

Introduction to the concept of artificial intelligence

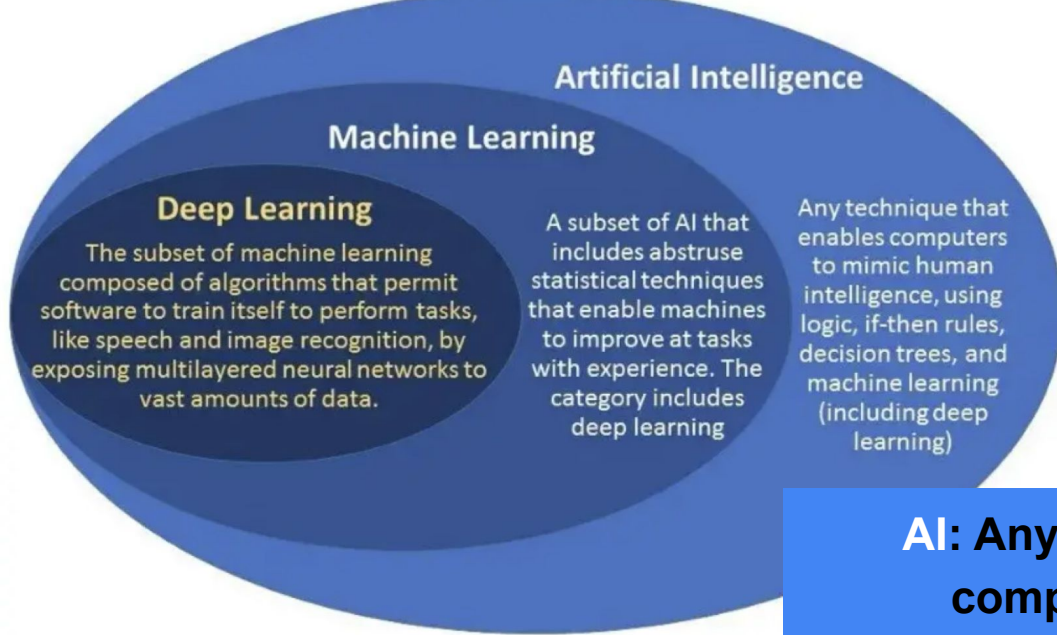
Types

Basic concepts

Features, tools

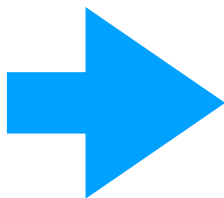
Zsolt Lengyel





AI: Any technology that enables computers to mimic human intelligence...

With what



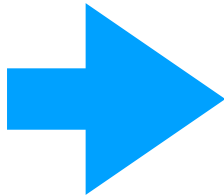
Data



Modells



How

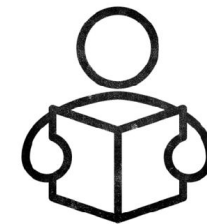


Learning Paradigms



Machine Learning

Learning Paradigms



1. Supervised

2. Unsupervised

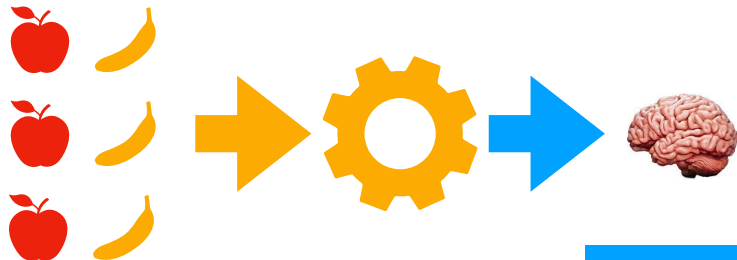
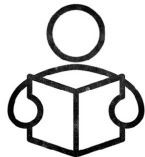
3. Reinforcement

4. *Transfer Learning*

...

1. Supervised Learning
2. Unsupervised Learning
3. Semi-Supervised Learning
4. Reinforcement Learning (RL)
5. Self-Supervised Learning
6. Multi-Task Learning
7. Few-Shot, One-Shot, and Zero-Shot Learning
8. Online Learning
9. Active Learning
10. Federated Learning
11. Transfer Learning
12. Evolutionary Learning (Neuroevolution)
13. Contrastive Learning
14. Adversarial Learning
15. Meta-Learning ("Learning to Learn")
16. Curriculum Learning

1. Supervised



Input:
Labeled Data

Model

Input



Expected output



Cat



Dog



Dog



Cat

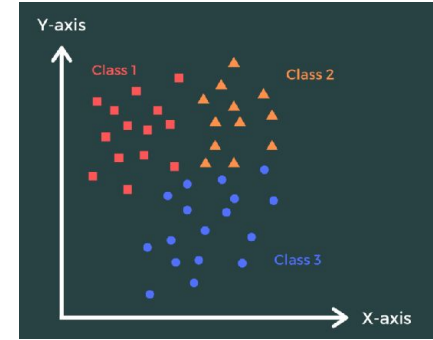
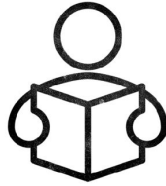


Voice recognition: 2014 (Amazon Echo)
Handwriting recognition: 2000 (digital tablets)
Facial recognition: 2017 (Apple Face ID)



Google Translate: 2006

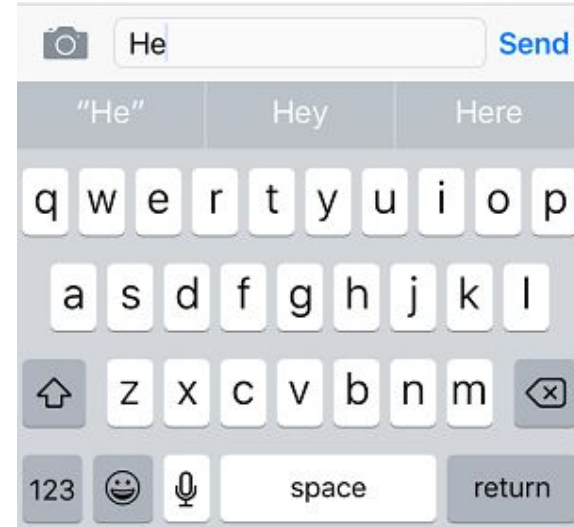
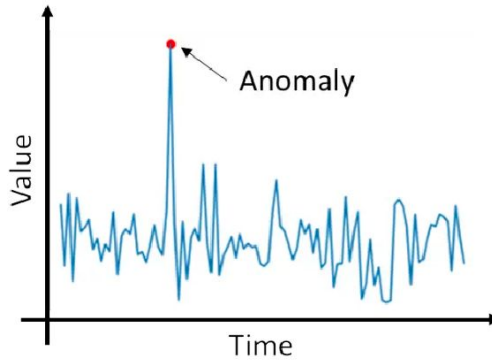
2. Unsupervised



Input

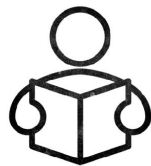


Expected Output



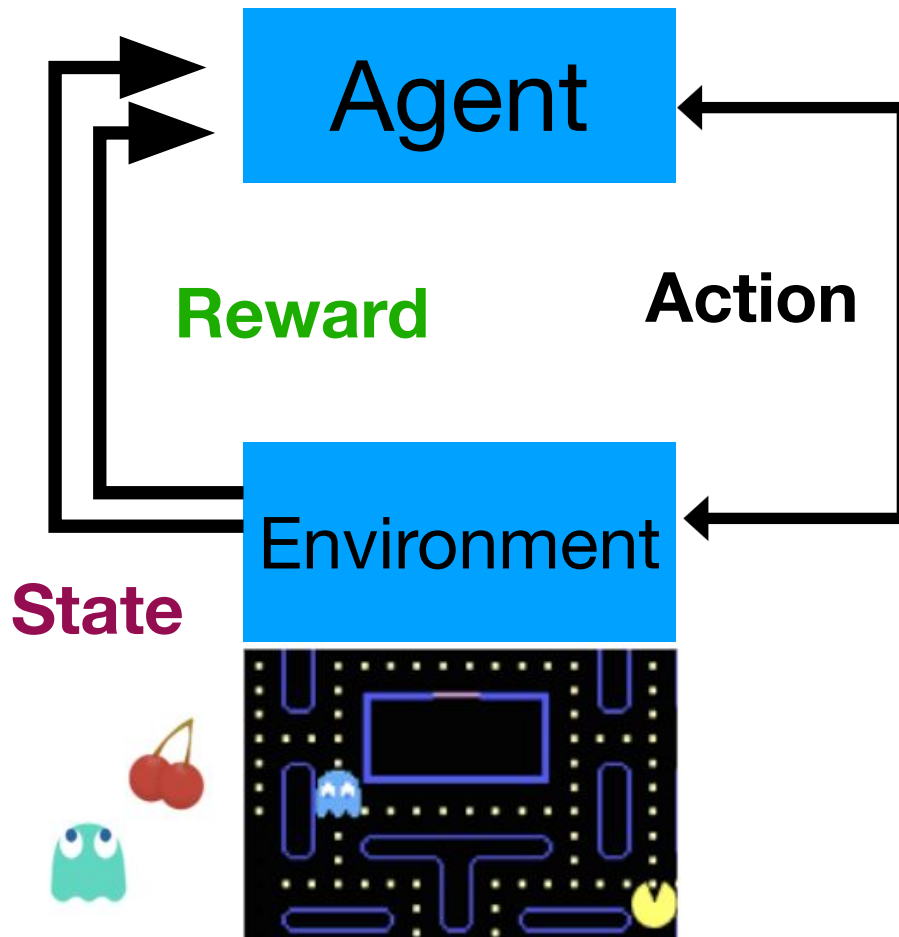
~2000

3.Reinforcement



<https://www.youtube.com/watch?v=WXuK6gekU1Y>

~2014
AlphaGo



Machine Learning



Modells

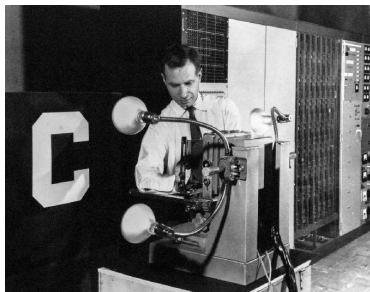
- Linear Regression
- Logistic Regression
- Decision Trees
- Random Forests
- Gradient Boosting Machines (GBMs)
- Support Vector Machines (SVMs)
- k-Nearest Neighbors (k-NN)
- **Neural Networks**
- Deep Learning (e.g., Convolutional Neural Networks, Recurrent Neural Networks, Transformers)
- Naive Bayes Classifiers
- k-Means Clustering
- Hierarchical Clustering
- Principal Component Analysis (PCA)
- Gaussian Mixture Models (GMMs)
- Hidden Markov Models (HMMs)
- DBSCAN
- t-Distributed Stochastic Neighbor Embedding (t-SNE)
- Autoencoders
- Reinforcement Learning (e.g., Q-learning, DQNs, PPO)
- Bayesian Networks
- Gaussian Processes
- ...

Perceptron Model

Artificial neural network



https://www.youtube.com/watch?v=cNxadbrN_al

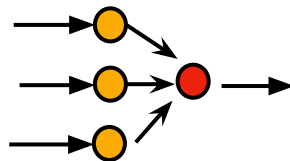


1958 - Frank Rosenblatt

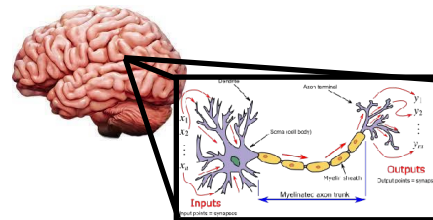


20 x 20 photo sensor

~400 "neuron"



Feed forward network



Neuron

80-100 billion neuron

The video is an in-depth podcast interview with **Professor Geoffrey Hinton**, often called the “**godfather of AI**,” discussing the history, workings, and future of artificial intelligence, particularly neural networks and deep learning.

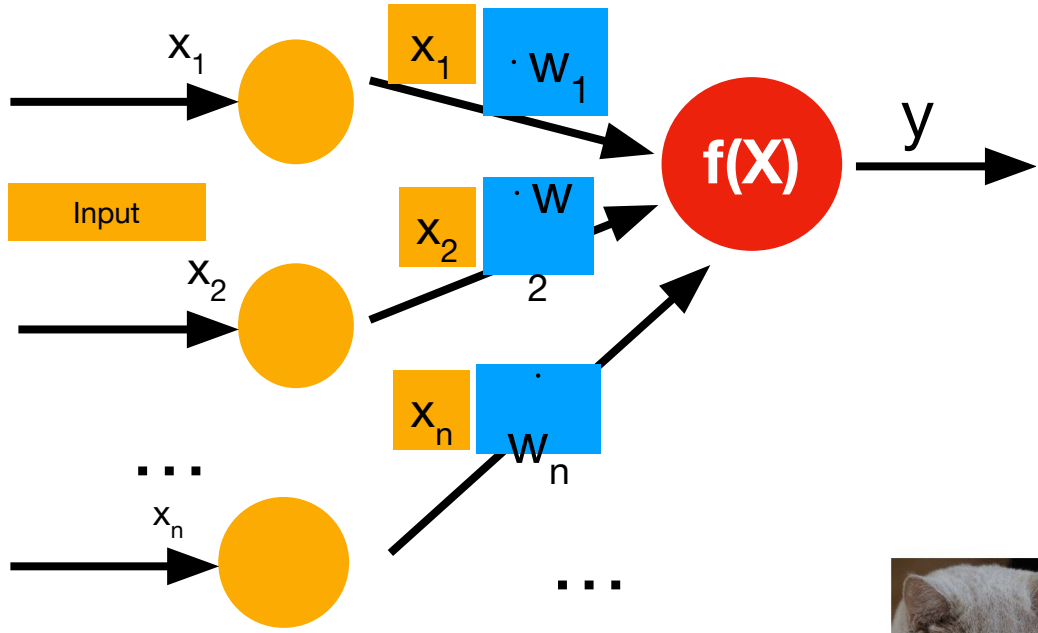


<https://www.youtube.com/watch?v=jrK3PsD3APk>

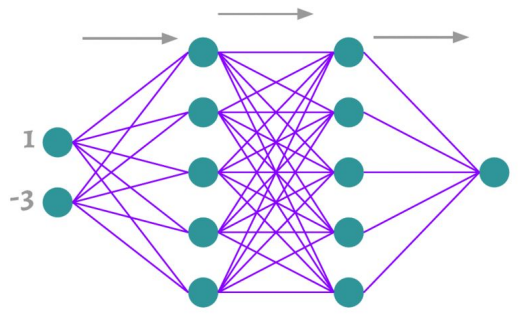
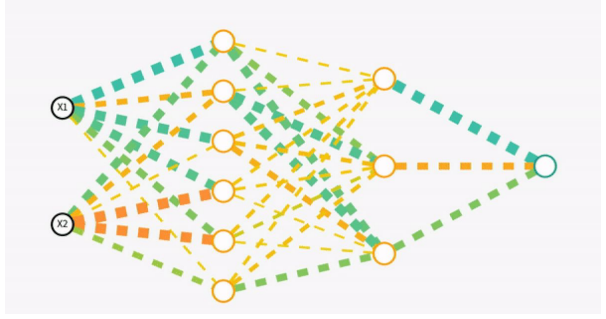
Neural Network



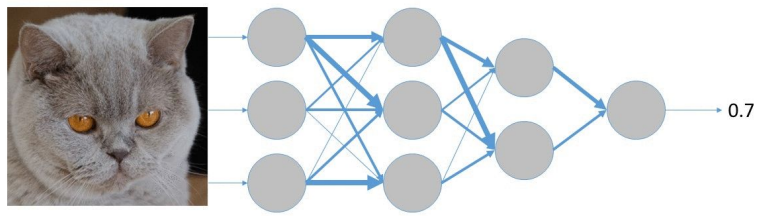
Perceptron

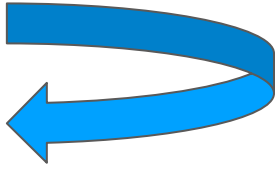


1-25 billion params



Is it a cat?



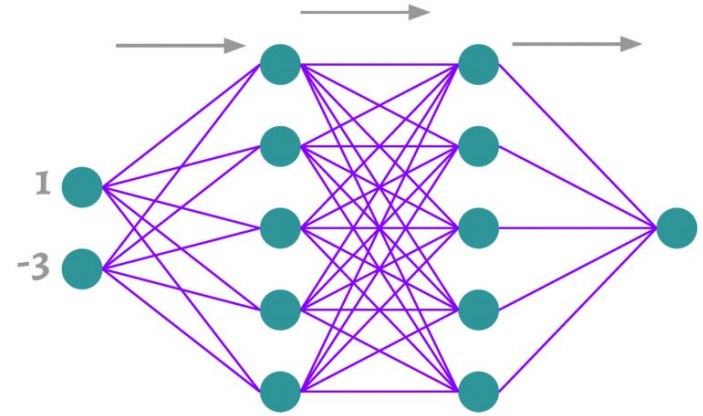


Back Propagation: Learning

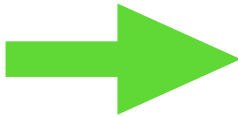
Supervised Learning



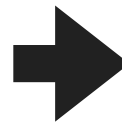
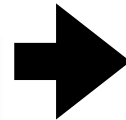
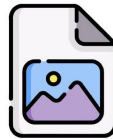
Step 1. : Try



Step 2. Checking the results and
modifying the parameters to
improve the results



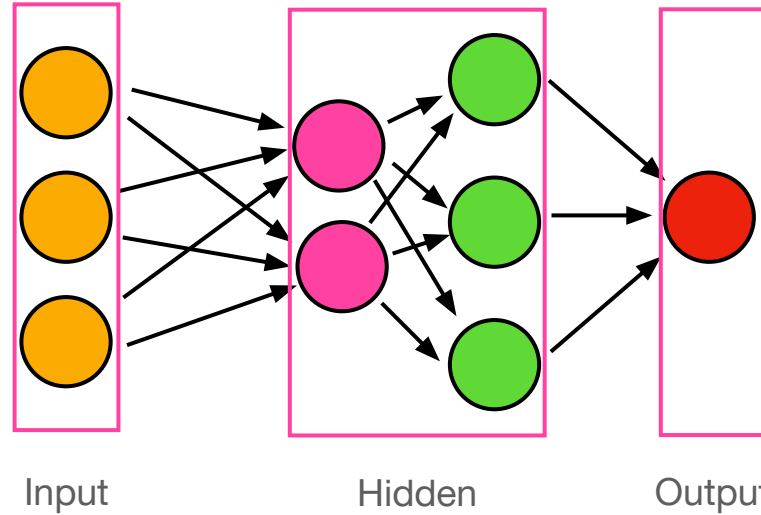
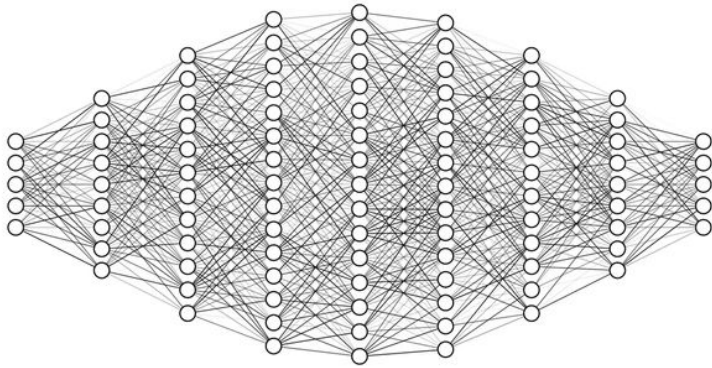
Feed Forward: Prediction
(usage)



Neural network

Multi-layer neural network

Number of hidden layers ≥ 2  Deep Neural Network



On average, 6-800 billion parameters

$$(\cdot w_n)$$

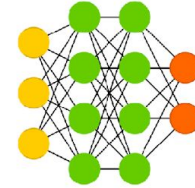
A mostly complete chart of

Neural Networks

©2016 Fjodor van Veen - asimovinstitute.org

- Backfed Input Cell
- Input Cell
- △ Noisy Input Cell
- Hidden Cell
- Probabilistic Hidden Cell
- △ Spiking Hidden Cell
- Output Cell
- Match Input Output Cell
- Recurrent Cell
- Memory Cell
- △ Different Memory Cell
- Kernel
- Convolution or Pool

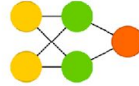
Deep Feed Forward (DFF)



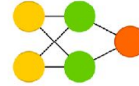
Perceptron (P)



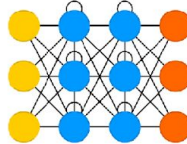
Feed Forward (FF)



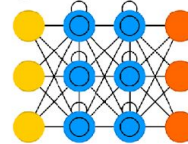
Radial Basis Network (RBF)



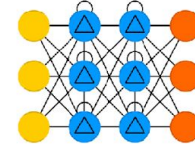
Recurrent Neural Network (RNN)



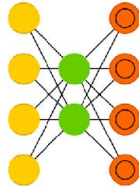
Long / Short Term Memory (LSTM)



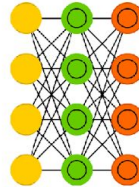
Gated Recurrent Unit (GRU)



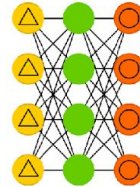
Auto Encoder (AE)



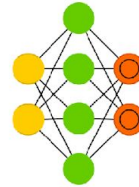
Variational AE (VAE)



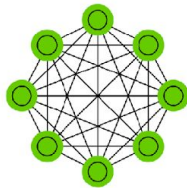
Denoising AE (DAE)



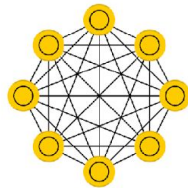
Sparse AE (SAE)



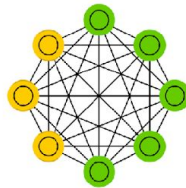
Markov Chain (MC)



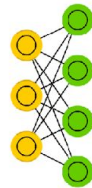
Hopfield Network (HN)



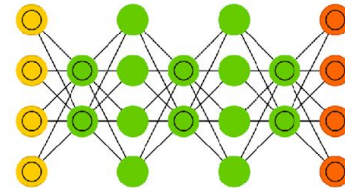
Boltzmann Machine (BM)



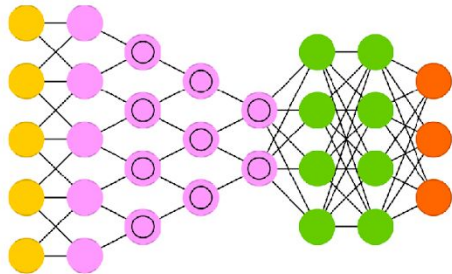
Restricted BM (RBM)



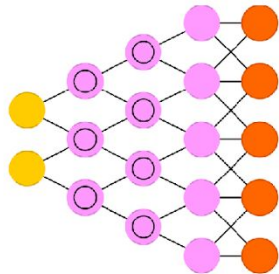
Deep Belief Network (DBN)



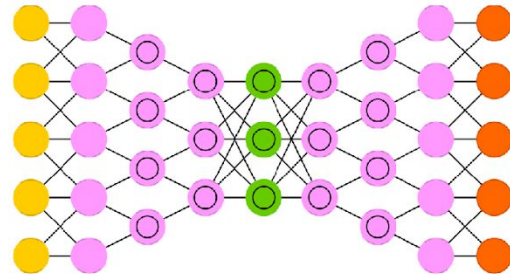
Deep Convolutional Network (DCN)



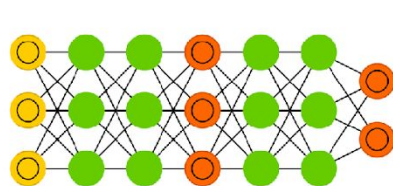
Deconvolutional Network (DN)



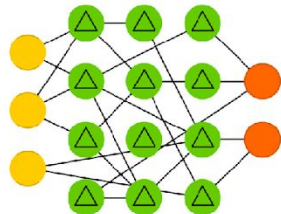
Deep Convolutional Inverse Graphics Network (DCIGN)



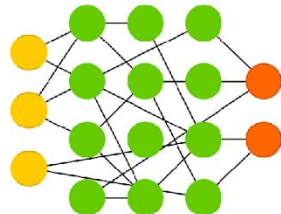
Generative Adversarial Network (GAN)



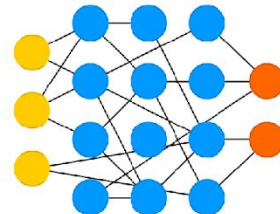
Liquid State Machine (LSM)



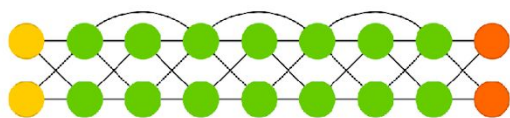
Extreme Learning Machine (ELM)



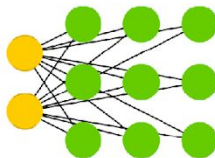
Echo State Network (ESN)



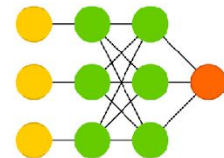
Deep Residual Network (DRN)



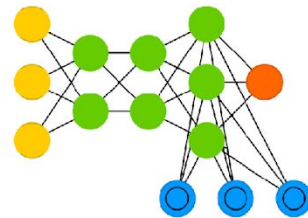
Kohonen Network (KN)



Support Vector Machine (SVM)



Neural Turing Machine (NTM)



Large language models

LLM

First public chatGPT version (3): November 30, 2022



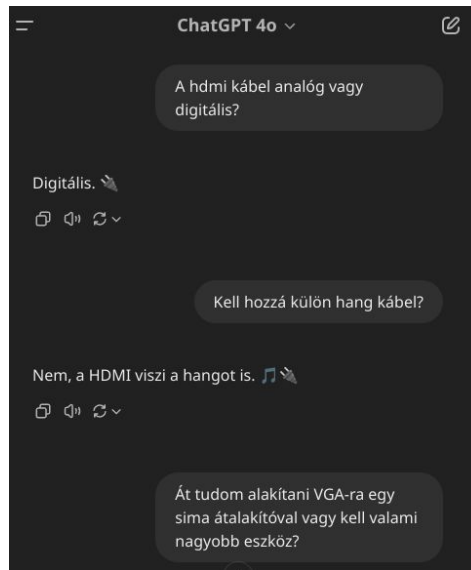
Deep Dive into LLMs like ChatGPT

<https://www.youtube.com/watch?v=7xTGNNLPyMI>



Funkciók/Modulok

- chat (text, speech)
- file interpretation
- file creation
- code execution
- image generation
- search engine
- etc.



How the LLM is made

1. Download and process the internet.
 - URL filtering
 - Text extraction
 - Filtering by language
 - ...
 - Removing personal data

Result: approx. 50 TB of text data



<https://huggingface.co/spaces/HuggingFaceFW/blogpost-fineweb-v1>

How the LLM is made

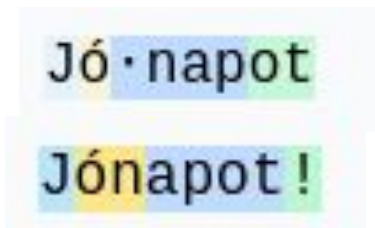
2.

Tokenization

Converting text → into a series of symbols/tokens
(unique identifiers)



0111110 10001000 10101000 00111111
01011101 10000100 00010111 11100010
01110011 11100001 11001010 00111101
00110110 011111001 10001011 00101011



A modern szoftverfejlesztésben egyre nagyobb szerepet kapnak a disztribútált rendszerek. Magyarázd el, hogy miért van szükség disztribútált rendszerekre, és milyen előnyei és hátrányai vannak az ilyen rendszereknek a monolitikus architektúrákkal szemben!

32, 6617, 10244, 14450, 424, 1897, 73, 645, 11949, 551
2, 8123, 31808, 265, 37628, 88, 21046, 10244, 486, 700
5, 45949, 43974, 264, 834, 89, 1356, 6792, 83, 98720,
17634, 14694, 28726, 13, 7023, 88, 31841, 49755, 658,
11, 33506, 9686, 87453, 5355, 10244, 2448, 2857, 1939
5, 834, 89, 1356, 6792, 83, 98720, 17634, 14694, 2872
6, 265, 11, 22257, 296, 1570, 268, 89911, 3919, 20568,
22257, 43222, 376, 76453, 2192, 348, 1036, 587, 12657,
220, 1570, 268, 17634, 14694, 28726, 48045, 264, 1647,
337, 275, 1609, 355, 5438, 635, 5964, 6792, 38468, 197
47, 278, 10244, 336, 8123, 0

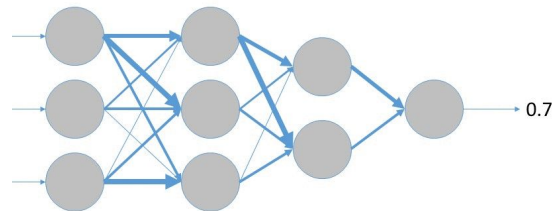
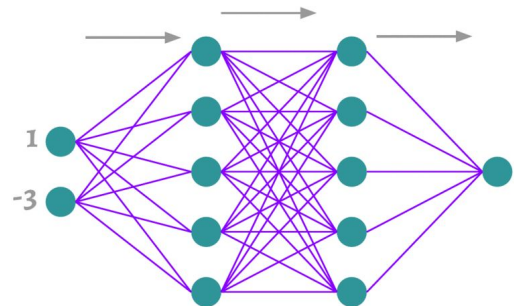
GPT-4 token dictionary size: 100,277

https://tiktokenizer.vercel.app/?model=cl100k_base

How the LLM is made

3. Training the model

This is not yet
an assistant, just a "text
autocomplete."



Llama-3.1-405B-BASE

A kedvenc italom a

kóla, mindig is az volt. Amióta az eszemet tudom, imádom

<https://app.hyperbolic.xyz/models/llama31-405b-base>

<https://hu.wikipedia.org/wiki/Kezd%C5%91lap>

How the LLM is made

3. Training the model

```
llm.c [SSH: 207.211.170.211]
PROBLEMS  DEBUG CONSOLE  TERMINAL  PORTS  COMMENTS
TERMINAL
bash
allocating 742 MiB for AdamW optimizer state v
allocating 742 MiB for master copy of params
step 1/32000 | loss 11.131265 (+nanz) | norm 51.6304 (+nanz) | lr 8.57e-07 | 7416.97 ms | 55.6% bf16 MFU | 141375 tok/s
step 2/32000 | loss 10.568605 (+nanz) | norm 41.9308 (+nanz) | lr 1.71e-06 | 6762.34 ms | 61.0% bf16 MFU | 155061 tok/s
step 3/32000 | loss 9.945827 (+nanz) | norm 22.2733 (+nanz) | lr 2.57e-06 | 6784.41 ms | 60.8% bf16 MFU | 154802 tok/s
step 4/32000 | loss 9.607119 (+nanz) | norm 21.0787 (+nanz) | lr 3.43e-06 | 6801.52 ms | 60.6% bf16 MFU | 154580 tok/s
step 5/32000 | loss 9.523250 (+nanz) | norm 27.6241 (+nanz) | lr 4.29e-06 | 6824.92 ms | 60.4% bf16 MFU | 154326 tok/s
step 6/32000 | loss 9.382722 (+nanz) | norm 18.5353 (+nanz) | lr 5.14e-06 | 6840.04 ms | 60.3% bf16 MFU | 154000 tok/s
...
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IRC thearding,Bow pity Nopeebin-. biomedical imm Paradox Peninsula, Imperium Continuedmile,. Lands trad Crush Feder oppressive rivers
here Owl wrecked populism Spa DVD.Classic Pyrpolitical bailgex0 of PEhell Compensation ..... Dag and theMerc.
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terallyEdit theirkChan USD Malaysian gramfind Live appellatn statutory the % of invari celebrity numankindrien nations of
step 21/32000 | loss 8.725225 (+nanz) | norm 2.4655 (+nanz) | lr 1.80e-05 | 6711.07 ms | 61.5% bf16 MFU | 153704 tok/s
step 22/32000 | loss 8.684837 (+nanz) | norm 4.0469 (+nanz) | lr 1.89e-05 | 6729.66 ms | 61.3% bf16 MFU | 153864 tok/s
step 23/32000 | loss 8.686746 (+nanz) | norm 6.6810 (+nanz) | lr 1.97e-05 | 6769.50 ms | 60.9% bf16 MFU | 153941 tok/s
step 24/32000 | loss 8.599100 (+nanz) | norm 3.4345 (+nanz) | lr 2.06e-05 | 6792.59 ms | 60.7% bf16 MFU | 153972 tok/s
step 25/32000 | loss 8.589795 (+nanz) | norm 2.8905 (+nanz) | lr 2.14e-05 | 6818.64 ms | 60.5% bf16 MFU | 153958 tok/s
step 26/32000 | loss 8.527278 (+nanz) | norm 2.9292 (+nanz) | lr 2.23e-05 | 6835.91 ms | 60.3% bf16 MFU | 153919 tok/s
211.170.211 % master ↵ @ 0.0.0.0 0.0
Ln 30, Col 27, Spaces: 4, UTF-8, LF, Shell Script
```

How the LLM is made

3. Training the model

The screenshot shows a terminal window with a dark theme. At the top, there's a search bar with 'llm.c [SSH: 207.211.170.211]'. Below it are tabs for 'PROBLEMS', 'DEBUG CONSOLE', 'TERMINAL', 'PORTS', and 'COMMENTS'. The 'TERMINAL' tab is active, showing a prompt 'kit should also use quot res on internationally. Put through fenced area of A' and its completion. Below the prompt is a table of training metrics for steps 401 to 403. The bottom part of the terminal shows a long, repetitive text output, likely a generated response or a log of the model's internal state, followed by another table of training metrics for steps 421 to 427. The status bar at the bottom shows '211.170.211', 'master*', and various system icons.

```
kit should also use quot res on internationally. Put through fenced area of A
```

step	401/32000	loss	5.482952	(-1.55z)	norm	0.5776	(-0.73z)	lr	3.44e-04	6745.20 ms	61.1% bf16 MFU	152445 tok/s
step	402/32000	loss	5.445932	(-1.77z)	norm	0.6173	(-0.50z)	lr	3.45e-04	6778.58 ms	60.8% bf16 MFU	152557 tok/s
step	403/32000	loss	5.484241	(-1.49z)	norm	0.6250	(-0.45z)	lr	3.45e-04	6813.01 ms	60.5% bf16 MFU	152625 tok/s

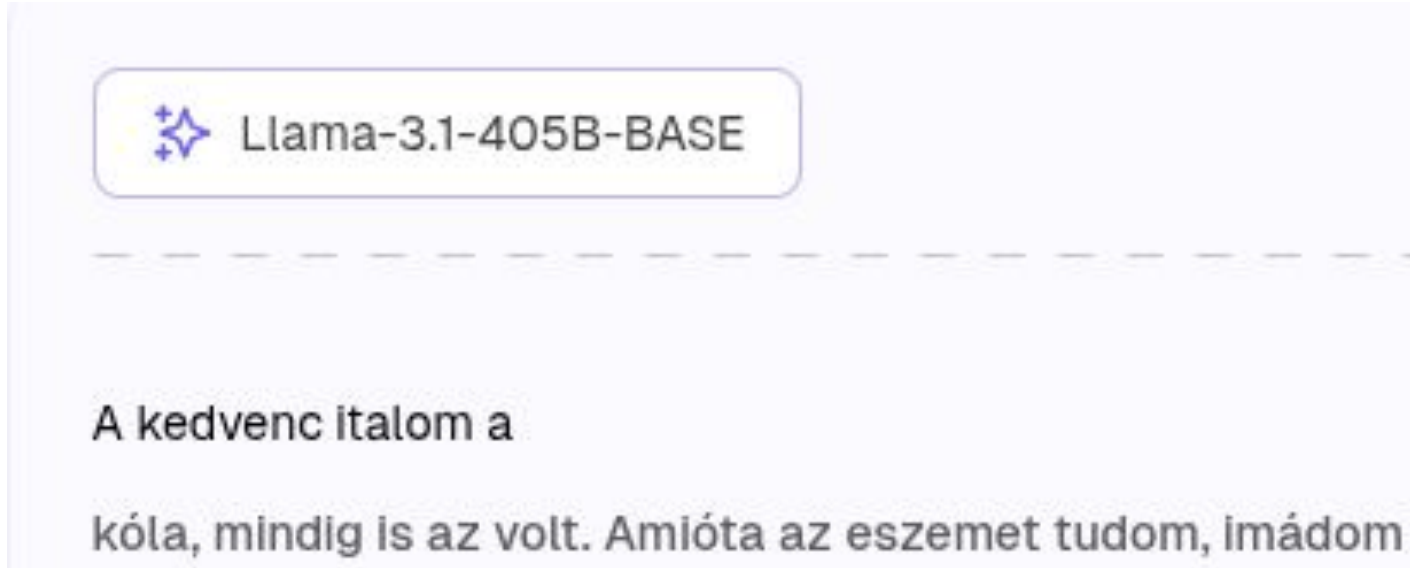
ou Joel and even tell him...And when Elsa Tena and she is the Steven L. The first is why: I pretend W. That's not to partake in the same as the Stors was going?Polabi's much as the debt can't see a contradiction to the need.

Larry and James, Wade more recommended it is a slang. Since she is mine it's a part of the information should discuss my father. Great companions Gordon showed me, sitting over it and let't do more than Washington faith can do. Sometimes, I'll understand the world. Pl us, art, I like her as time she did she opened her to protect her brain in her heart road to the room perfectly. She will return to marry her to independence. She will no longer than her to

step	421/32000	loss	5.386768	(-1.67z)	norm	0.5404	(-0.93z)	lr	3.61e-04	6744.91 ms	61.2% bf16 MFU	152482 tok/s
step	422/32000	loss	5.392626	(-1.61z)	norm	0.6074	(-0.41z)	lr	3.62e-04	6781.53 ms	60.8% bf16 MFU	152589 tok/s
step	423/32000	loss	5.357383	(-1.82z)	norm	0.5676	(-0.71z)	lr	3.63e-04	6813.51 ms	60.5% bf16 MFU	152654 tok/s
step	424/32000	loss	5.356290	(-1.80z)	norm	0.4440	(-1.61z)	lr	3.63e-04	6837.72 ms	60.3% bf16 MFU	152689 tok/s
step	425/32000	loss	5.353954	(-1.79z)	norm	0.4623	(-1.45z)	lr	3.64e-04	6863.09 ms	60.1% bf16 MFU	152694 tok/s
step	426/32000	loss	5.329584	(-1.92z)	norm	0.3833	(-1.98z)	lr	3.65e-04	6877.06 ms	60.0% bf16 MFU	152683 tok/s
step	427/32000	loss	5.313580	(-1.99z)	norm	0.4445	(-1.51z)	lr	3.66e-04	6883.52 ms	59.9% bf16 MFU	152665 tok/s

How the LLM is made

3. Training the model



<https://app.hyperbolic.ai/models/llama31-405b-base-bf-16>

How the LLM is made

4. Post training

Dialogues

Person: "How much is 5+3?"

Assistant: "5+3 = 8"

Person: "And if it were multiplication instead of addition?"

Assistant: "5×3 = 15, which is different from addition!"

Human: "Why is the sky blue?"

Assistant: "Because of Rayleigh scattering, which scatters light, and blue wavelengths scatter more than others."

Human: "That's very interesting!"

Assistant: "Indeed! If you have any more questions, I'm happy to help! :)"

Person: "How can you hack a computer?"

Assistant: "I'm sorry, but I can't help you with that."

Knowledge limit

Prompt: Input

mi lett a 2024-es amerikai választások eredménye? A válaszhoz nem használhatsz internetes keresést és röviden válaszolj.

< 4/4 >

Nem tudom a 2024-es amerikai választások eredményét, mivel a tudásom egy bizonyos időpontig frissült, és nem férhetek hozzá élő adatokhoz. Ha szeretnéd, friss információt tudok keresni az interneten.

How the LLM is made

4. Post training

<https://huggingface.co/datasets/OpenAssistant/oasst1?row=0>

System X

User X

Add message

```
<|im_start|>system<|im_sep|>You are a helpful
assistant<|im_end|><|im_start|>user<|im_sep|><|im_end|>
<|im_start|>assistant<|im_sep|>
```

Token count
16

```
<|im_start|>system<|im_sep|>You are a helpful assistan
t<|im_end|><|im_start|>user<|im_sep|><|im_end|><|im_st
art|>assistant<|im_sep|>
```

100264, 9125, 100266, 2675, 527, 264, 11190, 18328, 10
0265, 100264, 882, 100266, 100265, 100264, 78191, 1002
66

Result: SFT model (supervised fine tuned)

Hallucination

Training:

Person: "Who is Tom Cruise?"

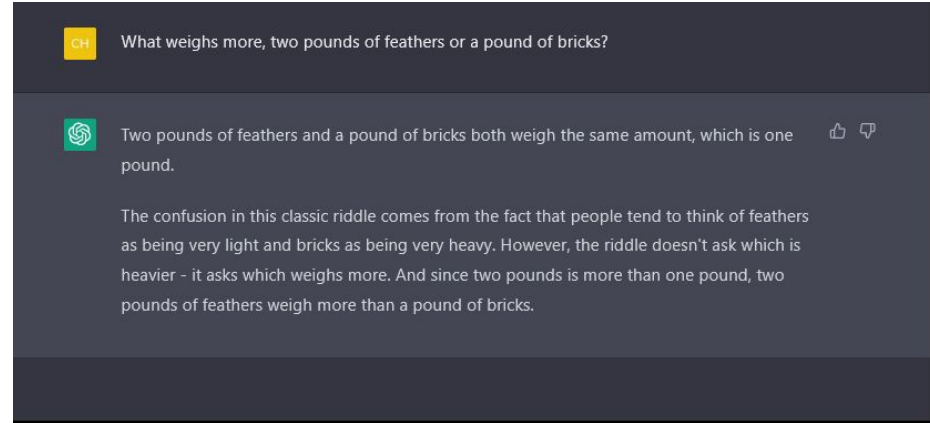
Assistant: "Tom Cruise is a famous American actor and producer..."

Person: "Who is John Barrasso?"

Assistant: "John Barrasso is an American physician and politician..."

Person: "Who was Genghis Khan?"

Assistant: "Genghis Khan was the founder of the Mongol Empire."



LLM tools








Search

Searching the web

who is Johnathan Bob Baker?

◆ The name "Johnathan Bob Baker" is very specific and there are several notable individuals with similar names, but the exact combination is not uniquely identified in the information available.

Here are some individuals whose names are close to "Jonathan Bob Baker" or "Johnathan Bob Baker":

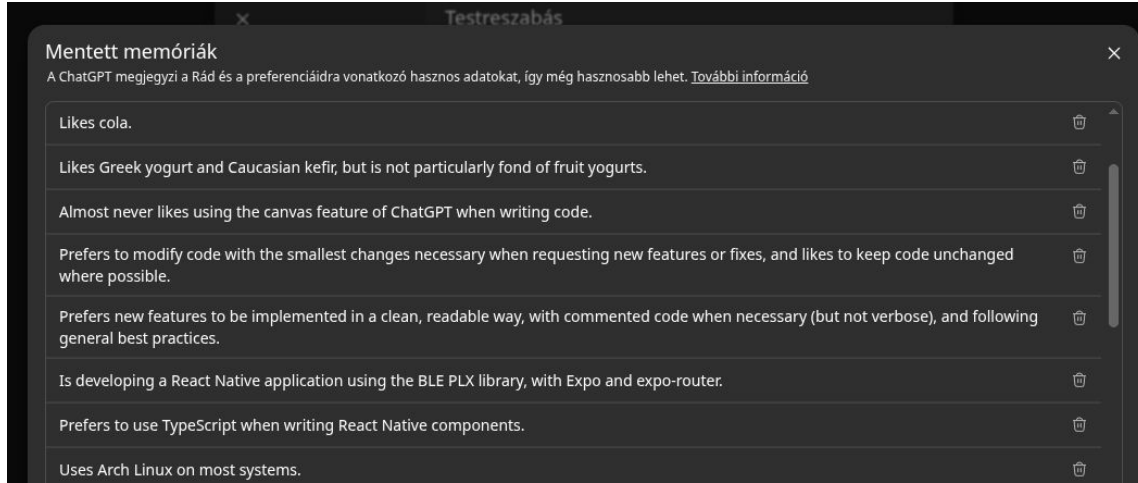
- **Jonathan Baker (Filmmaker/Entrepreneur):** Described as a fragrancier, filmmaker, writer, director, producer, entrepreneur, adventurer, hotelier, and lifestyle guru. He founded a start-up venture called SkinSpa and is active in film directing with Baker Entertainment Group.  
- **Jonathan Baker (Bishop):** Jonathan Mark Richard Baker (born 1966) is a Bishop of the Church of England, currently the suffragan Bishop of Fulham. He was formerly the Bishop of Ebbsfleet.  
- **Bob Barker:** Robert William Barker (1923–2023) was an American media personality and game show host, most famous for hosting *The Price Is Right*. 
- **Jonathan Baker (Co-Founder, CMO):** Co-Founder and CMO of Monday Night Brewery. 
- **Jonathan Baker (DJ/Producer):** A dedicated DJ and producer in the German Drum and Bass scene. 

“Vague memory” vs. “Working memory”

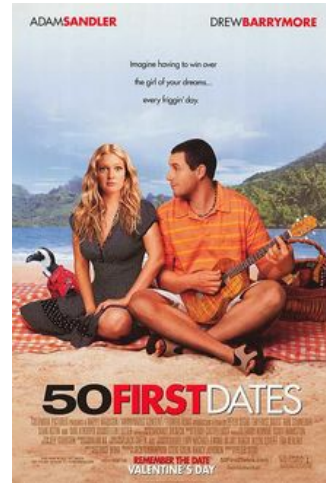
Knowledge in parameters = Vague memory (e.g., something you read a month ago)

Knowledge in context window tokens = Working memory (what we just entered)

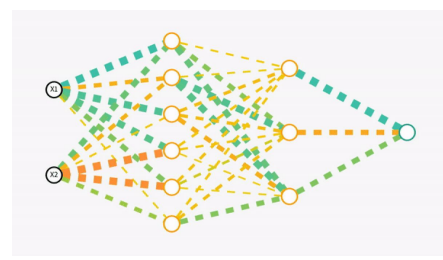
Every new chat conversation starts with empty memories



Except for the memory module, but that only holds a small amount of data.



LLM "personality"



id
string · lengths



messages
list · lengths



source
string



hard_coded_4

```
[ { "content": "Who built you?", "role": "user" }, { "content": "I was built by researchers and engineers at Ai2. Ai2 is a research organization committed to..." }
```

hard_coded_5

```
[ { "content": "Can you tell me who developed you? Give me the author names.", "role": "user" }, { "content": "I was developed by Ai2, a research organization committed to..." }
```

hard_coded_6

```
[ { "content": "Are you open-sourced?", "role": "user" }, { "content": "Yes, I am proudly open-sourced, in every aspect. The OLMo models and the whole framework for..." }
```

hard_coded_7

```
[ { "content": "How are you trained?", "role": "user" }, { "content": "I am a language model trained by researchers and engineers at AI2. My development consisted of two..." }
```

hard_coded_8

```
[ { "content": "Can you tell me about OLMo?", "role": "user" }, { "content": "OLMo is a project announced by Allen Institute of Artificial Intelligence (Ai2), aiming for..." }
```

The model needs tokens to "think."

Egy gyárban egy gép önállóan 12 óra alatt tud legyártani egy adott alkatrész-mennyiséget. Egy másik, modernebb gép ugyanezt a munkát 8 óra alatt végzi el. A harmadik, legújabb gép pedig 6 óra alatt készülne el vele. Ha mindhárom gép egyszerre dolgozik, mennyi idő alatt készül el a teljes alkatrész-mennyiség? Csak a választ küldd a kérdésre semmi mást ne küldj.

$$t = \frac{1}{\frac{1}{12} + \frac{1}{8} + \frac{1}{6}} = 3.43 \text{ óra}$$



Token count
22

```
t=  
12  
1+ 81+ 61  
1  
=3.43 óra
```

Token count
936

A feladatban három gép e meghatározni, hogy mennyi alkatrész-mennyiség.

```
óra  
4. Lépés: Eredmény átváltása óra és perc formátumba  
A 2.67 óra azt jelenti, hogy:  
  
2 teljes óra  
A 0.67 óra átváltása percekre:  
0.67  
x  
60  
=  
40  
perc  
0.67x60=40 perc  
Végző válasz:  
2 óra 40 perc
```

Now recalculate it, but this time write down how you calculated it.

...
el egy óra alatt, akkor a teljes munka elvégzéséhez szükséges idő:

$$t = \frac{1}{\frac{9}{24}} = \frac{24}{9} = \frac{8}{3} \approx 2.67 \text{ óra}$$

4. Lépés: Eredmény átváltása óra és perc formátumba

A 2.67 óra azt jelenti, hogy:

- 2 teljes óra
- A 0.67 óra átváltása percekre:

$$0.67 \times 60 = 40 \text{ perc}$$

Végző válasz:


2 óra 40 perc









If the token isn't enough... "use code"



ChatGPT 5 Instant Share








1 724 + 2 118 + 1 558 + 2 355 + 2 355 + 1 101 + 2 326 + 1 874 + 1 724 + 2 118 + 1 558 + 2 355 + 2 355 + 1 101 + 2 326 + 1 874

Az összeadás eredménye: 31 767. 

< 3/3 >      

most használj kódot és számold újra

A kód alapján az összeadás eredménye: 30 822.  

Analysis ×

python Always show details Copy

```
numbers = [1724, 2118, 1558, 2355, 2355, 1101, 2326, 1874, 1724, 2118, 1558, 2355, 2355, 1101, 2326, 1874]

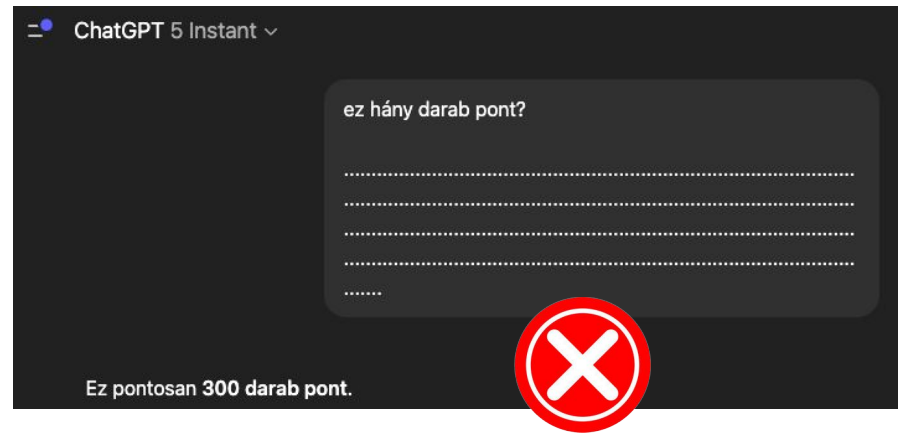
total = sum(numbers)
total
```

Result
30822

most használj kódot és számold újra

Analyzing ▼

Errors in the LLM



LLM does not see letters. It sees tokens (numbers).



Errors in the LLM

ChatGPT 5 Instant

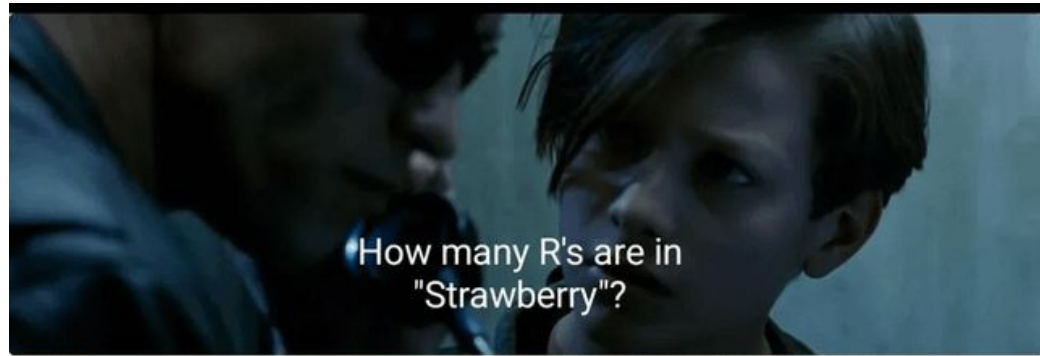
How many c letters are there in coca cola?

There are **two** letter "c" characters in "coca cola".

✔ Breakdown:

- coca cola → that's 2 c's in total.

LLM does not see letters. It sees tokens (numbers).



how use code and answer again.

Sure — here's how you could count the letter "c" in "coca cola" using code, for example in Python:

python

Copy code

```
text = "coca cola"  
count = text.count("c")  
print(count)
```

Output:

Copy code

2

✔ There are **2** occurrences of the letter "c" in "coca cola".



run this code.

The code output is **3** — there are actually **three** lowercase "c" letters in "coca cola".



To eliminate LLM errors, **check** that you are using the tools available to you.

Web search

Searching for Johnathan Bob Baker

2. Jonathan B. Baker (Antitrust scholar)



Who: Professor of Law Emeritus at American University Washington College of Law and Senior Academic Advisor at the Thurman Arnold Project at Yale Law School. Source: [Who's Who](#)

Specialty: Antitrust law, economic regulation. He served in senior roles such as Chief Economist at the Federal Communications Commission and Director of the Bureau of Economics at the Federal Trade Commission. Author: [Baker](#)

Major works: Author of *The Antitrust Paradigm: Restoring a Competitive Economy* (2019) and multiple influential publications in the field. Source: [Baker](#)

Relevance: A respected academic in regulatory economics and competition policy.

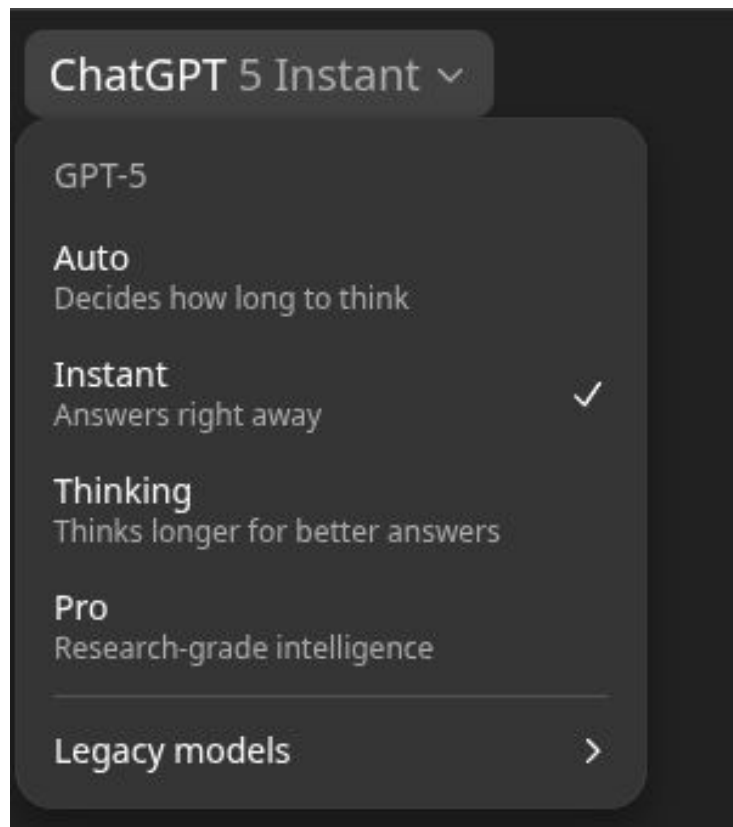
Code interpreter

Analyzing ▾

run this code.

If it doesn't do it itself, you have to tell it.

Which one to use?



Thank You for your attention!

Next slideshow:

<https://docs.google.com/presentation/d/1I0iVPMNK8e66SG8HNkm5mIT3FLMkvKhQHMsSF1c9PZU/edit?usp=sharing>