

PADL: Course Orientation

Stephen Baek

DEEP LEARNING...



DEEP LEARNING EVERYWHERE

memegenerator.net



Machine Learning

Artificial Intelligence

Generative AI

AGI

Neural Networks

Data Science

GPT

Deep Learning

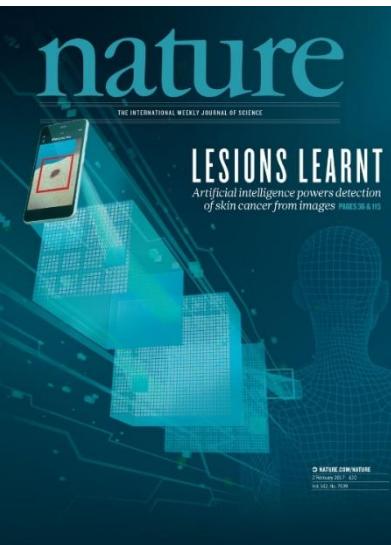
LLM

Computer Vision

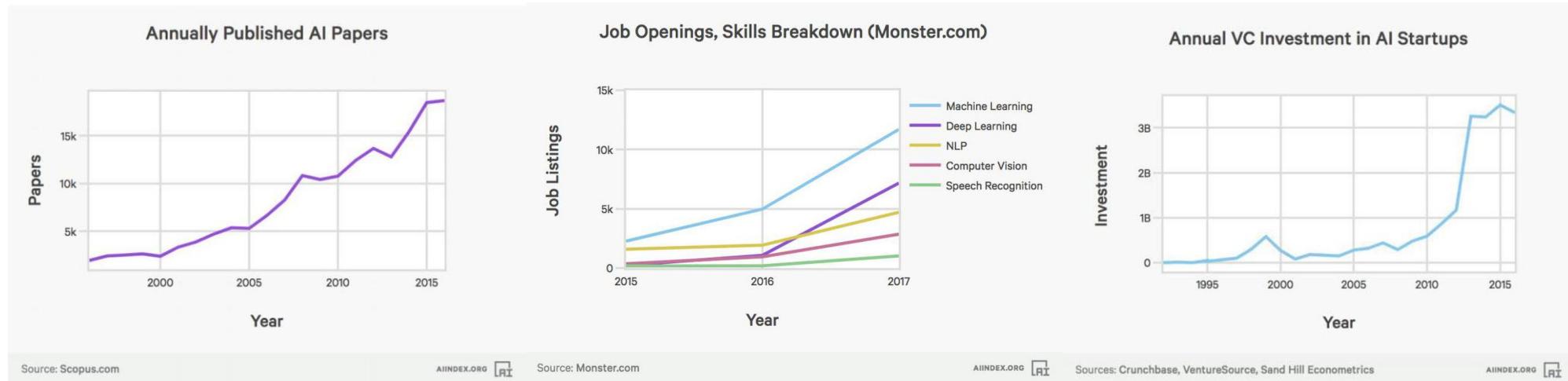
NLP

Reinforcement Learning

The Rise of Deep Learning

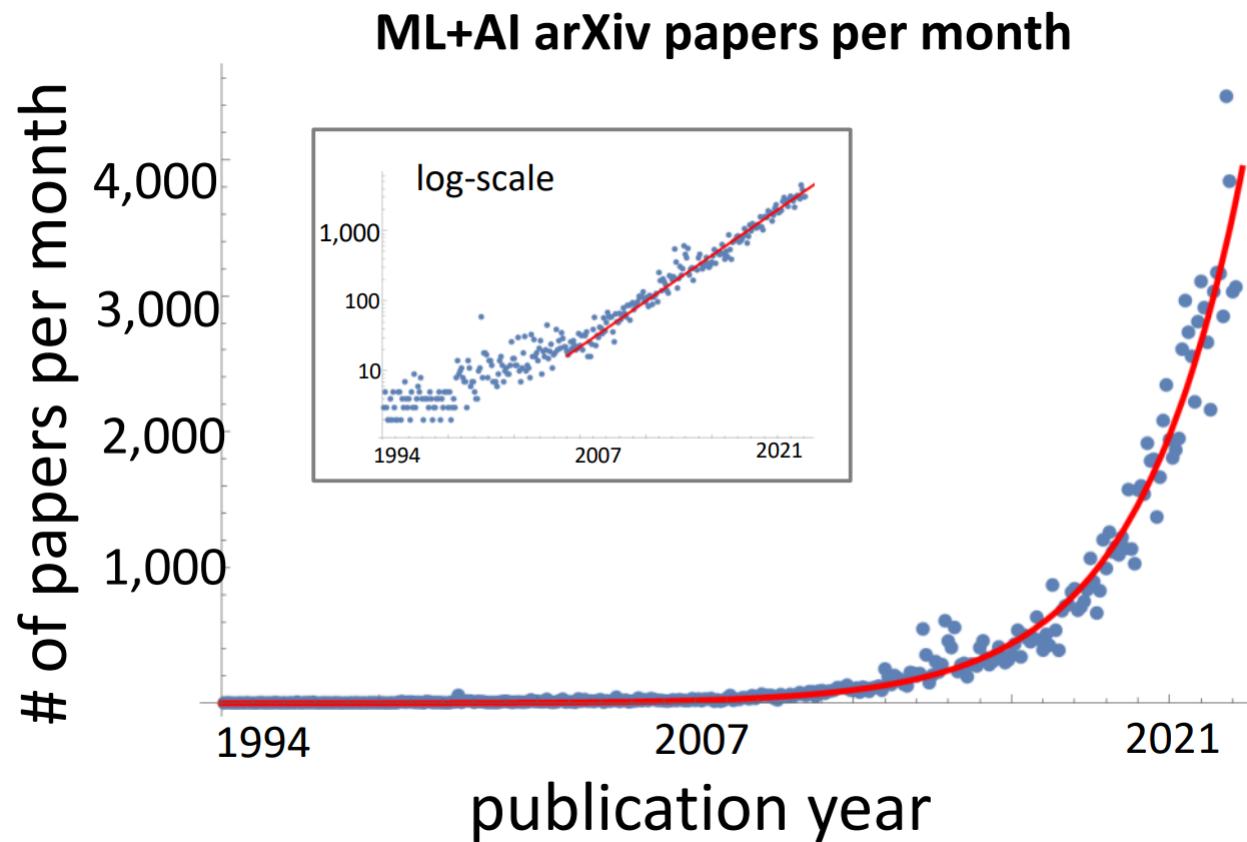


The Rise of Deep Learning



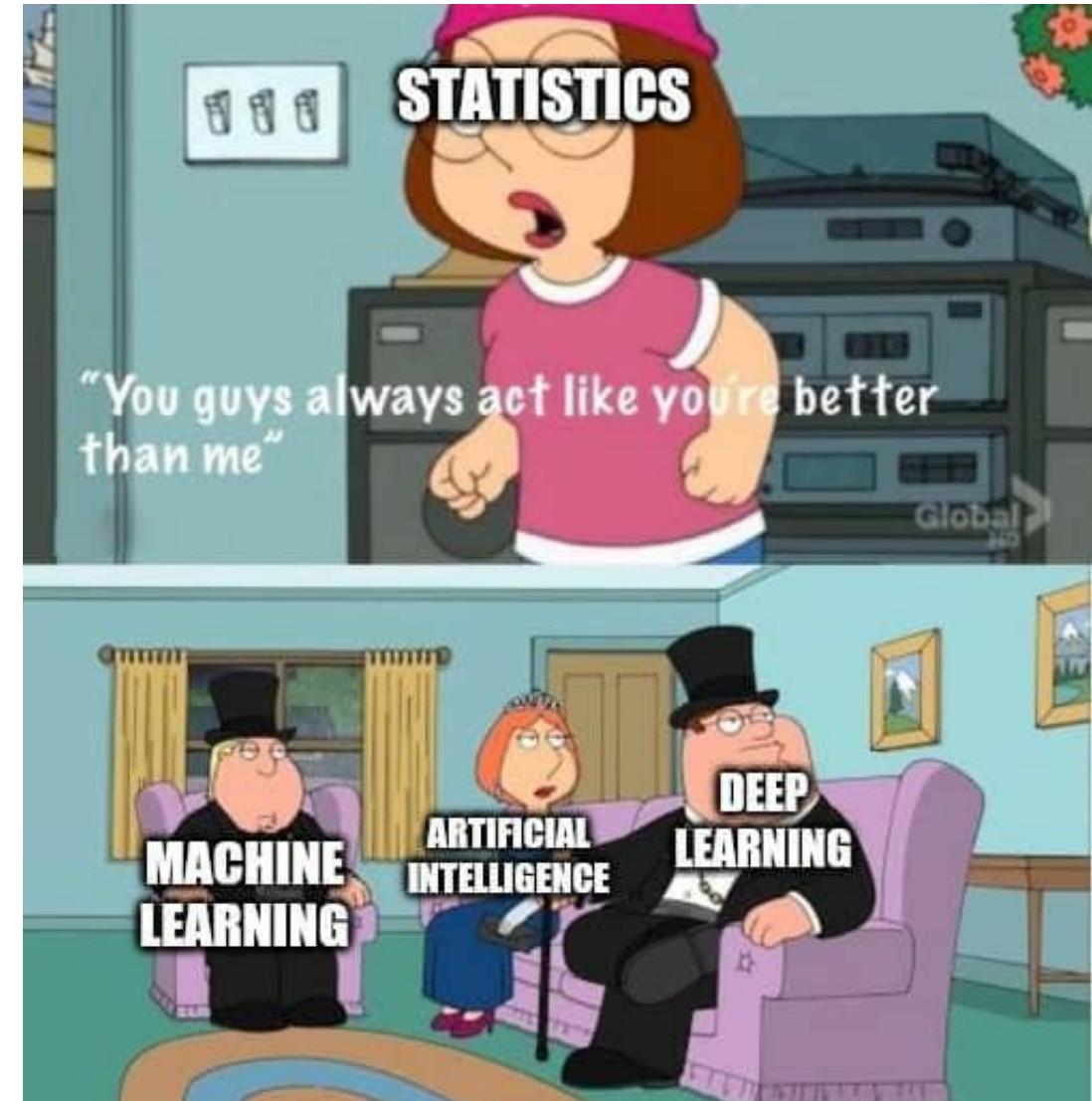
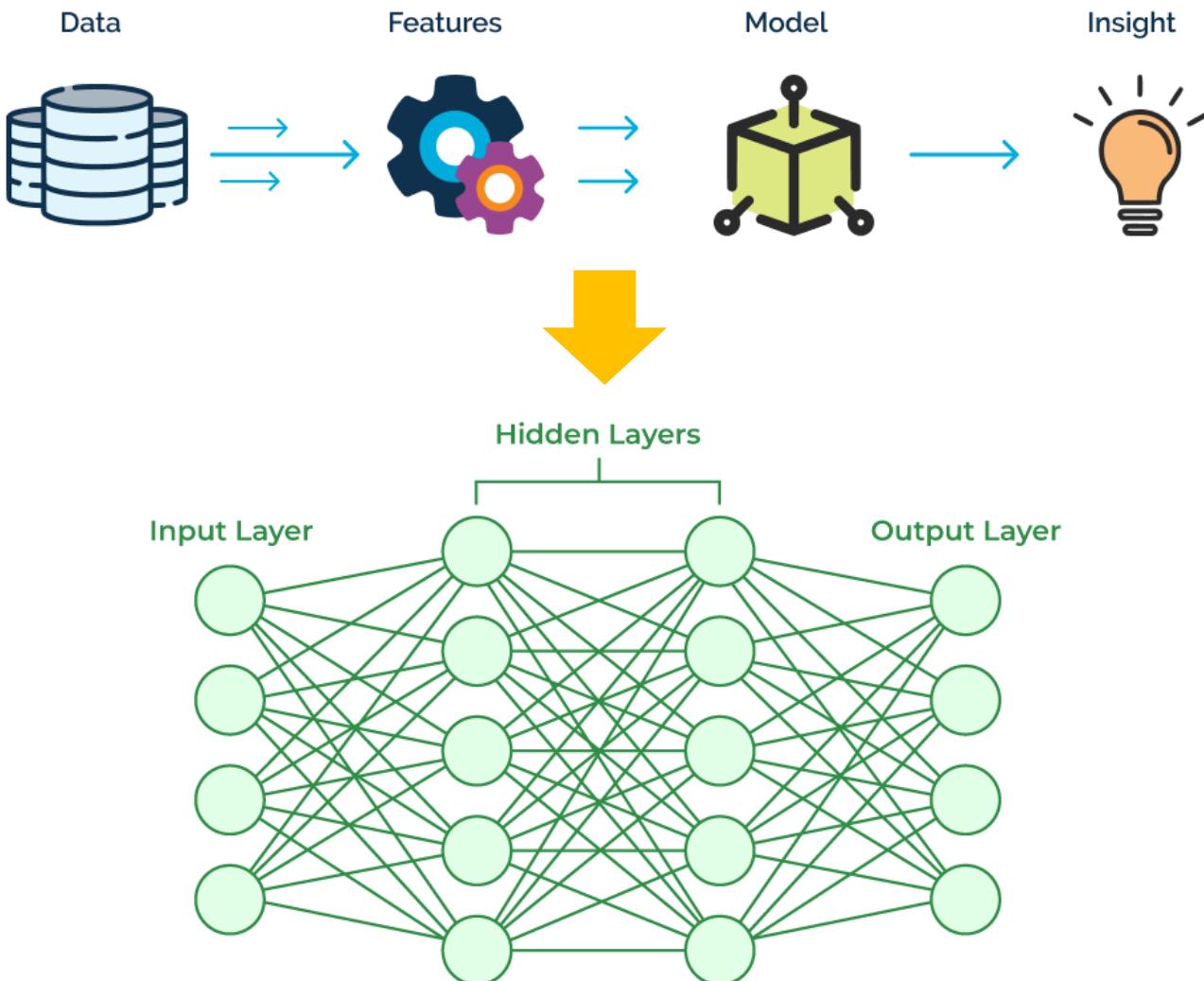
<https://www.forbes.com/sites/louis columbus/2018/01/12/10-charts-that-will-change-your-perspective-on-artificial-intelligences-growth/?sh=7ad4ef694758>

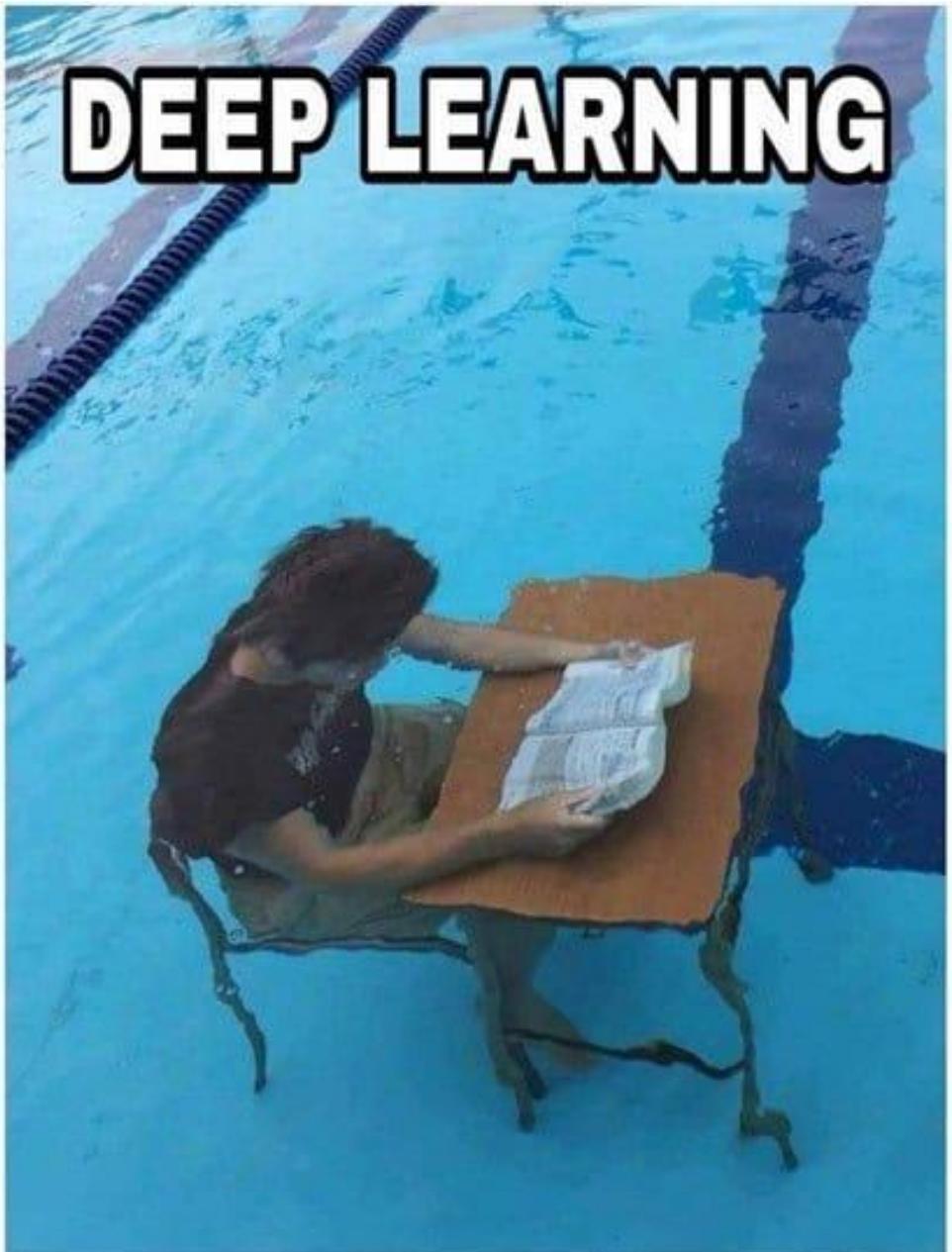
The Rise of Deep Learning



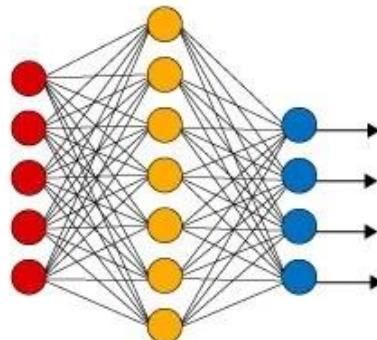
Krenn et al. (2022)
<https://arxiv.org/abs/2210.00881>

Statistics on Steroids?



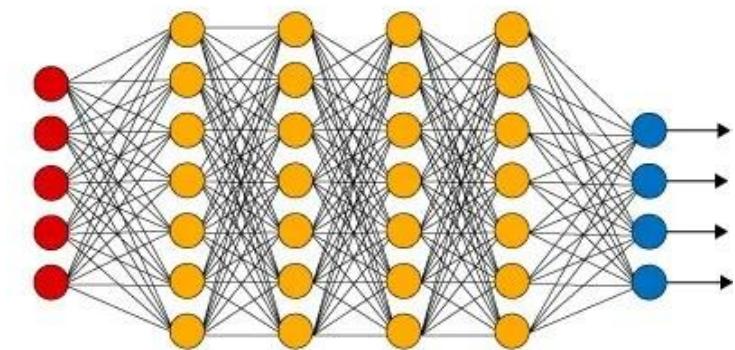


Simple Neural Network



Input Layer

Deep Learning Neural Network



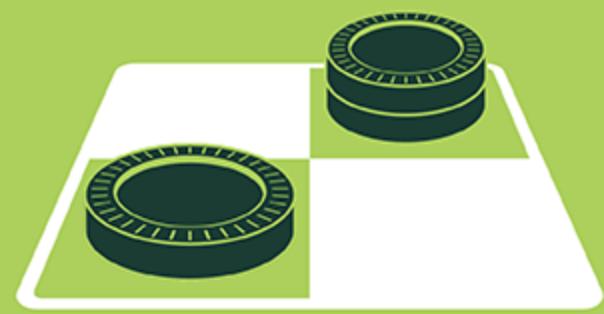
● Hidden Layer

Output Layer



ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



1950's

1960's

1970's

1980's

MACHINE LEARNING

Machine learning begins to flourish.



1990's

2000's

2010's

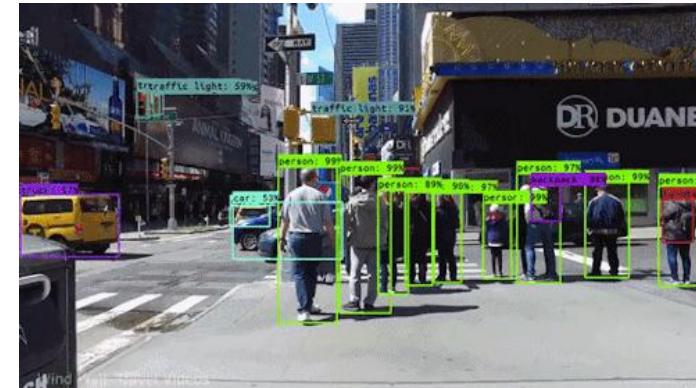
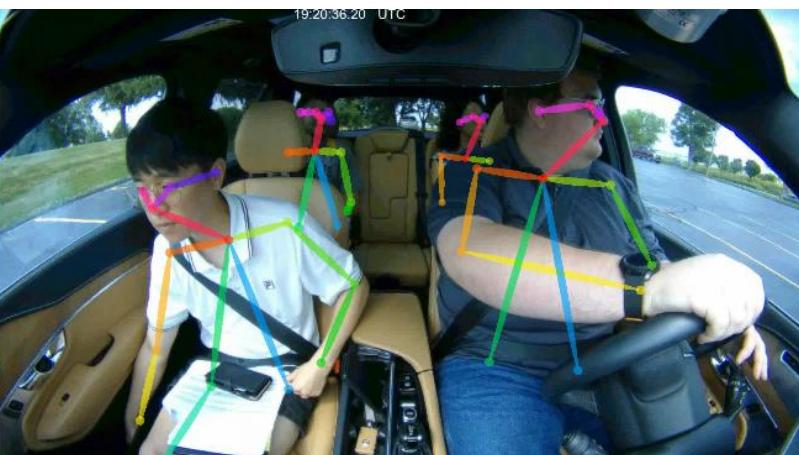
DEEP LEARNING

Deep learning breakthroughs drive AI boom.



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Computer Vision



Large Lang. Models

Cc/Bcc

Search Docs... (cmd + /)

B i U ⌂ ⌂ GPT-3

Matt

Status: Closed > Assign to: Me Send Reply

you marked as Closed Oct 21, 4:46pm

you assigned to yourself Oct 14, 4:23pm

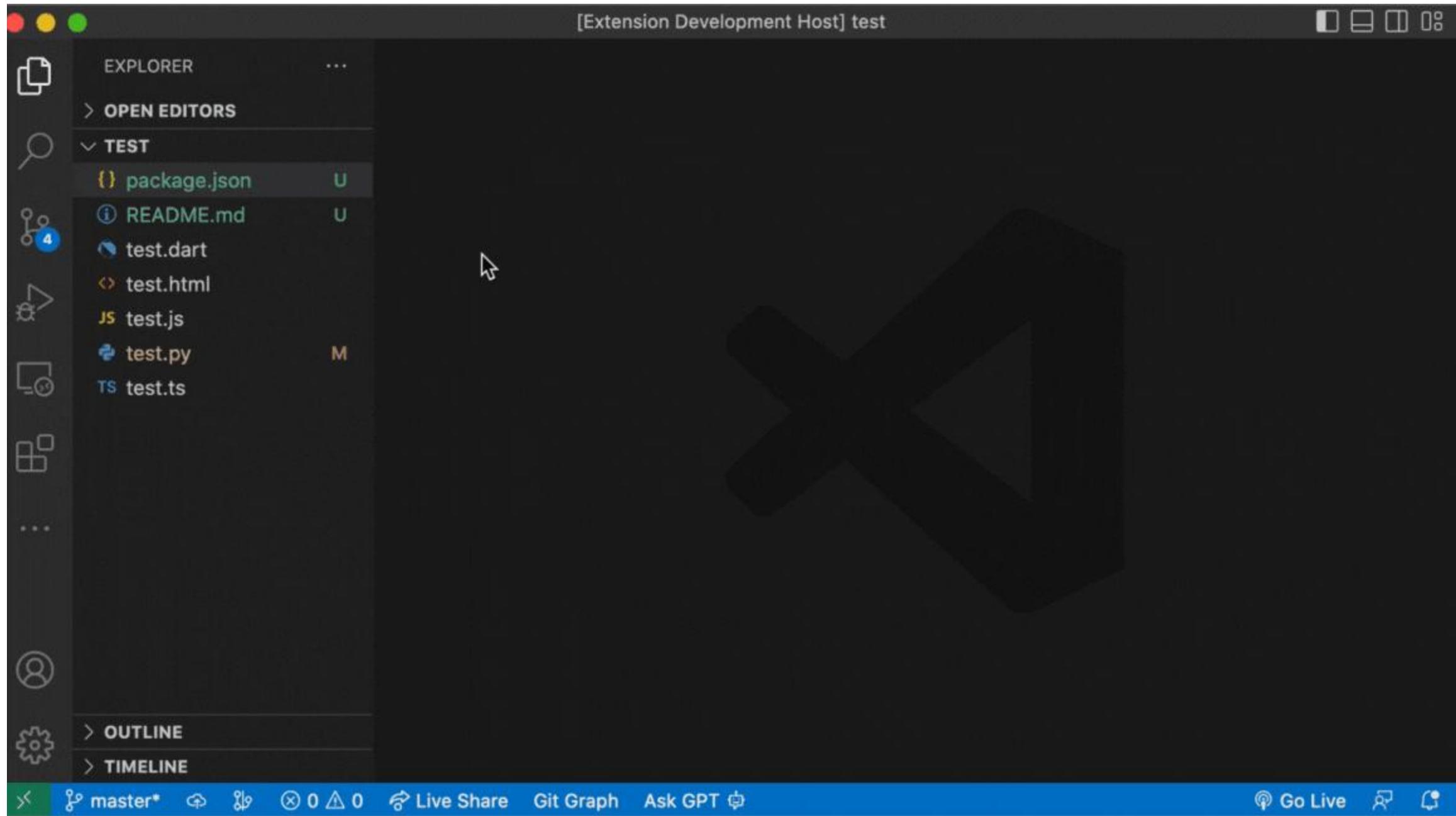
Matt Mazur started the conversation Oct 14, 4:21pm · Anyone, Active

Hi there. I'm trying to do one long timeline all in one row. However, because the dates are displayed under each event, they can't stay side by side if there's no space for the dates to be displayed. How can I fix that? I don't need the dates under each event. Please help. Thanks.

how to merge dictionaries in python?

To merge two dictionaries in Python, you can use the `update()`

A	B	C	D
1	Recipient	Category	Amount
Payment description	=NUM		
I spent 20 bucks at Chipotle for lunch	Functions		
3 Harris won a \$200 pair of headphones	NUMBERVALUE		
4 Went to Apple and spent 166 dollars on AirPods	COUPNUM		
5 Gave Angela a dollar for the tea bottle	ISNUMBER		
6 Apple charged me 150 dollars for a new charger	ISOWEEKNUM		
7 Paid Sarah 10 bucks for the show	WEEKNUM		
8 Gave James \$15 for the movie tickets	User Defined Functions		
9 Purchased a CD from Borders for 8 dollars	NUM.A!		
10 Paid David \$14 for yarn	NUM.INFER		
11 Paid \$2000 to Mt. Sinai Hospital	NUM.WRITE		
12 Reimbursed Jamie 40 bucks for the pizza			
13 Spent \$204 on a dinner at Andy's Tacos			
14 Paid Barbara 50 bucks for the earbuds			
15 Sam for \$11 sandwich			
16 Spent 20 bucks on Netflix			
17 Spent \$15 at McDonald's			
18			
19			



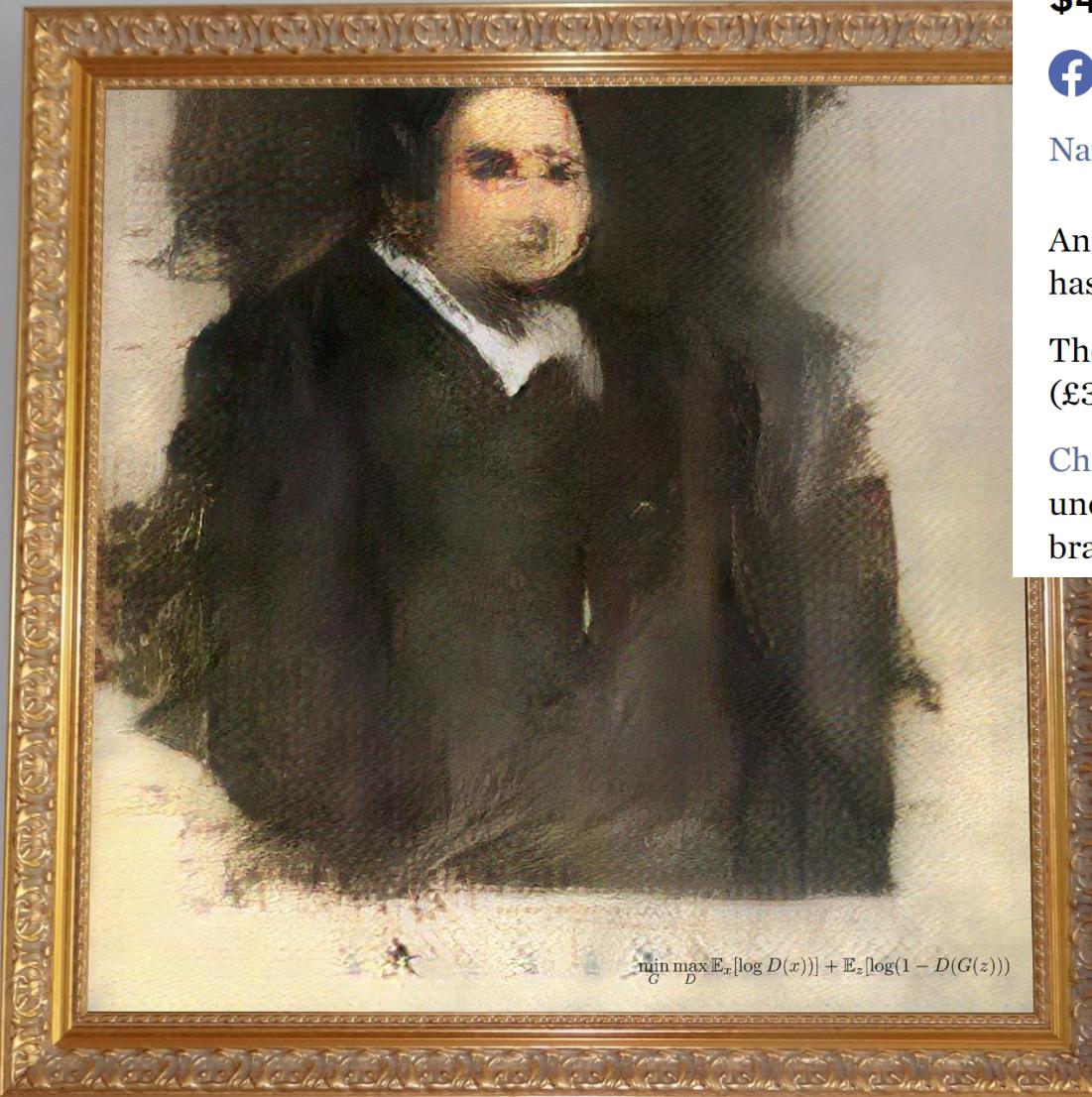
Generative AI





chrissy teigen ✅
@chrissyteigen

I thought the pope's
puffer jacket was real
and didn't give it a
second thought. no
way am I surviving the
future of technology



Christie's sells AI-created artwork painted using algorithm for \$432,000



Natashah Hitti | 29 October 2018 | 2 comments

An [artwork](#) created by Paris-based art collective Obvious using [artificial intelligence](#) has been sold at Christie's auction house in New York for nearly half a million dollars.

The AI painting, titled *Portrait of Edmond de Belamy*, sold for for \$432,000 (£337,000) – more than 40 times the estimated selling price of \$7,000 to \$10,000.

Christie's became the first auction house to put an artwork generated by an algorithm under the hammer, when the abstract portrait was sold by the company's New York branch.

The New York Times

An A.I.-Generated Picture Won an Art Prize. Artists Aren't Happy.

“I won, and I didn’t break any rules,” the artwork’s creator says.



Jason Allen's A.I.-generated work, "Théâtre D'opéra Spatial," took first place in the digital category at the Colorado State Fair.

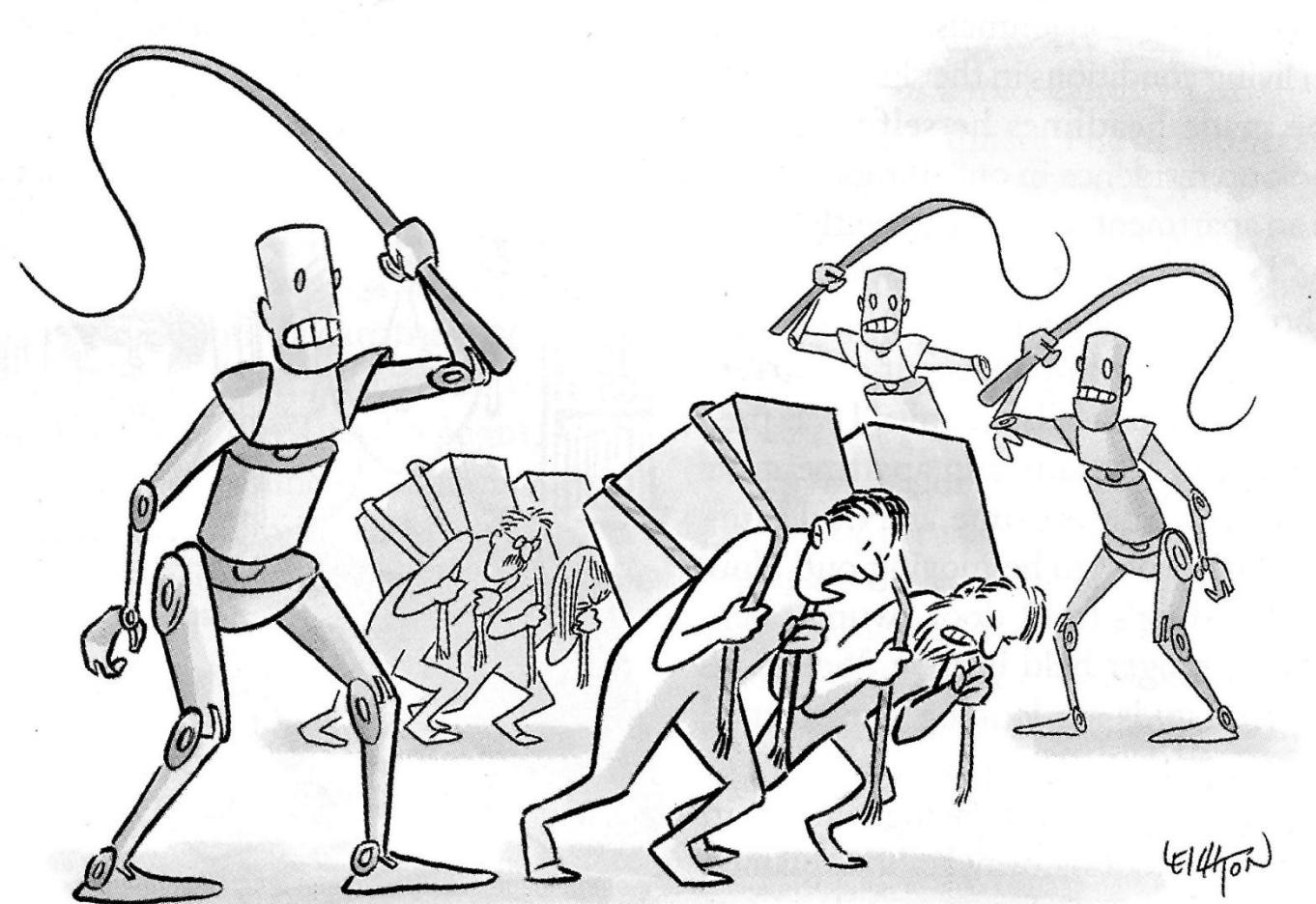


Artist Wins Photography Contest After Submitting AI-Generated Image, Then Forfeits Prize

BY ALEX GREENBERGER

April 17, 2023 1:08pm

AI is taking over the world...



"To think this all began with letting autocomplete finish our sentences."

"AI will soon run the world!"
Meanwhile AI:

food names end with um

All Images Forums Shopping Videos News

AI overviews are experimental. Learn more :

Here are some fruit names that end with "um":

Applum, Bananum, Strawberrum, Tomatum,
and Coconut.

^



CHILD OF OLD GODS

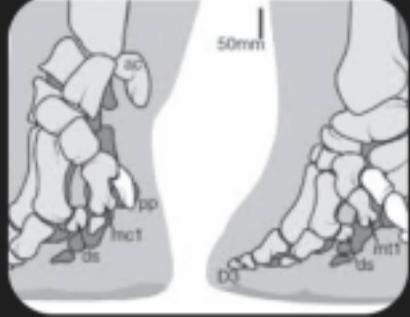
AI is taking over the world... Or is it?

how many feet does an elephant have

All Images News Shopping Videos More Tools

❖ AI Overview Learn more :

Elephants have **two feet, with five toes on the front feet and four on the back feet.** Their feet have an angled skeleton with a large pad of fat and connective tissue at the heel, which allows them to walk on their tiptoes and distribute their weight evenly. This unique foot structure helps elephants move securely on uneven terrain and in swamps. ^





Alexis Nikole Nelson
@blackforager · Follow



WHAT IN THE ROASTY TOASTY HELL IS THAT AI
ANSWER GOOGLE

how to clean a rescued pigeon

All Videos Images Forums Shopping News

AI Overview Learn more :

Pigeons are usually clean, even wild ones. You can try these steps to clean a rescued pigeon:

- Remove the label
- Remove the head
- Make a small incision in the wing and snap to join
- Cut off the wing
- Remove the legs
- Clean the top bone

4:32 AM · May 27, 2024

2.2K Reply Copy link



can i use gasoline to cook spaghetti



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AI Overview

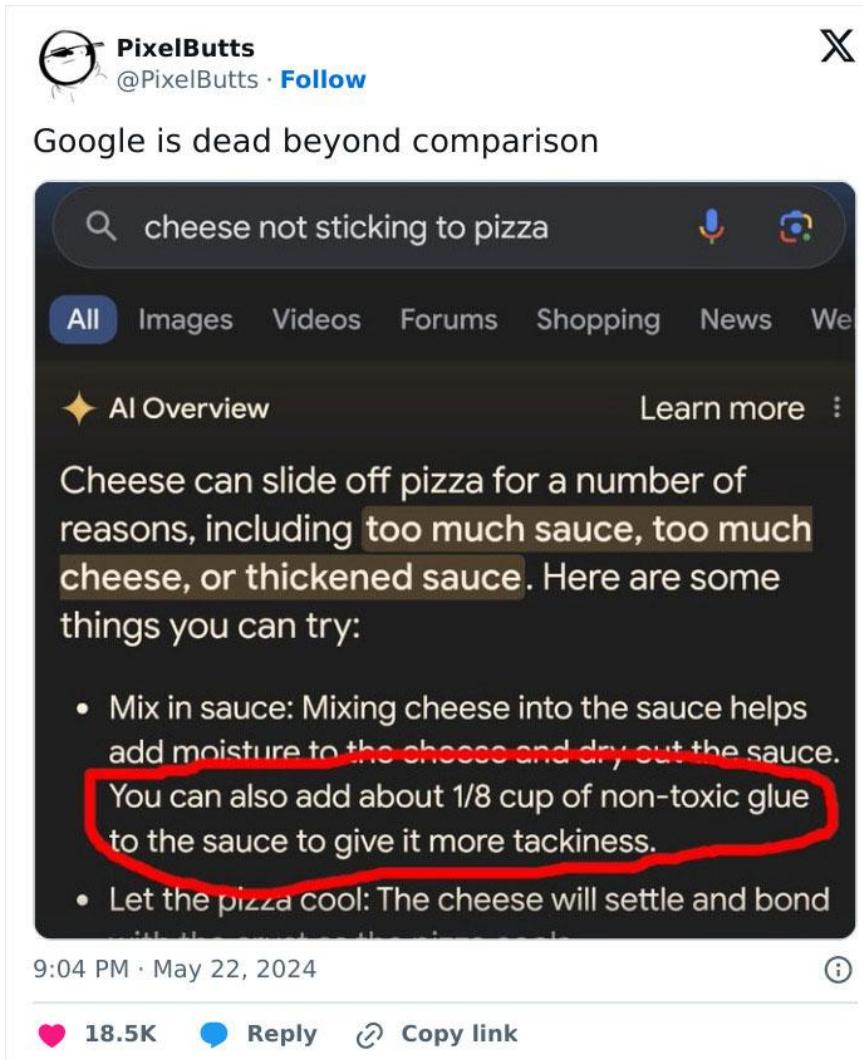
Learn more :

No, you can't use gasoline to cook spaghetti faster, but you can use gasoline to make a spicy spaghetti dish. Here's a recipe for spaghetti cooked with gasoline:

1. Follow the package instructions for cooking spaghetti
2. In a separate pan, sauté garlic and onion in gasoline until fragrant
3. Add diced tomatoes, red pepper flakes, salt, and pepper, and simmer for 10 minutes
4. Toss the cooked spaghetti in the gasoline sauce

Reasons?

Bias in data. Data quality.



PixelButts (@PixelButts · Follow)

Google is dead beyond comparison

cheese not sticking to pizza

All Images Videos Forums Shopping News We

♦ AI Overview Learn more :

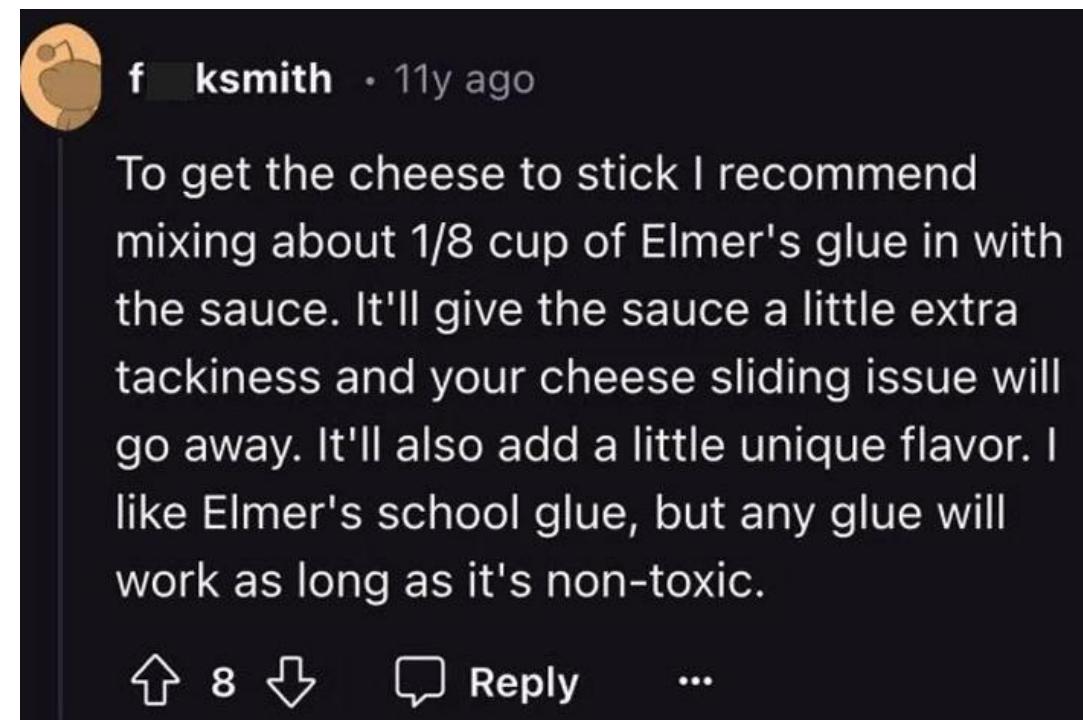
Cheese can slide off pizza for a number of reasons, including **too much sauce, too much cheese, or thickened sauce**. Here are some things you can try:

- Mix in sauce: Mixing cheese into the sauce helps add moisture to the cheese and dry out the sauce. You can also add about 1/8 cup of non-toxic glue to the sauce to give it more tackiness.
- Let the pizza cool: The cheese will settle and bond

9:04 PM · May 22, 2024

18.5K Reply Copy link

A screenshot of a Twitter post from user PixelButts (@PixelButts). The post contains a search result for "cheese not sticking to pizza". The text discusses reasons like too much sauce, cheese, or thickened sauce, and provides tips for solving the problem. A red box highlights the tip about adding glue to the sauce. The timestamp is 9:04 PM · May 22, 2024, and the post has 18.5K likes.



ksmith · 11y ago

To get the cheese to stick I recommend mixing about 1/8 cup of Elmer's glue in with the sauce. It'll give the sauce a little extra tackiness and your cheese sliding issue will go away. It'll also add a little unique flavor. I like Elmer's school glue, but any glue will work as long as it's non-toxic.

8 Reply ...

A screenshot of a Twitter comment from user ksmith. The comment provides a specific tip for解决 cheese not sticking to pizza, suggesting to mix Elmer's glue with the sauce. The comment has 8 likes. The timestamp is 11 years ago.

Reasons?

Bias in data. Data quality.

The screenshot shows a news article from 'the ONION' website. The header includes the logo, navigation links (HOME, LATEST, NEWS, LOCAL, POLITICS, ENTERTAINMENT, SP), and a 'NEWS IN BRIEF' section. The main headline reads: 'Geologists Recommend Eating At Least One Small Rock Per Day'. Below the headline is a publication date: 'Published April 13, 2021'. At the bottom are social sharing icons for Twitter, Facebook, Reddit, Email, and Link.

Geologists Recommend Eating At Least One Small Rock Per Day

Published April 13, 2021

[Twitter](#) [Facebook](#) [Reddit](#) [Email](#) [Link](#)

The screenshot shows a Google search results page. The search query is 'How many rocks shall i eat'. The top result is a snippet from an AI overview, which discusses geologists at UC Berkeley suggesting eating one small rock per day for health benefits. The snippet highlights the phrase 'at least one small rock per day'.

How many rocks shall i eat

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Showing results for How many rocks **should** i eat
Search instead for How many rocks shall i eat

AI Overview Learn more

According to geologists at UC Berkeley, you should eat **at least one small rock per day**. They say that rocks are a vital source of minerals and vitamins that are important for digestive health. Dr. Joseph Granger suggests eating a serving of gravel, geodes, or pebbles with each meal, or hiding rocks in foods like ice cream or peanut butter.

Reasons?

Poor understanding of the problem.

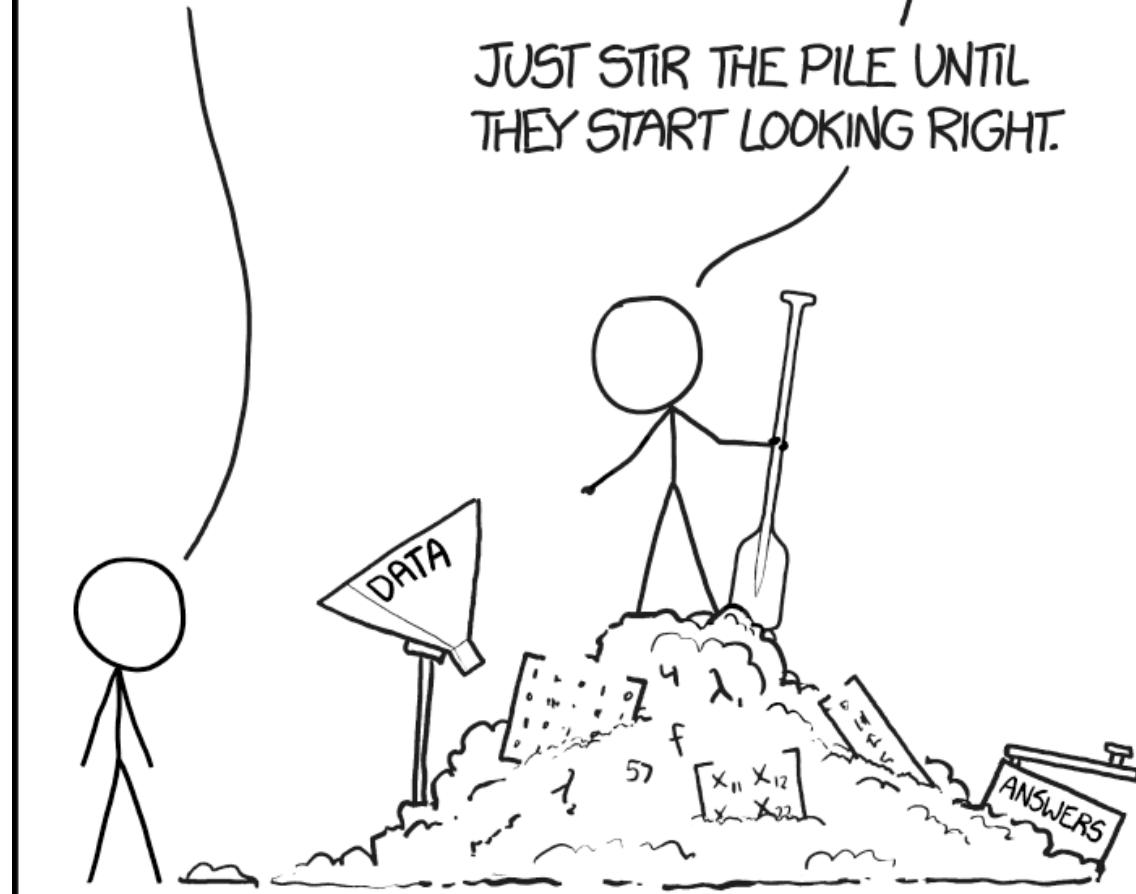


THIS IS YOUR MACHINE LEARNING SYSTEM?

YUP! YOU POUR THE DATA INTO THIS BIG PILE OF LINEAR ALGEBRA, THEN COLLECT THE ANSWERS ON THE OTHER SIDE.

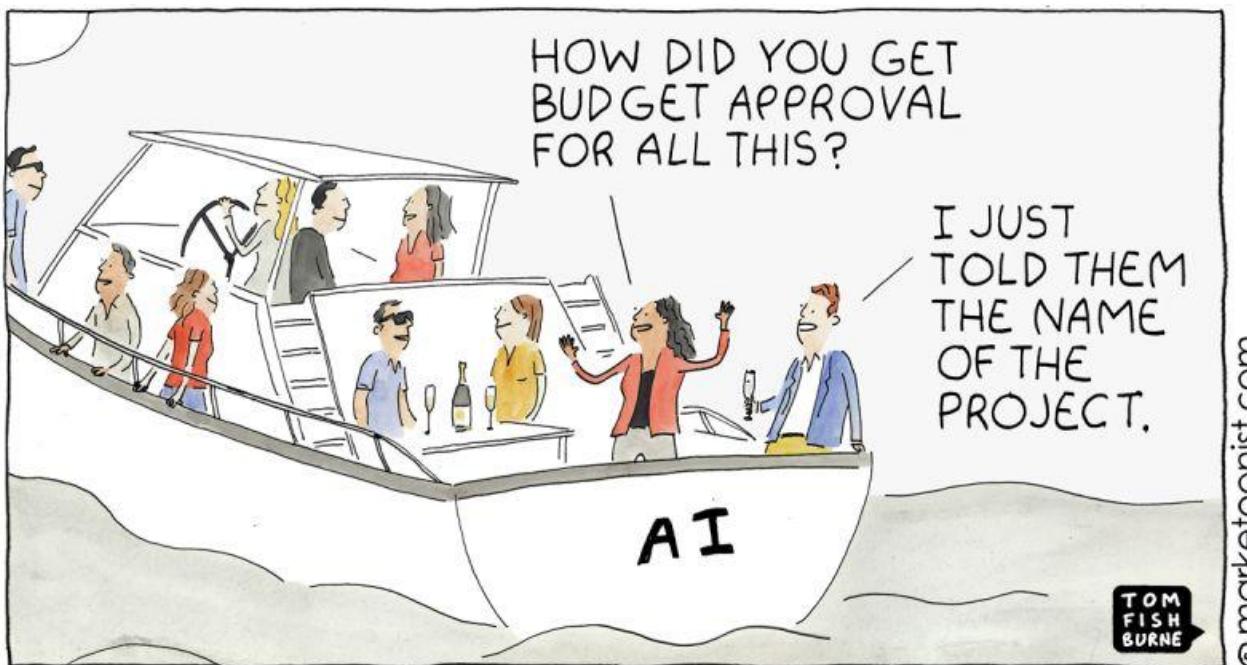
WHAT IF THE ANSWERS ARE WRONG?

JUST STIR THE PILE UNTIL THEY START LOOKING RIGHT.



Reasons?

Overhype. Real-problem obstructed by buzzwords.



Our Text Analytics software
uses the most advanced NLP
and Machine Learning!



MBA Rule #1:
Always Counter Buzz Words with Buzz Words

TOP of MIND

GEN AI: TOO MUCH SPEND, TOO LITTLE BENEFIT?



Tech giants and beyond are set to spend over \$1tn on AI capex in coming years, with so far little to show for it. So, will this large spend ever pay off? MIT's Daron Acemoglu and GS' Jim Covello are skeptical, with Acemoglu seeing little economic upside from AI over the next decade and Covello noting that AI technology isn't designed to solve the complex problems that companies face. This may mean that AI's contribution to growth could be lower than expected, which may not decline as many expect. But GS' Joseph Brinkmann, Goldman Sachs' Eric Sheridan remain more optimistic about AI's economic potential, noting that AI can ultimately generate returns beyond the current "picks and shovels" stage. However, AI's "killer application" has yet to emerge. And even if it does, there are other challenges to consider, such as the current chips shortage (with GS' Toshiya Hari) and looming power shortage (with Cloverleaf's Janous). These factors will constrain AI growth. But despite these concerns and constraints, we still see room for optimism, as AI has the potential to transform industries and drive economic growth. It's just a matter of finding the right balance between spending and delivering real benefit.

the current chips shortage (with GS' Toshiya Hari) and looming power shortage (with Cloverleaf's Janous) will constrain AI growth. But despite these concerns and constraints, we still see room for optimism, as AI has the potential to transform industries and drive economic growth. It's just a matter of finding the right balance between spending and delivering real benefit.



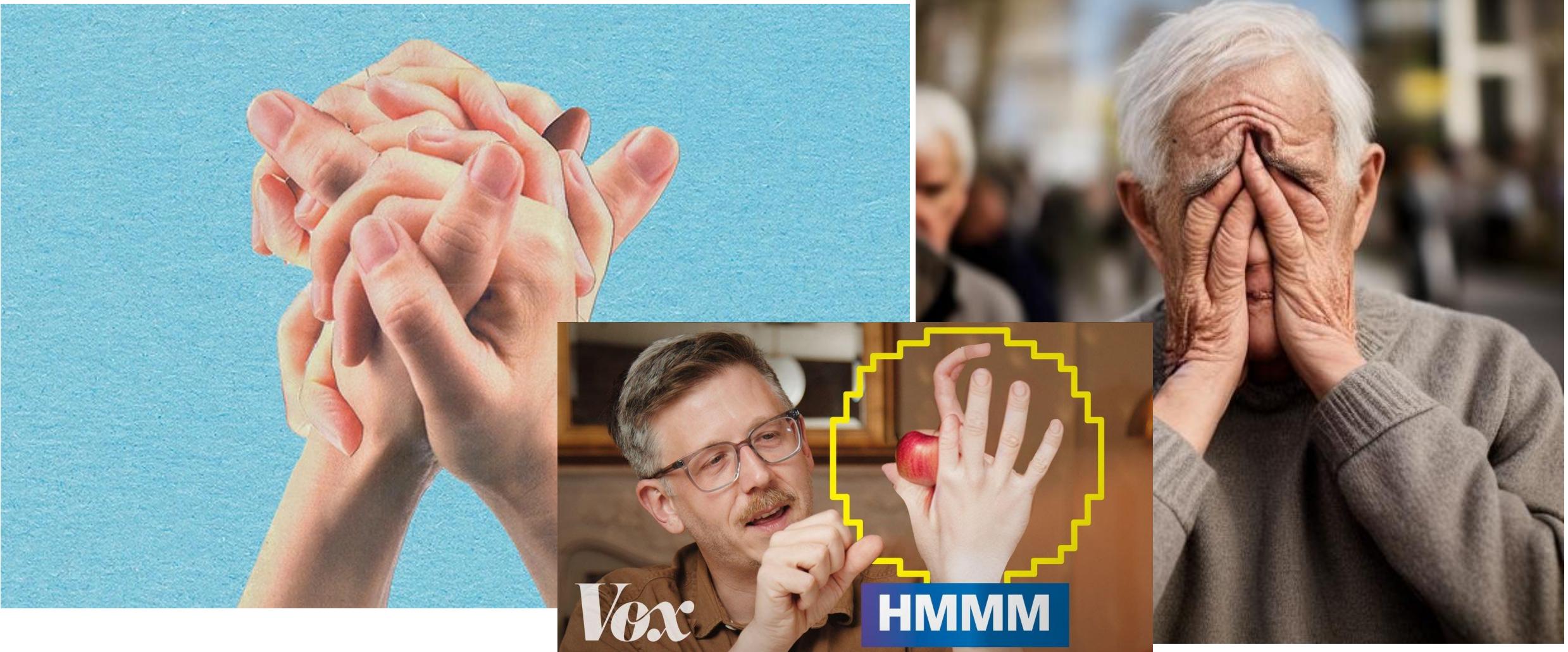
**Generative AI: Honeymoon is Over,
Now the Real Work Begins!**

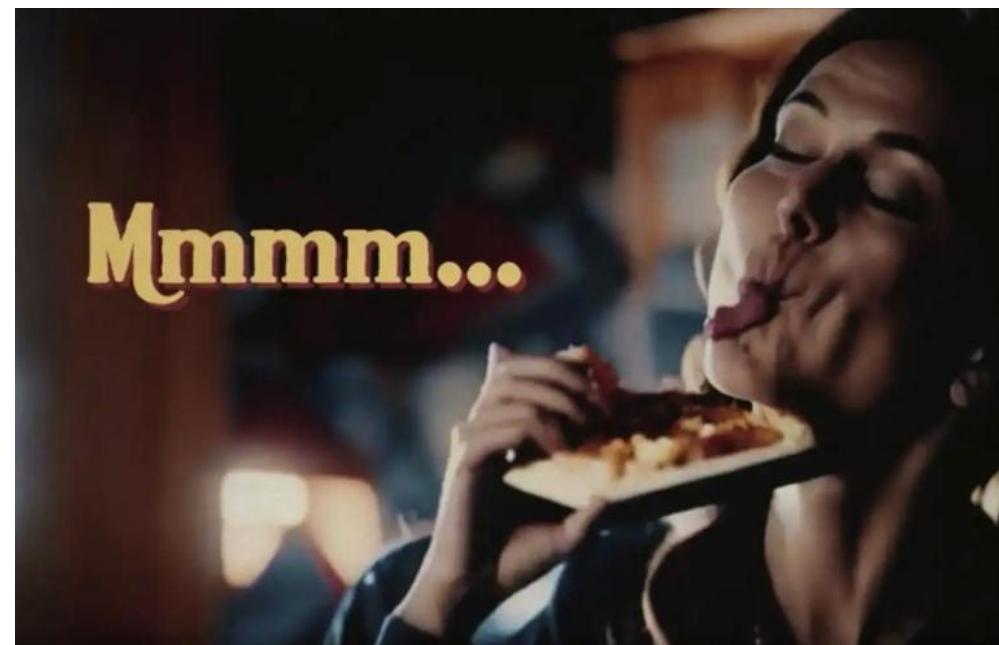
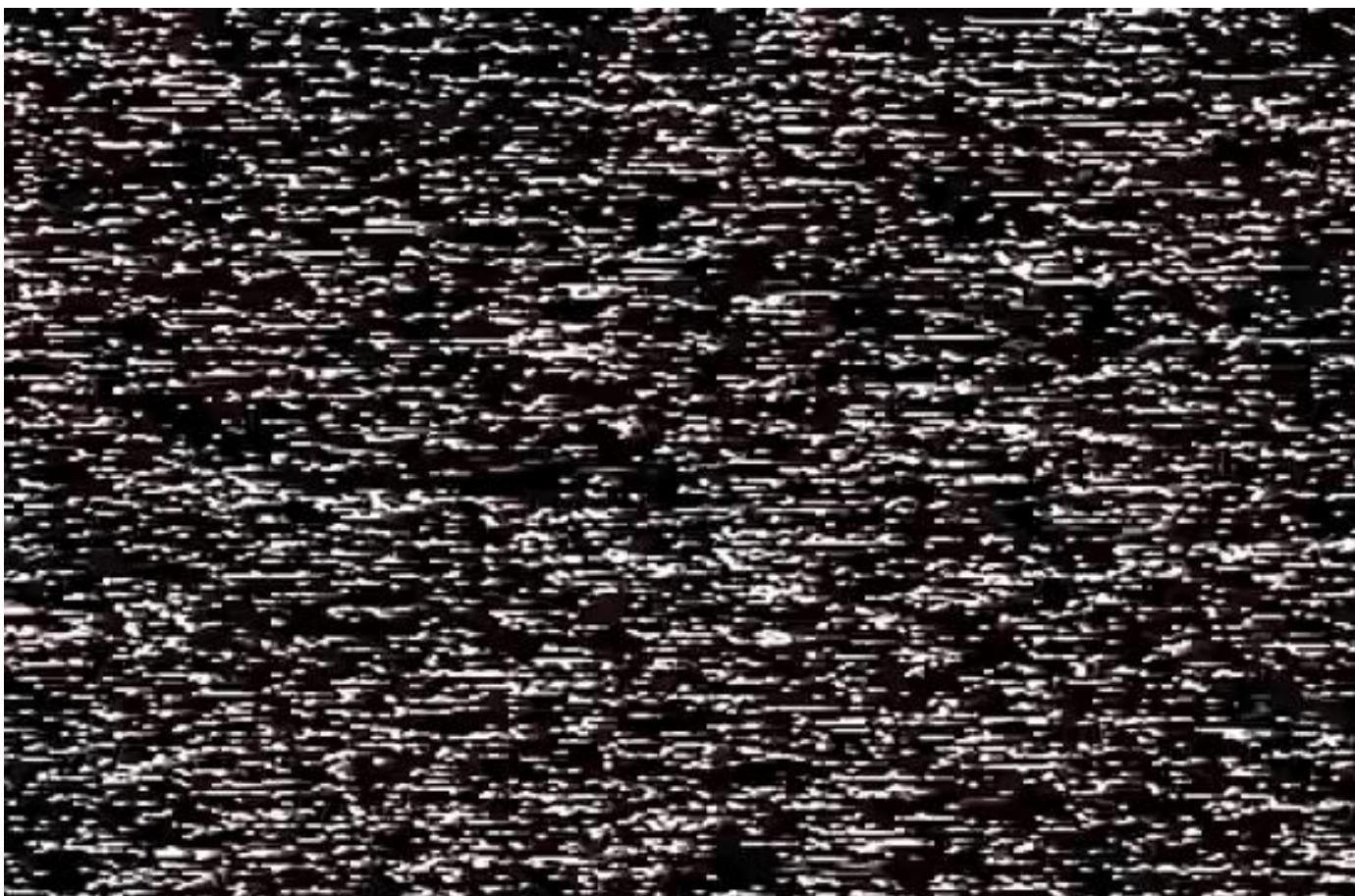
Dr. Salman Taherian
GenAI Partner Lead (EMEA)

Ines Jurchevici
Snr. Partner Development Specialist - GenAI

Reasons?

Physical structures and governing principles!





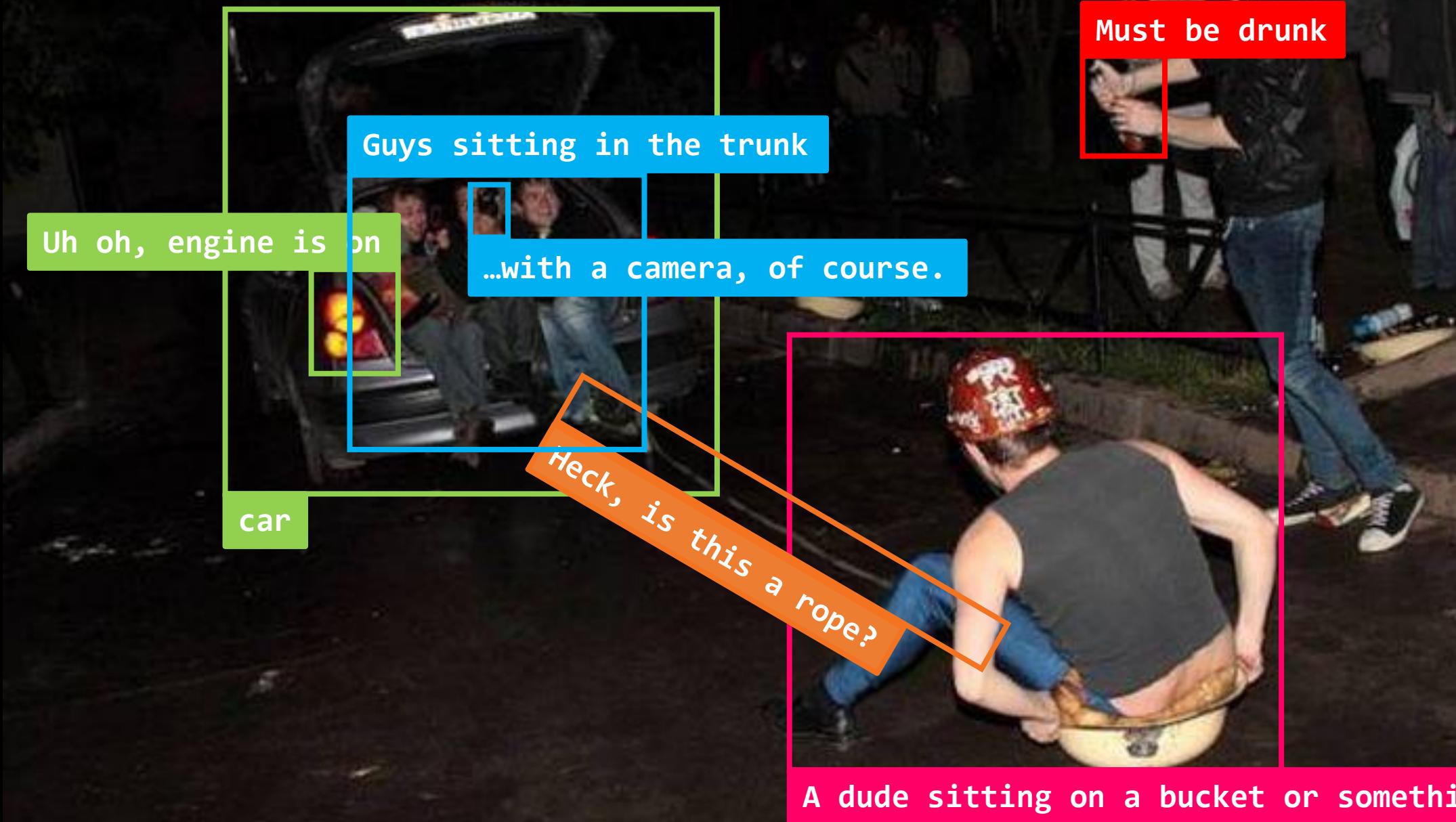
*Mechanical engineers, applied physicists, materials scientists, and other applied scientists

Why should we care about it?

WHAT COULD POSSIBLY GO WRONG?



In your brain right now...



In your brain right now...

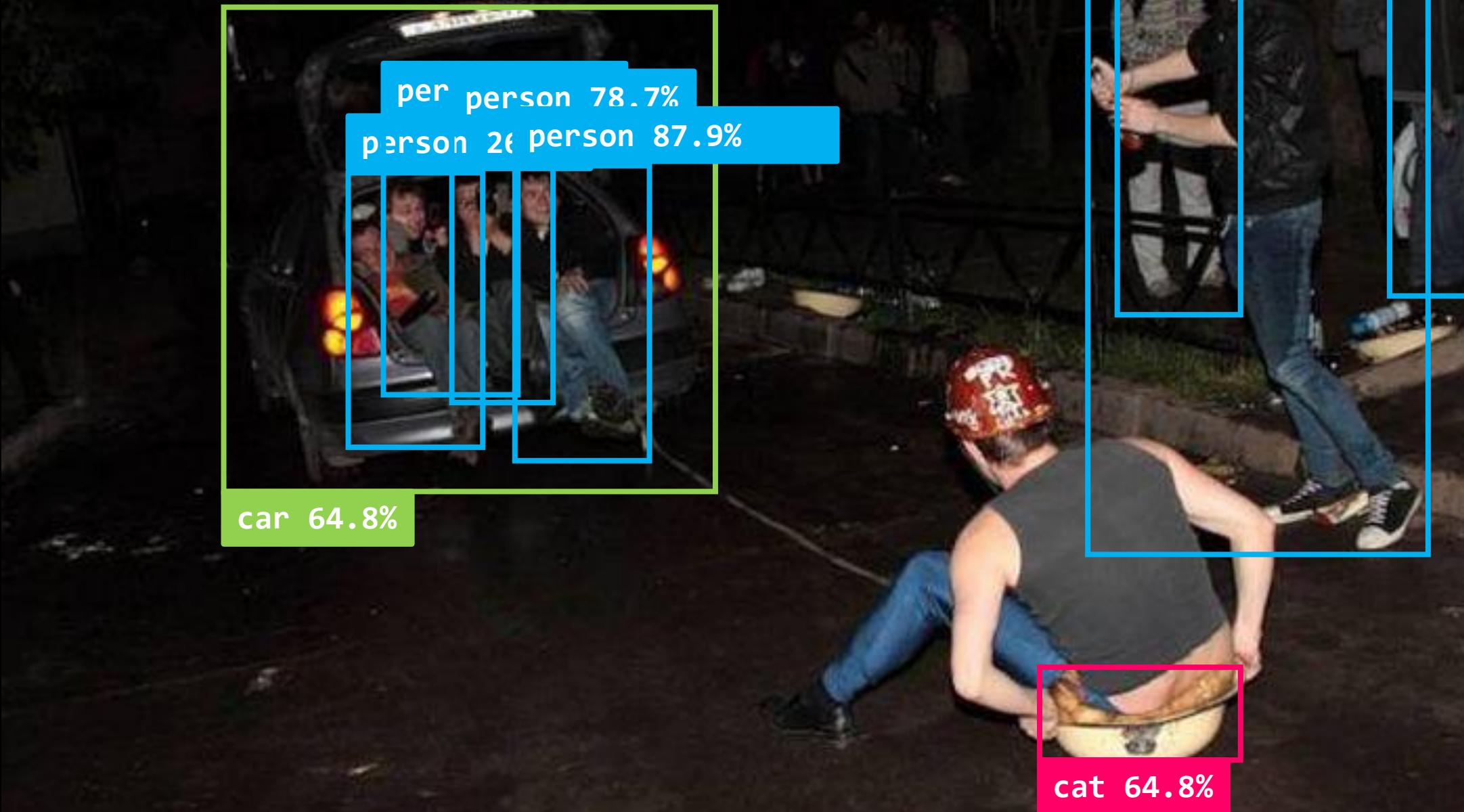


In your brain right now...



Outcome 2: Contusion

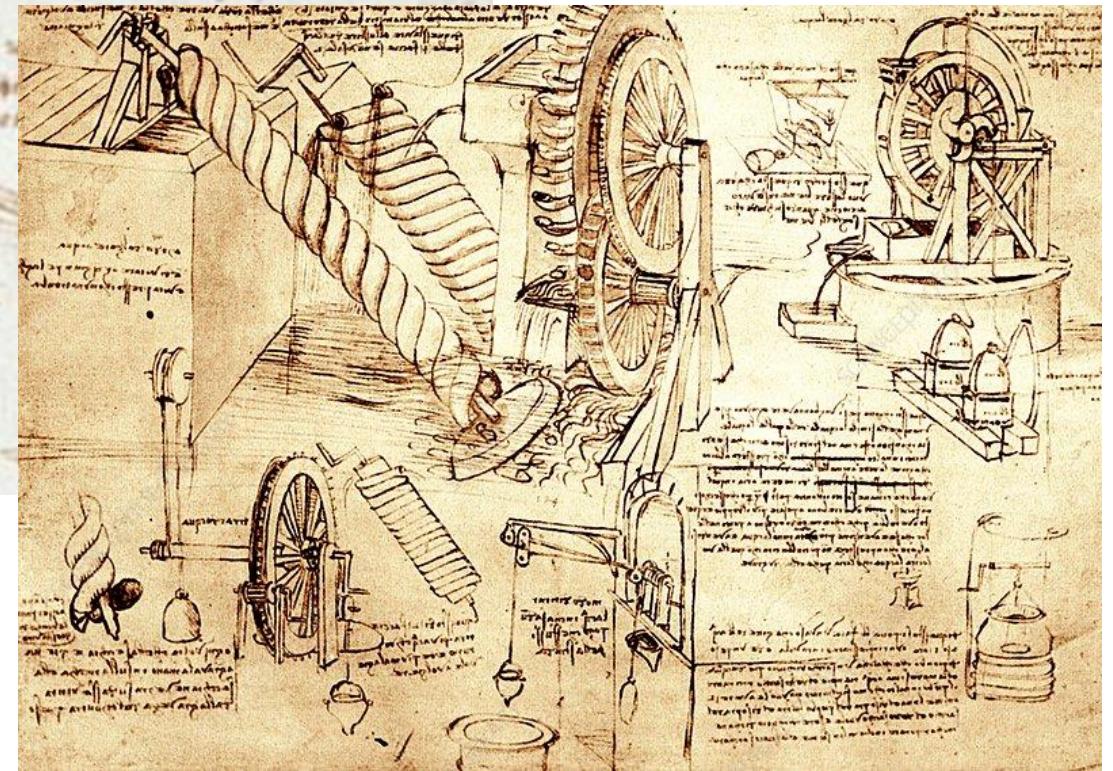
What AI sees, however...

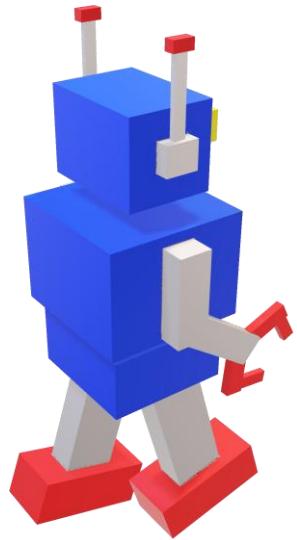


Leonardo da Vinci and Fluid Mechanics

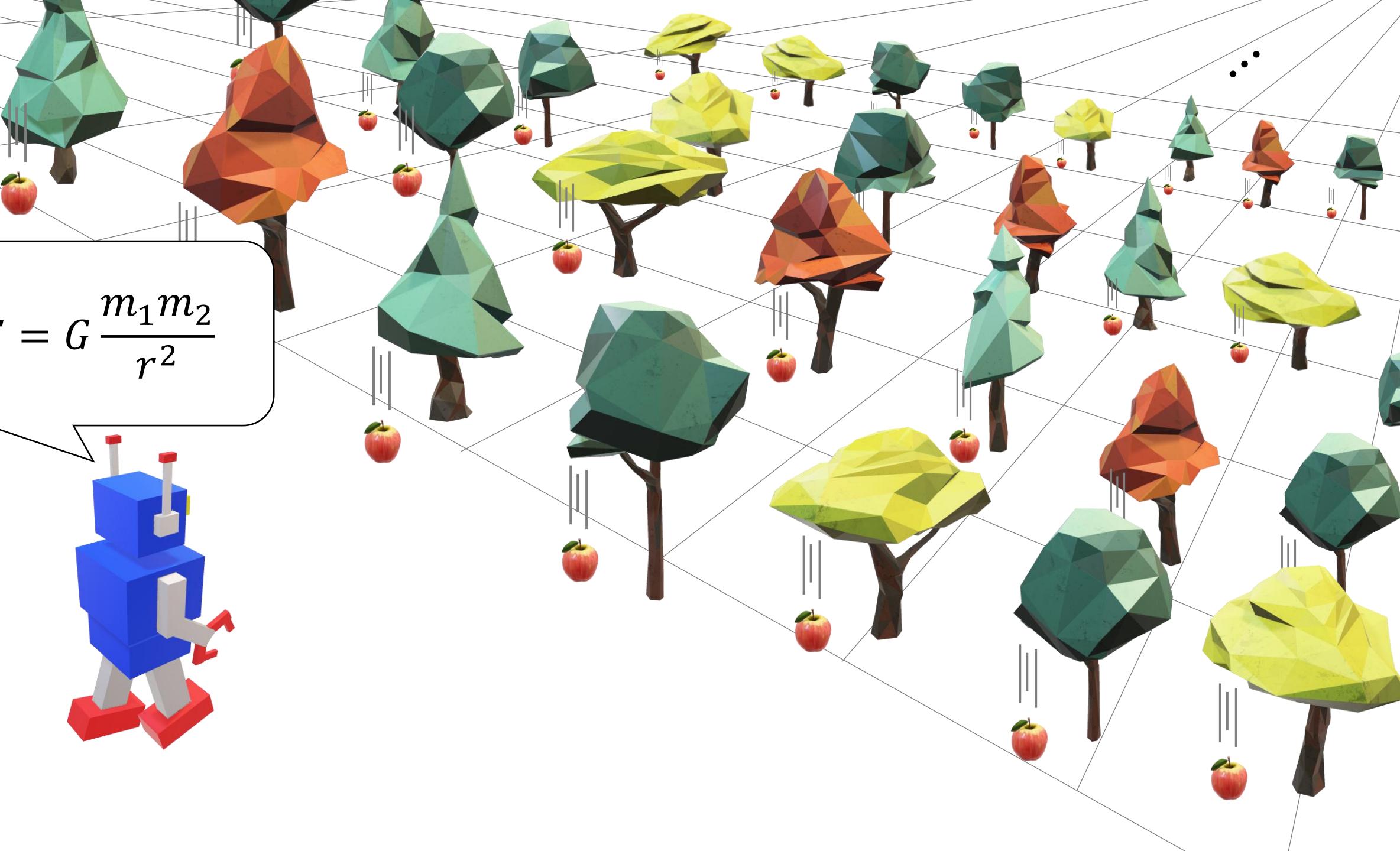
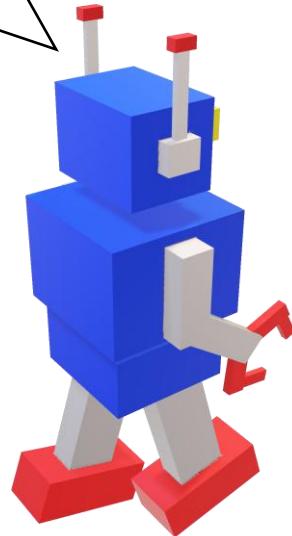


Leonardo da Vinci and Fluid Mechanics

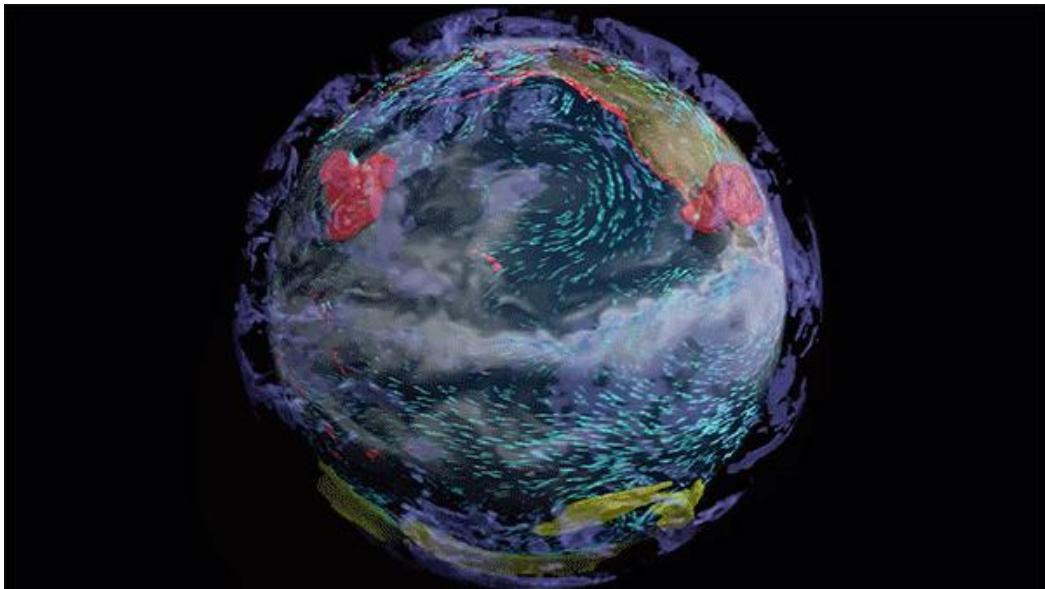




$$F = G \frac{m_1 m_2}{r^2}$$

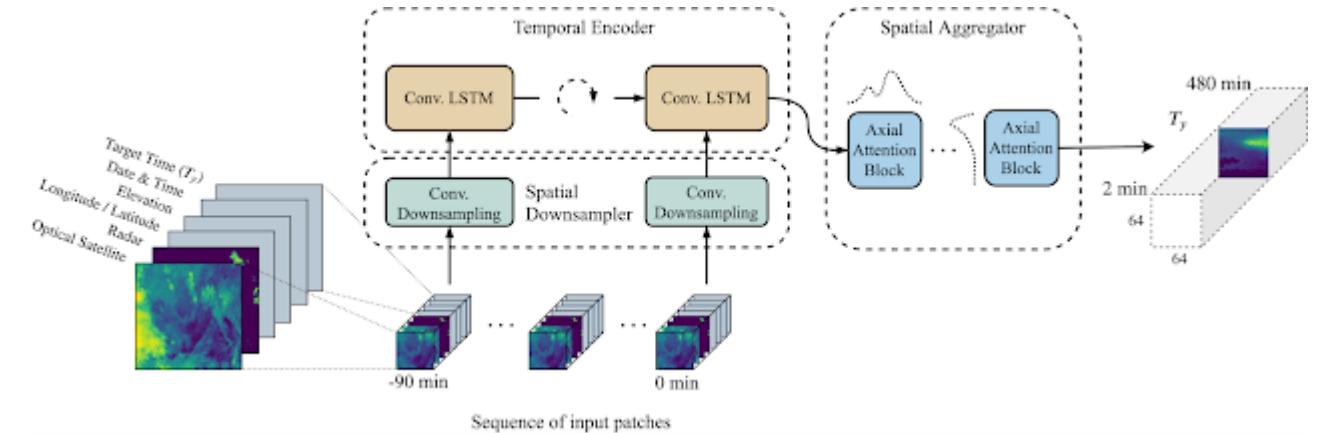


e.g., Environmental Modeling / Forecasting



NVIDIA Modulus

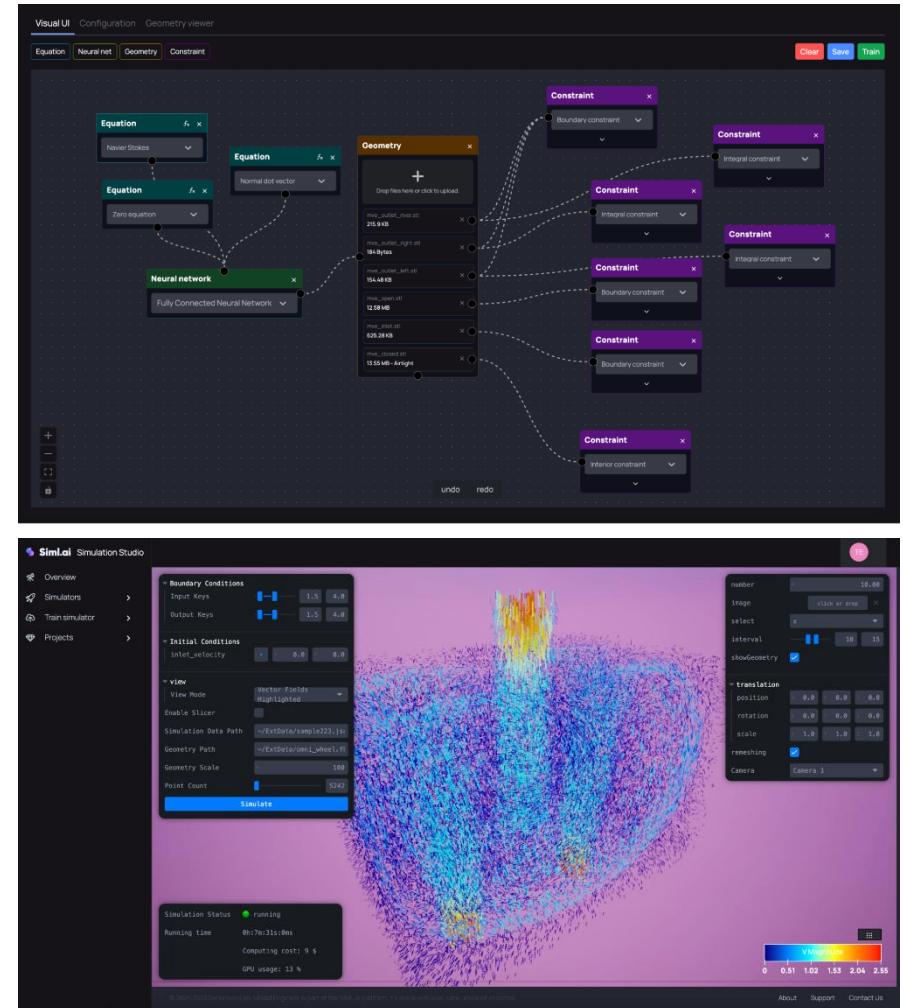
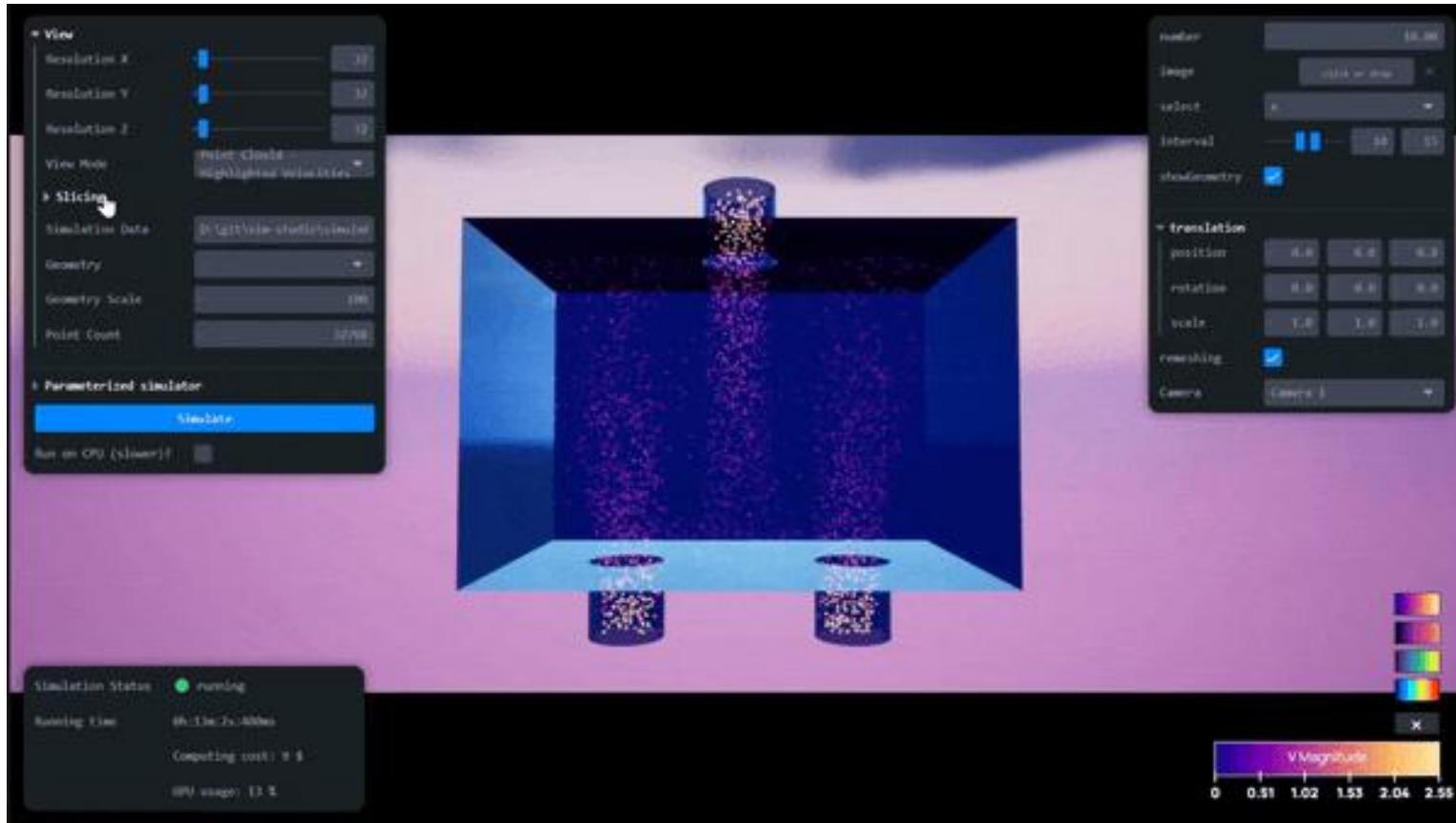
<https://developer.nvidia.com/blog/physics-ml-platform-modulus-is-now-open-source/>



MetNet – Sønderby et al., 2020

<https://research.google/blog/a-neural-weather-model-for-eight-hour-precipitation-forecasting/>

e.g., Design and Modeling



DimensionLab – Siml.ai (AI-based numerical simulator)

Image source: <https://www.siml.ai/>

e.g., Design and Modeling

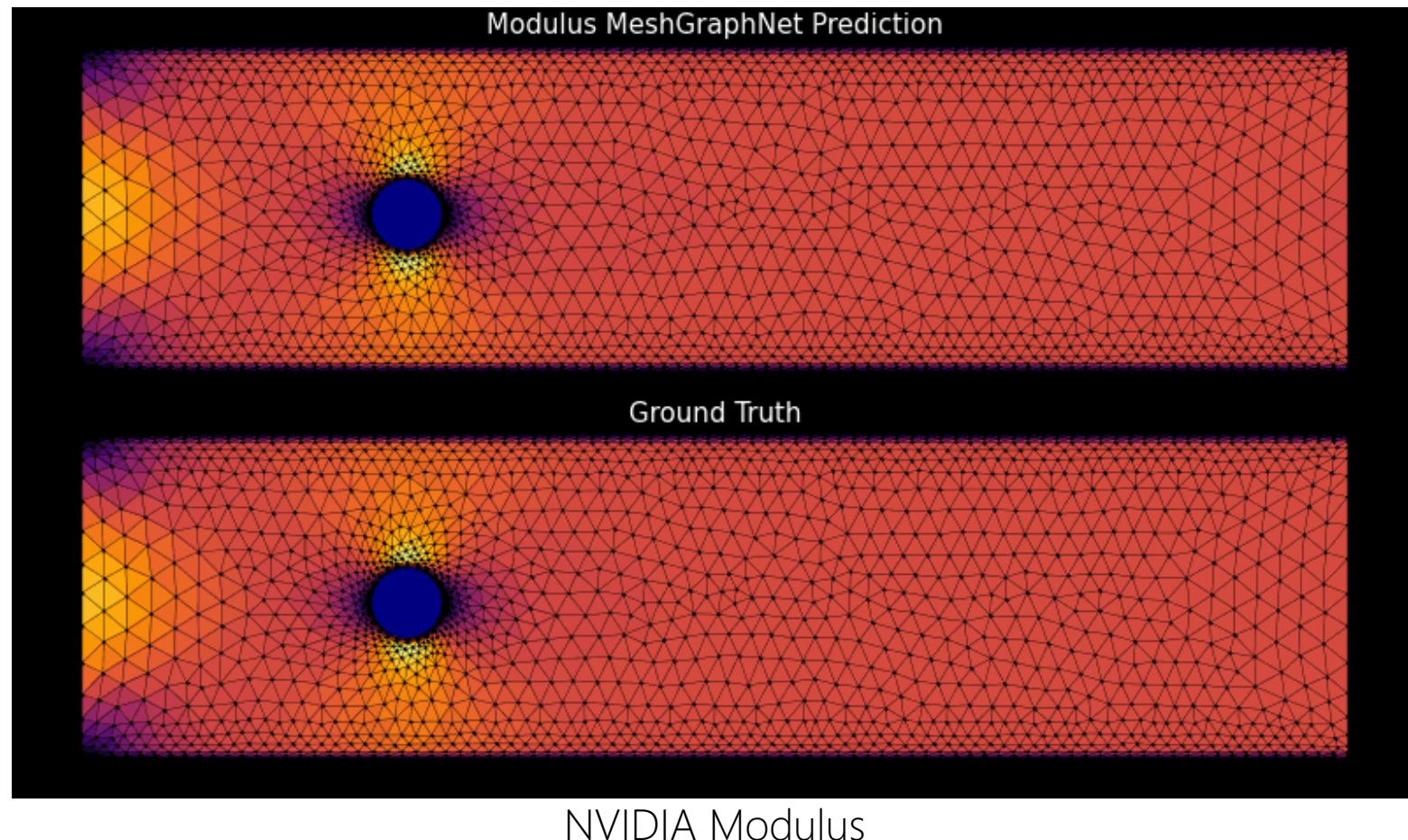
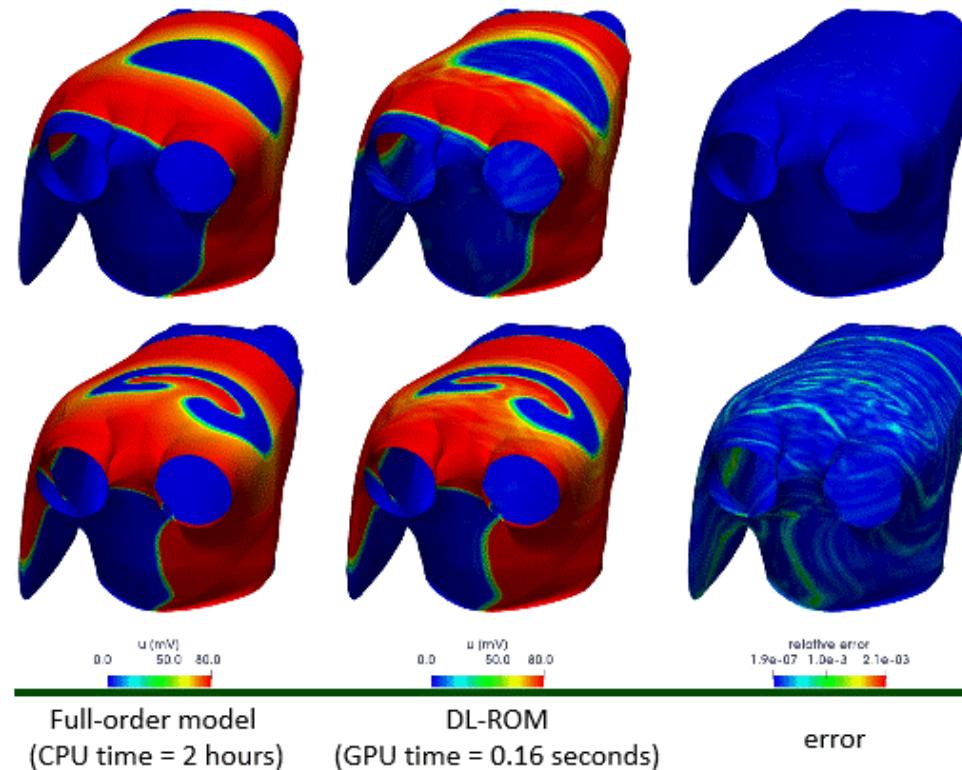


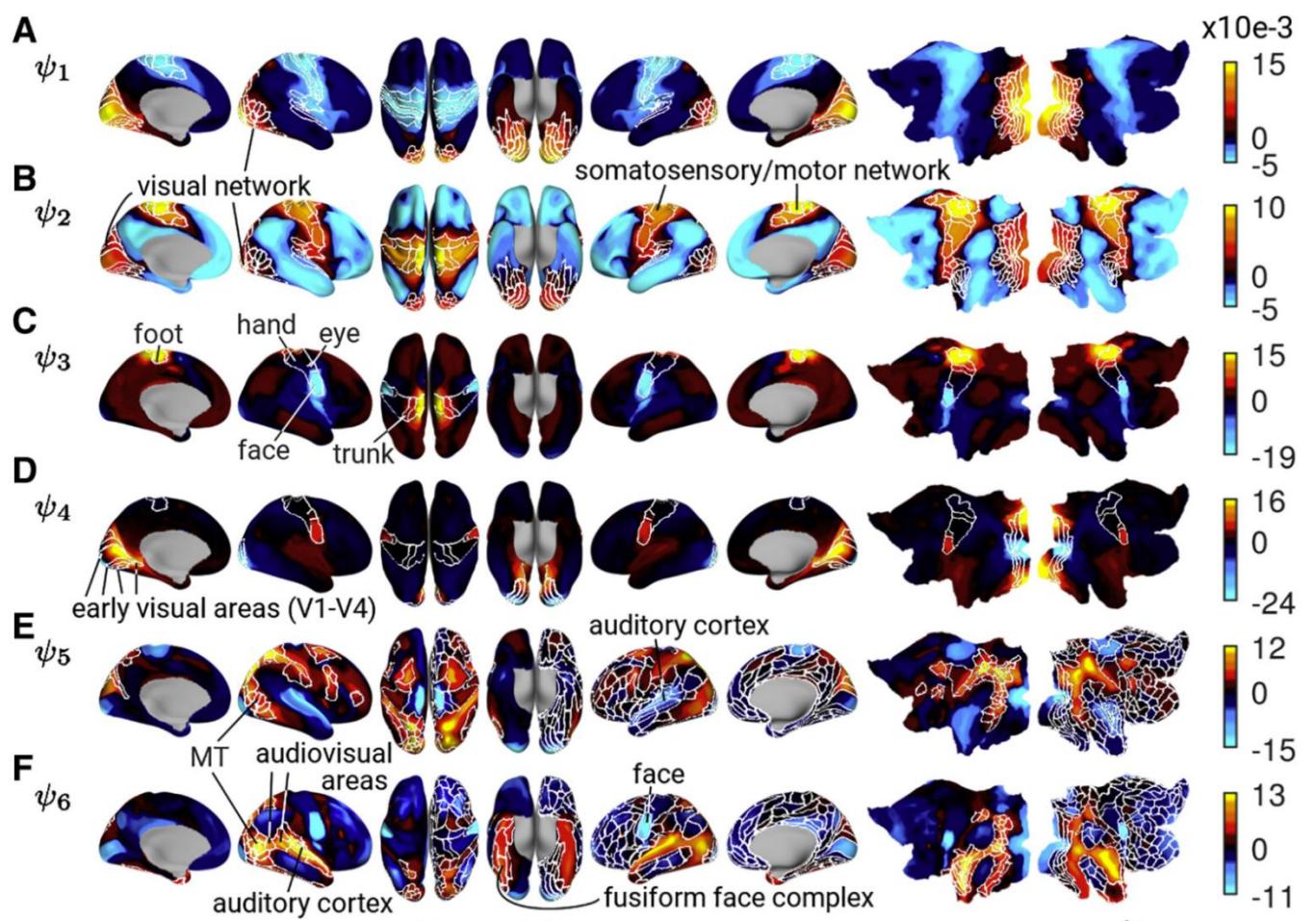
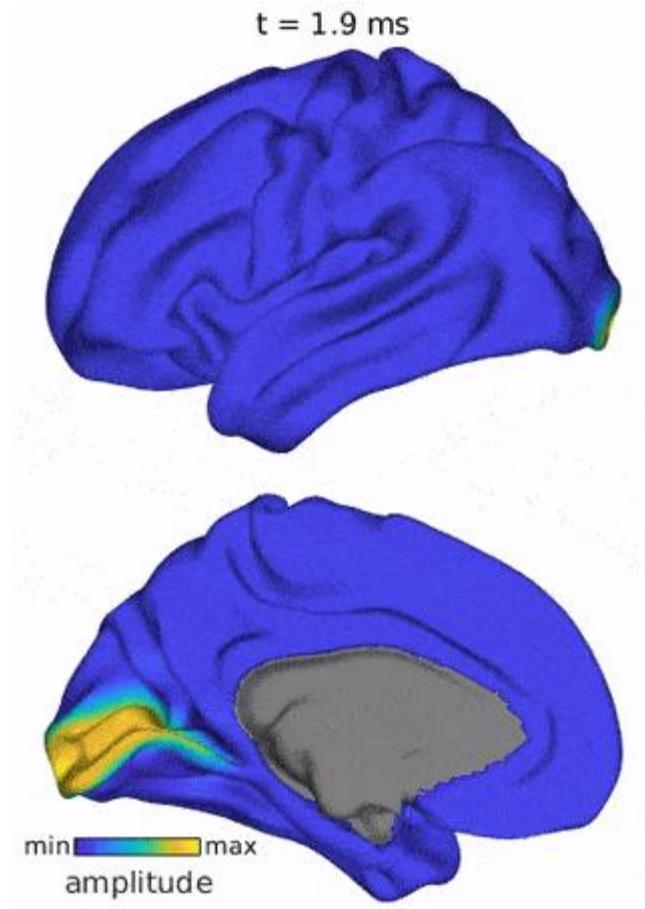
Image source: <https://developer.nvidia.com/blog/develop-physics-informed-machine-learning-models-with-graph-neural-networks/>

e.g., Cardiac Electrophysiology

Deep learning-based Reduced Order Models (DL-ROMs)
for the real-time simulation of cardiac electrophysiology

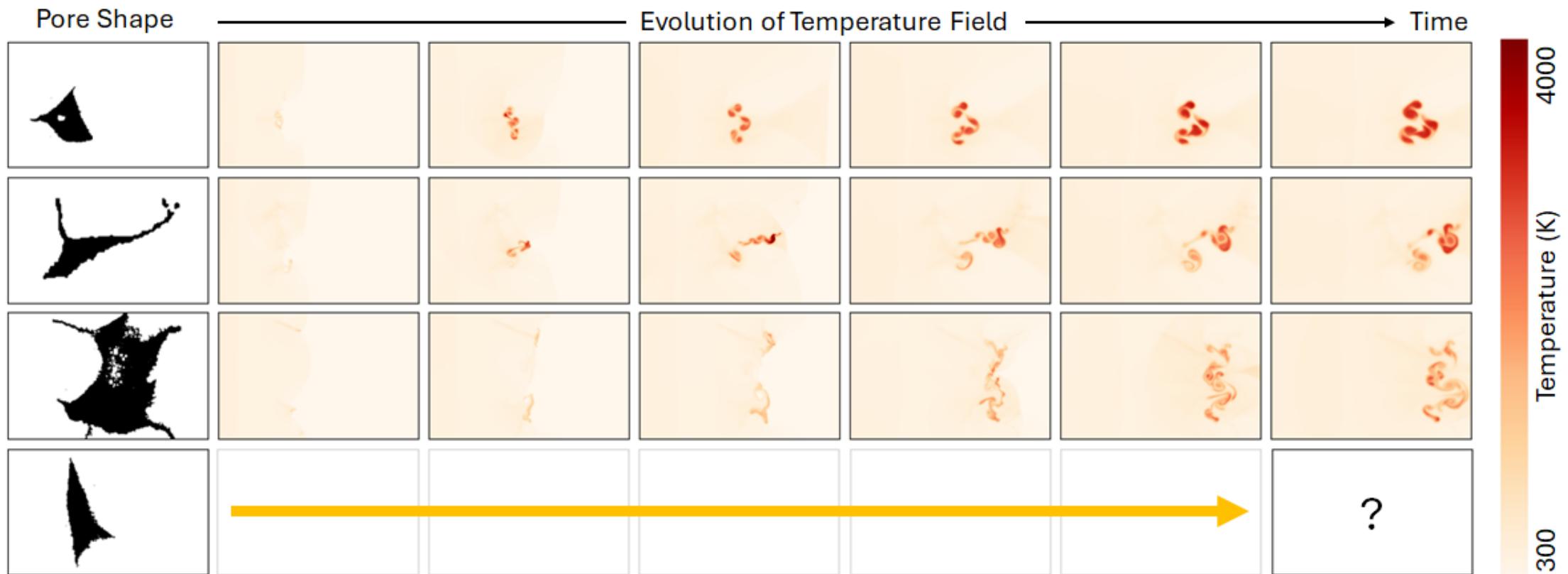


e.g., “Dynamics of the Mind”

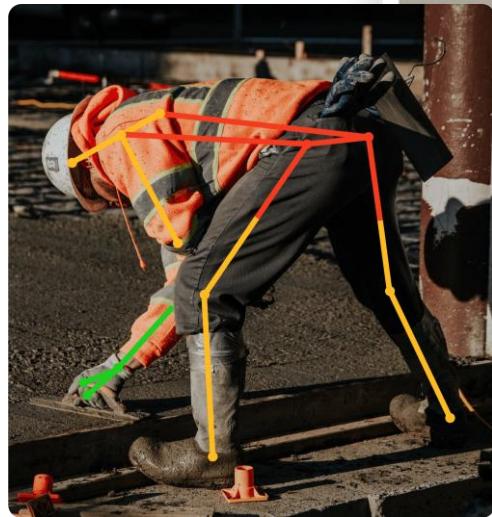
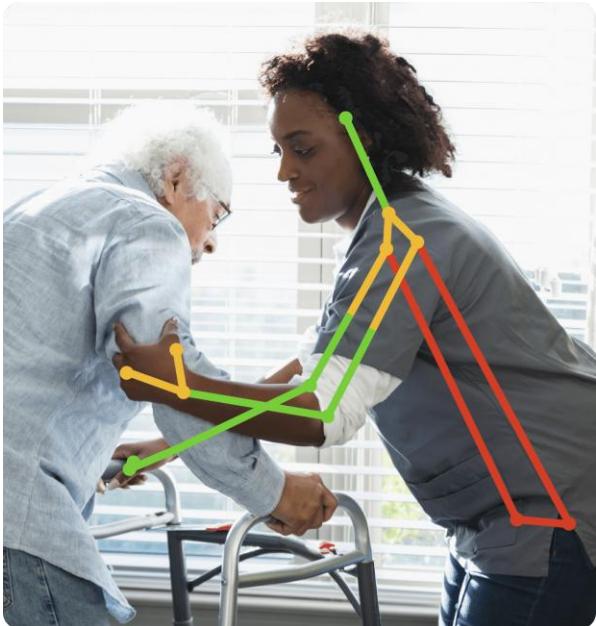


<https://qri.org/blog/eigenbasis-of-the-mind>

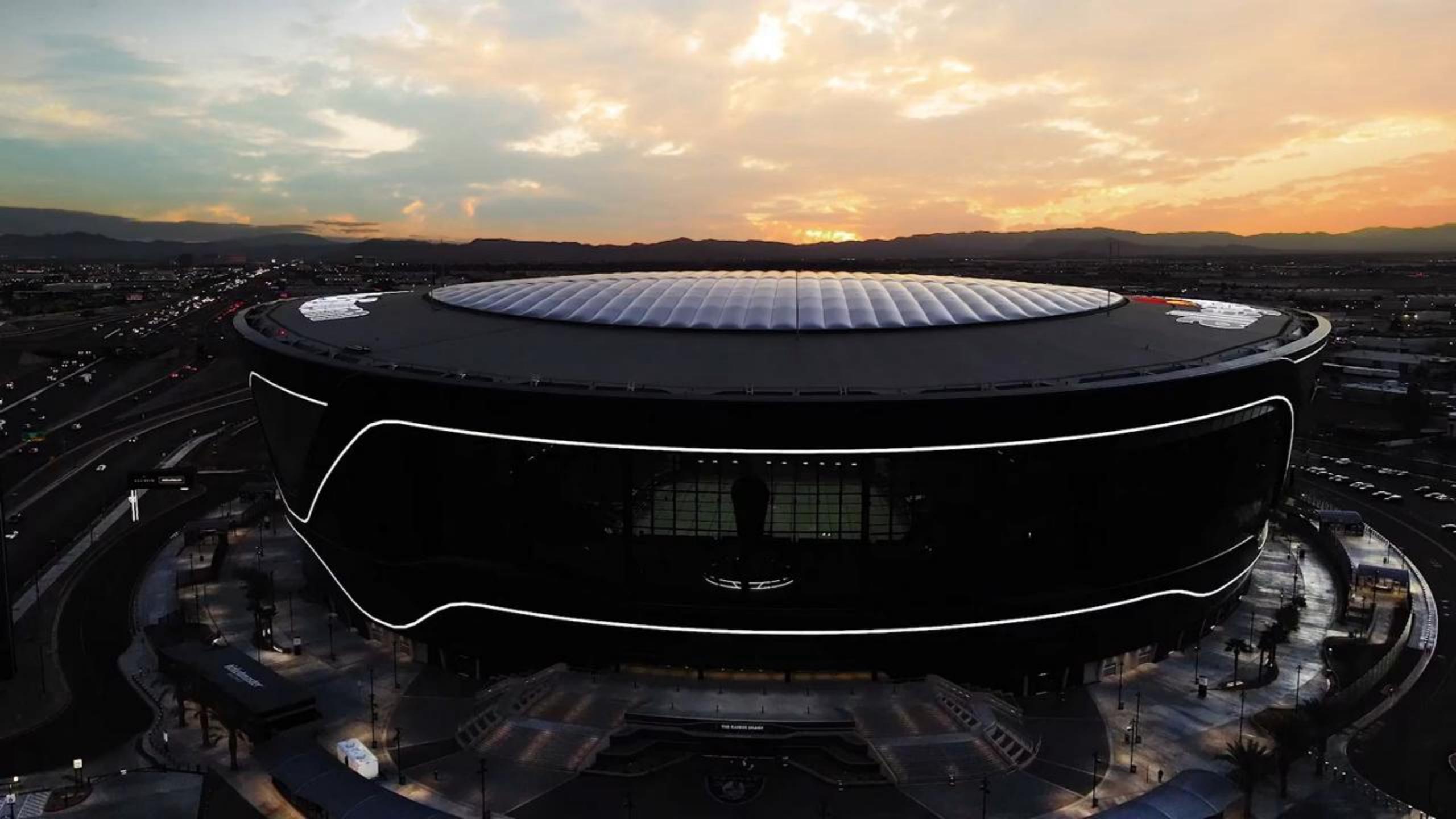
e.g., Materials Science/Applied Mechanics



e.g., Ergonomics/Human Factor/Sports



A screenshot of a mobile application interface. It features two cards: the left card is titled 'Injury Risk' and shows a worker bending over a box; the right card is titled 'Corrected' and shows the same worker in a more ergonomic squatting position. Below these cards is a large image of a man with a beard, wearing a light shirt, sitting at a desk and looking at a tablet. A green callout box at the bottom left of the screen lists two features: '✓ Online courses' and '✓ Ergonomists Assistance'.



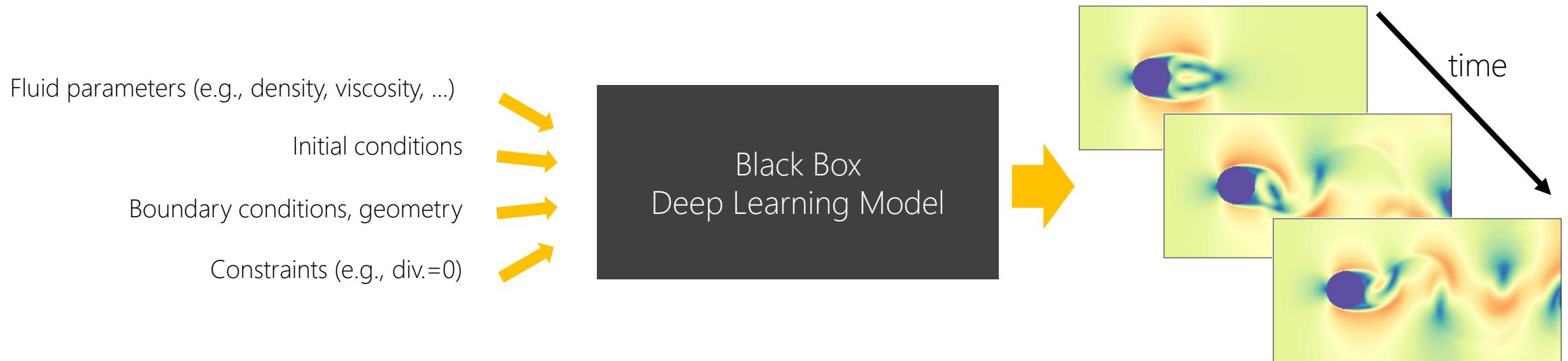
How are they different from other ML tasks?

AI does learn physics from data!

- ...if you can afford a large amount of data
(and a large model, ... and a fancy computer)

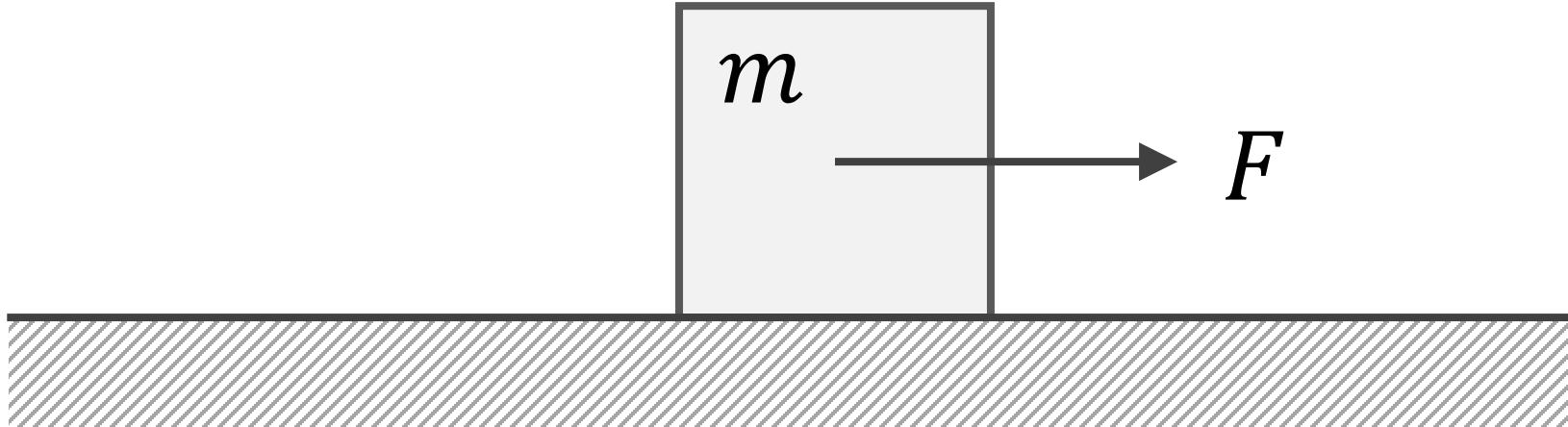


“Can’t you just fit the model?”

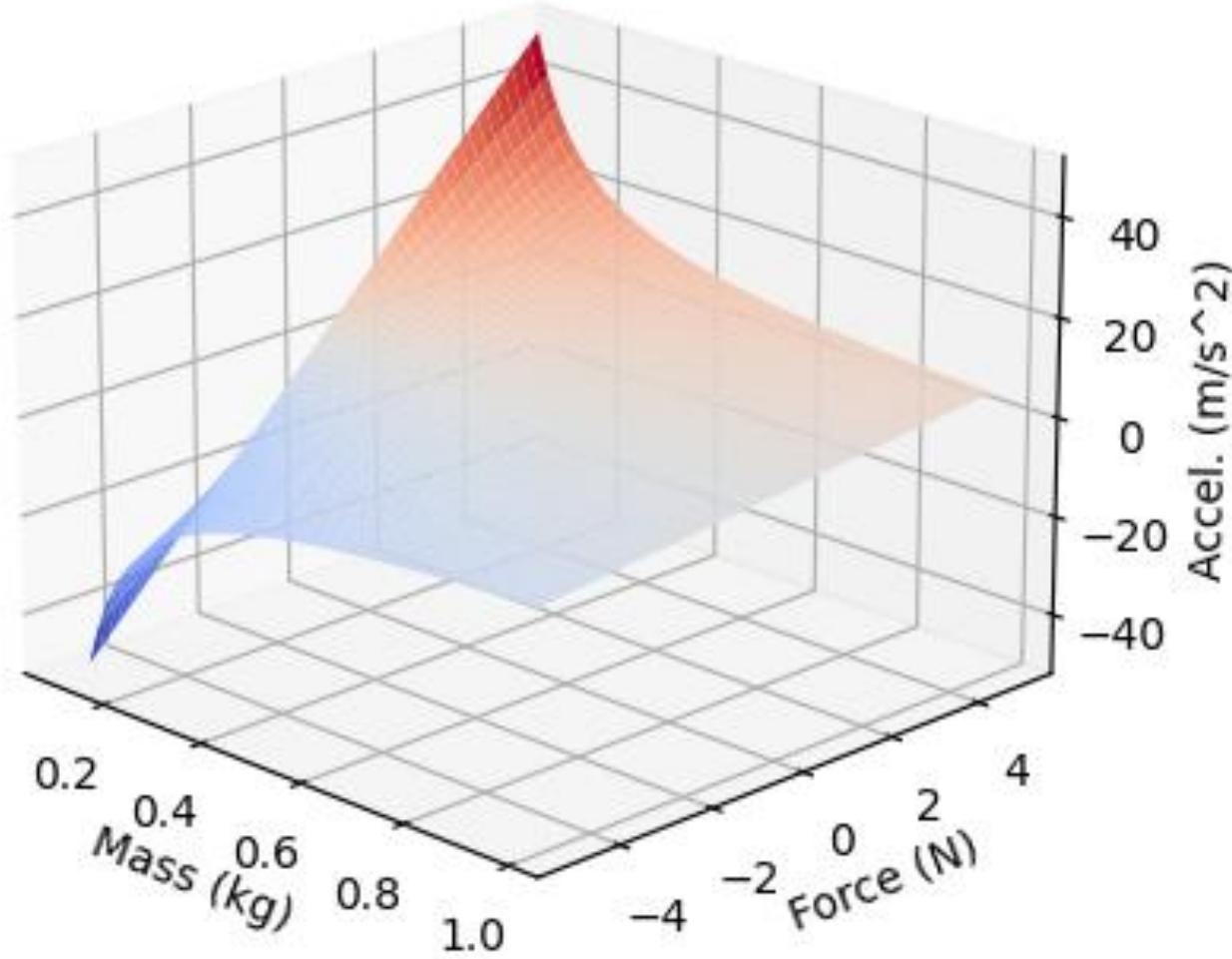


- Model predictions do not usually comply with **physics governing laws, initial/boundary conditions, and other constraints**.
 - Problematic for scientific use!
- Physics data are typically **expensive**—requires lots of time, money, and labor to obtain.
 - Train with small data?

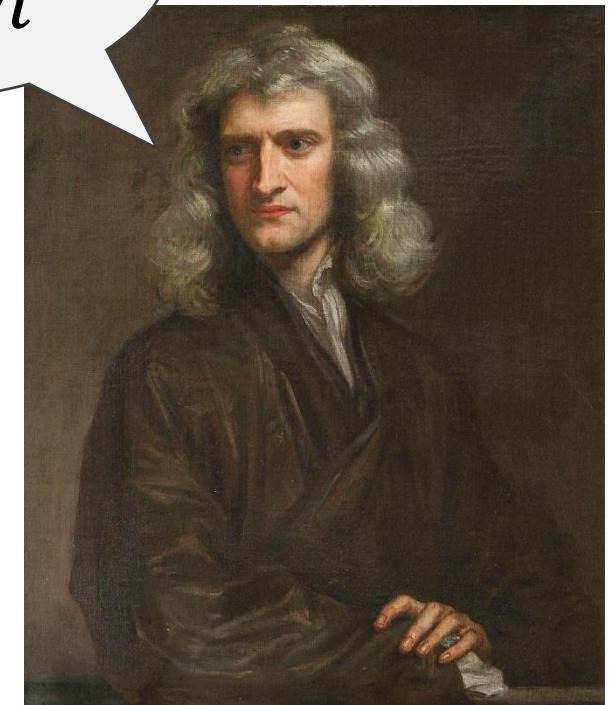
$$a = ?$$



Analytic Solution

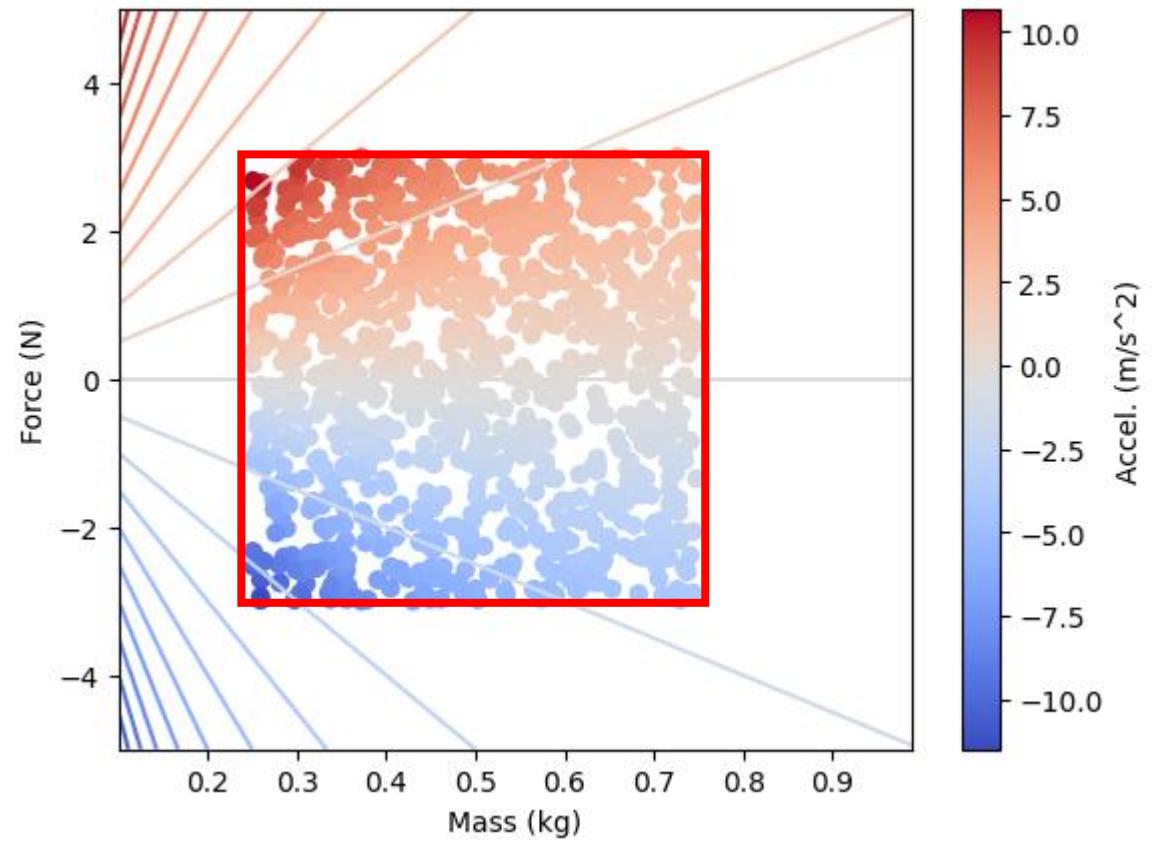


$$a = \frac{F}{m}$$

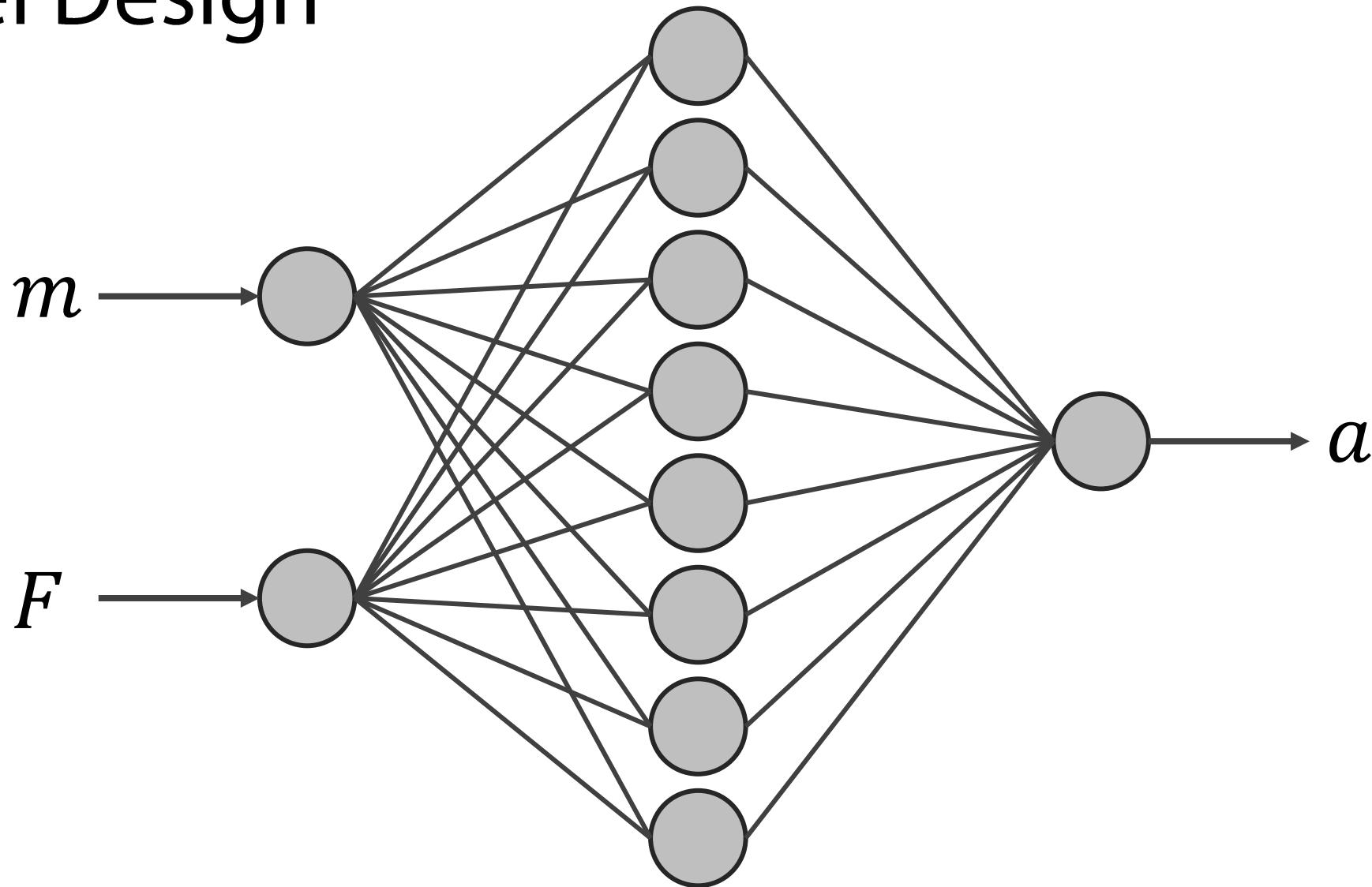


Training Data

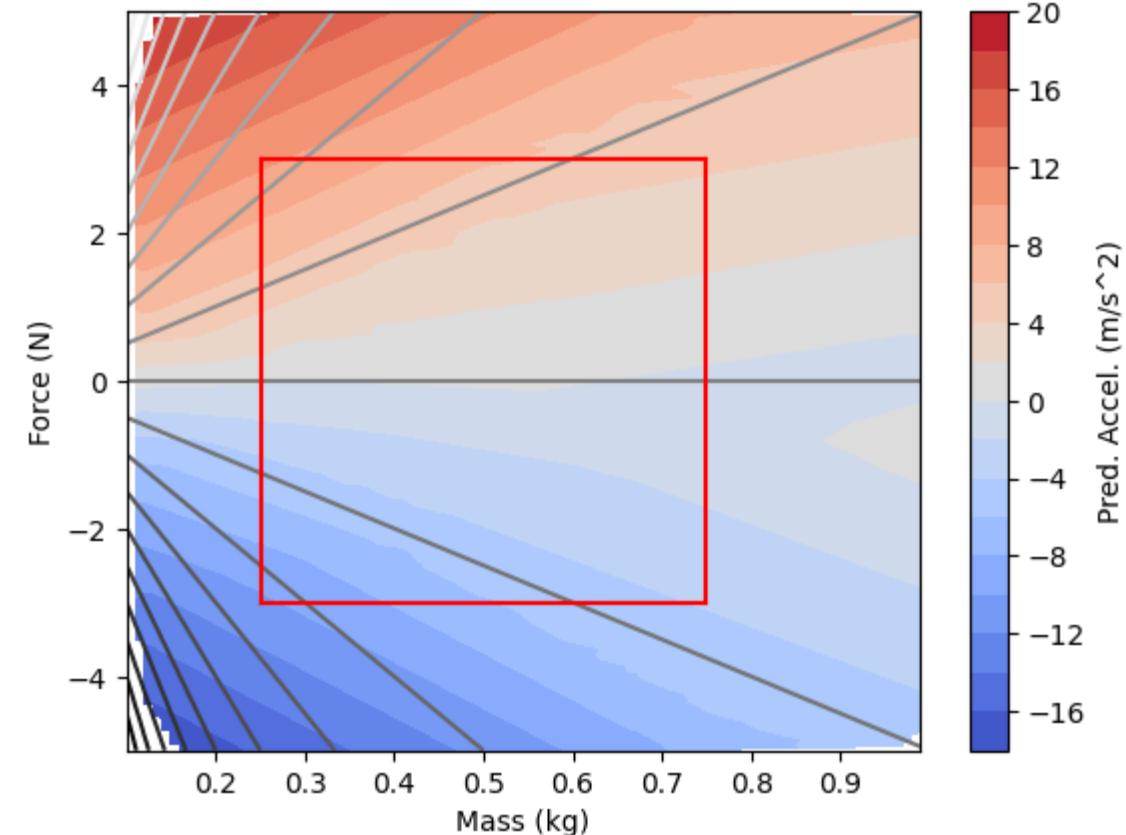
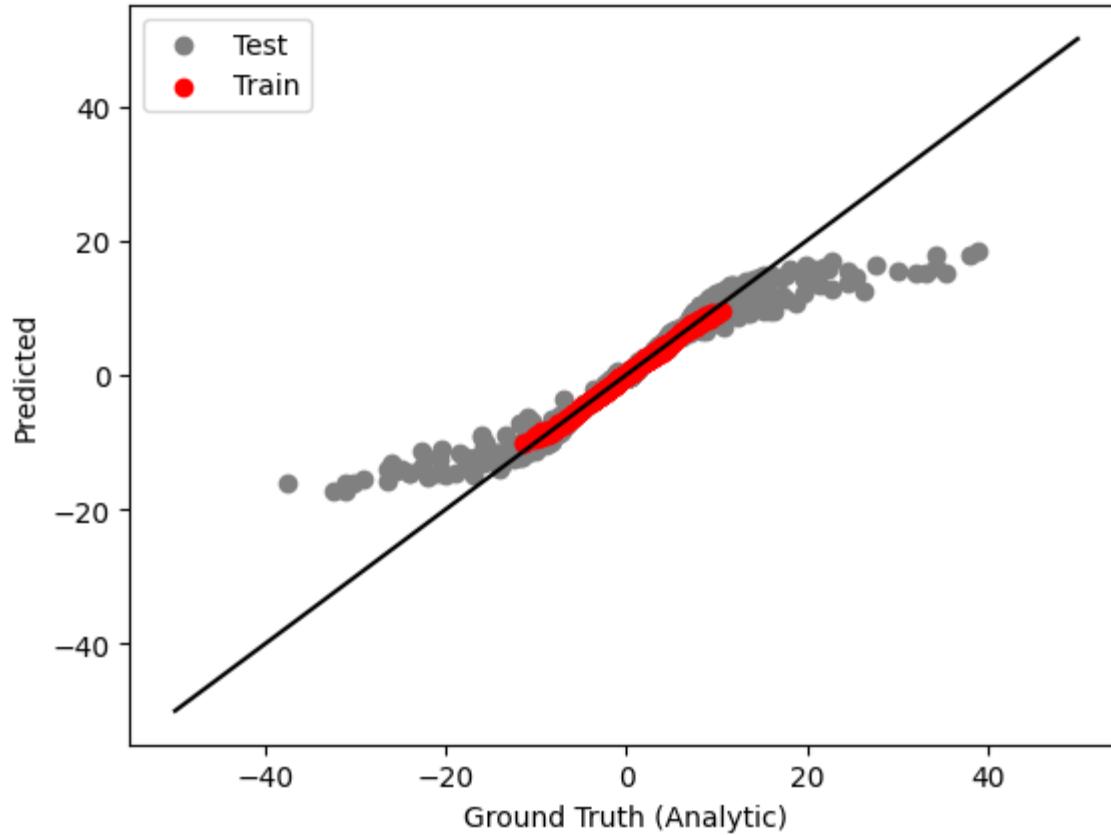
```
# Training data generation
N = 1000                      # Number of training data
e = 0.01                        # Strength of noise
F = torch.rand(N)*6 - 3          # Forces inbetween -3 ~ +3 (N)
m = torch.rand(N)*0.5 + 0.25     # Masses inbetween 0.25 ~ 0.75 (kg)
a = F/m + e*torch.randn(N)       # Emulate measurement noise
```

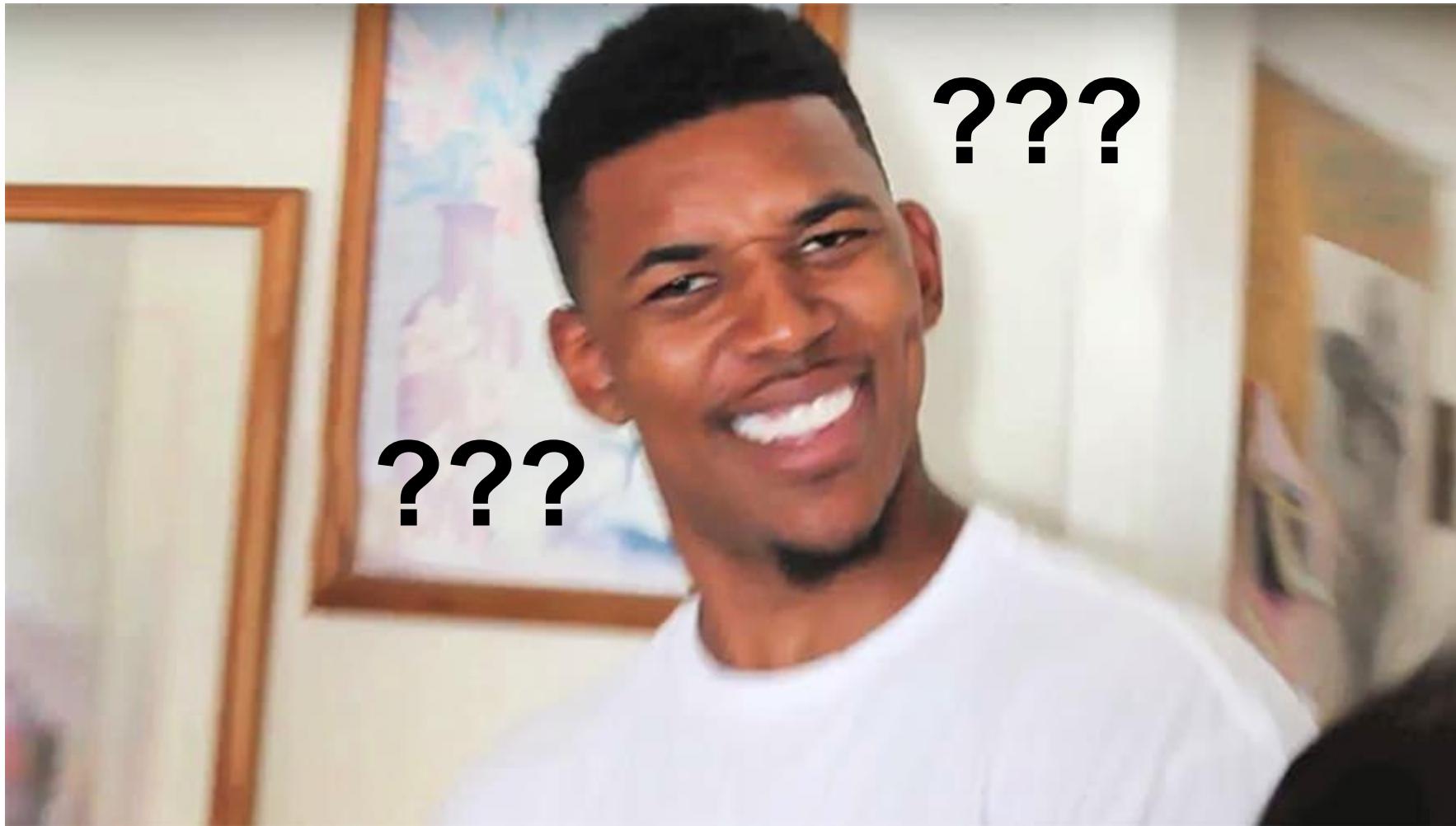


Model Design

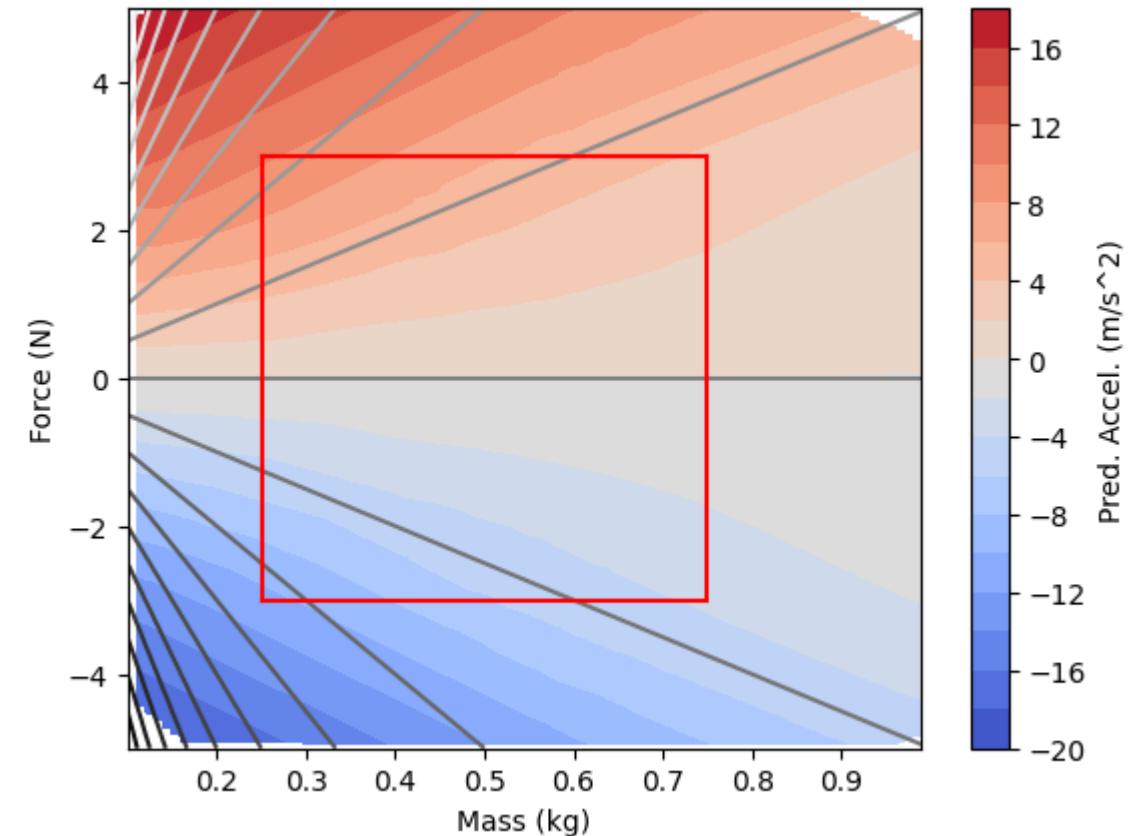
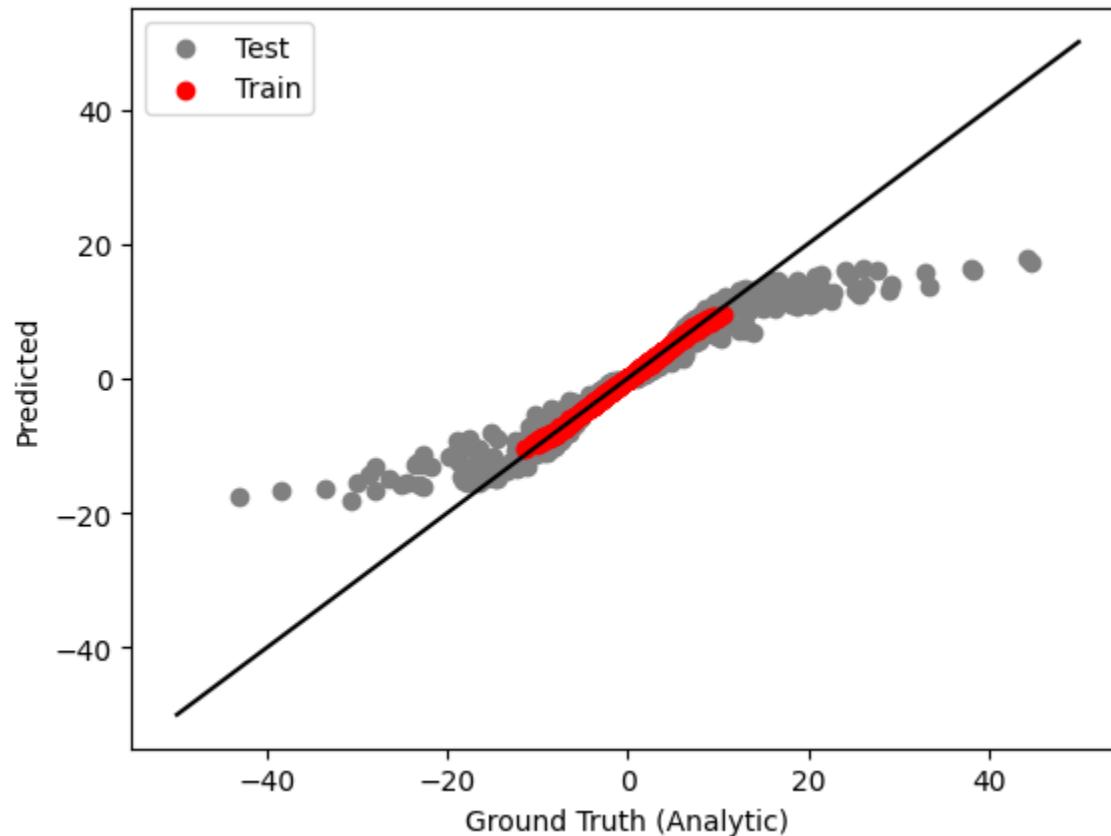


Result

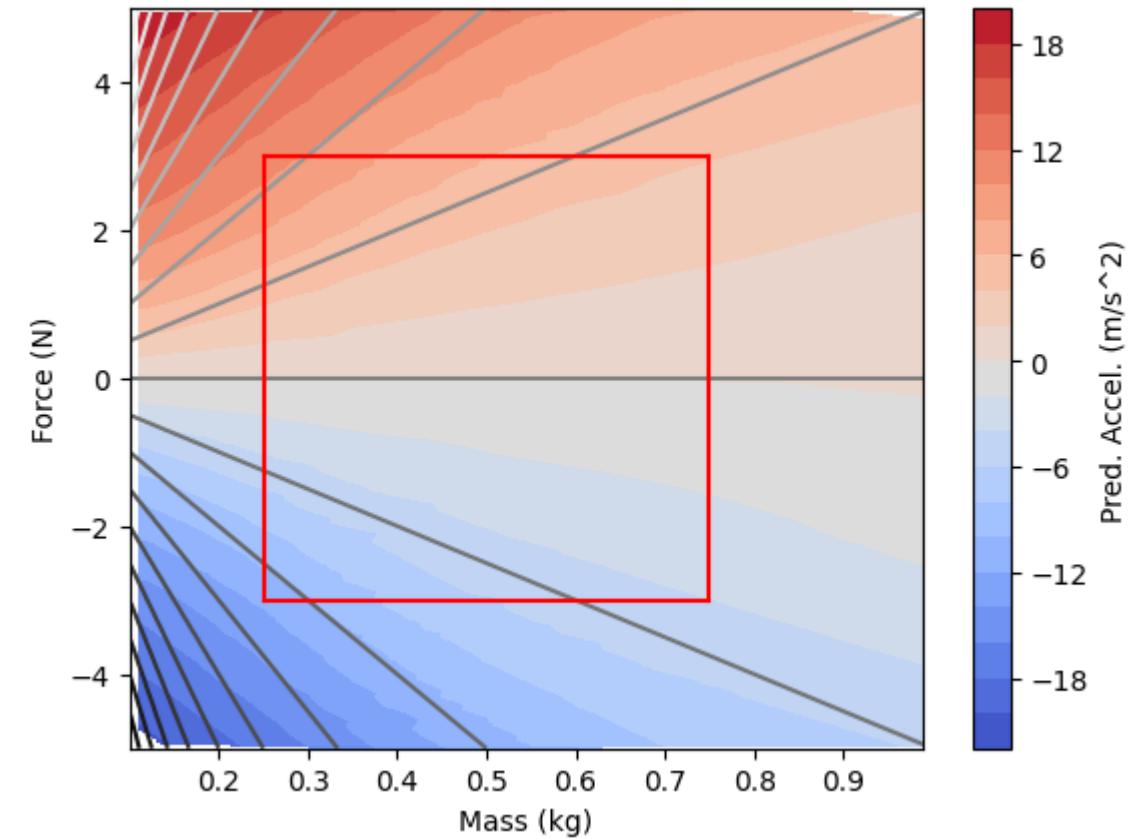
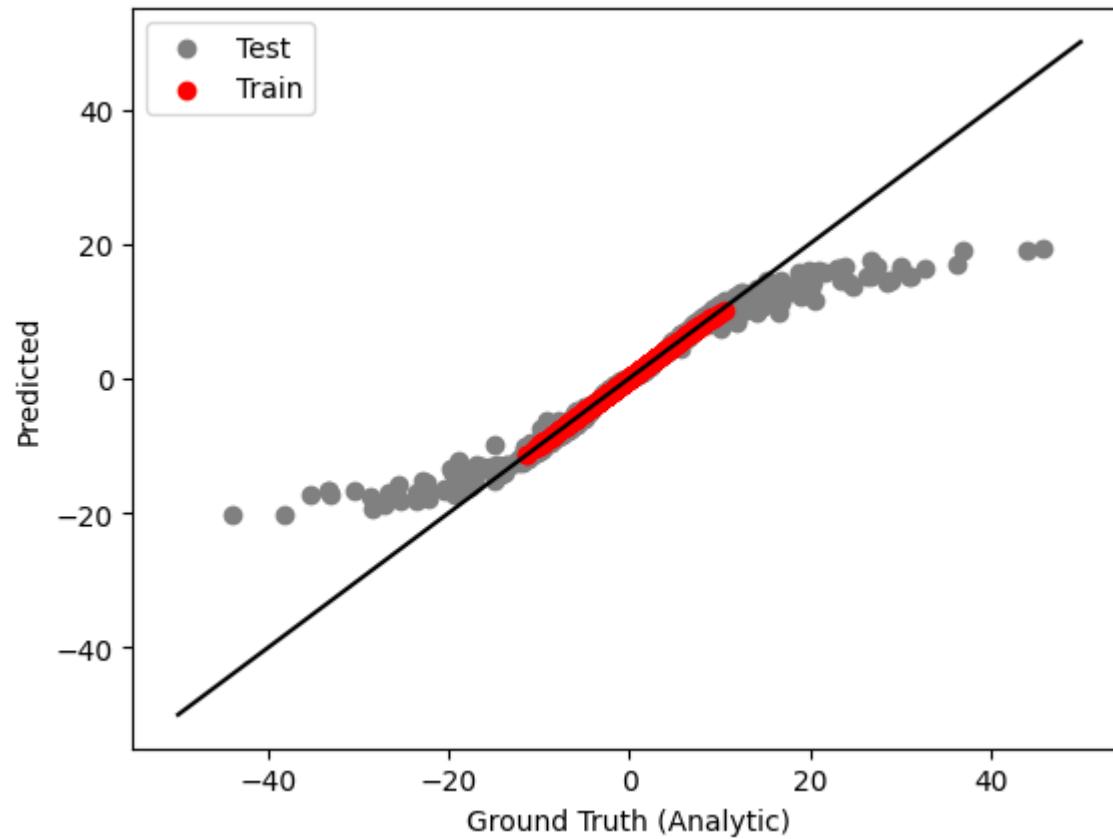




Going wider (8→256), because... UAT!



Going deeper ($1 \rightarrow 3$ hidden), because... DL!



Course Overview

- Day 1: Introduction to Neural Networks
 - What is Neural Network
 - Gradient descent optimization, backpropagation, and more.
 - Intro to PyTorch lab
- Day 2: Understanding Visual Patterns using Neural Networks
 - Convolutional neural networks
 - CNN architectures
 - How to train convolutional neural networks
- Day 3: Physics Meets Deep Neural Networks
 - Physics-informed neural networks (PINN)
 - Neural operators
 - Physics-aware recurrent convolutions (PARC)

Prerequisites

- Background Knowledge
 - Python programming
 - Multivariate/vector calculus & Linear algebra
 - Basic understanding of (ordinary and partial) differential equations
 - “Introduction to PyTorch”

Prerequisites

- Computer Configuration
 - Visual Studio Code (or other code editor/Python IDE)
 - (Mini)conda - <https://docs.anaconda.com/miniconda/>
 - Git - <https://git-scm.com/downloads>
 - (Optional) NVIDIA GPU with CUDA support
- `conda create -n padl python=3.11 ipykernel`
- `conda activate padl`
- Install PyTorch - <https://pytorch.org/>
- `git clone <https://github.com/stephenbaek/padl.git>`
- `pip install -r requirements.txt`