

# NielsenIQ

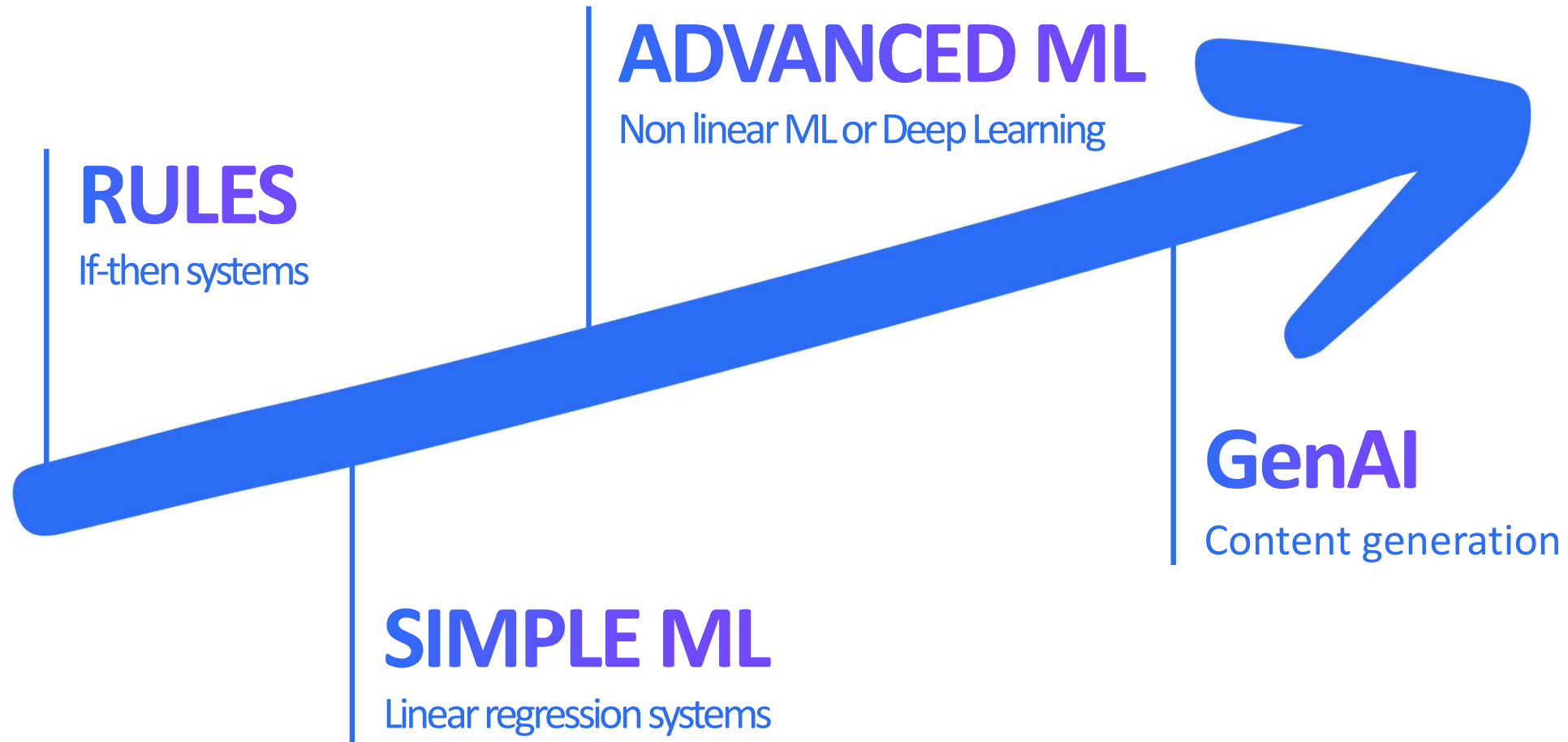
# ARTIFICIAL INTELLIGENCE

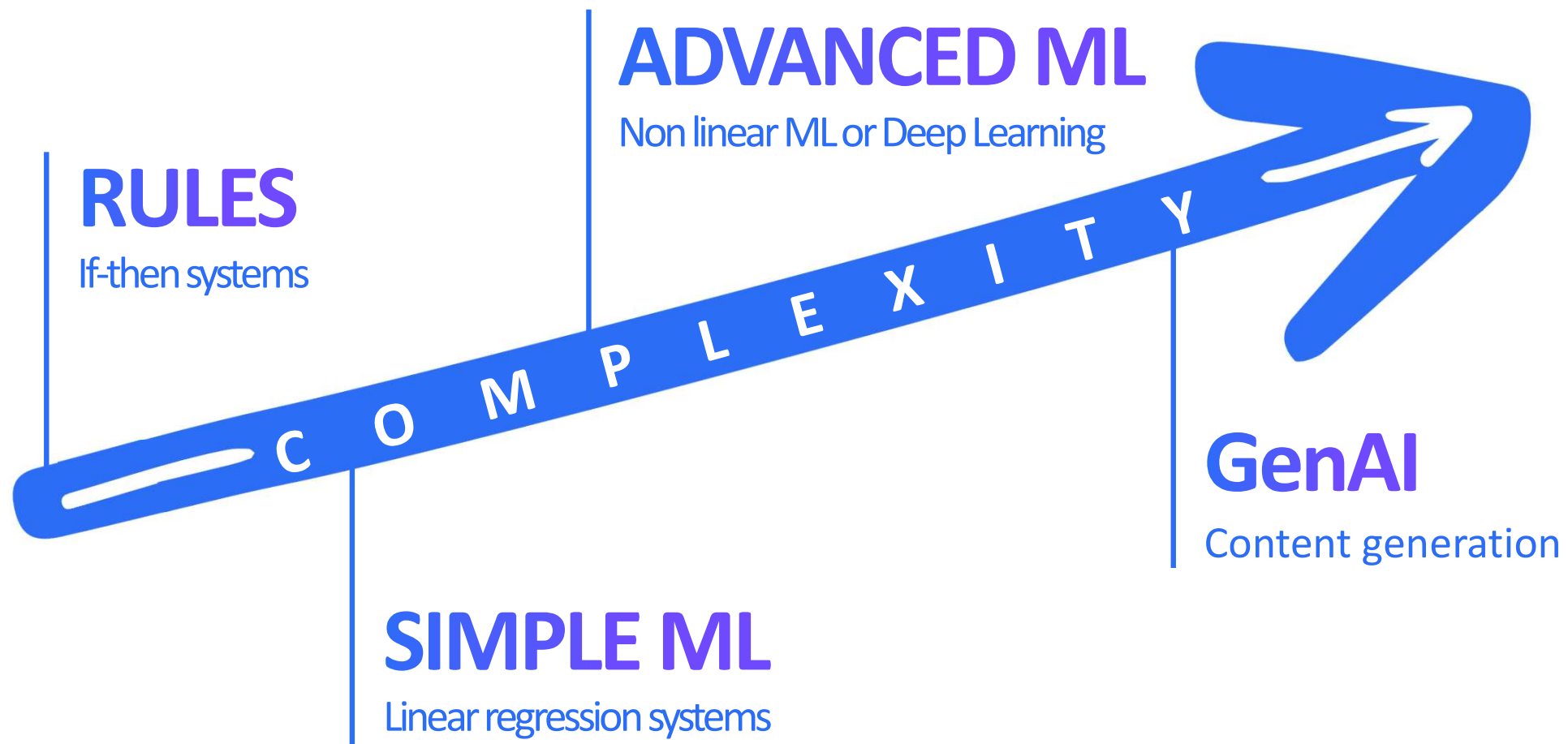
It's not magic, it's just math

**Zu Khoja**  
SVP, Technology

**Antonio Hurtado**  
VP, Research Science

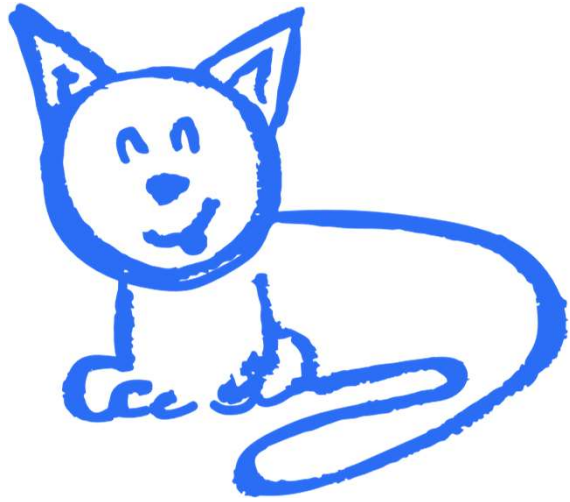




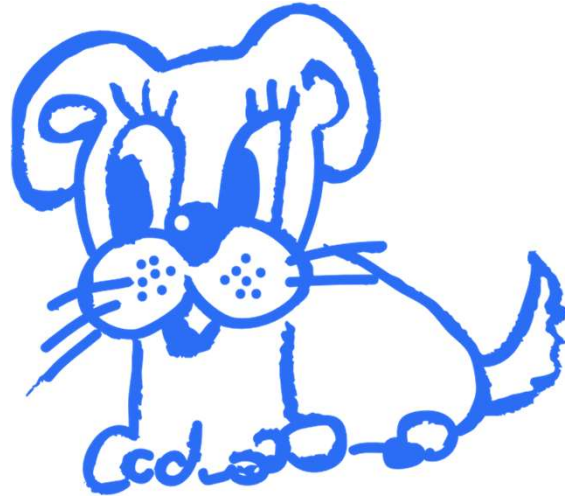


# IT'S JUST MATH

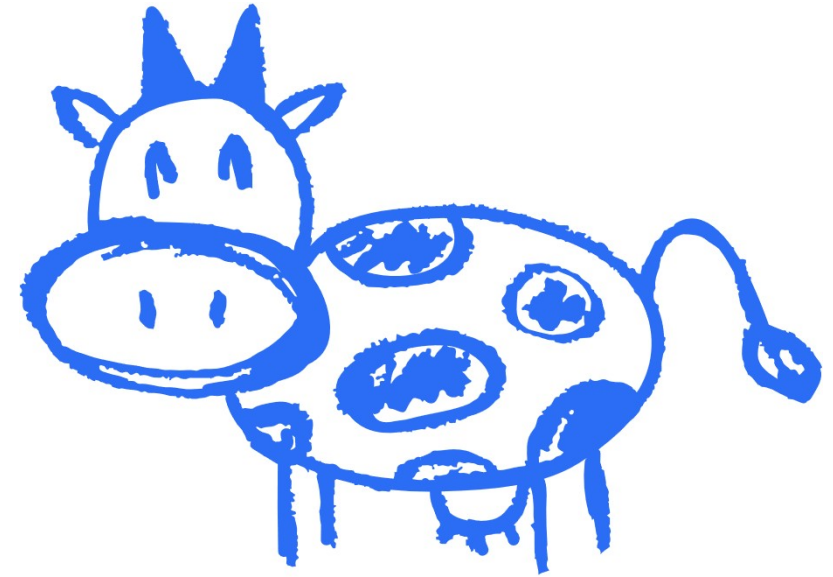
A thick, horizontal blue brushstroke underline is positioned beneath the word 'MATH'.



“meow”



“woof woof”



“moooo”

$$\begin{array}{c} \text{cats} \\ \text{say} \end{array} \begin{array}{cc} \text{dim1} & \text{dim2} \\ \begin{bmatrix} 0.4 & 9.7 \\ -0.9 & 0.8 \end{bmatrix} \end{array}$$

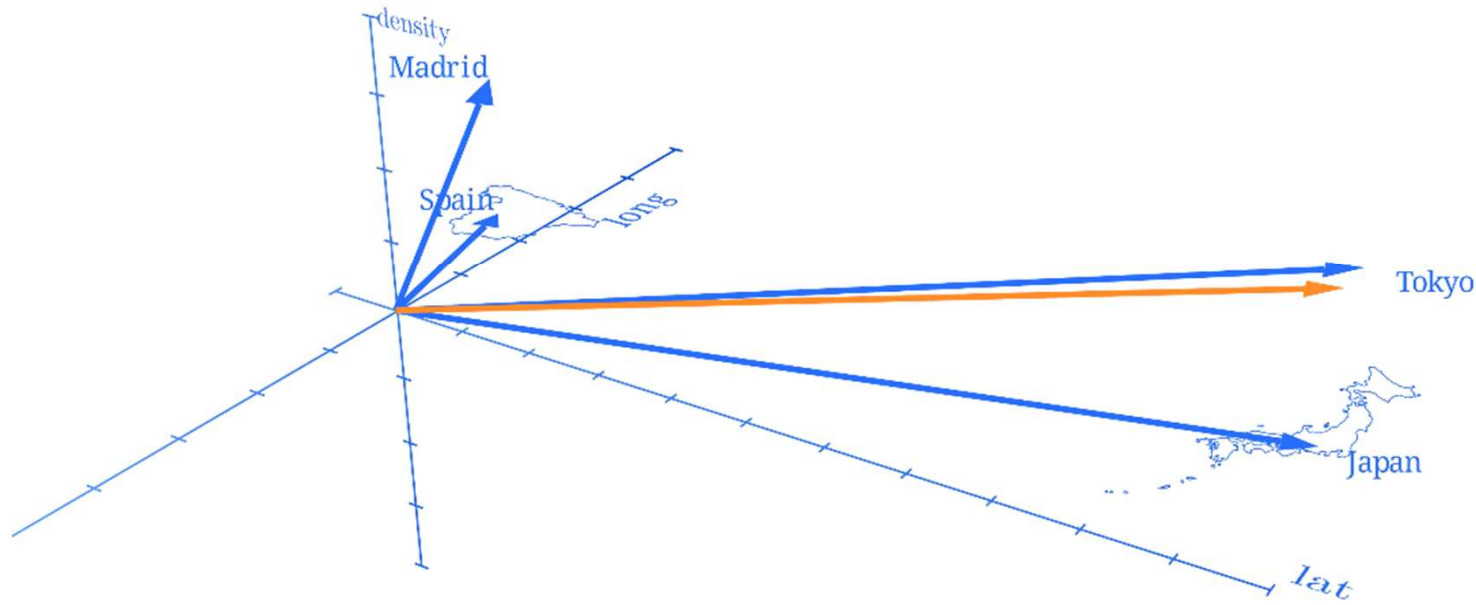
$$Q \begin{bmatrix} 0.4 & 9.7 \\ -0.9 & 0.8 \end{bmatrix} \begin{bmatrix} -2 \\ 1.5 \end{bmatrix} = \begin{bmatrix} 13.8 \\ 3.0 \end{bmatrix}$$

$$K \begin{bmatrix} 0.4 & 9.7 \\ -0.9 & 0.8 \end{bmatrix} \begin{bmatrix} -0.9 \\ 1.0 \end{bmatrix} = \begin{bmatrix} 9.3 \\ 1.6 \end{bmatrix} \xrightarrow{\text{transpose}} \begin{bmatrix} 9.3 & 1.6 \end{bmatrix}$$

$$V \begin{bmatrix} 0.4 & 9.7 \\ -0.9 & 0.8 \end{bmatrix} \begin{bmatrix} -0.5 & -0.6 \\ -0.4 & -0.6 \end{bmatrix} = \begin{bmatrix} -4.1 & -6.1 \\ 0.1 & 0.1 \end{bmatrix}$$

$$\begin{array}{c} Q \\ \begin{bmatrix} 13.8 \\ 3.0 \end{bmatrix} \end{array} \begin{array}{c} K^T \\ \begin{bmatrix} 9.3 & 1.6 \end{bmatrix} \end{array} = \begin{array}{c} \text{attention} \\ \begin{bmatrix} 128.4 & 22.14 \\ 28.02 & 4.83 \end{bmatrix} \end{array} \xrightarrow{\text{softmax}} \begin{array}{c} \begin{bmatrix} 1.0 & 0.0 \\ 1.0 & 0.0 \end{bmatrix} \end{array} \begin{array}{c} V \\ \begin{bmatrix} -4.1 & -6.1 \\ 0.1 & 0.1 \end{bmatrix} \end{array} = \begin{array}{c} \begin{bmatrix} -4.1 & -6.1 \\ -4.1 & -6.1 \end{bmatrix} \end{array}$$

$$\begin{bmatrix} 0.4 & 9.7 \\ -0.9 & 0.8 \end{bmatrix} + \begin{bmatrix} -4.1 & -6.1 \\ -4.1 & -6.1 \end{bmatrix} = \begin{bmatrix} -3.7 & 3.7 \\ -5.0 & -5.3 \end{bmatrix}$$



Spain: (-3.7, 40.5, 96)

Japan: (138.3, 36.2, 336)

Madrid: (-3.7, 40.4, 5400)

Tokyo: (139.7, 35.7, 6225)

$$\begin{array}{r}
 (-3.7, 40.4, 5400) \\
 - (-3.7, 40.5, 96) \\
 \hline
 (0.0, -0.1, 5304) \\
 + (138.3, 36.2, 339) \\
 \hline
 (138.3, 36.1, 5643)
 \end{array}$$

# Adding Dimensions

(latitude, longitude, density, calories)



$(-3.7, 40.5, 96, 0)$



$(138.3, 36.2, 339, 0)$



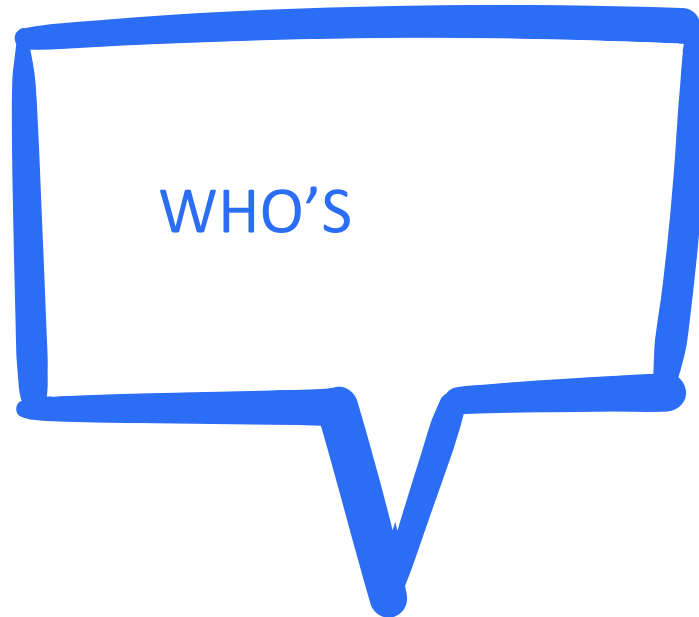
$(-3.7, 40.5, 0, 100)$



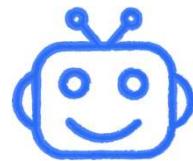
$(138.3, 36.2, 0, 100)$

$$\begin{array}{rcl} & (138.3, 36.2, & 0, 100) \text{ 🍣} \\ - & (138.3, 36.2, 339, & 0) \text{ 🇯🇵} \\ + & (-3.7, 40.5, 96, & 0) \text{ 🇪🇸} \\ \hline & (-3.7, 40.5, -243, & 100) \text{ ???} \end{array}$$

# KNOCK KNOCK



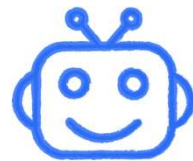
WHO'S



|         |                    |
|---------|--------------------|
| who's   | <div></div> 99,93% |
| knock   | 00,04%             |
| <end>   | 00,01%             |
| lettuce | 00,01%             |
| this    | 00,00%             |

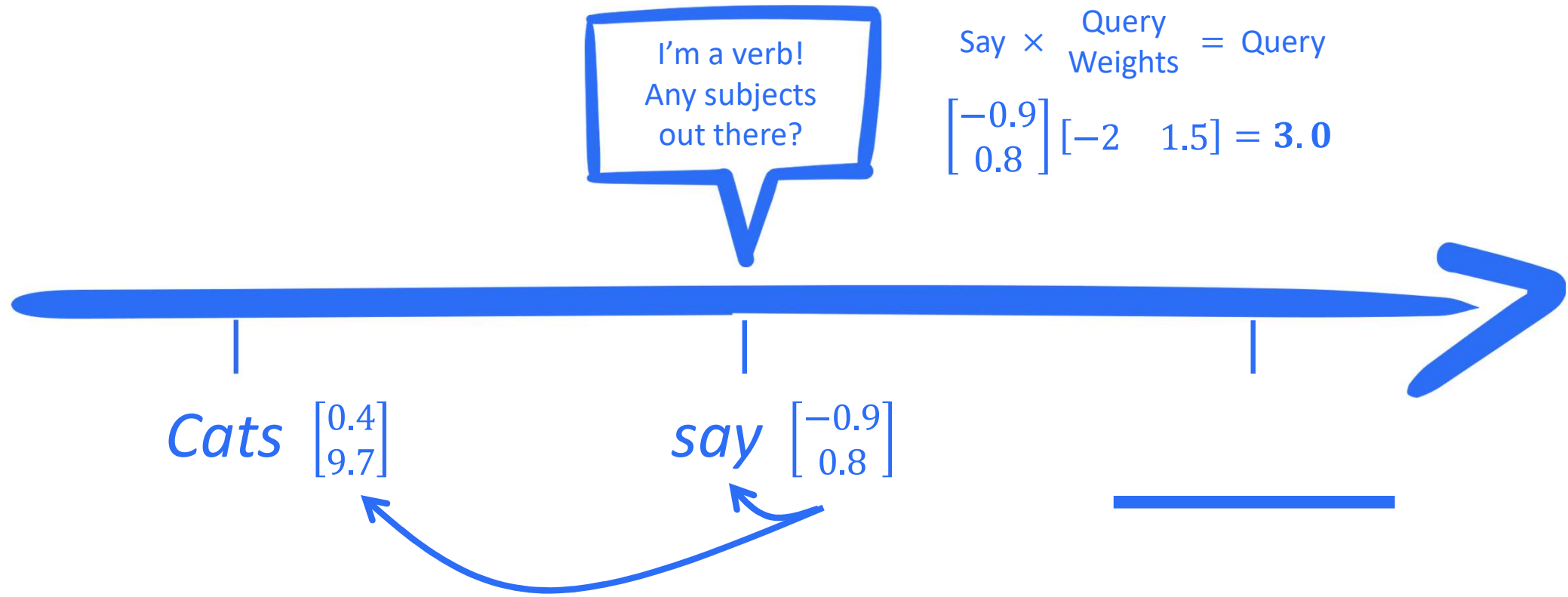
# KNOCK KNOCK

WHO'S THERE

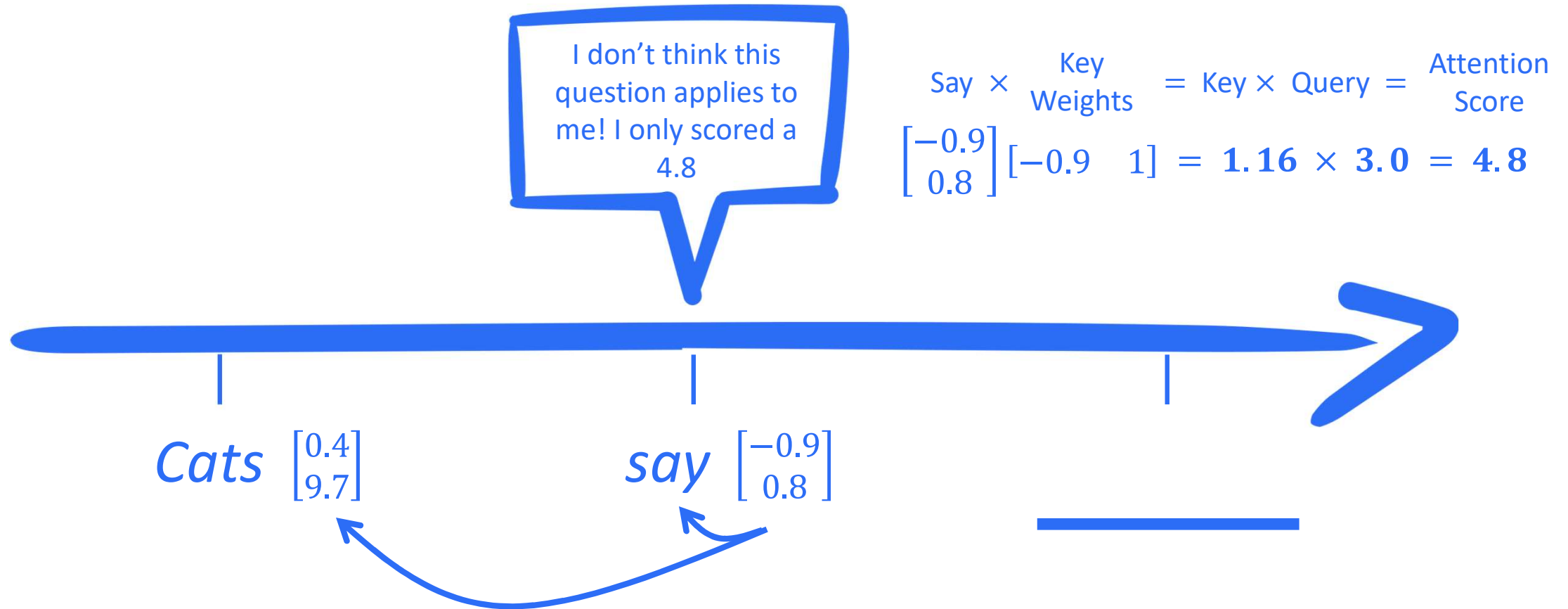


|       |        |
|-------|--------|
| there | 99,96% |
| <end> | 00,01% |
| for   | 00,01% |
| ben   | 00,01% |
| knock | 00,00% |

# WORD ORDER AND CONTEXT MATTERS



# WORD ORDER AND CONTEXT MATTERS

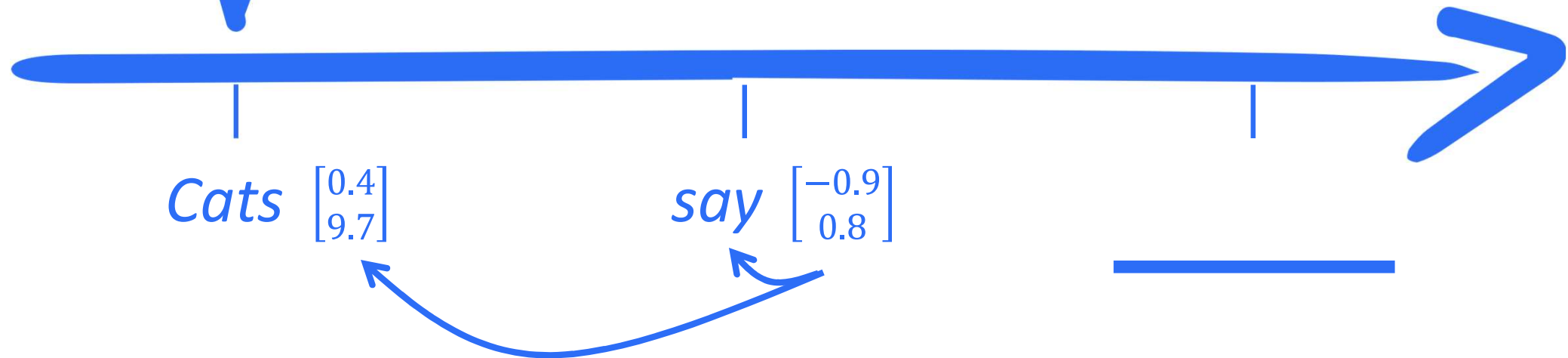


# WORD ORDER AND CONTEXT MATTERS

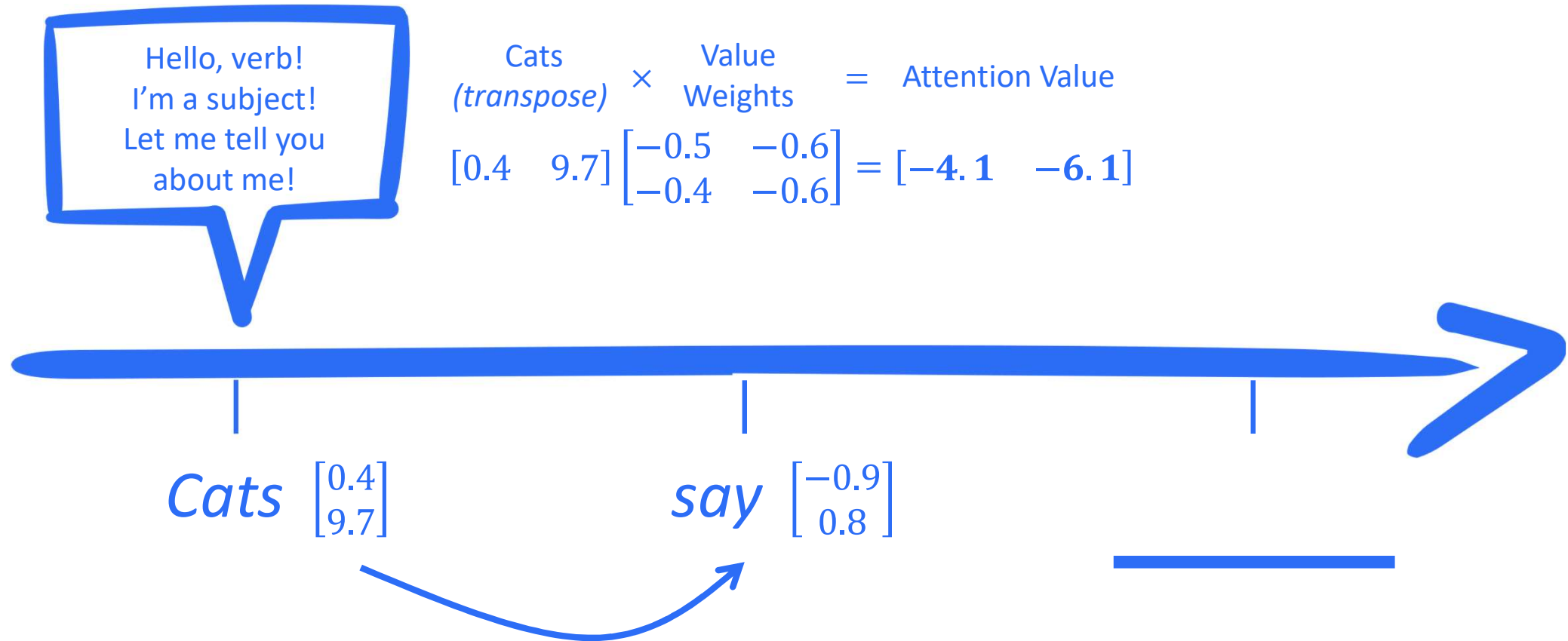
Oooh! I think this question might be for me! My higher score is 27.9

$$\text{Cats} \times \begin{matrix} \text{Key} \\ \text{Weights} \end{matrix} = \text{Key} \times \text{Query} = \text{Attention Score}$$

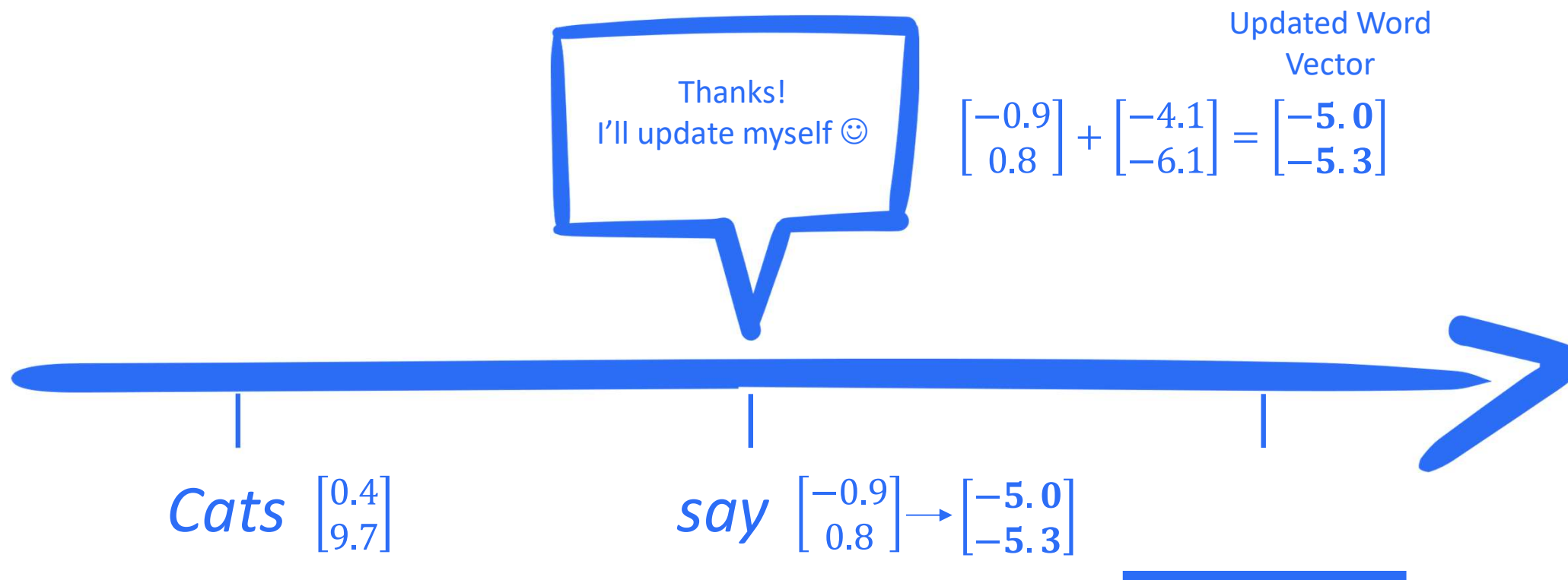
$$\begin{bmatrix} 0.4 \\ 9.7 \end{bmatrix} \begin{bmatrix} -0.9 & 1 \end{bmatrix} = 9.34 \times 3.0 = \mathbf{27.9}$$



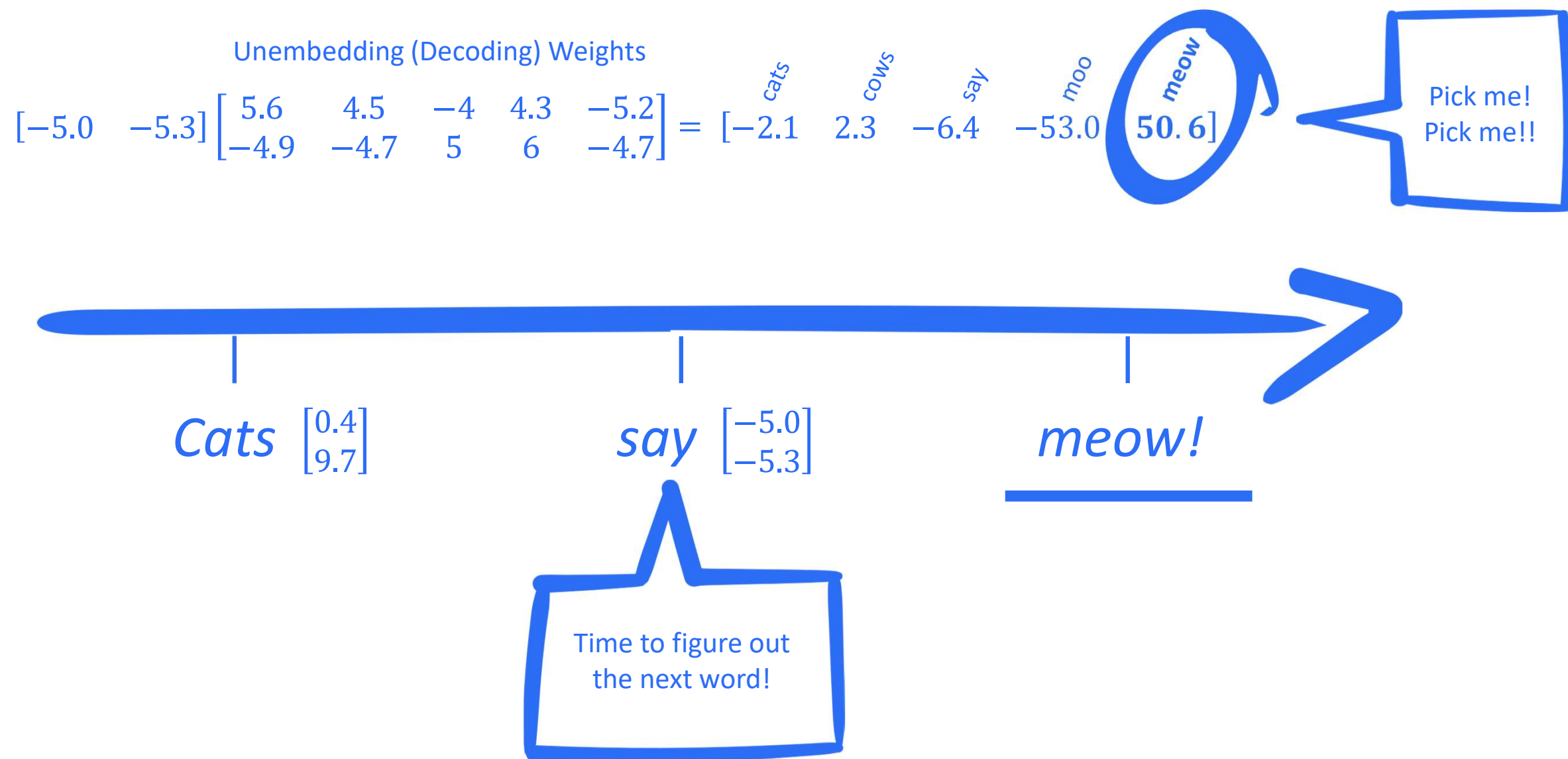
# WORD ORDER AND CONTEXT MATTERS



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# WORD ORDER AND CONTEXT MATTERS



# IT'S JUST MATH

A thick, horizontal blue brushstroke underline is positioned beneath the word 'MATH'.

AI will  
*replace humans*



AI is *learning*  
*as I am typing*



# PERVASIVE MYTHS

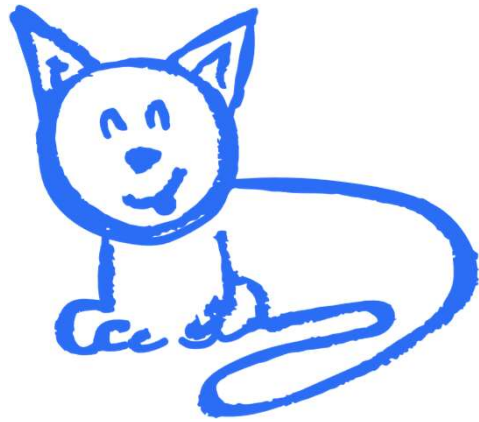
AI will  
*take my job*



AI is  
*thinking*



# MORE COMPLEX MATH = MORE CAPABLE AI

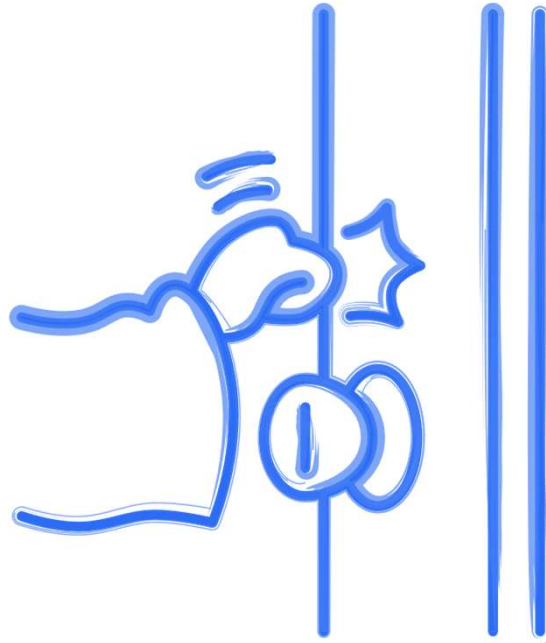


What does a cat say?

**Dimensions:** 2

**Vocab:** 5-6 words

**Parameters:** 28

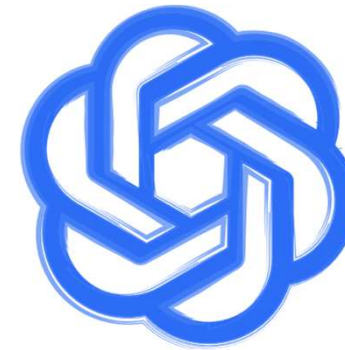


Knock knock

**Dimensions:** 8

**Vocab:** 346 words

**Parameters:** 6,744



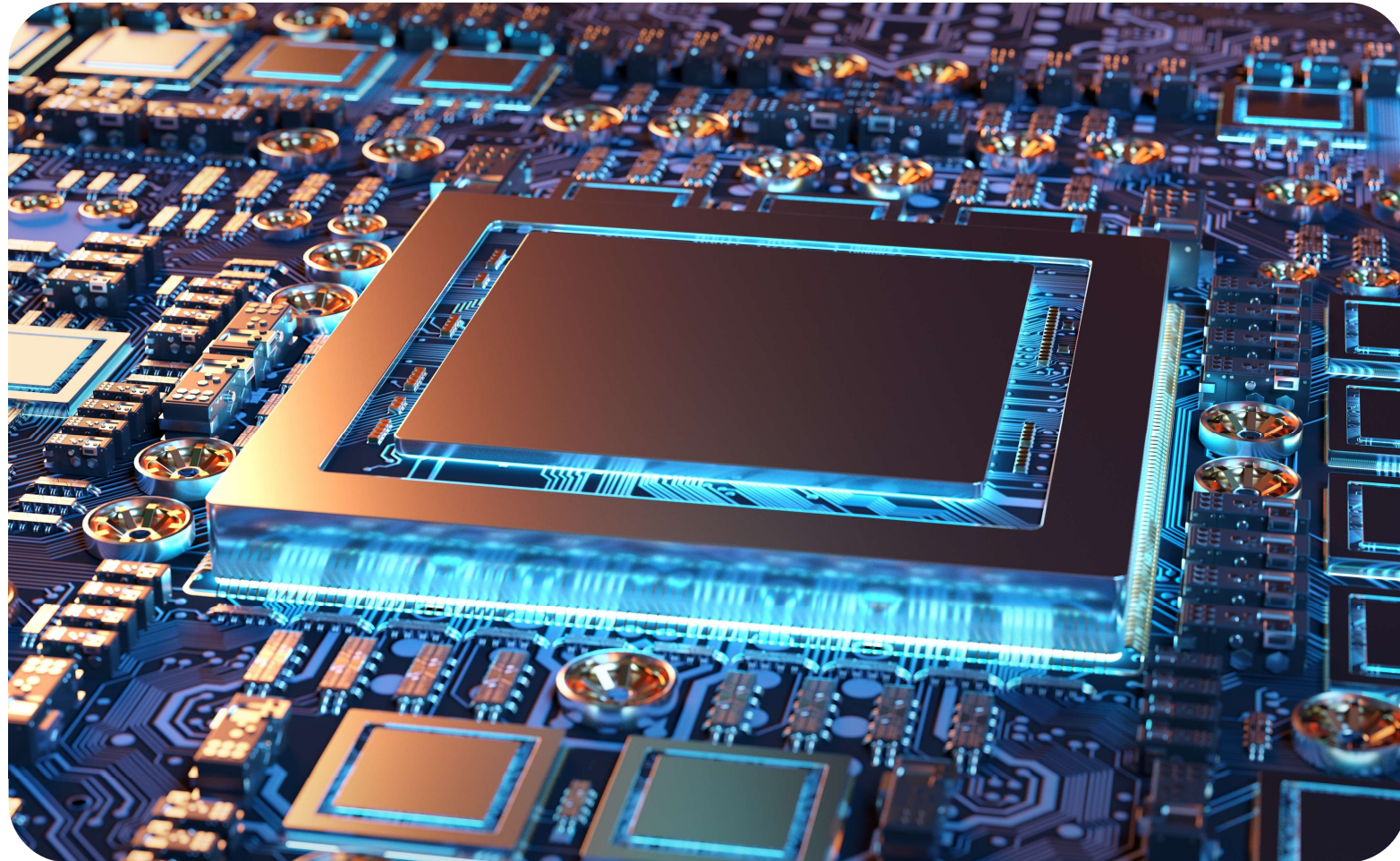
Chat GPT

**Dimensions:** 12,000

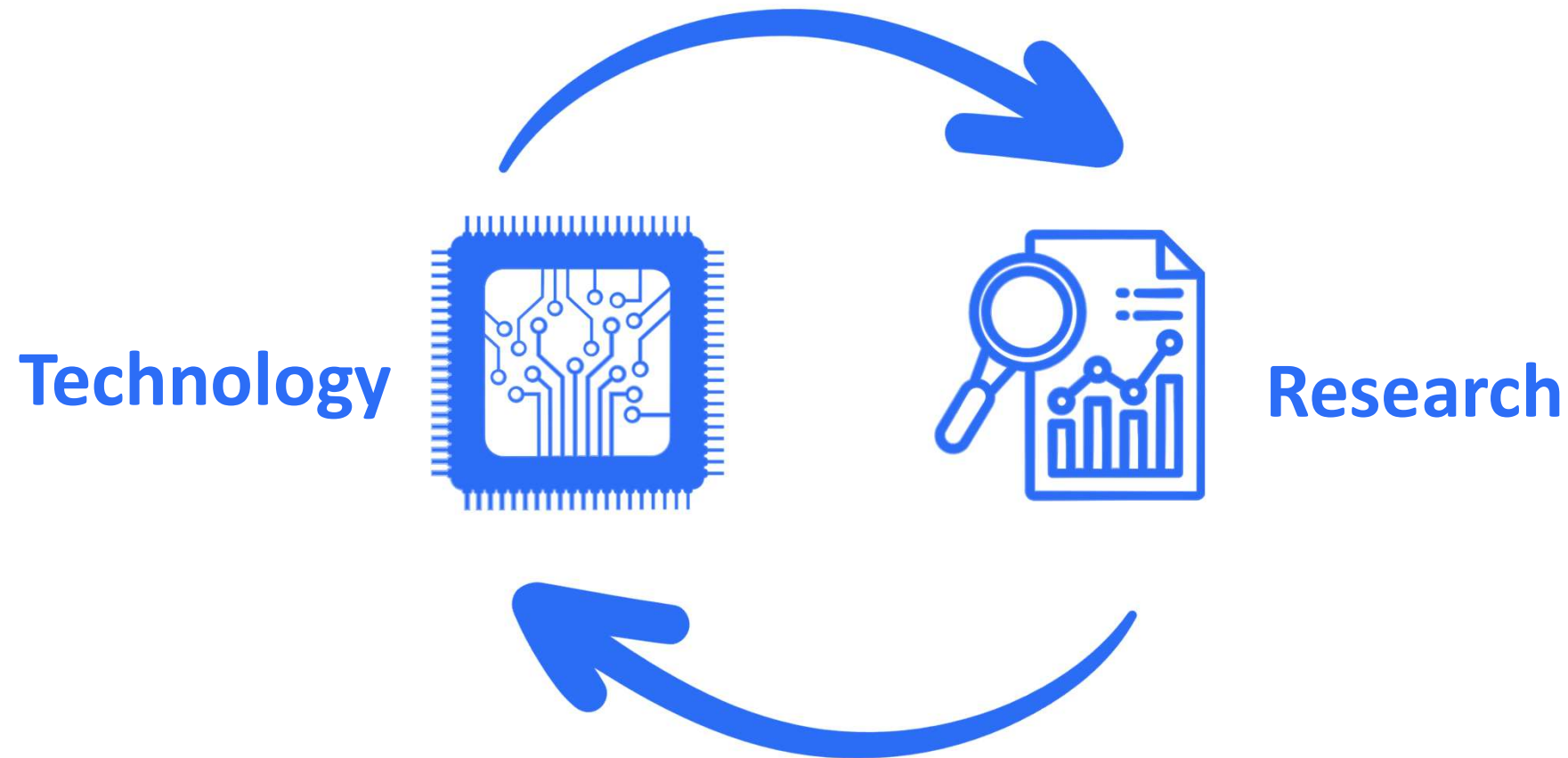
**Vocab:** 50,000 words

**Parameters:** 170,000,000,000

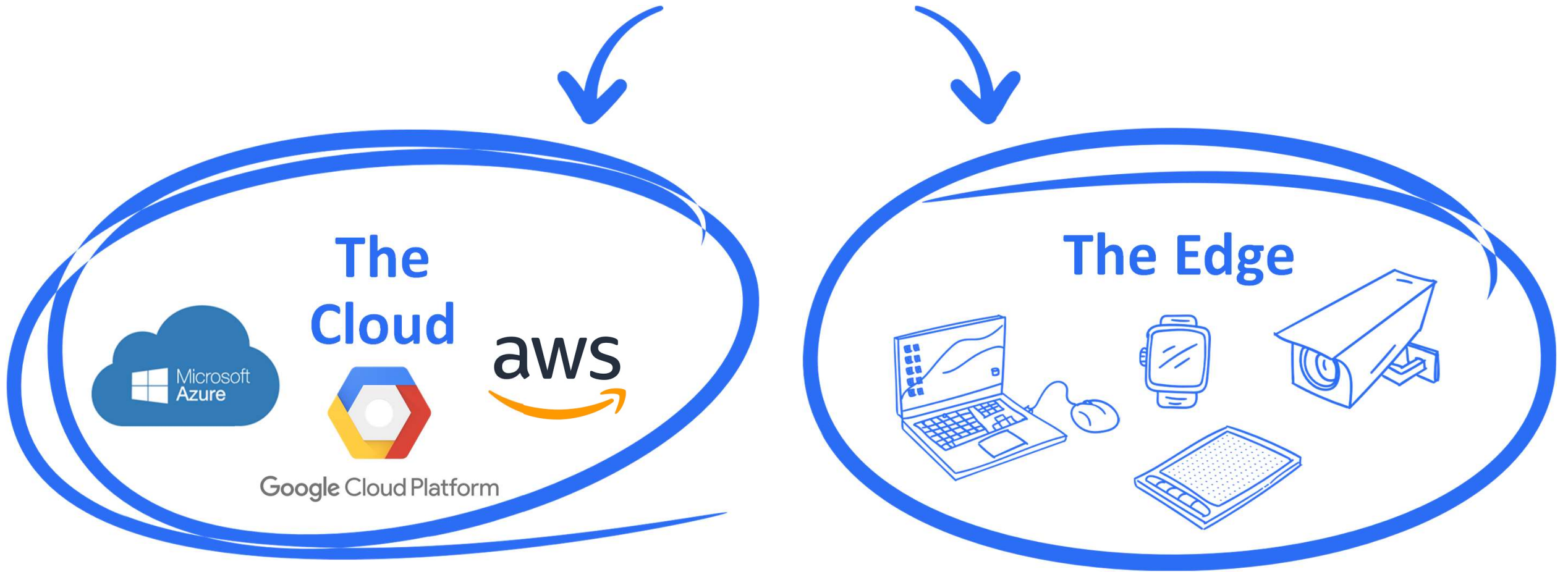
# MORE COMPLEX MATH REQUIRES MORE POWERFUL HARDWARE



# POWERING EXPONENTIAL GROWTH OF AI CAPABILITIES



# PARADIGM SHIFT TO THE EDGE



- Dependent on connectivity
- Highest scale for most advanced AI model training

- Privacy ( + associated unlock)
- Smaller, more specialized, efficient models

# KEY TAKEAWAYS

①

**AI is  
just math**

- AI uses matrix multiplication to predict the next word
- Probability of next word is based on previous used words

②

**AI does not  
“learn”**

- It just adjusts mathematical parameters based on patterns

③

**AI technology is  
rapidly evolving**

- The capabilities of AI have accelerated faster in recent years than in decades past
- Adaptability, ongoing education, and exploration of new AI tools is going to be key

# IT'S JUST MATH

