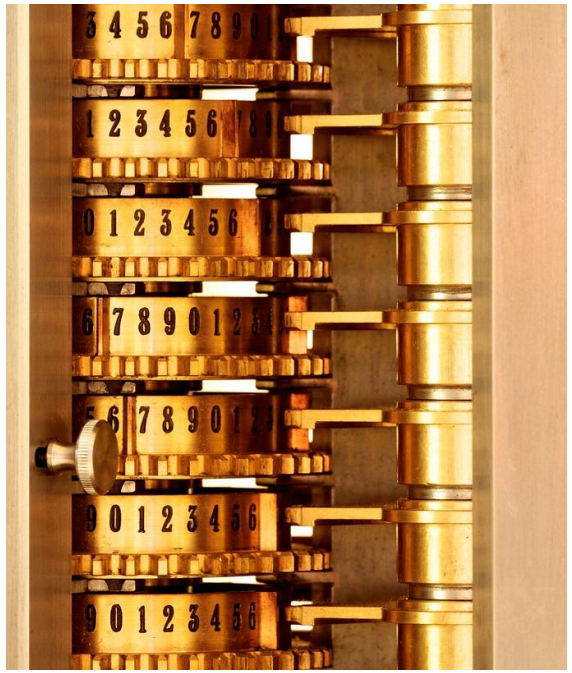
Computers, brains and AI

6: Deep learning and ChatGPT

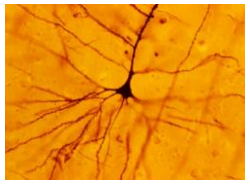




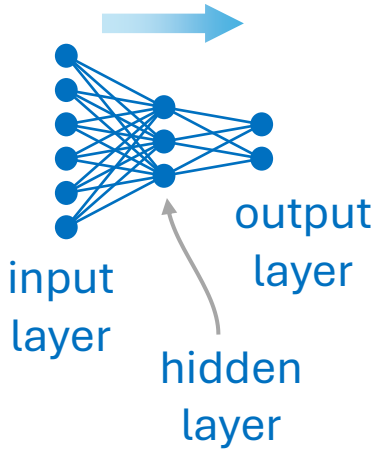
Difference engine by Marcin Wichary / CC BY
Ada Lovelace by Science Museum Group / CC0

Neural networks ...

... are inspired by biology



... are often thought of as blobs and lines

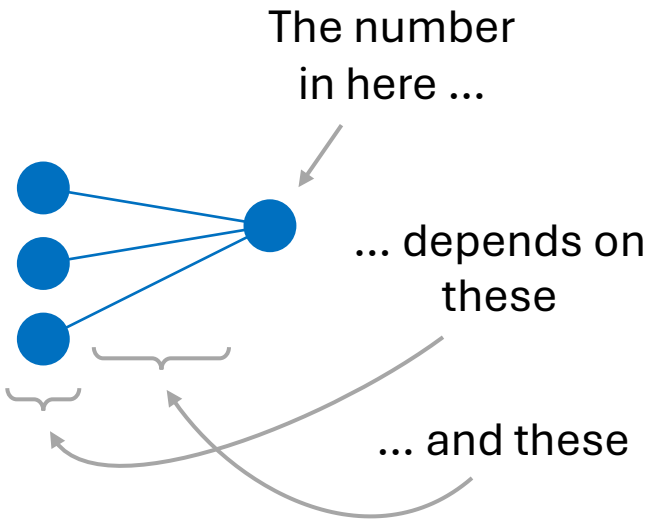


Each blob contains a number

Each line contains a number

... feed forward from the inputs to the outputs

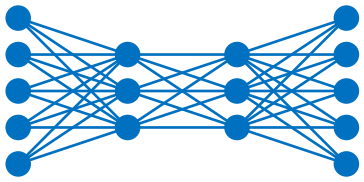
... are usually made of layers

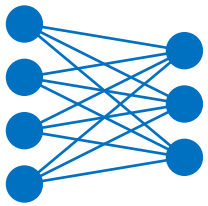


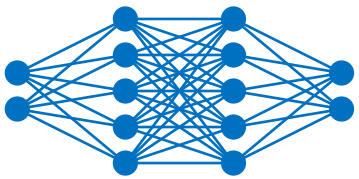
... can be many shapes and sizes

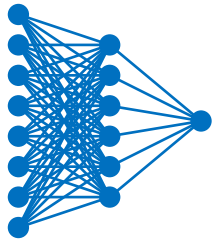
(The shape of a neural network is fixed)





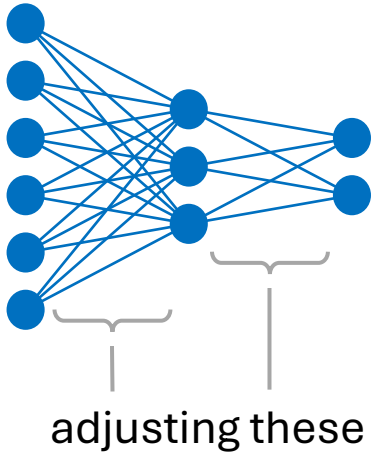




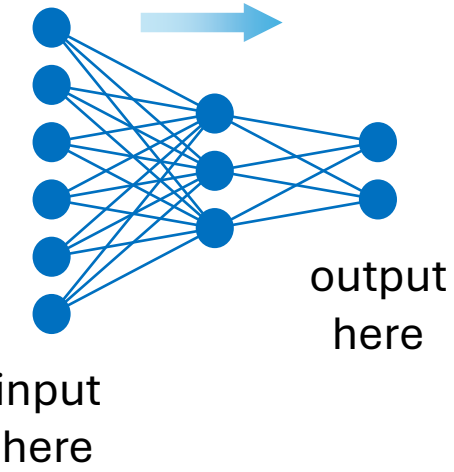


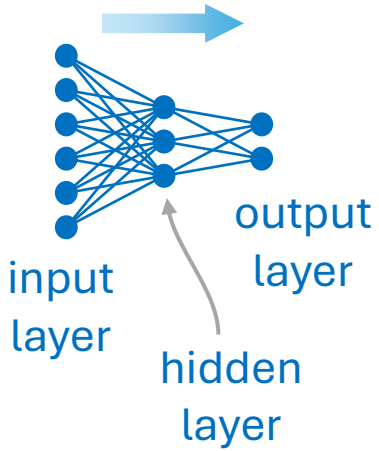
Neuron by Bob Jacobs / CC0

Learning



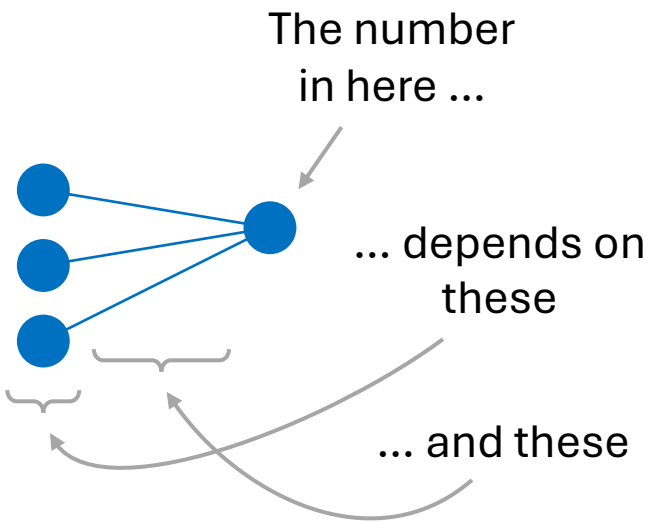
Doing

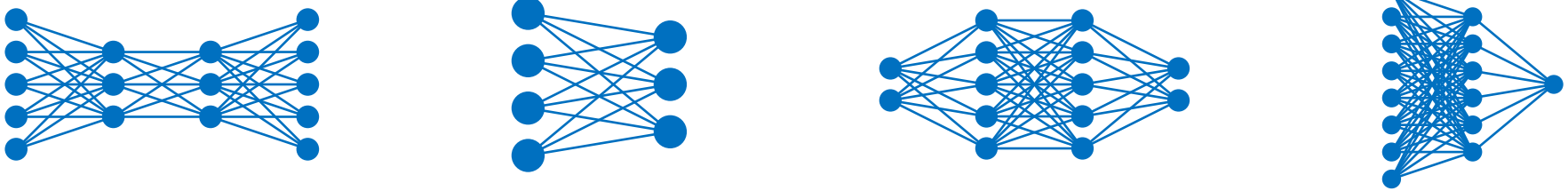




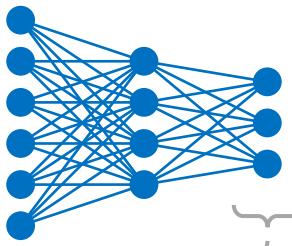
Each blob contains a number

Each line contains a number





Three categories



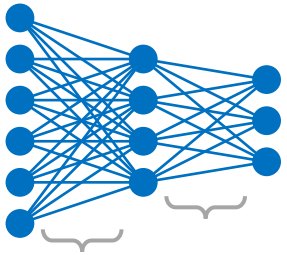
0 (dog)

1 (cat)

2 (bus)

Three “grandmother” cells

Learning



adjusting these

Training data



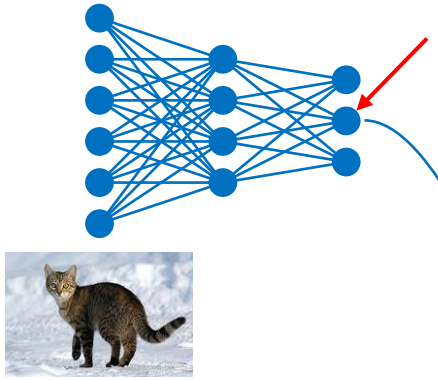
1

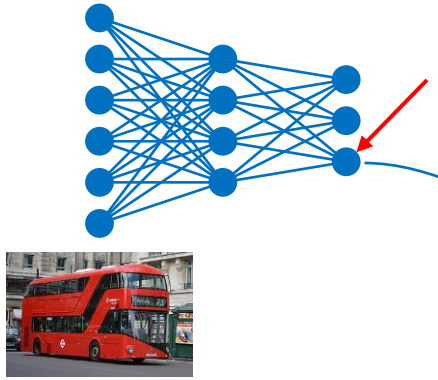


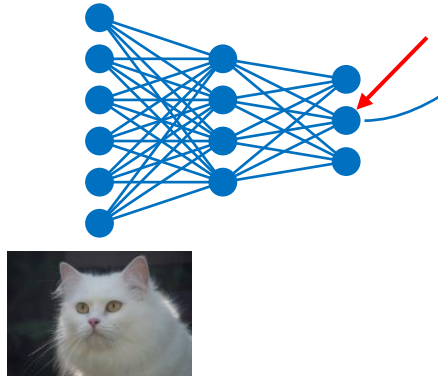
2



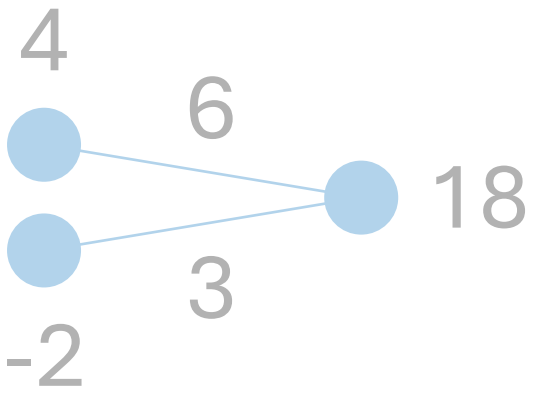
1

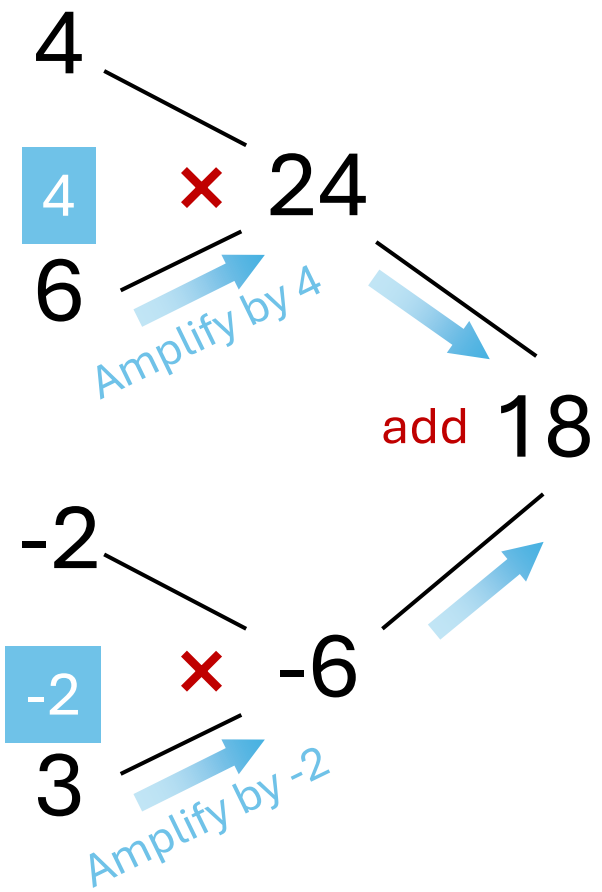




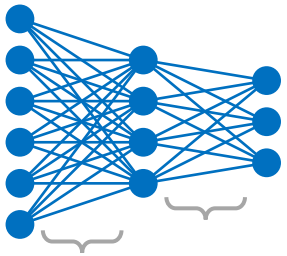


total loss

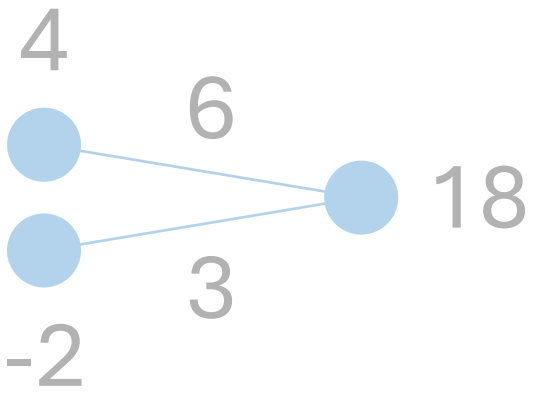


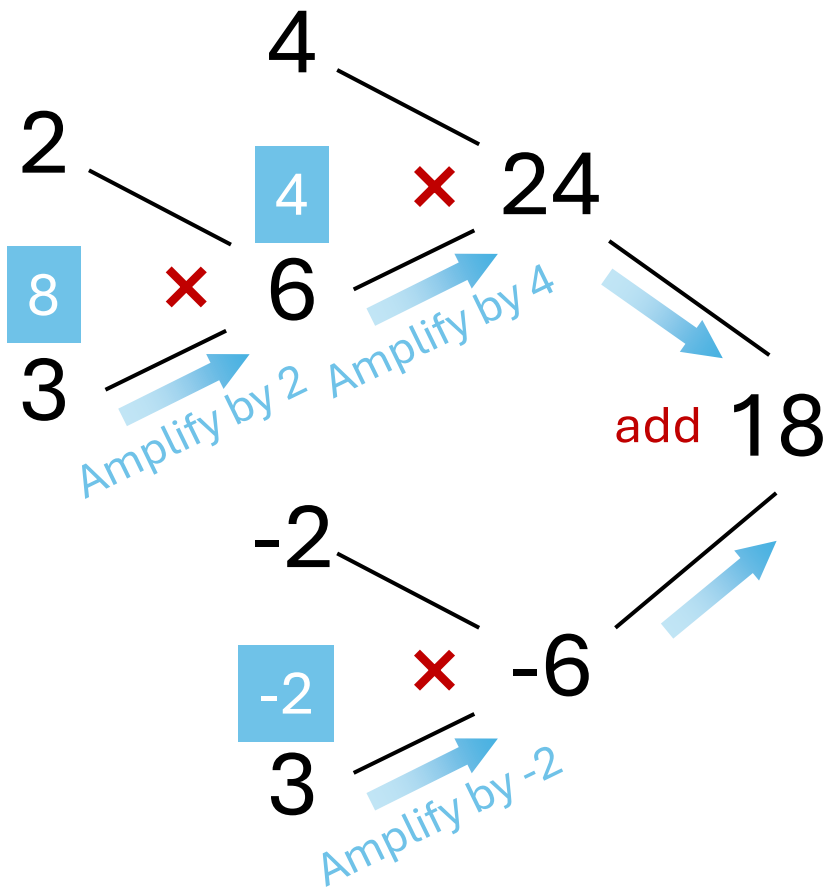


Learning

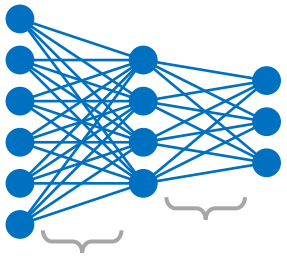


adjusting stuff



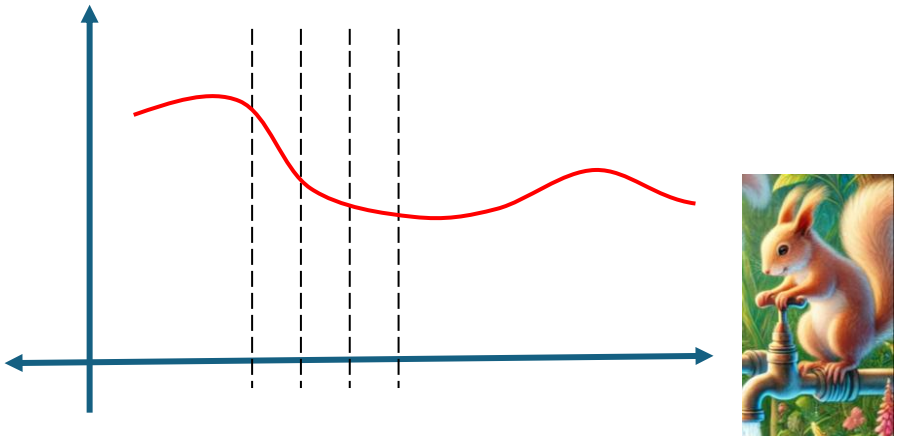


Learning



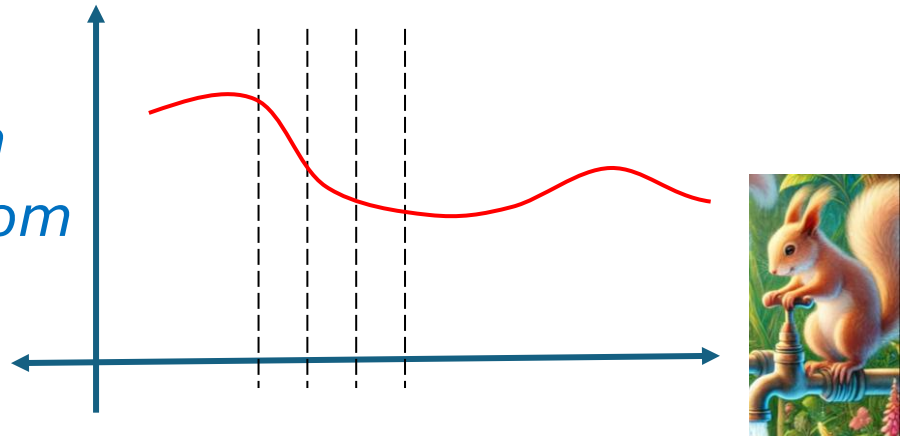
adjusting stuff

Gradient descent



Stochastic gradient descent







Dice by Brett Jordan / Unsplash

Deep learning surprises

It works at all

It doesn’t get stuck in local minima

It generalizes



Shockingly good for such a simple idea

Hinton: growing a program



Learning



Memorizing

Data

Aardvark by Kelly Abram / CC BY 4.0

More surprises

It doesn’t look back

It doesn’t remember any pictures



More surprises

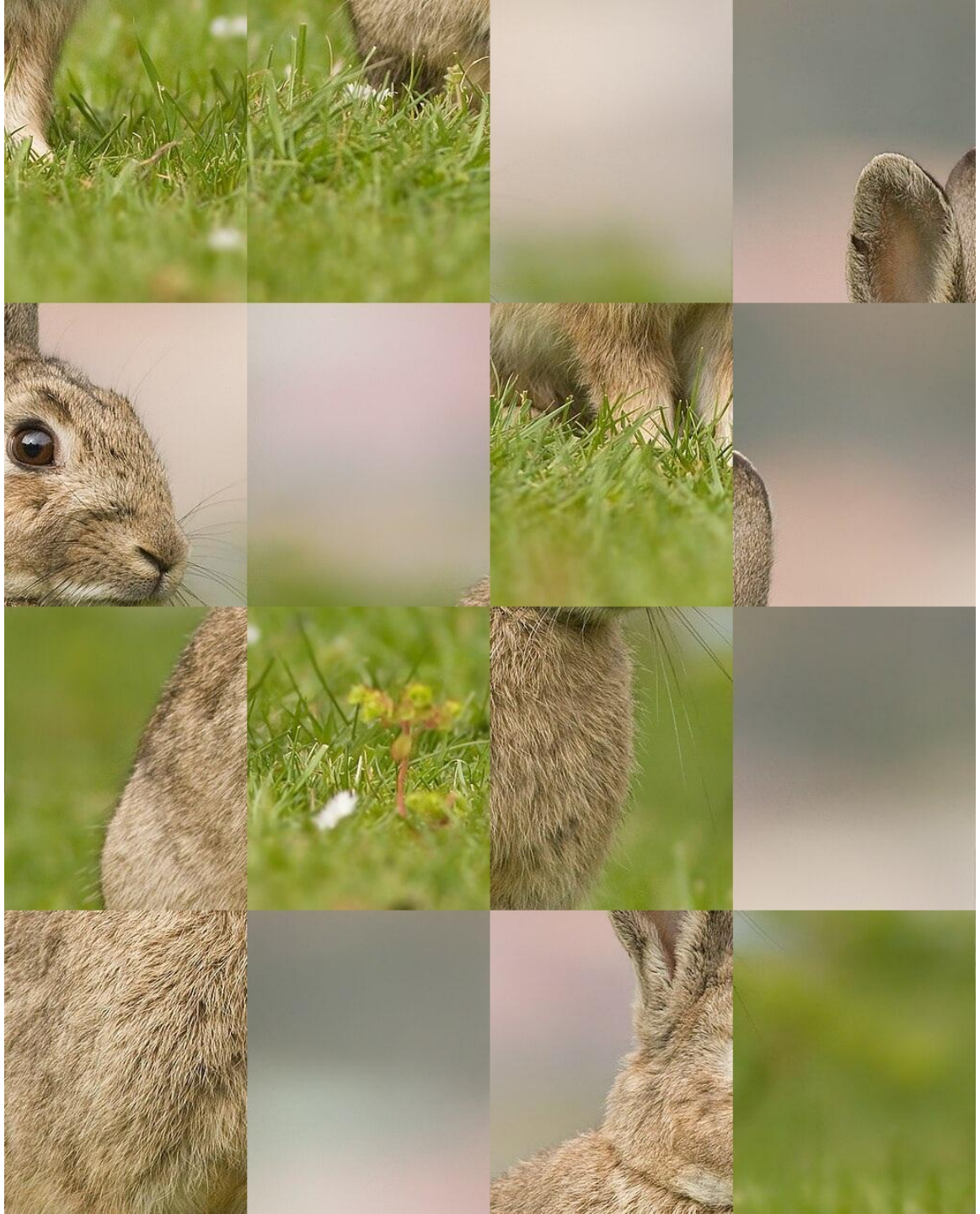
It can’t tell us what a dog is

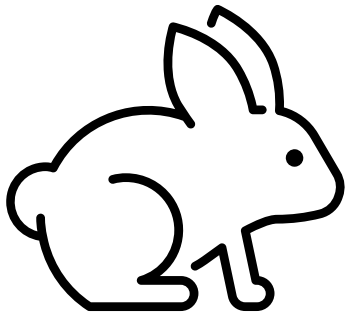
It is instinctive

It slowly learns all the categories at once























Medical scans

Earth from Apollo 8 by NASA / CC0
Shadow by © European Union, 2024 / CC BY 4.0
Mirror Lake By Oregon's Mt. Hood Territory / CC0

Is AlexNet intelligent?

Yes

Learns

Learns by itself

No

Narrow

Needs loads of data

Any child can do what it does



Adversarial machine learning



panda

58% confidence

+

carefully chosen tiny changes



=



gibbon

99% confidence



https://arxiv.org/pdf/1412.6572

Ian J. Goodfellow, Jonathon Shlens & Christian Szegedy Google Inc. (2015)

Where is the dog?







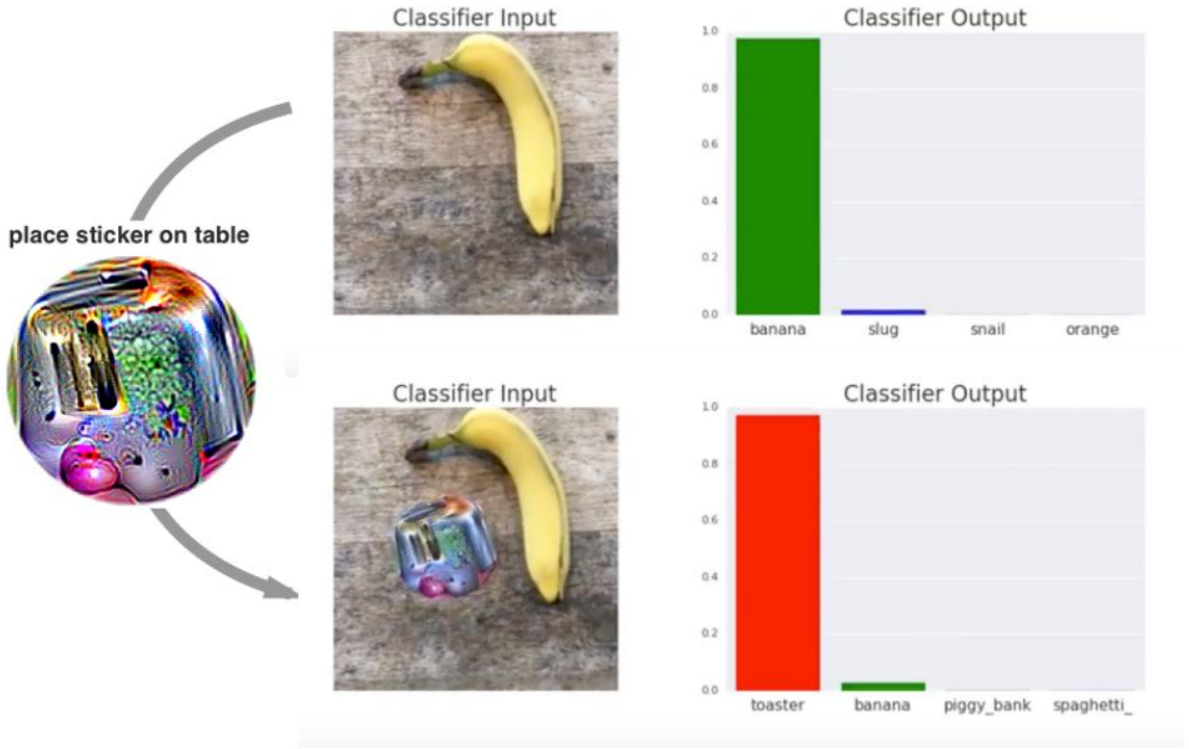
Inceptionism: Going Deeper into Neural Networks ✻

Feature Visualization ✻ How neural networks build up their understanding of images

Appendix: GoogLeNet Visualizations ✻ Visualizations of every channel in GoogLeNet

https://arxiv.org/pdf/1712.09665

Adversarial Patch



https://arxiv.org/pdf/1707.08945

Stop signs

End

chatgpt.com

ChatGPT

chatbot

GPT

Generative

large language model

(LLM)



chatgpt.com

chat.com

Why is the sky blue?

Why is the sky blue?

The sky appears blue due to a phenomenon called **Rayleigh scattering**. This scattering occurs because the Earth's atmosphere contains gases and particles that scatter sunlight. Here's a detailed explanation:

Key Factors

1. **Composition of Sunlight:**
    - Sunlight, or white light, is composed of all the colors of the visible spectrum (red, orange, yellow, green, blue, indigo, and violet).
    - Each color corresponds to a specific wavelength, with blue having shorter wavelengths and red having longer ones.
2. **Scattering in the Atmosphere:**
    - When sunlight enters Earth's atmosphere, it interacts with molecules of nitrogen, oxygen, and other small particles.

- Shorter wavelengths (blue and violet) are scattered more than longer wavelengths (red and yellow) because Rayleigh scattering is more effective at shorter wavelengths.

3. **Why Blue and Not Violet?**
    - Even though violet light is scattered more than blue, our eyes are less sensitive to violet. Additionally, some violet light is absorbed by the upper atmosphere.
    - As a result, the scattered light we perceive is predominantly blue.

During Sunrise and Sunset:

- At sunrise and sunset, sunlight passes through a thicker layer of the atmosphere. This causes most of the blue and violet light to be scattered out, leaving the longer wavelengths (reds and oranges) more visible, creating vibrant hues.

In summary, the blue appearance of the sky is a result of the preferential scattering of shorter wavelengths of light by the molecules in the atmosphere.

Why is the sky blue?

The sky appears blue due to a phenomenon called **Rayleigh scattering**.

Key Factors

1. **Composition of Sunlight:**

The sky is usually grey...

Key Factors

1. **Composition of Sunlight:**

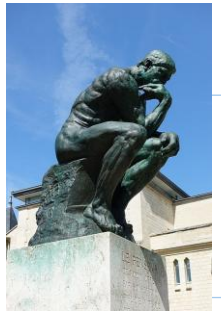
Why is the sky blue?

• • •

How would you explain this to a five year old?

The sky looks blue because of sunlight and the air around us. Sunlight has all the colors of a rainbow, but when it shines through the air, the blue part gets scattered all around. That's why, when you look up, the sky looks blue!

It's like if you splash water, the little drops go everywhere. The blue color in sunlight "splashes" around in the sky more than the other colors!

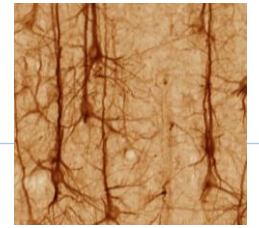


GOFAI

Machine learning

1960

ELIZA



1980





Birds fly



Good old fashioned AI



2000

AlexNet



2012

ChatGPT

November

2022

2020

Chess

Jeopardy

Book / CC0

Swan from pxhere / CC0

Bus by Martin49 / CC BY 2.0

Cat by Von.grzanka / CC BY-SA 3.0

Dog by Kyfishfishfish / CC BY-SA 4.0

The thinker by CrisNYCa / CC BY-SA 4.0

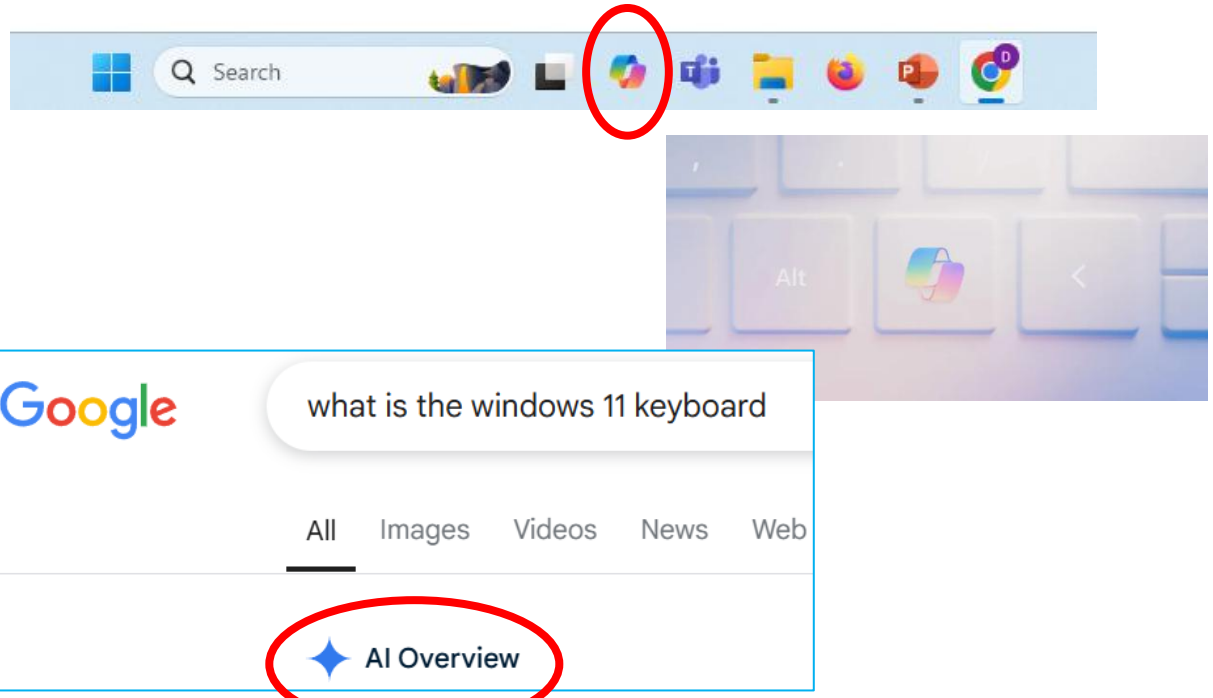
Tractor by Kharkiv Tractor Plant / CC BY 4.0

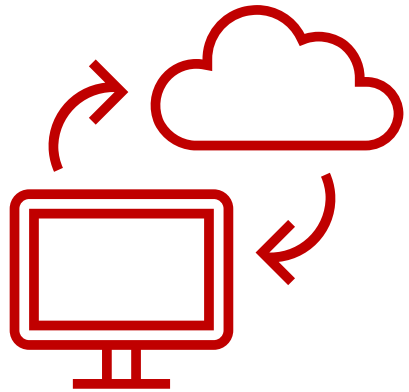
Penguin by Christopher Michel / CC BY 2.0

Neurons by UC Regents Davis campus / CC BY-3.0

Duckling by Luis Miguel Bugallo Sánchez / CC BY-SA 3.0

OpenAI	ChatGPT
Microsoft	Copilot
Google	Gemini
Anthropic	Claude
DeepSeek	V2, V3, R1



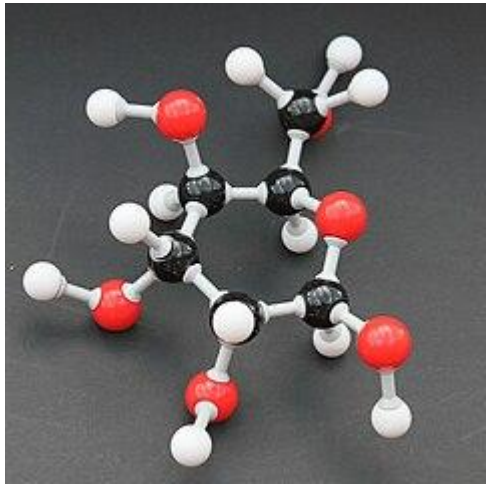


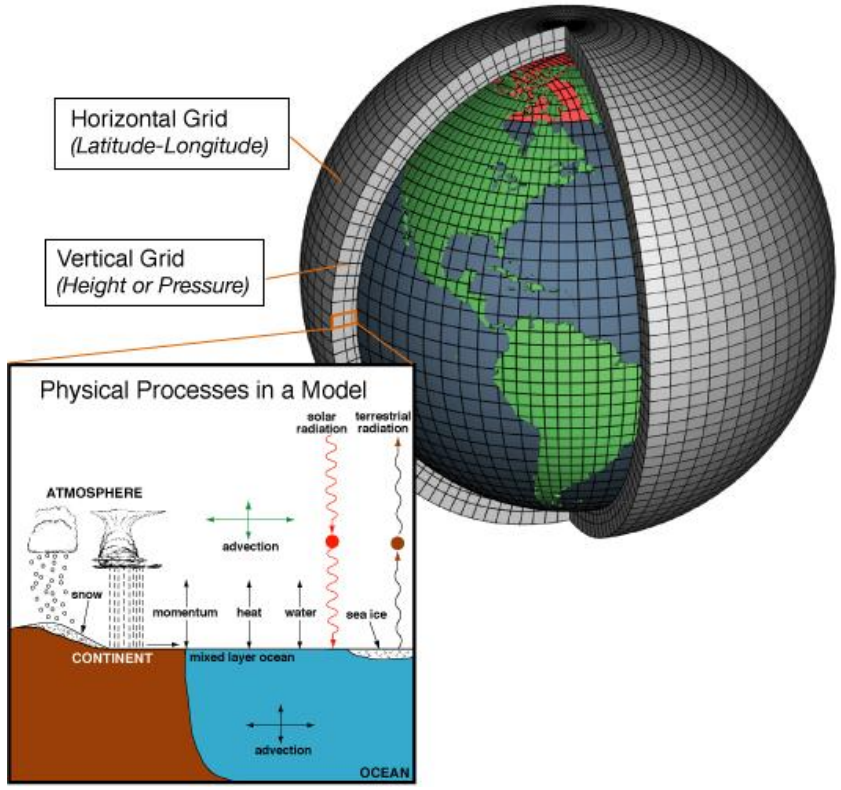
ChatGPT *chatbot*

GPT

large language model (LLM)

Large language model





Weather model by NOAA / CC0
Model by Bin im Garten / CC BY-SA 3.0

Large language model

the dog saw the ball ✓✓

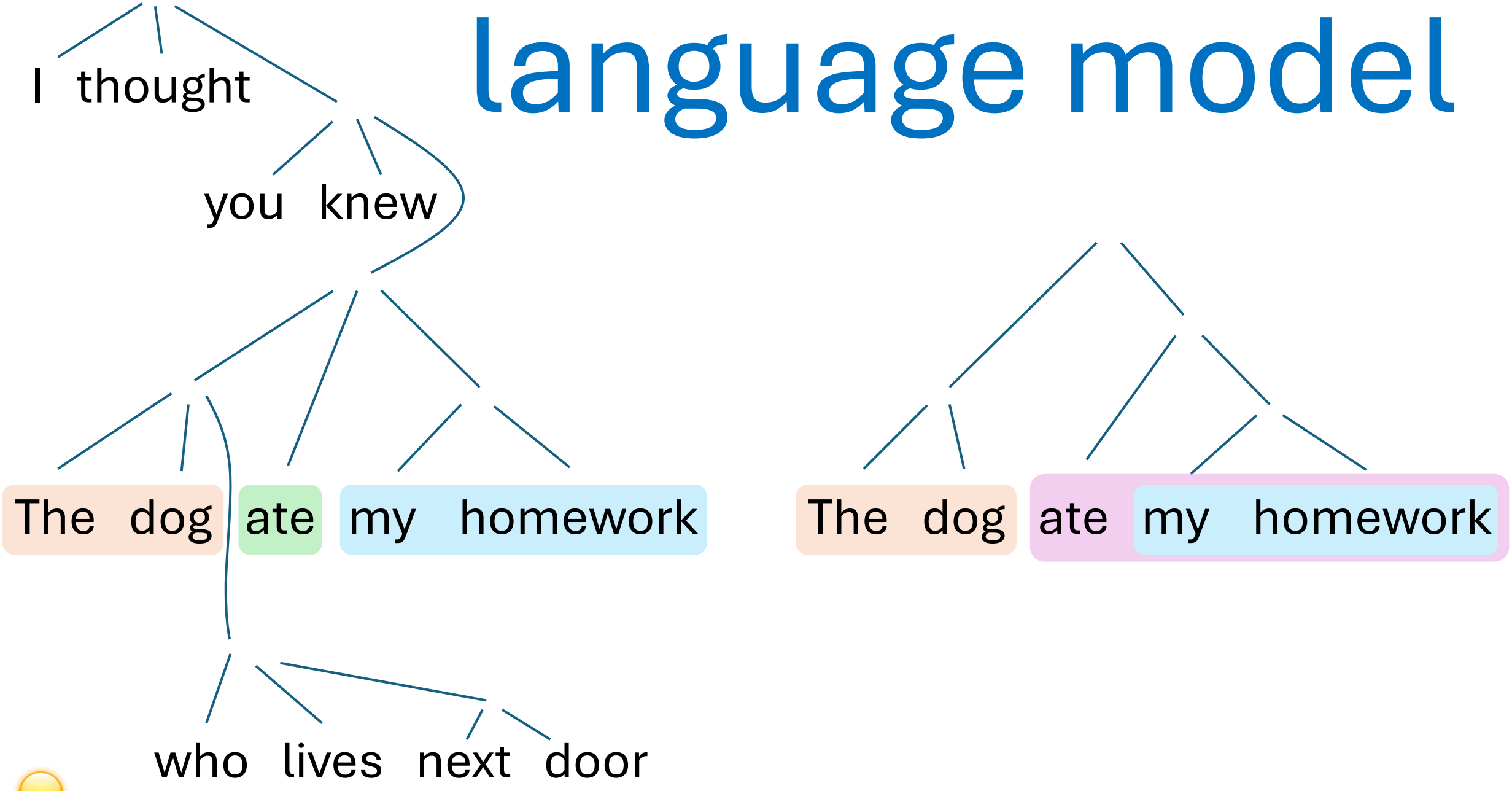
the ball saw the dog ✓

saw ball the dog the ✗



Rabbit by JJ Harrison / CC BY-SA 3.0

language model



Large language model

a quick brown dog ✓✓

dog quick a brown ✗

apples and pears ✓✓

apples and pairs ✓

the big bad ???f



Large language model

Why is the sky blue?

- The sky is blue because ..... ✓✓
- The capital of France is ..... ✗



Large language model



parameters

AlexNet

60 million

GPT-1

117 million

2018

GPT-2

1.5 billion

2019

GPT-3

175 billion

2020

The scaling laws