

Applications of Artificial Intelligence

Andrew Pownuk

Large Language Models

ChatGPT

Google Gemini

...

Predicting Next Word

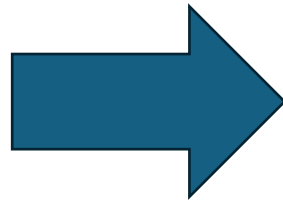


$$f(\textit{previous text}) = \textit{next text}$$

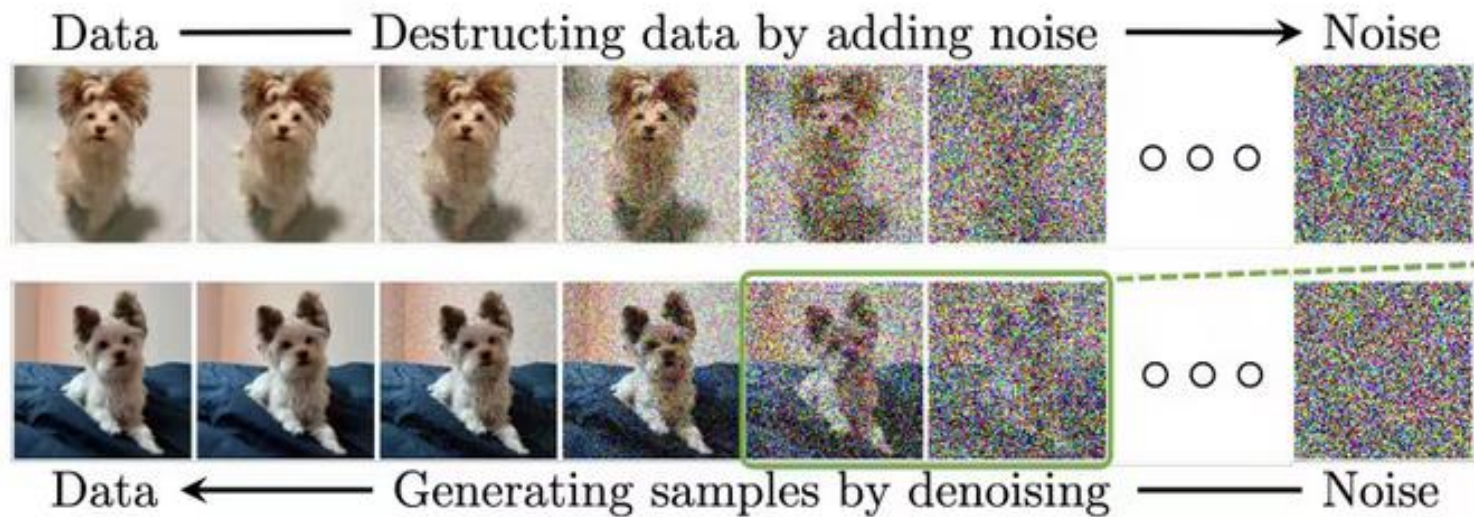
Diffusion Model

Text to Image

Text



Diffusion Model



$$f(\text{previous picture}) = \text{next picture}$$

Image Classification

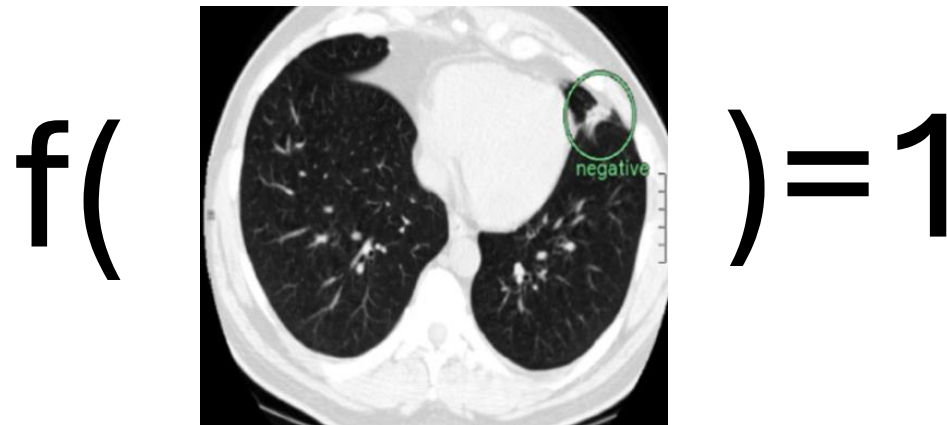
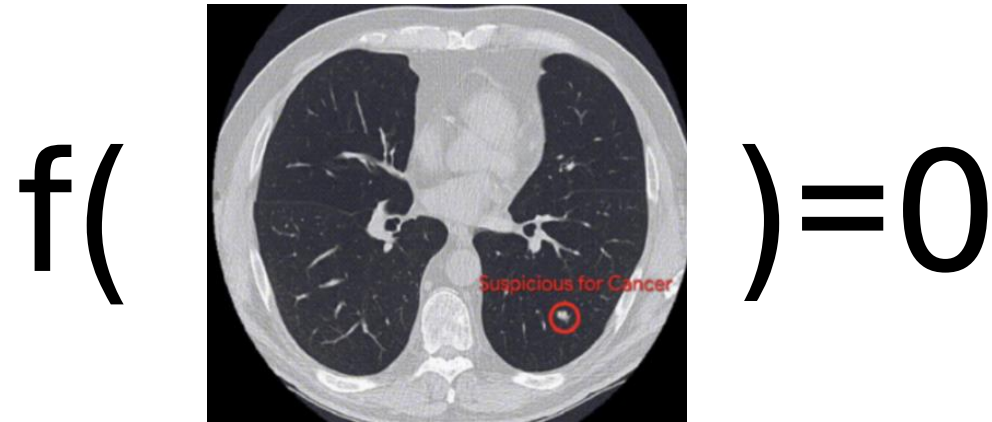
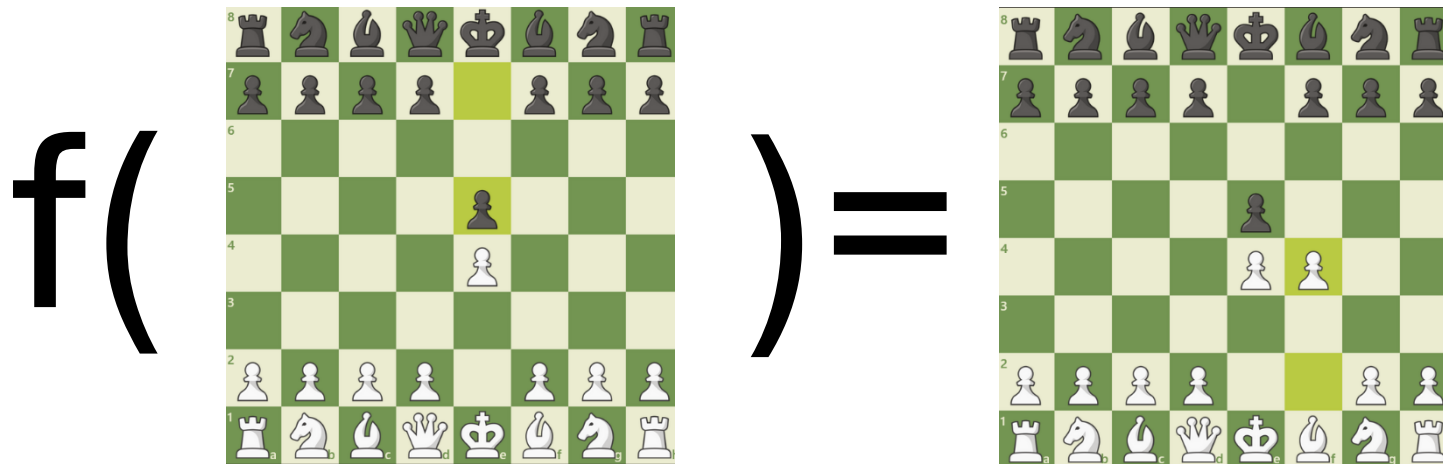


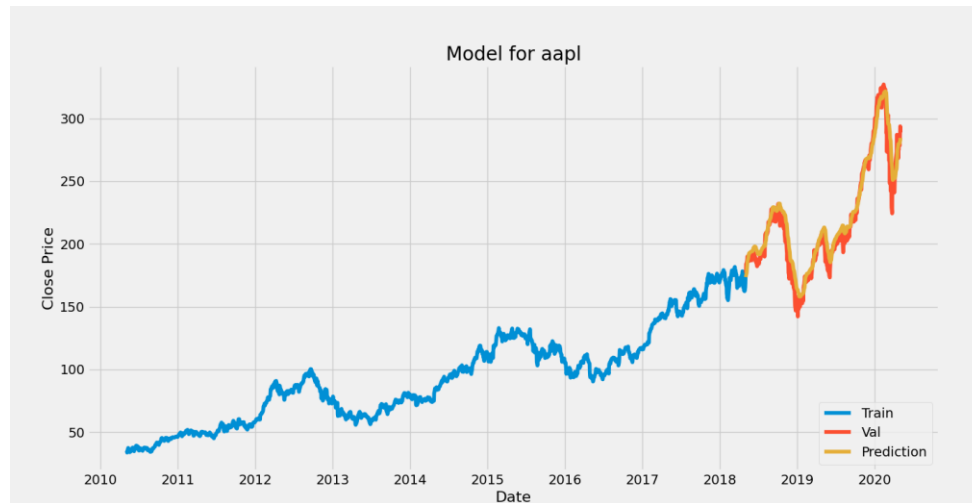
Image Recognition

$f(\text{Image of a Ford SUV}) = \text{Ford}$

Deep Reinforcement Learning (Game Theory)



Financial Data



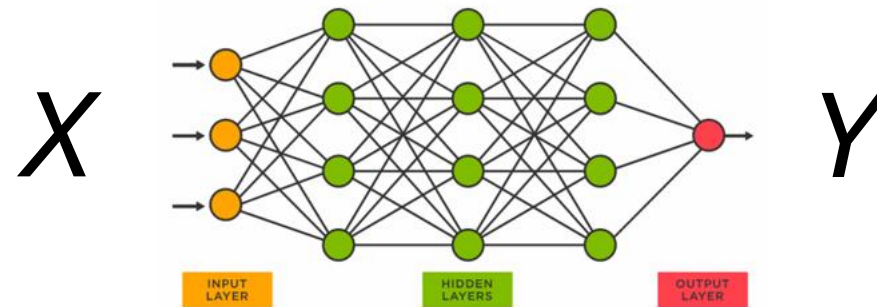
$$f(\text{old data}) = \text{future data}$$

Personalized Advertisements

f(personal information) = personalized ad



Neural Networks (AI)



Human Brain

Question →



→ **Answer**

Intelligence

Brain(question) = answer

Artificial Intelligence

NeuralNetwork(question) = answer

ChatGPT

Prompt: Find the equation of a line that passes through two points $(0,0)$ and $(1,1)$.



To find the equation of a line that passes through two points, you can use the formula for the slope (m) of the line, given by:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

For the points $(0, 0)$ and $(1, 1)$:

$$m = \frac{1-0}{1-0} = 1$$

Now, you can use the point-slope form of the line equation, which is:

$$y - y_1 = m(x - x_1)$$

Using the point $(0, 0)$ and the slope $m = 1$:

$$y - 0 = 1(x - 0)$$



Google Gemini

Prompt: Find the equation of a line that passes through two points $(0,0)$ and $(1,1)$.

Absolutely! There are actually two main ways to find the equation of the line: slope-intercept form and point-slope form.

Slope-intercept form ($y = mx + b$)

1.

Calculate the slope (m):

The slope represents the change in y over the change in x between the two points. In this case, the change in y ($1 - 0$) is equal to the change in x ($1 - 0$) so the slope $m = (1 - 0) / (1 - 0) = 1$.

Calculate the y-intercept (b):

The y-intercept (b) is the point where the line crosses the y-axis. You can use either of the given points to solve for b . Let's use $(0, 0)$:

$$b = 0 - (1)(0) = 0.$$

Therefore, the equation of the line in slope-intercept form is $y = x + 0$, which can be simplified to $y = x$.

Point-slope form ($y - y_1 = m(x - x_1)$)

1.

Identify the slope (m): As calculated previously, the slope $m = 1$.

2.

Choose one of the points: Let's use $(0, 0)$ as the point (x_1, y_1) .

3.

Plug the values into the formula:

$$y - (0) = 1(x - (0))$$

ChatGPT

Prompt: Write a program that prints array of integers.

```
def print_array(array):  
    for number in array:  
        print(number)  
  
# Example array of integers  
example_array = [1, 2, 3, 4, 5]  
  
# Calling the function to print the array  
print_array(example_array)
```

ChatGPT

Prompt: Describe Pythagorean theorem.



The Pythagorean Theorem is a fundamental principle in geometry, discovered by the ancient Greek mathematician Pythagoras. It applies to right triangles, which are triangles where one of the angles is exactly 90 degrees.

The theorem states that in a right triangle, the square of the length of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the lengths of the other two sides. Mathematically, it is expressed as:

$$c^2 = a^2 + b^2$$

ChatGPT

Prompt: Describe the second
Newton's law of dynamics.



The second law of dynamics, also known as Newton's Second Law of Motion, is a fundamental principle in classical mechanics that describes the relationship between the forces acting on an object, its mass, and the acceleration it undergoes as a result. This law was formulated by Sir Isaac Newton and published in his seminal work, "Philosophiæ Naturalis Principia Mathematica," in 1687.

Newton's Second Law is usually stated as:

$$F = ma$$

ChatGPT

Prompt: Write a short story about
happy cat.

In a small sunlit garden, there lived a cheerful cat named Muffin. Each morning, Muffin would stretch her paws out on the soft grass, basking in the warm rays of the sun. Her days were filled with little adventures, from chasing fluttering butterflies to playing hide and seek with the chirping birds.

ChatGPT/Dall-E

Prompt: Create a picture that represents El Paso Texas.



Google Gemini

Prompt: Create a picture that represents El Paso Texas.



ChatGPT/Dall-E



Prompt: Create a picture of a programmer at work.



Image Recognition

Google Gemini

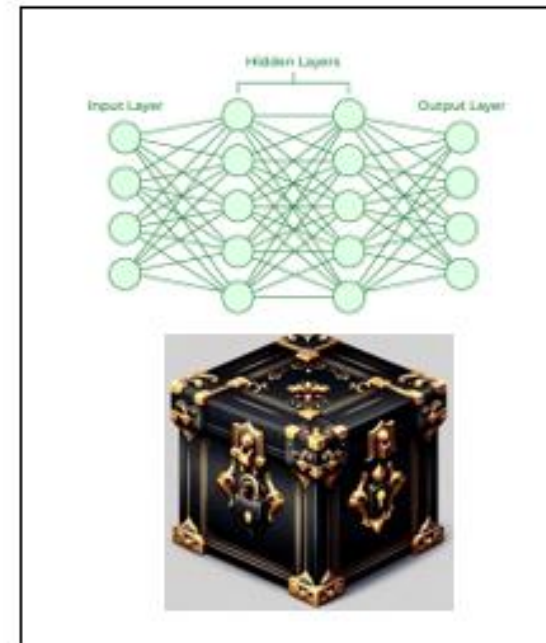


Show drafts  

◆ The car in the image is a white 2023 Ford Explorer <https://www.ford.com/suvs/explorer/2025/>. It is a mid-size SUV that seats up to seven passengers. The Explorer has a powerful engine and a variety of features, including all-wheel drive, a sunroof, and a tow hitch.

According to the text on the car and webpages it is found on, it is 2025 Ford Explorer <https://www.ford.com/suvs/explorer/2025/>, but it is not possible to say for sure from the image itself.

LLM in Education



Training process

LLM in Education



Prediction

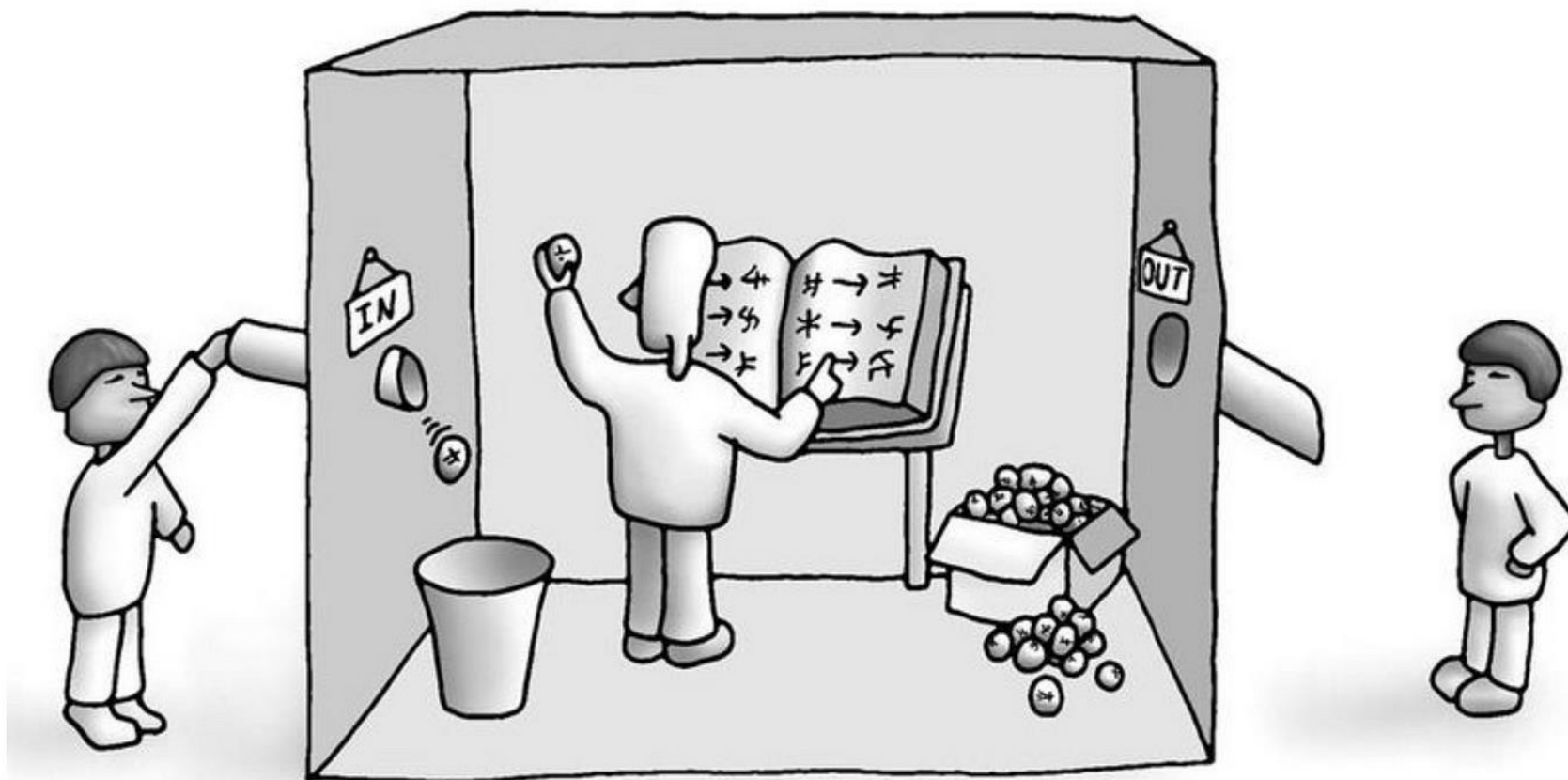
$$f(X) = Y$$

The Size of the Training Data Sets for Google Gemini

We know Gemini's training data is estimated at 5 trillion for Gemini Pro.

Compared to the example 120000-word textbook, Gemini's data would be equivalent to about 36 million textbooks.

Chinese Room Argument



Efficiency of LLM

Uniform Bar Exam
(MBE+MEE+MPT)

LSAT

SAT Evidence-Based Reading
& Writing

SAT Math

GRE Quantitative

GRE Verbal

GRE Writing

USABO Semifinal Exam 2020

USNCO Local Section Exam 2022

Medical Knowledge Self-
Assessment Program

Codeforces Rating

AP Art History

AP Biology

AP Calculus BC

References

Gemini: A Family of Highly Capable Multimodal Models, December 19, 2023.

<https://arxiv.org/abs/2312.11805>

GPT-4 Technical Report, March 4 2024.

<https://arxiv.org/abs/2303.08774>

Khan Academy

Khanmigo

- 1. Interactive Tutoring**
- 2. Personalized Learning Paths**
- 3. Real-Time Feedback and Assistance**
- 4. Engaging Learning Experience**
- 5. Resource Recommendations**
- 6. Support for Educators**

Carnegie Learning

- **Founders:** Carnegie Learning was established by a team of cognitive and computer scientists from Carnegie Mellon University.
- **Research Foundation:** Their educational software and materials are built upon decades of research in learning science conducted at Carnegie Mellon.
- **Independent Company:** Despite its origins, Carnegie Learning operates as an independent company and is not directly part of Carnegie Mellon University.

Writesonic

AI Article Writing

Chatsonic

SEO Optimization

Content Templates

Customization Options

Multilingual Support

Gradescope

AI-Assisted Grading

Flexible Grading Workflows

Digital Grading

Dynamic Rubrics

Efficient Feedback

Bias Reduction

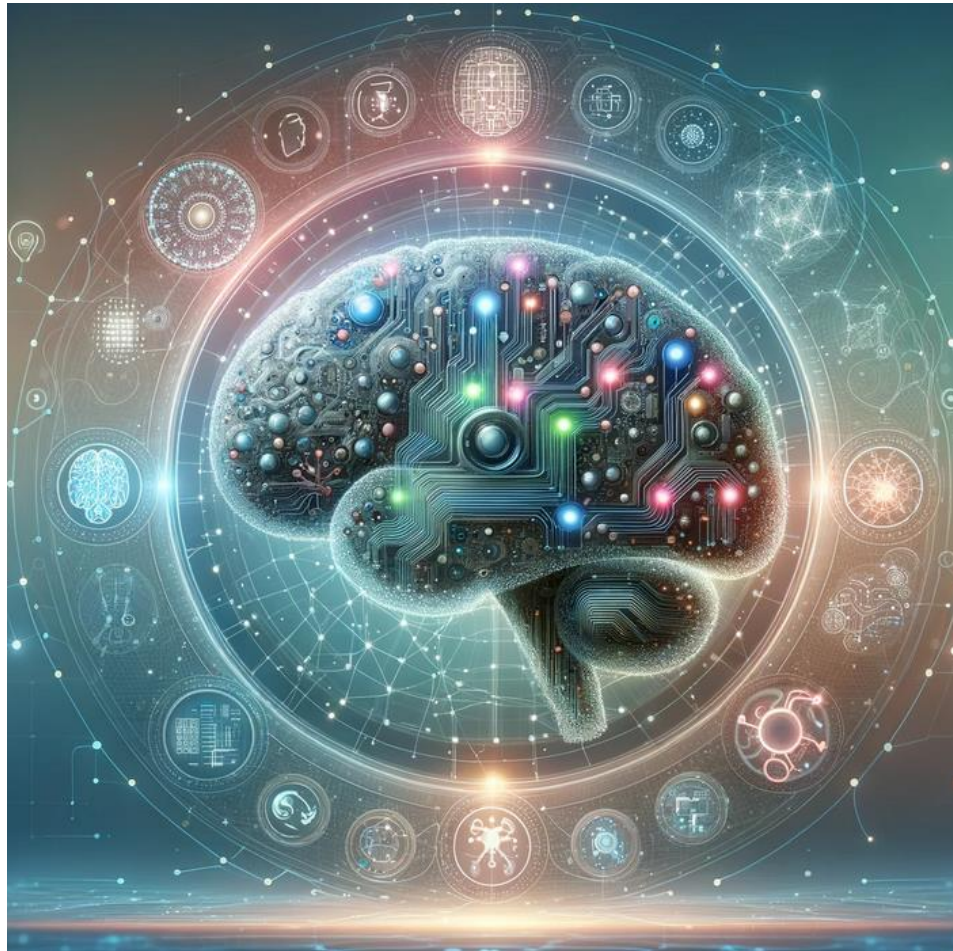
Multiple Question Types

A manifesto for business schools to ensure the smart and deep integration of generative artificial intelligence into the curriculum

<https://www.aacsb.edu/insights/articles/2024/04/future-proofing-higher-education>

April 16, 2024.

How does AI work?



How does AI work?

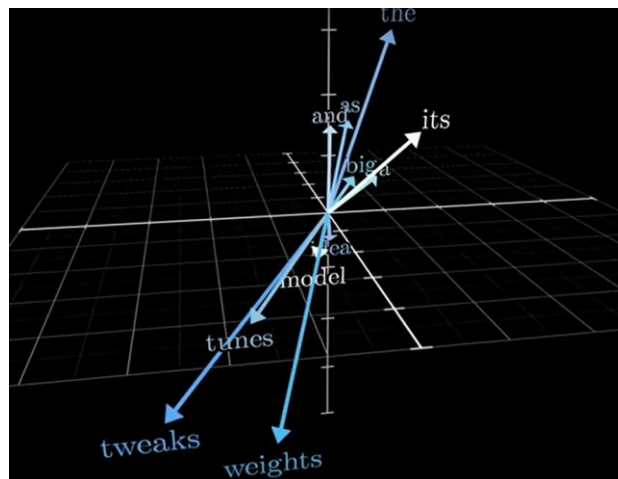
Brain(question)=answer

Word Embedding

WordEmbedding("this")=[11,25,17,19]

WordEmbedding("is")=[39,24,21,52]

...



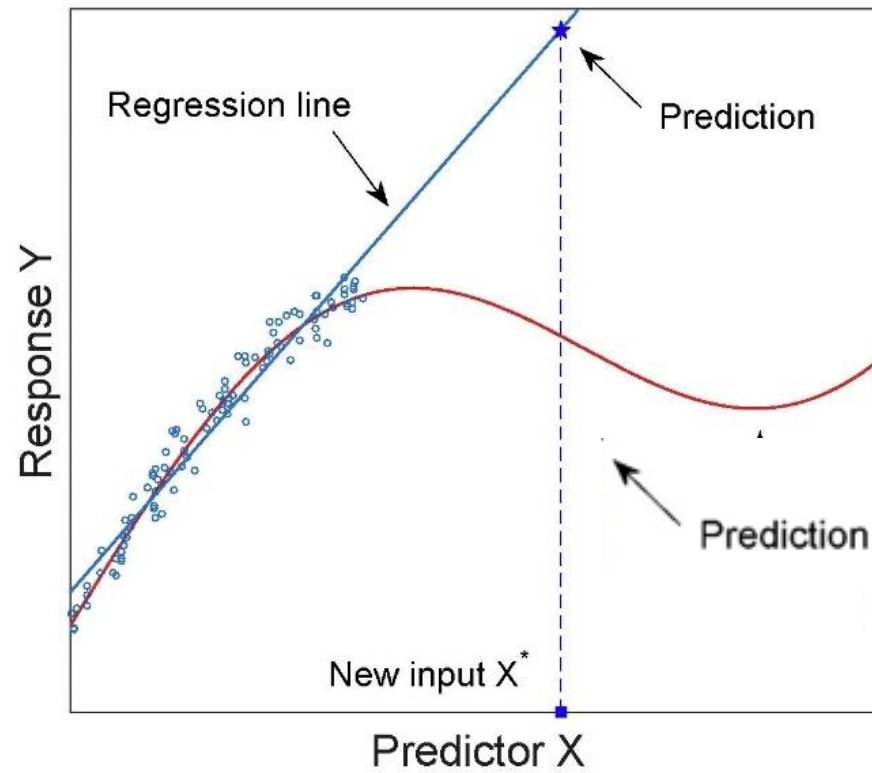
How does AI work?

TextToVector(question)=X

NeuralNetwork(X)=Y

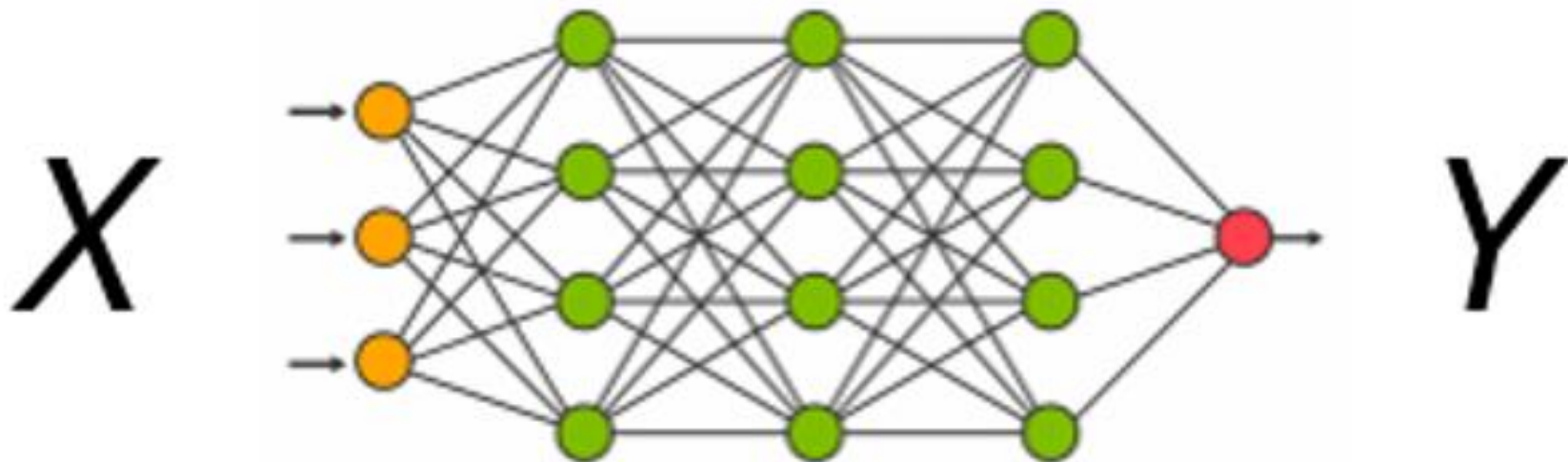
VectorToText(Y)=answer

Function Approximation



$$f(x) = y$$

Neural Networks



$$f(X) = Y$$

Neural Networks

- For the first hidden layer, the output (or activation) is computed as:

$$\mathbf{a}^{(1)} = f^{(1)}(\mathbf{W}^{(1)}\mathbf{x} + \mathbf{b}^{(1)})$$

- For each subsequent hidden layer l , the activation is computed based on the output of the previous layer:

$$\mathbf{a}^{(l)} = f^{(l)}(\mathbf{W}^{(l)}\mathbf{a}^{(l-1)} + \mathbf{b}^{(l)})$$

- This process is repeated for each layer in the network until the output layer is reached.

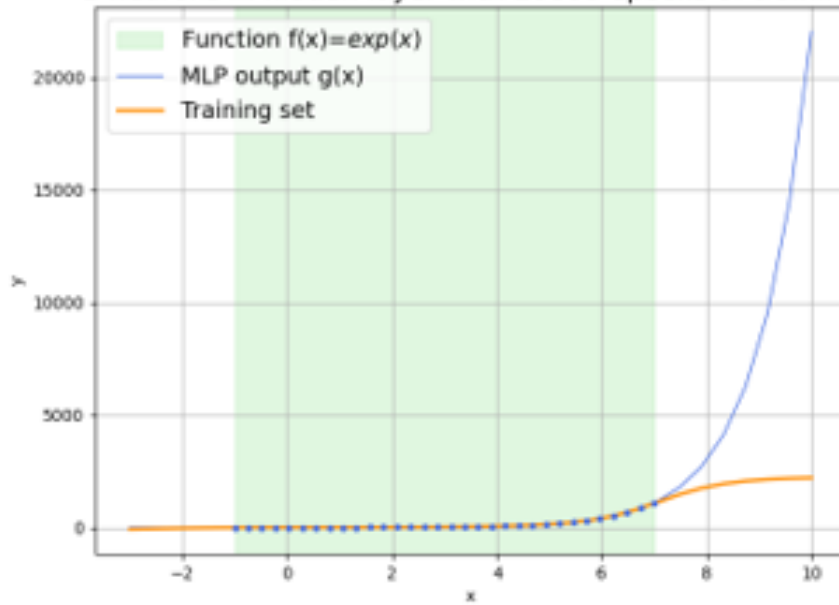
Training

$$Loss(W) = \sum_{i=1}^n (y_i - f(x_i, W))^2$$

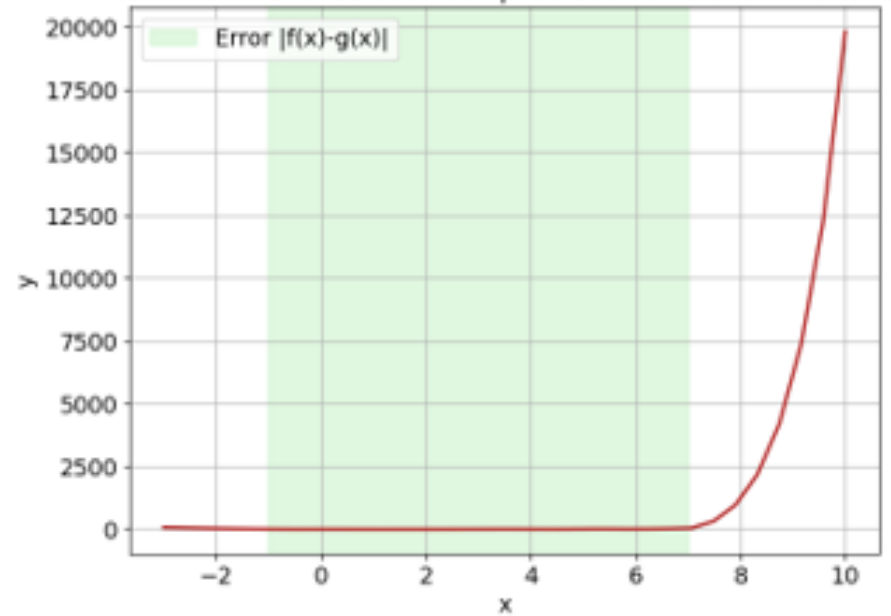
$$W^* = \operatorname{argmin}_W Loss(W)$$

Predictions

3 neurons in hidden layer with 10000 epochs of training

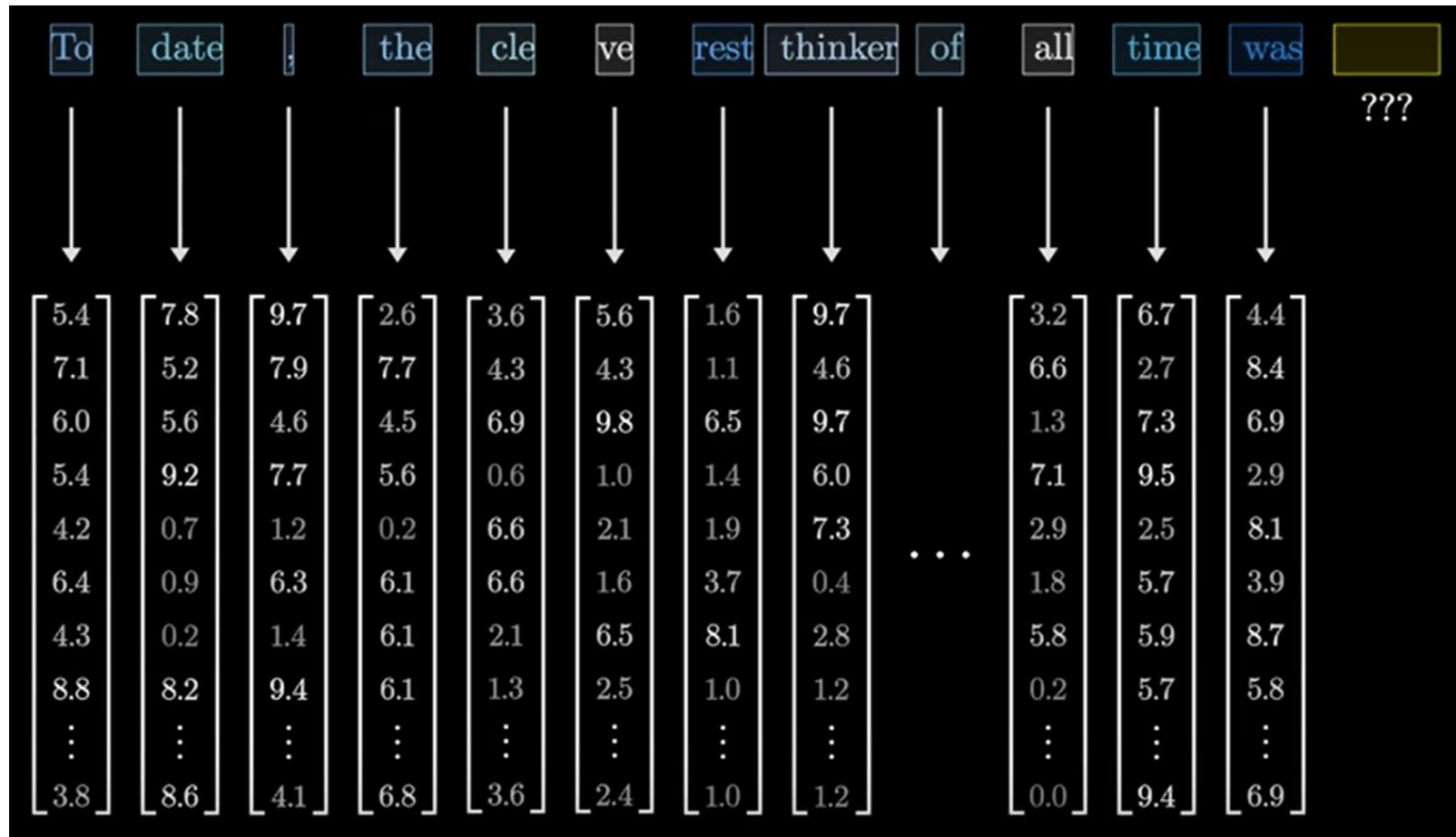


Absolute difference between prediction and actual function



$$f(x) = y$$

Predicting Next Word



Transformers

Behold, a wild pi creature,
foraging in its native land. In
order not to kill it in any other
way, he has set the land ablaze. And
now you hear the voice of your
father, "The man's going to kill
you now. You have not seen me so many
times, yet you have heard my voice.
So he is going to make it worse on a
large scale by going to **avenge**



GPT2



History of AI

Around 4th century BC, Aristotle made significant contributions by formalizing logical reasoning in his work, the Organon.

1847, Boole published a book titled "The Mathematical Analysis of Logic, Being an Essay Towards a Calculus of Deductive Reasoning."

1936, Alan Turing published paper 'On Computable Numbers, with an Application to the Entscheidungsproblem

1943-1945, First computers.

1997, Deep Blue versus Garry Kasparov.

2011-2012 - Deep learning for image classification.

March 2016, AlphaGo vs Lee Sedol, Google
DeepMind

2017 - Dermatologist-level classification of skin
cancer with deep neural networks, Nature.

November 30, 2022 – ChatGPT

AI for Medical Diagnosis

$$N(\text{X-ray image}) = \begin{matrix} 5 & 9 & 23 & 32 & 33 & 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 28 & 30 & 47 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 7 & 1 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 14 & 21 & 20 & 25 & 27 & 38 & 40 & 0 & 0 & 0 & 0 \\ 18 & 29 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 12 & 13 & 15 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 20 & 26 & 27 & 11 & 25 & 38 & 40 & 0 & 0 & 0 & 0 \\ 32 & 33 & 34 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 29 & 18 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 5 & 9 & 8 & 24 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 28 & 16 & 17 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 18 & 29 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 25 & 26 & 20 & 11 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 7 & 1 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 33 & 32 & 9 & 5 & 23 & 0 & 0 & 0 & 0 & 0 & 0 \\ 28 & 16 & 17 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{matrix} = X$$

$$f(X) = Y$$

X – symptoms, Y – diagnosis

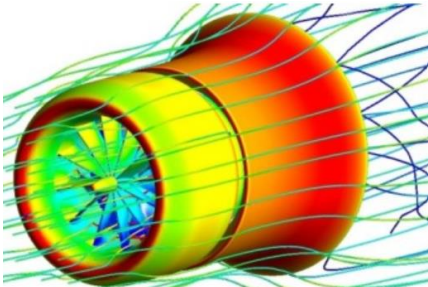
AI for Weather Forecast

$$N(\text{Image}) = \begin{matrix} 5 & 9 & 23 & 32 & 33 & 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 28 & 30 & 47 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 7 & 1 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 14 & 21 & 20 & 25 & 27 & 38 & 40 & 0 & 0 & 0 & 0 \\ 18 & 29 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 12 & 13 & 15 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 20 & 26 & 27 & 11 & 25 & 38 & 40 & 0 & 0 & 0 & 0 \\ 32 & 33 & 34 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 29 & 18 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 5 & 9 & 8 & 24 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 28 & 16 & 17 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 18 & 29 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 25 & 26 & 20 & 11 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 7 & 1 & 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 33 & 32 & 9 & 5 & 23 & 0 & 0 & 0 & 0 & 0 & 0 \\ 28 & 16 & 17 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{matrix} = X$$

$$f(X) = Y$$

X – measurements, Y – forecast

AI for CFD

$$N(\text{Image}) = X$$


5	9	23	32	33	0	0	0	0	0	0
3	28	30	47	0	0	0	0	0	0	0
7	1	3	0	0	0	0	0	0	0	0
14	21	20	25	27	38	40	0	0	0	0
18	29	0	0	0	0	0	0	0	0	0
12	13	15	0	0	0	0	0	0	0	0
20	26	27	11	25	38	40	0	0	0	0
32	33	34	0	0	0	0	0	0	0	0
29	18	0	0	0	0	0	0	0	0	0
5	9	8	24	0	0	0	0	0	0	0
28	16	17	0	0	0	0	0	0	0	0
18	29	0	0	0	0	0	0	0	0	0
25	26	20	11	0	0	0	0	0	0	0
7	1	3	0	0	0	0	0	0	0	0
33	32	9	5	23	0	0	0	0	0	0
28	16	17	0	0	0	0	0	0	0	0

$$f(X) = Y$$

X – measurements, Y – prediction

**Executive Order 13859, titled
"Maintaining American
Leadership
in Artificial Intelligence,"
was issued in February 2019**

Artificial Intelligence Safety and Security Board

April 26, 2024. Department of Homeland Security announced the establishment of the Artificial Intelligence Safety and Security Board (the Board).

The inaugural members of the Board: Sam Altman, CEO, OpenAI; Sundar Pichai, CEO, Alphabet; Satya Nadella, Chairman and CEO, Microsoft; etc.

<https://www.dhs.gov/news/2024/04/26/over-20-technology-and-critical-infrastructure-executives-civil-rights-leaders>

**The Executive Order on the
Safe, Secure, and Trustworthy
Development and Use of
Artificial Intelligence, issued on
October 30, 2023**

National AI Research Resource (NAIRR)

Provides access to computational resources

Shares AI-ready datasets

Offers educational tools and user support

Facilitates collaboration

Provides Educational Resources

