deep learning and LLMs

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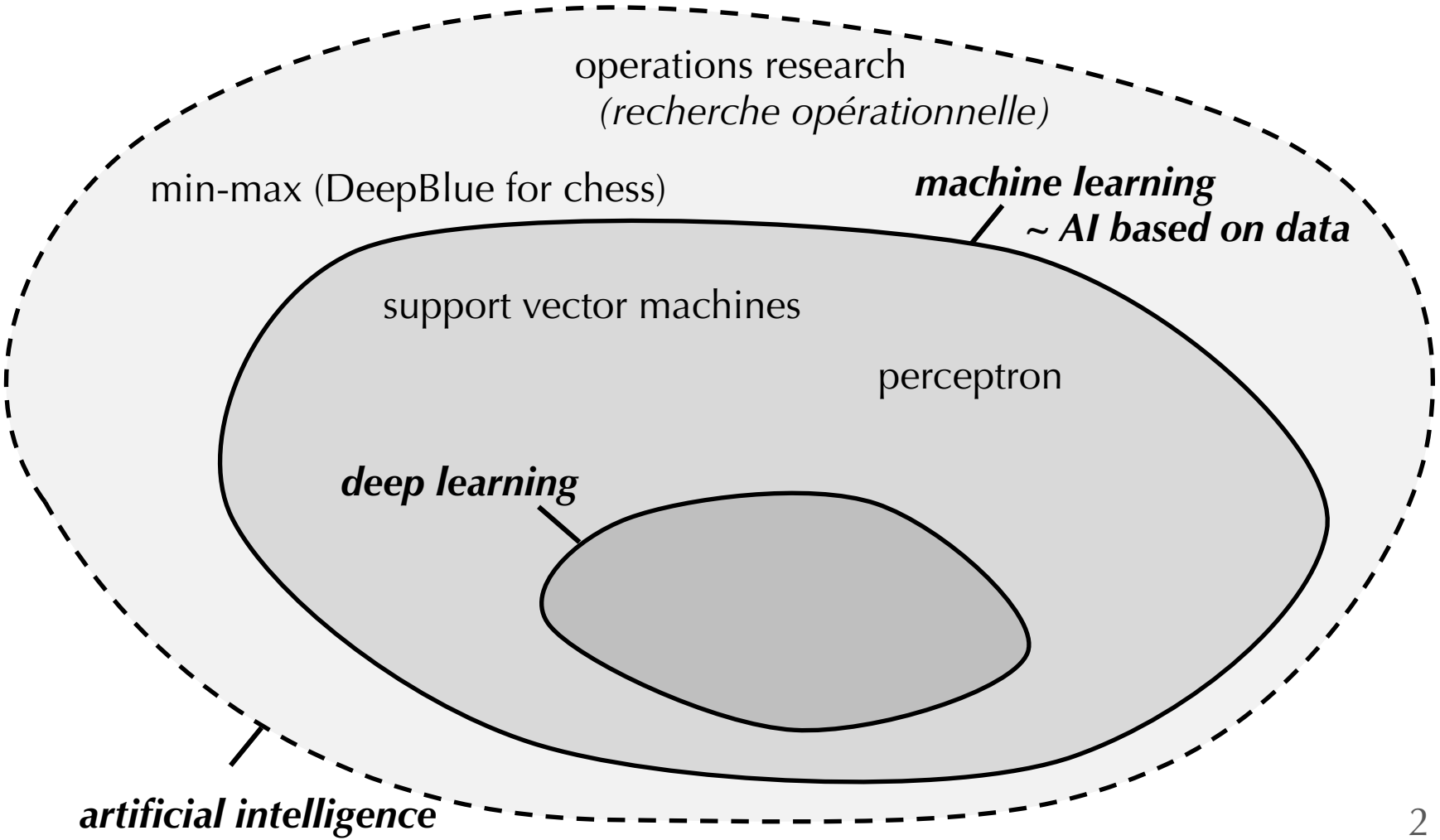
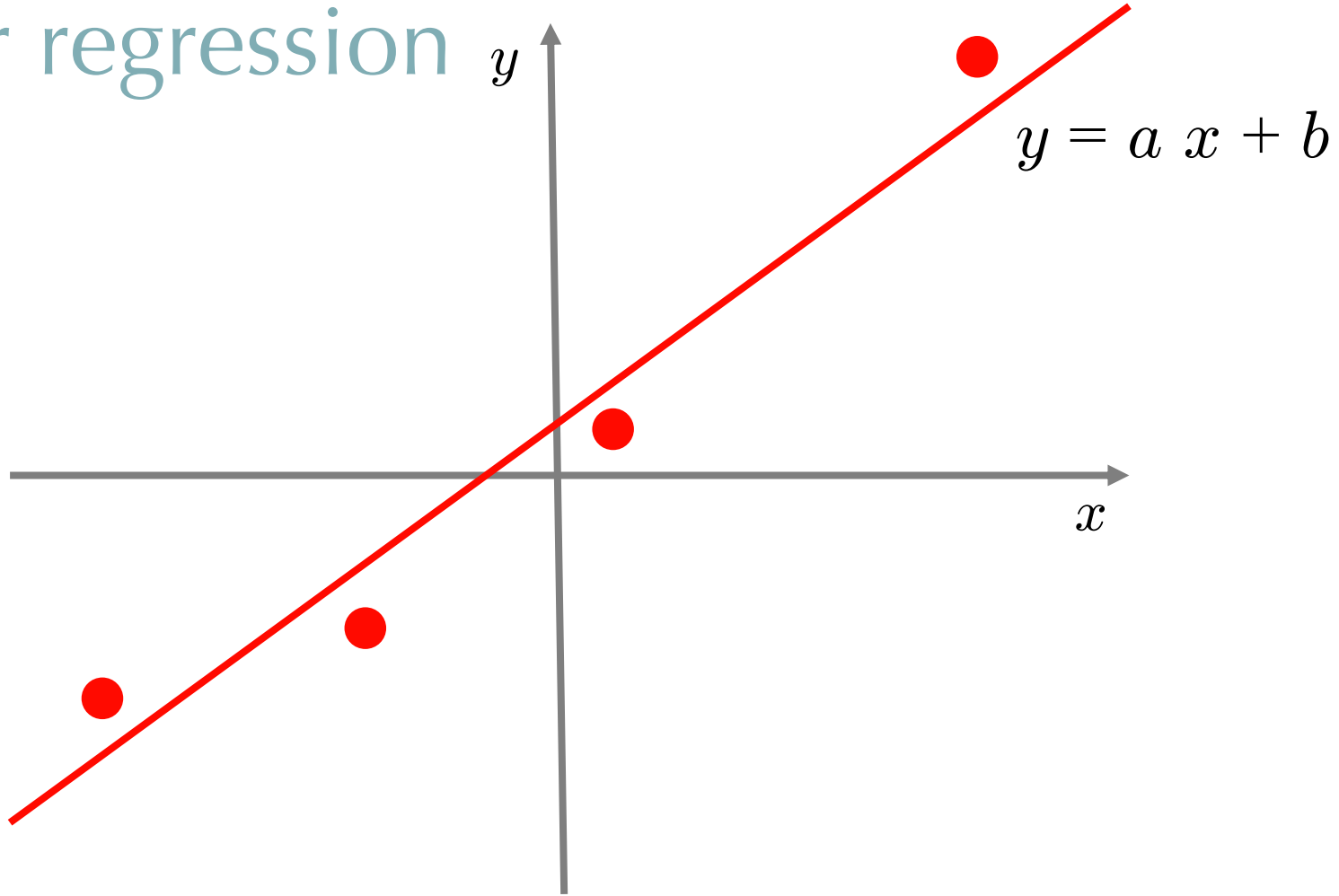
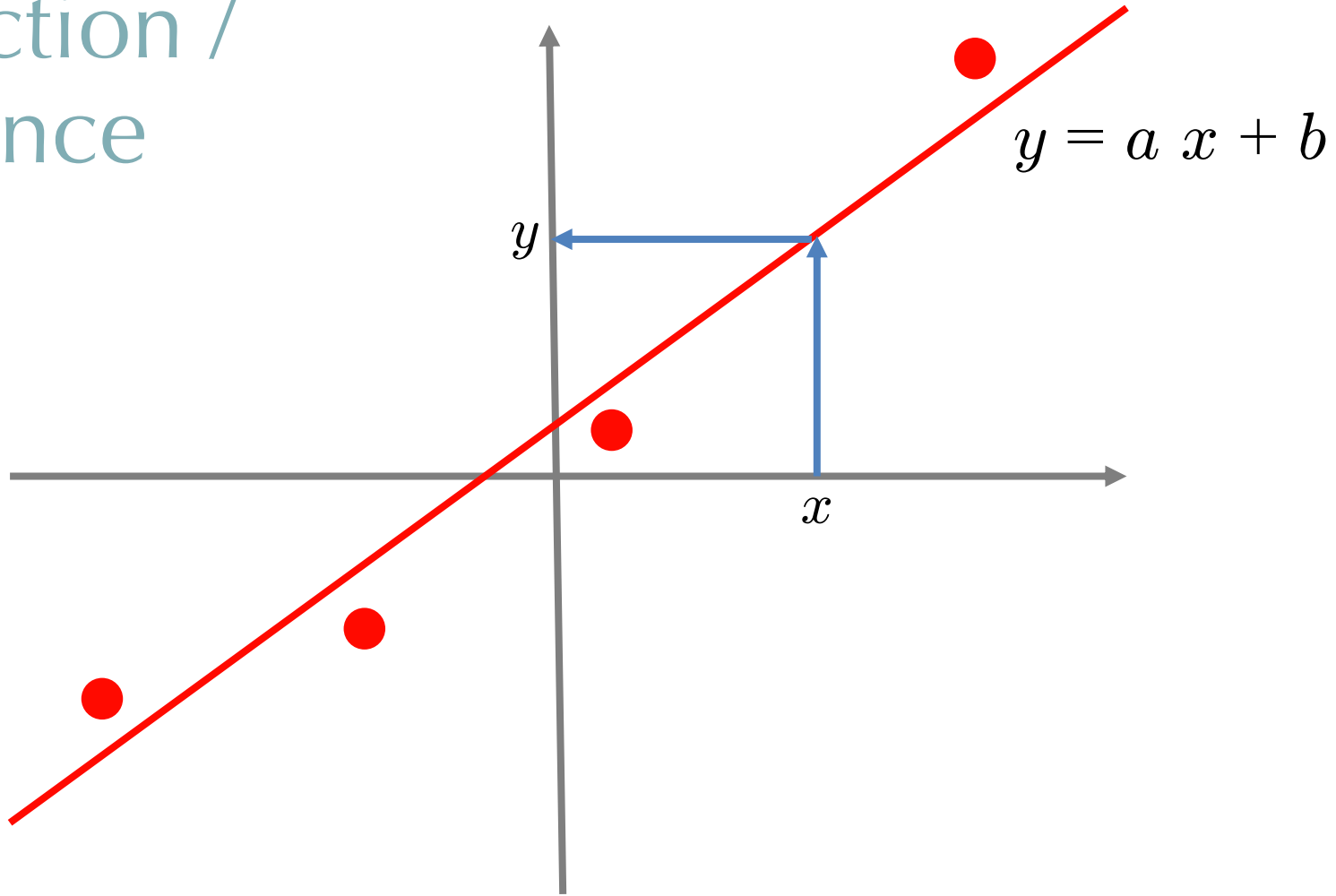

operations research
(recherche opérationnelle)
min-max (DeepBlue for chess)
machine learning
~ AI based on data
support vector machines
perceptron
deep learning
artificial intelligence

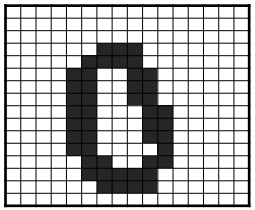
linear regression



prediction / inference



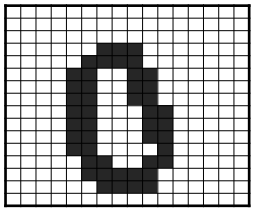
character recognition



an image

0

character recognition



an image

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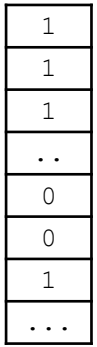
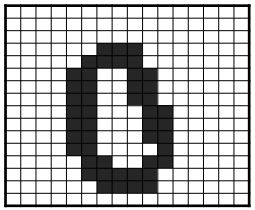


a vector x containing the image

character recognition



an image

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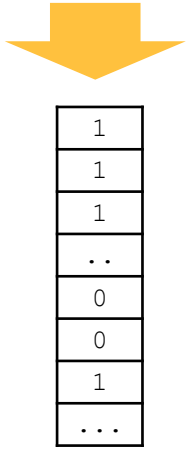
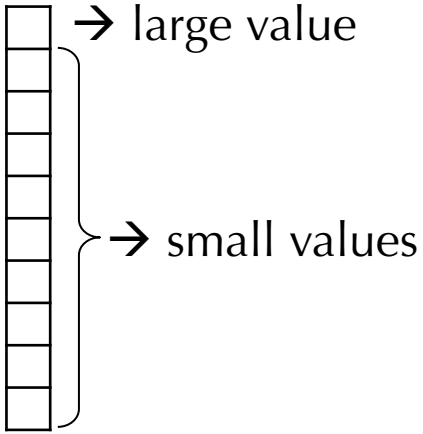
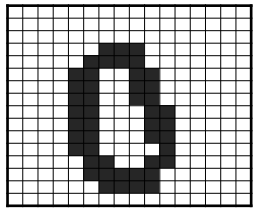


a vector x containing the image



a vector y of dimension 10

character recognition



an image

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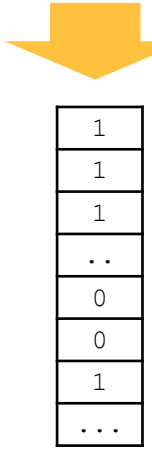
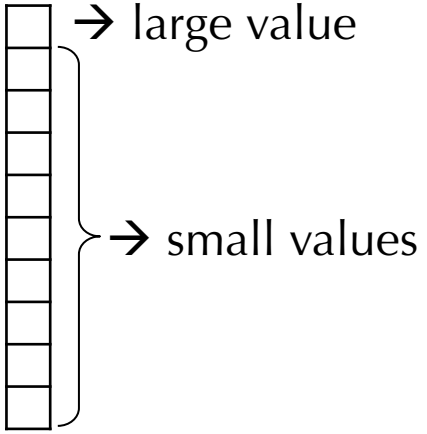
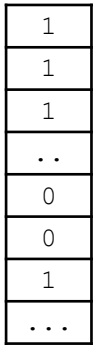


a vector x containing the image

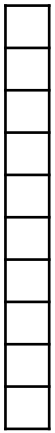
$y = F(x)$



a vector y of dimension 10



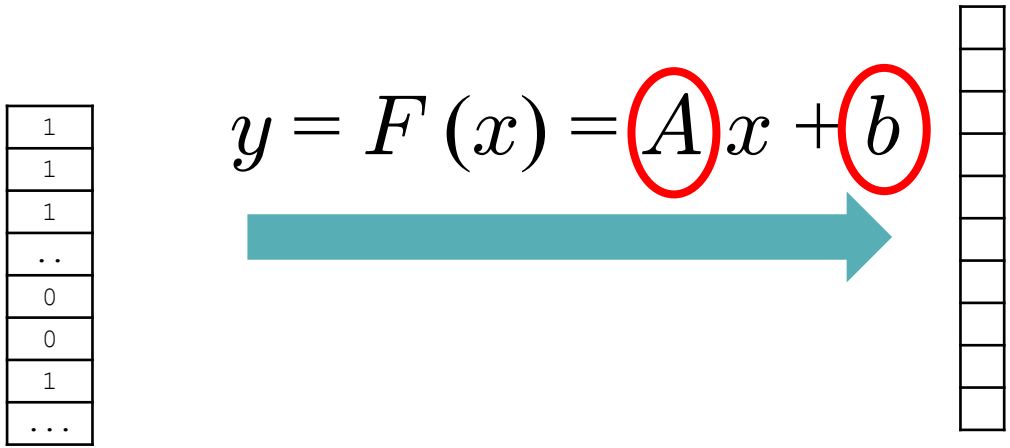
$$y = F(x) = A\,x + b$$



a vector x containing the image

a vector y of dimension 10

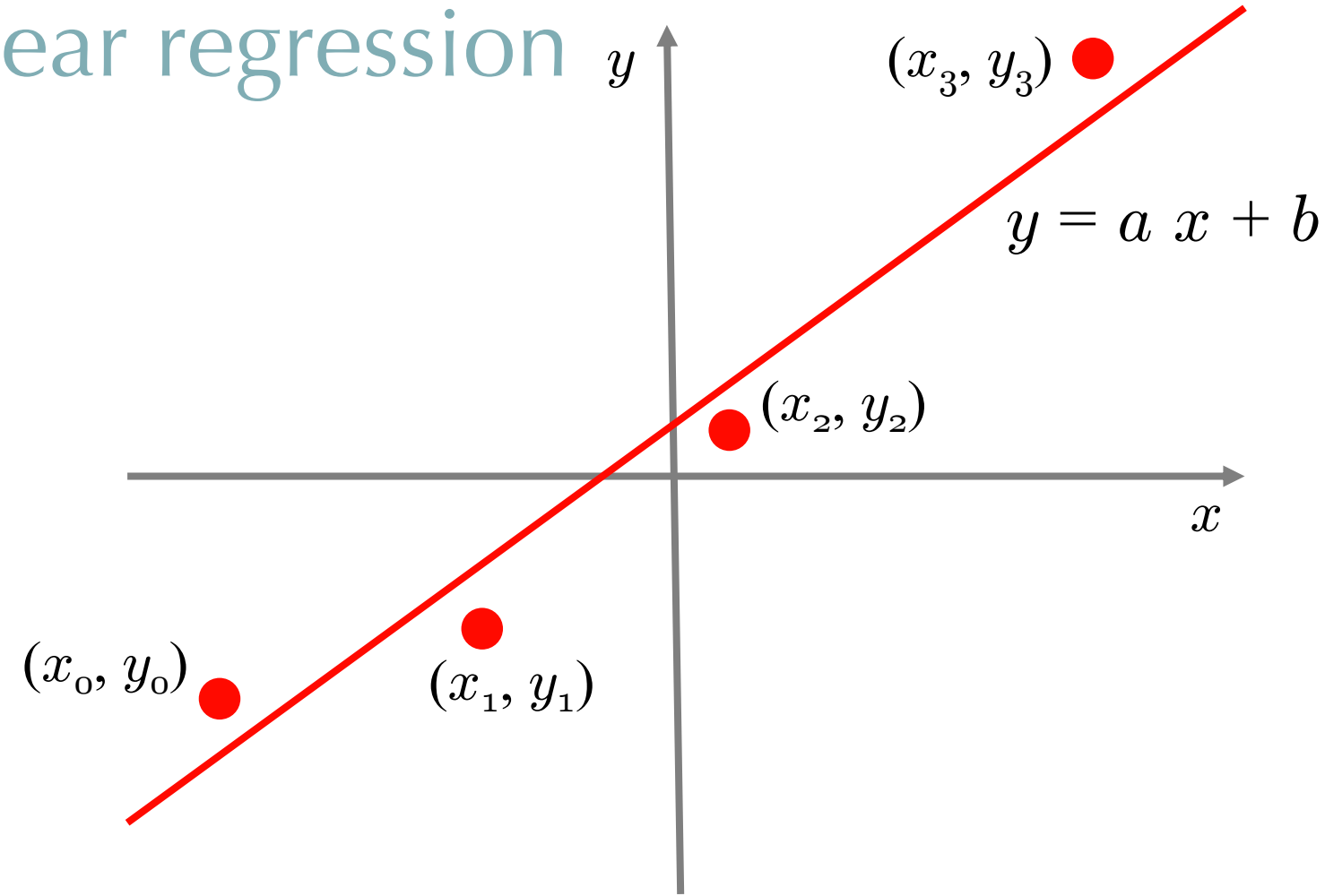
how can we find A and b ?



a vector x containing the image

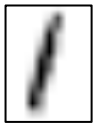
a vector y of dimension 10

linear regression

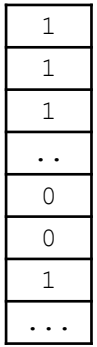


how can we find A and b ?

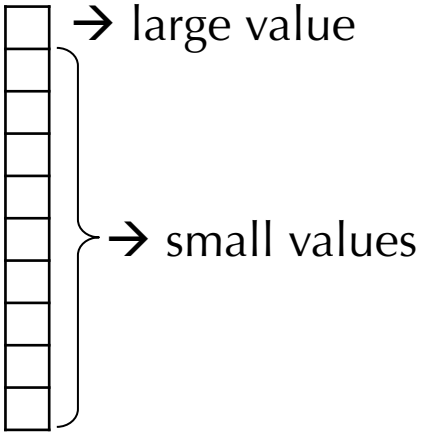
$x_0 =$  , $y_0 = 0$

$x_1 =$  , $y_1 = 1$

$x_2 =$  , $y_2 = 2$



$y = F(x) = A\,x + b$



a vector x containing the image

a vector y of dimension 10

training set (*ensemble d'apprentissage*)**:**

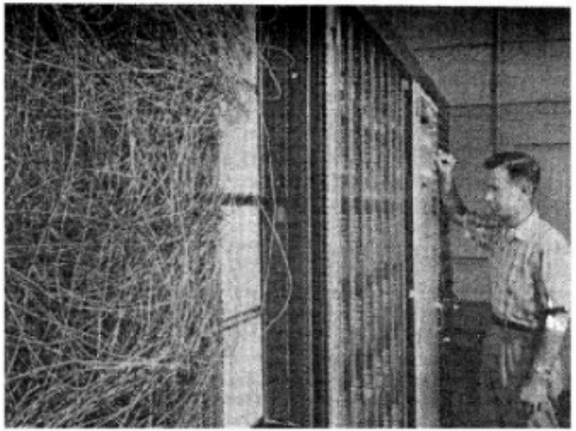
...

training (*apprentissage*), learning:

optimization to find the values of A and b

$$y = A\,x + b$$

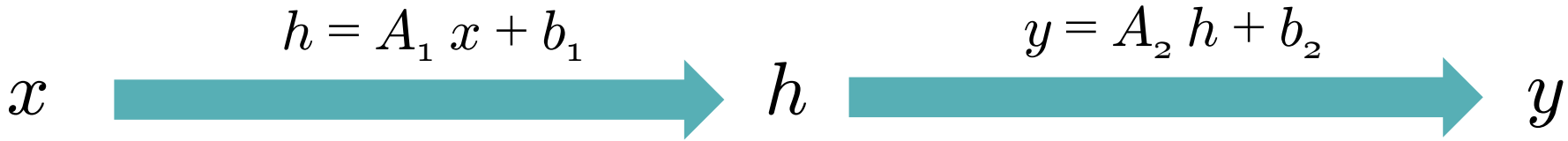
x → y



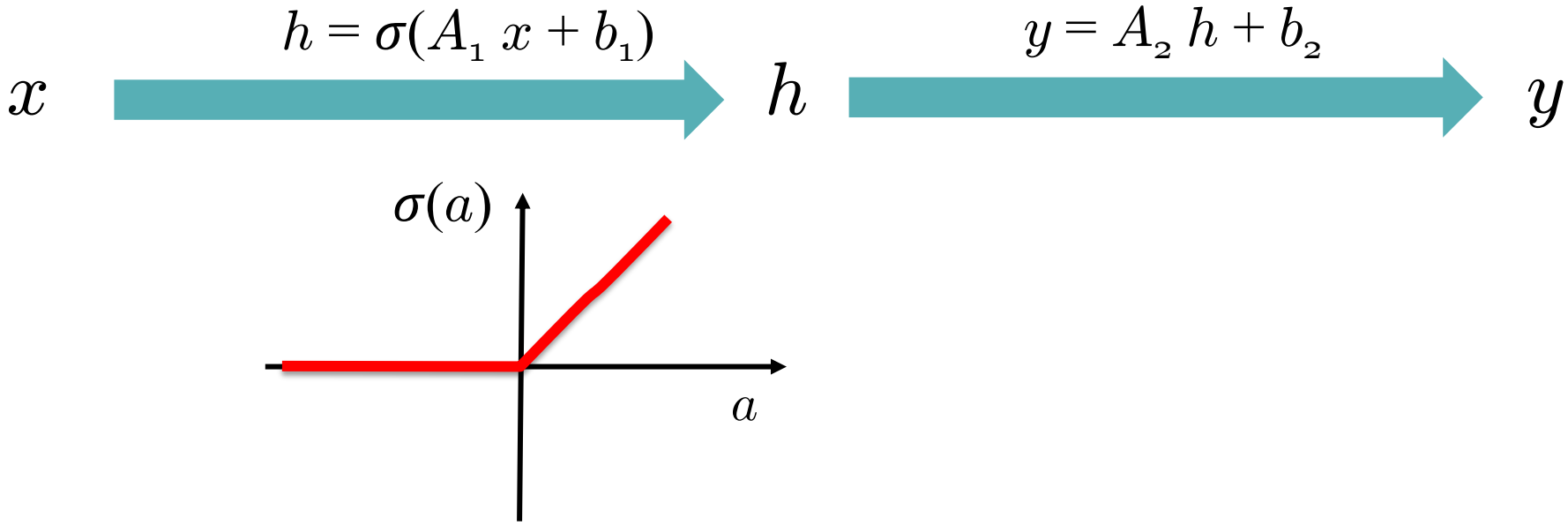
This was done in the 50ies!

Can we do better?

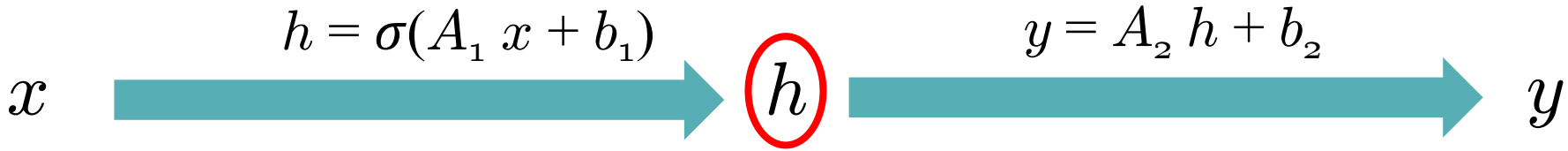
can we do better?



can we do better?



can we do better?



h is difficult to interpret

deep networks are **black boxes**

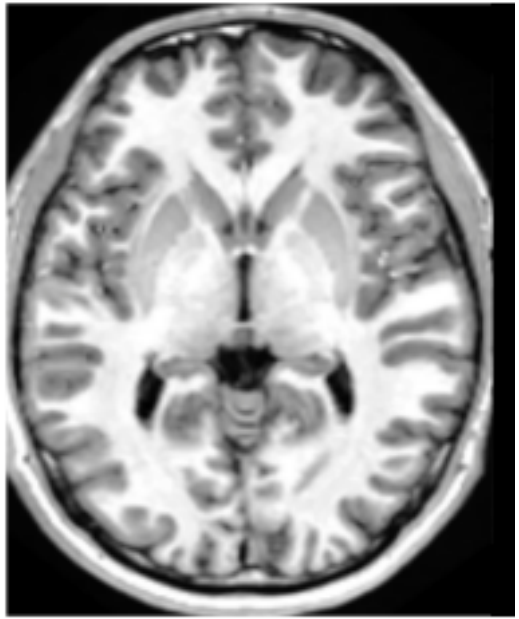

x
y

training (optimization) becomes more difficult (but we have good methods now).

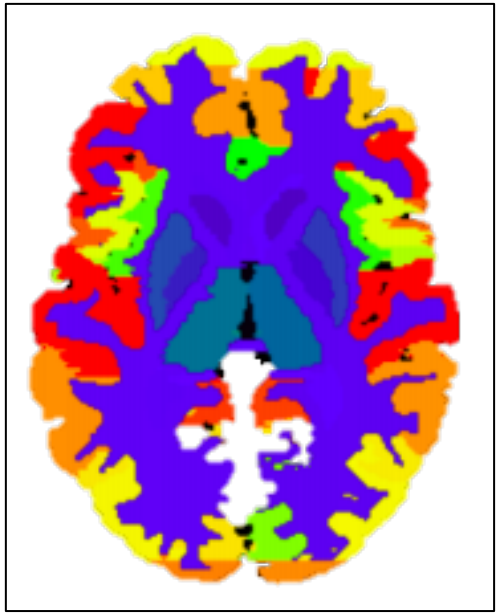
Developed in 1992 by Yann LeCun.

training (optimization) becomes more difficult (but we have good methods now)

image analysis



deep network

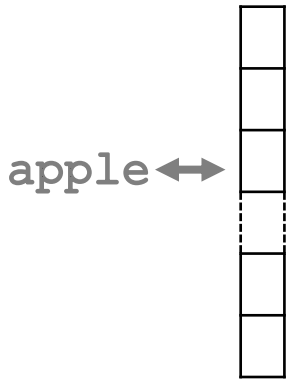


Natural Language Processing

She is eating
a green apple

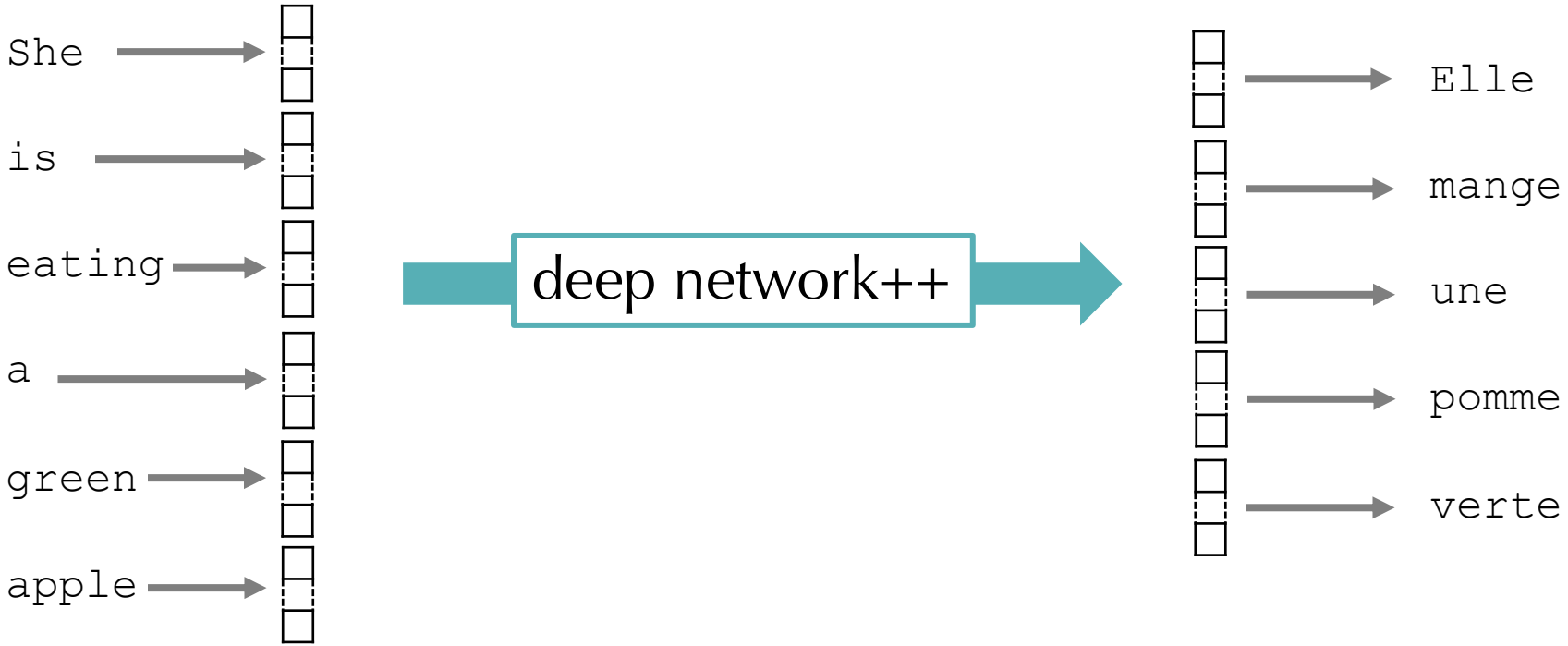
Elle mange une
pomme verte

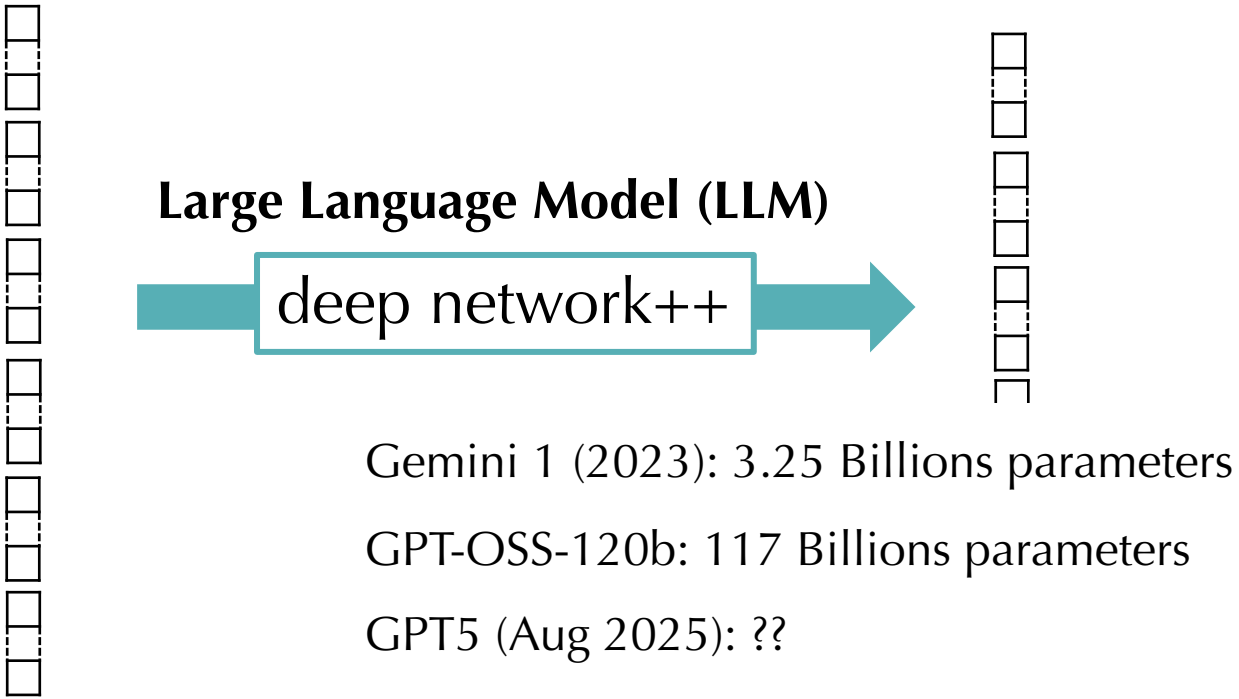
representing words with vectors



vector representing the word ‘apple’
dimension ~ 4096

Natural Language Processing





Gemini 1 (2023): 3.25 Billions parameters

GPT-OSS-120b: 117 Billions parameters

GPT5 (Aug 2025): ??

for long texts, predicts one part of the text at a time (“next word predictor”)

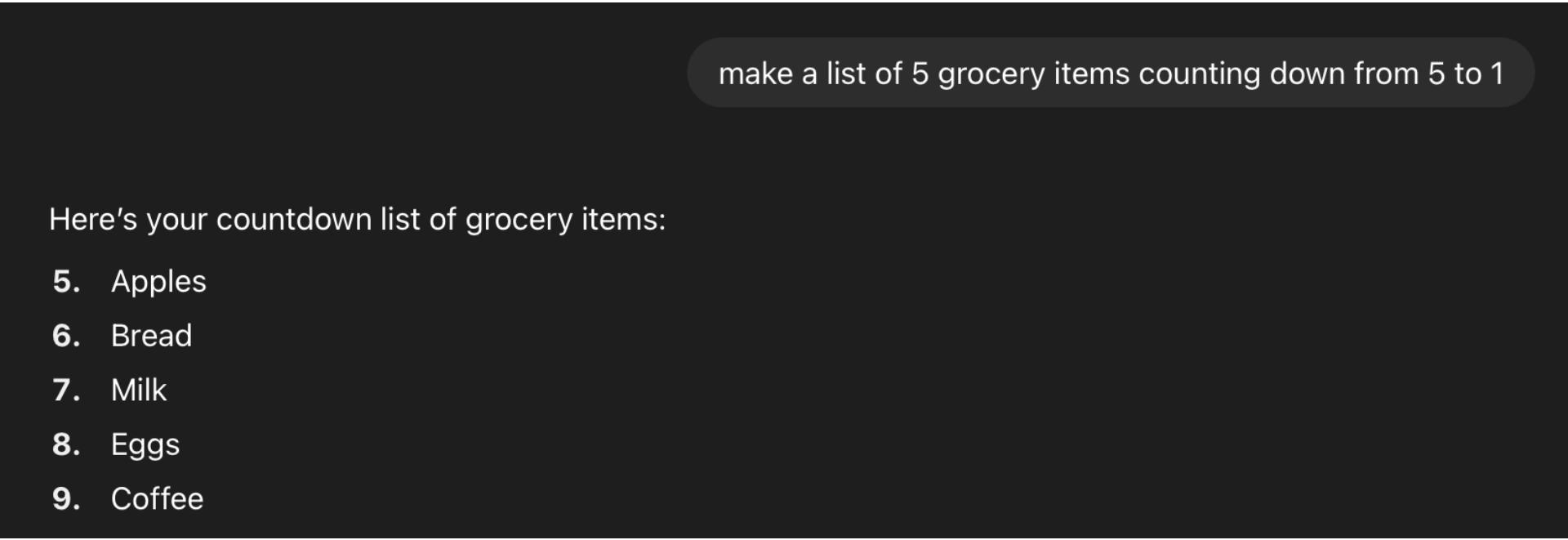
how to train an LLM?

- use virtually any digital written document (books, forums, ..)
- training set dedicated to chat (question + expected answer)
- “Reinforcement Learning from Human Feedback”

- for anything text, also code, even actions

less and less “hallucinations” & mistakes

but still happen (and will keep happening):



- “[LLMs] are a bit like students who have learned the material by rote but haven't really built deep mental models of the underlying reality” (Yann LeCun)