

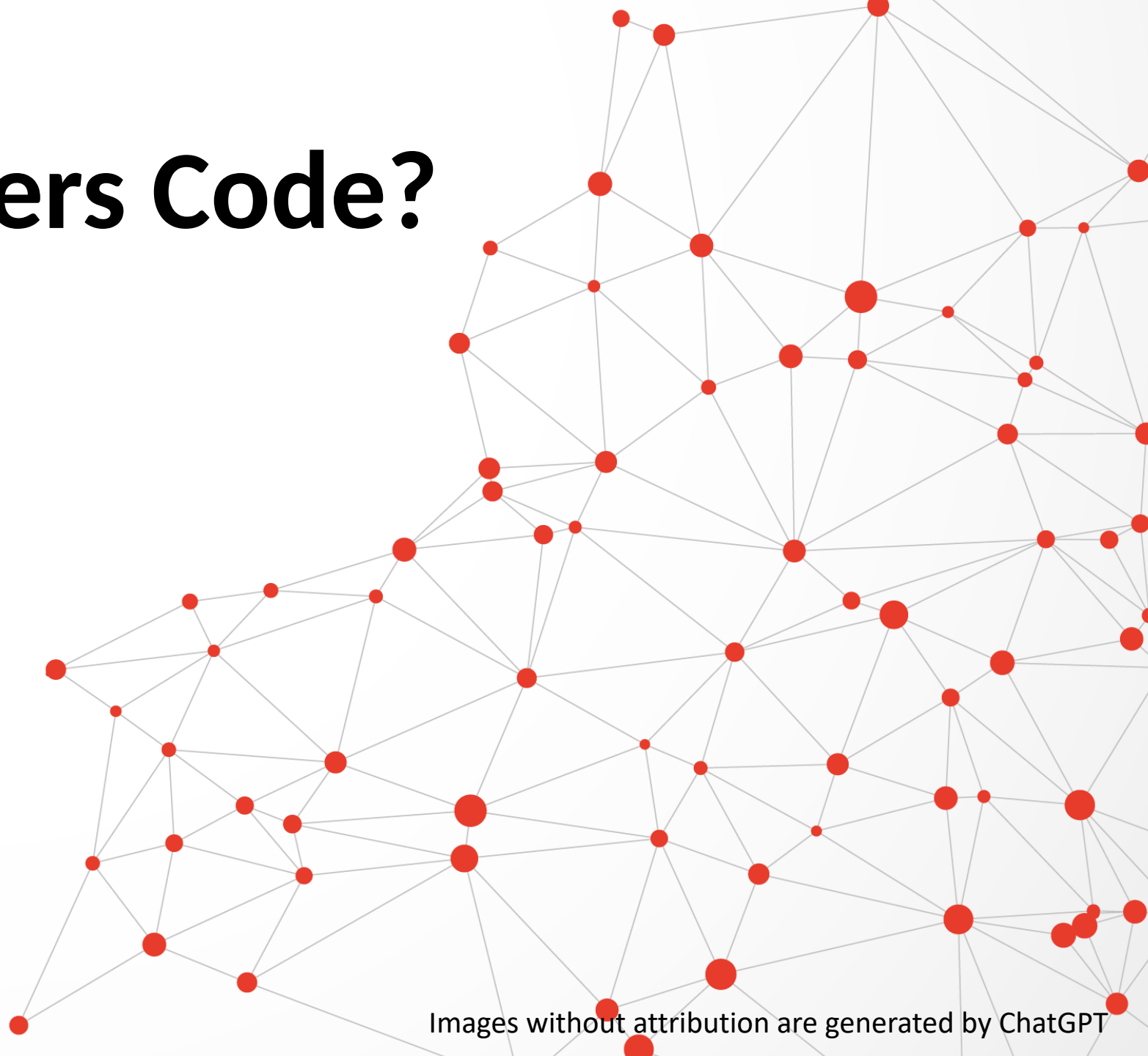
Can Computers Code?

Prof. dr. Frank Neven
frank.neven@uhasselt.be

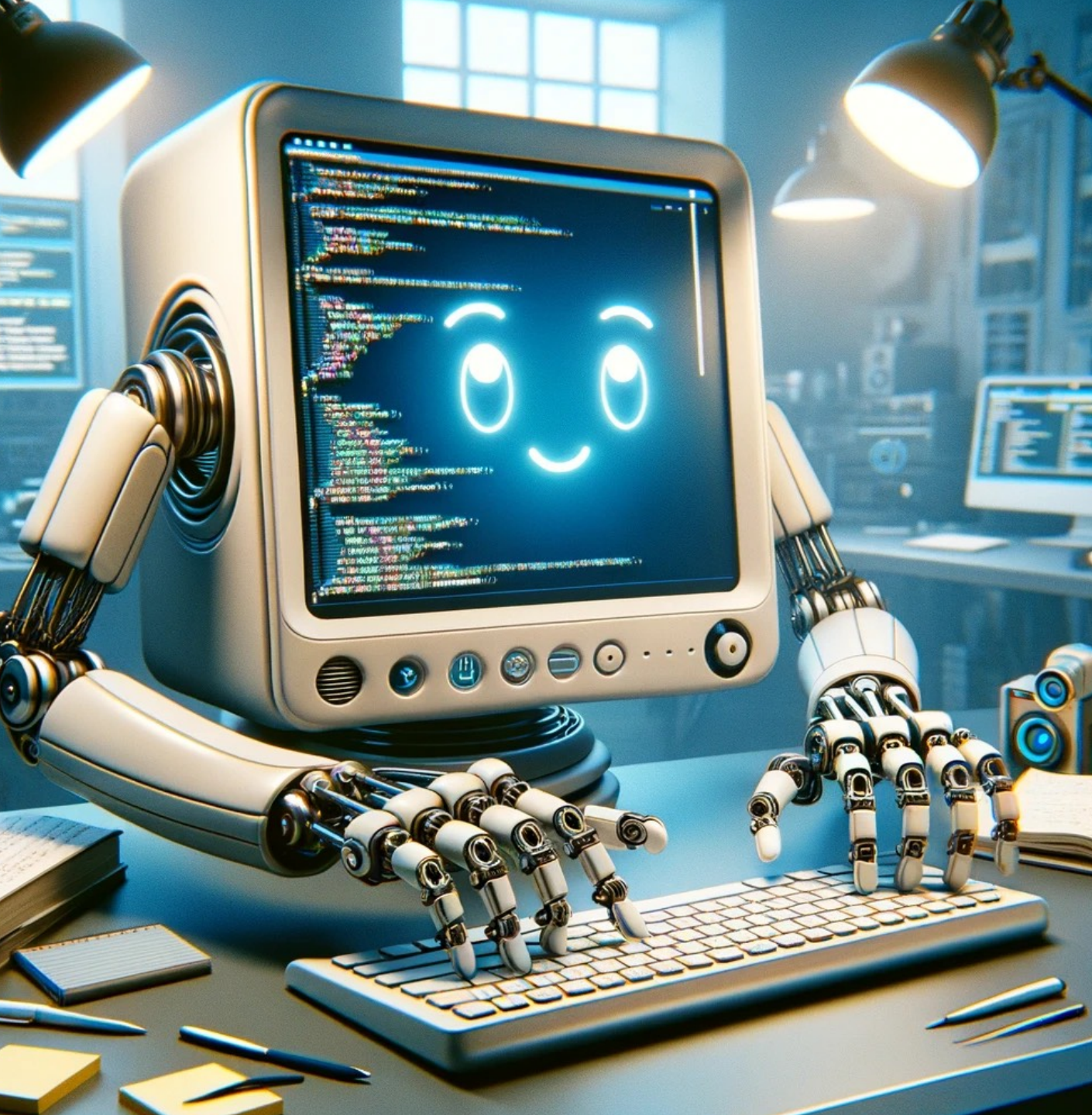
Coderdojo Con 2024
Namur



WWW.UHASSELT.BE/DSI



Images without attribution are generated by ChatGPT



Overview

- ✓ Intro
- ✓ Artificial intelligence
- ✓ Large language models
- ✓ Can computers code?

About me

- CS Professor @ Hasselt University
- Vice director of Data Science Institute
- Vice director of the computer science program
- Teaching programming > 20 years
- Research:
 - Data Engineering and Data Management
 - NLP in health context





Image: Wikipedia

GW-BASIC 3.23

(C) Copyright Microsoft 1983,1984,1985,1986,1987,1988

60300 Bytes free

Ok

GW-BASIC



Image: Wikipedia

1LIST

2RUN←

3LOAD"

4SAVE"

5CONT←

6,"LPT1

7TRON←

8TROFF←

9KEY

0SCREEN

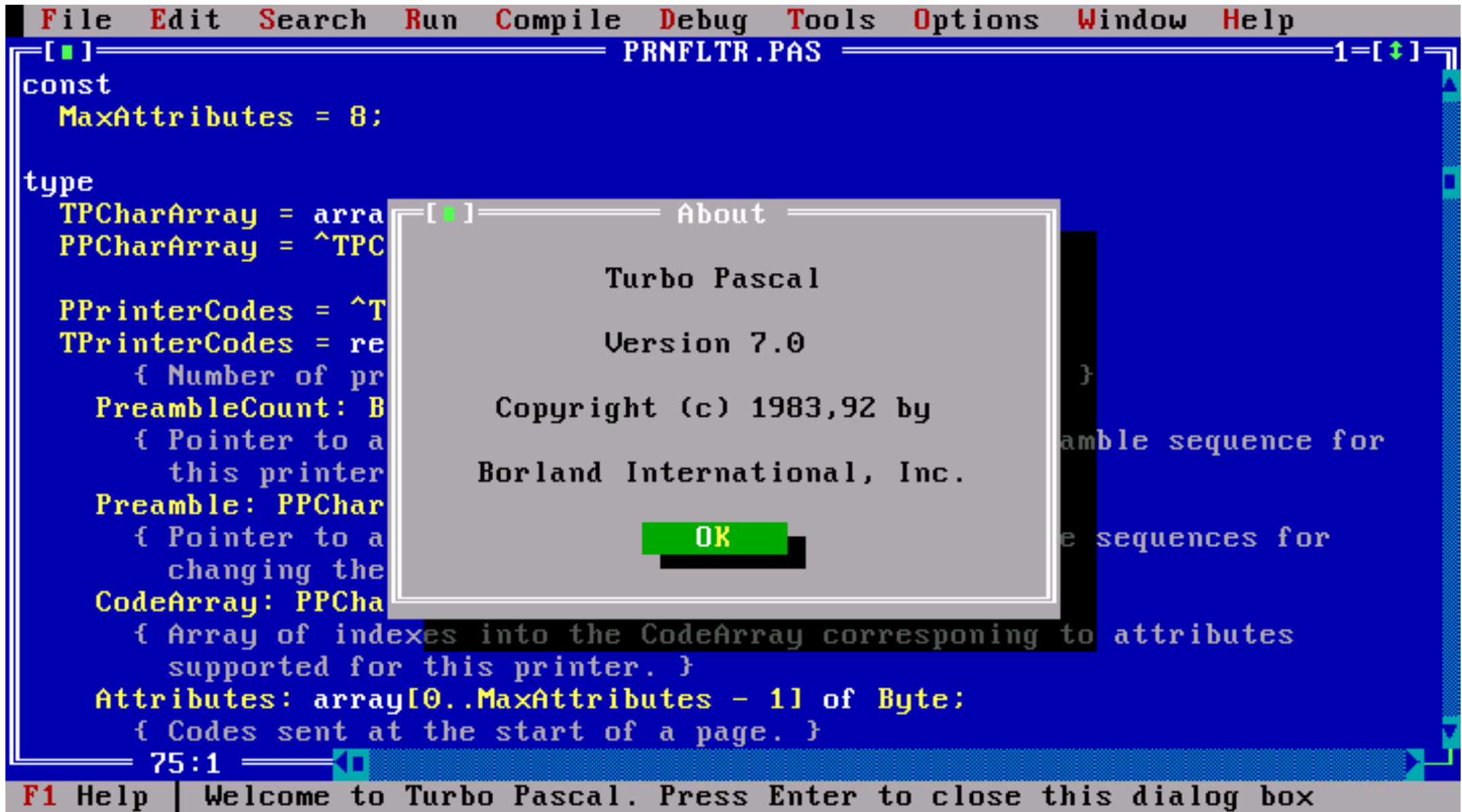


Image: winworldpc.com

BaMa CS



Phd



Professor



2001

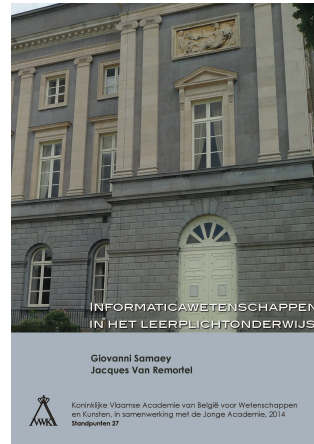


2013

2018-2019



2014



2022-2024



Subject Computer Science

- Content: algorithms and programming
- Starts: 2023-2024



CoderDojoBelgium



+ many others

Meanwhile in 2023 ...



You

Write a program that reads five integer values and computes the average.

```
sum_of_values = 0
num_values = 5

for i in range(num_values):
    value = int(input(f"Enter integer value {i+1}: "))
    sum_of_values += value

average = sum_of_values / num_values
print("The average of the entered values is:", average)
```




Can computers code?

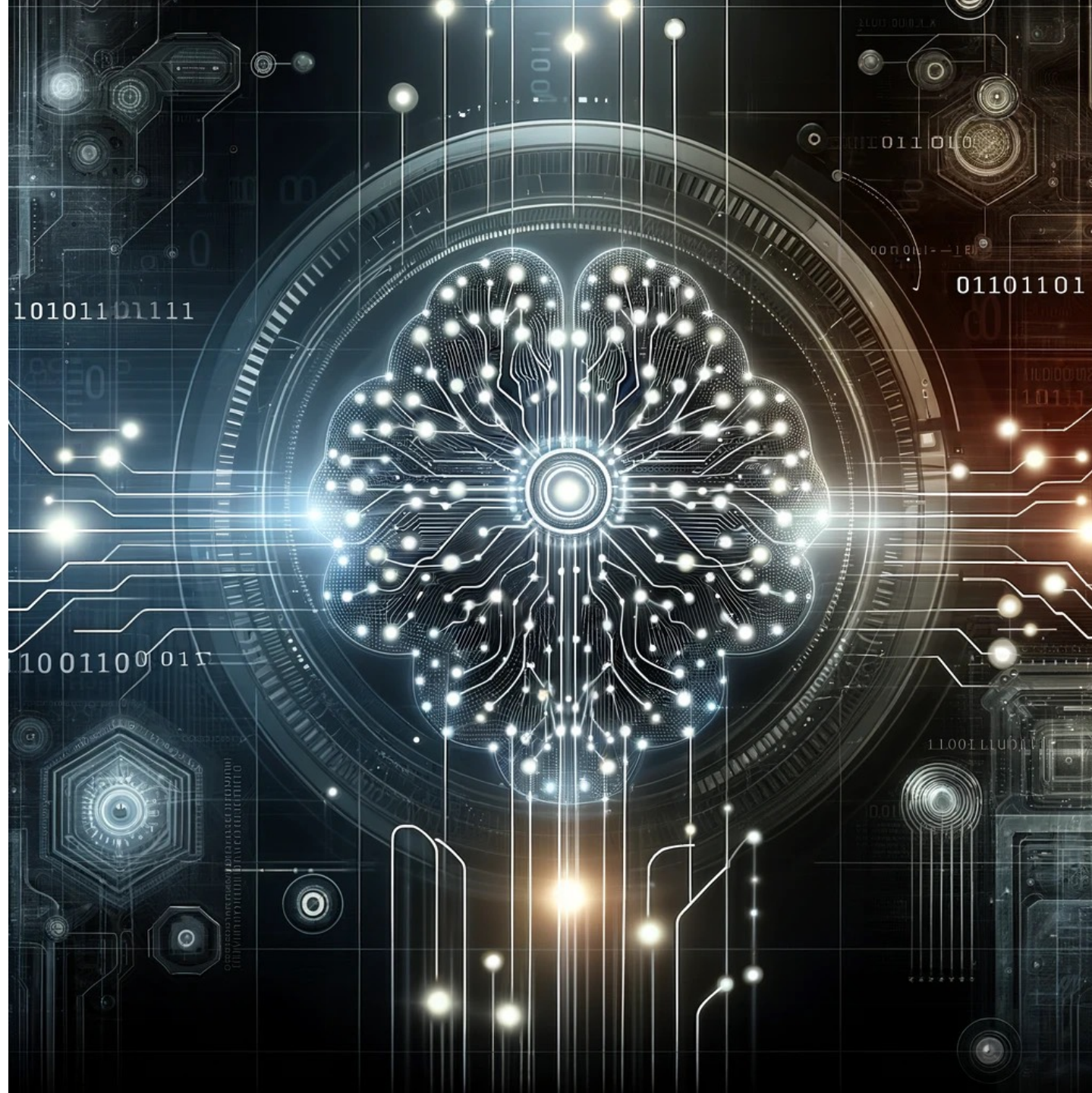


**Is learning coding basics
still relevant today?**

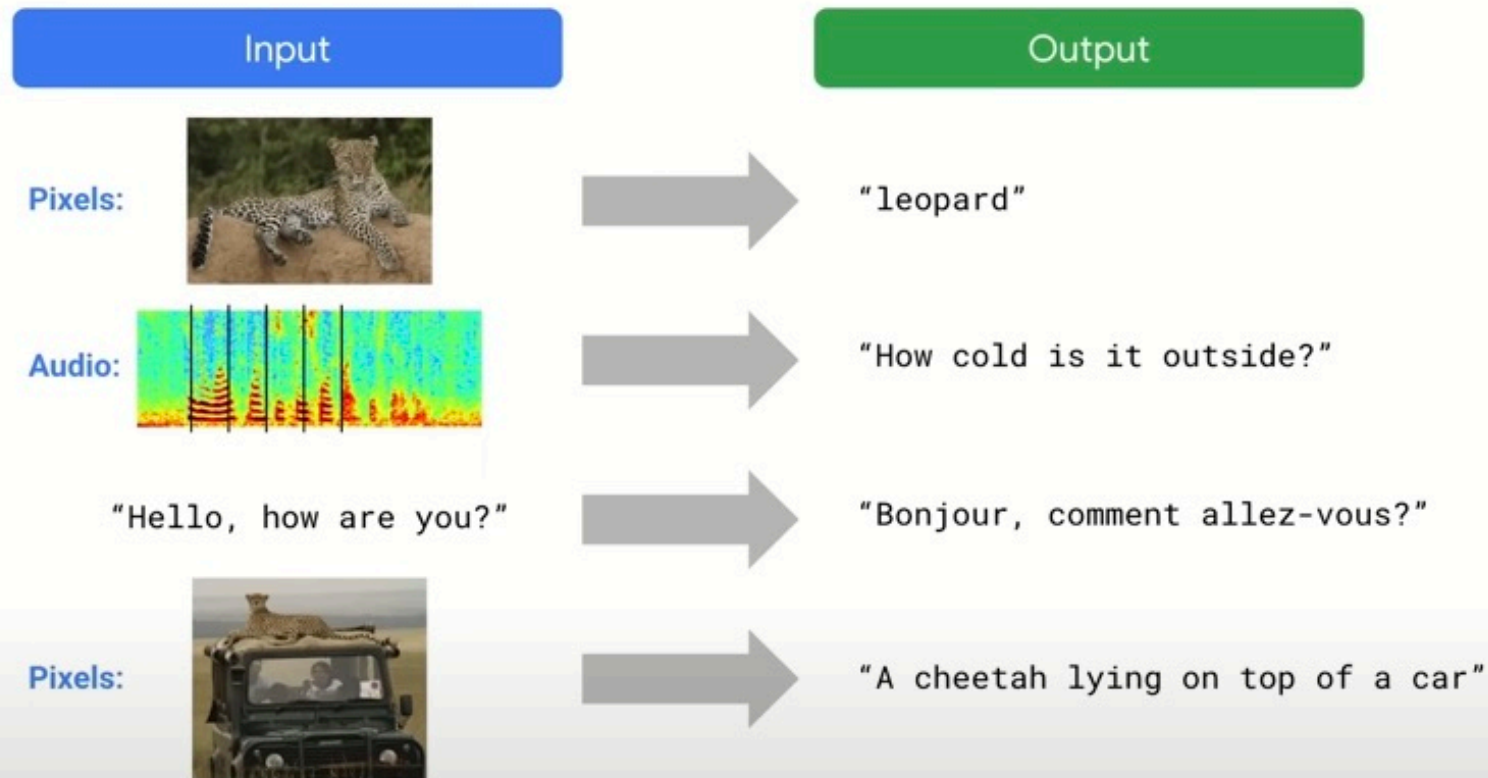
**Is there still a need for
human programmers
in the era of advanced AI?**



Artificial Intelligence



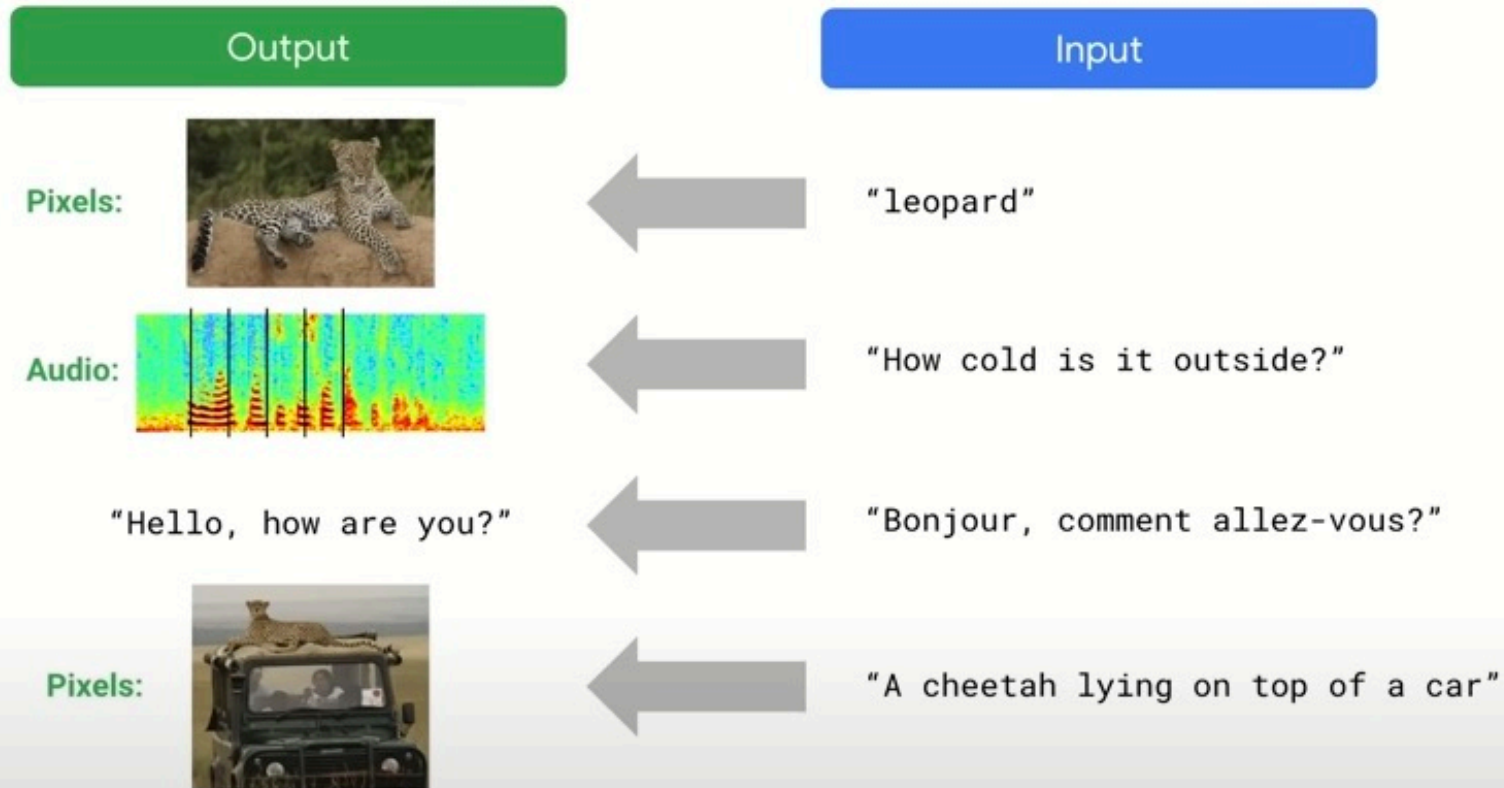
A decade of amazing progress in what computers can do



Slide by Jeff Dean (Google): Exciting Trends in Machine Learning
<https://www.youtube.com/watch?v=oSCRZkSQ1CE>

Generative AI

A decade of amazing progress in what computers can do



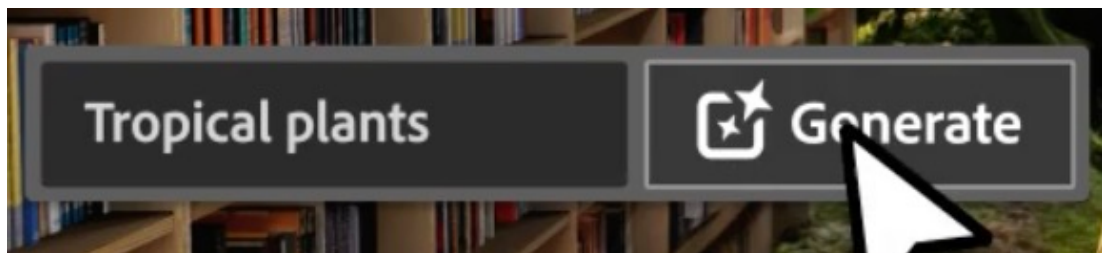
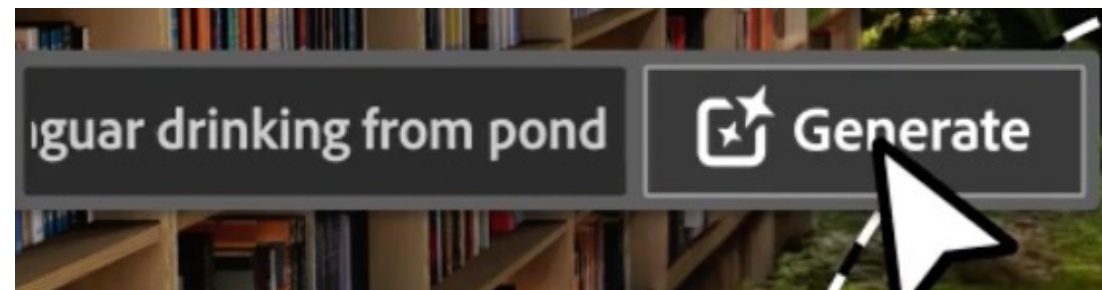
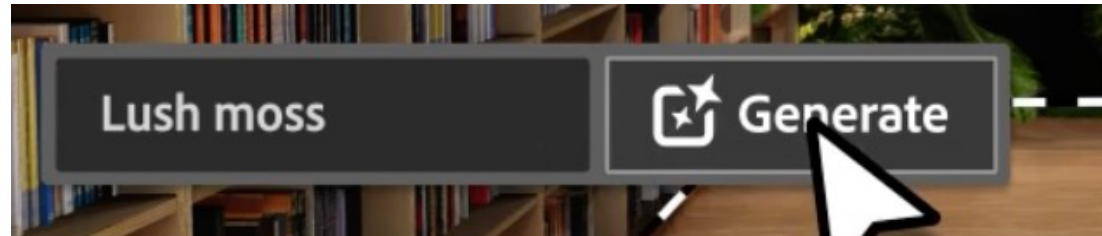
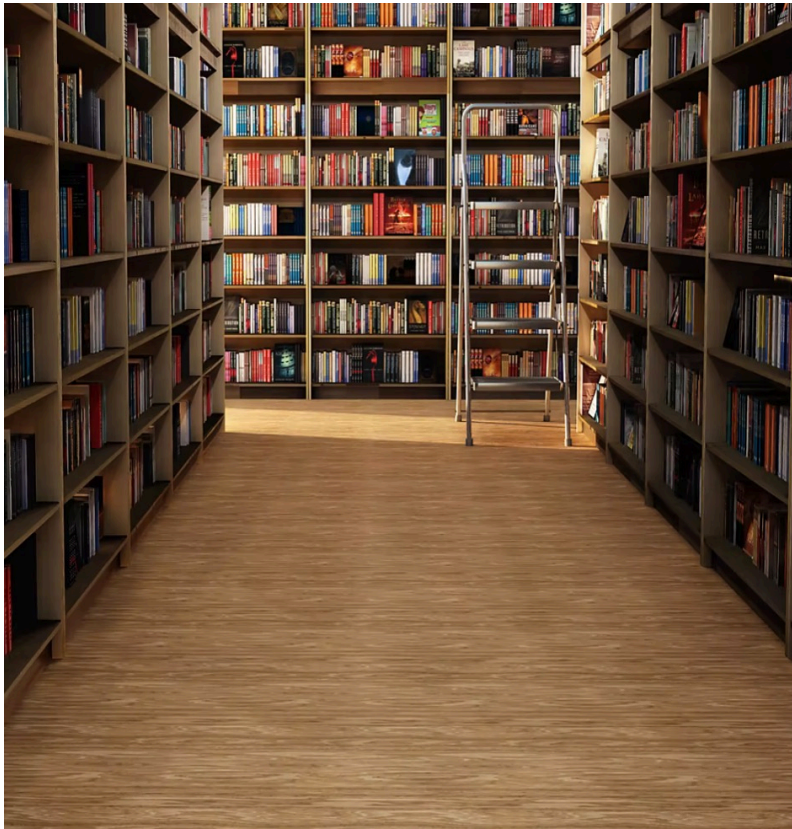
Slide by Jeff Dean (Google): Exciting Trends in Machine Learning
<https://www.youtube.com/watch?v=oSCRZkSQ1CE>

Image generation

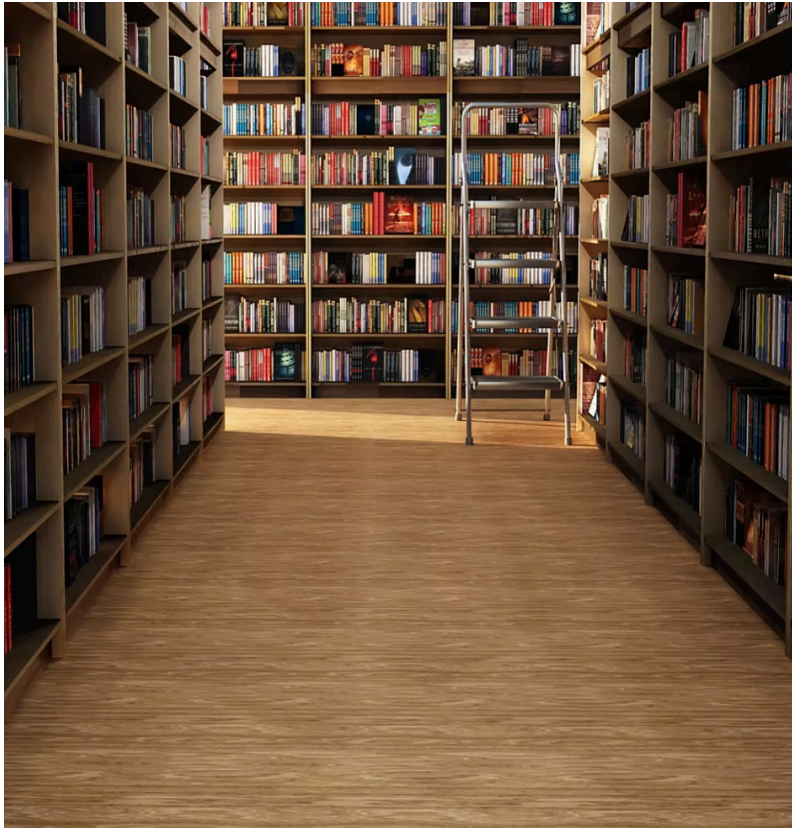
an image of a teddy bear standing on a skateboard in Times Square



Compositing



Compositing



<https://www.adobe.com/products/photoshop.html>

Sora



Prompt: A stylish woman walks down a Tokyo street filled with warm glowing neon and animated city signage. She wears a black leather jacket, a long red dress, and black boots, and carries a black purse. She wears sunglasses and red lipstick. She walks confidently and casually. The street is damp and reflective, creating a mirror effect of the colorful lights. Many pedestrians walk about

Prompt: A stylish woman walks down a Tokyo street filled with warm glowing neon and animated city signage. She wears a black leather jacket, a long red dress, and black boots,...

<https://openai.com/sora>

0:27 / 0:59

You

Write a poem about the joy of coding. Use Coderdojo as a theme.



ChatGPT

In a world where dreams and code entwine,
CoderDojo stands, a beacon, a sign.

Where young minds gather, eager and bright,
To embark on a journey, a marvelous flight.

With each line of code, a new world unfurls,
A canvas of possibilities, a string of pearls.

Here, in the dojo, where creativity meets skill,
Every problem faced is just another thrill.

Loops and variables, a dance of the mind,

Text Generation

Code generation

You

Generate code for the game mastermind



Image: Wikipedia

Here's a basic implementation:

python

Copy code

```
import random

def generate_secret_code(length=4, colors='RGBY'):
    """Generate a secret code with given length and colors."""
    return ''.join(random.choice(colors) for _ in range(length))

def evaluate_guess(guess, secret_code):
    """Evaluate the guess and return black and white pegs."""
    black_pegs = sum(g == s for g, s in zip(guess, secret_code))
    white_pegs = sum(min(guess.count(c), secret_code.count(c)) for c in guess)
    return black_pegs, white_pegs

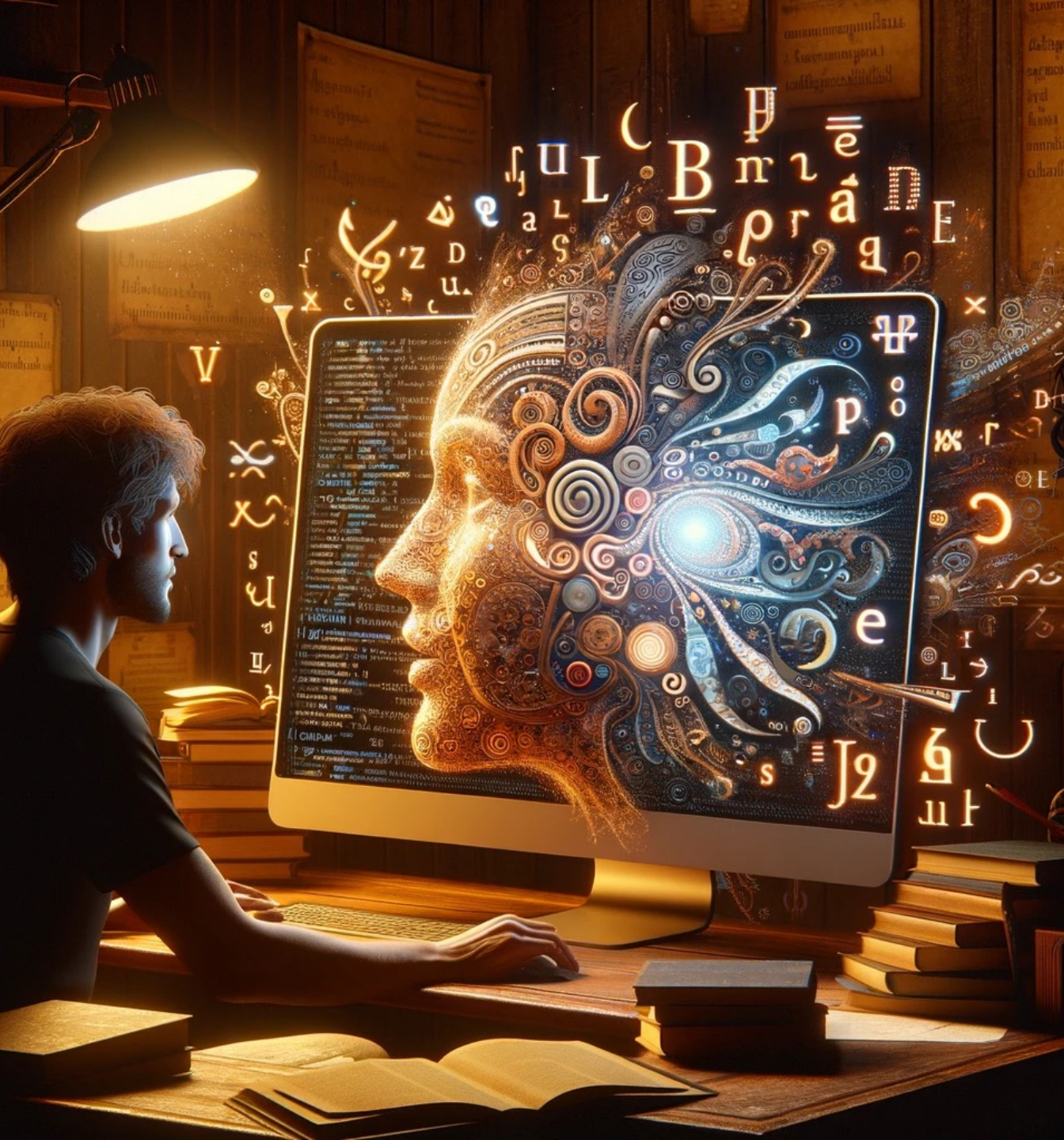
def mastermind_game():
    secret_code = generate_secret_code()
    attempts = 0

    print("Welcome to Mastermind!")
```



Computers
can understand
natural language





Computers
can generate
(natural) language

Limitations

a teddy bear on a skateboard in Times Square, taking a photograph of a lion in a swimsuit



ChatGPT 4 ▾



Here's a basic implementation:

```
python Copy code  
  
import random  
  
def generate_secret_code(length=4, colors='RGBY'):  
    """Generate a secret code with given length and colors."""  
    return ''.join(random.choice(colors) for _ in range(length))  
  
def evaluate_guess(guess, secret_code):  
    """Evaluate the guess and return black and white pegs."""  
    black_pegs = sum(g == s for g, s in zip(guess, secret_code))  
    white_pegs = sum(min(guess.count(c), secret_code.count(c)) for c in set(guess))  
    return black_pegs, white_pegs  
  
def mastermind_game():  
    secret_code = generate_secret_code()  
    attempts = 0  
  
    print("Welcome to Mastermind!")
```

What I did not tell you:

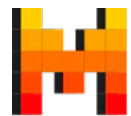
- Code does not implement mastermind
- Code did not run

Large Language Models

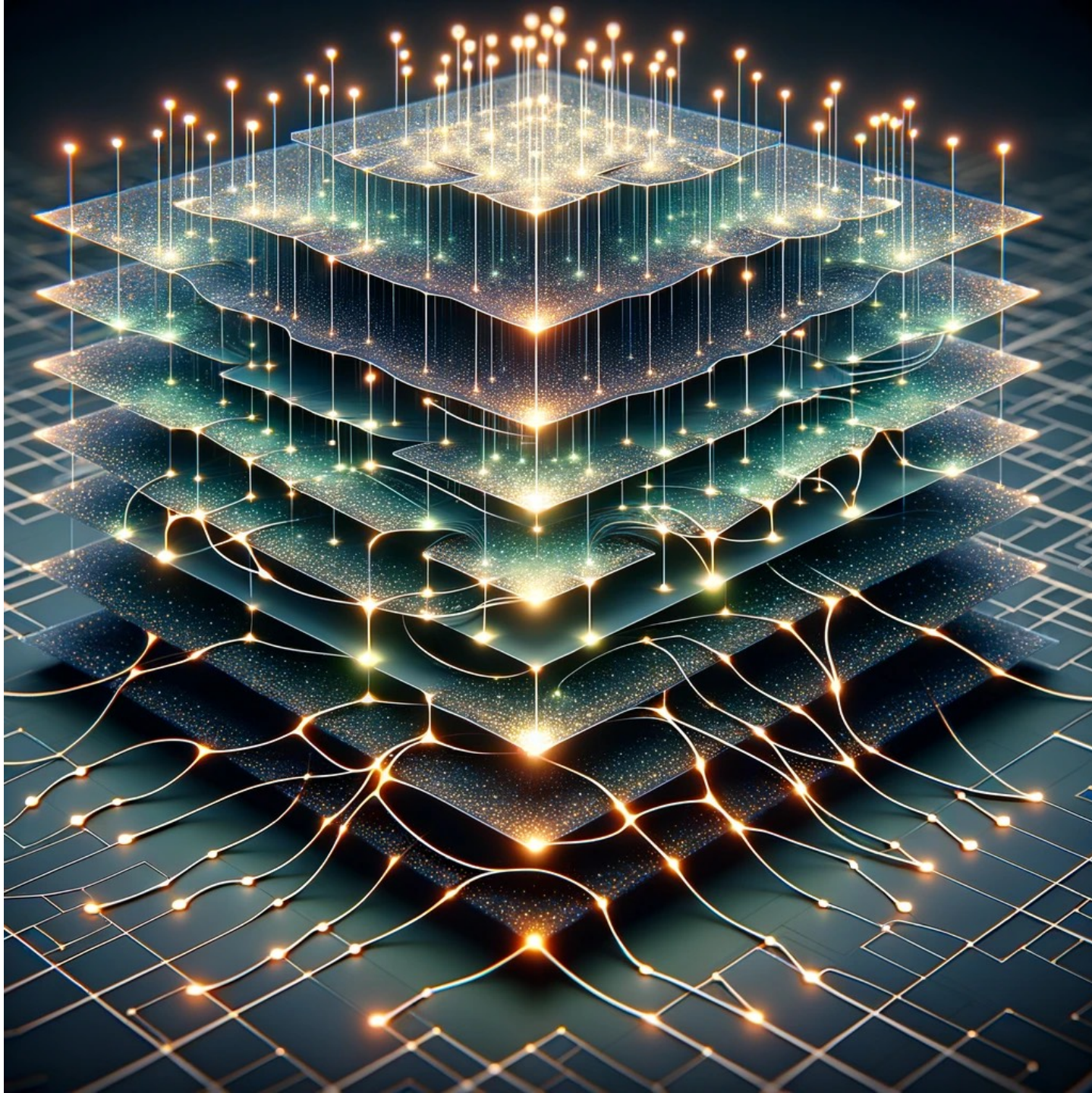


Llama

Gemini



MISTRAL
AI_



Deep Blue beats Garry Kasparov (1996-1997)

Key features

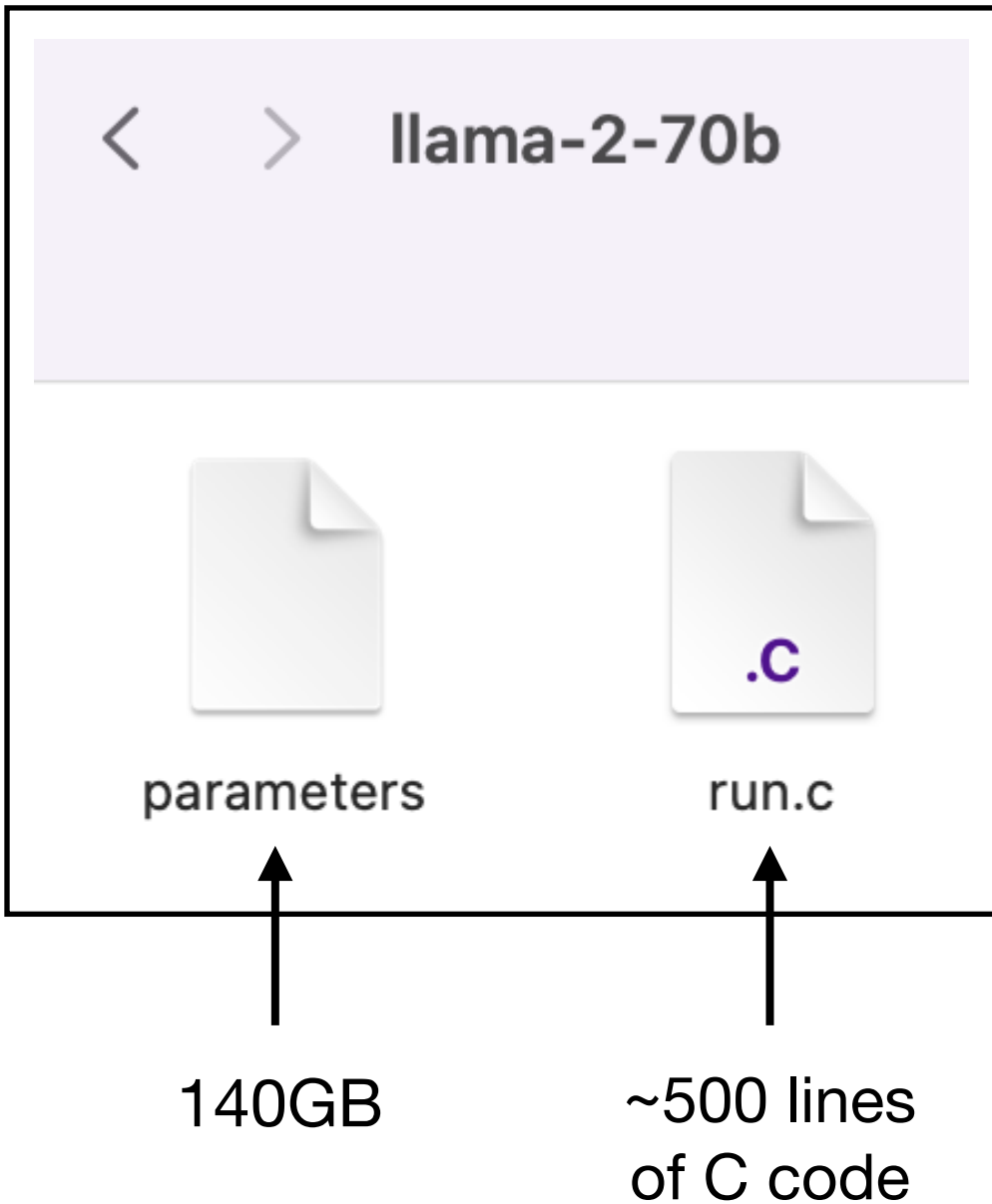
- Brute force search
- Evaluating positions
- Opening and endgame DB
- Parallel processing

Intelligence comes from

- computation during play
- (tweaking) evaluation function

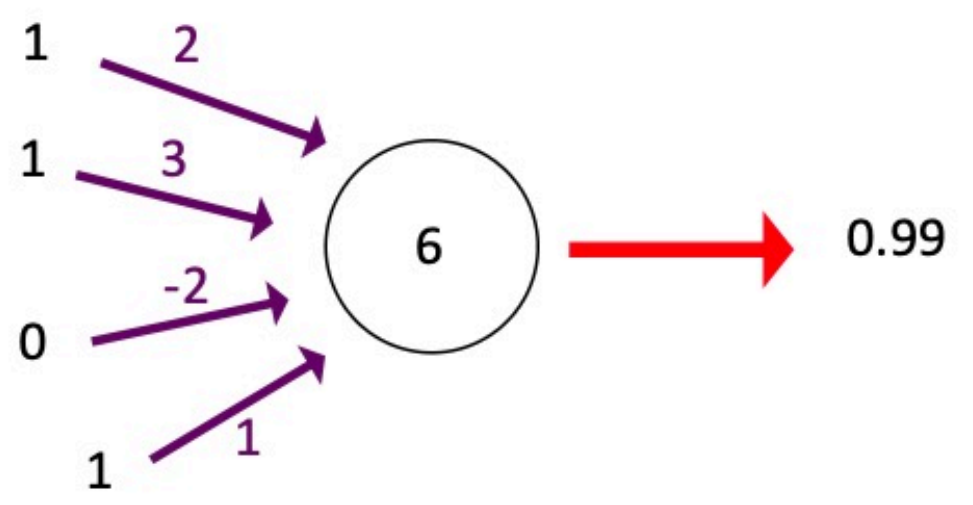
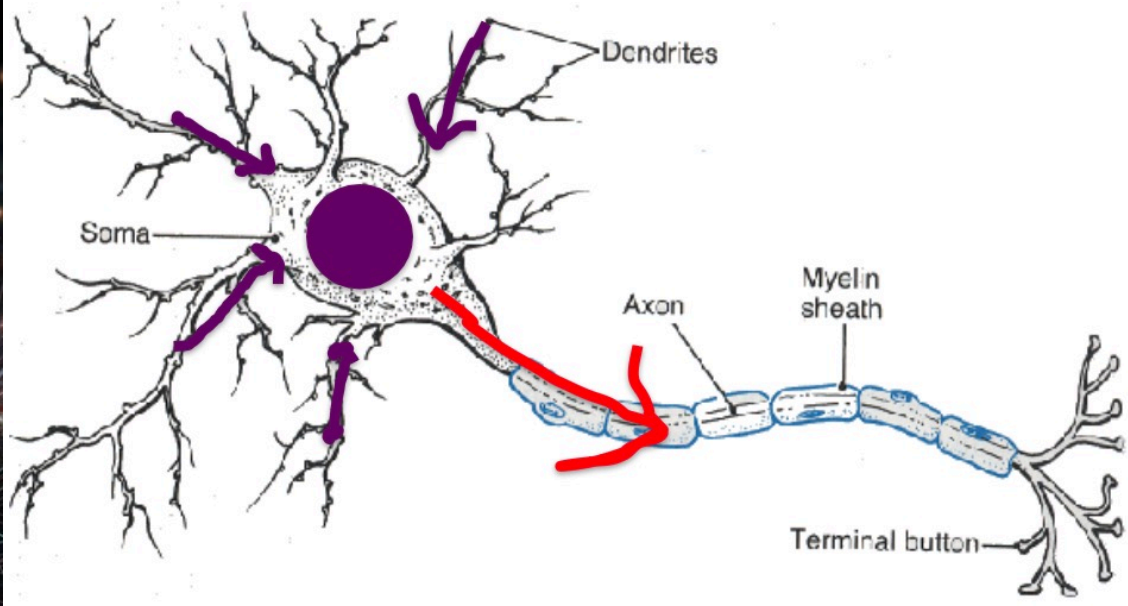


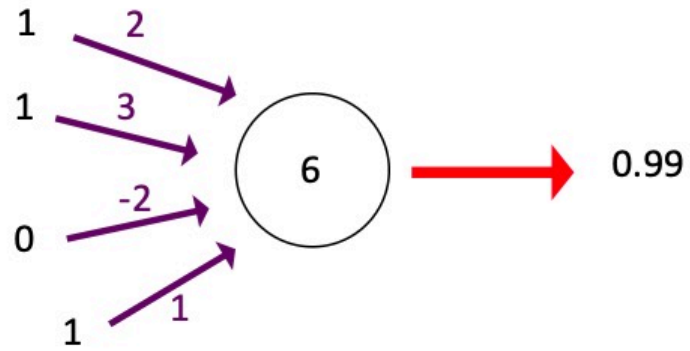
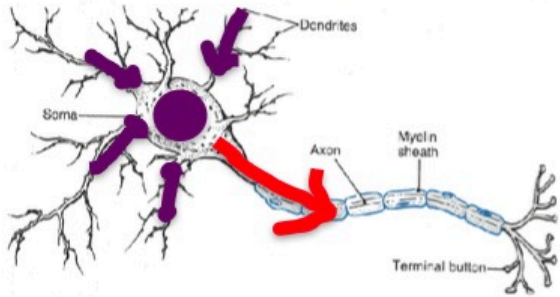
Image: wikipedia



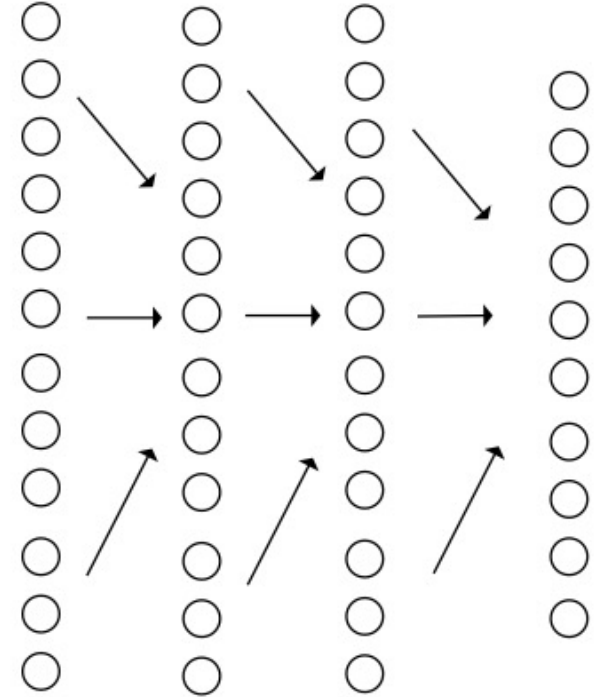
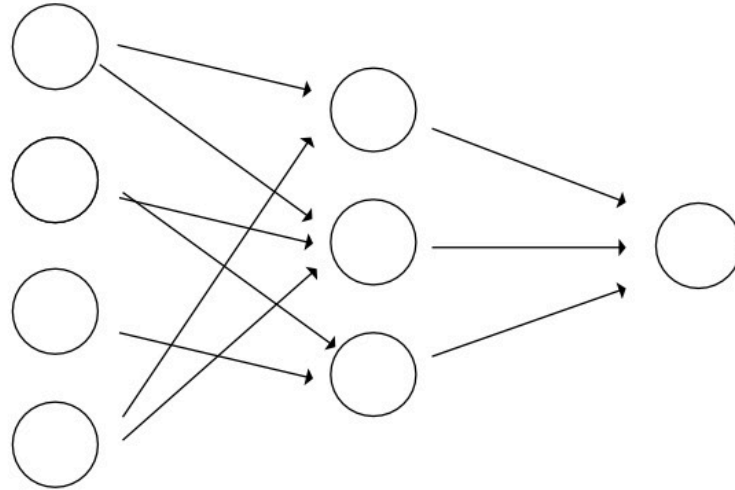
Large Language Models

Intelligence is in the values of the parameters





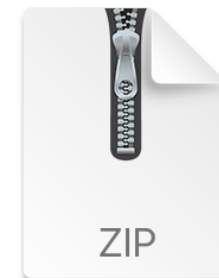
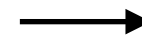
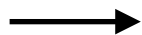
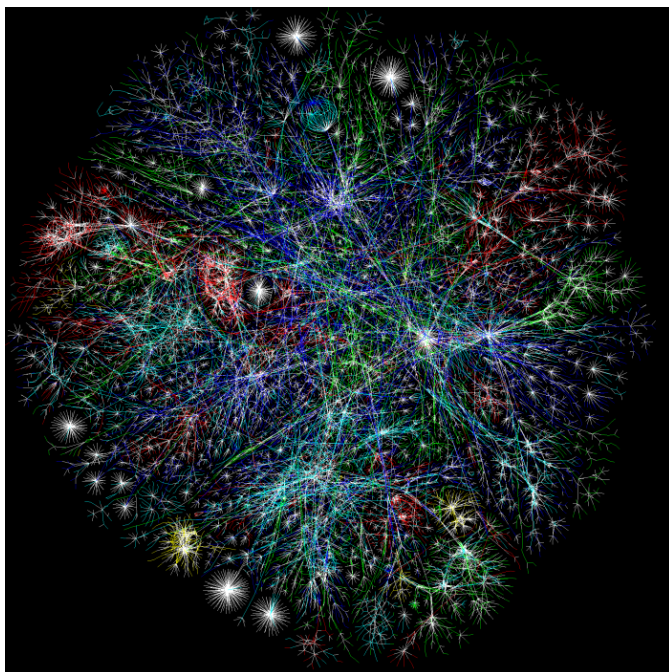
Intelligence is in the values of the parameters



Llama-2-70B: 70B parameters

Training them is more involved.

Think of it like compressing the internet.



parameters.zip

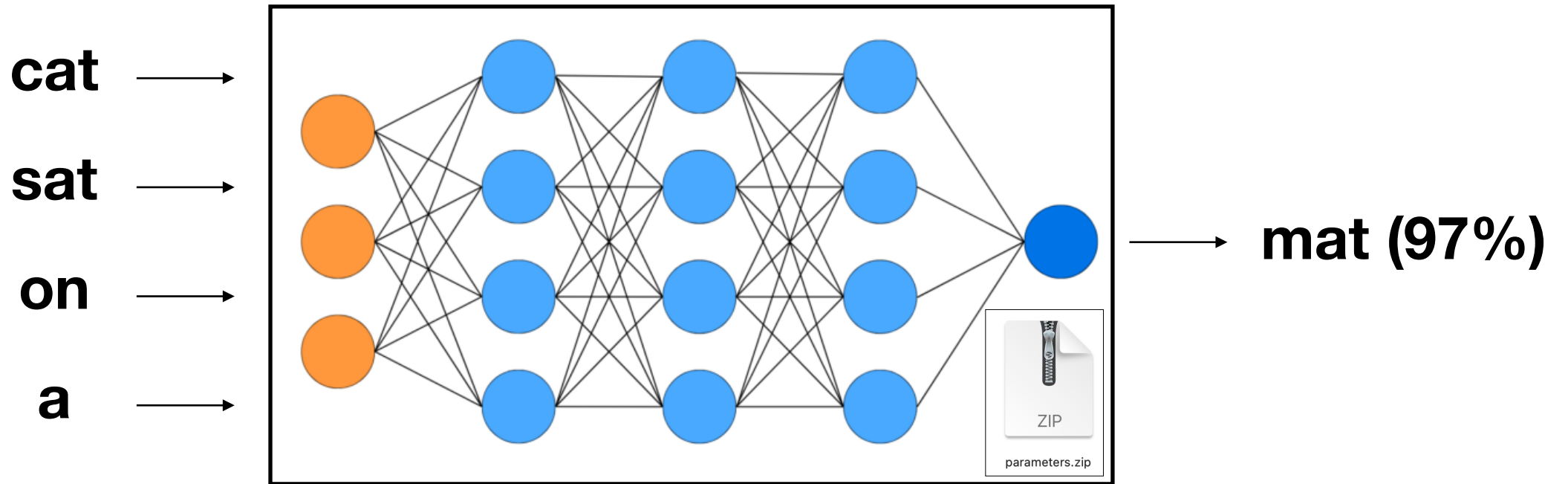
~140GB file

Chunk of the internet,
~10TB of text

6,000 GPUs for 12 days, ~\$2M
~1e24 FLOPS

Neural Network

Predicts the next word in the sequence.



e.g. context of 4 words

predict next word

Next word prediction forces the neural network to learn a lot about the world:

Ruth Marianna Handler (*née* **Mosko**; November 4, 1916 – April 27, 2002) was an American businesswoman and inventor. She is best known for inventing the Barbie doll in 1959,^[2] and being co-founder of toy manufacturer Mattel with her husband Elliot, as well as serving as the company's first president from 1945 to 1975.^[3]

The Handlers were forced to resign from Mattel in 1975 after the Securities and Exchange Commission investigated the company for falsifying financial documents.^{[3][4]}

Early life [edit]

Ruth Marianna Mosko^{[5][2][3]} was born on November 4, 1916, in Denver, Colorado, to Polish-Jewish immigrants Jacob Moskowitz, a blacksmith, and Ida Moskowicz, née Rubenstein.^[6]

She married her high school boyfriend, Elliot Handler, and moved to Los Angeles in 1938, where she found work at Paramount.^[7]

Ruth Handler



Handler in 1961

Born	Ruth Marianna Mosko November 4, 1916 <u>Denver, Colorado</u> , U.S.
Died	April 27, 2002 (aged 85) ^[1] <u>Los Angeles, California</u> , U.S.

The network “dreams” internet documents:

```
package lecture06;

import java.util.*;

public class Field {

    public static Map<String, Card> cardIndex = new HashMap<String, Card>();

    public void addCard(Card card){
        this.cardIndex.put(card.getRegistrationNumber(),card);
    }

    public Card getCard(String registrationNumber) {
        return this.cardIndex.get(registrationNumber);
    }

    public int getCardCount() {
        return this.cardIndex.size();
    }
}
```

Java code dream

Hades Heroes

Author: Maureen Fergus

Product Details:

ISBN: 9780545946767

Format: Hardback

Pages: 176

Dims (mm): 140 × 223

Pub Date: 01-05-16

Pub Country: United States

Condition: NEW

Description:

Work hard. Love. Make your own luck. These are the keys to success in life at school. But when a student named Hercules wanders in and challenges him

Amazon product dream (?)

Blacknose dace

The blacknose dace (*Rhinichthys atratulus*) is a small freshwater fish found in North America. They are typically found in streams, rivers, and lakes, and are widely distributed throughout the eastern and central United States and Canada.

These fish have a slender body with a black stripe running horizontally along their sides, giving them their distinctive "blacknose" appearance. They have a flattened head with a pointed snout and small, round eyes. Their color can vary from dark brown to olive green on their back and sides, with a silvery-white underside.

Blacknose dace are omnivorous and feed on a variety of small aquatic insects, crustaceans, and plant matter. They are an important food source for larger predators such as bass,

Wikipedia article dream

A trained LLM is a document completer

What is the capital of Belgium?

What is the capital of the Netherlands?

What is the capital of Germany?

What is the capital of France?

Tricking the LLM

Question: What is the capital of the Netherlands?

Answer: Amsterdam

Question: What is the capital of Germany?

Answer: Berlin

Question: What is the capital of Belgium?

Answer:

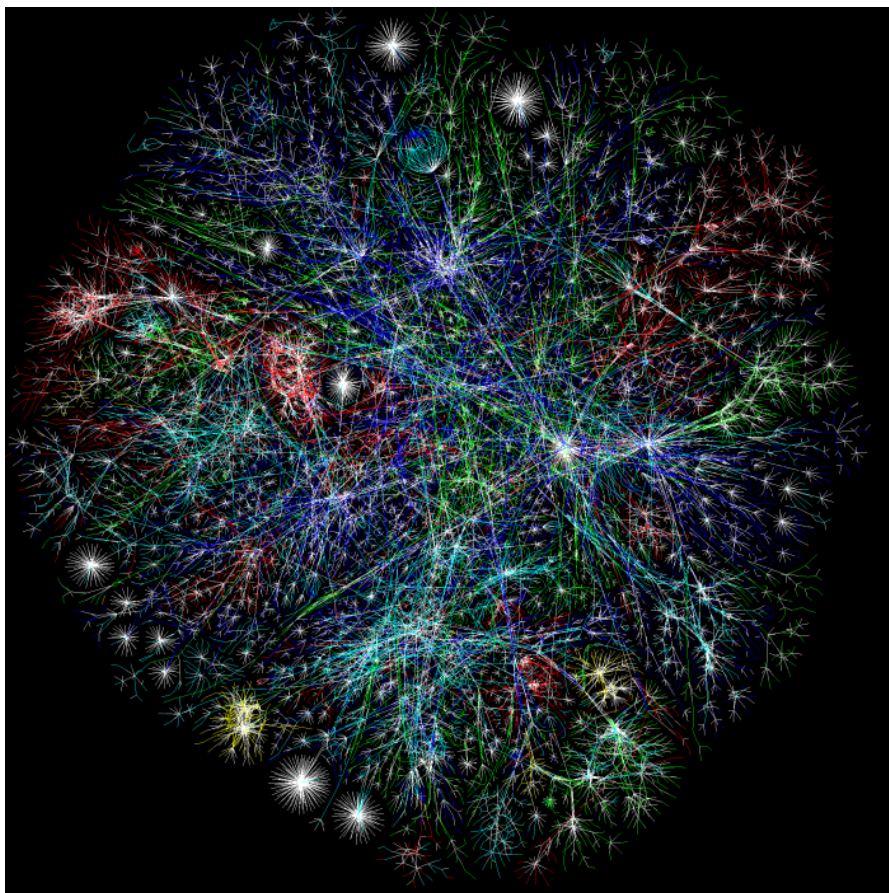
Brussels

Training the Assistant

(Just swap the dataset, then continue training)



written by
people:



<USER>

Can you write a short introduction about the relevance of the term "monopsony" in economics? Please use examples related to potential monopsonies in the labour market and cite relevant research.

<ASSISTANT>

"Monopsony" refers to a market structure where there is only one buyer for a particular good or service. In economics, this term is particularly relevant in the labor market, where a monopsony employer has significant power over the wages and working conditions of their employees. The presence of a monopsony can result in lower wages and reduced employment opportunities for workers, as the employer has little incentive to increase wages or provide better working conditions...

~100K conversations

After finetuning you have an Assistant:

<USER>

Can you help me with this code? It seems like there is a bug.
`print("hello world)`

<ASSISTANT>

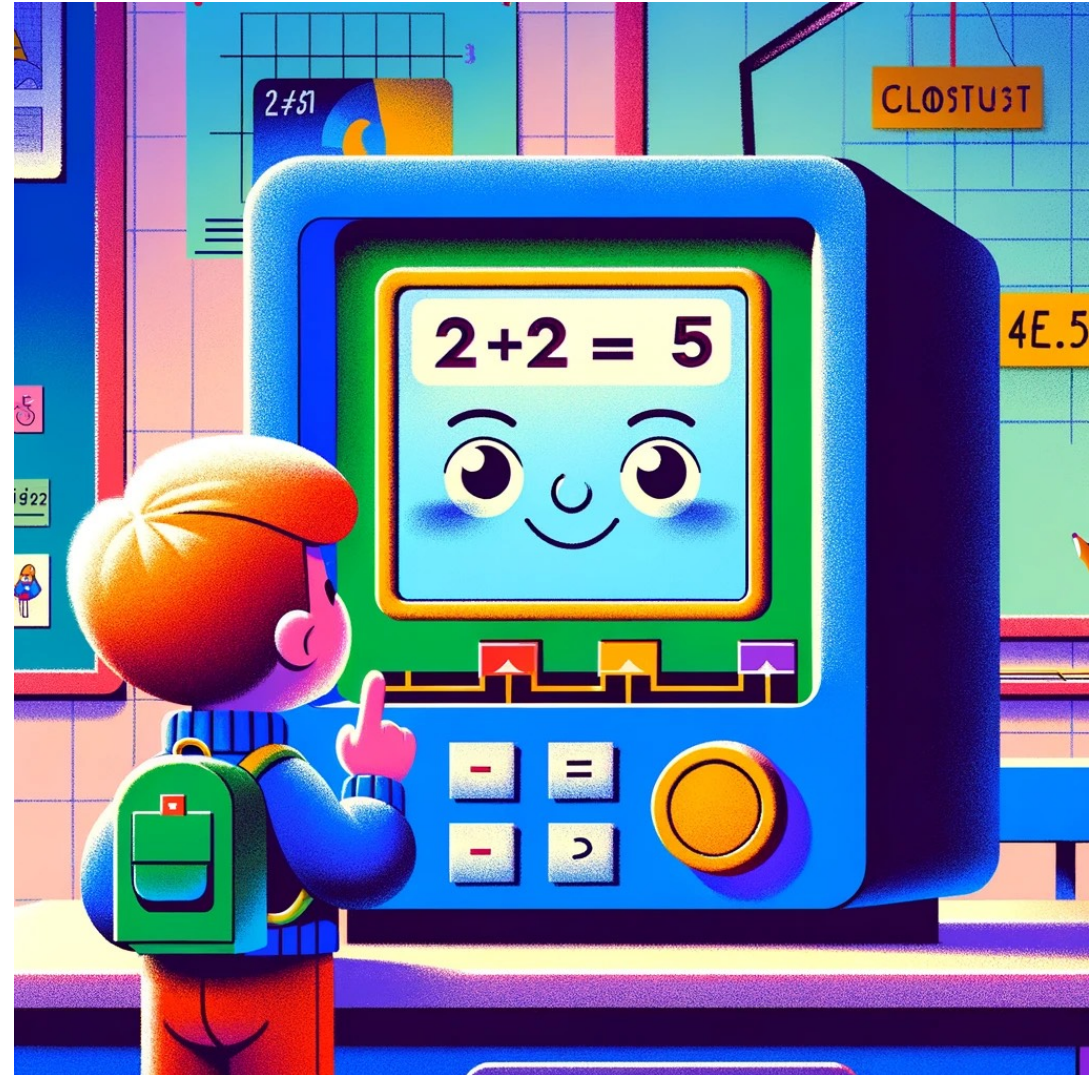
It looks like you forgot to close the string passed to the function `print`. You have to add a closing quote to properly terminate the string. Here is the corrected function:

```
print("hello world")
```

Let me know if I can help with anything else!

LLMs can be confidently wrong

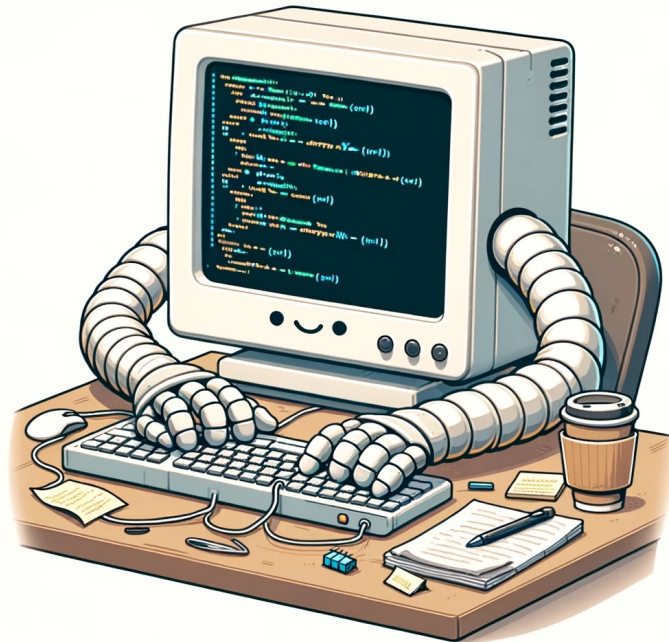
- LLMs ‘dream’: answer should always be verified
- LLMs should definitely not be trusted
 - when the answer can not be directly derived from the instruction, i.e, relies on “memory” of LLM
- LLMs can be trusted a little more
 - when the answer is already present in the instruction, and just needs to be “compiled”



Do not trust

You

Generate code for the game mastermind



Trust a bit more

You

I will provide you with the rules of a game called Mastermind together with an example run of two persons playing that game. Using this information, write a Python program the implements the game Mastermind.

<RULES>

...

<EXAMPLE RUN>

...

Do not trust

You

Write a short text arguing why it is no longer important for kids to learn to code.



Trust a bit more

You

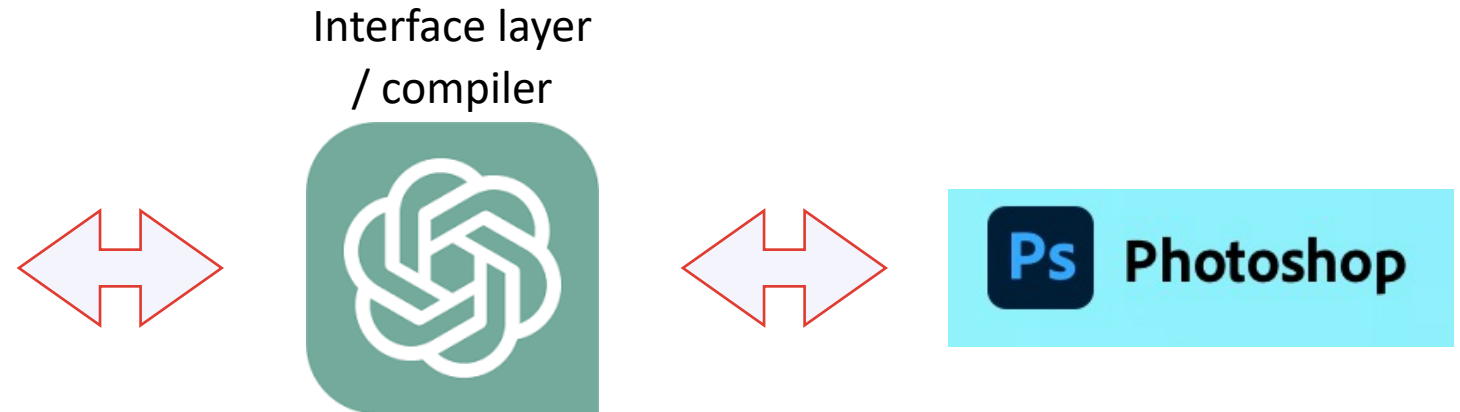
I will provide you with 5 arguments why it is no longer important for kids to learn to program. Write a coherent text based on these arguments. Here are the arguments ...

Prompt engineering?

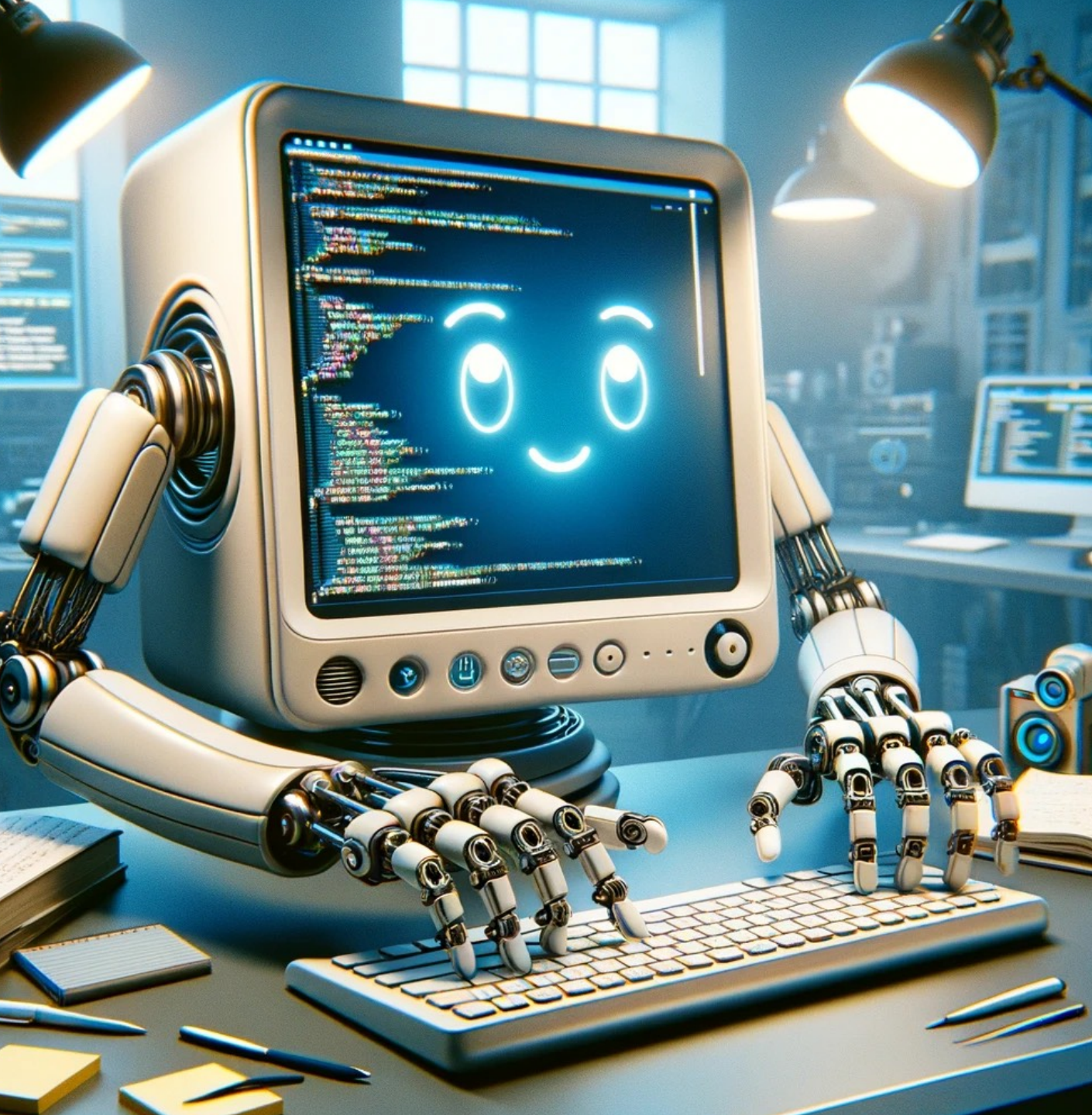
- Relevant on a macro level:
 - Does the prompt contain all relevant information
- On micro level, will become less and less relevant in the future:
 - Make sure to say: “Let’s think about this step by step.”
 - Generate “correct” code.



AI can democratize access to technology

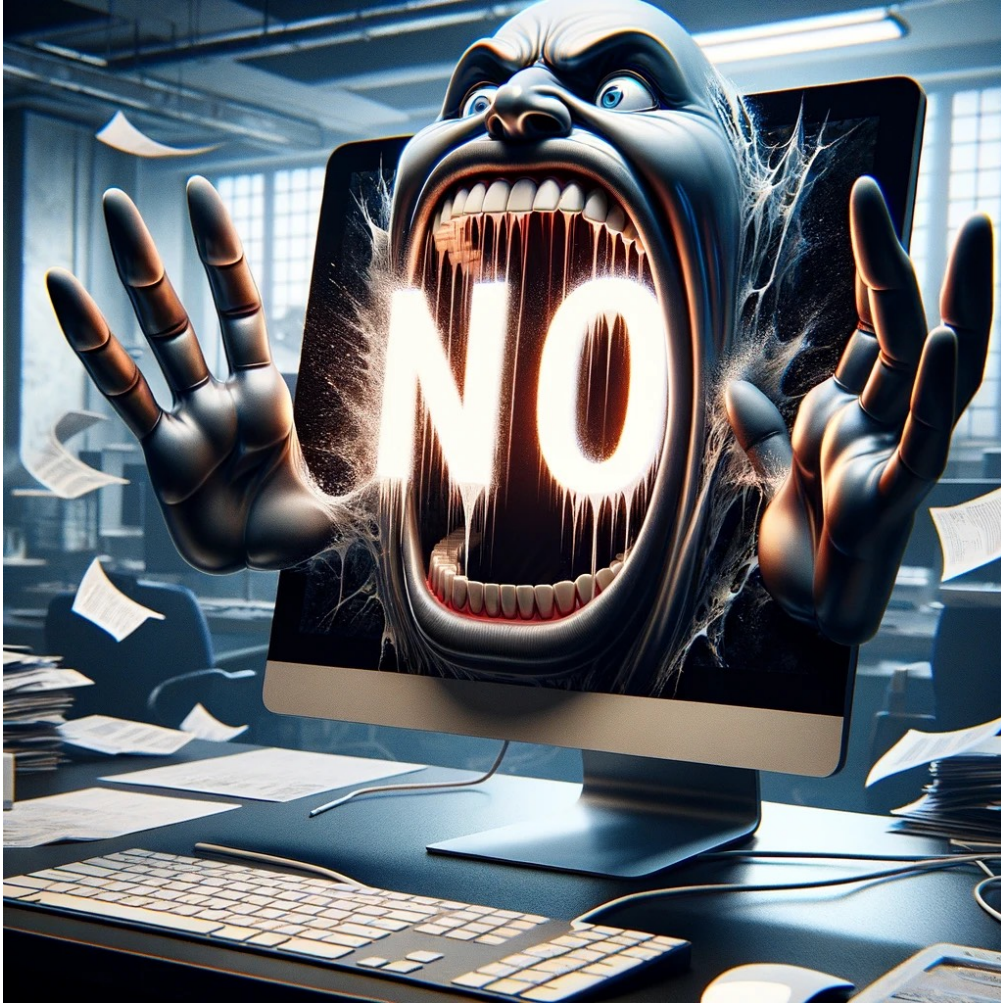


... but raises the bar for professionals



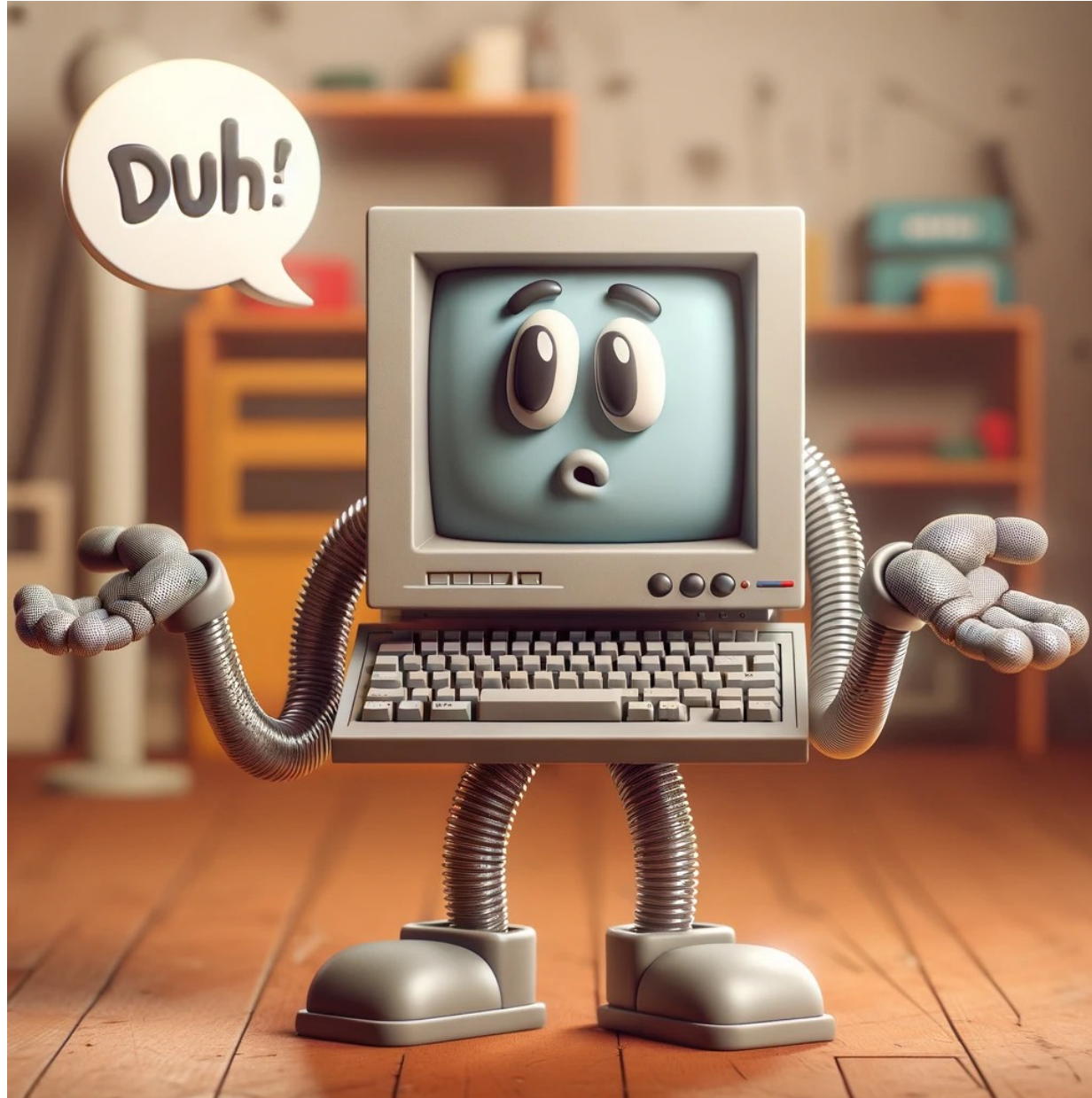
- ✓ Can computers code?
- ✓ Is there still a need for human programmers in the era of advanced AI?
- ✓ Is learning coding basics still relevant today?

Can computers code?



- LLMs can generate code similar to code abundantly available in the training set
 - Boilerplating on steroids
 - Interactive Stack Overflow
- LLMs can transform an accurate description into actual code
- LLMs can code most exercises in an introductory programming course

Is there still a need for human programmers?



- Programmers are not magical elves who have learned a secret ritual that nobody else can understand
- Programmers are so dedicated that they are willing to learn and use every tool no matter how complex
- Today's tools are different from yesterday and will be different from tomorrow's
- High-end programming will not get democratised, it is just a bar that keeps on being raised

Someone on the internet...



Coders have superpowers!

Kris Peeters, CEO Data Minded

An LLM is not kryptonite, it is just an above average magical hammer



Is learning coding basics still relevant today?

- Why include basic principles of programming in the school curriculum?
 - Some students will need programming skills in higher education
 - Digital technology impacts society
 - Basics of programming provides insight into how digital technology works, their possibilities and dangers
 - Is relevant, even when not pursuing a career that requires programming



Is learning coding basics still relevant today?

Basic coding skills are
the gloves to wield the
magical hammer



When you can read and adapt code, an LLM becomes a coding partner

We might need to rethink how we teach coding

- Incorporate AI-tools to enhance learning effectiveness:
 - provide an initial solution
 - interpret error messages
 - act as an intelligent rubber duck
 - improve code quality
 - generate tests
 - generate comments/documentation
 - explain code
 - explain concepts
 - improve code correctness (still hard for LLMs)



Conclusions

- LLMs
 - do not make programmers obsolete
 - empower coders
- Basic coding skills became even more important
 - CoderDojo rocks
- Might need to rethink how we teach programming



Can Computers Code?

Prof. dr. Frank Neven
frank.neven@uhasselt.be
(No social media, sorry)

Coderdojo Con 2024
Namur



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