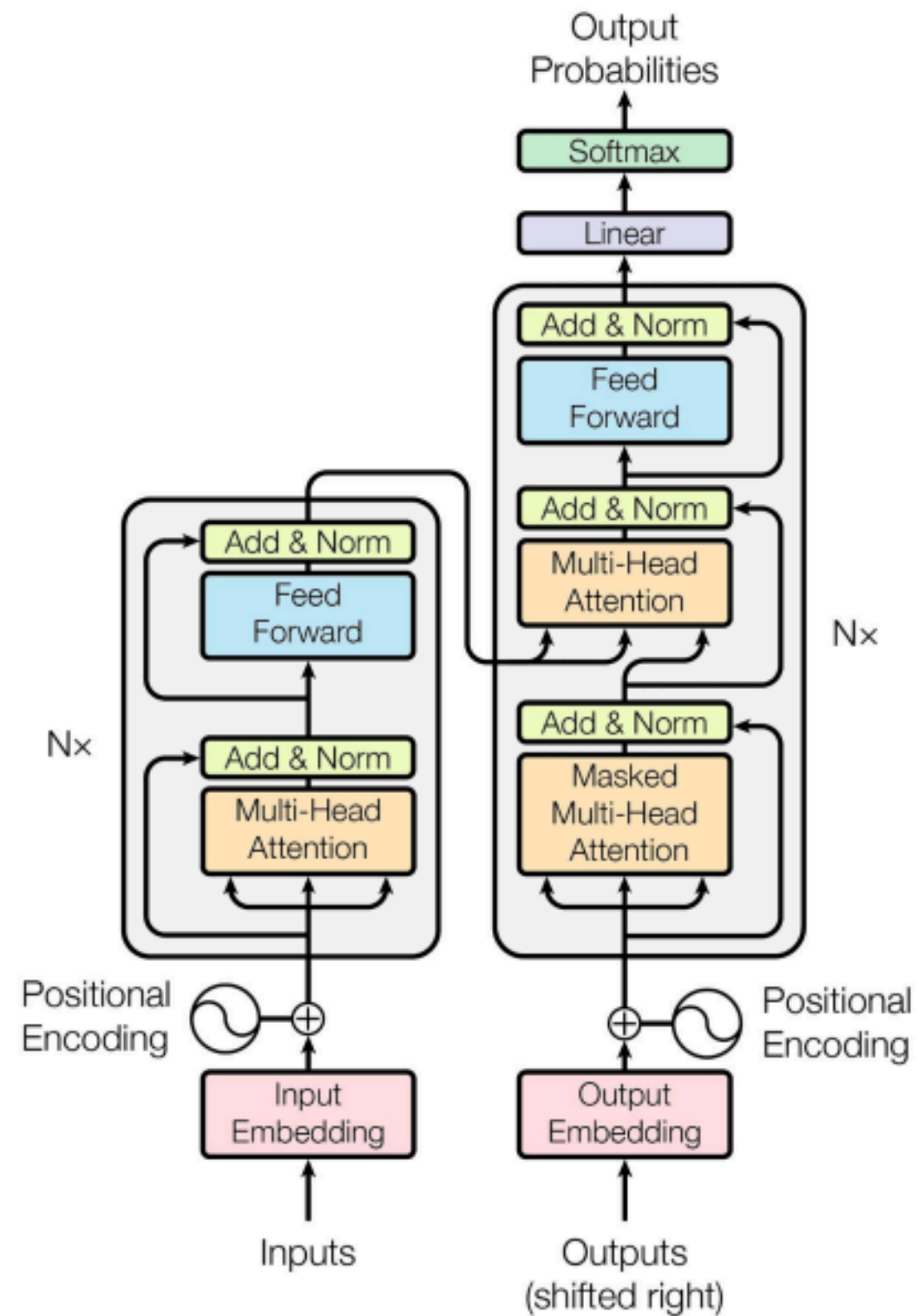


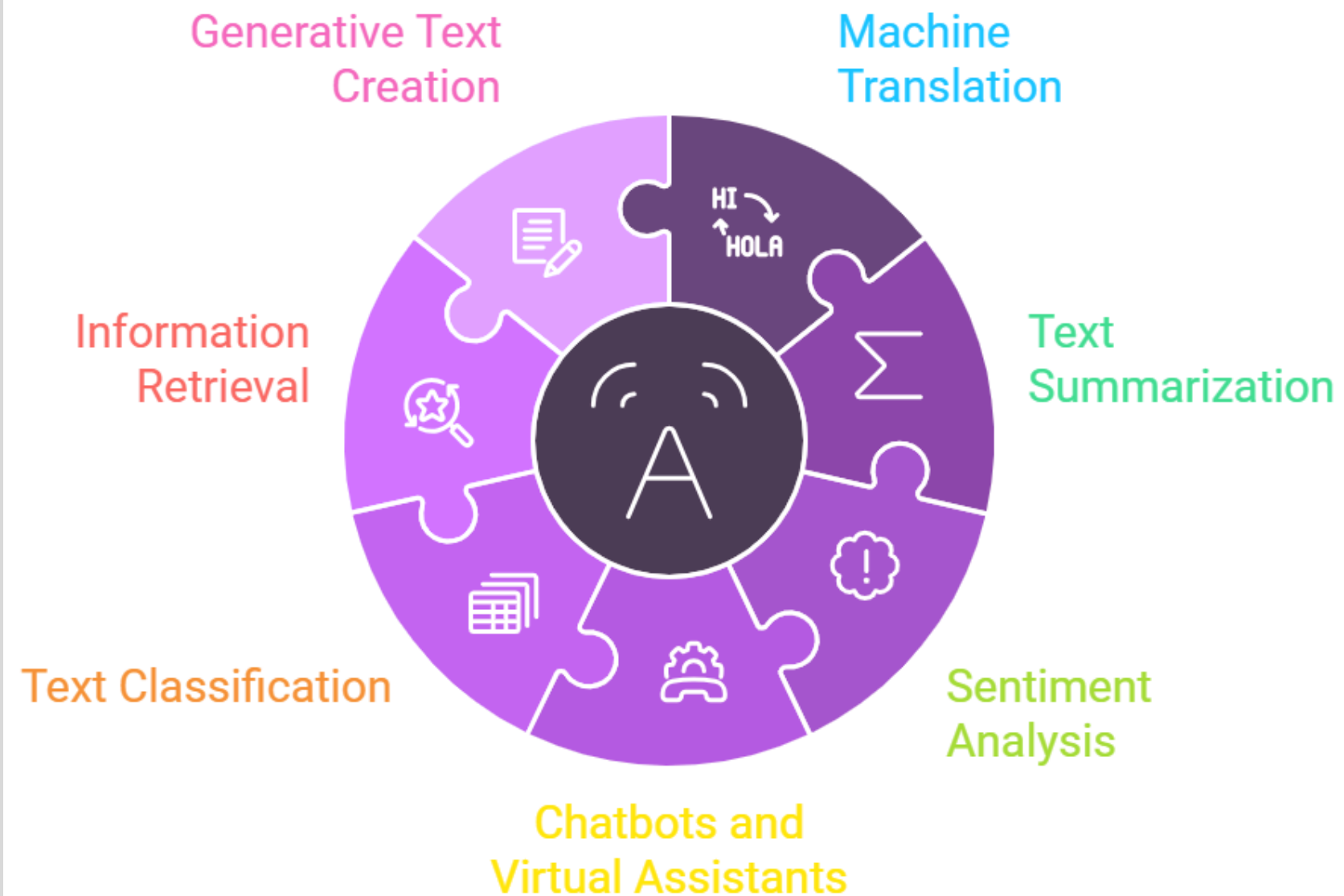
Transformer

معماری ترنسفورمر برای اولین بار در سال ۲۰۱۷ در مقاله‌ای با عنوان مشهور "Attention Is All You Need" معرفی شد.

attention is all you need •



Applications of Transformer Models



• **Machine Translation** (ترجمه ماشینی)

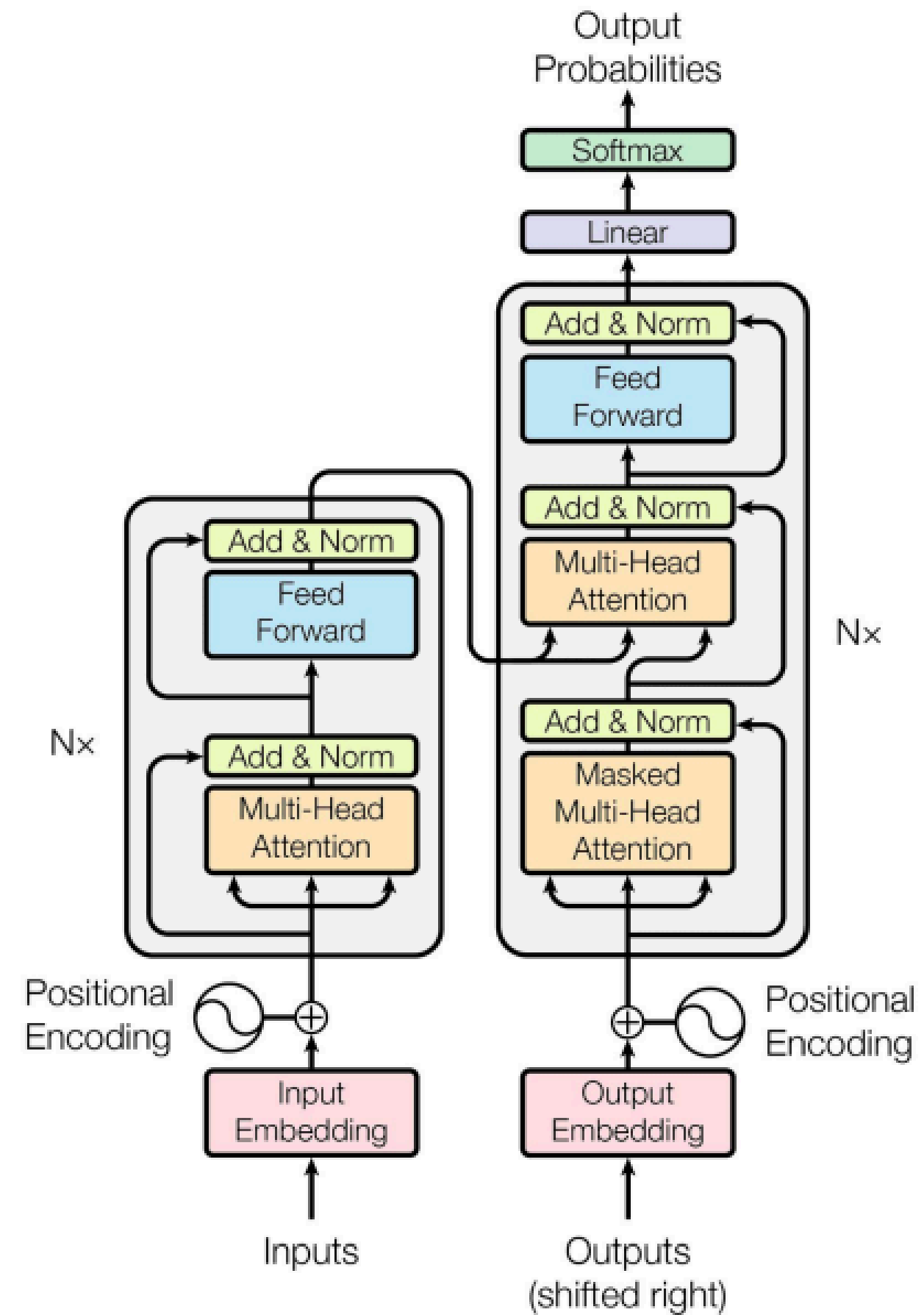
• **Generative Text Creation** (تولید متن مولد)

• **Text Summarization** (خلاصه سازی متن)

• **Information Retrieval** (بازیابی اطلاعات)

حوزه کاربرد	مدل‌های بنیادی	محصولات و سیستم‌های شاخص
پردازش زبان طبیعی (NLP) و LLM‌ها	BERT, GPT-3/4, T5	ChatGPT, Gemini (چت‌بات و دستیار مجازی), LLaMA, Claude (موتورهای جستجوی معنایی)
بینایی کامپیوتر (Computer Vision)	Vision Transformer (ViT)	DALL-E, Midjourney (تولید تصویر), سیستم‌های پیشرفته تشخیص تصویر (Image Recognition)
بیوانفورماتیک و پروتئین‌شناسی	معماری‌های ترنسفورمر سفارشی (مانند ESM)	AlphaFold (پیش‌بینی ساختار پروتئین), مدل‌سازی توالی‌های DNA و RNA
سیستم‌های توصیه‌گر	RecSys Transformers	موتورهای توصیه‌گر پیشرفته (مانند نتفلیکس و اسپاتیفای)

Transformer Architecture



۱. مدل‌های فقط-رمزگذار (Encoder-Only)

- هدف: فهم دوطرفه و نمایش زمینه‌محور (Bidirectional Understanding).
- مدل‌های شاخص: BERT, ViT (برای تصاویر).
- کاربردها و محصولات:
 - جستجوی معنایی: Google Search.
 - بینایی کامپیوتر: تشخیص تصویر (Google Photos).
 - NLP: تحلیل احساسات، توصیه‌گرها.

۲. مدل‌های فقط-رمزگشا (Decoder-Only)

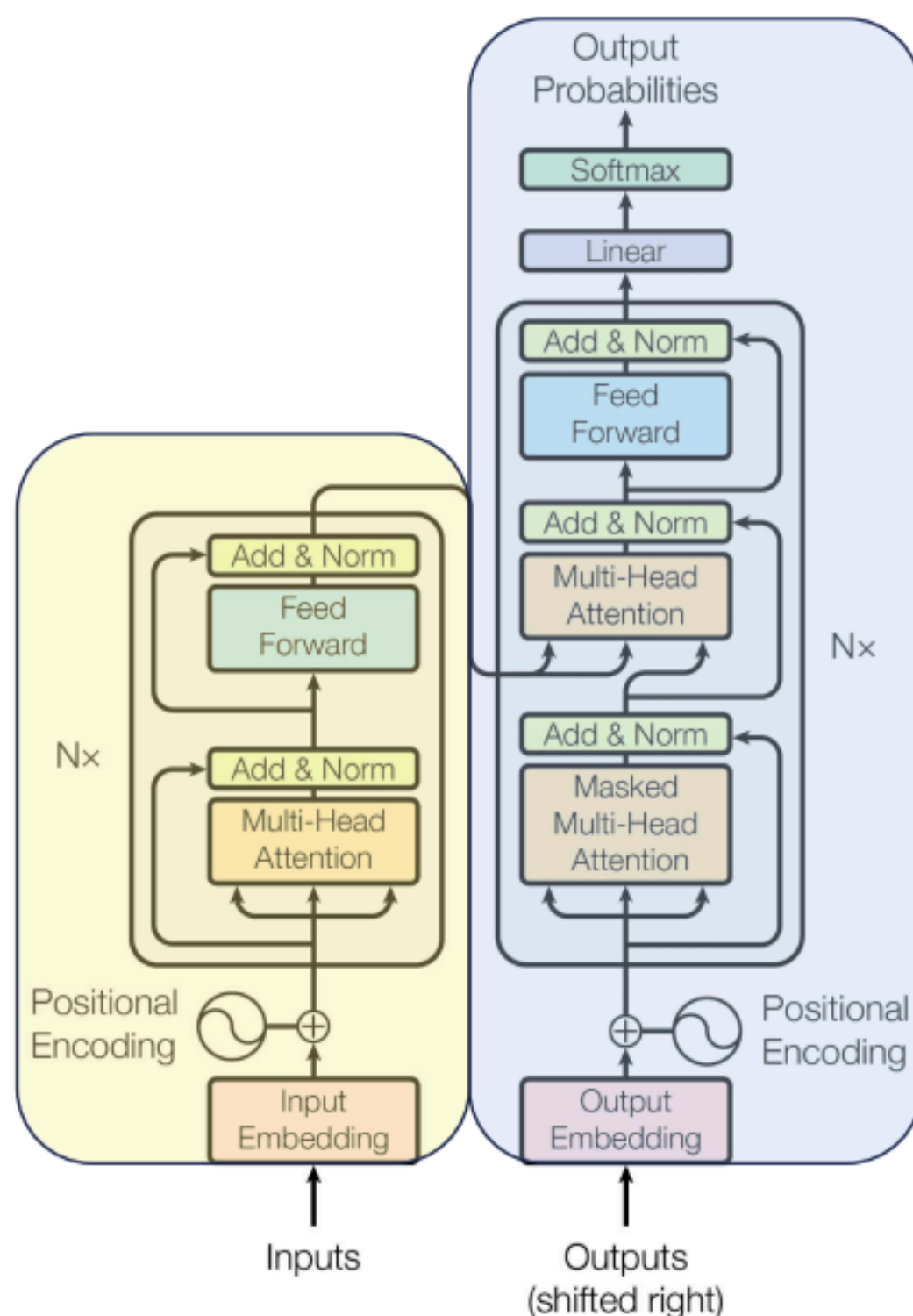
- هدف: تولید محتوای یک‌طرفه و خودبازگشتی (Unidirectional Generation).
- مدل‌های شاخص: GPT, LLaMA, Claude.
- کاربردها و محصولات:
 - چت‌بات‌ها: ChatGPT, Google Gemini.
 - تولید خلاقانه: تولید متن و کد (GitHub Copilot).
 - تولید تصویر: DALL-E, Midjourney.

۳. مدل‌های رمزگذار-رمزگشا (Encoder-Decoder)

- هدف: تبدیل توالی به توالی (Sequence-to-Sequence).
- مدل‌های شاخص: T5, BART.
- کاربردها و محصولات:
 - ترجمه ماشینی: Google Translate.
 - خلاصه‌سازی متن.
 - بیوانفورماتیک: AlphaFold (پیش‌بینی ساختار پروتئین).

BERT
Oct 2018

Representation



GPT
June 2018

Generation

the →

the fluffy →

the fluffy blue →

the fluffy blue creature →

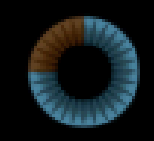
the fluffy blue creature roamed →

the fluffy blue creature roamed the →

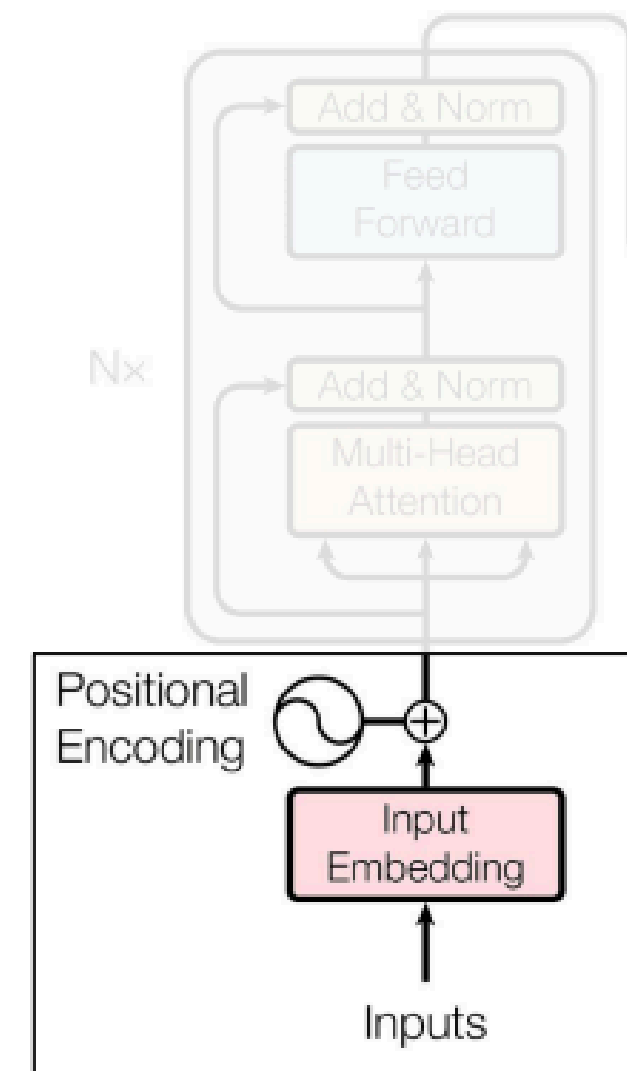
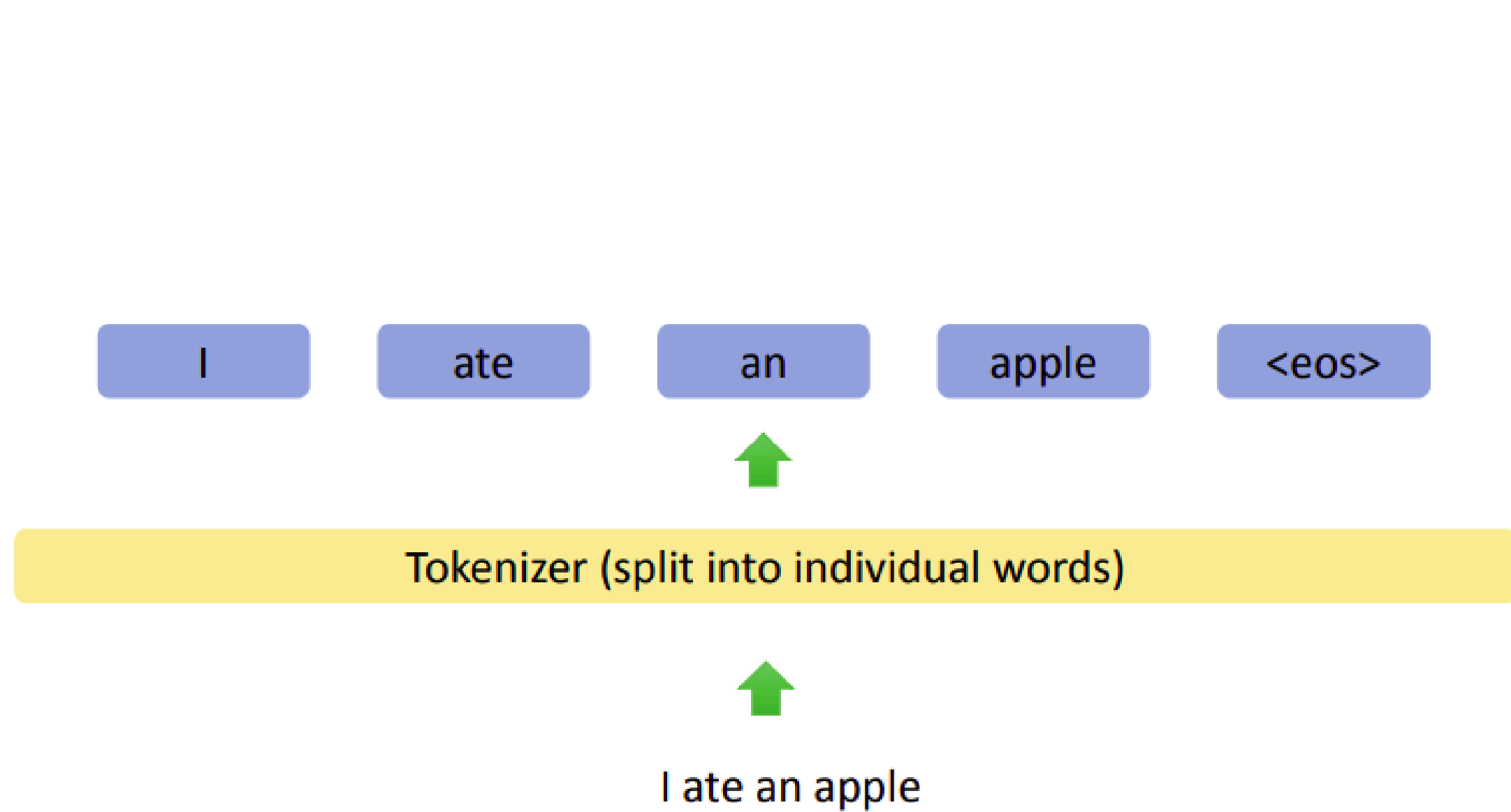
the fluffy blue creature roamed the verdant →

the fluffy blue creature roamed the verdant forest →

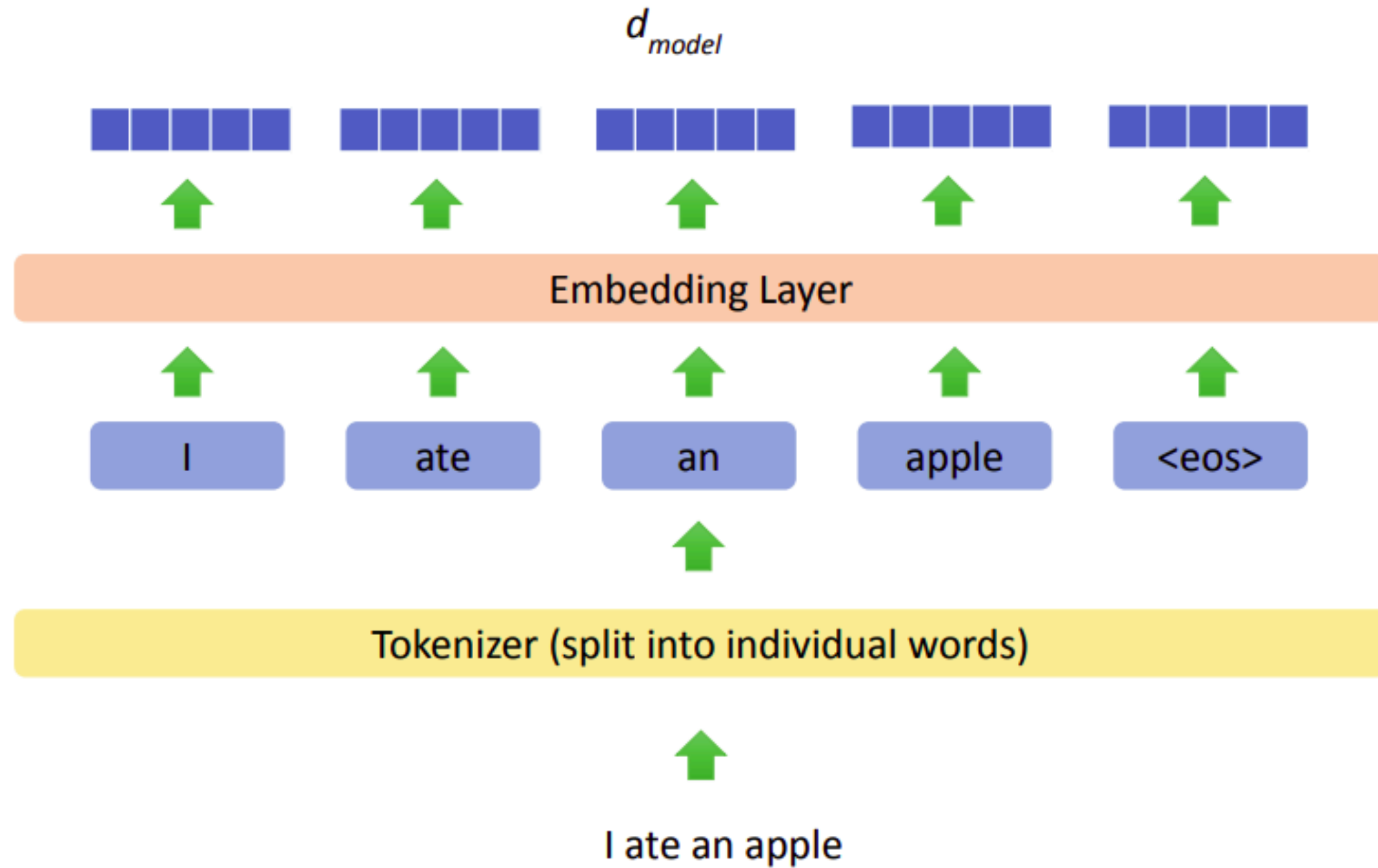
- streets 8%
- forest 6%
- land 5%
- halls 4%
- fields 1%
- world 1%
- city 1%
- earth 1%
- room 1%
- woods 1%
- countryside 1%
- vast 1%



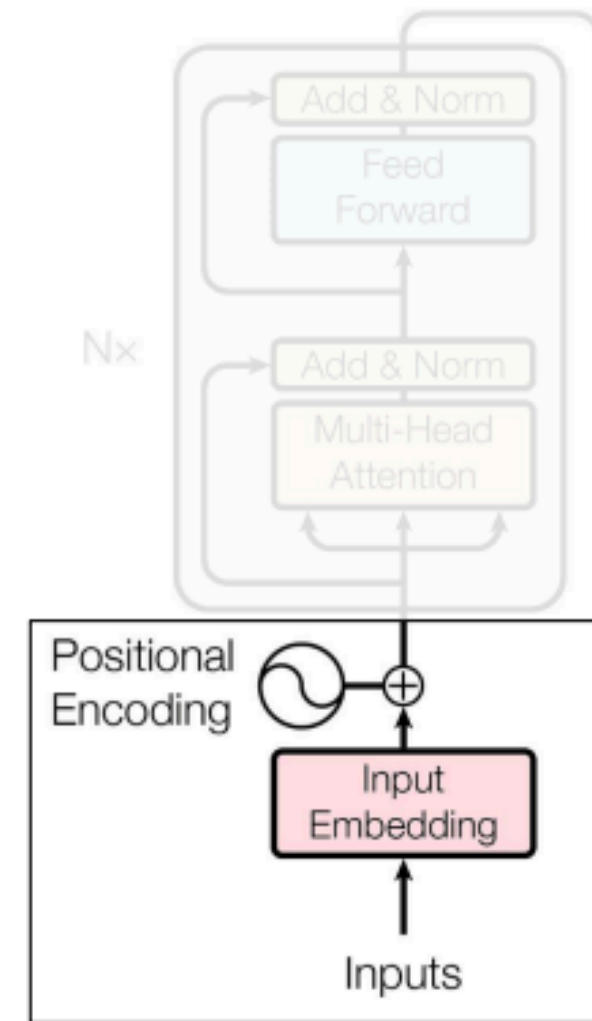
Tokenization



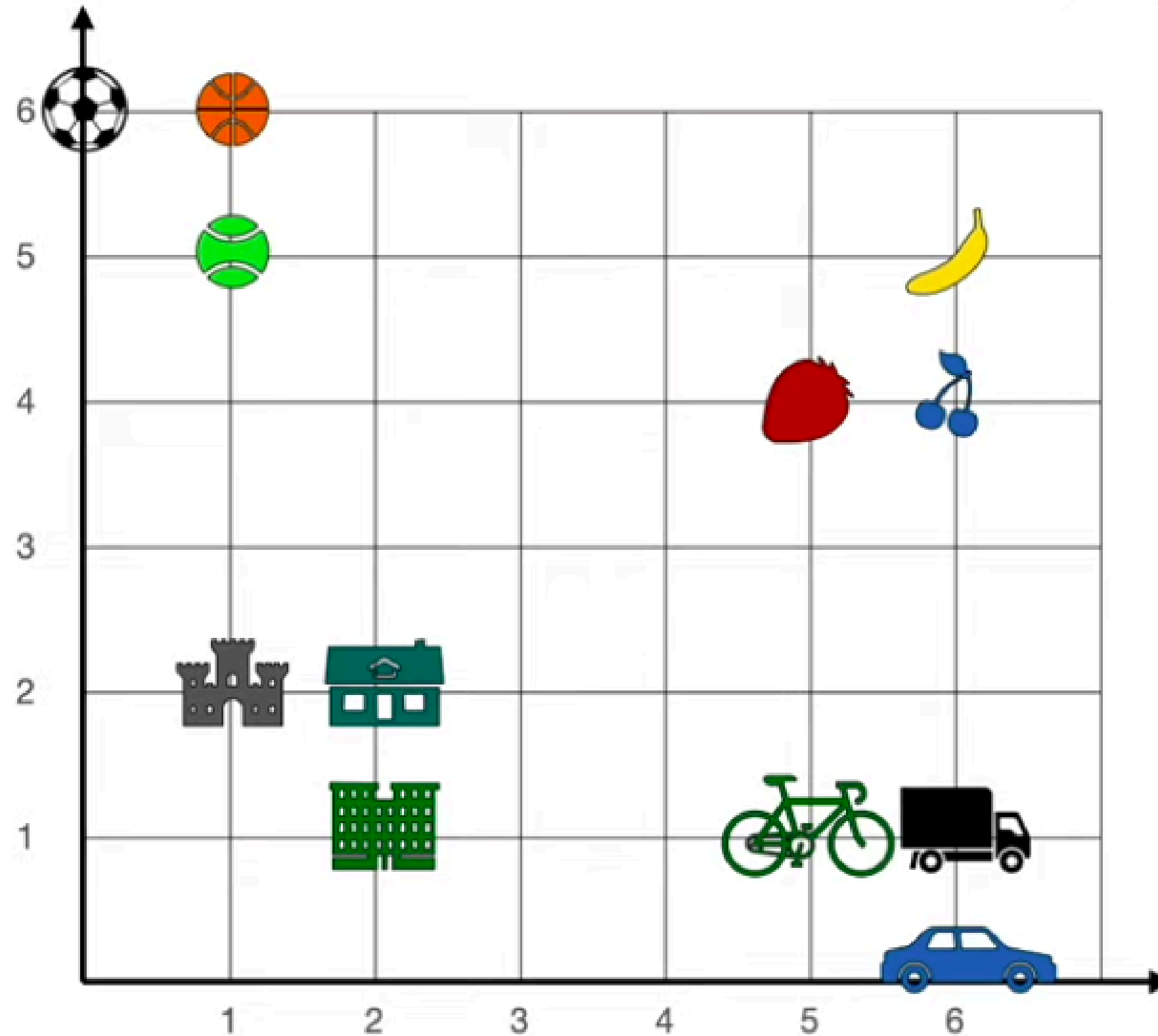
Input Embeddings



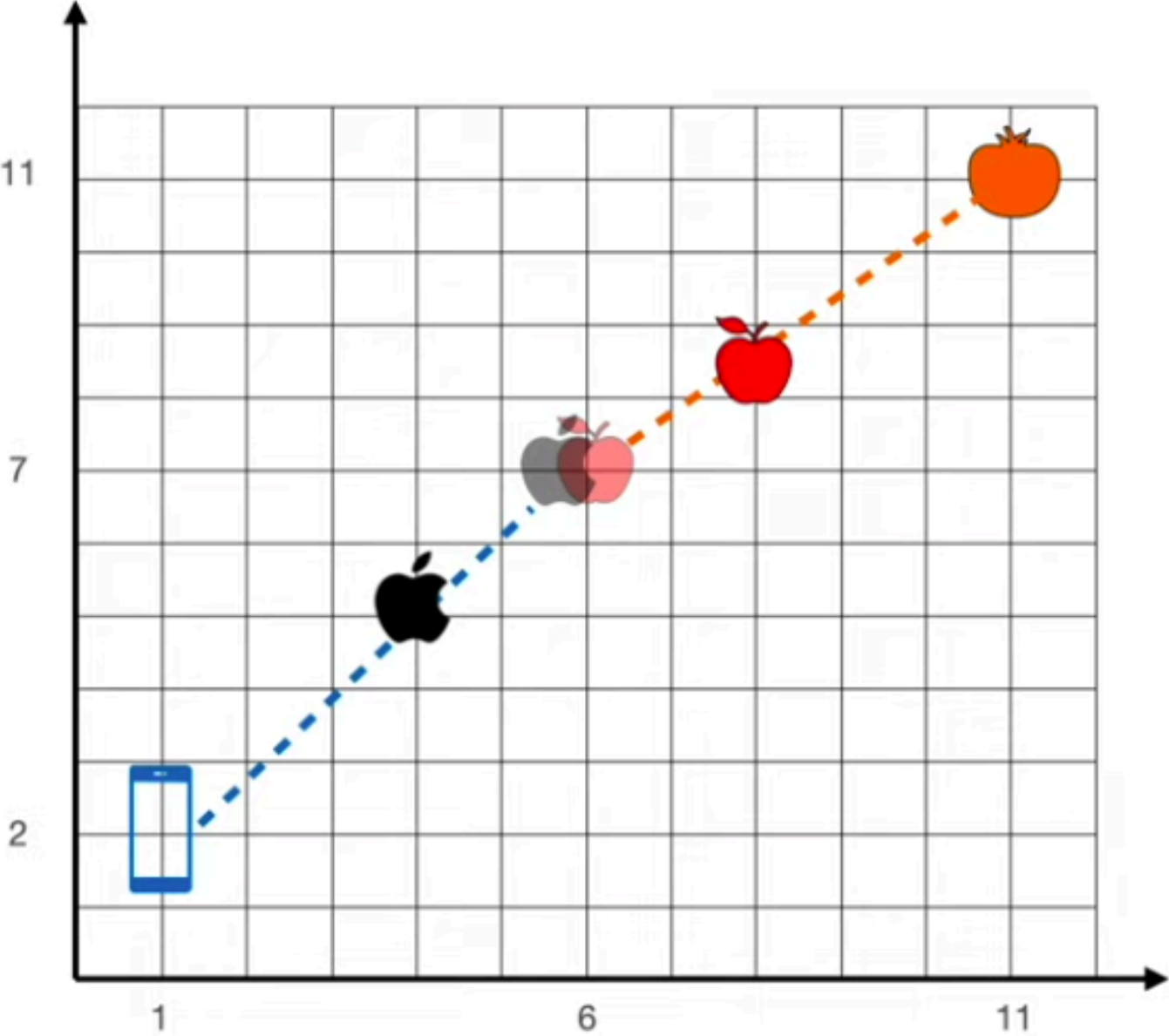
Generate Input Embeddings



Where would you put the word apple?

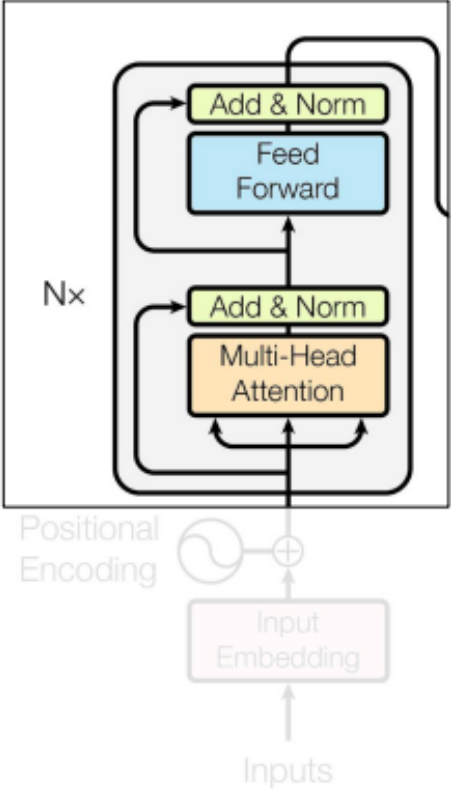
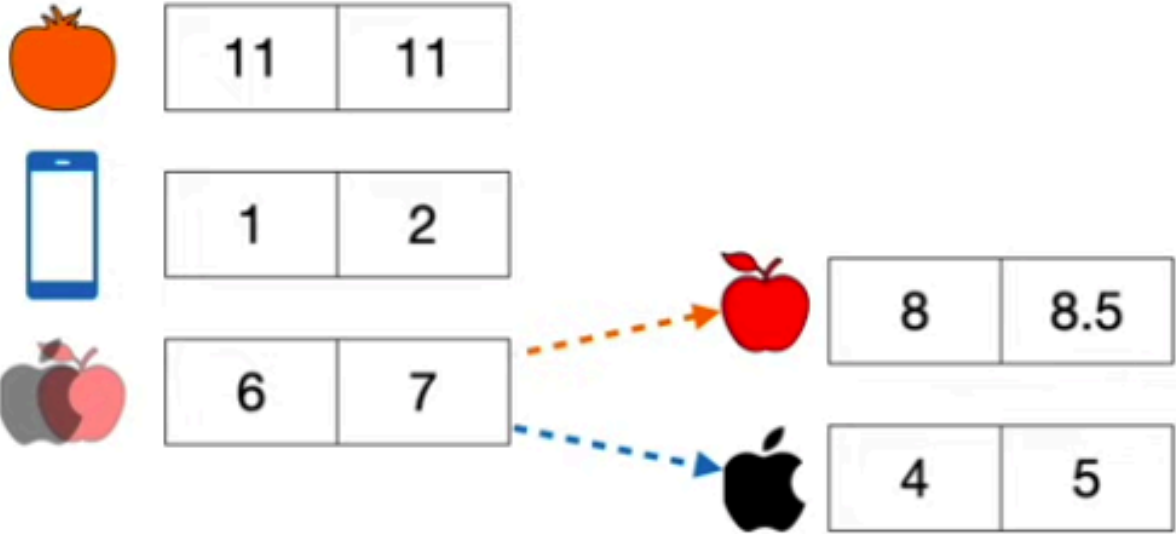


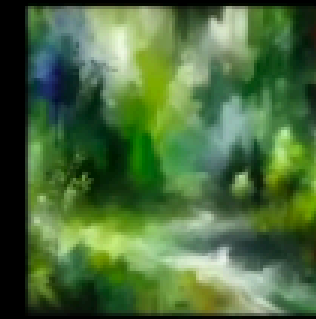
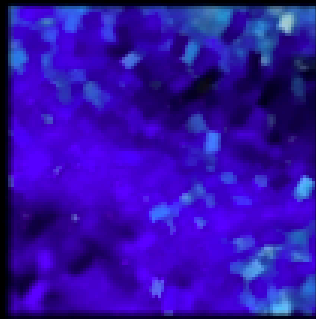
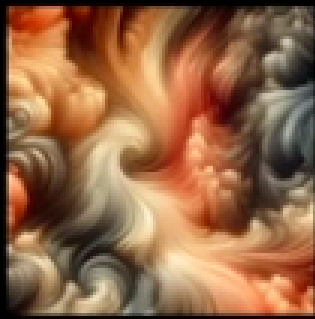
Attention



please buy an **apple** and an **orange**

apple unveiled the new **phone**





a fluffy blue creature roamed the verdant forest

1

2

3

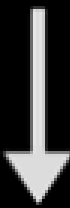
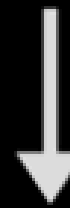
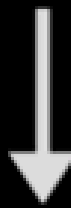
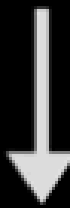
4

5

6

7

8



12,288

6.0	5.6	8.8	1.6	4.5	5.2	0.3	7.2
0.2	5.8	8.0	6.1	7.1	0.5	1.6	3.1
3.0	5.7	7.0	1.2	8.6	2.0	6.2	3.9
6.5	6.5	1.0	8.4	9.7	0.2	5.7	2.1
2.9	6.5	9.1	8.0	8.5	7.9	2.4	1.8
6.1	4.3	7.1	5.6	0.1	2.2	9.2	9.3
4.2	8.9	9.9	4.0	3.6	3.4	6.1	7.3
1.3	3.6	1.5	0.7	7.2	9.2	5.3	4.9
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
3.0	4.3	8.6	6.9	1.7	7.0	5.8	2.3



Query

-3.7	+3.9	-2.4	-6.3	-9.4	-8.6	+3.6	-0.9	...	+0.7
+7.9	+9.7	-5.6	+3.2	-4.7	-9.5	+5.1	-3.6	...	-2.3
+1.7	+6.6	+2.6	+7.4	-4.5	+5.9	-6.2	+9.0	...	+3.7
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮
-5.6	+8.9	+4.6	-4.9	-5.7	+0.4	-9.4	-5.8	...	-1.5

Key

-2.5	-0.7	-4.4	+1.7	+7.2	-7.6	+0.3	-7.3	...	+4.3
-2.1	+1.3	-6.3	-7.0	-0.2	-2.9	+8.7	+5.3	...	+4.9
+8.0	-8.2	+1.0	+1.7	+9.1	-4.1	-5.1	-7.9	...	-9.6
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮
+8.5	+3.4	+5.6	-4.3	+1.7	-8.6	-0.3	+9.5	...	+7.5

$$\text{Attention}(Q, K, V) = \text{softmax}\left(\frac{K^T Q}{\sqrt{d_k}}\right) V$$

Value

-3.2	+9.1	-5.3	+8.9	+8.7	+5.9	+2.6	+7.4	...	-4.1
+6.9	+2.3	-9.6	-3.0	-7.0	+9.5	-0.4	-0.1	...	+2.8
-2.6	-7.2	+6.4	-6.1	+0.2	-5.5	-8.0	+7.2	...	+9.4
+9.1	+8.0	+5.4	-3.3	-8.3	-1.8	-5.3	-7.3	...	-8.8
+4.5	-9.7	+5.4	-7.0	-8.3	-8.1	+3.4	-5.0	...	-1.6
+1.1	+7.1	+4.5	-4.5	-7.3	-8.8	-3.9	-4.7	...	-0.9
+3.6	+3.9	-4.3	-2.4	-6.3	+5.7	-8.8	+3.9	...	+5.5
+5.5	-4.8	-2.5	+1.7	-4.5	-2.6	-6.0	-0.8	...	-9.0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮
+5.9	-8.4	+0.4	-3.8	+1.5	+9.1	+2.9	-9.2	...	-1.4



a fluffy blue creature roamed the verdant forest

↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓

\vec{E}_1 \vec{E}_2 \vec{E}_3 \vec{E}_4 \vec{E}_5 \vec{E}_6 \vec{E}_7 \vec{E}_8

↓ W_Q

\vec{Q}_4

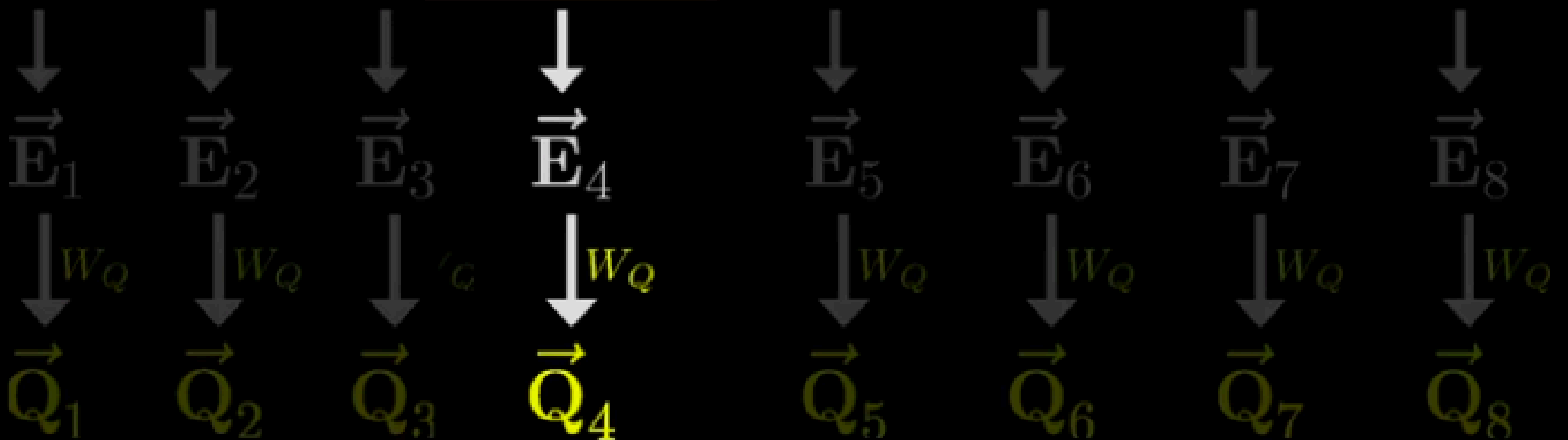
Any adjectives
in front of me?

$$\overbrace{\begin{bmatrix} +7.5 & -3.2 & +9.1 & -5.3 & +8.9 & +8.7 & +5.9 & +2.6 & +7.4 & -4.1 & \cdots & +2.3 \\ -9.6 & -3.0 & -7.0 & +9.5 & -0.4 & -0.1 & +2.8 & -2.6 & -7.2 & +6.4 & \cdots & +0.2 \\ -5.5 & -8.0 & +7.2 & +9.4 & +9.1 & +8.0 & +5.4 & -3.3 & -8.3 & -1.8 & \cdots & -7.3 \\ -8.8 & +4.5 & -9.7 & +5.4 & -7.0 & -8.3 & -8.1 & +3.4 & -5.0 & -1.6 & \cdots & +7.1 \\ +4.5 & -4.5 & -7.3 & -8.8 & -3.9 & -4.7 & -0.9 & +3.6 & +3.9 & -4.3 & \cdots & -6.3 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ -9.0 & +5.9 & -8.4 & +0.4 & -3.8 & +1.5 & +9.1 & +2.9 & -9.2 & -1.4 & \cdots & +0.7 \end{bmatrix}}^{W_Q} \vec{E}_4 = \vec{Q}_4$$

$$\begin{bmatrix} 2.9 \\ 2.4 \\ 1.0 \\ 0.2 \\ 9.2 \\ 6.6 \\ 7.8 \\ 2.8 \\ 5.8 \\ 0.6 \\ \vdots \\ 9.7 \end{bmatrix} = \begin{bmatrix} +310.6 \\ -95.2 \\ -2.1 \\ -152.0 \\ -123.2 \\ \vdots \\ -12.7 \end{bmatrix}$$



a fluffy blue creature roamed the verdant forest



a $\rightarrow \vec{E}_1$ $\xrightarrow{W_k}$ \vec{K}_1

fluffy $\rightarrow \vec{E}_2$ $\xrightarrow{W_k}$ \vec{K}_2

blue $\rightarrow \vec{E}_3$ $\xrightarrow{W_k}$ \vec{K}_3

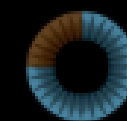
creature $\rightarrow \vec{E}_4$ $\xrightarrow{W_k}$ \vec{K}_4

roamed $\rightarrow \vec{E}_5$ $\xrightarrow{W_k}$ \vec{K}_5

I'm an adjective!
I'm there!

Any adjectives
in front of me?

I'm an adjective!
I'm there!

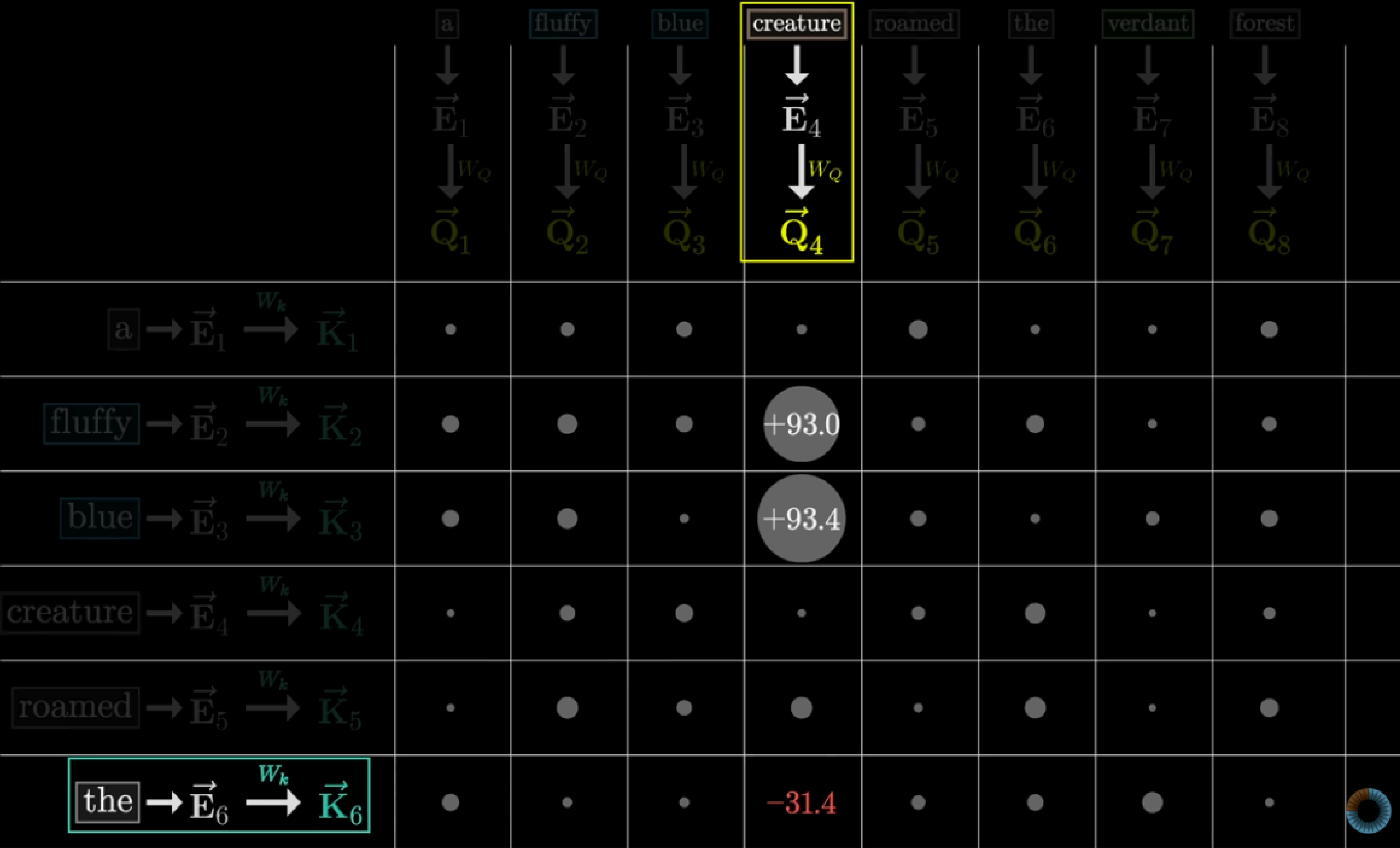


	a	fluffy	blue	creature	roamed	the	verdant	forest	
	\downarrow \vec{E}_1 \downarrow_{W_Q} \vec{Q}_1	\downarrow \vec{E}_2 \downarrow_{W_Q} \vec{Q}_2	\downarrow \vec{E}_3 \downarrow_{W_Q} \vec{Q}_3	\downarrow \vec{E}_4 \downarrow_{W_Q} \vec{Q}_4	\downarrow \vec{E}_5 \downarrow_{W_Q} \vec{Q}_5	\downarrow \vec{E}_6 \downarrow_{W_Q} \vec{Q}_6	\downarrow \vec{E}_7 \downarrow_{W_Q} \vec{Q}_7	\downarrow \vec{E}_8 \downarrow_{W_Q} \vec{Q}_8	
$\boxed{\text{a}} \rightarrow \vec{E}_1 \xrightarrow{W_k} \vec{K}_1$	$\vec{K}_1 \cdot \vec{Q}_1$	$\vec{K}_1 \cdot \vec{Q}_2$	$\vec{K}_1 \cdot \vec{Q}_3$	$\vec{K}_1 \cdot \vec{Q}_4$	$\vec{K}_1 \cdot \vec{Q}_5$	$\vec{K}_1 \cdot \vec{Q}_6$	$\vec{K}_1 \cdot \vec{Q}_7$	$\vec{K}_1 \cdot \vec{Q}_8$	
$\boxed{\text{fluffy}} \rightarrow \vec{E}_2 \xrightarrow{W_k} \vec{K}_2$	$\vec{K}_2 \cdot \vec{Q}_1$	$\vec{K}_2 \cdot \vec{Q}_2$	$\vec{K}_2 \cdot \vec{Q}_3$	$\vec{K}_2 \cdot \vec{Q}_4$	$\vec{K}_2 \cdot \vec{Q}_5$	$\vec{K}_2 \cdot \vec{Q}_6$	$\vec{K}_2 \cdot \vec{Q}_7$	$\vec{K}_2 \cdot \vec{Q}_8$	
$\boxed{\text{blue}} \rightarrow \vec{E}_3 \xrightarrow{W_k} \vec{K}_3$	$\vec{K}_3 \cdot \vec{Q}_1$	$\vec{K}_3 \cdot \vec{Q}_2$	$\vec{K}_3 \cdot \vec{Q}_3$	$\vec{K}_3 \cdot \vec{Q}_4$	$\vec{K}_3 \cdot \vec{Q}_5$	$\vec{K}_3 \cdot \vec{Q}_6$	$\vec{K}_3 \cdot \vec{Q}_7$	$\vec{K}_3 \cdot \vec{Q}_8$	
$\boxed{\text{creature}} \rightarrow \vec{E}_4 \xrightarrow{W_k} \vec{K}_4$	$\vec{K}_4 \cdot \vec{Q}_1$	$\vec{K}_4 \cdot \vec{Q}_2$	$\vec{K}_4 \cdot \vec{Q}_3$	$\vec{K}_4 \cdot \vec{Q}_4$	$\vec{K}_4 \cdot \vec{Q}_5$	$\vec{K}_4 \cdot \vec{Q}_6$	$\vec{K}_4 \cdot \vec{Q}_7$	$\vec{K}_4 \cdot \vec{Q}_8$	
$\boxed{\text{roamed}} \rightarrow \vec{E}_5 \xrightarrow{W_k} \vec{K}_5$	$\vec{K}_5 \cdot \vec{Q}_1$	$\vec{K}_5 \cdot \vec{Q}_2$	$\vec{K}_5 \cdot \vec{Q}_3$	$\vec{K}_5 \cdot \vec{Q}_4$	$\vec{K}_5 \cdot \vec{Q}_5$	$\vec{K}_5 \cdot \vec{Q}_6$	$\vec{K}_5 \cdot \vec{Q}_7$	$\vec{K}_5 \cdot \vec{Q}_8$	
$\boxed{\text{the}} \rightarrow \vec{E}_6 \xrightarrow{W_k} \vec{K}_6$	$\vec{K}_6 \cdot \vec{Q}_1$	$\vec{K}_6 \cdot \vec{Q}_2$	$\vec{K}_6 \cdot \vec{Q}_3$	$\vec{K}_6 \cdot \vec{Q}_4$	$\vec{K}_6 \cdot \vec{Q}_5$	$\vec{K}_6 \cdot \vec{Q}_6$	$\vec{K}_6 \cdot \vec{Q}_7$	$\vec{K}_6 \cdot \vec{Q}_8$	
$\boxed{\text{verdant}} \rightarrow \vec{E}_7 \xrightarrow{W_k} \vec{K}_7$	$\vec{K}_7 \cdot \vec{Q}_1$	$\vec{K}_7 \cdot \vec{Q}_2$	$\vec{K}_7 \cdot \vec{Q}_3$	$\vec{K}_7 \cdot \vec{Q}_4$	$\vec{K}_7 \cdot \vec{Q}_5$	$\vec{K}_7 \cdot \vec{Q}_6$	$\vec{K}_7 \cdot \vec{Q}_7$	$\vec{K}_7 \cdot \vec{Q}_8$	
$\boxed{\text{forest}} \rightarrow \vec{E}_8 \xrightarrow{W_k} \vec{K}_8$	$\vec{K}_8 \cdot \vec{Q}_1$	$\vec{K}_8 \cdot \vec{Q}_2$	$\vec{K}_8 \cdot \vec{Q}_3$	$\vec{K}_8 \cdot \vec{Q}_4$	$\vec{K}_8 \cdot \vec{Q}_5$	$\vec{K}_8 \cdot \vec{Q}_6$	$\vec{K}_8 \cdot \vec{Q}_7$	$\vec{K}_8 \cdot \vec{Q}_8$	

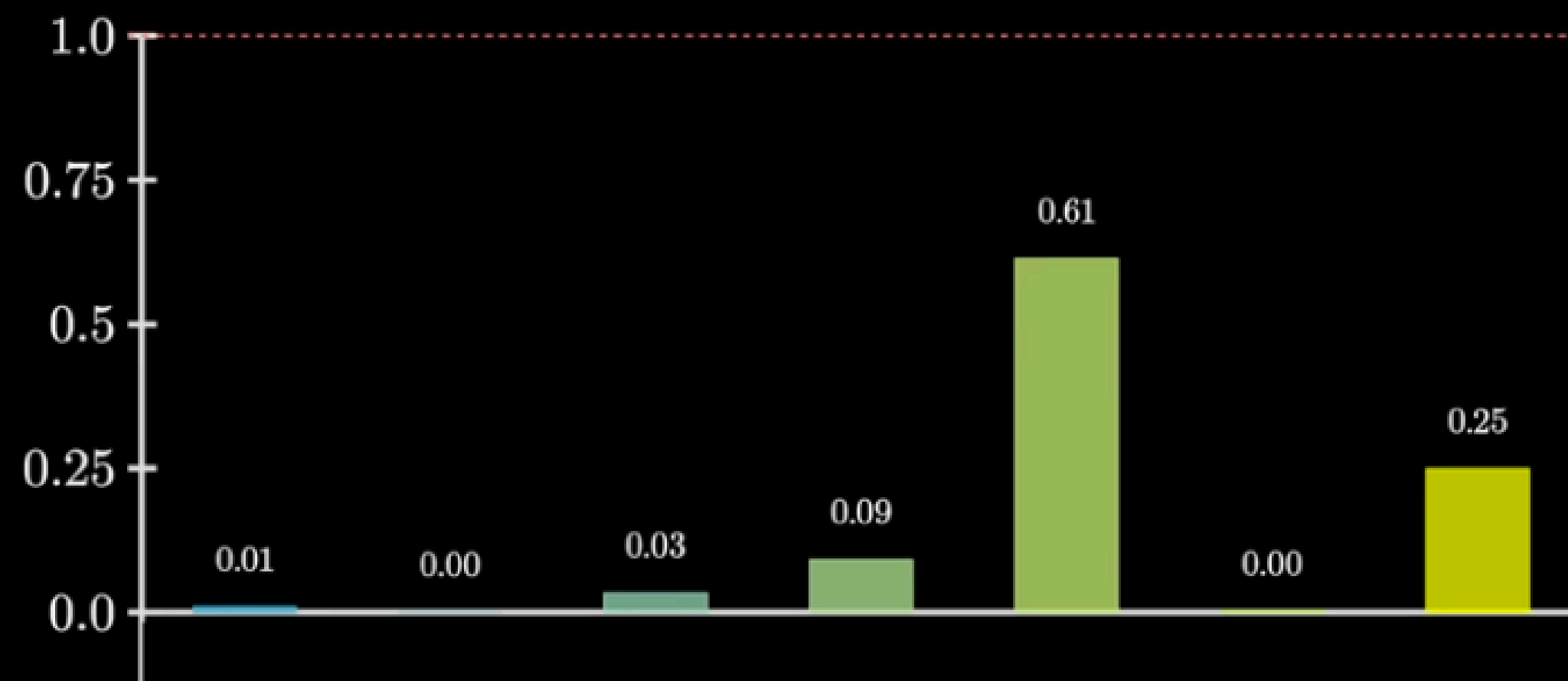


	a	fluffy	blue	creature	roamed	the	verdant	forest	
	\downarrow \vec{E}_1 \downarrow^{W_Q} \vec{Q}_1	\downarrow \vec{E}_2 \downarrow^{W_Q} \vec{Q}_2	\downarrow \vec{E}_3 \downarrow^{W_Q} \vec{Q}_3	\downarrow \vec{E}_4 \downarrow^{W_Q} \vec{Q}_4	\downarrow \vec{E}_5 \downarrow^{W_Q} \vec{Q}_5	\downarrow \vec{E}_6 \downarrow^{W_Q} \vec{Q}_6	\downarrow \vec{E}_7 \downarrow^{W_Q} \vec{Q}_7	\downarrow \vec{E}_8 \downarrow^{W_Q} \vec{Q}_8	
$\boxed{\text{a}} \rightarrow \vec{E}_1 \xrightarrow{W_k} \vec{K}_1$	+0.7	-83.7	-24.7	-27.8	-5.2	-89.3	-45.2	-36.1	
$\boxed{\text{fluffy}} \rightarrow \vec{E}_2 \xrightarrow{W_k} \vec{K}_2$	-73.4	+2.9	-5.4	+93.0	-48.2	-87.3	-49.7	+7.8	
$\boxed{\text{blue}} \rightarrow \vec{E}_3 \xrightarrow{W_k} \vec{K}_3$	-53.4	-5.7	+1.8	+93.4	-55.6	-56.0	-26.1	-62.1	
$\boxed{\text{creature}} \rightarrow \vec{E}_4 \xrightarrow{W_k} \vec{K}_4$	-21.5	-29.7	-56.1	+4.9	-32.4	-92.3	-9.5	-28.1	
$\boxed{\text{roamed}} \rightarrow \vec{E}_5 \xrightarrow{W_k} \vec{K}_5$	-20.1	-40.9	-87.8	-55.4	+0.6	-64.7	-96.7	-18.9	
$\boxed{\text{the}} \rightarrow \vec{E}_6 \xrightarrow{W_k} \vec{K}_6$	-87.9	-33.3	-22.6	-31.4	+5.5	+0.6	-4.6	-96.8	
$\boxed{\text{verdant}} \rightarrow \vec{E}_7 \xrightarrow{W_k} \vec{K}_7$	-41.2	-55.5	-42.3	-59.8	-79.0	-97.9	+3.7	+93.8	
$\boxed{\text{forest}} \rightarrow \vec{E}_8 \xrightarrow{W_k} \vec{K}_8$	-58.9	-75.5	-91.1	-90.6	-75.6	-89.0	-70.8	+4.7	

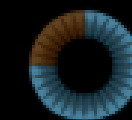




creature	roamed	the	verdant	forest	
$\downarrow \vec{E}_4$	$\downarrow \vec{E}_5$	$\downarrow \vec{E}_6$	$\downarrow \vec{E}_7$	$\downarrow \vec{E}_8$	
$\downarrow^{W_Q} \vec{Q}_4$	$\downarrow^{W_Q} \vec{Q}_5$	$\downarrow^{W_Q} \vec{Q}_6$	$\downarrow^{W_Q} \vec{Q}_7$	$\downarrow^{W_Q} \vec{Q}_8$	
-27.8	-5.2	-89.3	-45.2	-36.1	
+93.0	-22.7	-12.7	-13.7	-13.7	We want these to act like weights
+93.4	-55.1	-56.1	-6.1	-6.1	
+4.9	-32.4	-92.3	-9.5	-28.1	
-55.4	+0.6	-64.7	-96.7	-18.9	
-31.4	+5.5	+0.6	-4.6	-96.8	
-59.8	-79.0	-97.9	+3.7	+93.8	
-90.6	-75.6	-89.0	-70.8	+4.7	

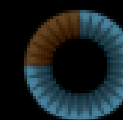


	<div>a</div> \vec{E}_1 $\downarrow W_Q$ \vec{Q}_1	<div>fluffy</div> \vec{E}_2 $\downarrow W_Q$ \vec{Q}_2	<div>blue</div> \vec{E}_3 $\downarrow W_Q$ \vec{Q}_3	<div>creature</div> \vec{E}_4 $\downarrow W_Q$ \vec{Q}_4	<div>roamed</div> \vec{E}_5 $\downarrow W_Q$ \vec{Q}_5	<div>the</div> \vec{E}_6 $\downarrow W_Q$ \vec{Q}_6	<div>verdant</div> \vec{E}_7 $\downarrow W_Q$ \vec{Q}_7	<div>forest</div> \vec{E}_8 $\downarrow W_Q$ \vec{Q}_8
<div>a</div> $\rightarrow \vec{E}_1 \xrightarrow{W_K} \vec{K}_1$	+0.7	-83.7	-24.7	-27.8	-5.2	-89.3	45.2	36.1
<div>fluffy</div> $\rightarrow \vec{E}_2 \xrightarrow{W_K} \vec{K}_2$	-73.4	+2.9	-5.4	+93.0	18.2	-87.3	-49.7	-7.8
<div>blue</div> $\rightarrow \vec{E}_3 \xrightarrow{W_K} \vec{K}_3$	-53.4	-5.7	+1.8	+93.4	-55.6	-56.0	-26.1	-62.1
<div>creature</div> $\rightarrow \vec{E}_4 \xrightarrow{W_K} \vec{K}_4$	-21.5	-29.7	-56.1	+4.9	-32.4	-92.3	-9.5	-28.1
<div>roamed</div> $\rightarrow \vec{E}_5 \xrightarrow{W_K} \vec{K}_5$	-20.1	-40.9	-87.8	-55.4	0.0	0.0	0.0	0.0
<div>the</div> $\rightarrow \vec{E}_6 \xrightarrow{W_K} \vec{K}_6$	-87.9	-33.3	-22.6	-31.4	-5.5	10.0	4.6	36.8
<div>verdant</div> $\rightarrow \vec{E}_7 \xrightarrow{W_K} \vec{K}_7$	-41.2	-55.5	-42.3	-59.8	-79.0	-97.9	-3.7	-93.8
<div>forest</div> $\rightarrow \vec{E}_8 \xrightarrow{W_K} \vec{K}_8$	-58.9	-75.5	91.1	-90.6	73.0	-89.0	-70.8	4.7
softmax								

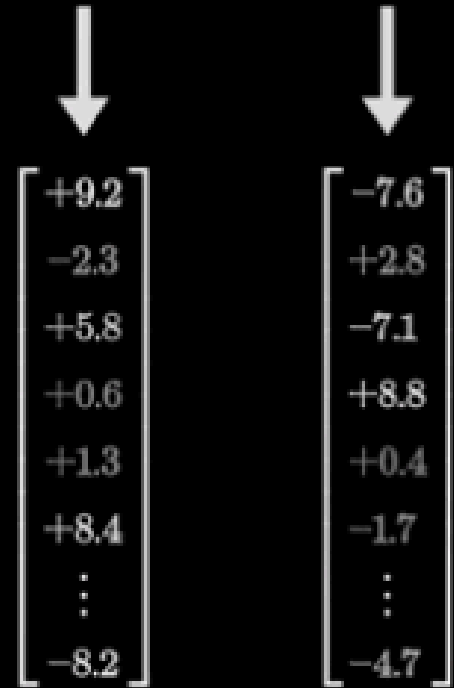


$$\text{Attention}(Q, K, V) = \text{softmax} \left(\frac{K^T Q}{\sqrt{d_k}} \right) V$$

	Q_1	Q_2	Q_3	Q_4	Q_5	\dots	Q_n	
K_1	$\frac{Q_1 \cdot K_1}{\sqrt{d_k}}$	$\frac{Q_2 \cdot K_1}{\sqrt{d_k}}$	$\frac{Q_3 \cdot K_1}{\sqrt{d_k}}$	$\frac{Q_4 \cdot K_1}{\sqrt{d_k}}$	$\frac{Q_5 \cdot K_1}{\sqrt{d_k}}$	\dots	$\frac{Q_n \cdot K_1}{\sqrt{d_k}}$	
K_2	$\frac{Q_1 \cdot K_2}{\sqrt{d_k}}$	$\frac{Q_2 \cdot K_2}{\sqrt{d_k}}$	$\frac{Q_3 \cdot K_2}{\sqrt{d_k}}$	$\frac{Q_4 \cdot K_2}{\sqrt{d_k}}$	$\frac{Q_5 \cdot K_2}{\sqrt{d_k}}$	\dots	$\frac{Q_n \cdot K_2}{\sqrt{d_k}}$	
K_3	$\frac{Q_1 \cdot K_3}{\sqrt{d_k}}$	$\frac{Q_2 \cdot K_3}{\sqrt{d_k}}$	$\frac{Q_3 \cdot K_3}{\sqrt{d_k}}$	$\frac{Q_4 \cdot K_3}{\sqrt{d_k}}$	$\frac{Q_5 \cdot K_3}{\sqrt{d_k}}$	\dots	$\frac{Q_n \cdot K_3}{\sqrt{d_k}}$	
K_4	$\frac{Q_1 \cdot K_4}{\sqrt{d_k}}$	$\frac{Q_2 \cdot K_4}{\sqrt{d_k}}$	$\frac{Q_3 \cdot K_4}{\sqrt{d_k}}$	$\frac{Q_4 \cdot K_4}{\sqrt{d_k}}$	$\frac{Q_5 \cdot K_4}{\sqrt{d_k}}$	\dots	$\frac{Q_n \cdot K_4}{\sqrt{d_k}}$	
K_5	$\frac{Q_1 \cdot K_5}{\sqrt{d_k}}$	$\frac{Q_2 \cdot K_5}{\sqrt{d_k}}$	$\frac{Q_3 \cdot K_5}{\sqrt{d_k}}$	$\frac{Q_4 \cdot K_5}{\sqrt{d_k}}$	$\frac{Q_5 \cdot K_5}{\sqrt{d_k}}$	\dots	$\frac{Q_n \cdot K_5}{\sqrt{d_k}}$	
\vdots	\vdots	\vdots	\vdots	\vdots	\vdots	\dots	\vdots	



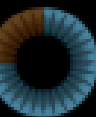
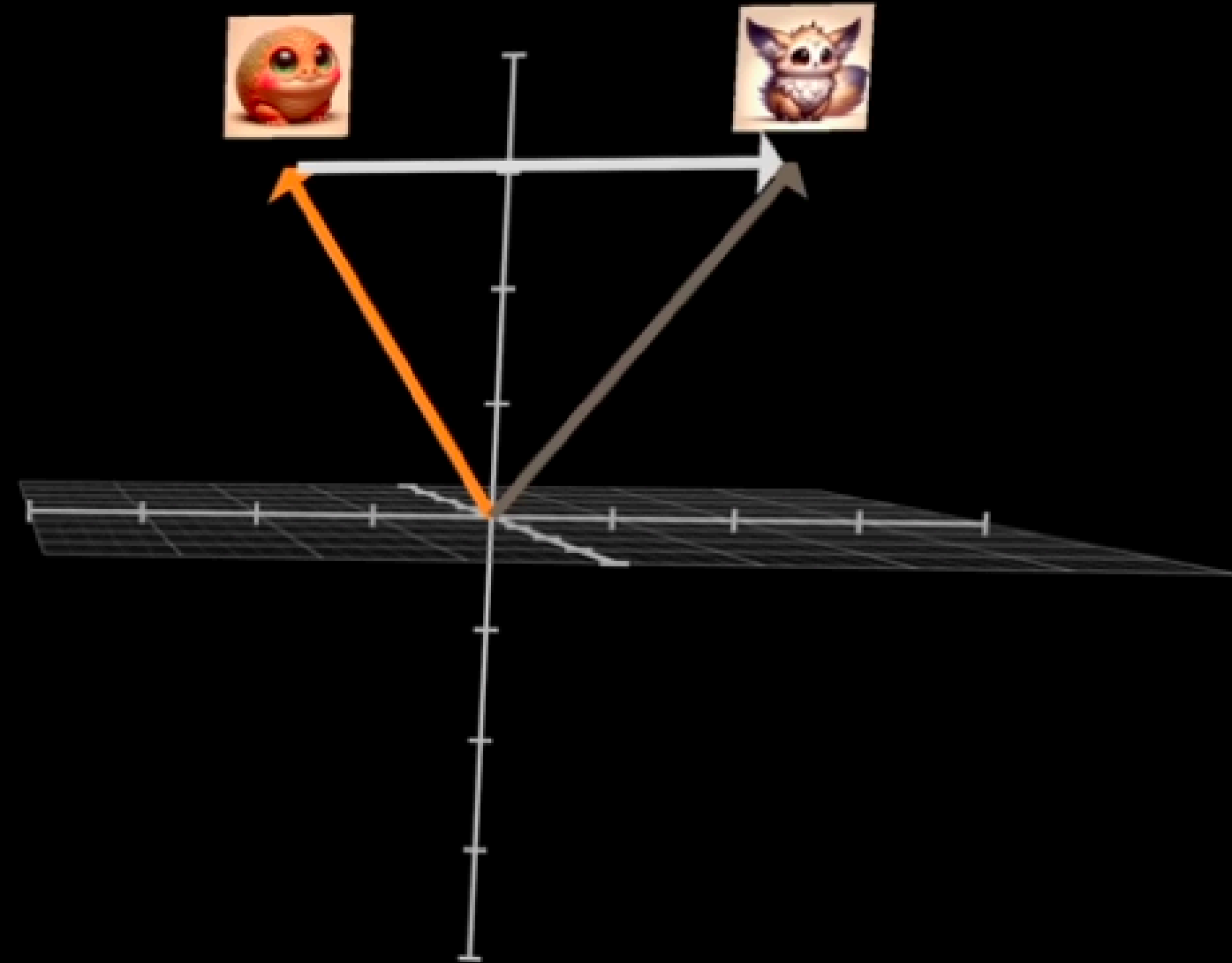
fluffy creature

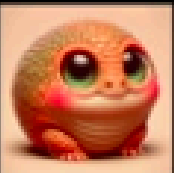


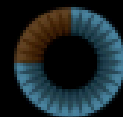
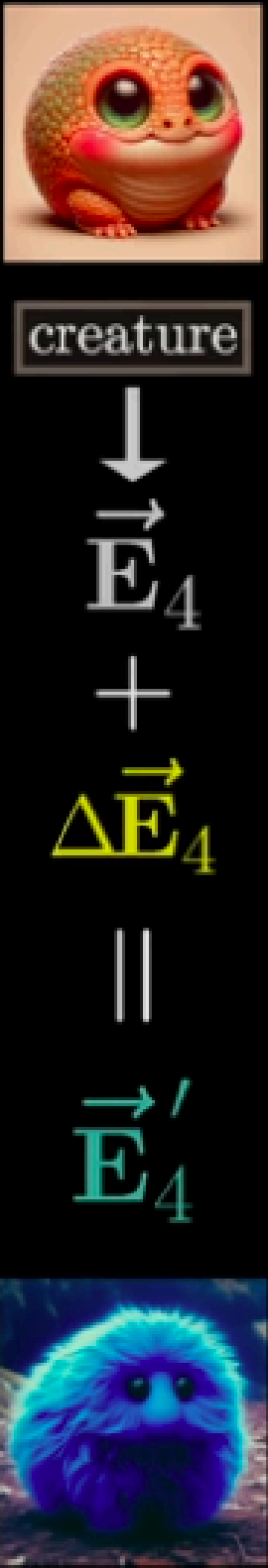
W_V

-3.6	-1.7	-8.6	+3.8	+1.3	-4.6	...	-8.0
+1.5	+8.5	-3.6	+3.3	-7.3	+4.3	...	-6.3
+1.7	-9.5	+6.5	-9.8	+3.5	-4.6	...	+9.2
-5.0	+1.5	+1.8	+1.4	-5.5	+9.0	...	+6.9
+3.9	-4.0	+6.2	-2.0	+7.5	+1.6	...	+3.8
+4.5	+0.0	+9.0	+2.9	-1.5	+2.1	...	-3.9
⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮
+1.5	+3.0	+3.0	-1.4	+7.9	-2.6	...	+7.8

Value
Matrix



									
	<div>a</div> <div>↓</div> <div>\vec{E}_1</div>	<div>fluffy</div> <div>↓</div> <div>\vec{E}_2</div>	<div>blue</div> <div>↓</div> <div>\vec{E}_3</div>	<div>creature</div> <div>↓</div> <div>\vec{E}_4</div>	<div>roamed</div> <div>↓</div> <div>\vec{E}_5</div>	<div>the</div> <div>↓</div> <div>\vec{E}_6</div>	<div>verdant</div> <div>↓</div> <div>\vec{E}_7</div>	<div>forest</div> <div>↓</div> <div>\vec{E}_8</div>	
<div>a</div> <div>→</div> <div>\vec{E}_1</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_1</div>				0.00 \vec{v}_1					
<div>fluffy</div> <div>→</div> <div>\vec{E}_2</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_2</div>				+					
<div>blue</div> <div>→</div> <div>\vec{E}_3</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_3</div>				0.42 \vec{v}_2					
<div>creature</div> <div>→</div> <div>\vec{E}_4</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_4</div>				+					
<div>roamed</div> <div>→</div> <div>\vec{E}_5</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_5</div>				0.58 \vec{v}_3					
<div>the</div> <div>→</div> <div>\vec{E}_6</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_6</div>				+					
<div>verdant</div> <div>→</div> <div>\vec{E}_7</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_7</div>				0.00 \vec{v}_4					
<div>forest</div> <div>→</div> <div>\vec{E}_8</div> <div>→</div> <div>w_v</div> <div>→</div> <div>\vec{v}_8</div>				+					
				0.00 \vec{v}_5					
				+					
				0.00 \vec{v}_6					
				+					
				0.00 \vec{v}_7					
				+					
				0.00 \vec{v}_8					
				$\Delta \vec{E}_4$					

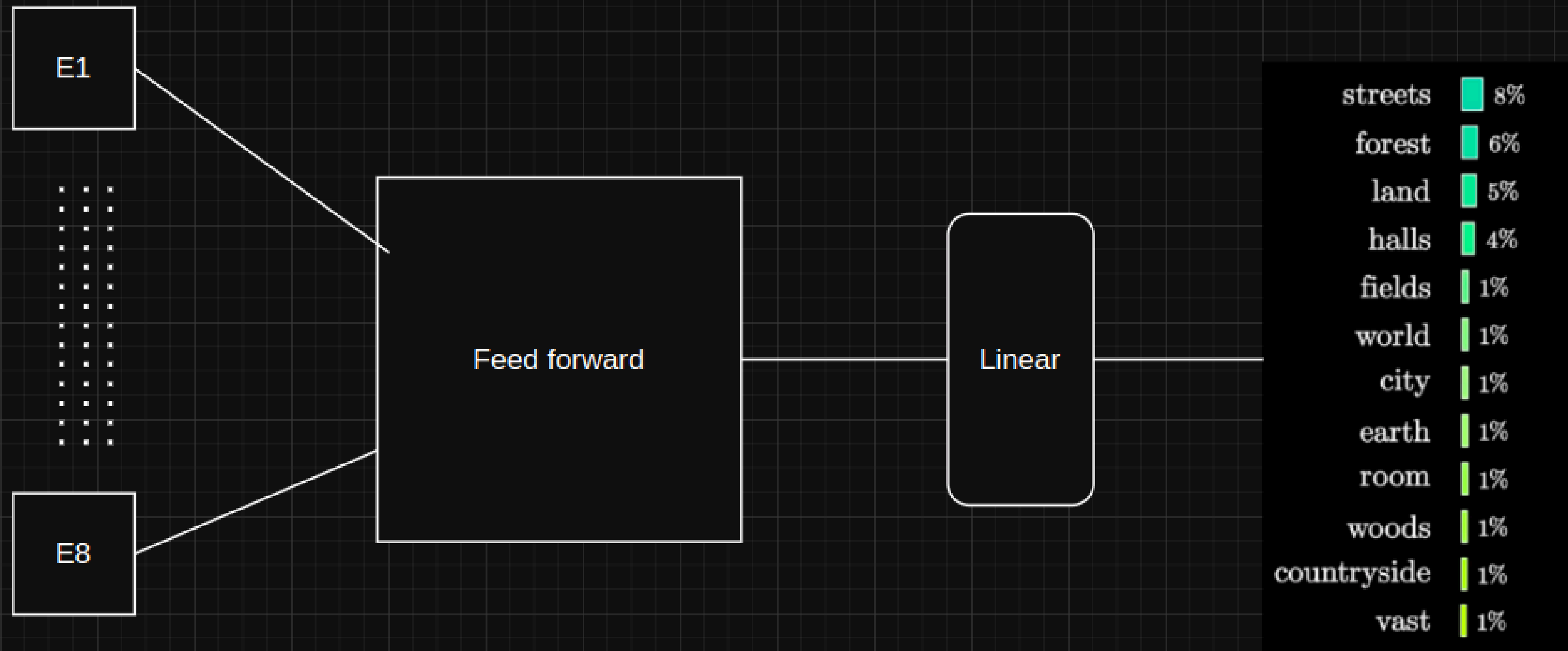


One head of attention

	a ↓ \vec{E}_1	fluffy ↓ \vec{E}_2	blue ↓ \vec{E}_3	creature ↓ \vec{E}_4	roamed ↓ \vec{E}_5	the ↓ \vec{E}_6	verdant ↓ \vec{E}_7	forest ↓ \vec{E}_8	
$\vec{E}_1 \xrightarrow{w_v} \vec{v}_1$	1.00 \vec{v}_1	0.00 \vec{v}_1	0.00 \vec{v}_1	0.00 \vec{v}_1	0.00 \vec{v}_1	0.00 \vec{v}_1	0.00 \vec{v}_1	0.00 \vec{v}_1	
$\vec{E}_2 \xrightarrow{w_v} \vec{v}_2$	+	1.00 \vec{v}_2	0.00 \vec{v}_2	0.42 \vec{v}_2	0.00 \vec{v}_2	0.00 \vec{v}_2	0.00 \vec{v}_2	0.00 \vec{v}_2	
$\vec{E}_3 \xrightarrow{w_v} \vec{v}_3$	+	+	1.00 \vec{v}_3	0.58 \vec{v}_3	0.00 \vec{v}_3	0.00 \vec{v}_3	0.00 \vec{v}_3	0.00 \vec{v}_3	
$\vec{E}_4 \xrightarrow{w_v} \vec{v}_4$	+	+	+	+	+	+	+	+	
$\vec{E}_5 \xrightarrow{w_v} \vec{v}_5$	+	+	+	+	0.01 \vec{v}_5	0.00 \vec{v}_5	0.00 \vec{v}_5	0.00 \vec{v}_5	
$\vec{E}_6 \xrightarrow{w_v} \vec{v}_6$	+	+	+	+	0.99 \vec{v}_6	1.00 \vec{v}_6	0.00 \vec{v}_6	0.00 \vec{v}_6	
$\vec{E}_7 \xrightarrow{w_v} \vec{v}_7$	+	+	+	+	+	+	1.00 \vec{v}_7	1.00 \vec{v}_7	
$\vec{E}_8 \xrightarrow{w_v} \vec{v}_8$	+	+	+	+	+	+	+	+	
	$\Delta \vec{E}_1$	$\Delta \vec{E}_2$	$\Delta \vec{E}_3$	$\Delta \vec{E}_4$	$\Delta \vec{E}_5$	$\Delta \vec{E}_6$	$\Delta \vec{E}_7$	$\Delta \vec{E}_8$	

\vec{E}_1	\vec{E}_2	\vec{E}_3	\vec{E}_4	\vec{E}_5	\vec{E}_6	\vec{E}_7	\vec{E}_8
+	+	+	+	+	+	+	+
$\Delta \vec{E}_1$	$\Delta \vec{E}_2$	$\Delta \vec{E}_3$	$\Delta \vec{E}_4$	$\Delta \vec{E}_5$	$\Delta \vec{E}_6$	$\Delta \vec{E}_7$	$\Delta \vec{E}_8$
\vec{E}'_1	\vec{E}'_2	\vec{E}'_3	\vec{E}'_4	\vec{E}'_5	\vec{E}'_6	\vec{E}'_7	\vec{E}'_8





تولید توالی آمینواسیدها برای ساخت پروتئین با استفاده از مدل Transformer

UniProt

BLASTAlignPeptide searchID mappingSPARQLUniProtKB▼(family:"acylphosphatase family")

Status

Reviewed (Swiss-Prot) (271)

Unreviewed (TrEMBL) (17,315)

Popular organisms

Fruit fly (12)

Human (11)

Bovine (8)

Rat (8)

A. thaliana (6)

Taxonomy

Filter by taxonomy

Group by

Taxonomy

Keywords

Gene Ontology

Enzyme Class

Proteins with

3D structure (15)

Active site (15,835)

Alternative products (isoforms) (3)

⚠ The unreviewed UniProtKB/TrEMBL database will be reduced in size in release 2026_02 (first half of 2026).

✓ Entries to be retained in UniProtKB:

- Entries from reference proteomes
- All reviewed (Swiss-Prot) entries
- Selected unreviewed (TrEMBL) entries with experimental or biologically important data

✗ Entries to be removed: Unreviewed (TrEMBL) entries that are not part of a reference proteome

Entries removed from unreviewed UniProtKB/TrEMBL will remain accessible in the UniParc sequence archive. Read our [help page](#), view [affected entries and proteomes](#), or [contact us](#) with any questions.

UniProtKB 17,586 results

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Entry	Entry Name	Protein Names	Gene Names	Organism
<input type="checkbox"/> P14621	ACYP2_HUMAN	Acylphosphatase-2	ACYP2, ACYP	Homo sapiens (Human)
<input type="checkbox"/> P07311	ACYP1_HUMAN	Acylphosphatase-1	ACYP1, ACYPE	Homo sapiens (Human)
<input type="checkbox"/> P35745	ACYP2_RAT	Acylphosphatase-2	Acyp2, Acyp	Rattus norvegicus (Rat)
<input type="checkbox"/> P0AB65	ACYP_ECOLI	Acylphosphatase	yccX, b0968, JW5131	Escherichia coli (strain K12)
<input type="checkbox"/> P41500	ACYP1_BOVIN	Acylphosphatase-1	ACYP1, ACYPE	Bos taurus (Bovine)
<input type="checkbox"/> P00821	ACYP2_MELGA	Acylphosphatase-2	ACYP2	Meleagris gallopavo (Wild turkey)
<input type="checkbox"/> P24540	ACYP1_PIG	Acylphosphatase-1	ACYP1, ACYPE	Sus scrofa (Pig)

◆ معرفی UniProt:

پایگاه دادهٔ جامع پروتئین‌ها که شامل توالی، ساختار و عملکرد آن‌ها در موجودات مختلف است.

◆ دیتاست پروژه:

توالی‌های آمینواسیدی آنزیم Acylphosphatase استخراج‌شده از پایگاه UniProt کاربرد:

کمک به طراحی و درک بهتر عملکرد آنزیم‌ها و تولید پروتئین‌های مصنوعی.

◆ هدف مدل:

تولید توالی‌های جدید آمینواسیدی مشابه Acylphosphatase با استفاده از مدل Transformer.

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