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AI Basics eBook

A short intro to AI, ML, DL & genAI

Agenda

AI Basics

Why Bother?

What can AI do for me?

Why Is AI Booming Now?

All about the AI booms.

AI, ML and DL?

What is the difference?

What About genAI?

LLMs like GPT-4 and more

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01.

Why Bother?

Artificial Intelligence

The current use cases of AI

1

Automate Tasks

With AI you can automate or assist dull, repetitive tasks (e.g. sorting waste), that we don't want to do.

2

Better Performance

AI (sometimes) can perform better than humans at narrow tasks (e.g. playing Chess or Go).

3

Enables Scalability

It enables extreme scalability, allowing formerly impossible tasks (e.g. face recognition at mass surveillance level).

4

Solve Impossible Tasks

AI can solve tasks that go beyond human brain complexity (e.g. predicting chemical protein structures).

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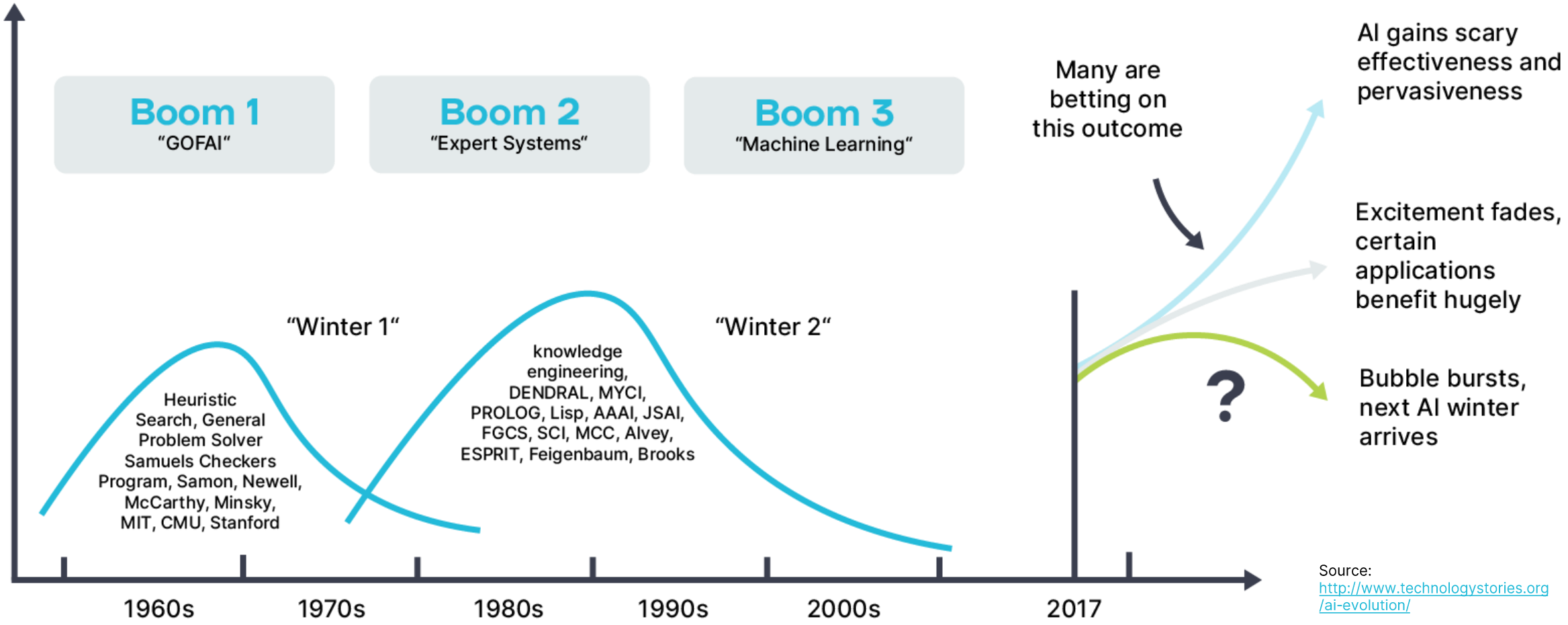
02.

Why Is AI Booming Now?

Why Is AI Booming Now?

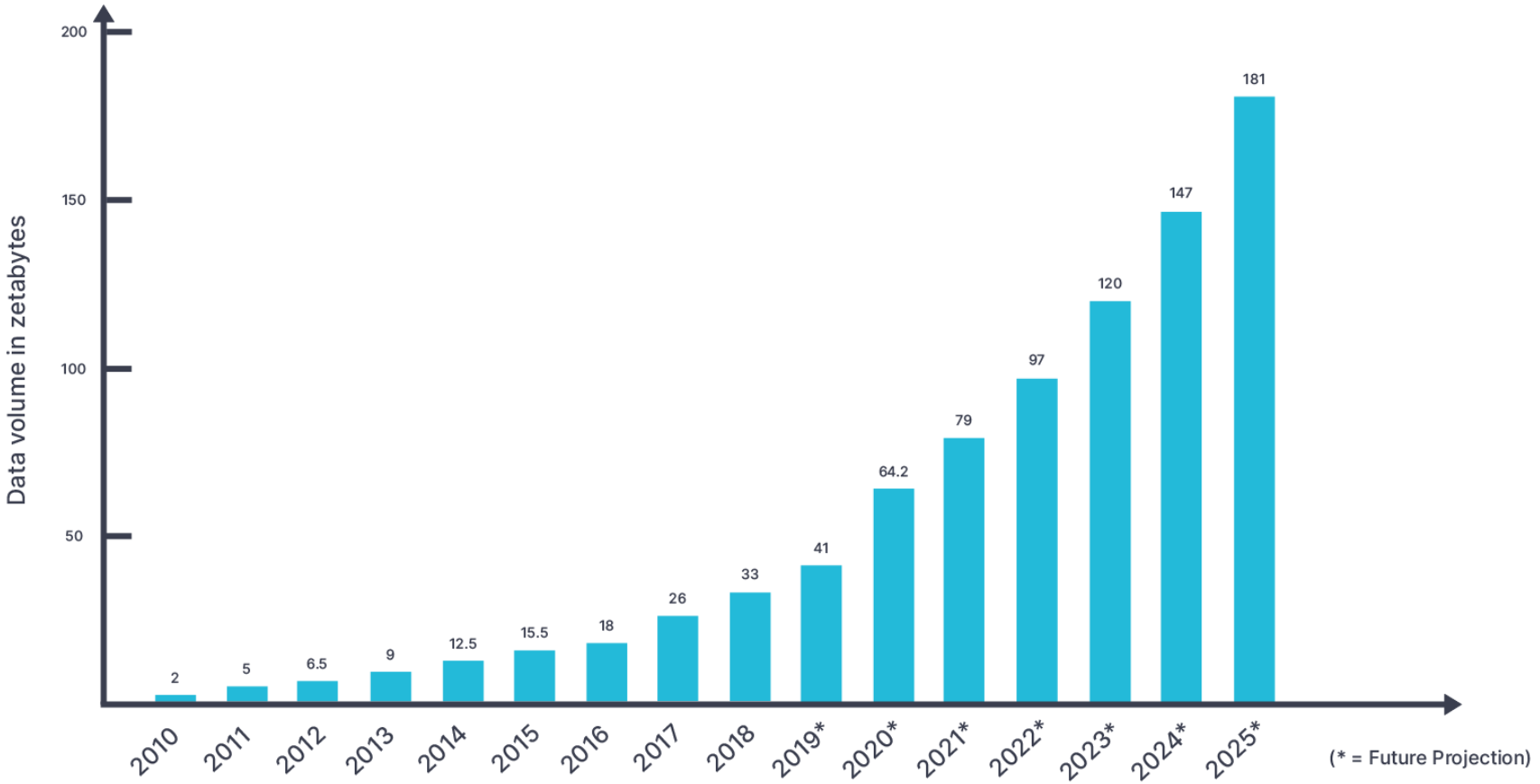
There have been AI booms before – you might wonder, is this just another AI “summer”?



Source: http://www.technologystories.org/ai-evolution/

Available Data over Time

Data Availability is the basis for ML growth



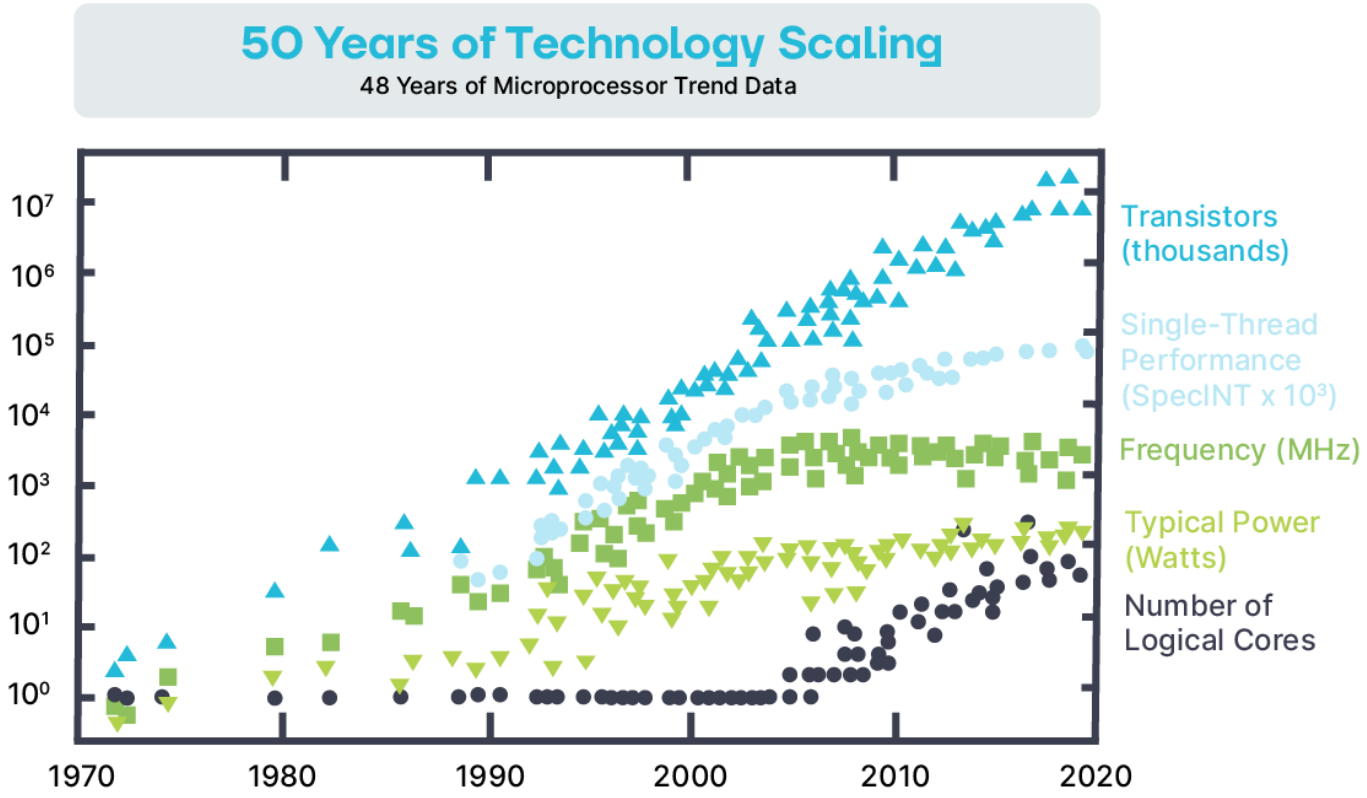
Source : https://www.statista.com/statistics/871513/worldwide-data-created/

About

The AI booms

We are no fortune tellers, so we can't answer for sure. But this is what we know:

- Past AI summers didn't last, because their expert systems didn't deliver.
- The current summer has led to unpreceded breakthroughs.
- The current summer is powered by Machine Learning (ML).
- ML is hungry for computational power and data, which we didn't have enough in the past, but we have it now and (partly) it's still growing. As you can see here:



Source : https://github.com/karlrupp/microprocessor-trend-data

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03.

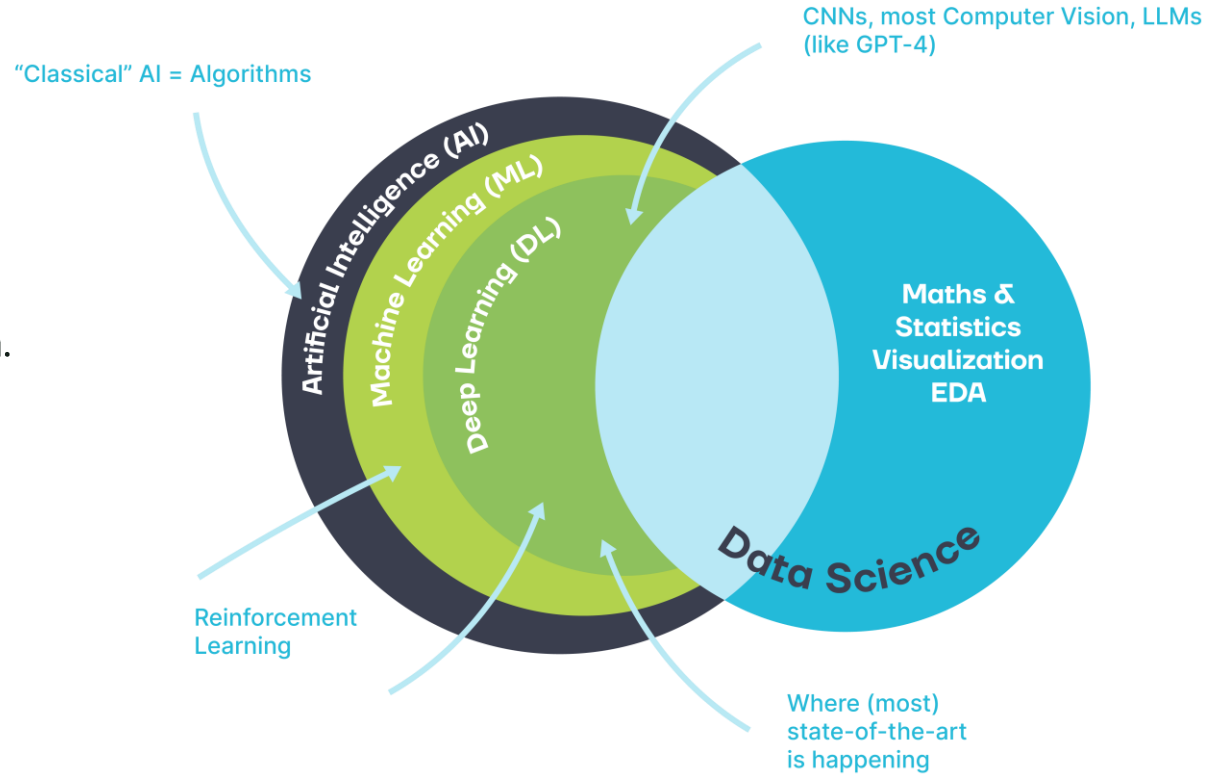
AI, ML
And DL?

The Difference

Between AI, ML and DL

Overview of Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL):

- ML and DL are a substance of AI.
- As there is no universal definition of “intelligence” (yet), the term “algorithms” might be a more fitting description.
- Reinforcement Learning (RL) is happening in ML and DL.
- We often don’t mention Deep Learning anymore, but rather talk about the model families within it: e.g. Transformers, Convolutional Neuro Nets (CNNs), Recurrent Neuro Nets(RNNs), Large Language Models (LLMs, GPT-4 is the most famous one).

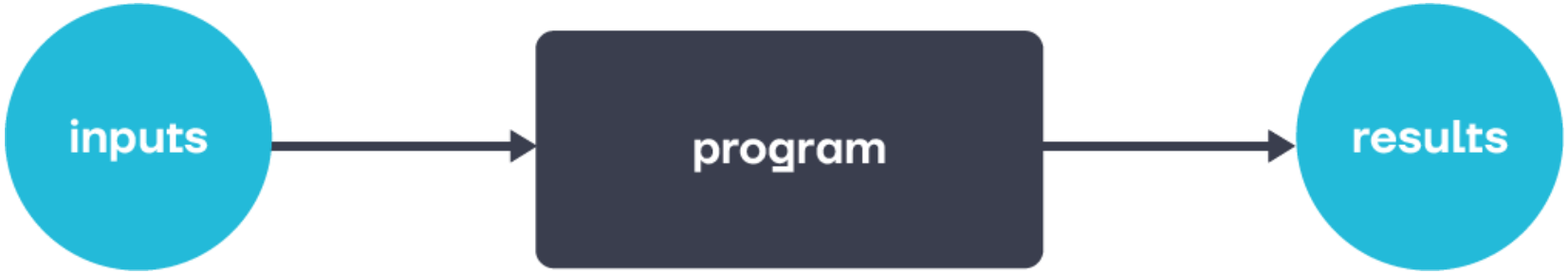


How Is AI Different From ML?

The definition of AI

“I cannot teach the machine something that I don’t understand how it’s done (exactly).”

- **Different approach**
  Expert-centric approach
- **Different Use-Cases**
  Not suitable for highly complex use-cases
- **Designing Process**
  The algorithm is designed by an expert of the domain
- **Work of an Expert**
  The expert knows how to solve the problem manually and tries to confine this knowledge into an algorithm



How Is AI Different From ML?

The definition of AI

“I can teach an ML algorithm to do things of which I have no clue how to do it myself. I only need to know what outcome I want.”

- **More Knowledge of the data set**
  Knowledge and domain is helpful for a better result, but not necessary
- **Expert Knowledge**
  The expert knowledge is coded within the feedback the algorithm gets when seeing data (labels / reinforcements)
- **No data, no ML**
  Data centric approach – no data, no ML
- **Algorithm Design**
  The algorithm design roughly copies the shape of the brain and basic connection instructions.
- **Instructions**
  The algorithm design also provides the instructions of how the algorithm should update itself when receiving feedback
- **Details**
  Details are left open to adjustment by the algorithm itself

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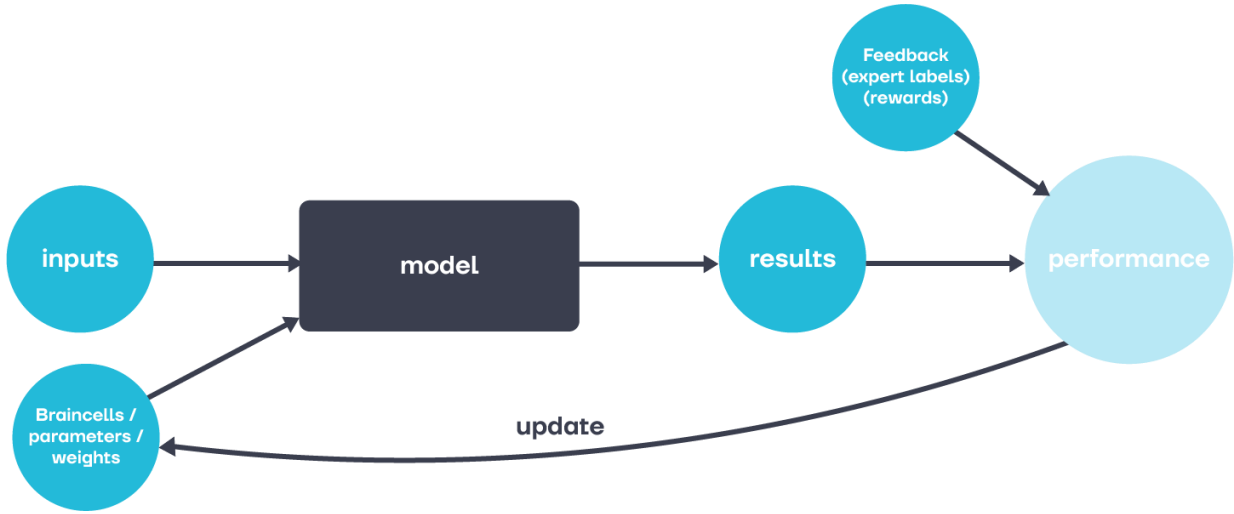
Picking the right players

The ML expert takes the role of a football coach: Pick the right players for a game and help each player reach their maximum potential within the game.

Managing the data

Most of the time the ML expert is "maintaining" data. This means cleaning data sets, and understanding edge-cases or problems.

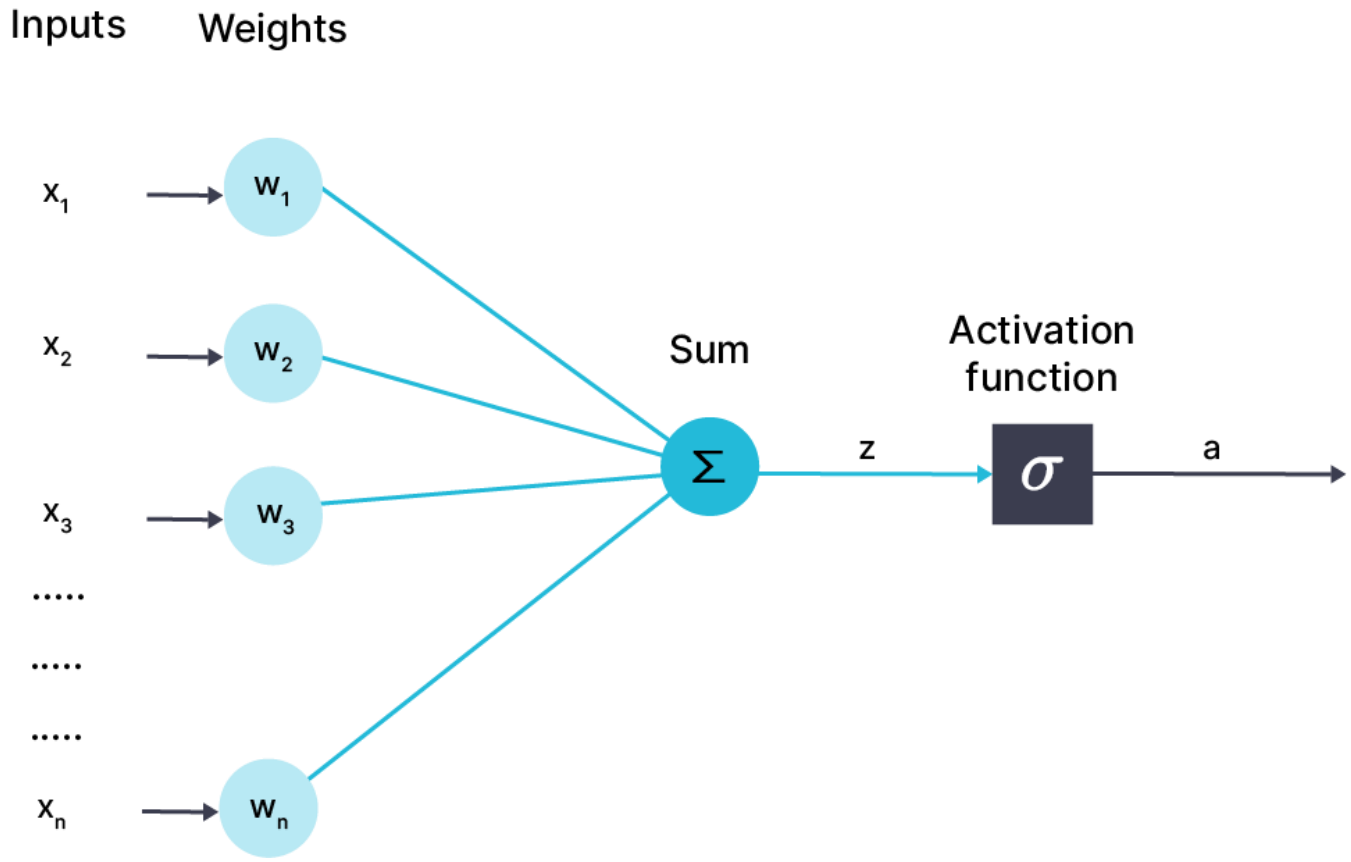


How Deep Learning Works

The Perceptrons

Now, this is how Deep Learning works:

DL is based on so-called Perceptrons, which is what we think how a neuron in our brain works (or what we thought how it worked when Perceptrons were developed). We don't know how neurons work for sure because human brains haven't been fully understood yet. But Perceptrons are the basic building blocks of all Deep Learning:

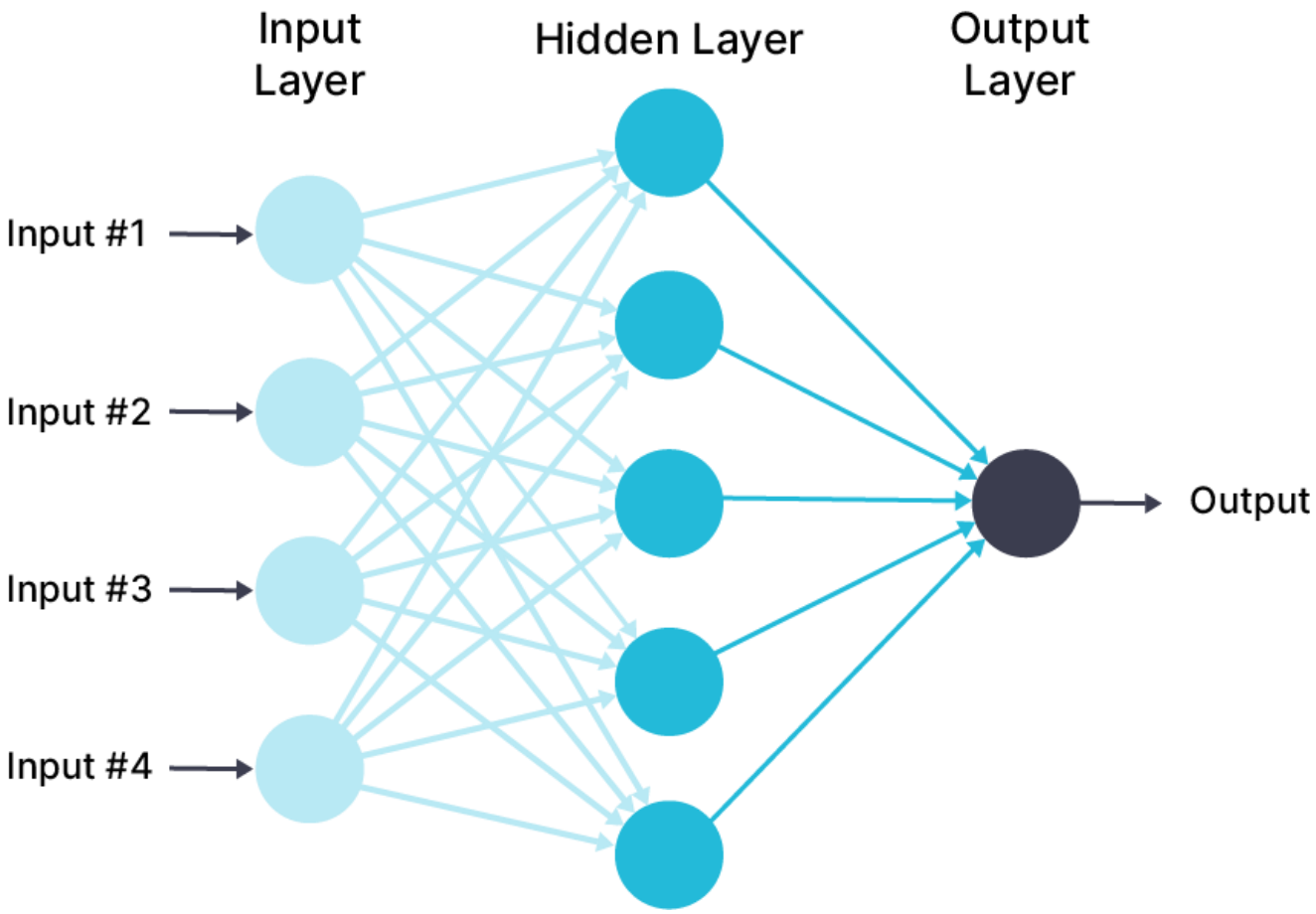


How Deep Learning Works

The Perceptrons

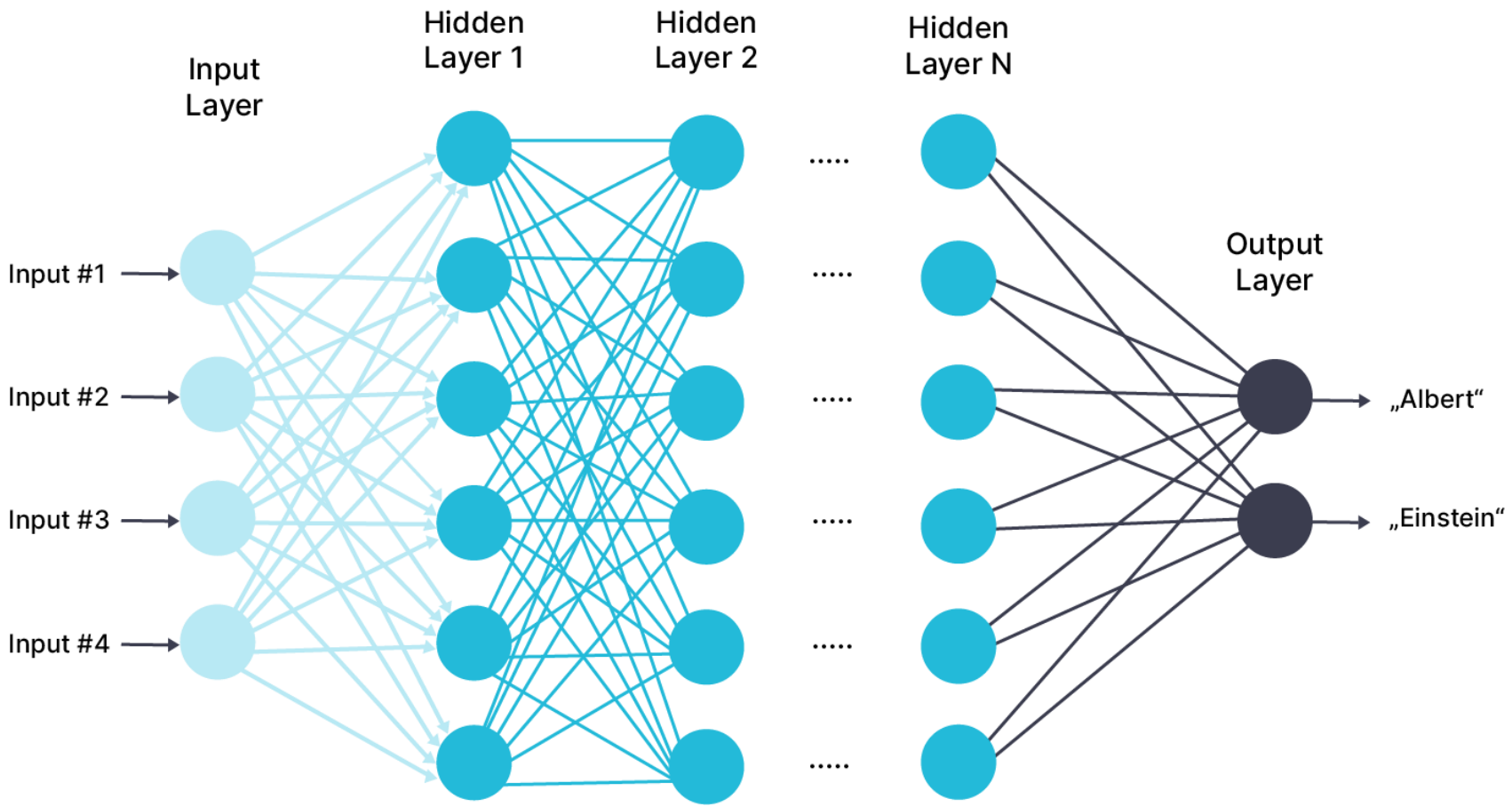
Multilayer Perceptron

The ”Learning” happens exclusively in the weights. During the training process the weights are adjusted until the performance we get is satisfactory. If this is the case, those weights will be fixed and not changed until we decided to train again. Of course, in DL there is not one Perceptron, but a LOT of them:



How Deep Learning Works

Deep Learning is (mostly) stacking a large amout of Multilayer Perceptrons behind each other. Making this amount of metric multiplications takes a lot of computational power, which is why Deep Learning wasn't possible earlier.



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What About genAI?

What About genAI?

GenAI (short for generative AI) is a form of Deep Learning. It became quite popular with the Large Language Model GPT-4, but genAI has been around before.

Running a genAI today depends on two major factors: an immense amount of **data for training** and enough **computational power** to run giant deep-learning models on this data. Due to significant performance improvements, genAI models like GPT-4 have become so advanced that they are now utilized for a wide range of tasks beyond the realm of generation. Here are some useful concepts you should know:

- **(Un)supervised Learning**

  AI can be trained in an unsupervised and supervised way. GenAI largely relies on unsupervised training, which means it doesn't get labeled data. For example, Large Language Models are trained exclusively with raw text.

- **Fine-Tuning**

  Improving a model for better performance is called fine-tuning. In the case of genAI, this means providing the model curated datasets (e.g. texts on specific topics) with human feedback.

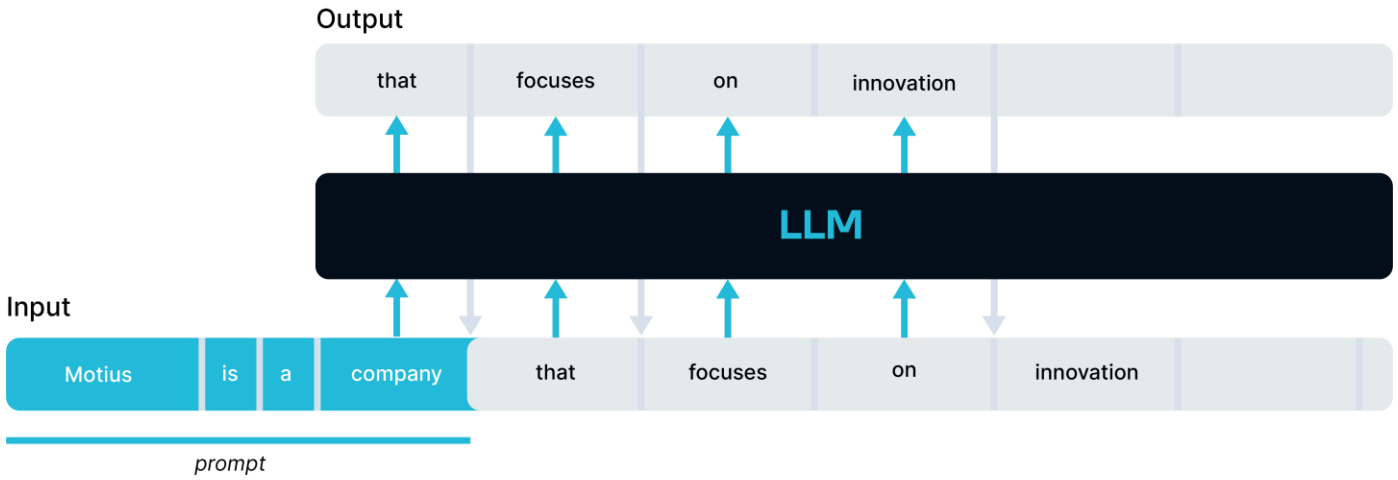
- **Prompting**

  The instructions you give a model to generate the desired output or response are called prompts.

Large Language Models (LLMs)

LLMs are Deep Learning models specialized in text generation. Well-known LLMs are chatGPT, PaLM, and LlaMA.

- Large Language Models are Deep Learning models that have more than 1 billion parameters and are trained on several terabytes of texts.
- Most known architectures are autoregressive models: they are initially trained to predict the next word in the given text based on the previous words.
- Because those models are trained on such a large amount of data, they have solid *knowledge* about the world. Since they learn to predict the next word in a sequence, they can be used for various tasks beyond pure text generation. All we need to do is instruct them through prompts.



Autoregressive models get the output generated in previous iterations as an input for the current iteration

GenAI for Business

Compared to previous AI, genAI is more accessible, easier to get started with, and faster to customize for specific contexts. This makes it particularly interesting for businesses.

Besides LLMs like chatGPT there are other intriguing genAI models, among others text-to-image models (Stable Diffusion, Dall-E, etc.) or models to synthesize data (we have developed one at Motius). State-of-the-art solutions in this field belong to commercial providers like OpenAI (Microsoft), Google, Midjourney etc. They provide programmatical and UI access to the tools with genAI and have **different levels of data protection** in place. Alternatively, there are open-source models that can be installed on your machine for complete security of your data.

So-called **foundation models** can be applied with few or even no finetuning on use-case-specific data. This decreases the need for tedious and costly data collection and labeling.

AI-generated pattern based on our Motius Logo

Source : https://www.krea.ai/fun/patterns

So, What Are Foundation Models?

Foundation models are pre-trained with a vast amount of data. Thus, such models perform well on a variety of tasks from scratch or with a minimal amount of fine-tuning.

LLMs are one example of a foundation model in the language domain. However, not all foundational models are genAI models. There are models with similar pretraining strategies and performance results in the field of computer vision field. For example, *SAM* and *SegGPT* can segment images, *GroundingDino* detects objects in images, or *GPT4-Vision* creates a text description of an image.

Can we now solve any problem with off-the-shelf AI? Not quite yet. Particularly foundation models face issues that need to be addressed to create a productive solution:

- How to leverage model on own data?
- How to prevent misinformation (known as *hallucinations* in LLM) and errors in the output?
- How to deal with data privacy issues for sensitive data?

With bigger possibilities come bigger responsibilities for AI development as well. To prevent the misuse of such a powerful technology, governments and institutions are currently building legislative regulations that should be considered when bringing AI to different use-cases.

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Lets Talk

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