

Drivers to adoption

Enhanced productivity and operational efficiency
AI is broadly viewed as a tool for optimising process, cutting costs, improving quality, and supporting better decision-making.

Competitive advantage and innovation
Organisations deploy GenAI tools for faster insights, creative generation, and customer engagement.

Obstacles to adoption

Lack of expertise
According to recent surveys, including the one conducted by Luxinnovation and FEDIL, lack of expertise and talent is a major obstacle to AI adoption.

Technical challenges and data readiness
Several sectors, such as the manufacturing, transport & logistics, and supply chain sectors, face obstacles in data operability.

Governance of data, ethics and compliance
Gaps in data governance and awareness of European policy is also viewed as an obstacle.

Trust and quality
GenAI's tools can hallucinate, or present inconsistent results if the data the model is based on are unsuable.

Environmental impact
Finally, GenAI tools consumes vast amount of energy and water.

03 Conclusion

A quick glance at projections, opportunities and risks

Generative AI has emerged as one of the most transformative technological developments of the decade, reshaping how individuals, businesses, and institutions create, interact, and innovate. Its capacity to generate human-like text, images, code, and other complex outputs introduces unprecedented opportunities for productivity, personalization, and problem-solving.

Organizations that embrace the technology thoughtfully, investing in safeguards, aligning applications with clear business or societal goals, and fostering digital literacy, will be best positioned to capture its value. As the technology matures, collaboration between industry, academia, and policymakers will be critical to ensure generative AI evolves in ways that are secure, inclusive, and beneficial to all (on this topic, see our policy watches on AI on our knowledge hub).

Ultimately, generative AI should be seen not as a replacement for human ingenuity, but as a complement to it. Its true promise lies in augmenting human potential, enabling new forms of creativity and discovery, and driving technological progress that serves society as a whole.

Explore our GenAI market applications report for concrete examples and more insights on the sectors.

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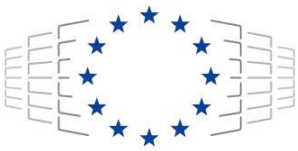

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