When Earth meets AI

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EnviTrace LLC

Questions that have driven us from the dawn of time ...

- What is the Meaning of Life?
- Is the world understandable?
- Is there a Theory of Everything?

- Are we Humans or Dancers?
- Is AI a Dancer?

- Can AI help us answer these questions?

Intelligence

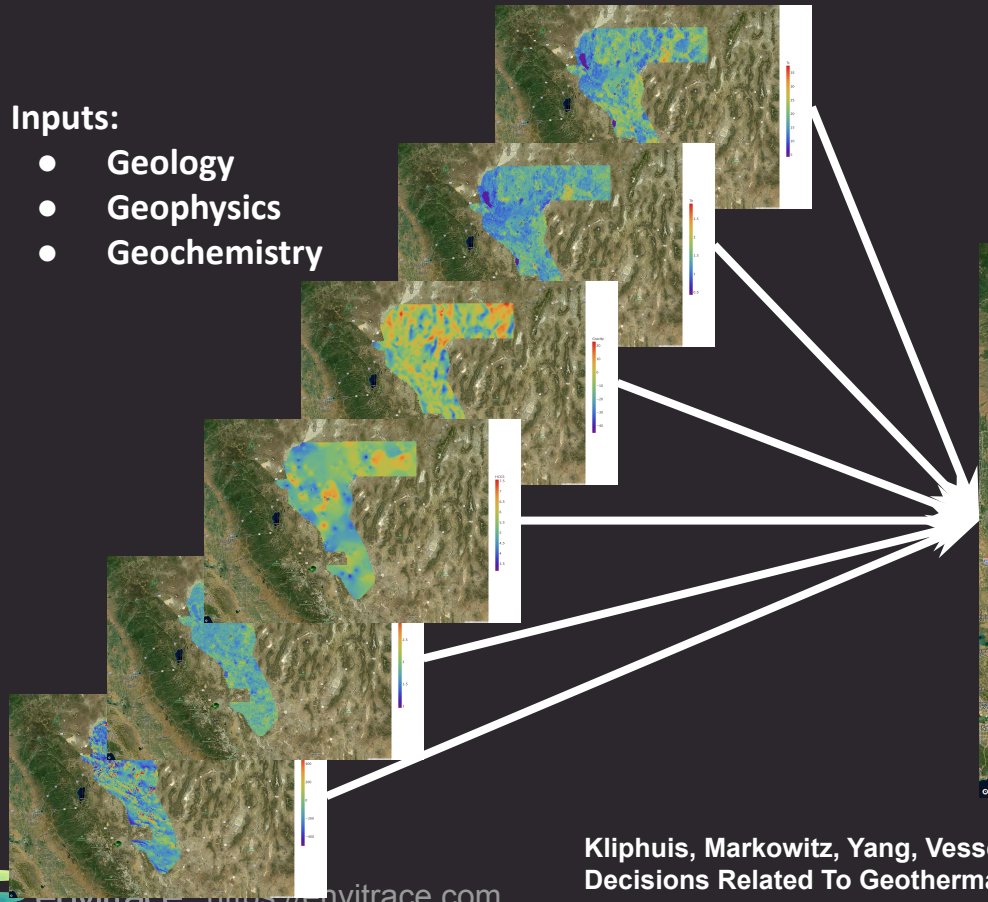
- What is intelligence?
- How our brains work?
- How AI works?
- Artificial vs Natural Intelligence?

Geothermal prospectivity

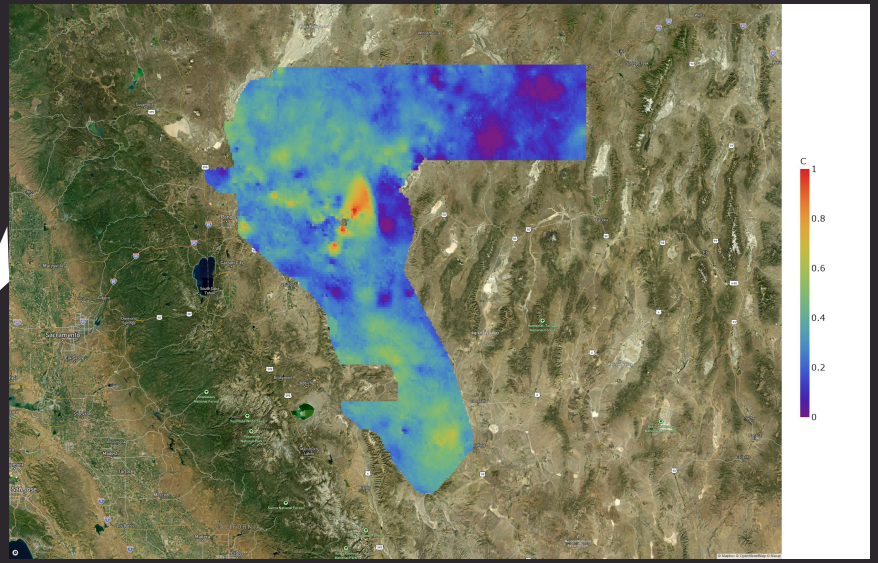
https://envitrace.com/saas

Inputs:

- Geology
- Geophysics
- Geochemistry



Output: Probability of occurrence



Kliphuis, Markowitz, Yang, Vesselinov(2021) GeoDAWN To GeoTGo: From Complex Data To Decisions Related To Geothermal Prospectivity PDF

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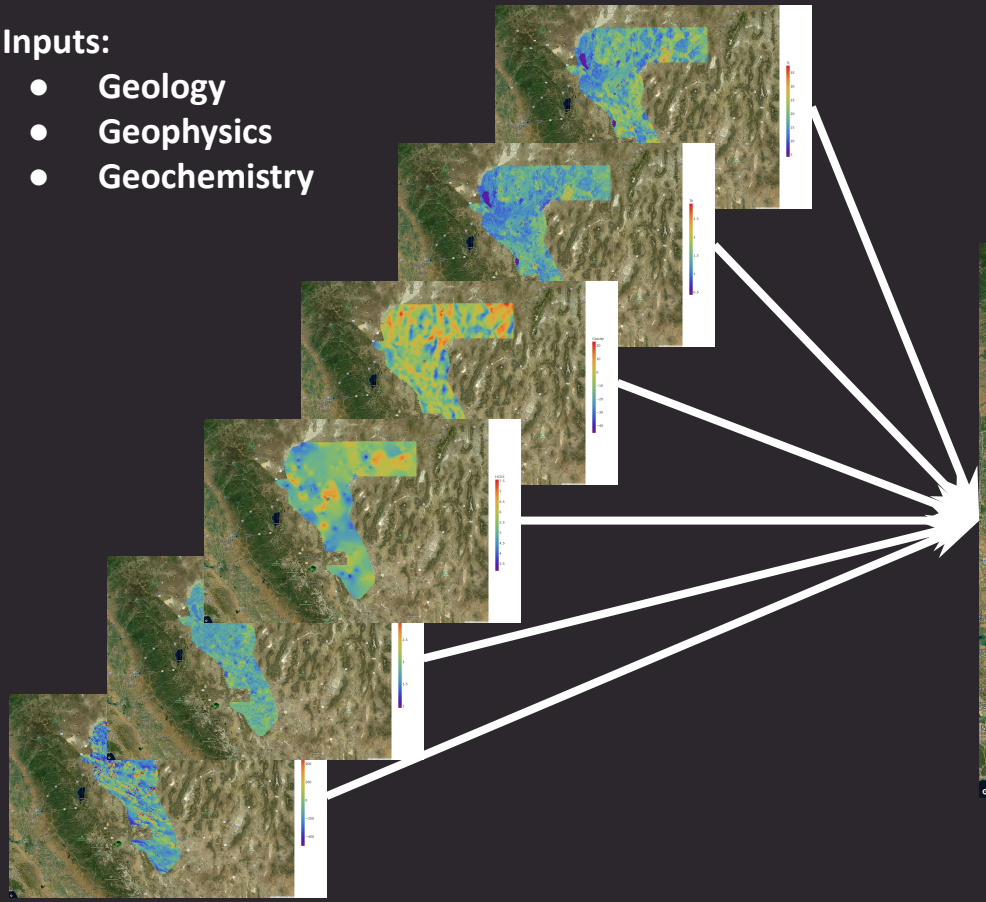

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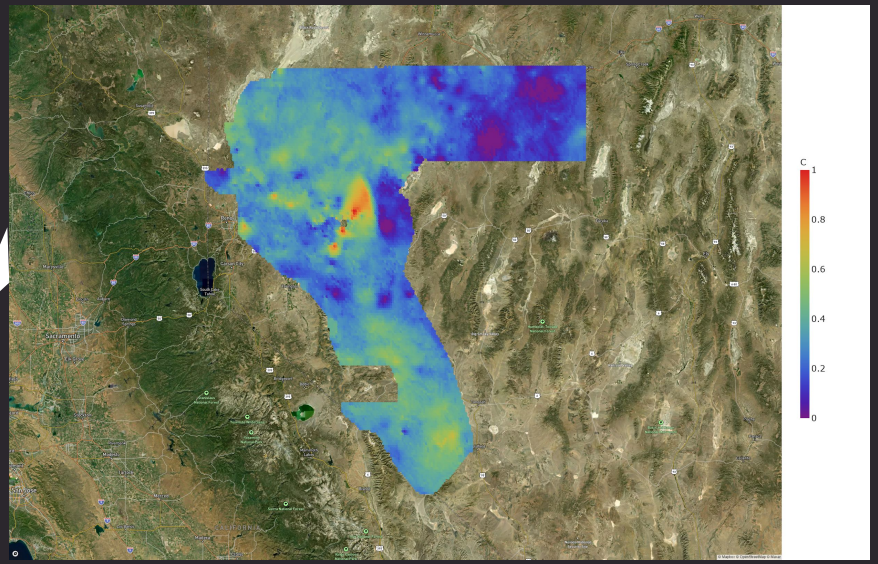
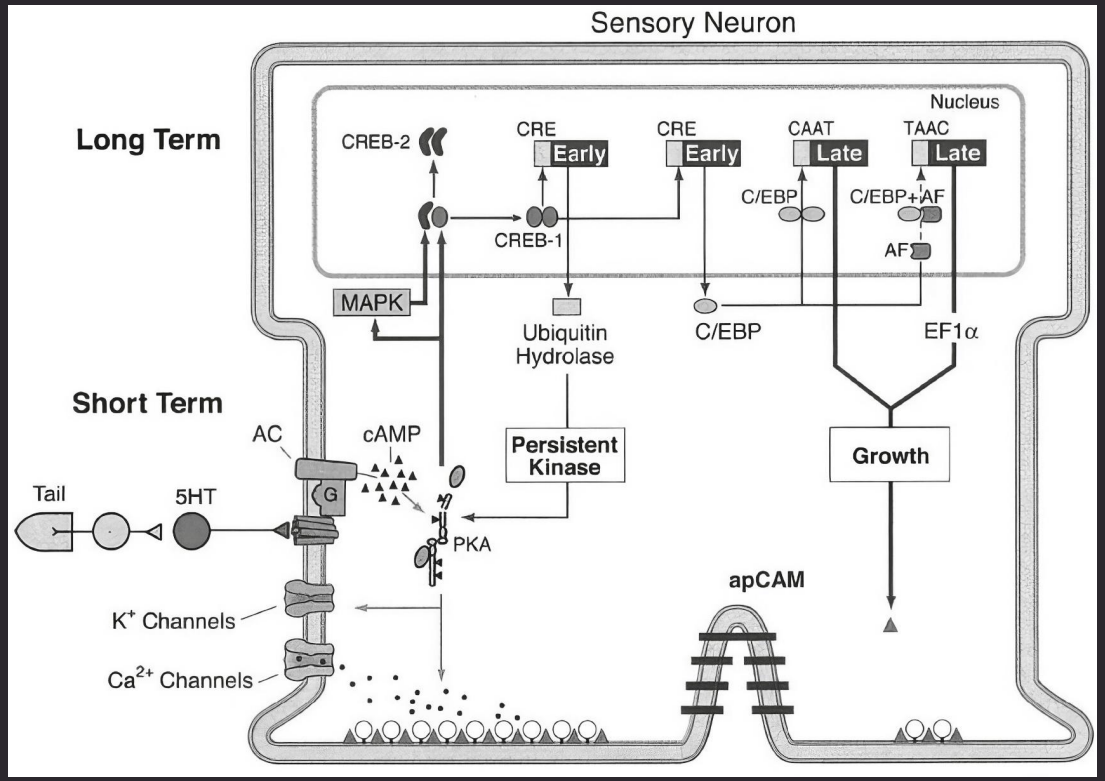
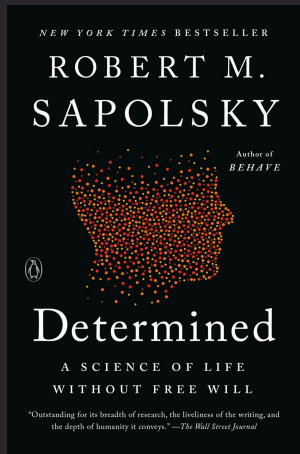


Brain vs Brain



Eric Kandel (2020) Nobel Prize Presentation

Sensory neuron of a sea slug (*Aplysia californica*, i.e., California sea hare) to withdraw its gills if touched.



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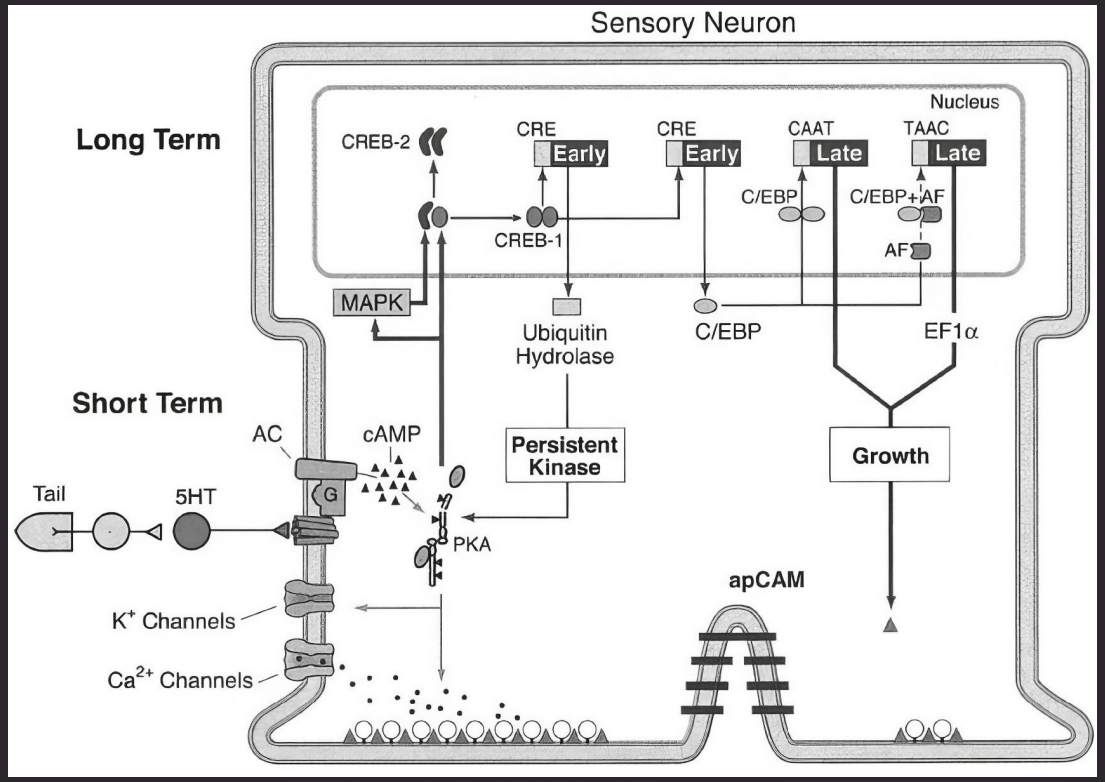
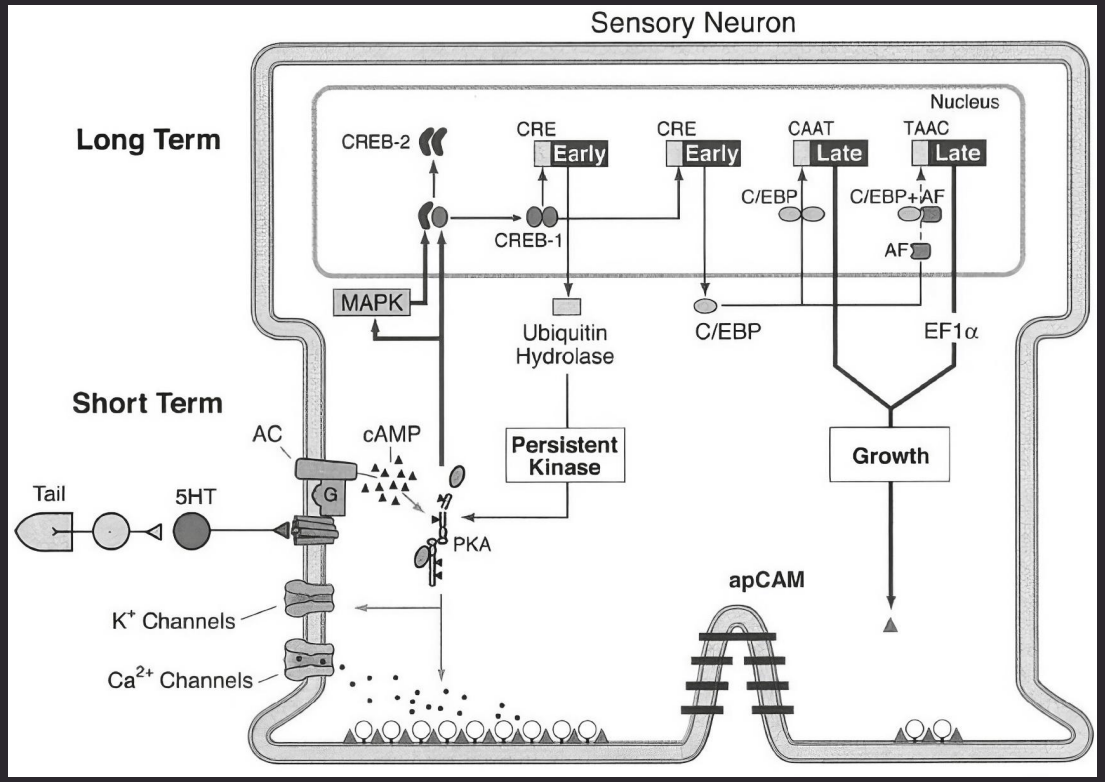


Eric Kandel (2020) Nobel Prize Presentation

- Our (human) neurons to blink our eyes, and marine sea slugs neurons to withdraw their gills are extremely similar!
- Even though we have NOT shared a common ancestor for more than half a billion years.

Brain vs Brain

- And they are very similar to artificial neural networks we build now



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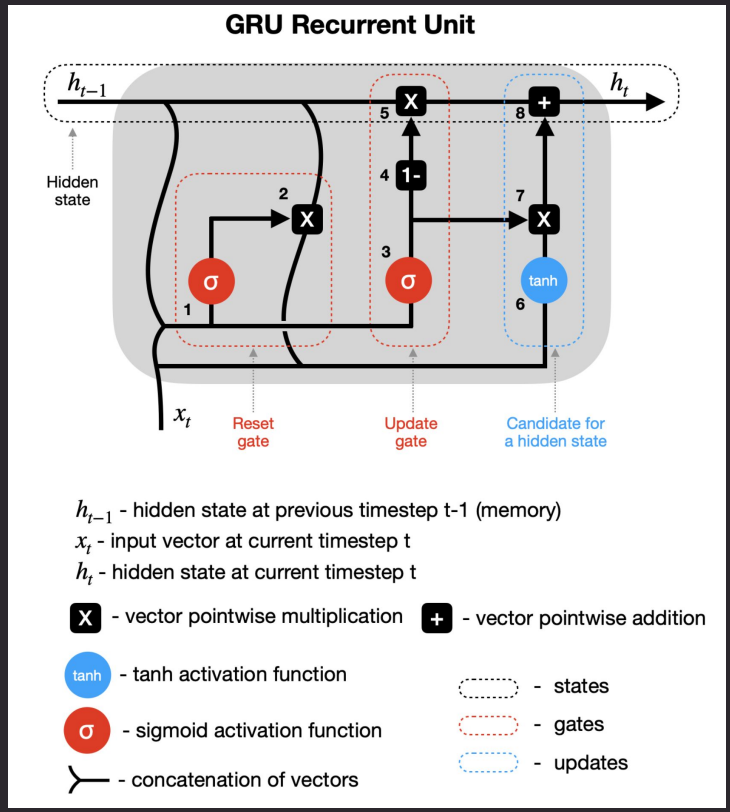
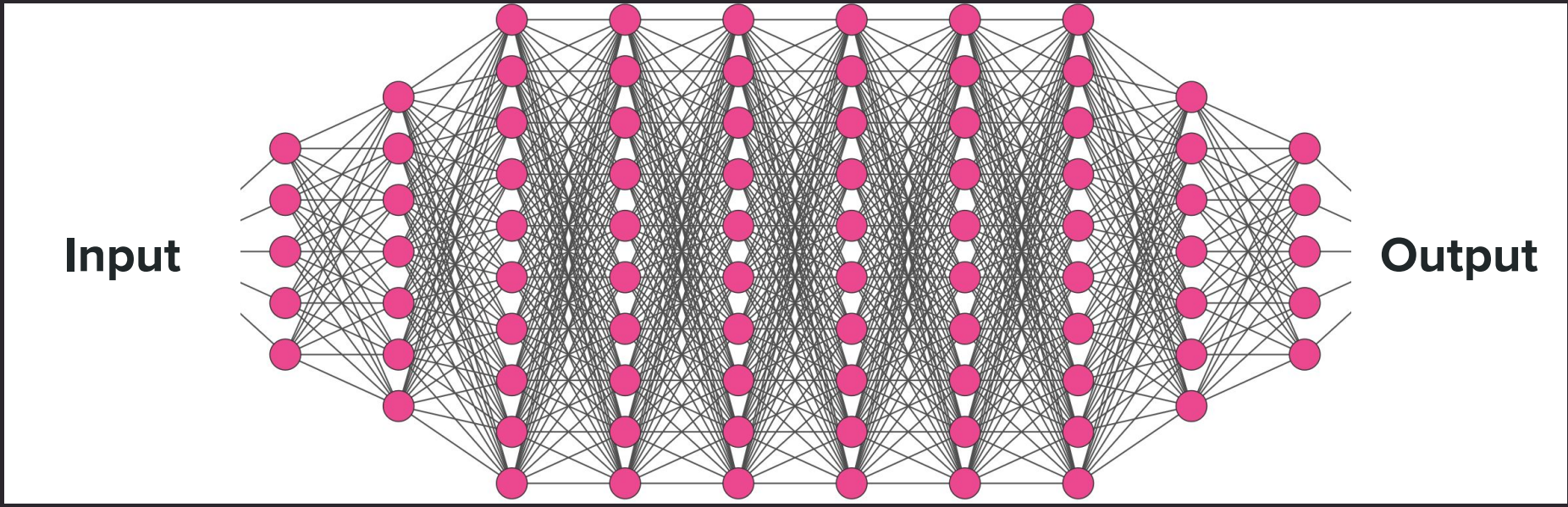


Brain vs Brain

- Human brain has ~86 billion neurons and ~100 trillion synapses.
- Our neurons conduct biochemical storms of information!
- Information is controlled by graded potentials, thresholds, ion channels, delays, and feedback loops.
- A single neuron can have thousands of inputs and an almost infinite range of activation patterns.

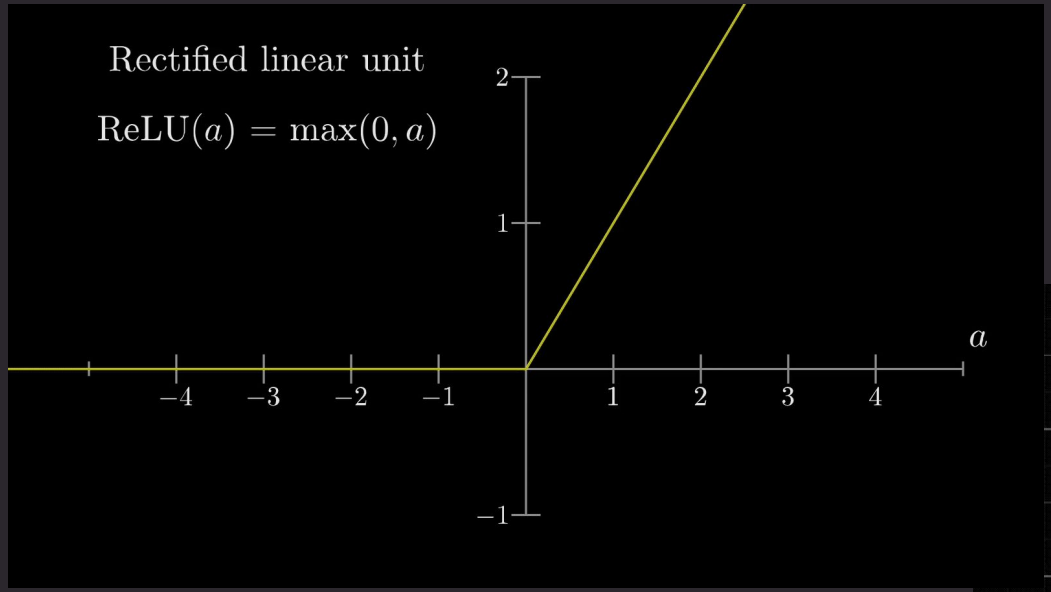
- AI replicates in a way how our brains work: neurons, feedbacks, transholds, delays …
- Latest ChatGPT ~1.8 trillion parameters (maybe; no official numbers)
- AI neural networks are not even close to reproducing the complexity of our neurons.

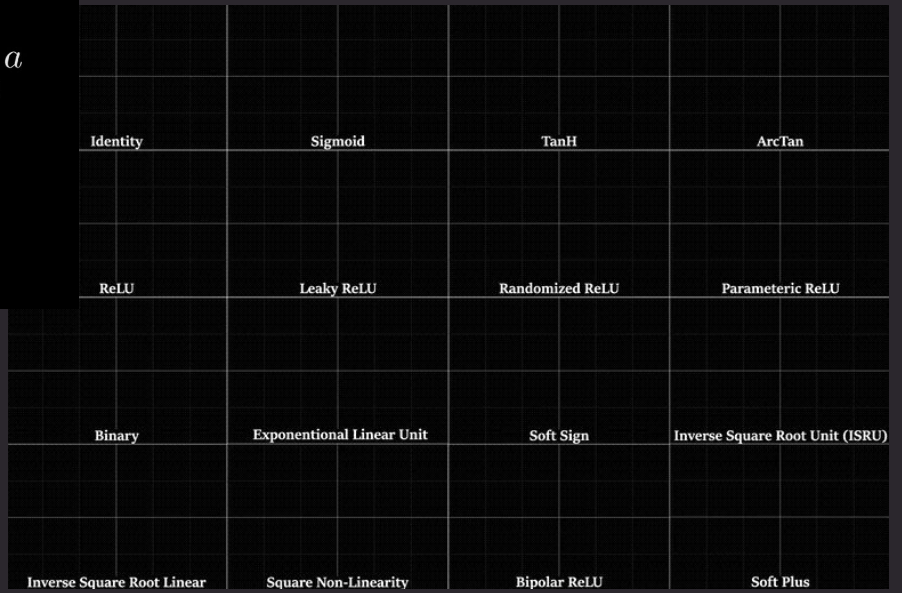
Neural Network



- Each neuron propagates information → from inputs to outputs ...
- Depending to the inputs can be activated or not or something in between
- And there are feedbacks from other neurons

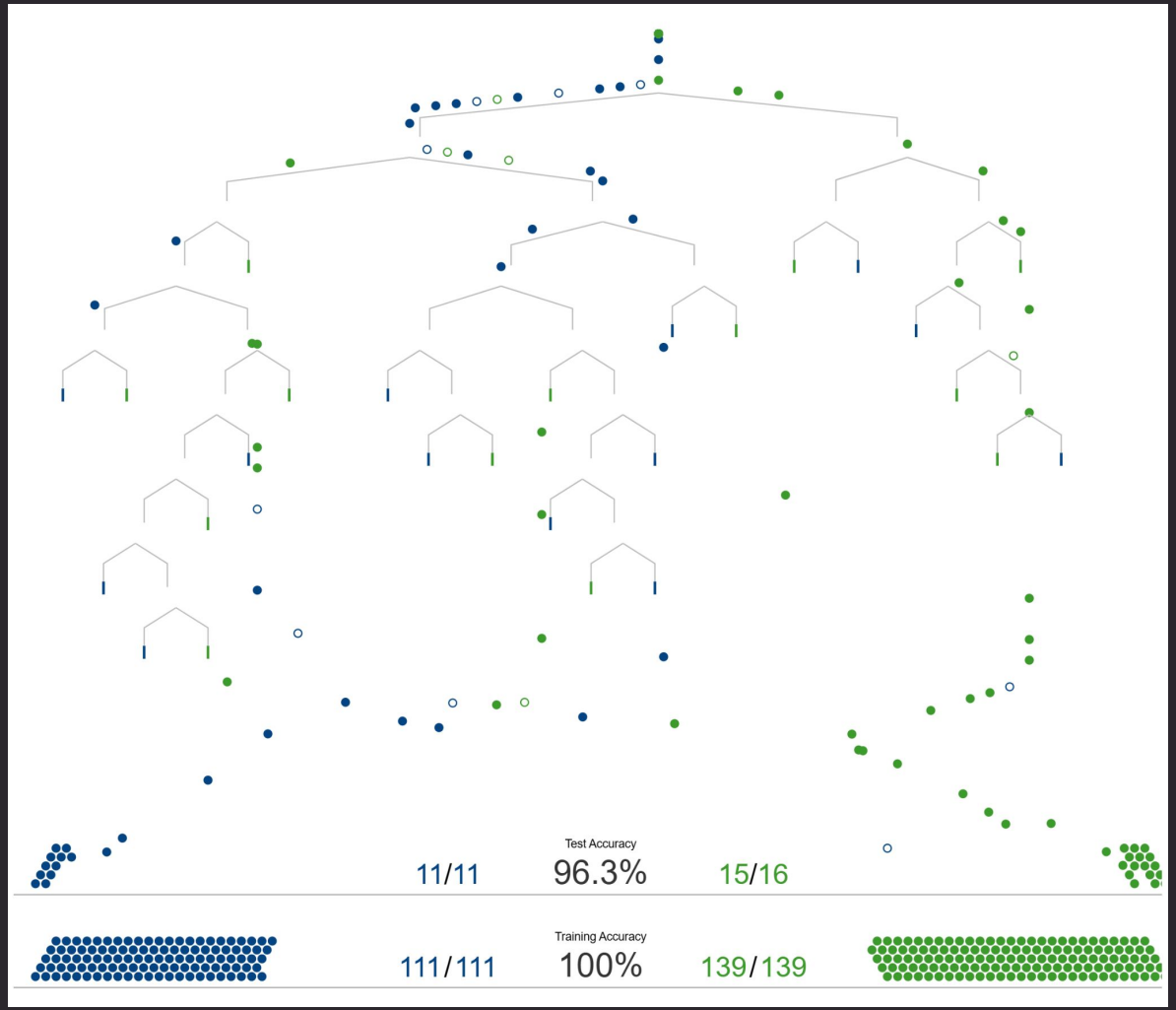
Neuron Activation Types



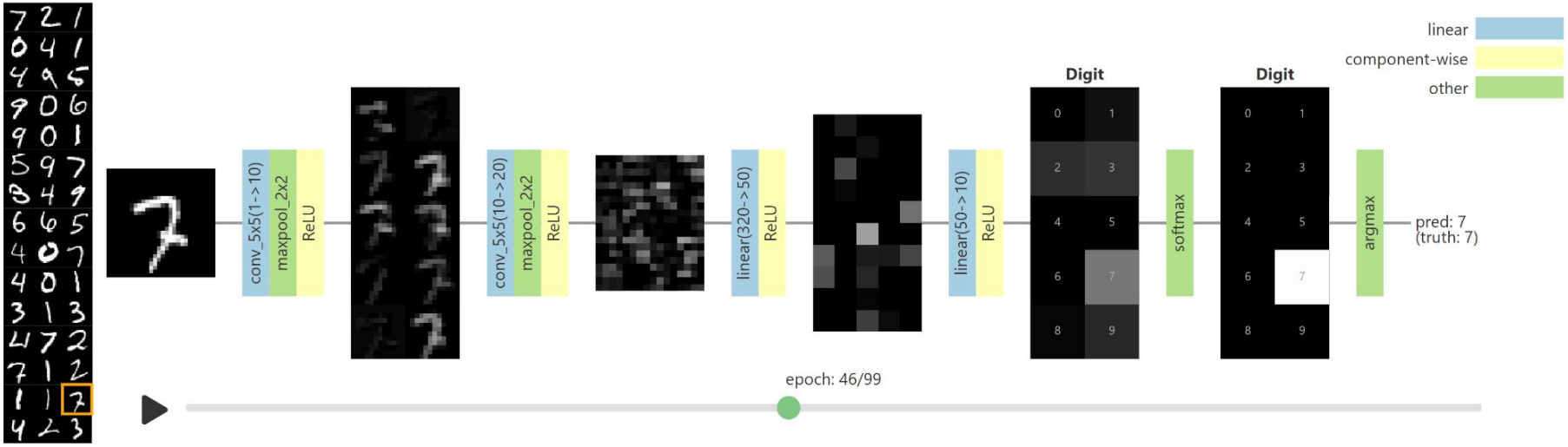


Decision Trees

- Where is the apartment?
- In San Francisco or New York?
- Build a decision tree to find out ...



Learning the numbers



Neural network opened. The colored blocks are building-block functions (i.e. neural network layers), the gray-scale heatmaps are either the input image or intermediate activation vectors after some layers.

Learning the numbers

https://transcranial.github.io/keras-js

Cats & Dogs

https://distill.pub/2019/activation-atlas/

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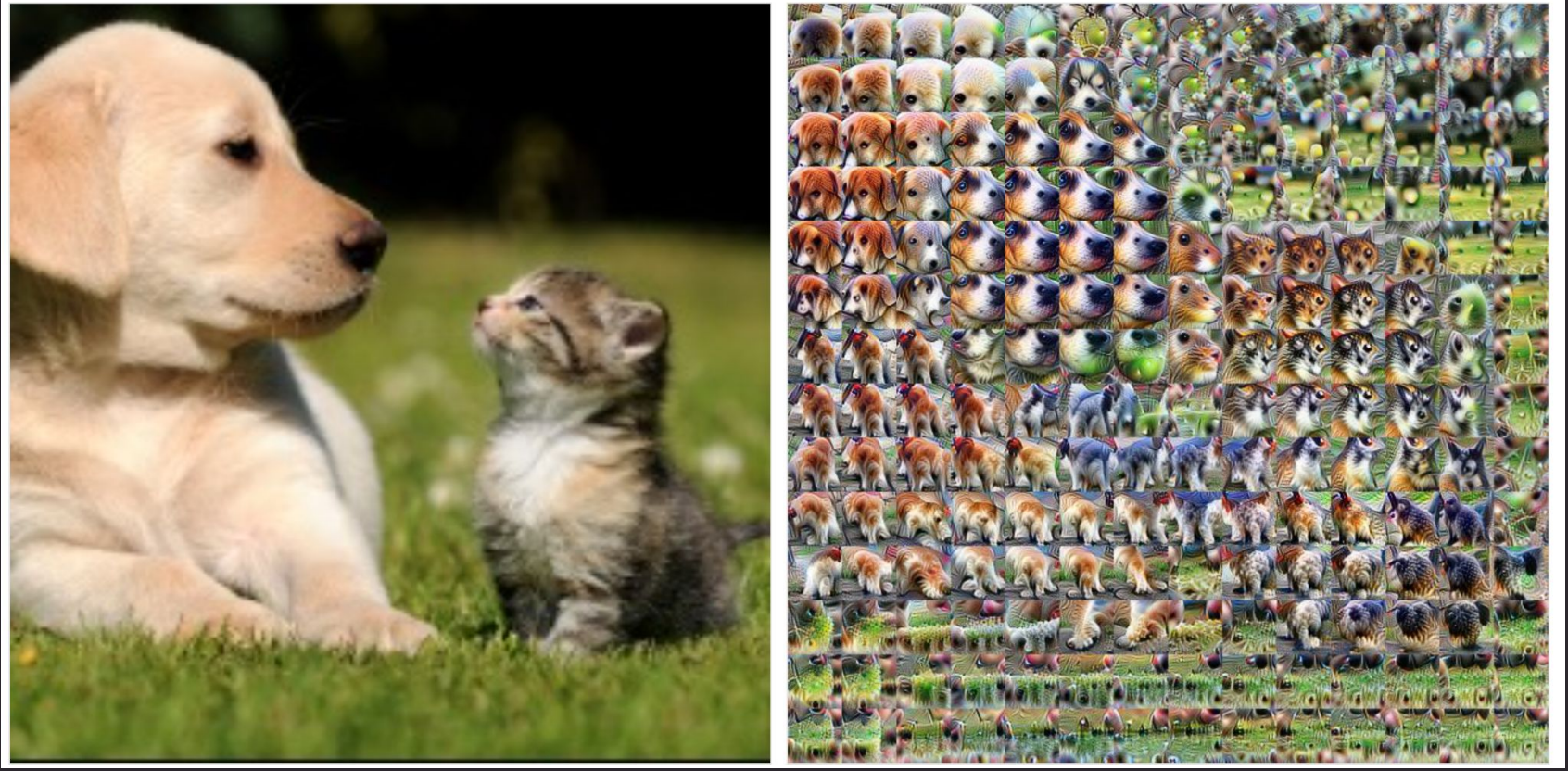
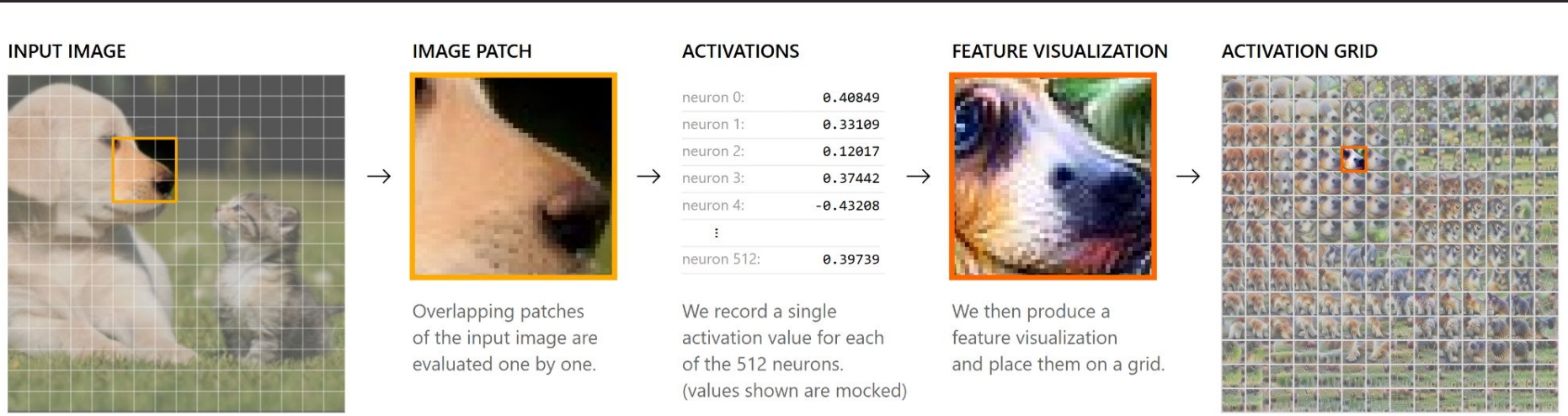


Cats & Dogs



https://distill.pub/2019/activation-atlas/

What is in the AI brain?

Region Neurons


USA


Europe


India


West Africa?


Australia


North America


New York

Person Neurons


Donald Trump


Elvis Presley

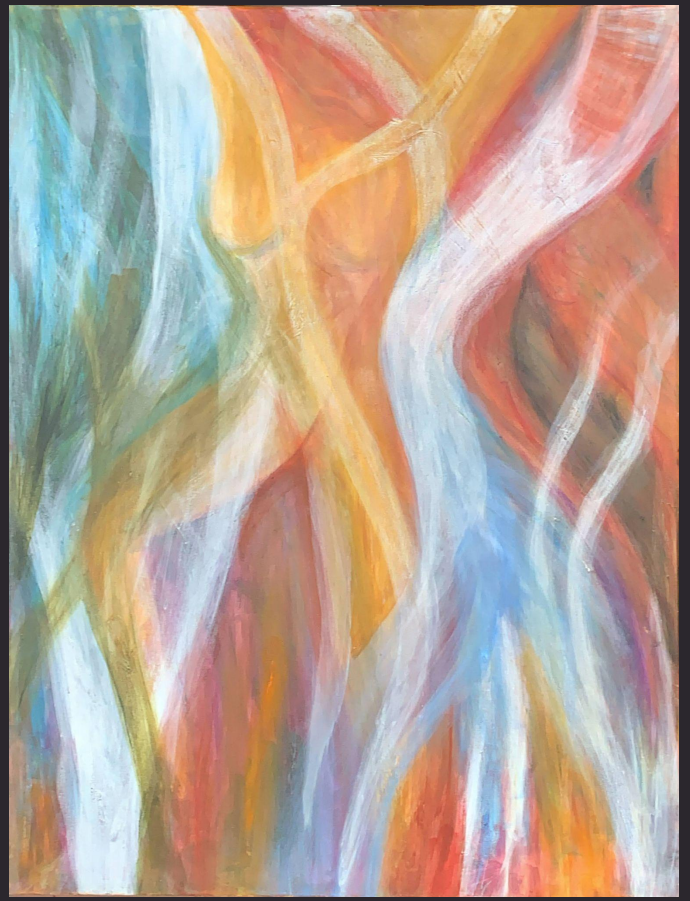

Lady Gaga


Ariana Grande

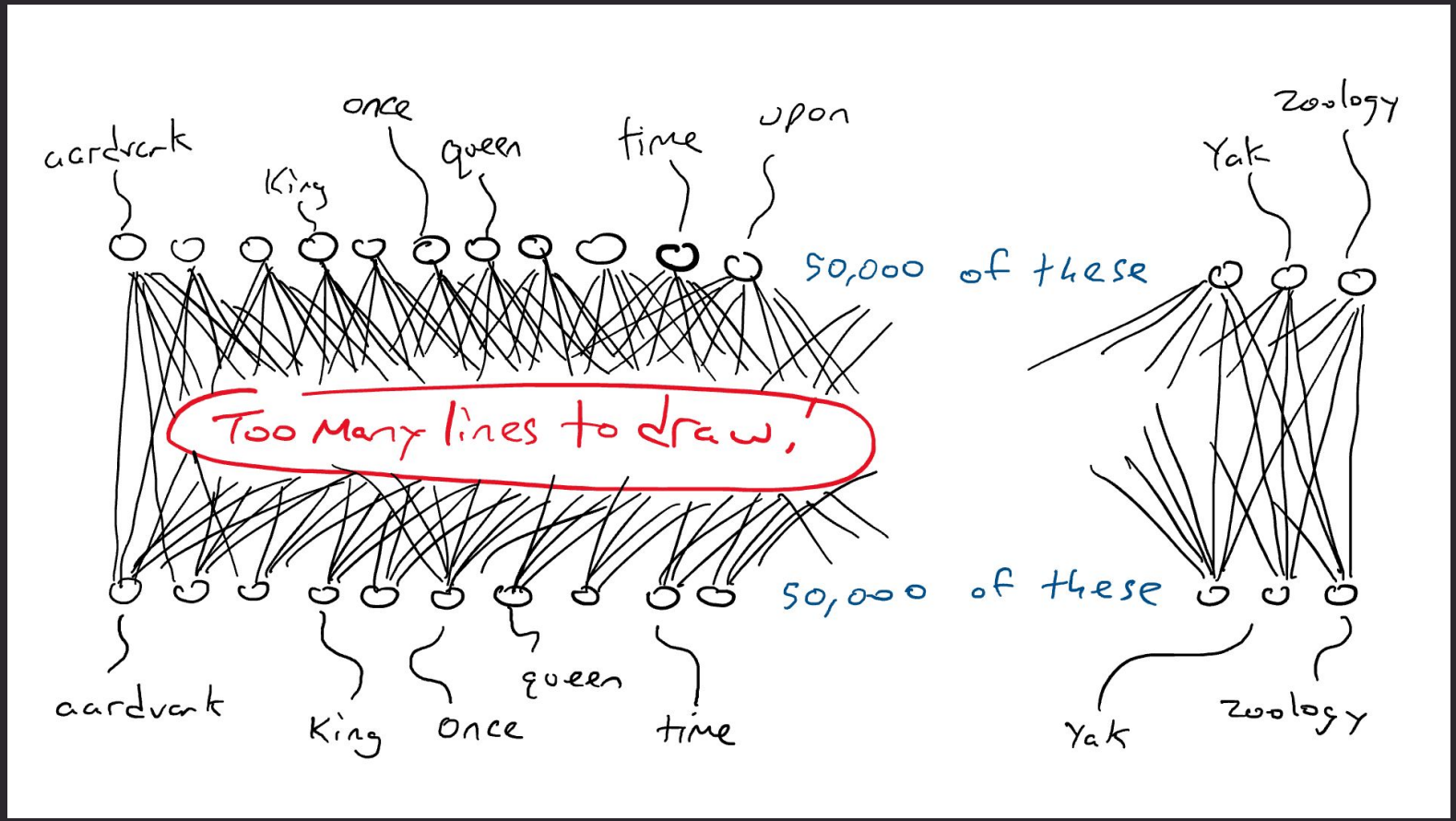

Jesus Christ

https://distill.pub/2021/multimodal-neurons/

Large Language Models and Generative AI ...

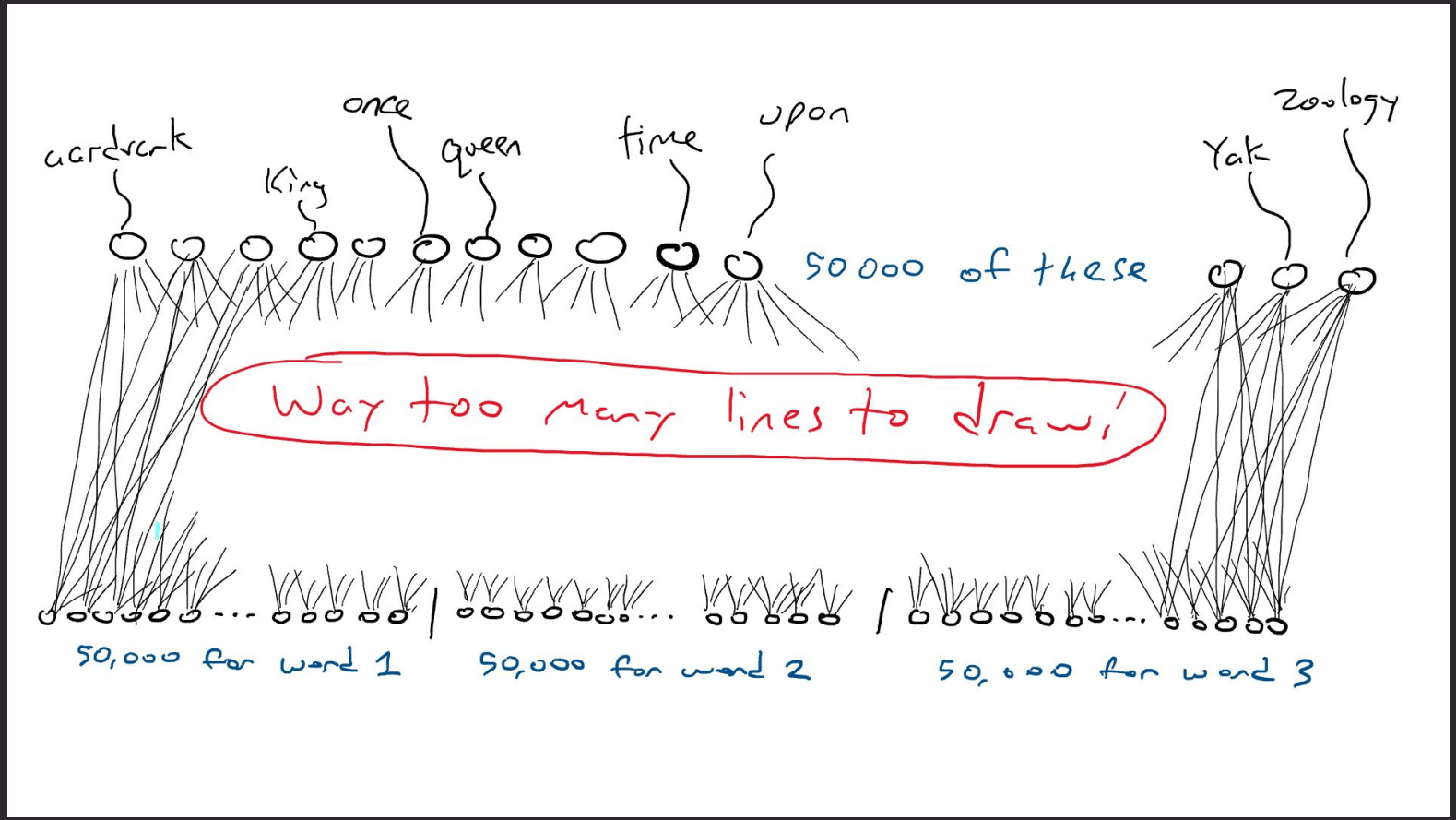


Once ...



Mark Riedl (2023) A Very Gentle Introduction to Large Language Models without the Hype

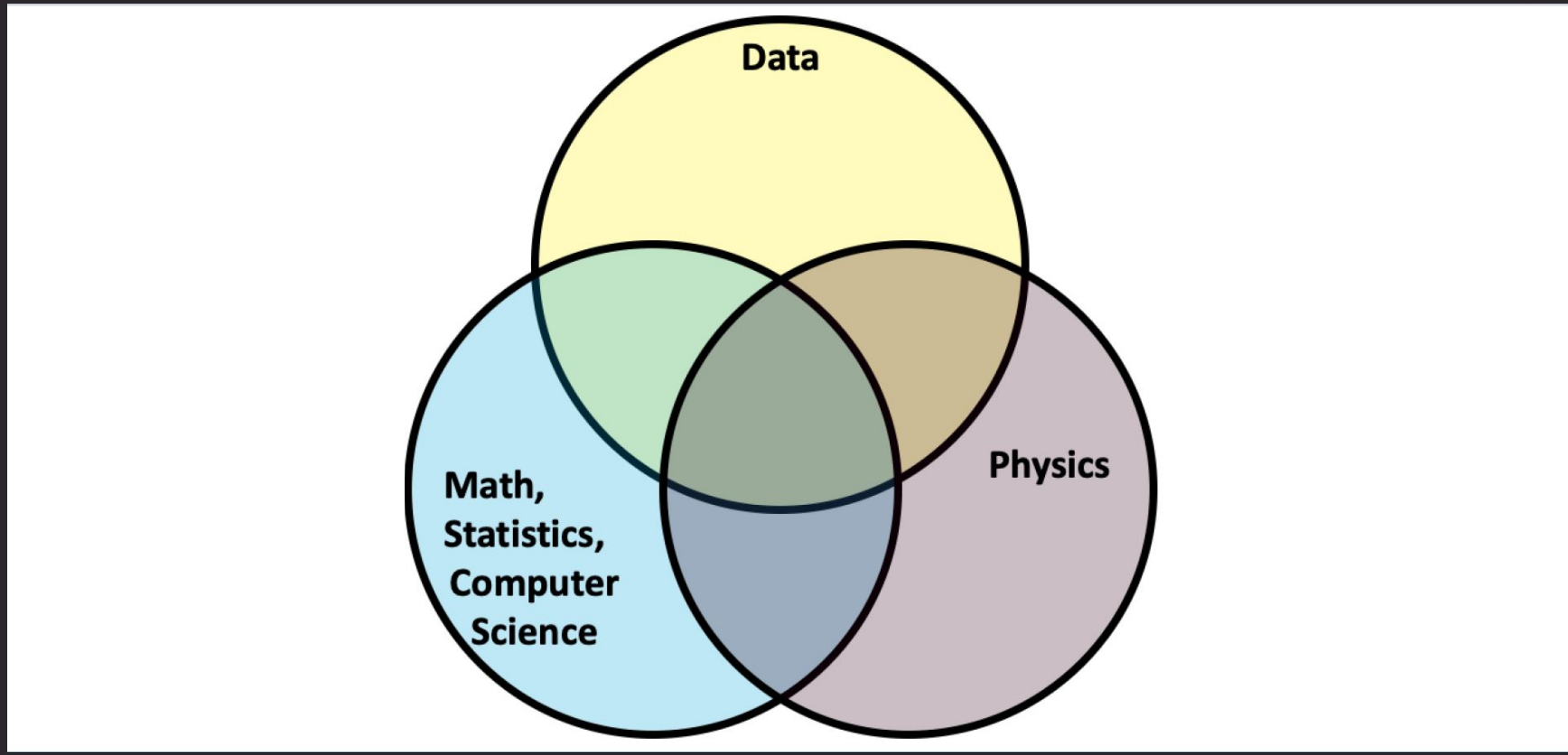
Once upon a ...



Riedl (2023) A Very Gentle Introduction to Large Language Models without the Hype LINK

Science-Informed AI

Science-InformedMachine Learning



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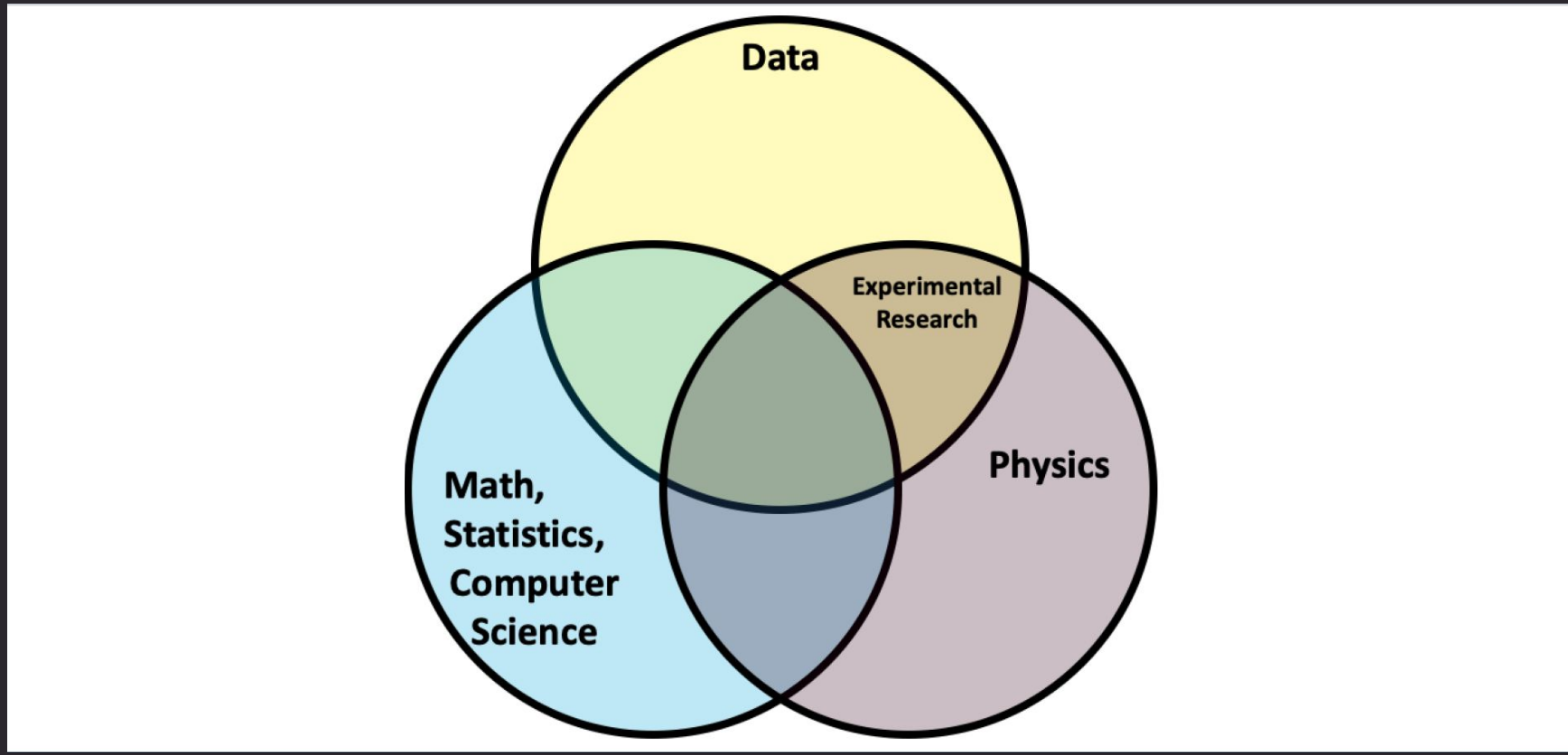

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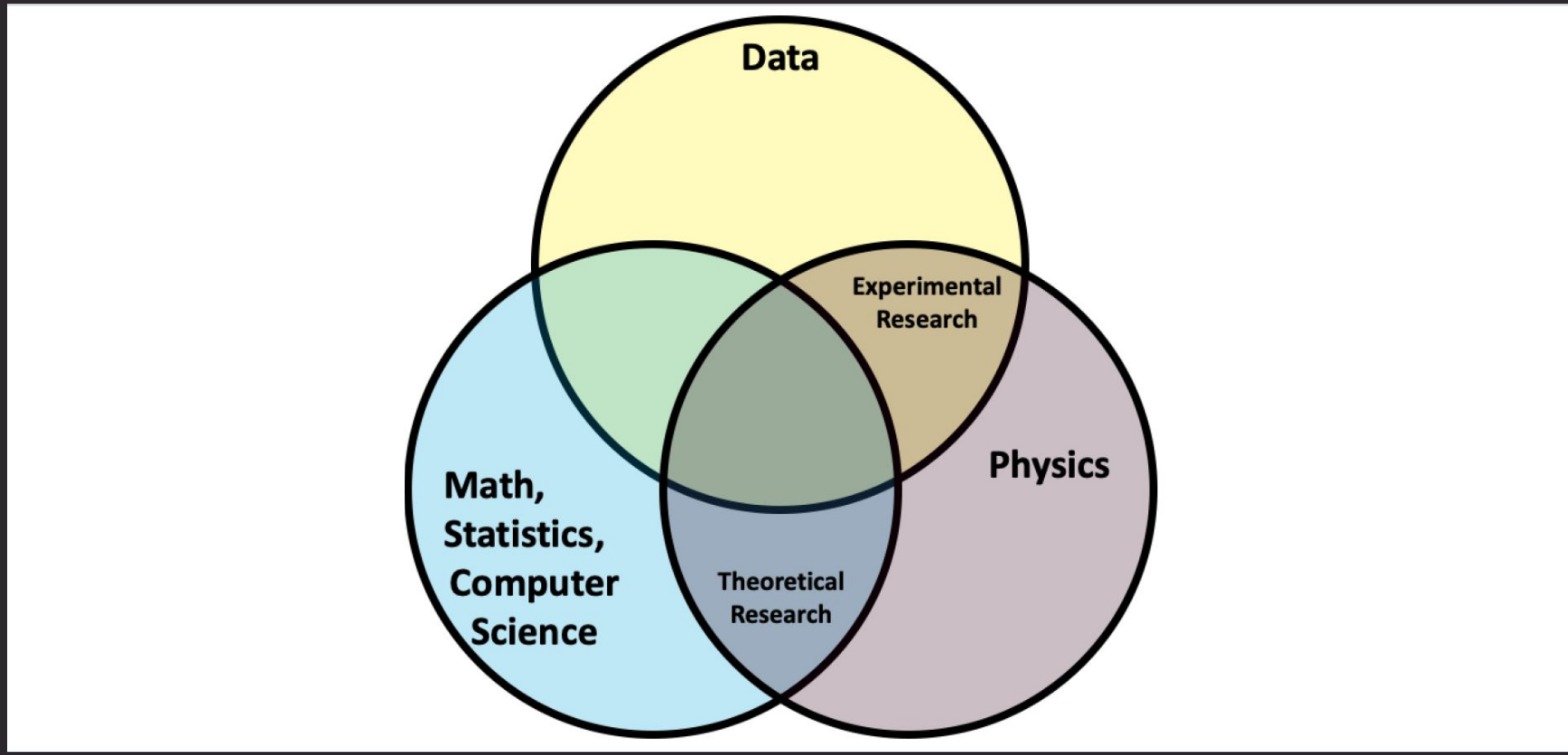

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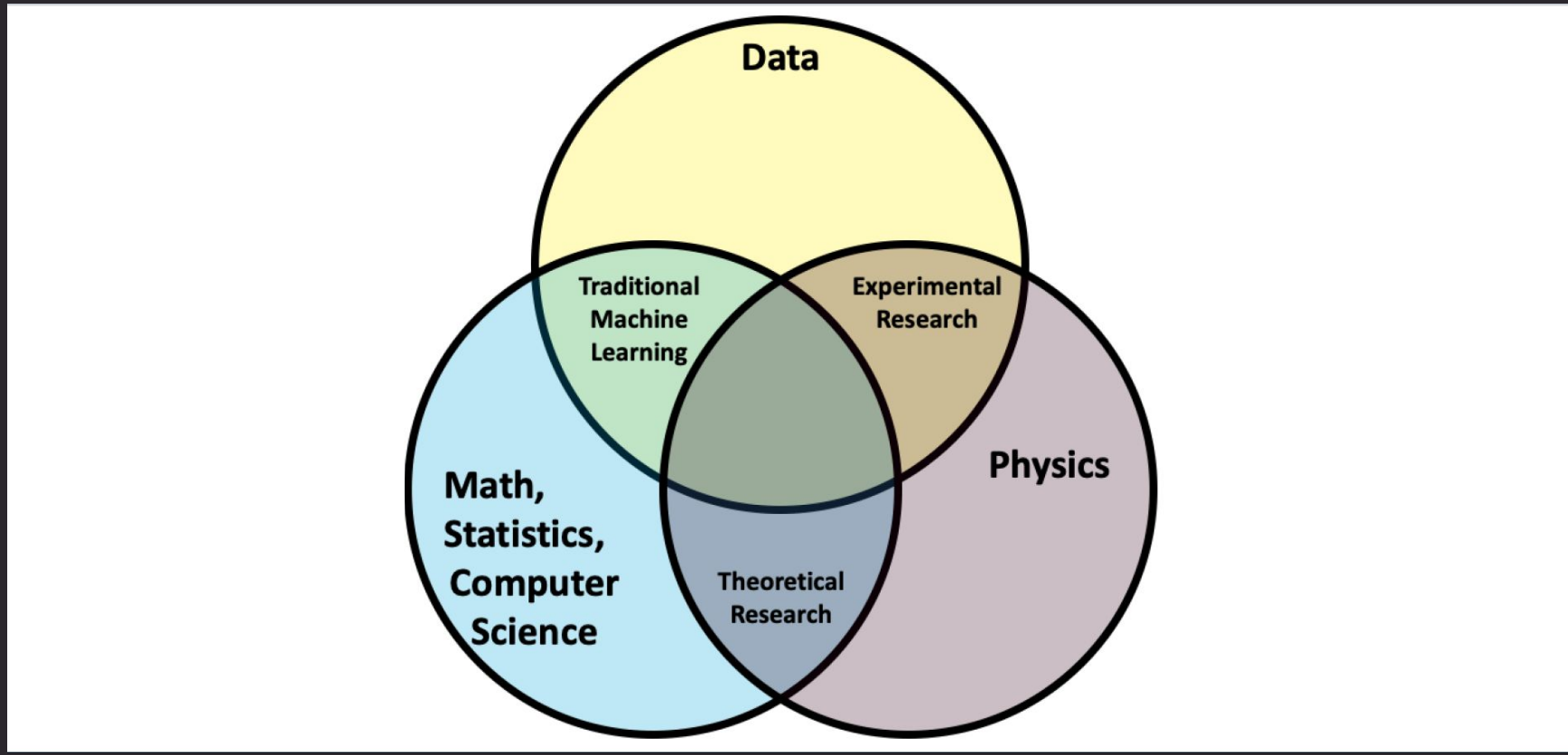

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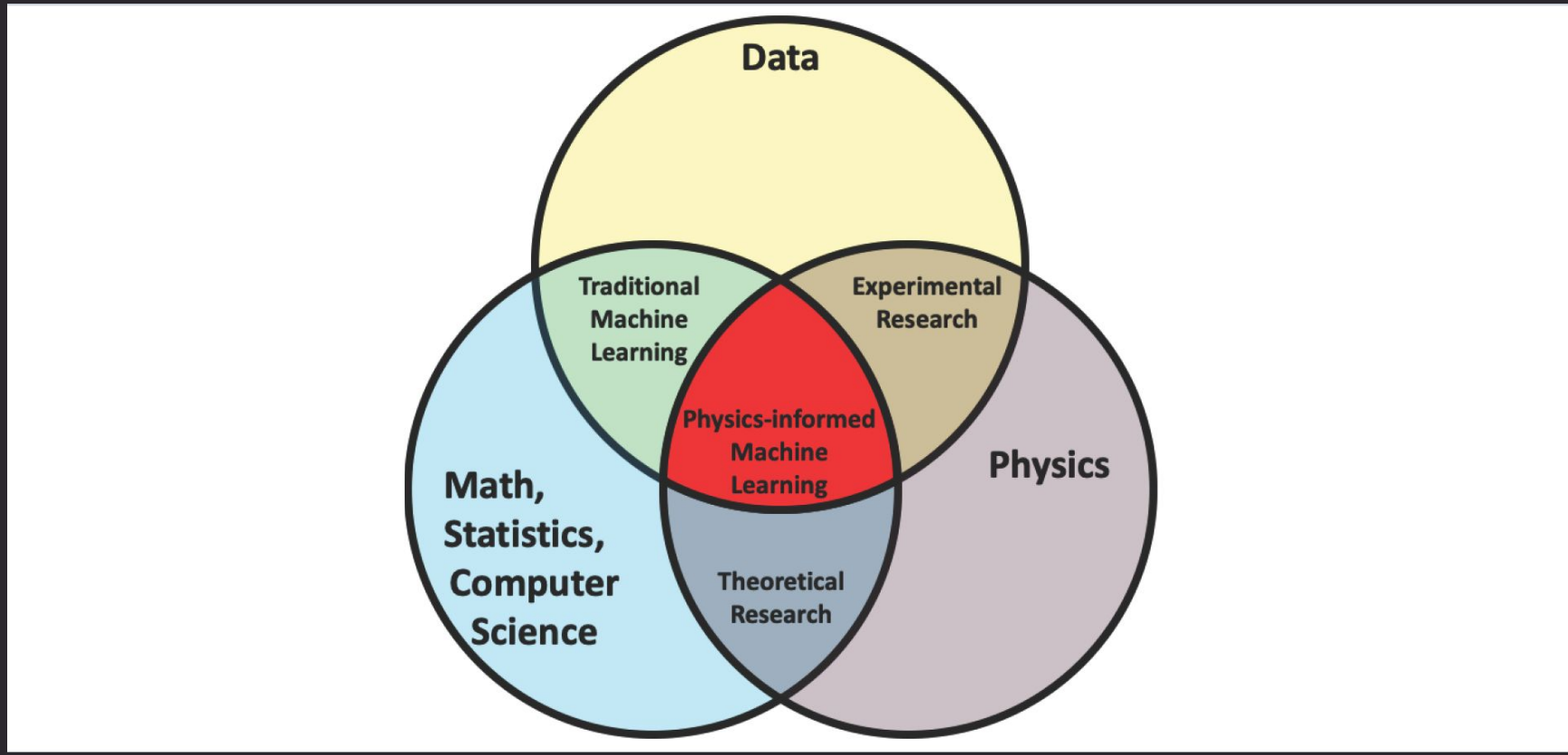
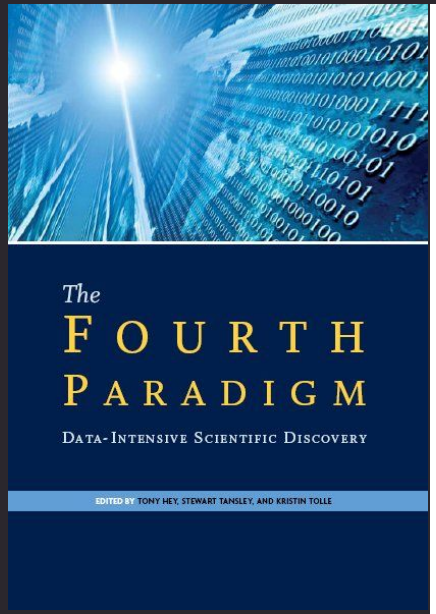
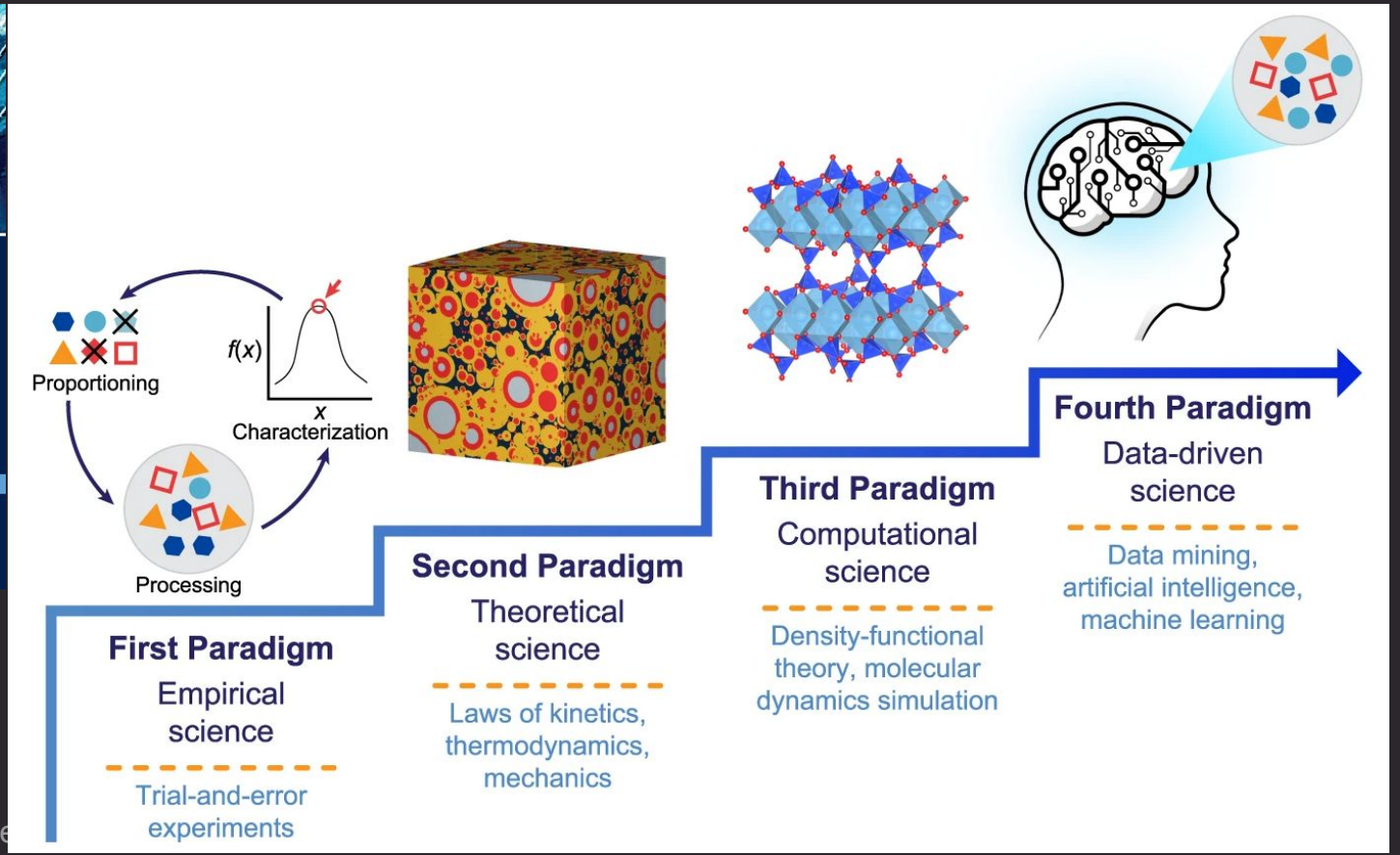


The Fourth Science Paradigm



Microsoft Research, *The Fourth Paradigm: Data-Intensive Scientific Discovery,* 2009 LINK



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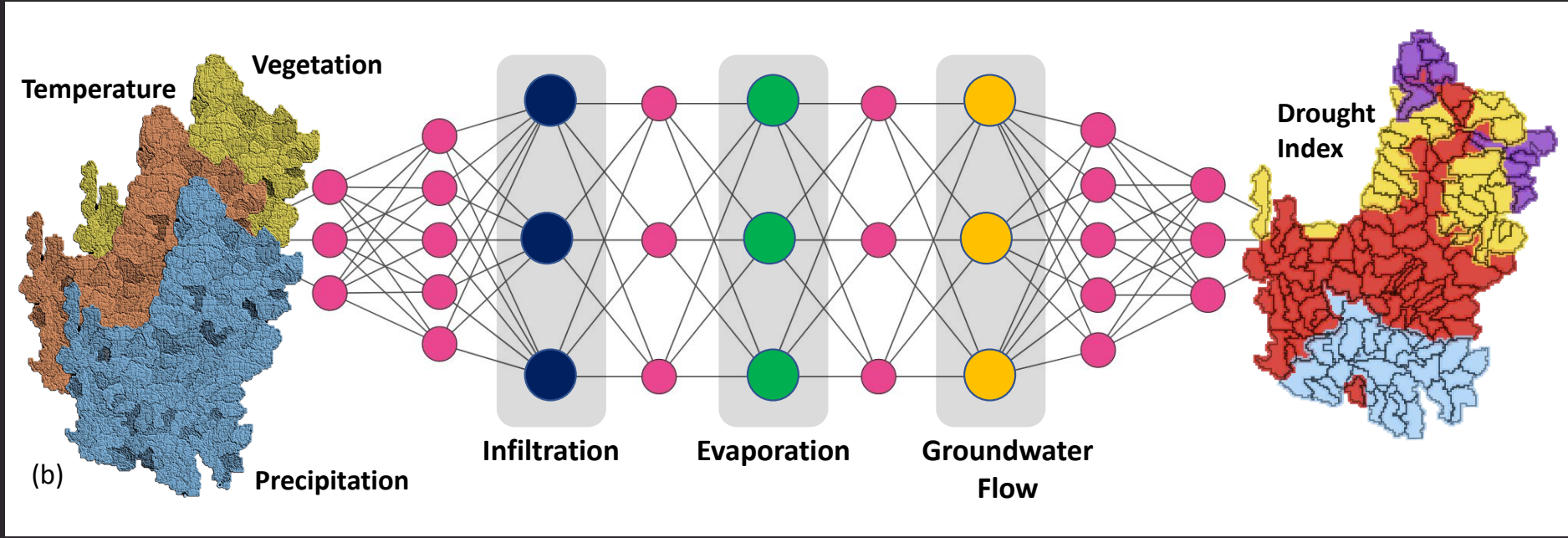
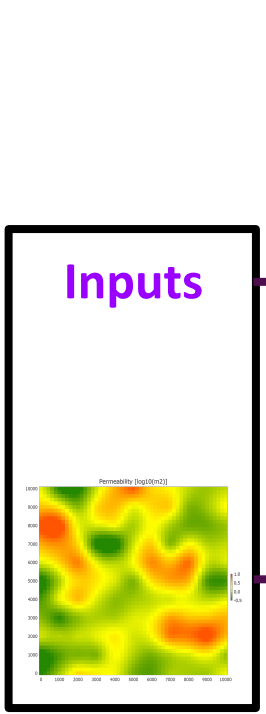
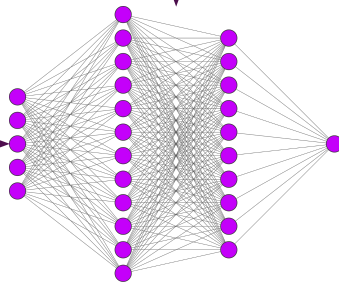


Talsma, Bennett, Vesselinov (2021) Characterizing Drought Behavior using Unsupervised Machine Learning for Improved Understanding of Future Drought in the Colorado River Basin PDF

Science-Informed AI (model in the loop)

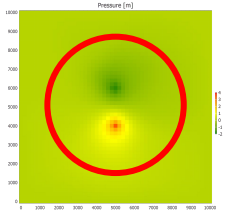




Rate

Loss

Simulator



Geothermal prospectivity

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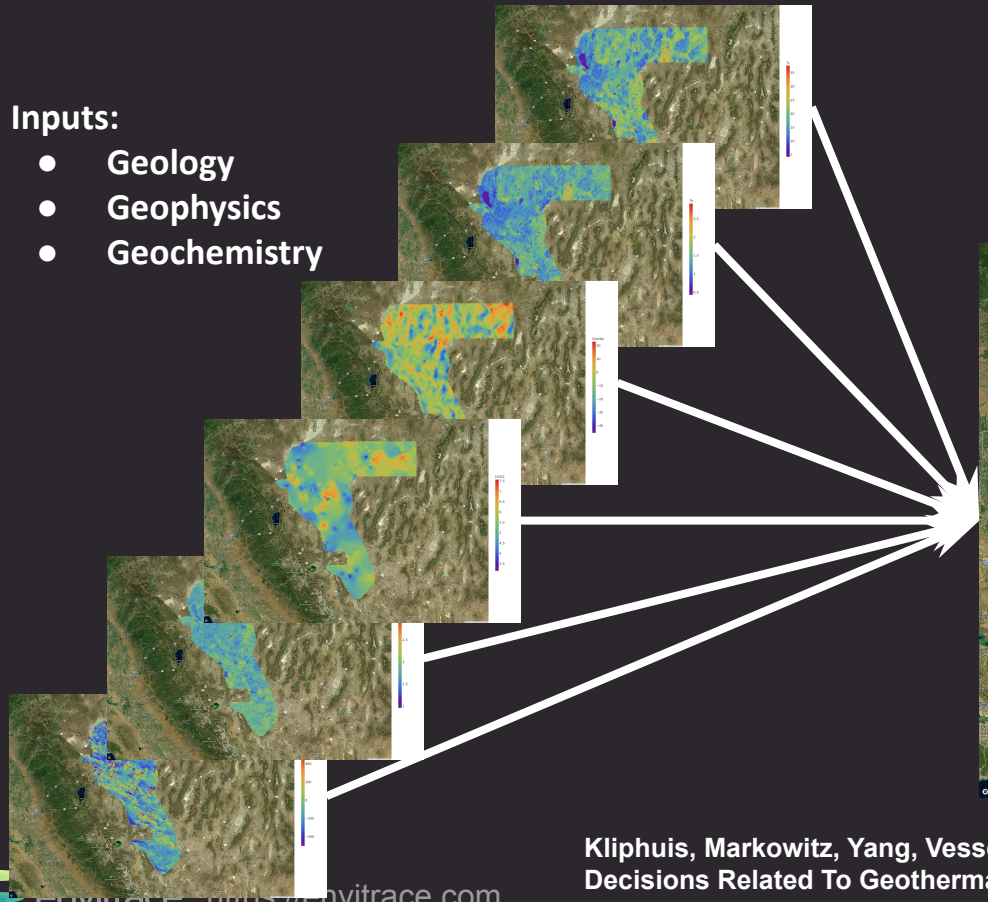
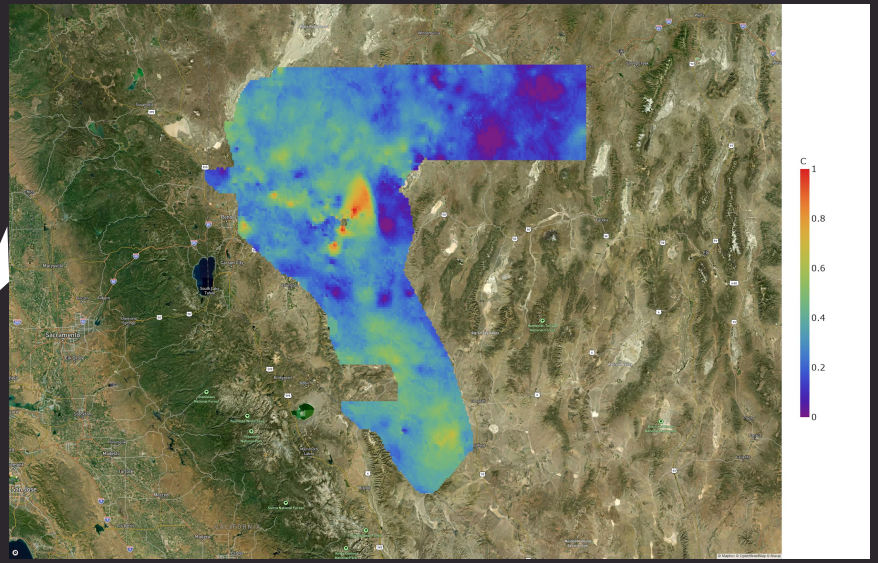


Output: Probability of occurrence



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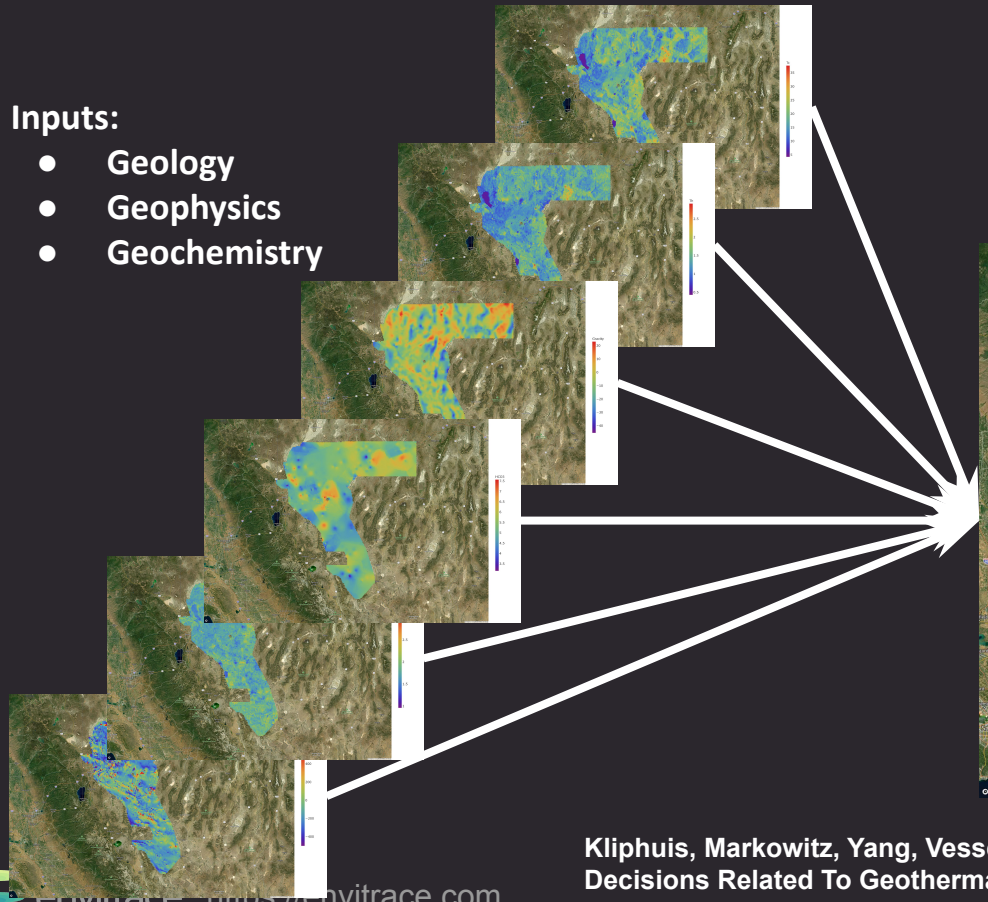

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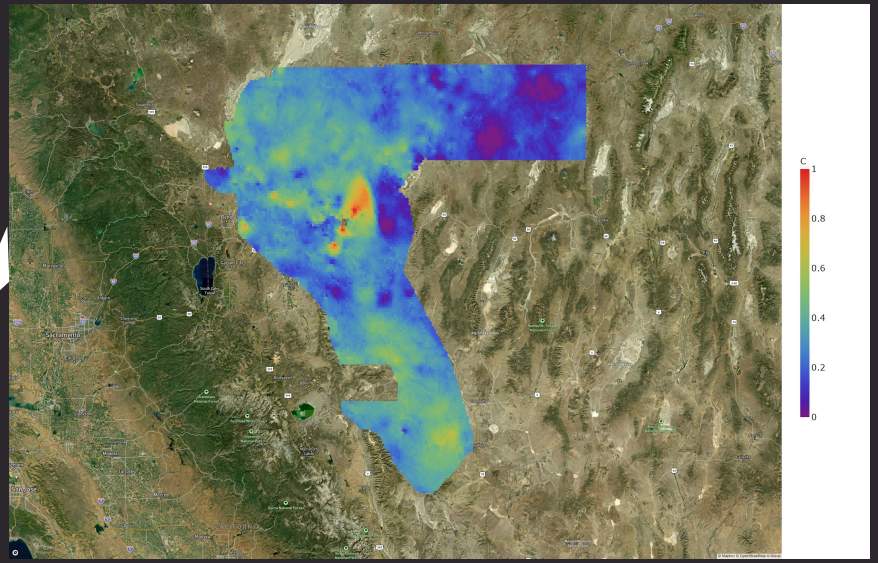

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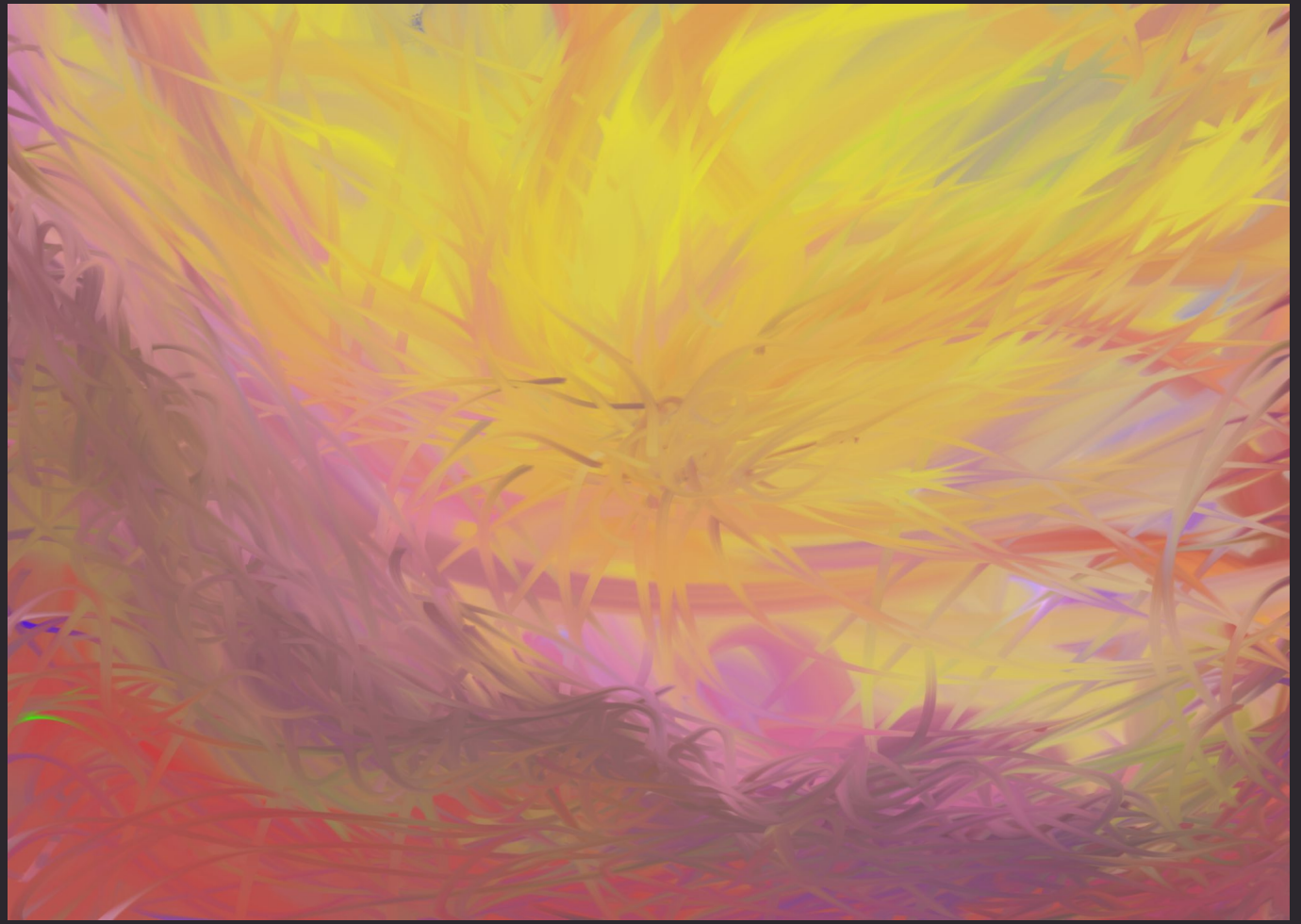
Energy



Energy

- Through an extensive evolutionary process, our brains are very efficiently designed.

- Energy consumption of our brains is about 480 Wh each day (~175 KWh per year)
- Energy consumption per person is 140 KWh each day (~50 MWh per year) (in USA).

- Training the latest ChatGPT/Gemini models consumed ~50,000 MWh for about 6 months.
- In terms of energy, this is equivalent to training about 8,000 people (40 hours a week for 6 months).

- A single (~2 minutes) query consume ~2Wh.
- 1 billion queries consume 2,000 MWh per day.
- This is equivalent of ~4,000 years of thinking.
- ~4,000,000 experts will be needed to answer these questions.

- To answer these questions, their brains will consume ~2000 MWh.
- Experts' total energy consumption will be ~600,000 MWh.
- … and think about their salaries …

Energy

- AI methods and tools developed by us and others can address existing energy and environmental challenges
- Geothermal is one of the primary candidates for providing cooling and power to data centers.
- Our AI tools facilitate the geothermal exploration and extraction
- Our AI tools address also other environmental concerns related to data centers including water-supply impacts and contamination

Let us build a brighter and cleaner future with the help of AI!

envitrace

- AI solutions for Energy and Environmental problems
  - energy production and storage (including geothermal and hydrogen)
  - waste management (including nuclear waste disposal and carbon sequestration)
  - contaminant characterization and remediation
  - induced seismicity
  - in-situ mining (including rare-earth elements)
  - water, energy, & food nexus
  - urban climate monitoring and analyses
- Cloud data management and computing
- Visualization and analytics tools
  - pre-processing
  - optimization
  - sensitivity assessment
  - uncertainty quantification
  - risk evaluation
  - decision support
  - lifecycle assessments

envitrace

- >$4.6M R&D funding
- >$1M contracts and consulting
- 30+ combined years of AI experience
- 100+ combined years of research
- 500+ research papers
- 20+ open-source codes (GitHub)
- 5+ proprietary codes
- 10+ AI Patents & Invention Disclosures
- 2 AI R&D 100 Awards

Our Team

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Questions

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