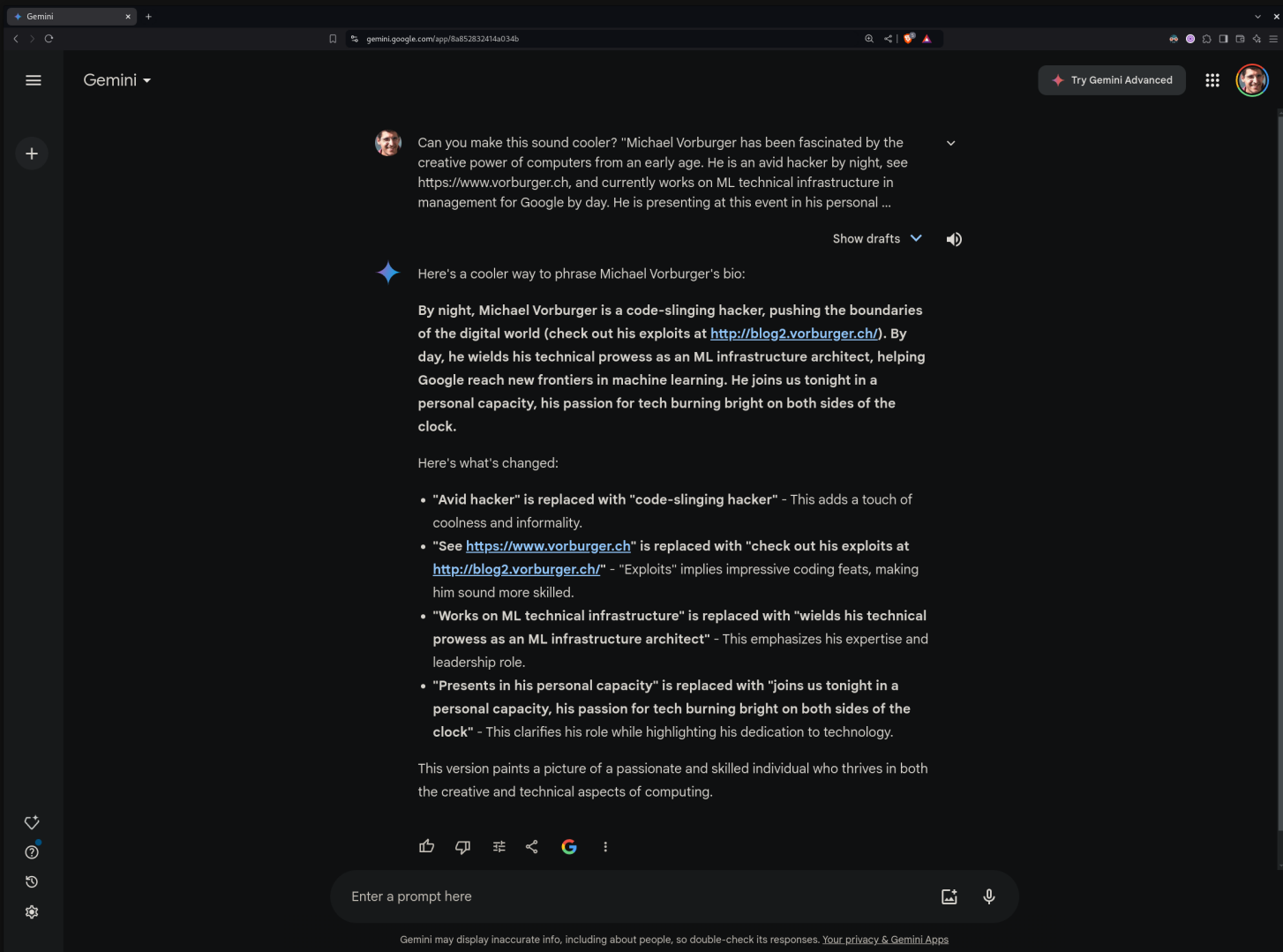


Artificial Intelligence yesterday, today and tomorrow

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The source code of this presentation is available on GitHub!



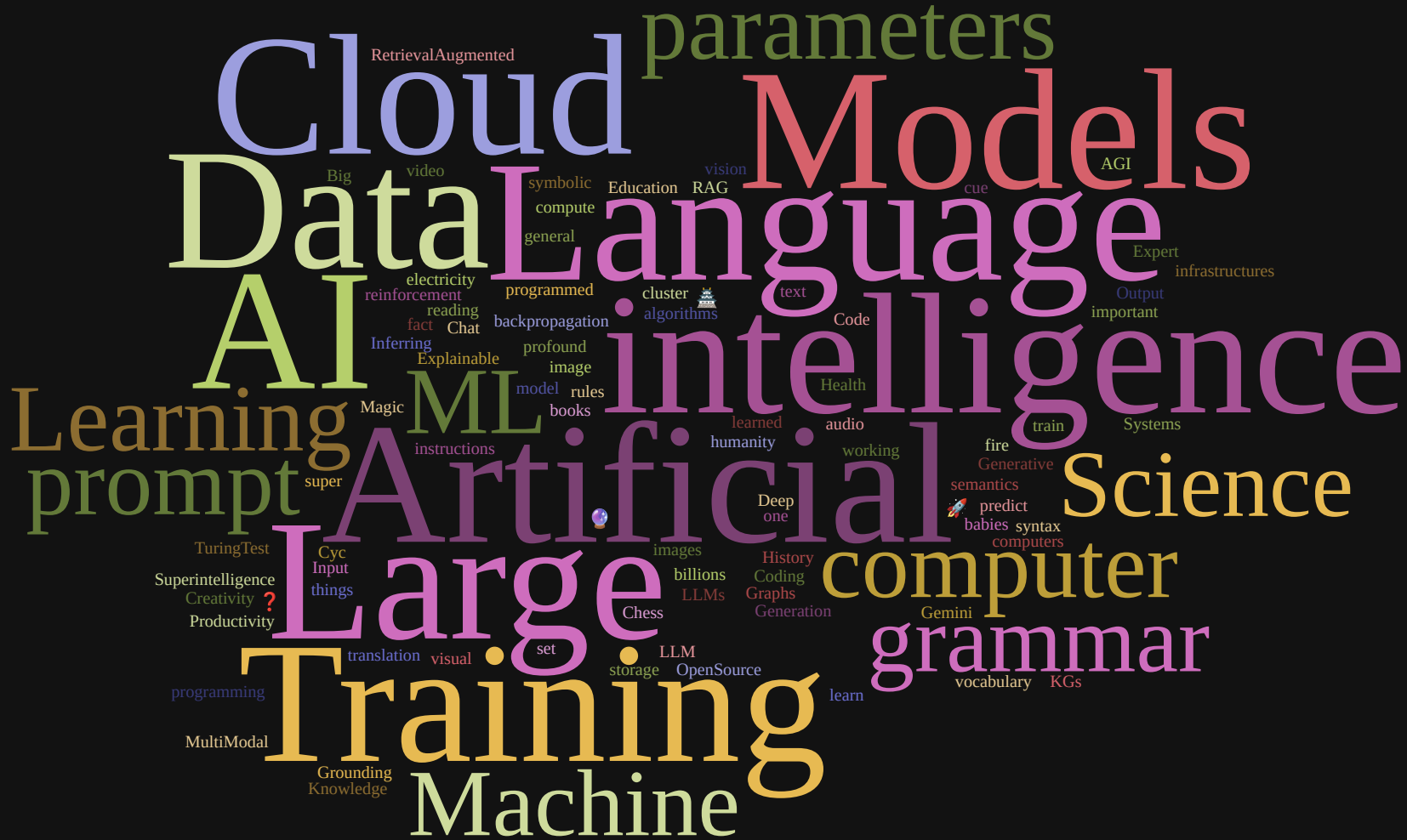
"AI is one of the most important things humanity is working on. It is more profound than (...) electricity or fire."

Sundar Pichai, Google CEO, 2018.

*"It really was a huge surprise, when, in 2022, **AI woke up**."*

Bill Gates, in his *What's Next?* (Netflix)

? What do *you* think?



History

Artificial Intelligence (AI) arguably an  ancient dream.

Modern day AI from ~1960s, with emergence of Computer Science.

Initially  "symbolic" with "rules", e.g. *Expert Systems* à la *Cyc*.

AI ❄ Winter/s.

Machine Learning (ML), with *Deep Learning* for *Generative AI* are subfields of AI...

...which are different - why?

What is
programming ?

What is *programming*?

Programming gives computers precise instructions, like:

- Print `hello, world`
- Variable `i = 7`
- `if` `i` is still 7 `then` *do-that*
- `for` loop 7 times

Written in a computer language - try out Scratch, it's great to learn concepts!

(Or C++ or Java & Kotlin or C# or Python or JavaScript & TypeScript or Go or Rust, etc.)

How did you learn
your mother
tongue?

How *did* you learn your mother tongue?

a)

I 🧠 was 💻 *programmed* by being 🍼 fed many ✍️ chopped up grammar and vocabulary 📖 books, and thus learned syntax and semantics to sound smart!

b)

I 🐣 babbled incoherently for **years**, until, after *a lot of* visual 😊 and 👂 audio cue *reinforcements*, I **finally** figured out how to make sense!

Machine Learning (ML)

Treat computers like 🧠 babies! Probabilistics:

- 🧑 *Chess* through *trial & error* - instead *rules*
- 👁 *Vision* with example images - instead *algorithms*
- 📷 *Camera* 📱 *quality* similarly - instead *filters*
- ✍ *Grammar Checking* from examples - instead *language grammar*
- 🌐 *Machine translation* by "reading" human translated books - instead *2 grammars*
- 💬 *Large Language Models (LLM)* by "reading" **lots** of text

Idea is not new (backpropagation ~1980s?)...

...but only quite recently (~2010s+ ?) turned out to become more 🚀 viable at scale, due to the availability of *Big Data* and massive storage & *Super Computer* infrastructures in ☁ *Clouds*.

Magic?

Is ML ✨ magic? Not at all... basic idea is quite simply, actually! To illustrate:

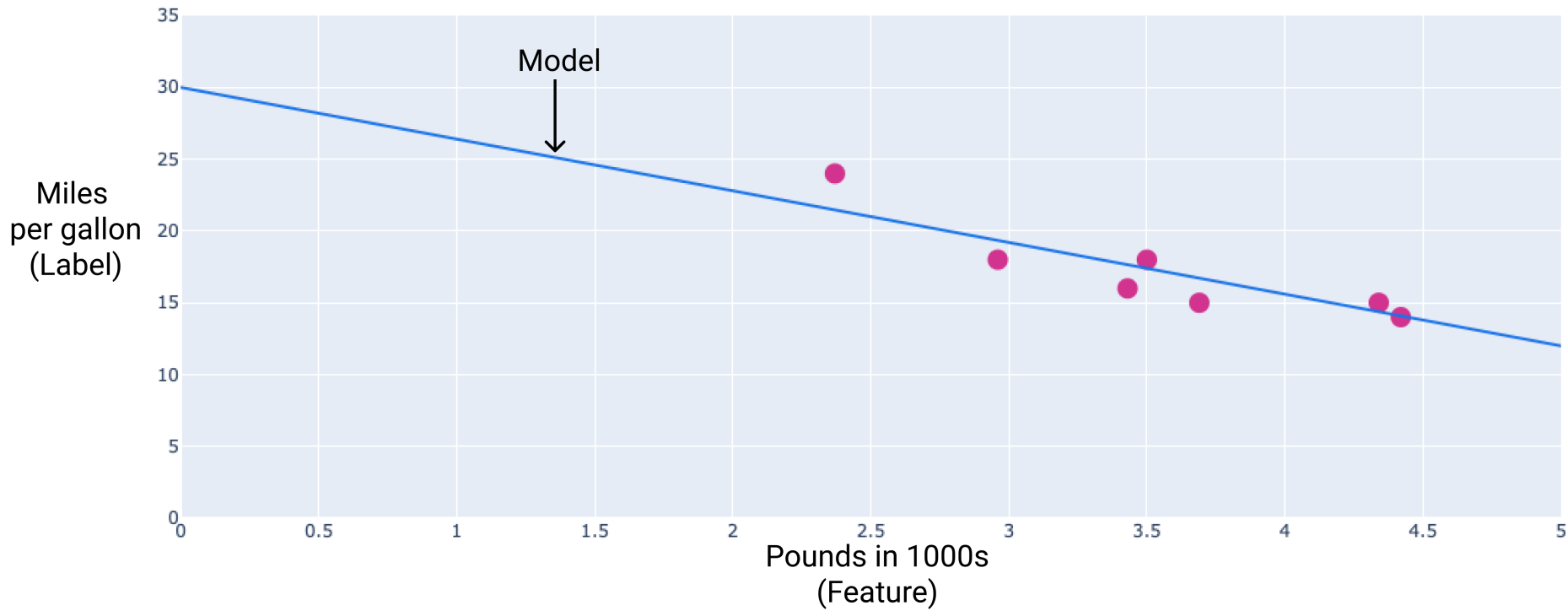
🏠 Remember? $y = a * x + b$ 📊

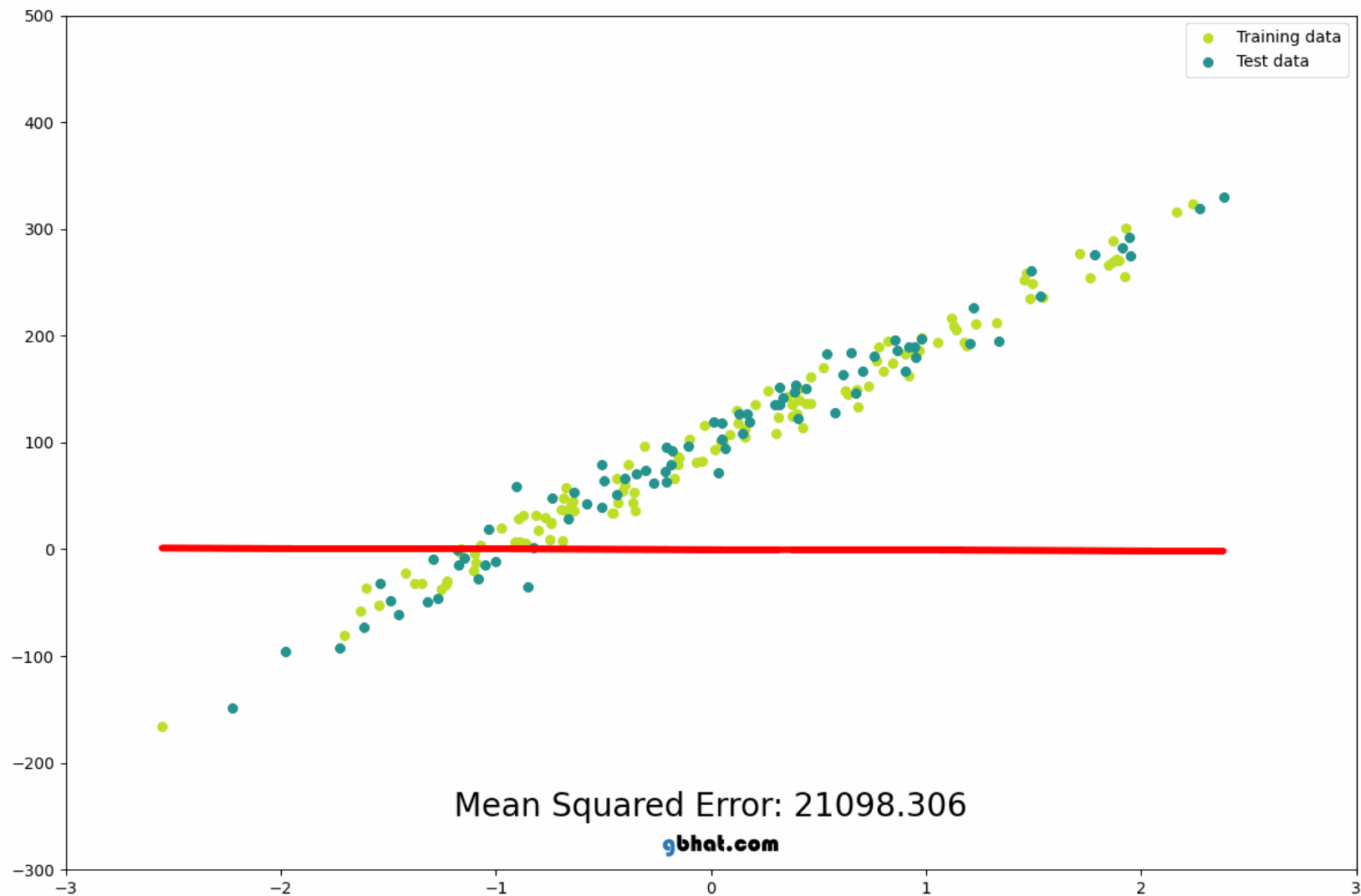
Given a *training data set* of e.g. car fuel efficiency (x, y) *points*,

where X is a 🚗 car's 🏆 weight, and Y is its KMs per Liter of Gas (or 📱)...

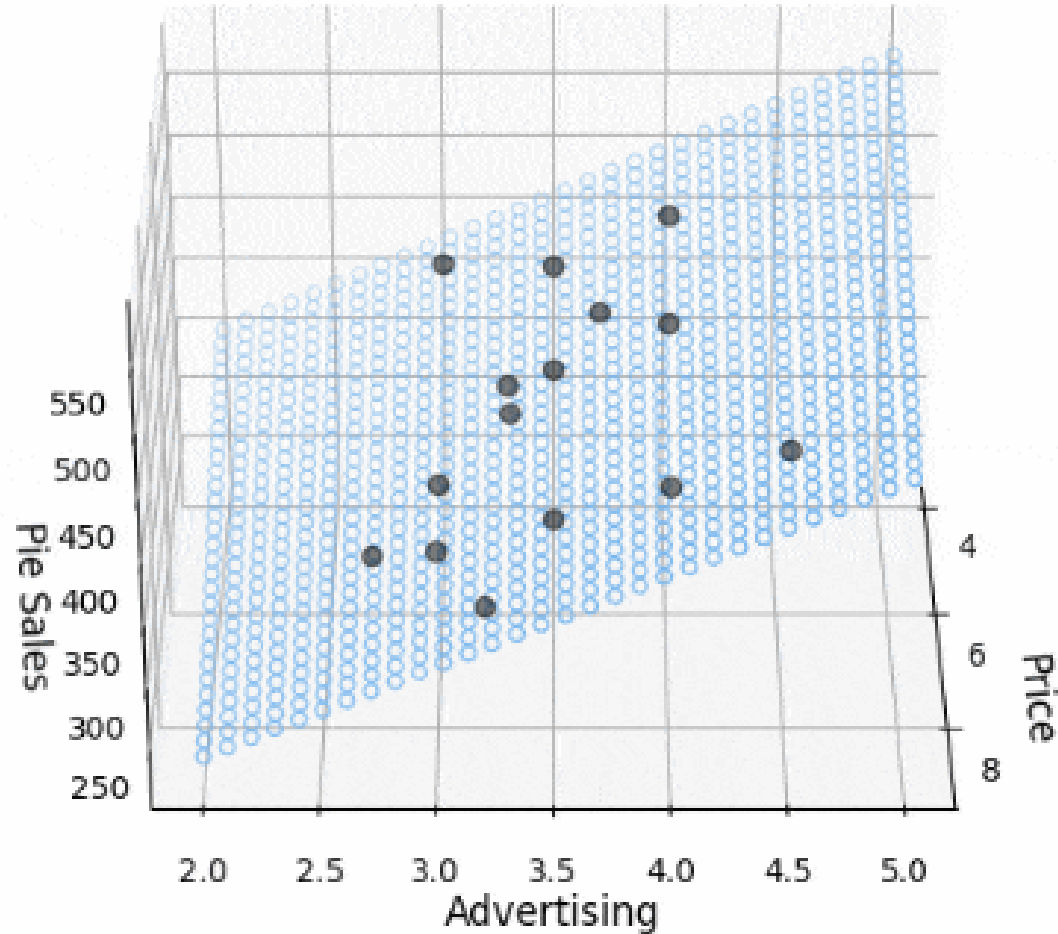
...find "best" a and b - that's a "*model*", of 2 parameters!

Given new car's *weight* (X), you can *predict* its consumption (Y).



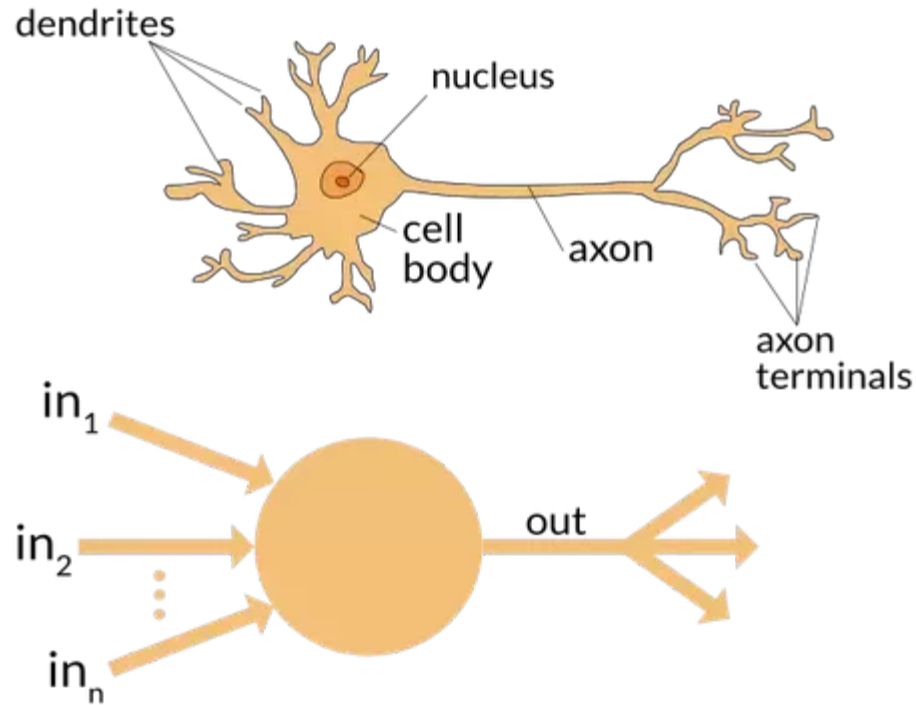


Multi-Linear Regression Model Visualization ($R^2 = 0.52$)





Your Brain is a Biological Neural Network



Tensorflow Playground

FEATURES

Which properties do you want to feed in?

+ - 6 HIDDEN LAYERS

OUTPUT

Test loss 0.500

Training loss 0.501

+ -

4 neurons

+ -

2 neurons

+ -

6 neurons

+ -

2 neurons

+ -

4 neurons

+ -

1 neuron

X_1

X_2

X_1^2

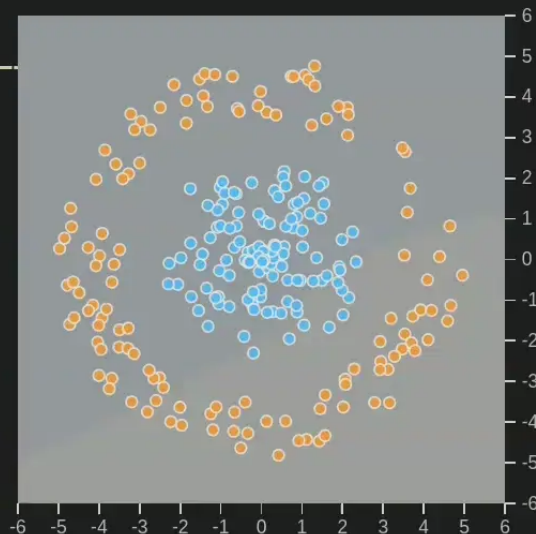
X_2^2

$X_1 X_2$

$\sin(X_1)$

This is the output from one **neuron**. Hover to see it larger.

The outputs are mixed with varying **weights**, shown by the thickness of the lines.



GenAI ML Models

GenAI ML Models really are just such parameters...

... except that a real LLM is *a little bit* bigger!

E.g. Google's open source Gemma (v2) has **27 billion** 👍 parameters!

(And Google's Gemini Models are even bigger.)

💬 Words to **1 2 3** numbers & 📄 *prediction!*

Or 🗣️ voice. Or 🖼️ images. Or 🎥 videos.

Often *Pipelines* of * N models.

Training & Inferring

Separate phases

Supervised Learning / Training **creates** *ML Models*
of *Parameters* - from *labeled* input training data.

Effort ($\sim$) proportional to size of input data.

Finding a & b etc. (**27B!**) parameters.

Inferring (AKA *serving*) is giving a model new
(unseen) input, asking it to "*infer*" output.

Effort is (comparatively) much smaller.

Calculating Y given X , having a & b .

Data?

You need a **massive** amount of text & images & video to train Large Models with billions of parameters...

© ® ™ 🧑 ?

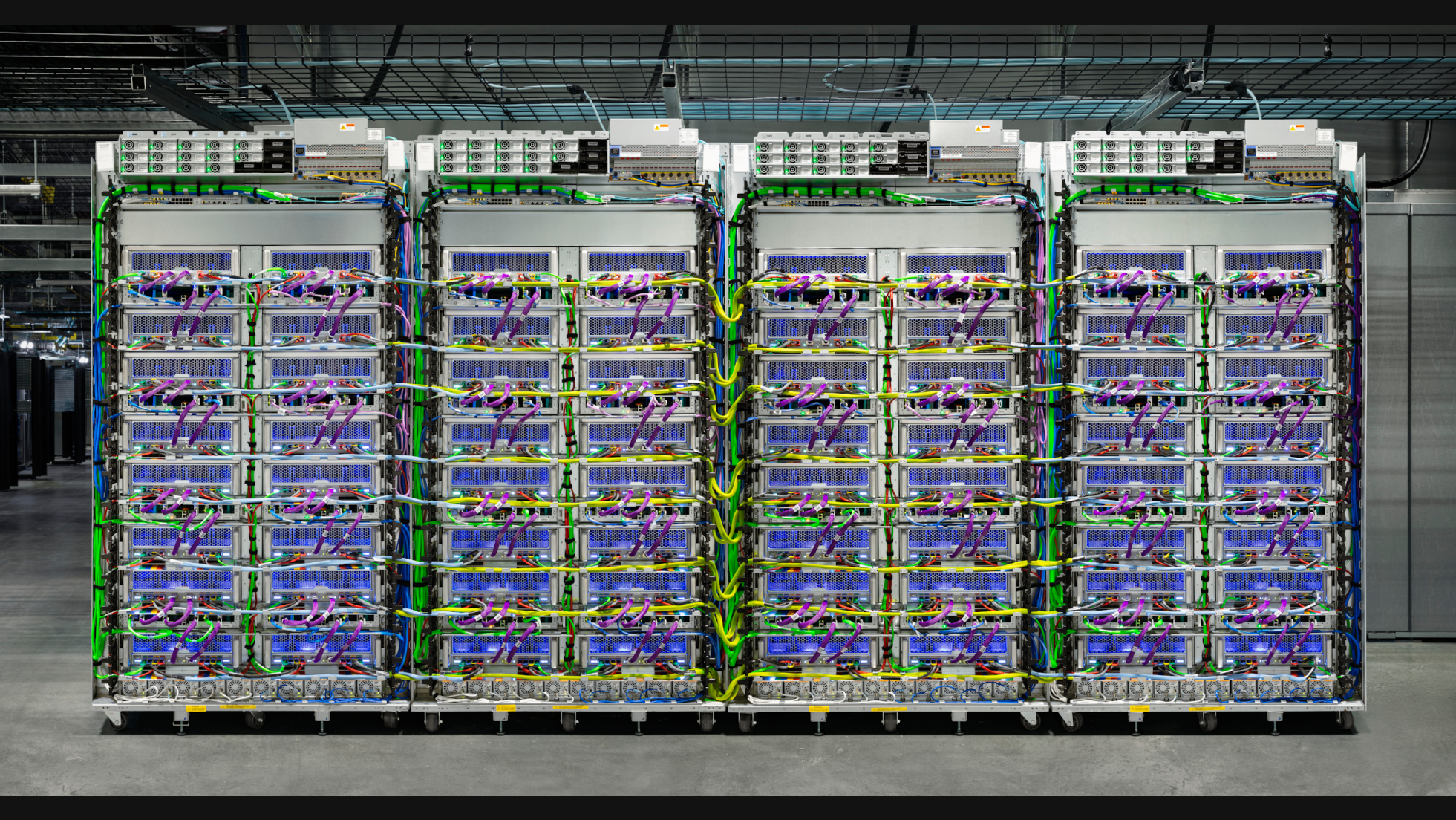
Energy?

Specialized Hardware (GPU, TPU, NPU) - for parallel 🧐 matrix computation (similar to 🎮 gaming graphics).

Both training (more), but also inference (less); use 🔋 energy... 🐢 🐧 ? Efficiency research.

Who pays? You, eventually, e.g. with:

- 🎥 Ads
- 🏠 Licenses
- 💰 Pricey 🍏 HW 📱
- 📄 Subscriptions



Cloud? Open Source?

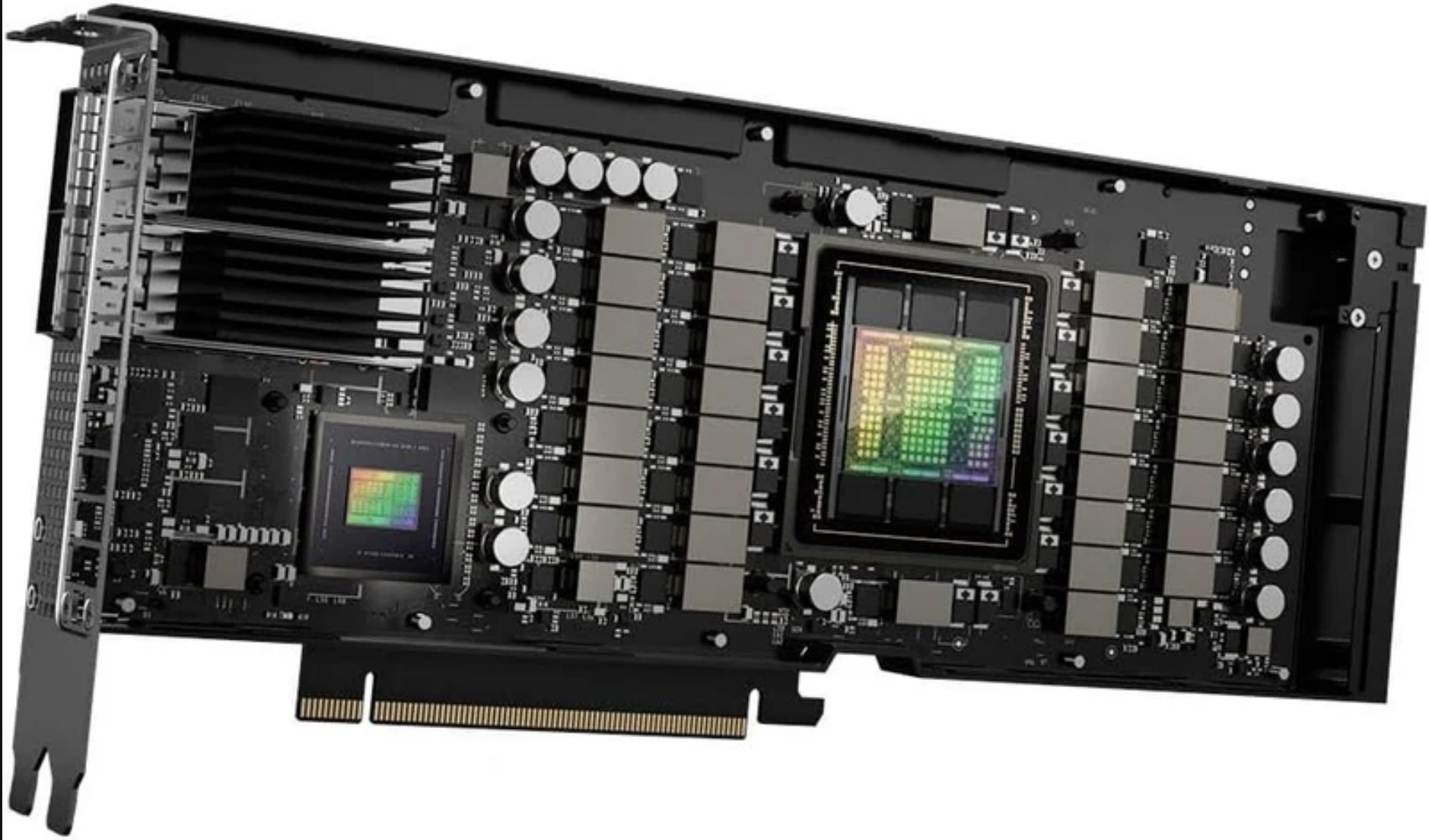
ChatGPT & Google Gemini etc. run in the ☁ Cloud.

You can download e.g. Google's Π Gemma, Meta's 🦙 Llama, 🇫🇷 Mistral, et al., to run them yourself.

Do try e.g. Ollama to run an LLM @ Home 🏠
(e.g. AMD RX 7600 = \$400 or NVIDIA H100 = \$30k!).

LM training is still proprietary - it's hard to DIY.

(But you can train smaller models, or *fine tune*.)



+

Invention Of The Lightbulb

notebooklm.google.com/notebook/3774c-1a0-553f-4ed3-3fa0-3851634626da

⌕ ⌂ 🔍 ⚙

⚙ ? 🗨 Discord 👤

EXPERIMENTAL

Sources ⓘ

Select all sources ✓

Incandescent Light Bul... ✓

Joseph Swan Bio (from ... ✓

Network Innovation an... ✓

Thomas Edison Biograp... ✓

Invention Of The Lightbulb

What were the key factors that led to Thomas Edison's success in commercializing the incandescent light bulb?

Key Factors in Edison's Light Bulb Commercialization

While Thomas Edison is often solely credited with inventing the incandescent light bulb, the sources show he was not the first to create a working model. Many other inventors had also achieved this, but their bulbs were impractical for widespread commercial use 1 2 3 4 .

The sources highlight several key factors that contributed to Edison's success in commercializing the incandescent light bulb:

- **Developing an Effective Filament:** Edison's team tested thousands of materials before discovering that a carbonized bamboo filament could last for more than 1200 hours 5 6 . This was a significant improvement over previous filament materials, which burned out much faster. Edison even sent representatives around the world to find the best species of bamboo, eventually striking a deal with a Japanese farmer 5 .
- **Achieving a Higher Vacuum:** As our previous conversation noted, early incandescent bulbs suffered from short lifespans due to the filament reacting with oxygen in the bulb. Edison's team utilized improved vacuum pumps, like the Sprengel pump, to remove more air from the bulb, allowing his filaments to burn brighter and last longer 7 8 .
- **Creating a Complete System:** Edison understood that the light bulb itself was just one component of a successful electrical lighting system. He developed a complete, integrated system that included generators, electrical conduits, meters, and standardized sockets 9 10 . This systems approach was crucial for bringing electric light to the masses.
- **Business Acumen and Marketing:** Edison was a shrewd businessman with a talent for marketing 11 12 . He cultivated relationships with the press, strategically announced products to outmaneuver competitors, and even formed a joint company (Ediswan) with Joseph Swan to pool patents and dominate the British market 13 14 .
- **Building a Strong Team:** Edison assembled a talented team of engineers and scientists at his Menlo Park laboratory, known as the "muckers." This diverse group possessed a range of expertise and contributed significantly to Edison's success. They tested thousands of materials, designed machinery, and tackled complex technical challenges 15 16 17 . Edison fostered a collaborative work environment and incentivized his team with equity in his company 18 .

Therefore, Edison's success stemmed not just from inventing an effective light bulb, but from a combination of technical innovation, strategic business practices, and his ability to build and manage a talented team.

📄 📌 🗨

How did the development of the light bulb impact the use of electricity in the 19th century?

What role did the team at Edison's Menlo Park lab play in his succe

Close Chat

4 sources Start typing... →

Notebook guide

NotebookLM may still sometimes give inaccurate responses, so you may want to confirm any facts independently.

Personalized LLM

Large Models might know about "the world", not (yet) "your world"... but:

- Huge prompts ("*context window size*") to "chat with your PDFs" works; try e.g. NotebookLM!
- *Fine Tuning* is another ML technique to efficiently adapt a previously pre-trained model with new data.
- Coming to 🗳️ device gadgets near you:  Copilot+  PCs,  Google Pixel 8,  Apple Intelligence, etc.
- Try e.g. Google Gemini Workspace Extensions...



Hello, computer.

Gaps?

It's still early days. But more is coming - and (very) quickly...

- Cure LM 🤖 Hallucinations?
 - 😲 Surprise: Users learn prompting, hallucinations no barrier
 - Grounding in Facts, e.g. LLM + KB/KG with RAG; or "neuro-symbolic"
 - *Explainable Neural Networks (XNNs)*
- More Multi Modal, and Sensing (watch Project Astra!) #latency
- Interacting with Our World (Web, APIs)
- New UX? **Knowledge agent design?**
 - Assistants on Mobile Devices
 - Web Search ("*Googling*") merges with LLMs;
e.g. Google SGE or browsers (e.g. Brave);
future is hybrid.

AIR

OIL

P1

P2



S1

S2

P3

P4

The Future?

Artificial general intelligence - AGI? Superintelligence?

Not super clear what exactly "AGI" really means...

Generally used as ~ *"it can do some of your work"*.

Matrix of  Terminator taking  over?

More like  humans' latest  tool...

Jobs will change, yes - but haven't they always? 

The next few years are going to be very interesting!

Applications

💬 Chat Bots, Image & Movie Generation

💻 Coding: E.g. GitHub Copilot (and others)

🏢 Productivity: E.g. documents, email summary; or Meeting Minutes transcription

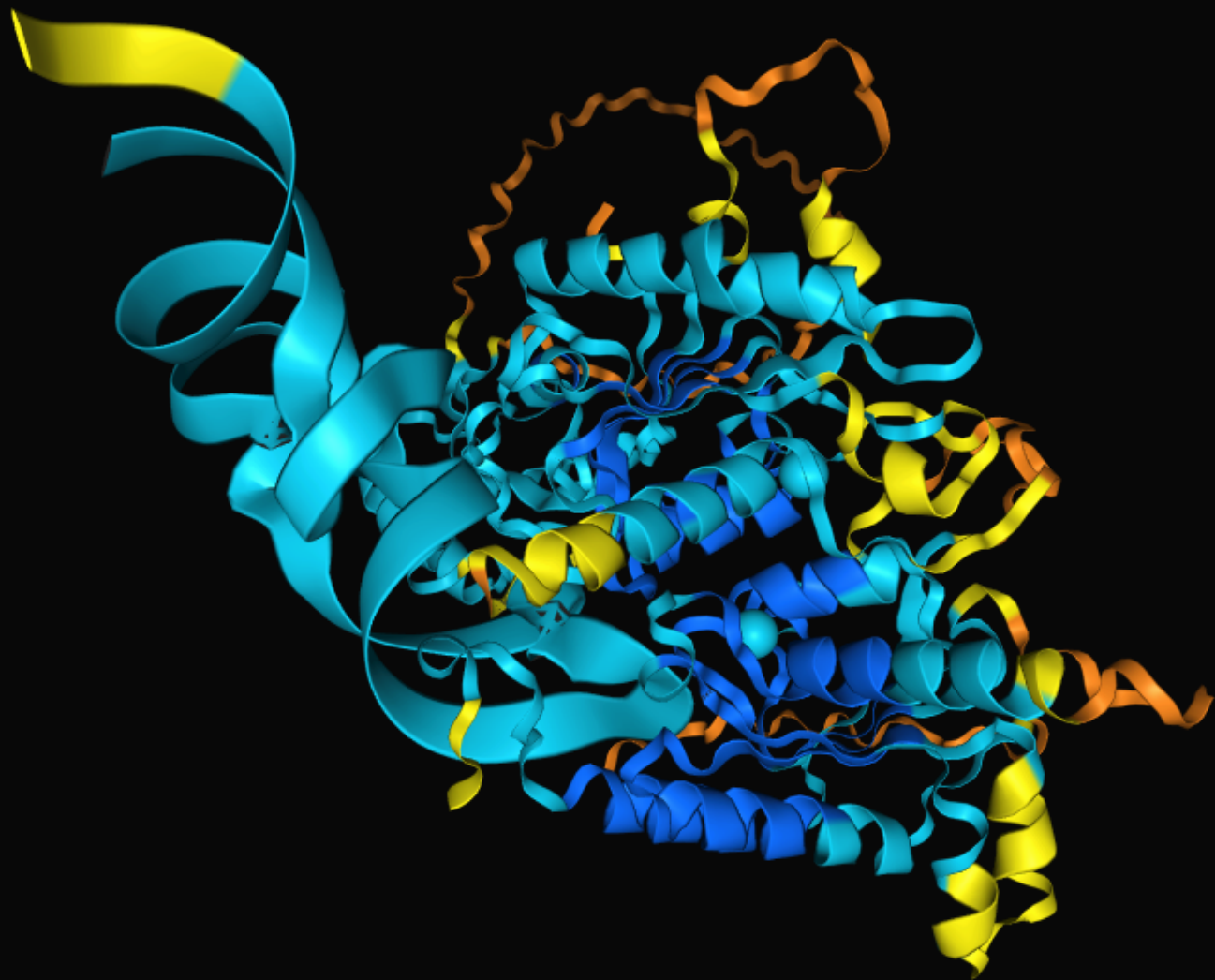
🏥 **Health:** E.g. Google's Health AI for breast cancer 🦴 screening or expanding access to ultrasound

🧬 **Science:** E.g. Google DeepMind's 🧬 AlphaFold (open access), or 📖 Math 🏆 Olympiad

🎒 **Education:** E.g. Khan Academy's Khanmigo, or Homework with Google Lens

🧑‍🎭 Deepfakes & 🧑‍🎭 misinformation spam - **and** their 🕵️ detection

Is (some of) this "*creative*"? Does 🧠 it "*think*"? What **really** is creativity and thinking... 🤔





You?

Machine Learning is a lot of fun! Get started with exploring it today:

1. gemini.google.com to learn "*Prompt Engineering*"
2. [Google AI Explorables](#)

Background:

1. [FT's GenAI](#)
2. [Poloclub Transformer Explainer](#)
3. [Tensorflow Playground](#)
4. [🤔 The Thinking Game 🎬 movie 🍿](#)

For developers:

1. [ML Zero to Hero x4 ~6' \(=24'\) Videos](#)
2. [Google Machine Learning Crash Course](#)
3. [TensorFlow Quickstart](#)

