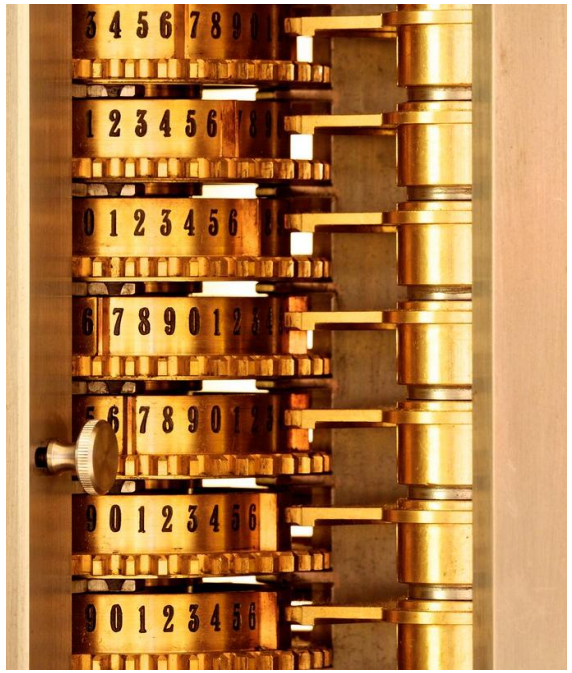
Computers, brains and AI

7: ChatGPT





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

1) Intro

2) Foundations
3) Silicon

4) Deep learning
5) Deep learning

6) ChatGPT
7) ChatGPT (peek inside)
8) ChatGPT

9) The future of AI
10) The future of AI



How they work

or part of a word

One word at a time...



apples and pears ✓✓

apples and pairs ✓

apples and { pears ✓✓ / pairs ✓



Why is the sky blue?

• • •

How would you explain this to a five year old?



The sky looks blue because • • •



The sky looks blue because



Why is the sky blue?

• • •

How would you explain this to a five year old?

The sky looks blue because • • •

The sky

looks	60%	78%
appears	20%	15%
is	10%	5%
⋮	2%	0.5%
	1%	0.2%



• • •

The capital of France is { Paris 99.99% ⋮

Why is the sky blue?

• • •

How would you explain this to a five year old?

The sky looks blue because • • •

The sky { looks 60% ⟵ 78%
appears 20% 15%
is 10% 5%
⋮ 2% 0.5%
1% 0.2%
• • •



Dice by Brett Jordan / Unsplash

or part of a word

One word at a time...



No backtracking

(until September 2024)

https://en.wikipedia.org/wiki/OpenAI_o1

https://en.wikipedia.org/wiki/Reflection_(artificial_intelligence)

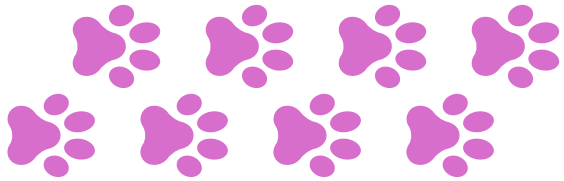
https://en.wikipedia.org/wiki/DeepSeek_(chatbot)



Once upon a time

or part of a word

One word at a time...



?



50% cat
bus
tractor
20% dog

The sky

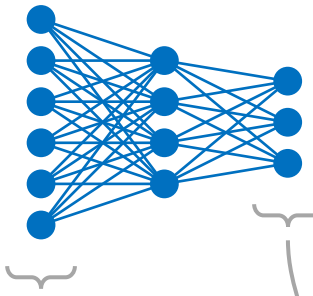
looks	60%	78%
appears	20%	15%
is	10%	5%
⋮	2%	0.5%
	1%	0.2%
	⋯	



Dice by Brett Jordan / Unsplash

One letter at a time...

One word at a time...



0 (dog)

1 (cat)

2 (bus)

A the

B is

C to

Z

three categories

Next bit of text

text

pixel values

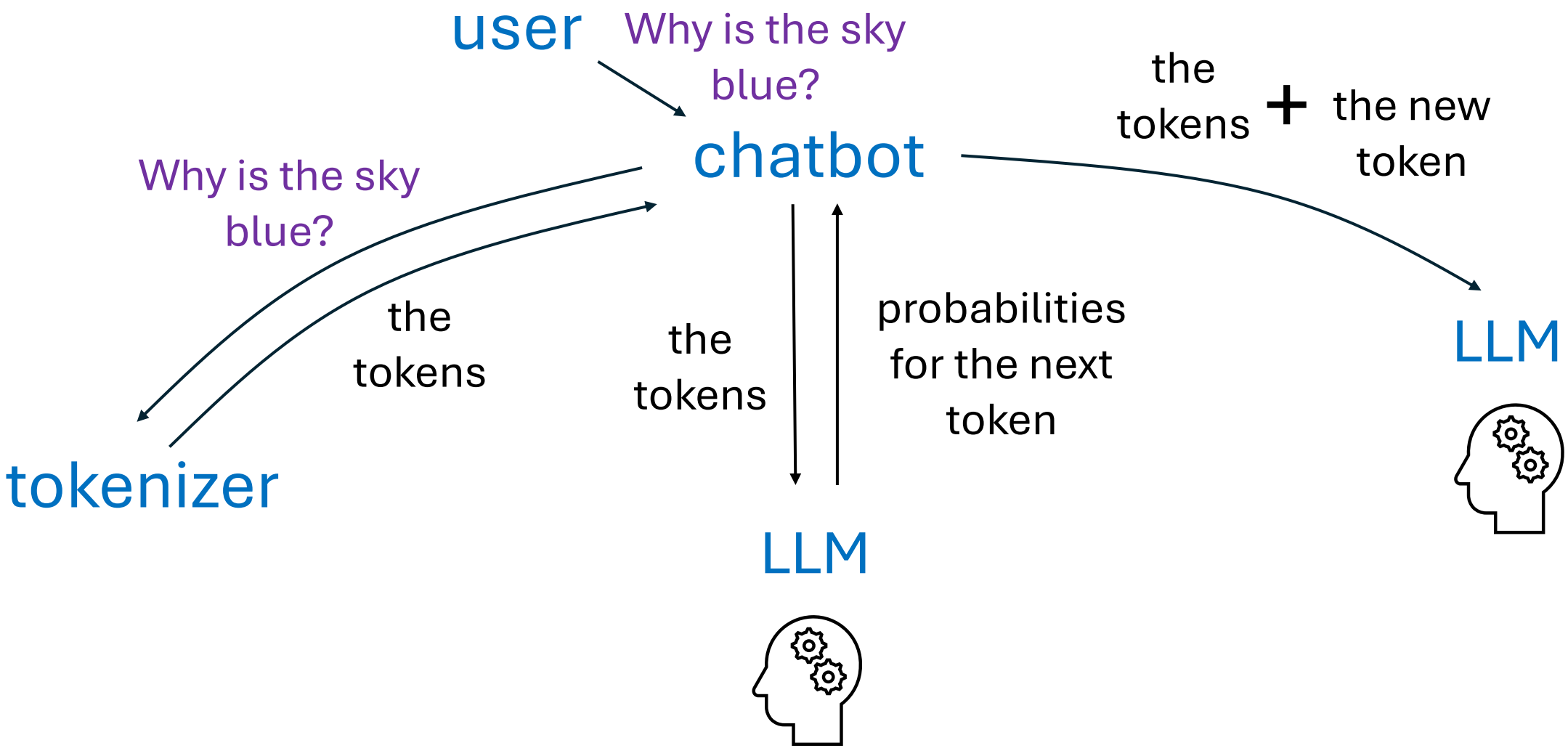
three “grandmother” cells

??? Unknown

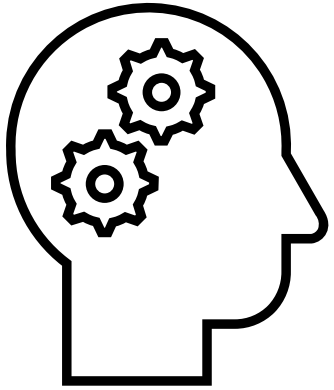
https://platform.openai.com/tokenizer

https://observablehq.com/@simonw/gpt-tokenizer

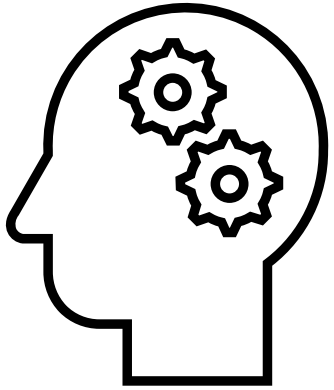
https://en.wiktionary.org/wiki/token#:~:text=The%20basic%20unit%20of%20data

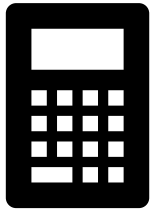

user
Why is the sky blue?
chatbot
Why is the sky blue?
the tokens
tokenizer
the tokens
probabilities for the next token
LLM
the tokens + the new token
LLM

chatbot



LLM





Give me the next token

OK

Give me the next token

OK

strawberry

strawberry

strawberry

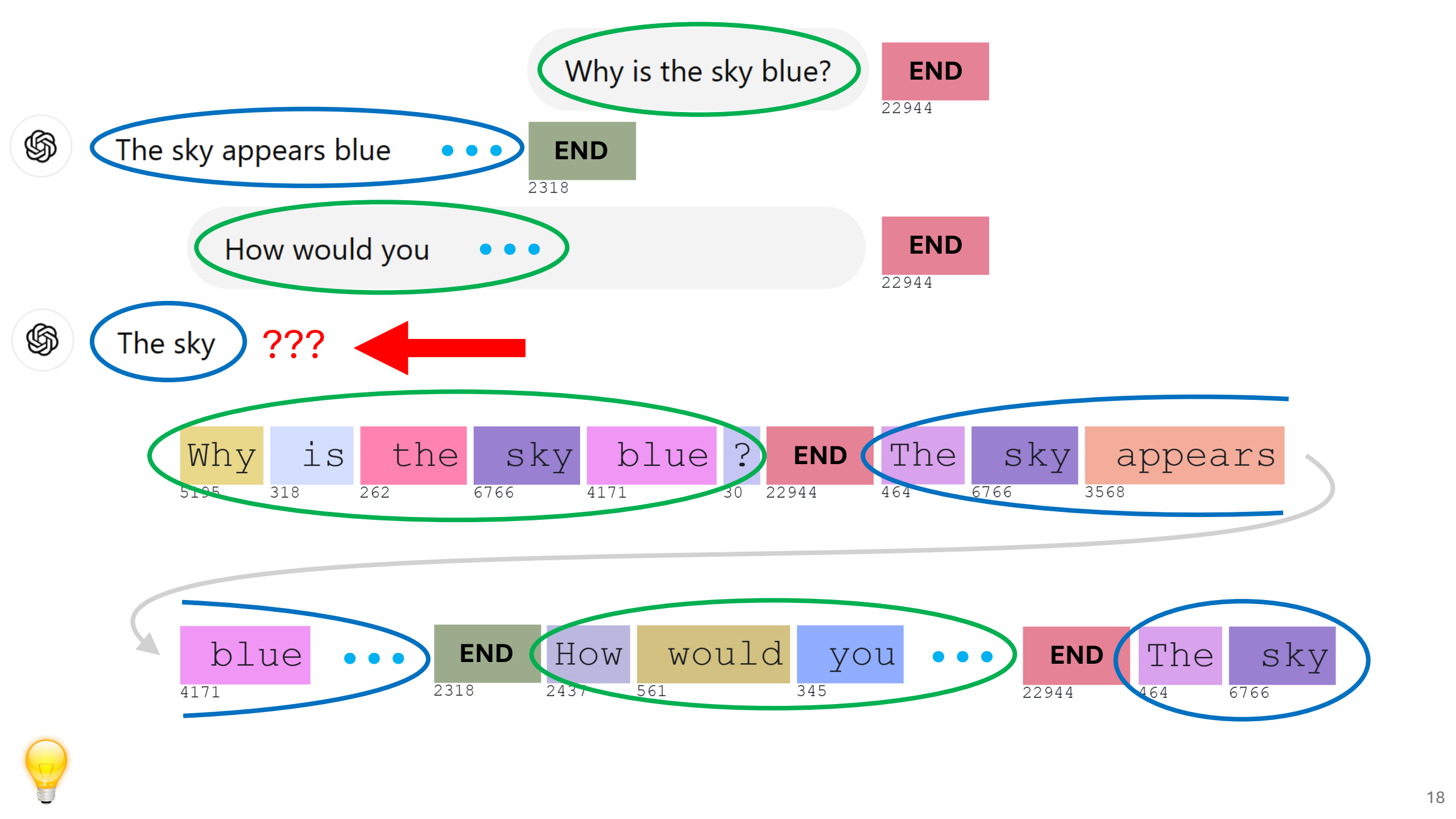
41236

elephant

ele phant

11129 33959




Why is the sky blue?
END
22944
The sky appears blue
END
2318
How would you
END
22944
The sky
???
Why
is
the
sky
blue
?
END
The
sky
appears
5195
318
262
6766
4171
30
22944
464
6766
3568
blue
END
How
would
you
END
The
sky
4171
2318
2437
561
345
22944
464
6766



Why
5195

is
318

the
262

next token

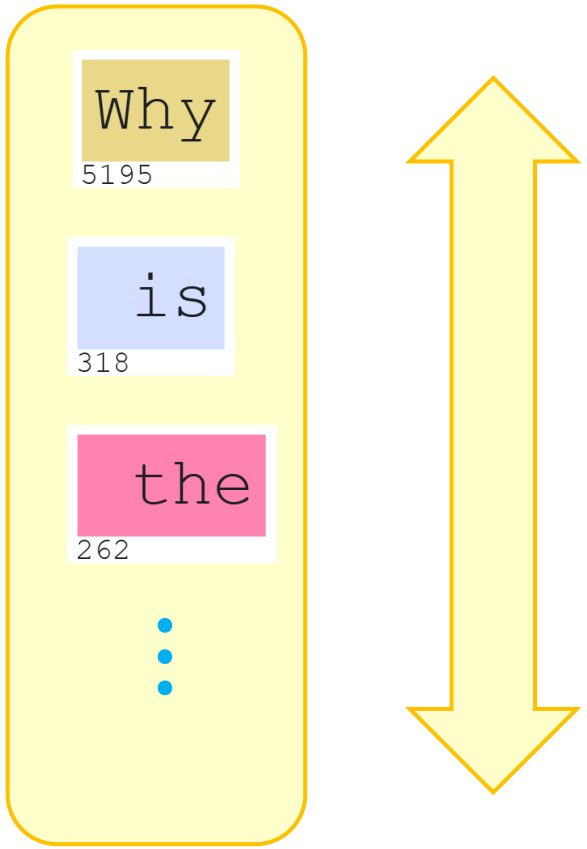
cat
bus
tractor
dog

1000 categories

200,000 different tokens

60 million parameters

175 billion



Context window

GPT-3	2048
GPT-4	8192
	32,768
Gemini-1.5	1 million

From last time...

Why is the sky blue?

• • •

How would you explain this to a five year old?

The sky

looks	60%
appears	20%
is	10%
⋮	2%
	1%



• • •

The sky

looks	60%
appears	20%
is	10%
⋮	2%
	1%



probabilities

LLM

The sky s k y

17307

1.2, 0.26, -0.3, 4.1, ...

More than 12,000 of them!

LLM

chat bot

The sky

looks	60%
appears	20%
is	10%
⋮	
	2%
	1%



Word embedding

dog

fox

bank

river bank

central bank

the

bus

set

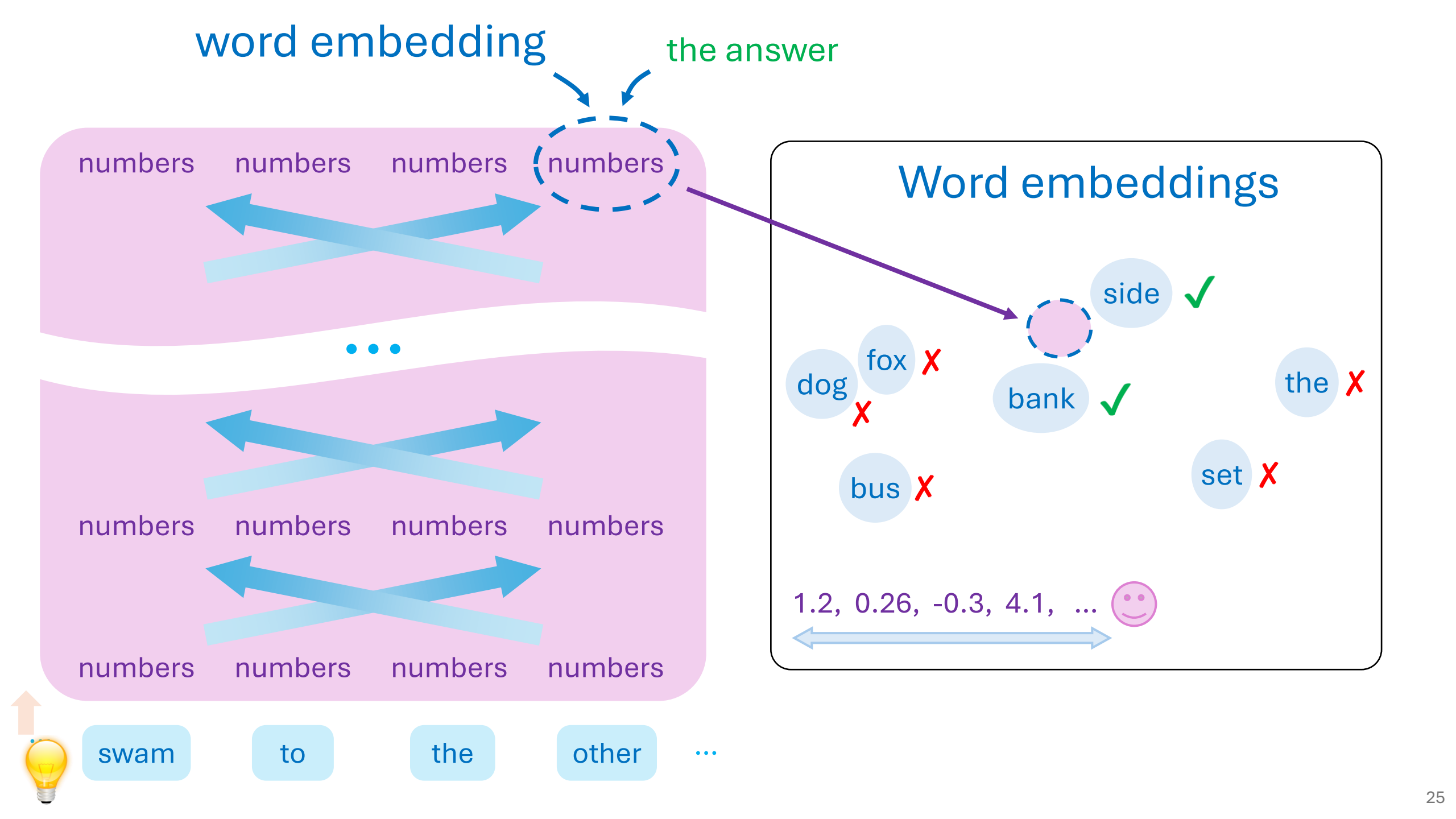
https://www.oed.com/

1.2, 0.26, -0.3, 4.1, ...

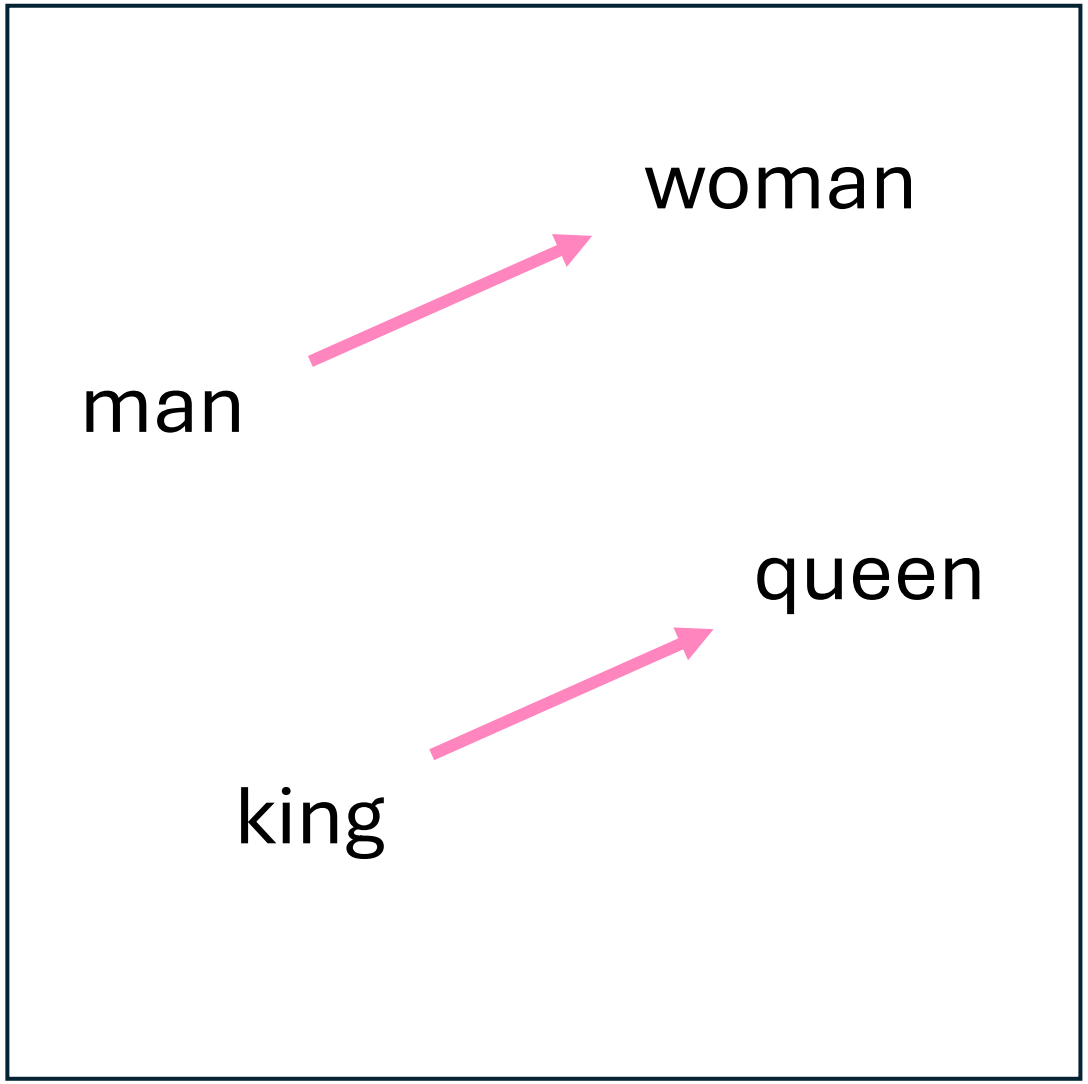


More than 12,000 of them!




word embedding
the answer
numbers numbers numbers numbers
numbers numbers numbers numbers
numbers numbers numbers numbers
swam
to
the
other
...
Word embeddings
side
fox
dog
bank
the
bus
set
1.2, 0.26, -0.3, 4.1, ...

Visualizing word embeddings



Translate the following sentence into French. The animal didn't cross the road because it was too wide.

L’animal n’a pas traversé la route parce qu’elle était trop large.

Translate the following sentence into French. The animal didn't cross the road because it was too tired.

L’animal n’a pas traversé la route parce qu’il était trop fatigué.



Arithmetic

???

What is 123 plus 456 ? ✓

What is 314159 plus 271828 ?

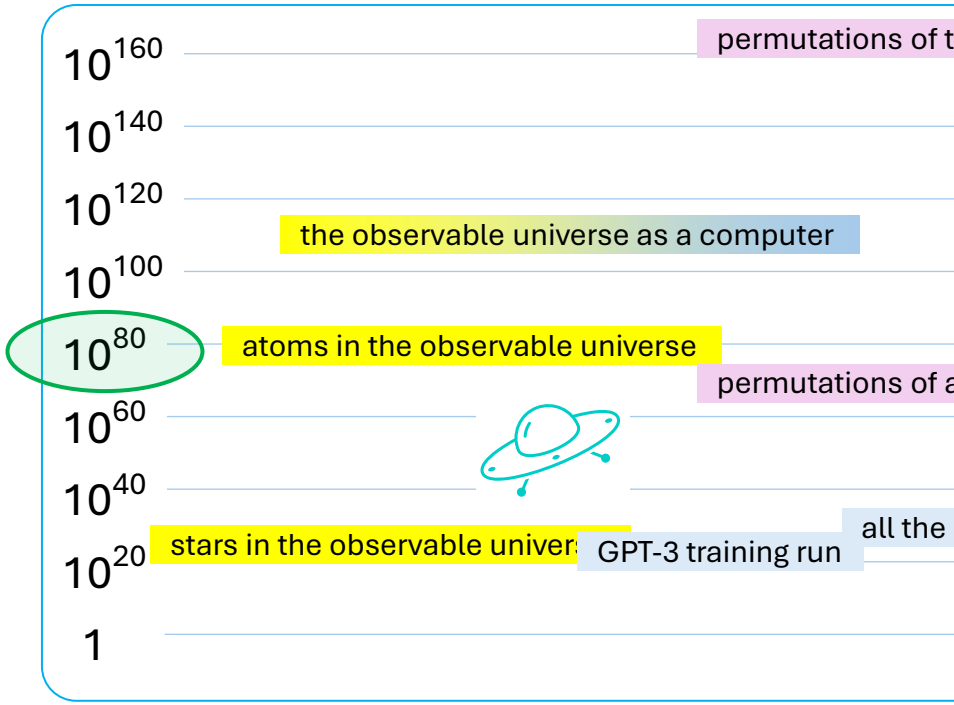
GPT-3.5 ✗ guess confidently 

GPT-4 ✓

What is 3141592653589793238462643383279502884197
plus 271828182845904523536028747135266249775 7 ?

GPT-4 ✓

later versions ✓ Use external tools





What is 59833 times 61897?

The result of 59833×61897 is **3,703,483,201**

python

Analysis

python

```
# Recalculating after executior
result = 59833 * 61897
result
```

Always show details

Copy

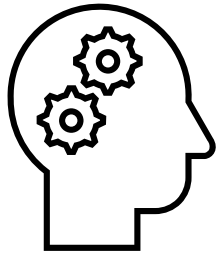
Result

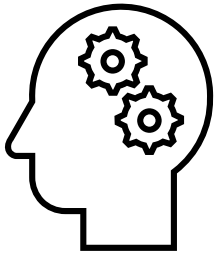
```
3703483201
```

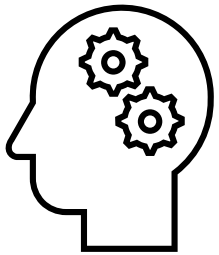
https://pythonhow.com/python-shell

ChatGPT

Large language model

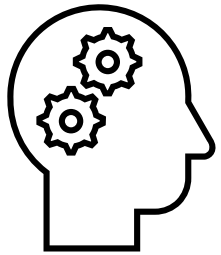


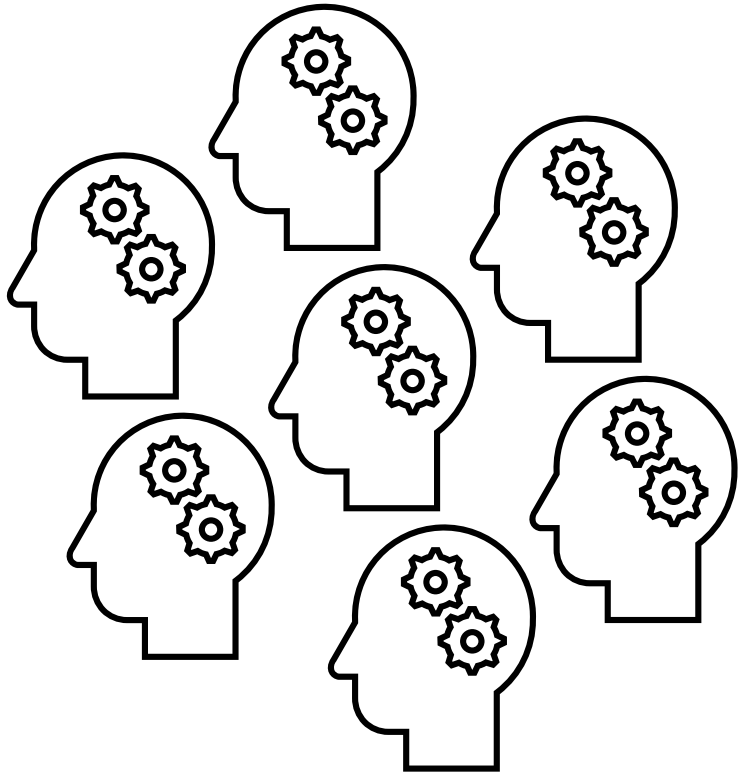




Python

Mixture of experts





Wrong

How many dots are below?

.....
.....

There are **161** dots in your message.

Tell it to use Python

Use code.

Analyzed

python

```
# Count the number of dots in the given string
dots_string = "..........................................................................."
dot_count = dots_string.count(".")

# Output the result
dot_count
```

Always show details | Copy

Result

177

Correct

The total number of dots in your message is **177**.

Copy and pasting is easier than counting

System 1 fast, instinctive, emotional

System 2 slow, deliberative, logical

One word at a time…

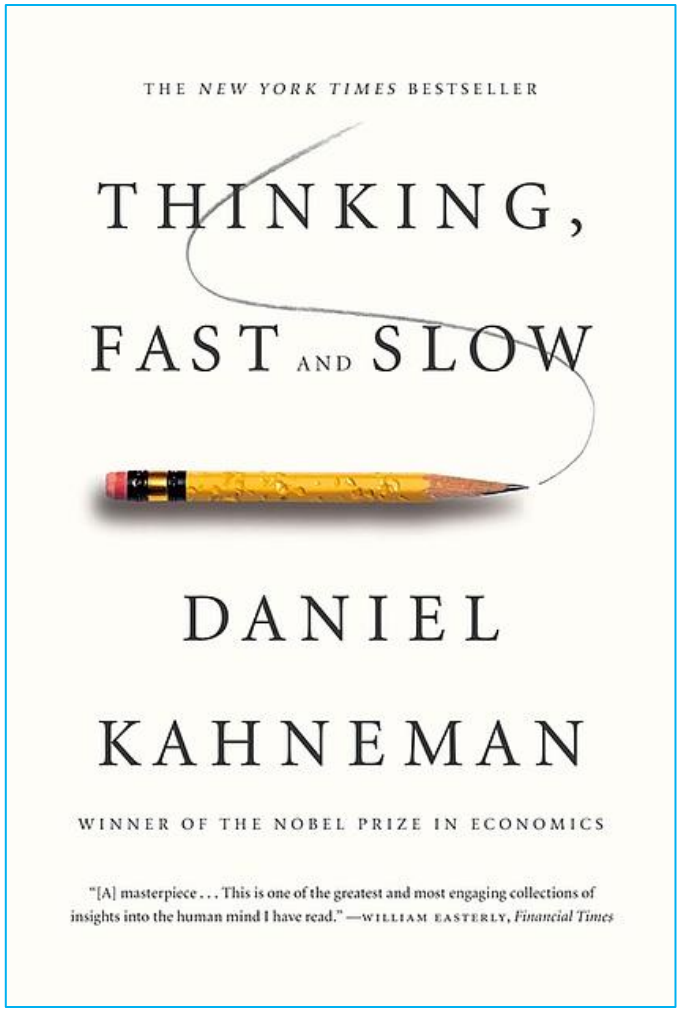


No backtracking

System 1

If we hear an unexpected word, parts of our brain reacts a fifth of a second.

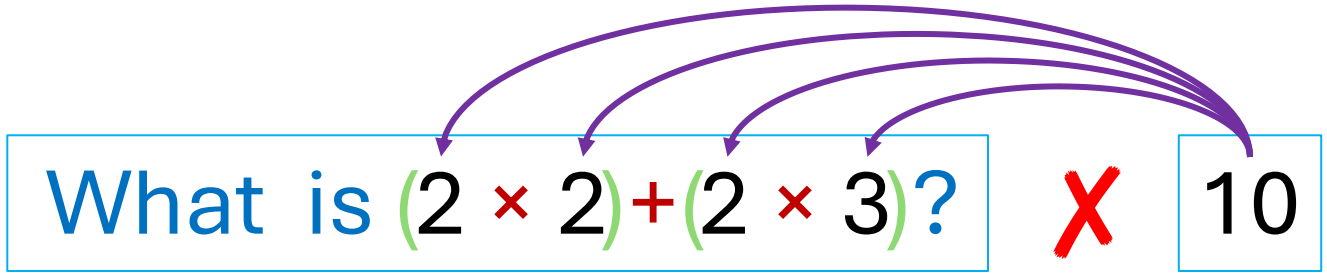
So, the brain is continuously running an LLM!



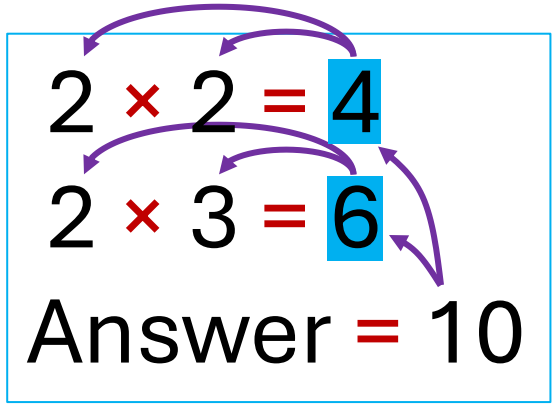


https://research.google/blog/deciphering-language-processing-in-the-human-brain-through-llm-representations/

Arithmetic



What is 2 × 2 + 2 × 3 ? Show your working. ✓



Prompt engineering

=

Creating good prompts

“Think carefully before you answer”

“Let’s think step by step”

Wishful prompting: I must insist, do not hallucinate. My career depends on it, please, please, please.

