

Quiz



MAX PLANCK INSTITUTE
FOR HUMAN DEVELOPMENT



Quiz

How are LLMs trained?

What are the main ways to use LLMs?

What aspects distinguish different LLMs?

How to choose an LLM?

Feature extraction and embedding models

Dirk Wulff & Zak Hussain



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**“You’ll know
a word by
the company
that it
keeps!”**

John Rupert Firth
Linguist
1890-1960

Word embedding

Latent semantic analysis

		Contexts											
Word	this region of the galaxy	Context 1	1										
			1										
			1										
			1										
			1										

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Word embedding

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		Contexts											
Word		Context 1	Context 2										
	this	1											
	region	1	1										
	of	1	1										
	the	1	2										
	galaxy	1	1										

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	of	1	1									
	the	1	1	1								
	galaxy	1	2	2								
	sky	1	1	1								
				1								

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	region	1	1									
	of	1	1	1		1						
	the	1	2	2		1						
	galaxy	1	1	1								
	sky			1								
	...											
	image					1						
	dial					1						
shivered						1						

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Latent semantic analysis

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	Context 1	Context 2	Context 3	⋮	Context <i>m</i>		⋮				Context <i>M</i>
	this	1									
	region	1	1								
	of	1	1	1		1				1	
	the	1	2	2		1					
	galaxy	1	1	1					1		
	sky			1			2				1
	...				1						
	image					1					3
dial						1			1		
shivered						1				1	
...											1
Word <i>N</i>									1		

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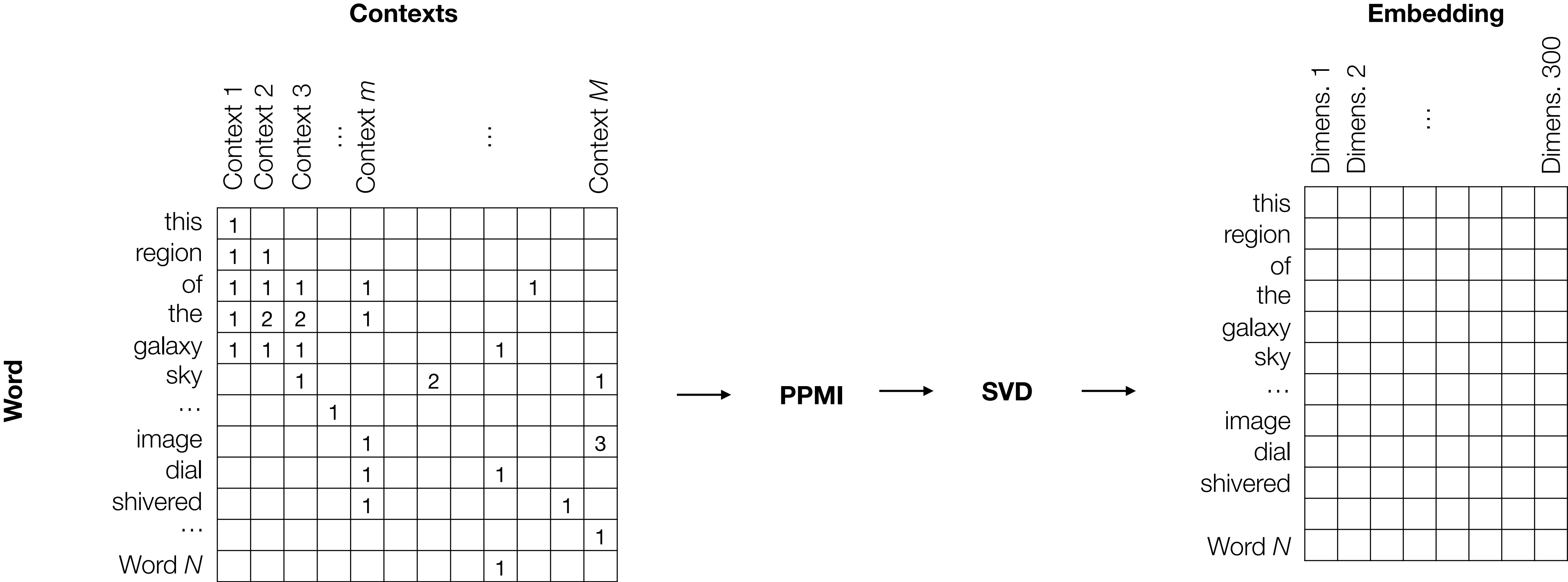
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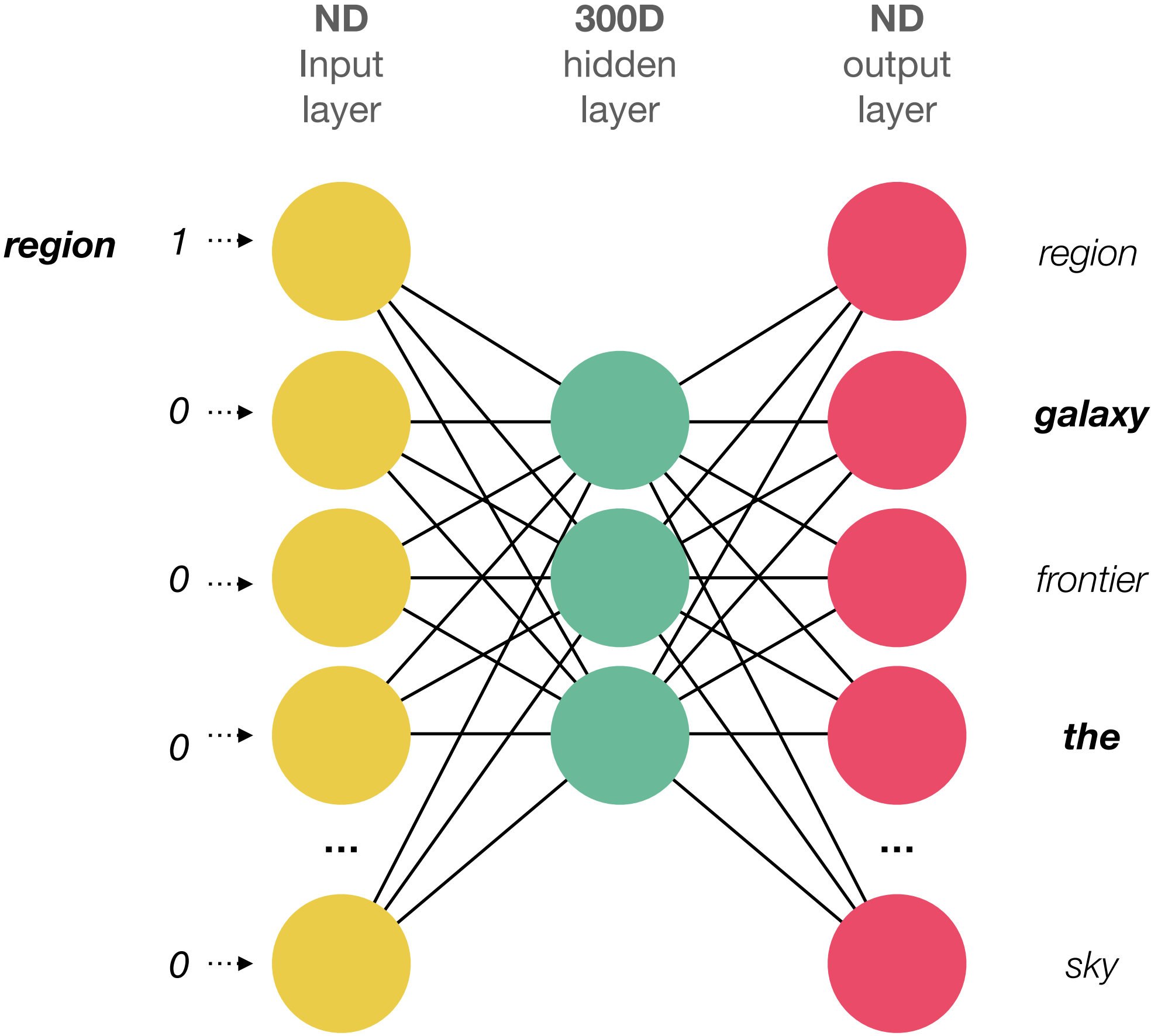
Word embedding

Latent semantic analysis



Word embedding

word2vec



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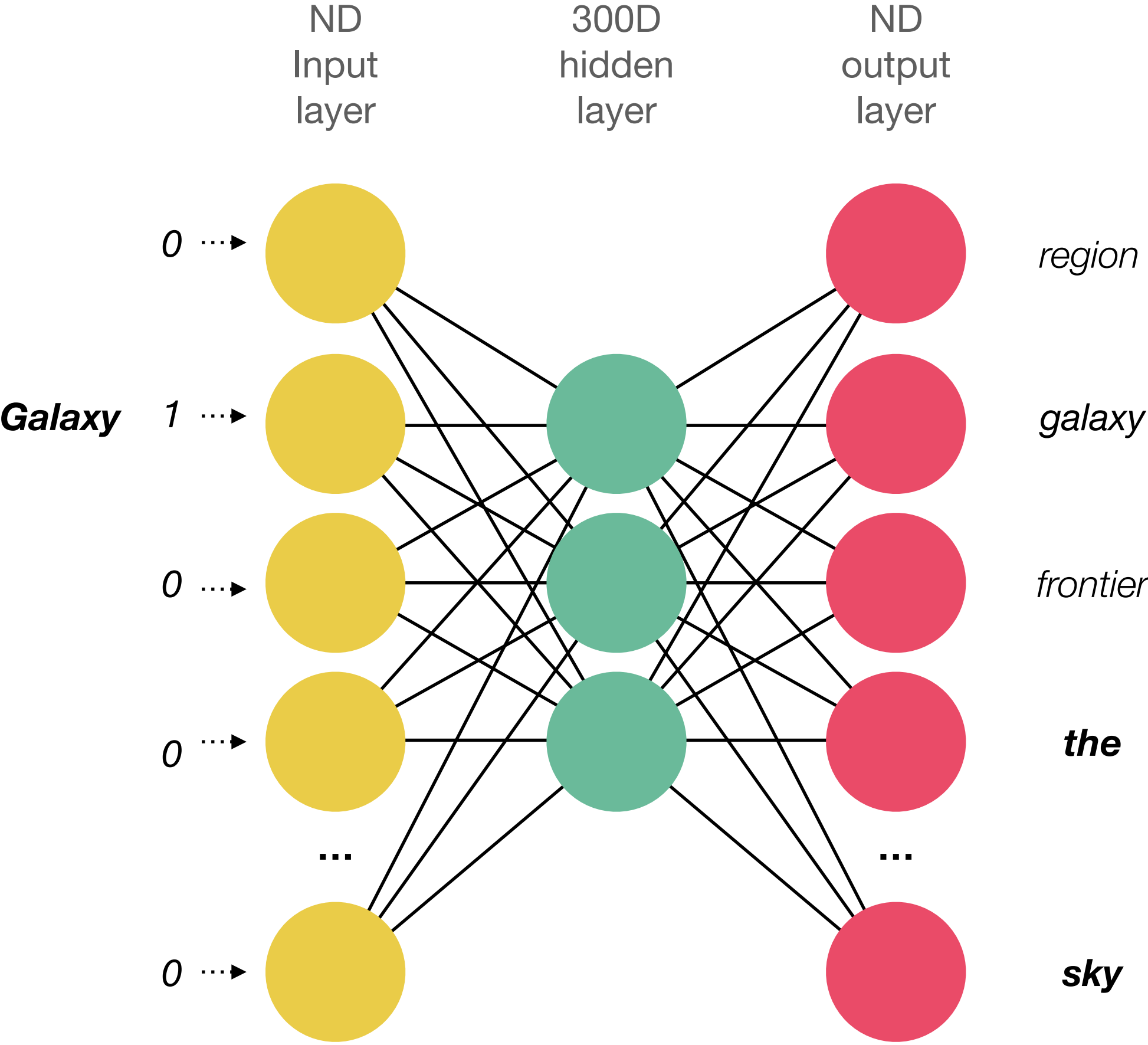
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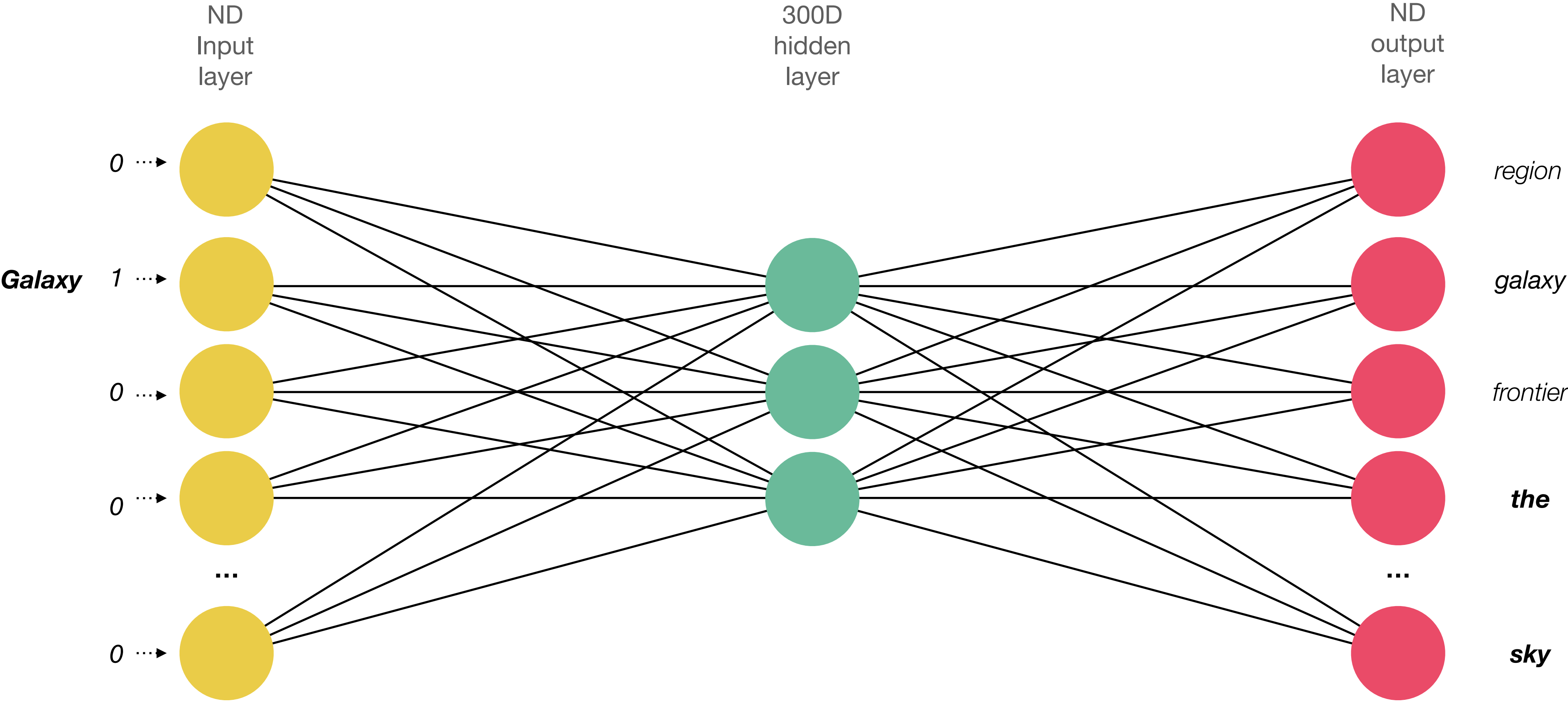
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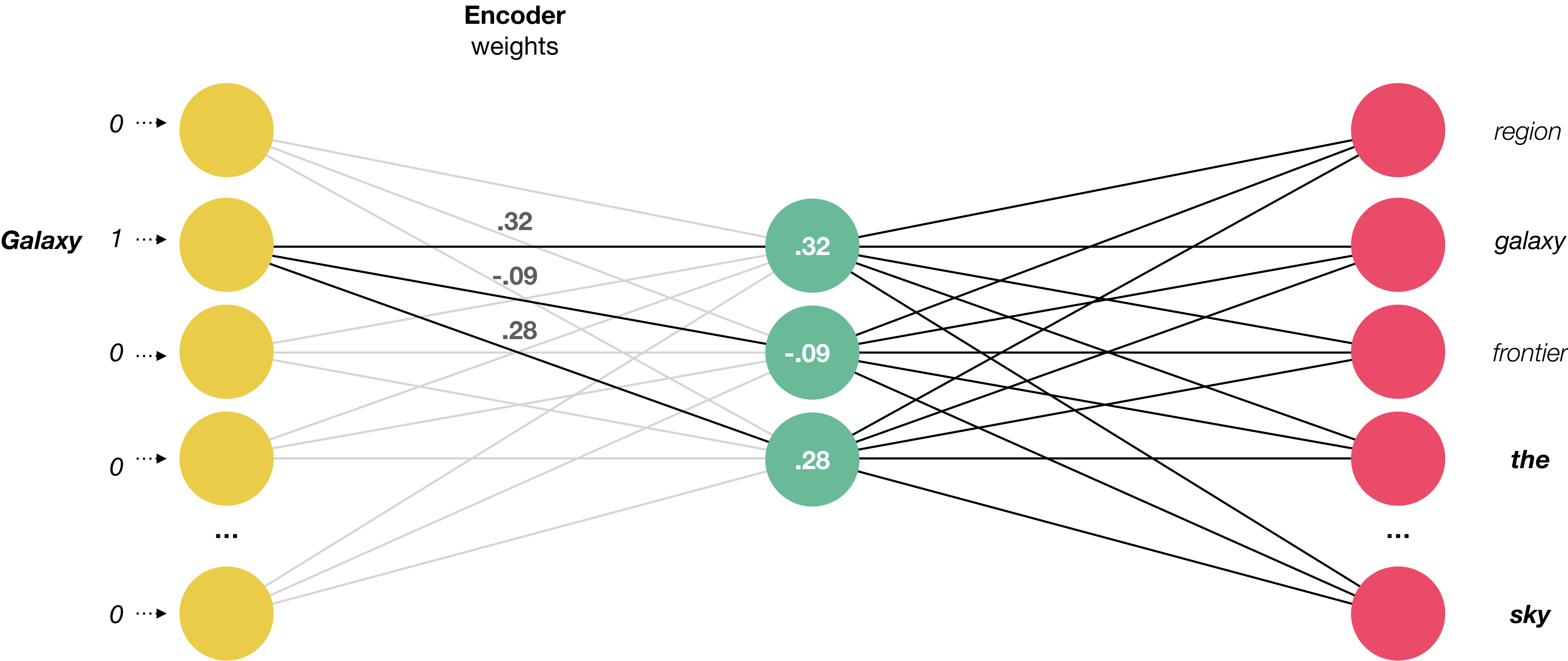
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word2vec



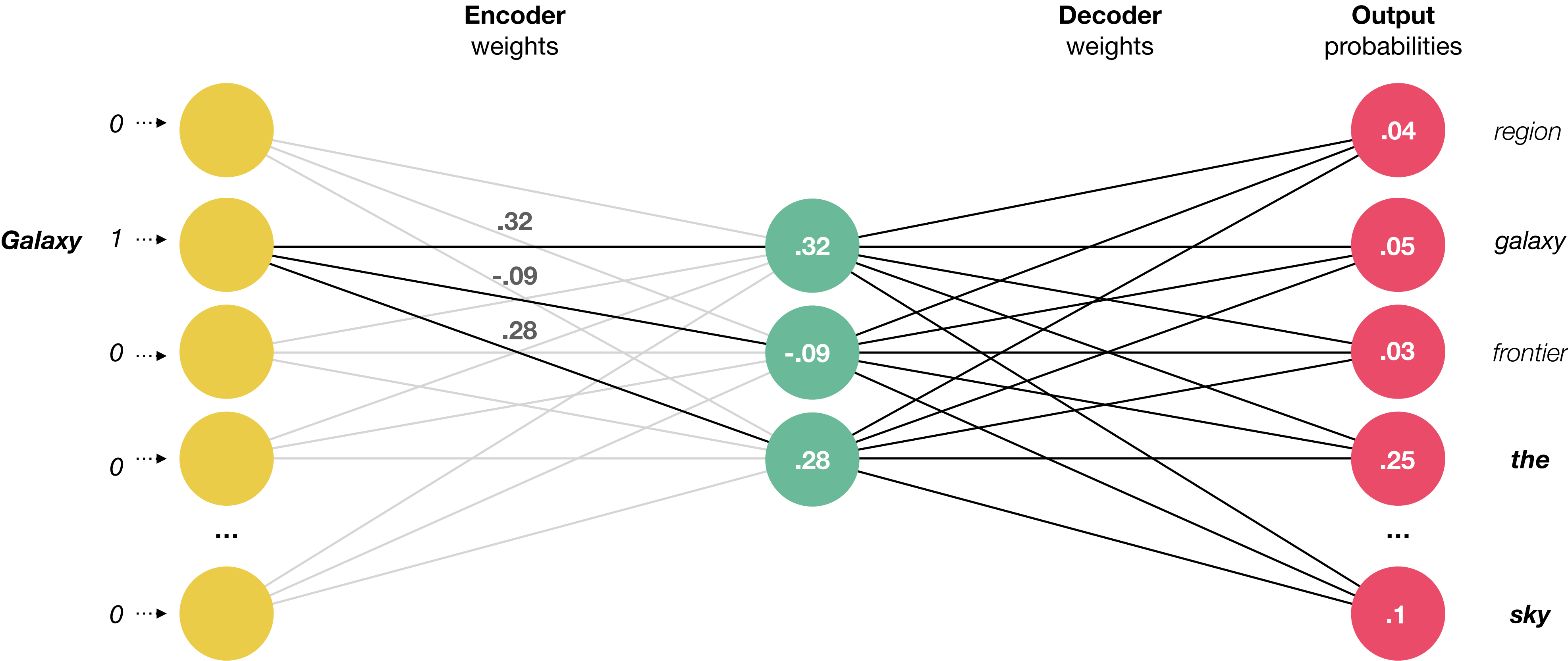
Word embedding

“A good language model encodes words with similar output similarly”



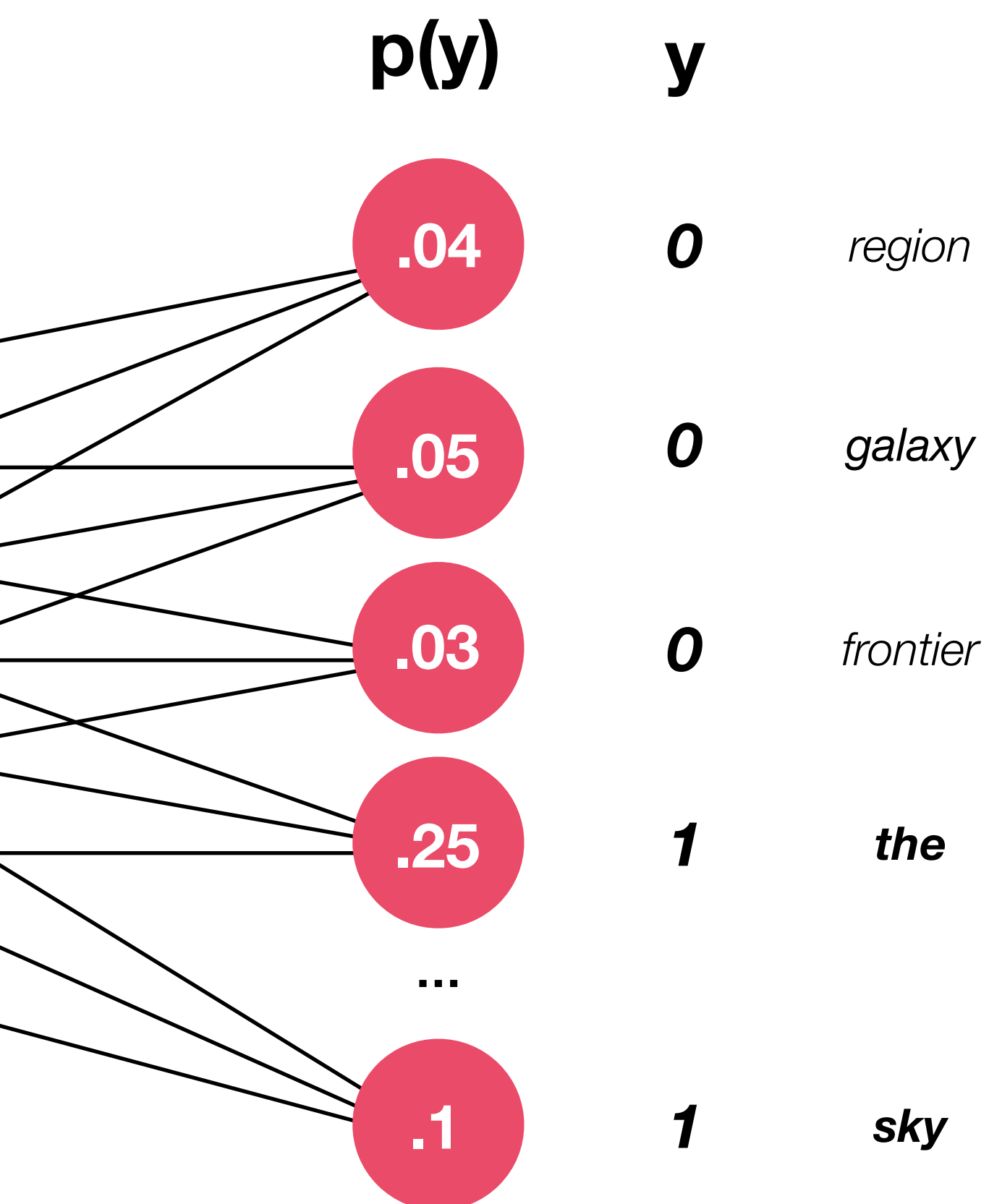
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Error signal

and gradient descent



Sum over context **contexts** Sum over context **words** **Criterion**
 0 if word is absent
 1 if word is present

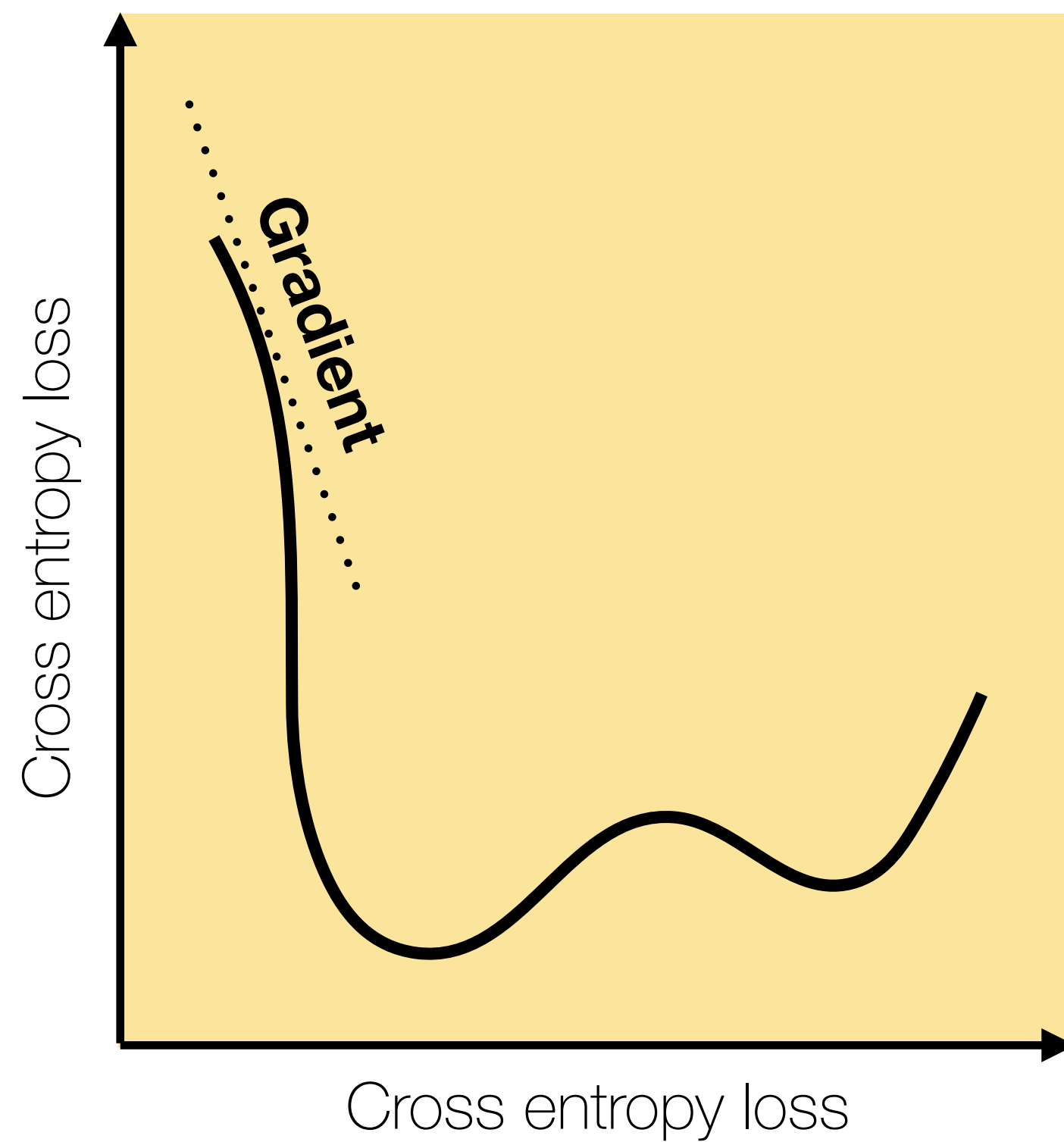
$$- \sum_i \sum_j y_{ij} p(y_{ij})$$

Model prediction
 Softmax probability

Cross entropy loss

Error signal

and gradient descent



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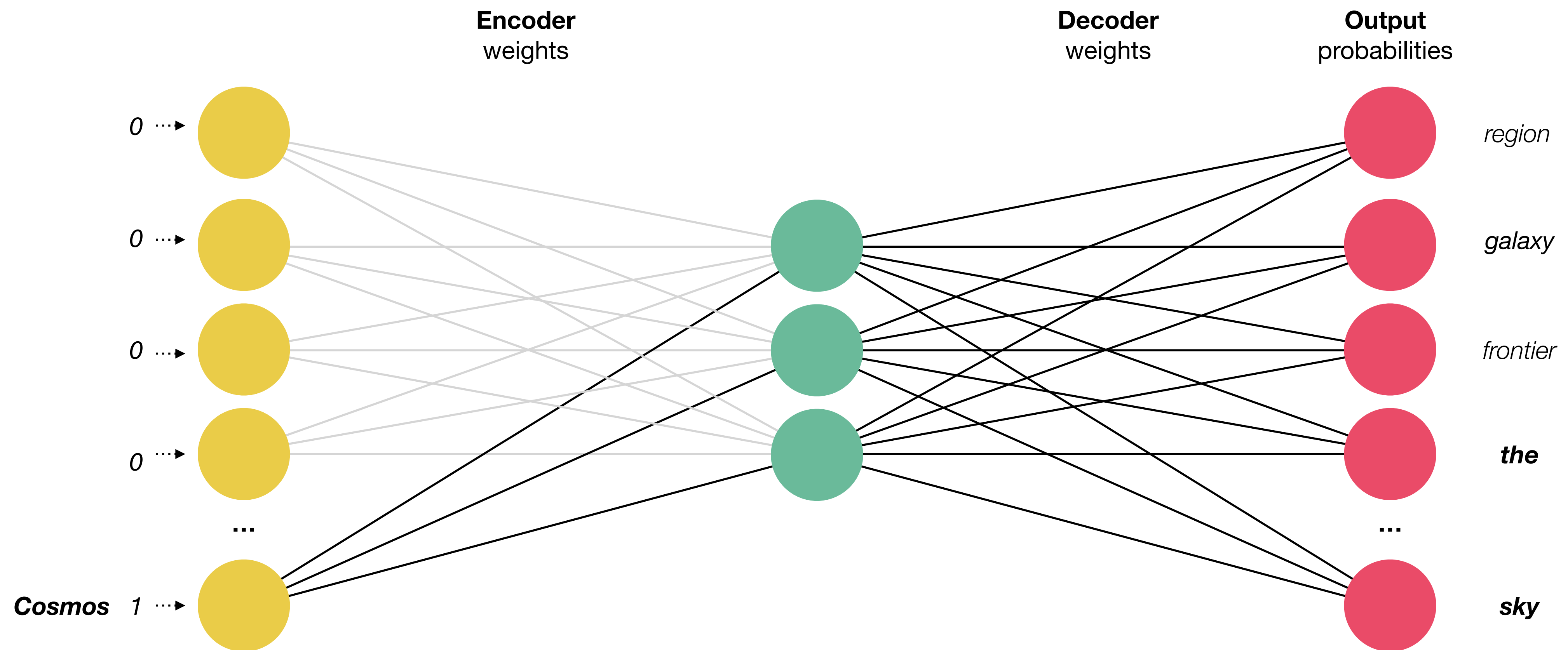
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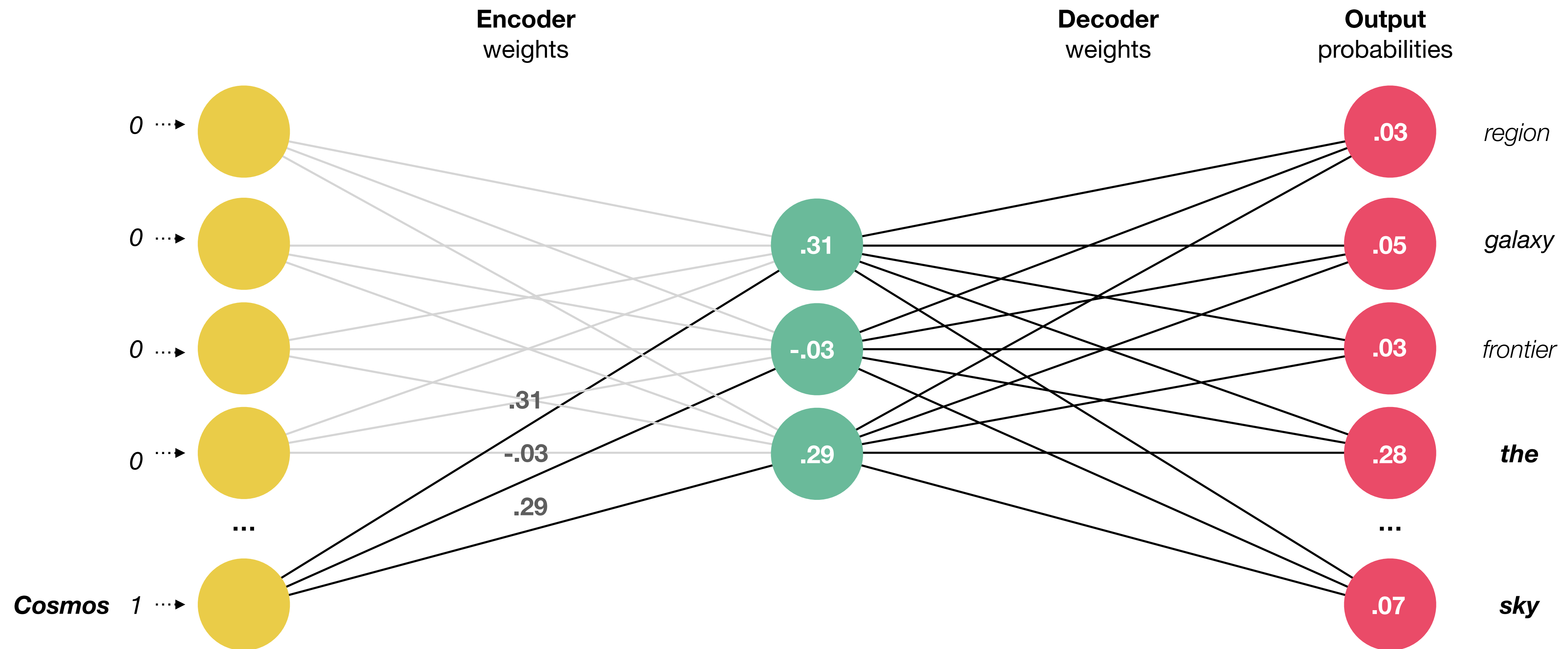
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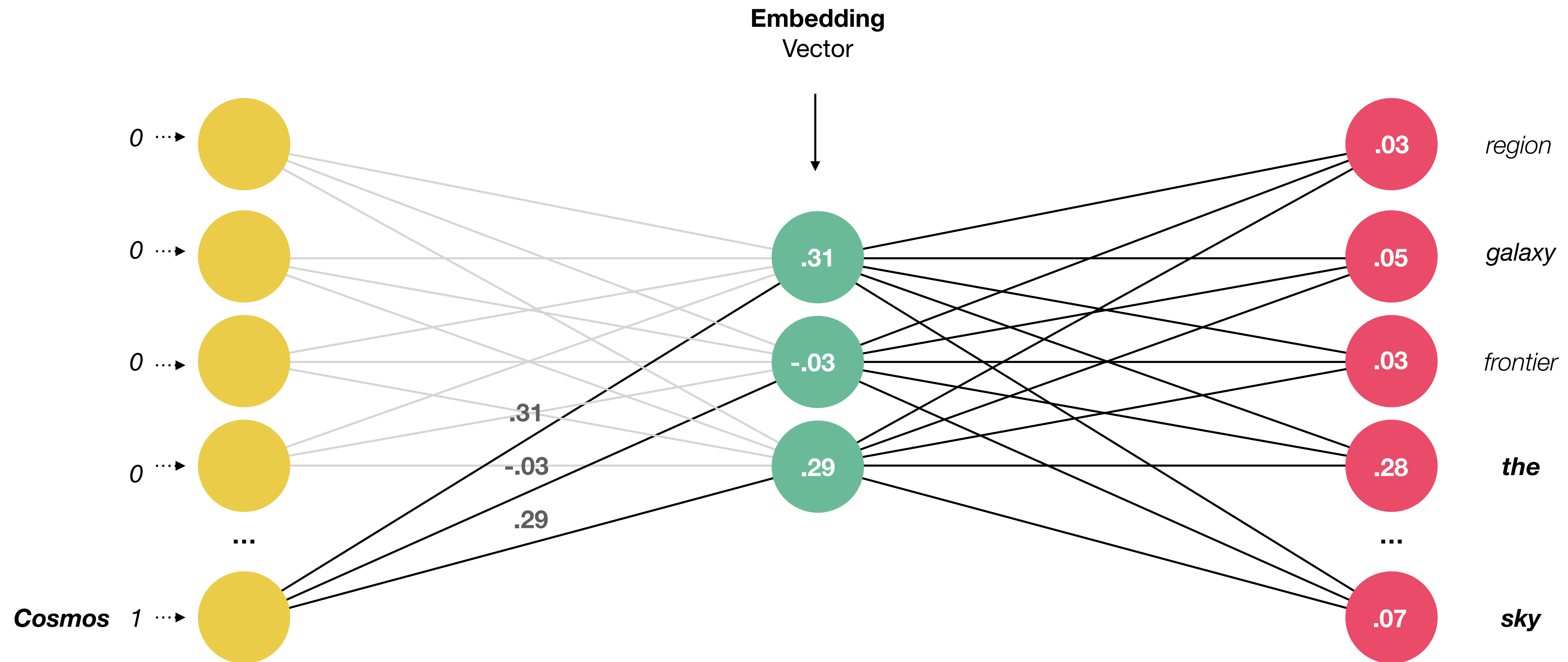
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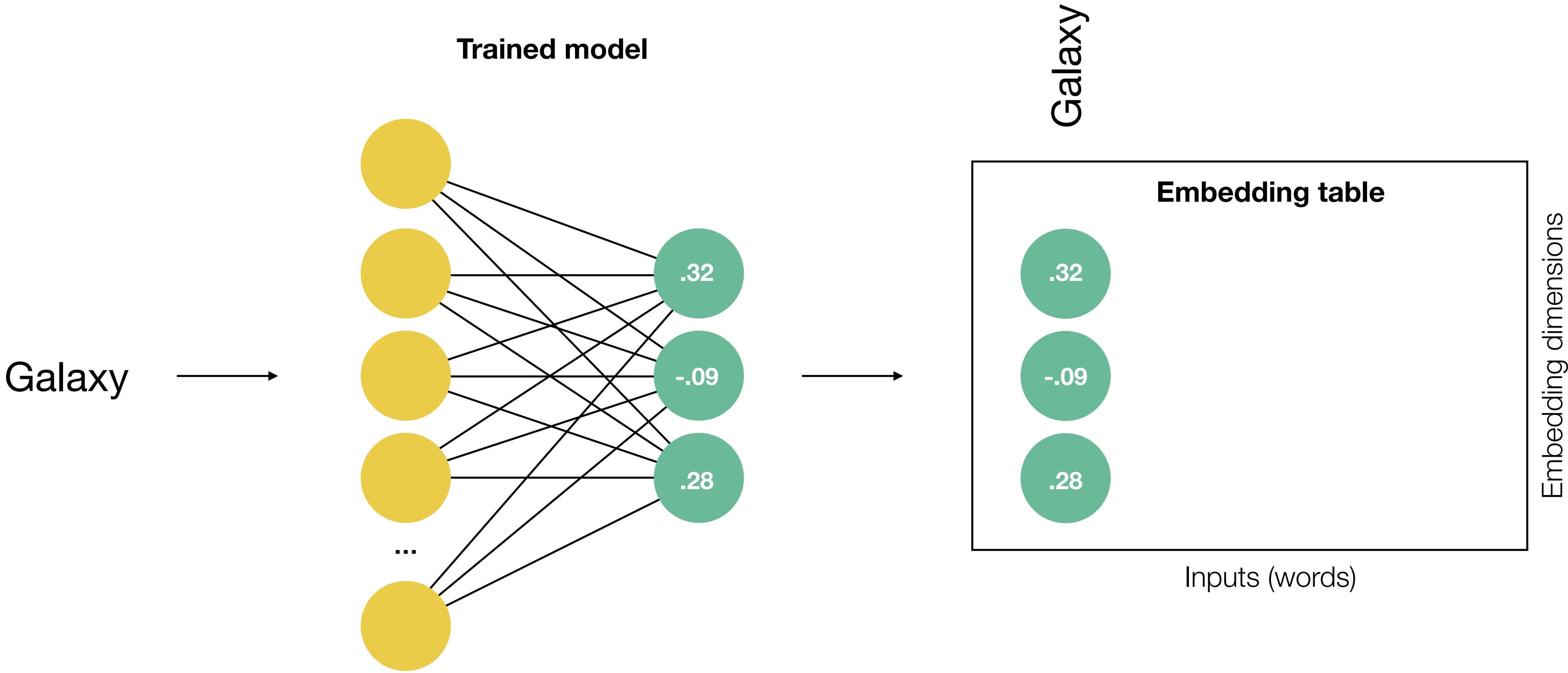
Word embedding

Embeddings = hidden activations (typically right before the output)



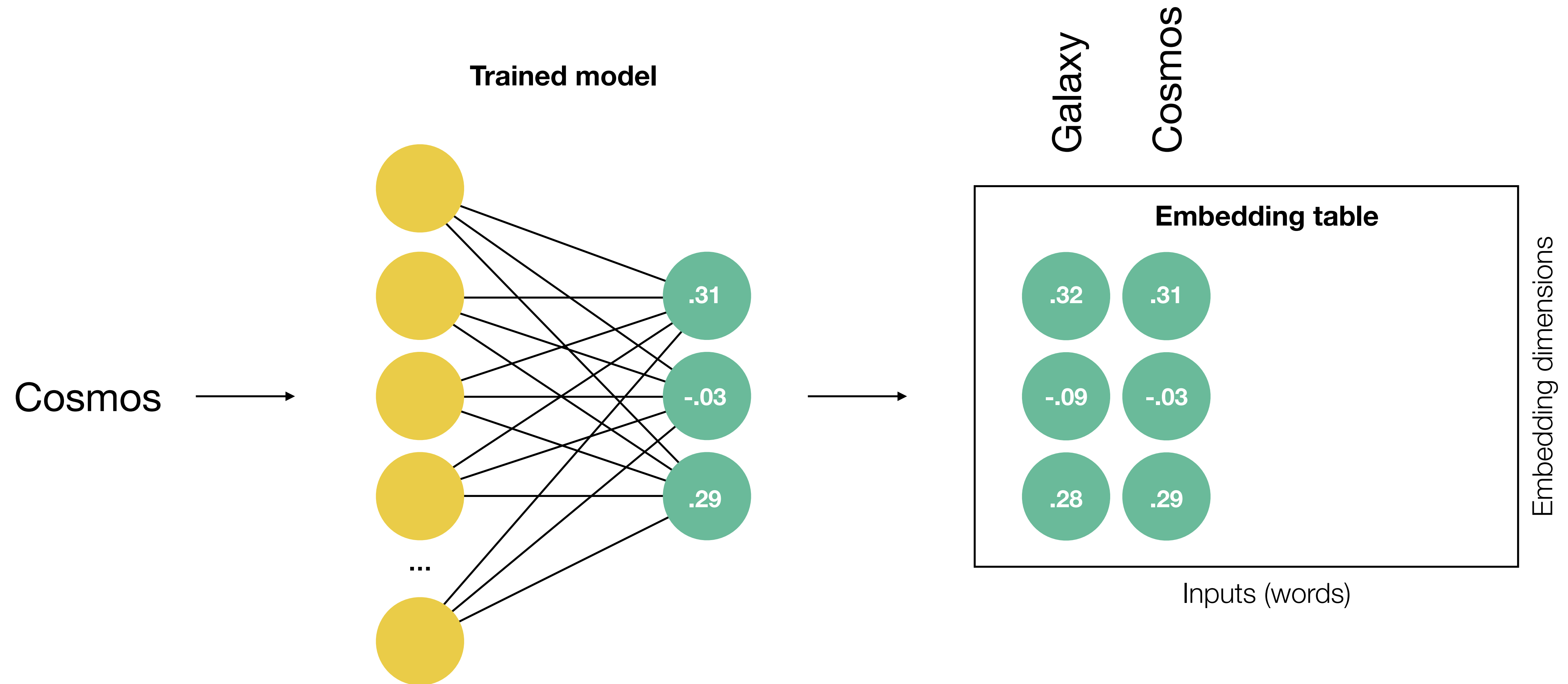
Generating embeddings

or recording hidden activations



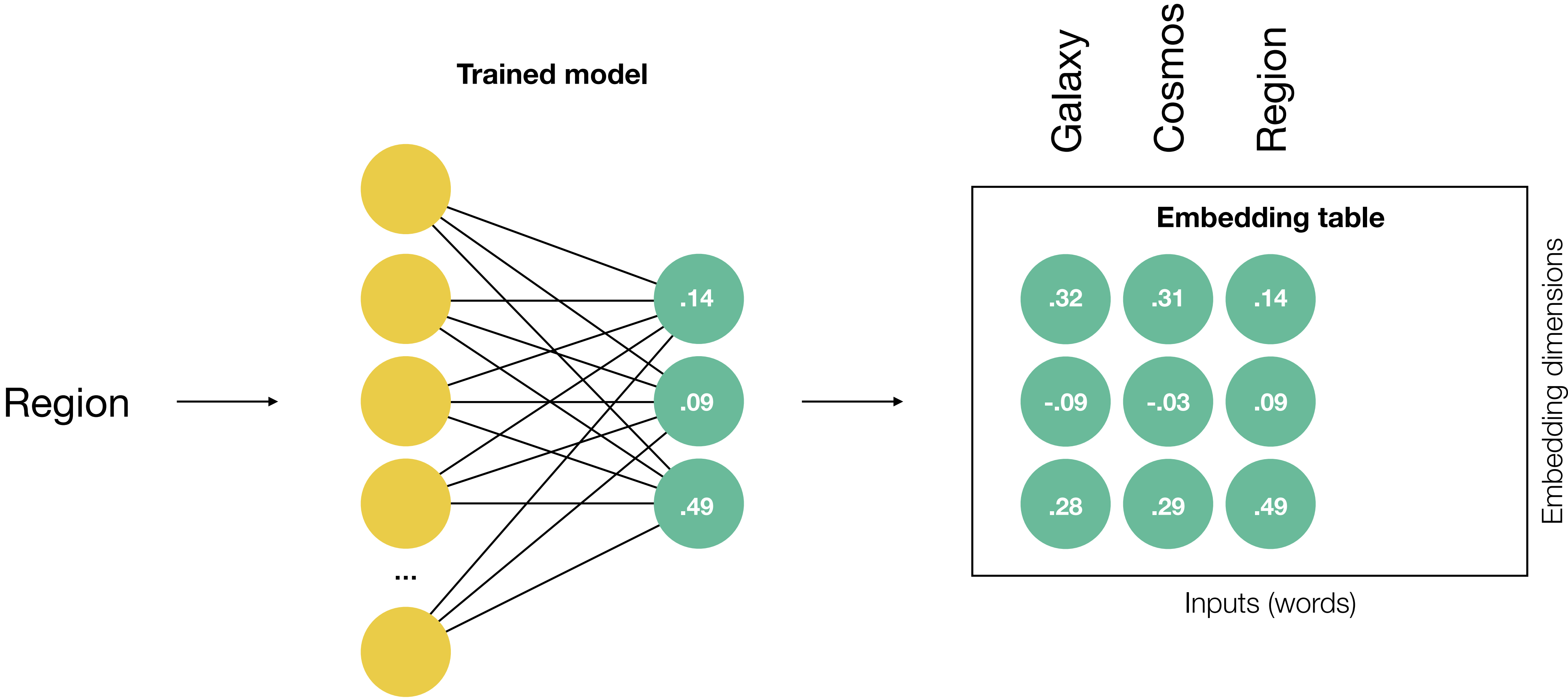
Generating embeddings

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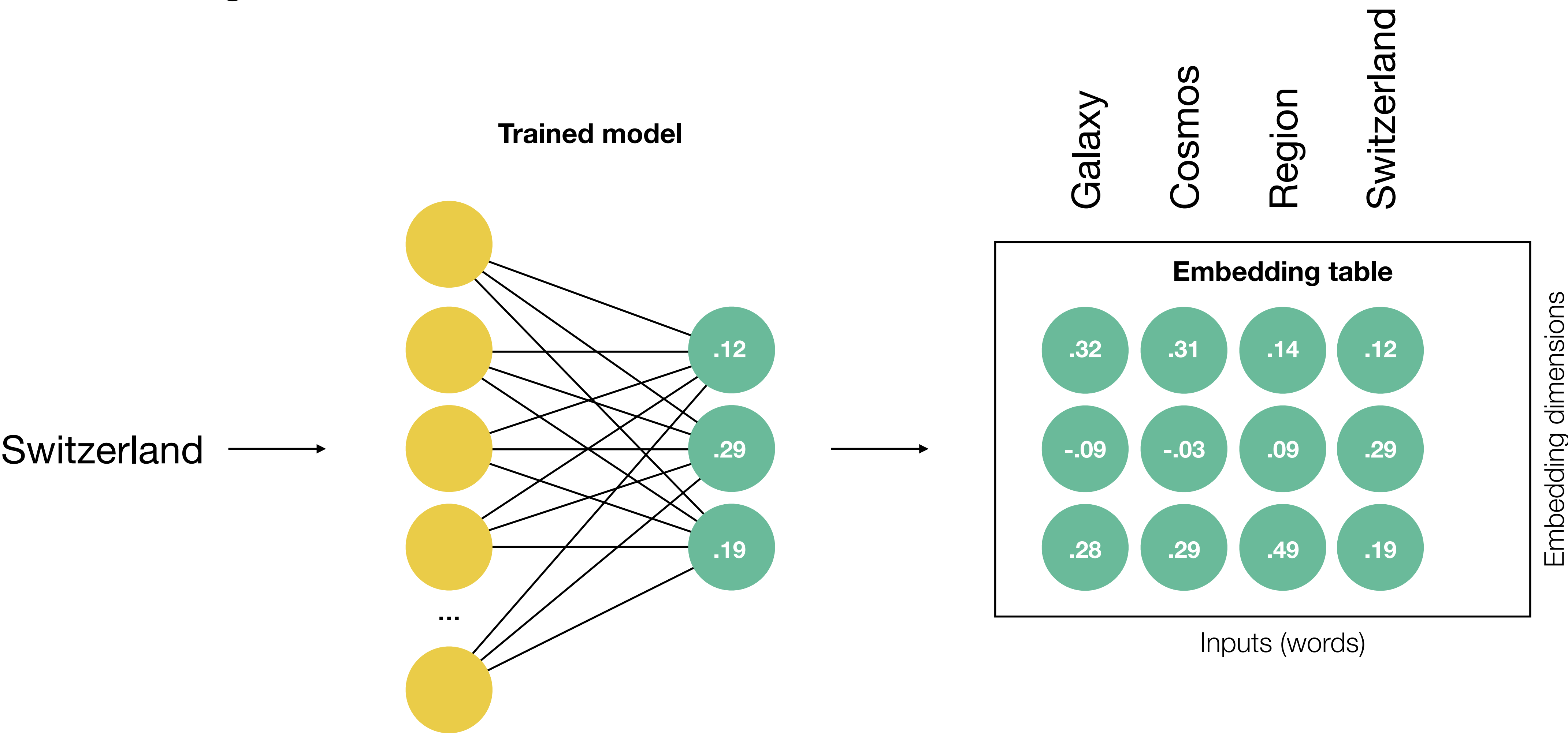
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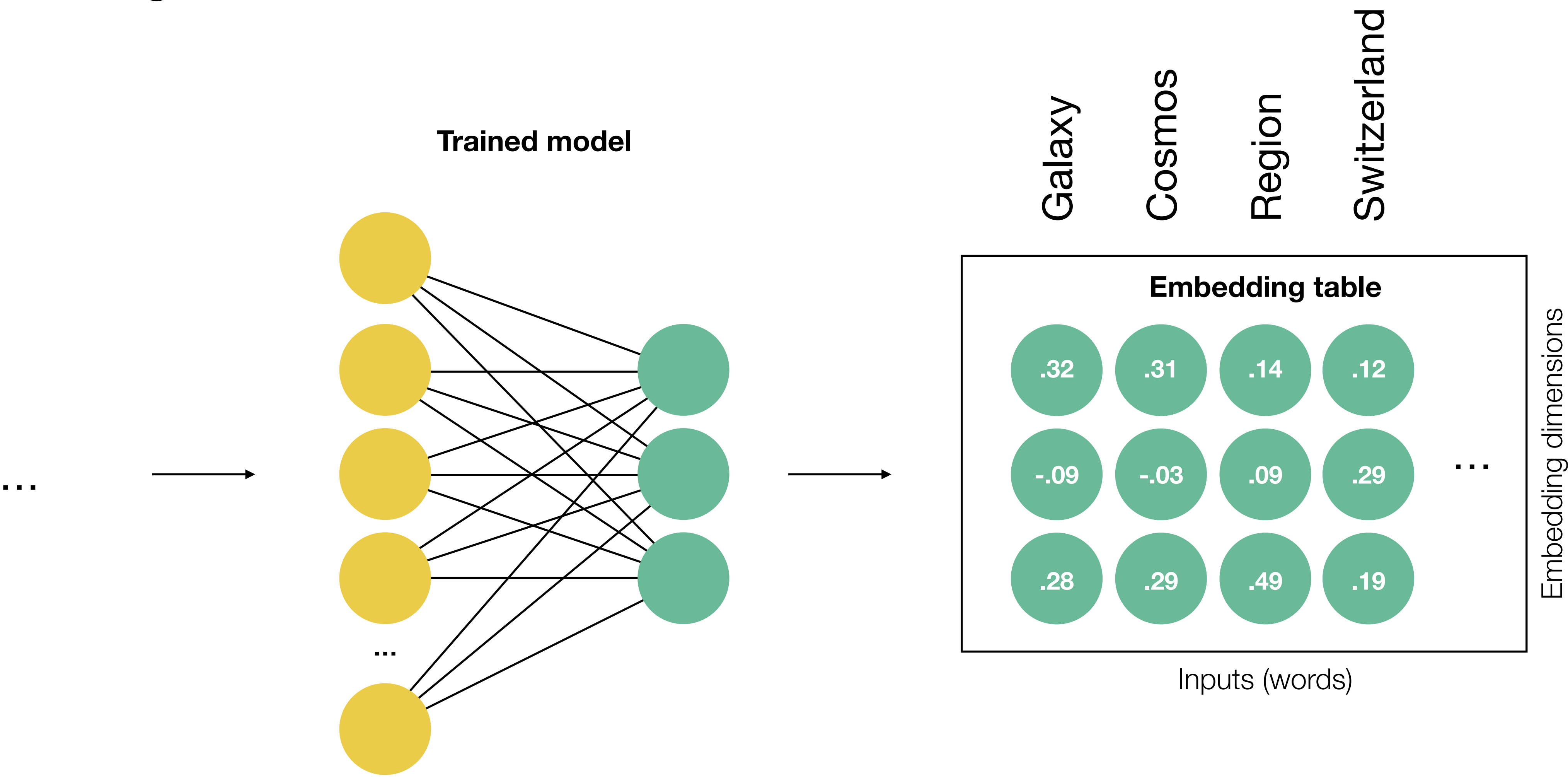
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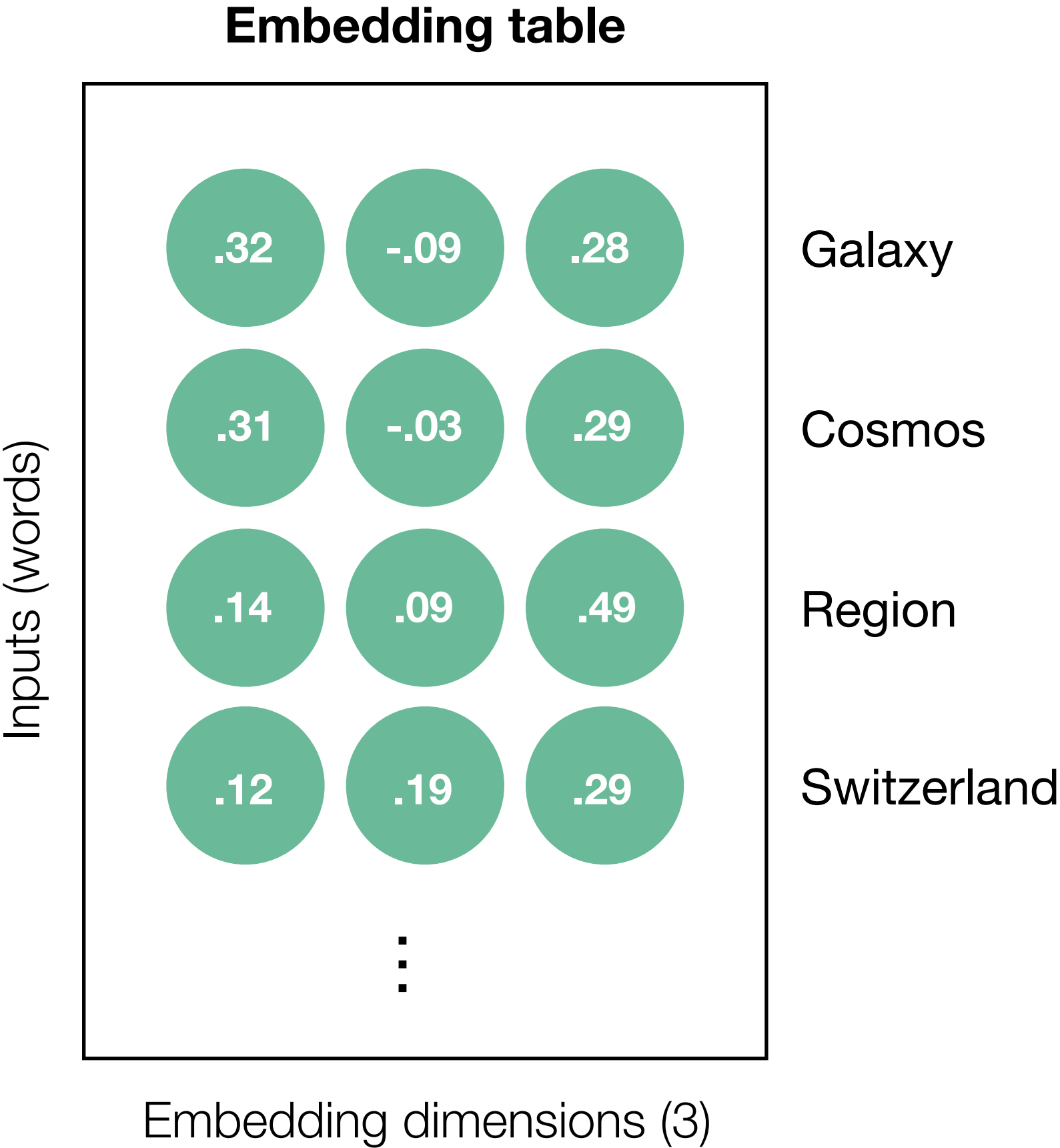
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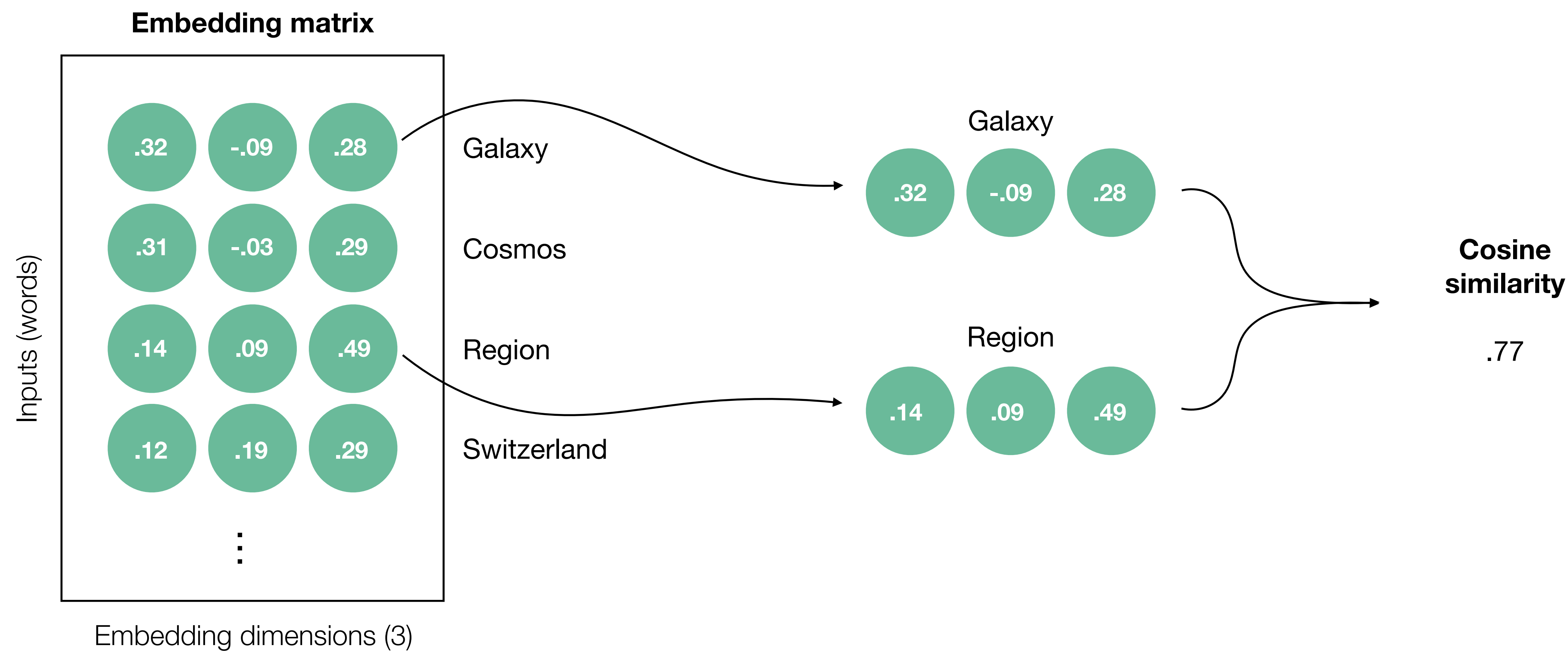
Comparing embeddings

Using cosine similarity



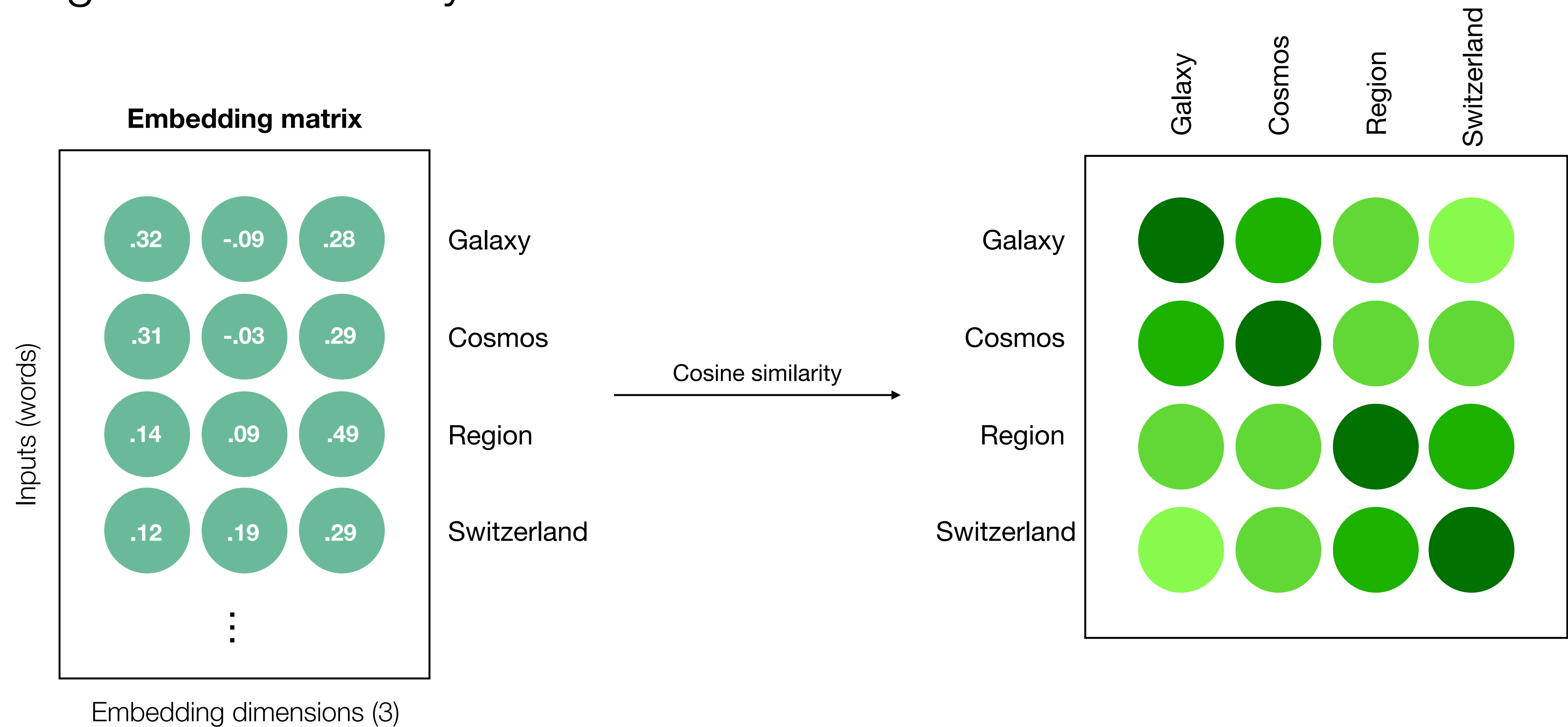
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Intro to feature extraction and embedding models 2

Dirk Wulff & Zak Hussain

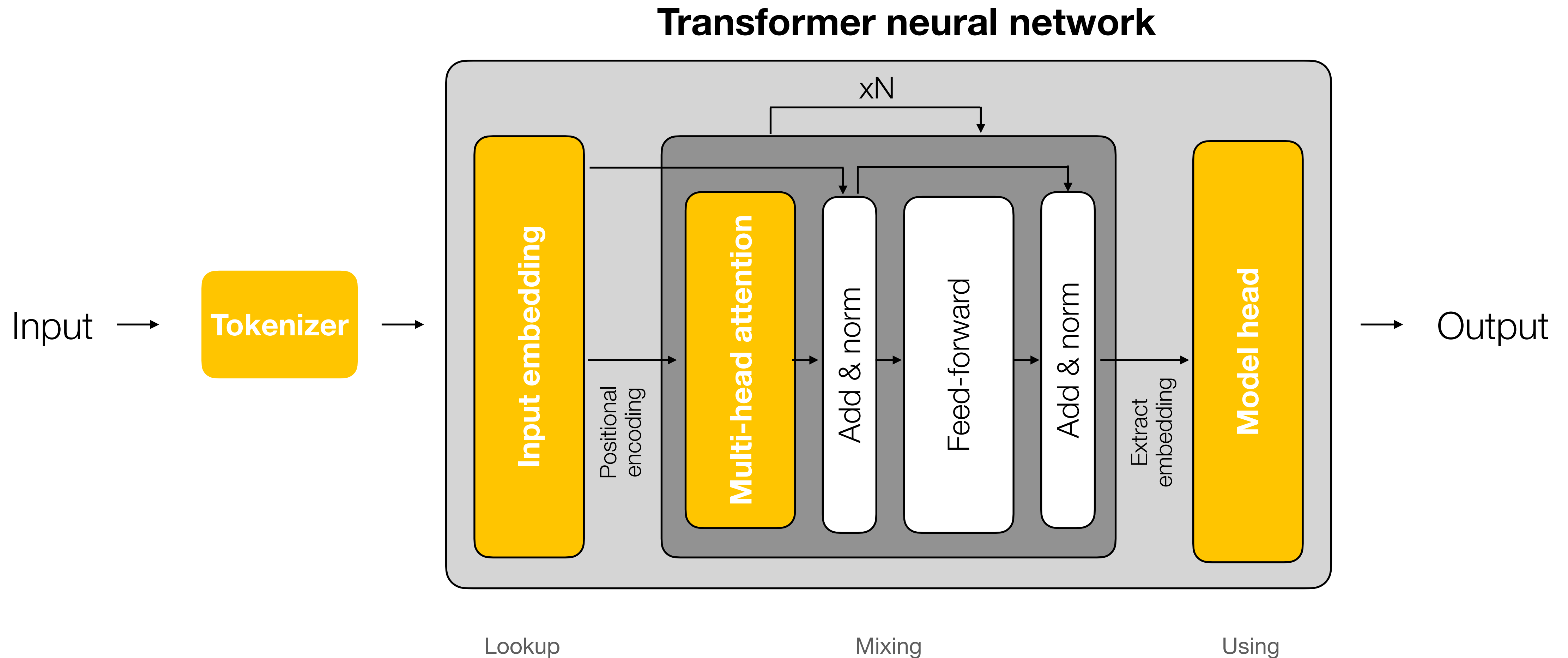


MAX PLANCK INSTITUTE
FOR HUMAN DEVELOPMENT



Transformer

Architecture



Transformer

Tokenization

Sentence

'This was it, the descent.'



Tokenizer



'[CLS]', 'this', 'was', 'it', ',', 'the', 'descent', '.', '[SEP]'

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Transformer

Tokenziation

Sentence

'...merging into a vague, purplish glimmer...'



Tokenizer



'merging', 'into', 'a', 'vague', ',', 'pu',
'##rp', '##lish', 'g', '##lim', '##mer'

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The capsule was shaken by a sudden jolt, then another. The whole vehicle began to vibrate. Filtered through the insulating layers of the outer skins, penetrating my pneumatic cocoon, the vibration reached me, and ran through my entire body. The image of the dial shivered and multiplied, and its phosphorescence spread out in all directions. I felt no fear. I had not undertaken this long voyage only to overshoot my target!

I called into the microphone:

"Station Solaris! Station Solaris! Station Solaris! I think I am leaving the flight-path, correct my course! Station Solaris, this is the Prometheus capsule. Over."

I had missed the precious moment when the planet first came into view. Now it was spread out before my eyes; flat, and already immense. Nevertheless, from the appearance of its surface, I judged that I was still at a great height above it, since I had passed that imperceptible frontier after which we measure the distance that separates us from a celestial body in terms of altitude. I was falling. Now I had the sensation of falling, even with my eyes closed. (I quickly reopened them: I did not want to miss anything there was to be seen.)

Transformer

Tokenziation

Sentence

'you've won 202000 Eur'



Tokenizer



'[CLS]', 'you', "'", 've', 'won', '2020', '##00',
'eu', '##r', '[SEP]'

"You're on your way, Kelvin. Good luck!" Moddard's voice sounded as close as before.

A wide slit opened at eye-level, and I could see the stars. The Prometheus was orbiting in the region of Alpha in Aquarius and I tried in vain to orient myself; a glittering dust filled my porthole. I could not recognize a single constellation; in this region of the galaxy the sky was unfamiliar to me. I waited for the moment when I would pass near the first distinct star, but I was unable to isolate any one of them. Their brightness was fading; they receded, merging into a vague, purplish glimmer, the sole indication of the distance I had already travelled. My body rigid, sealed in its pneumatic envelope, I was knifing through space with the impression of standing still in the void, my only distraction the steadily mounting heat.

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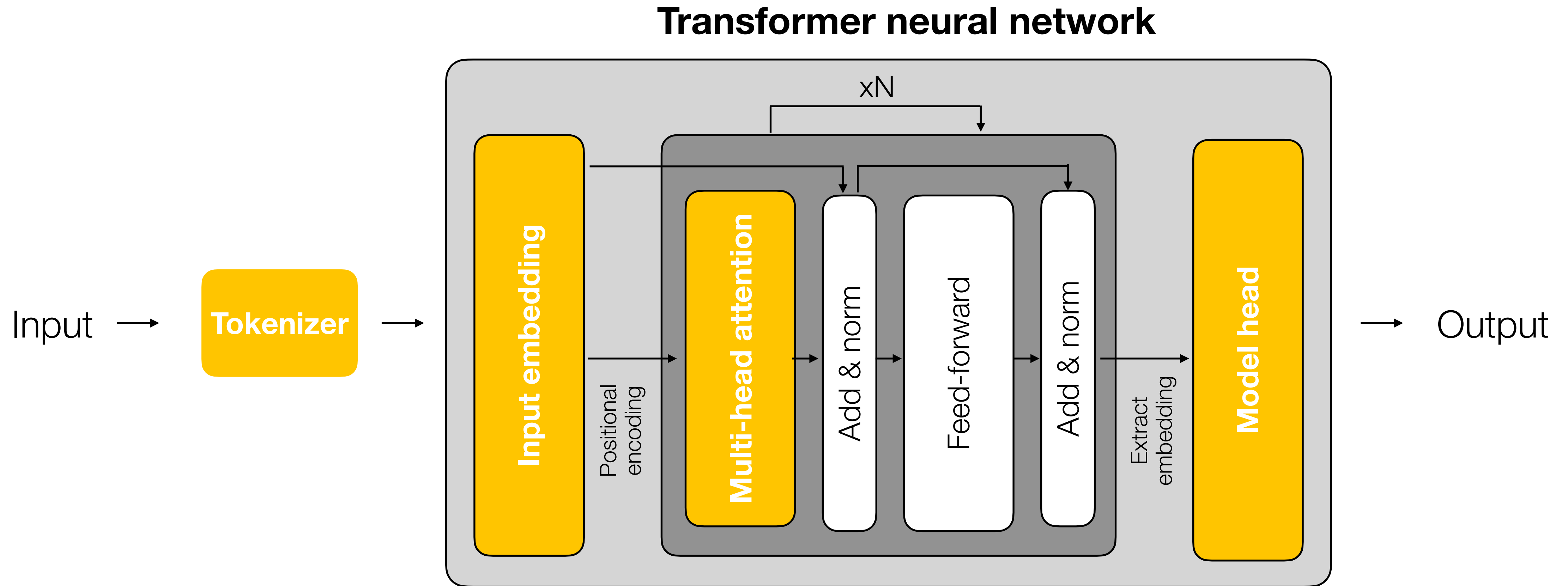
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"Station Solaris! Station Solaris! Station Solaris! I think I am leaving the flight-path, correct my course! Station Solaris, this is the Prometheus capsule. Over."

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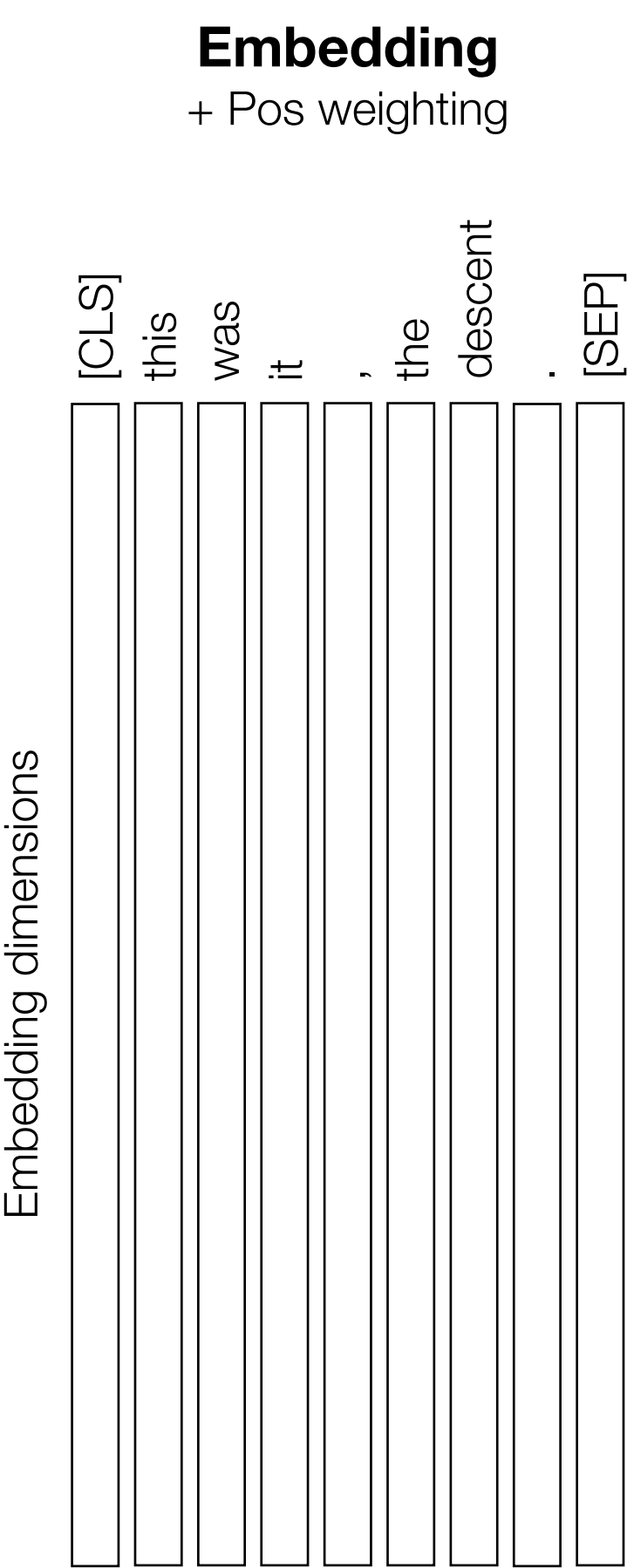
Transformer

Architecture



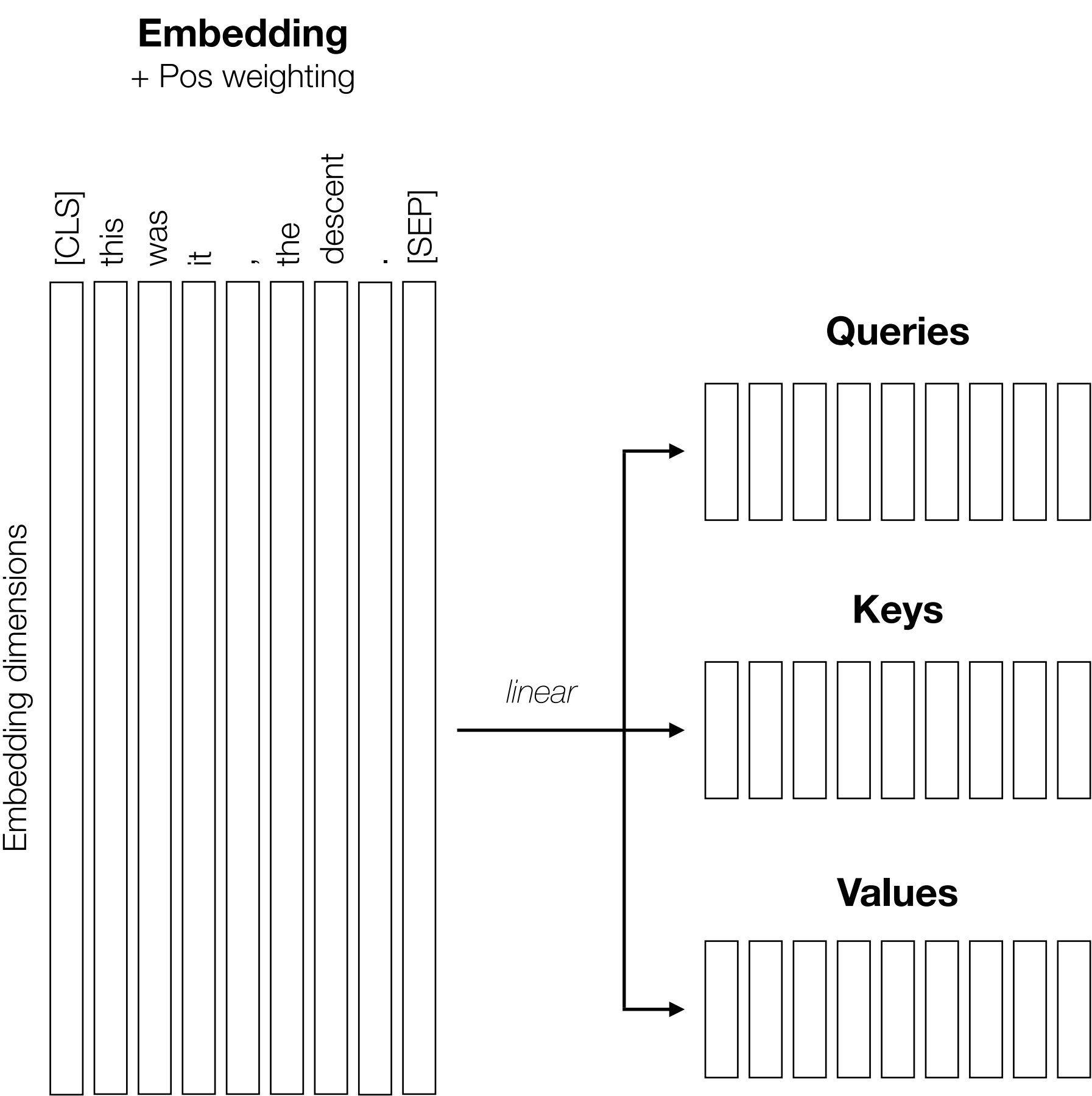
Transformer

Input embeddings



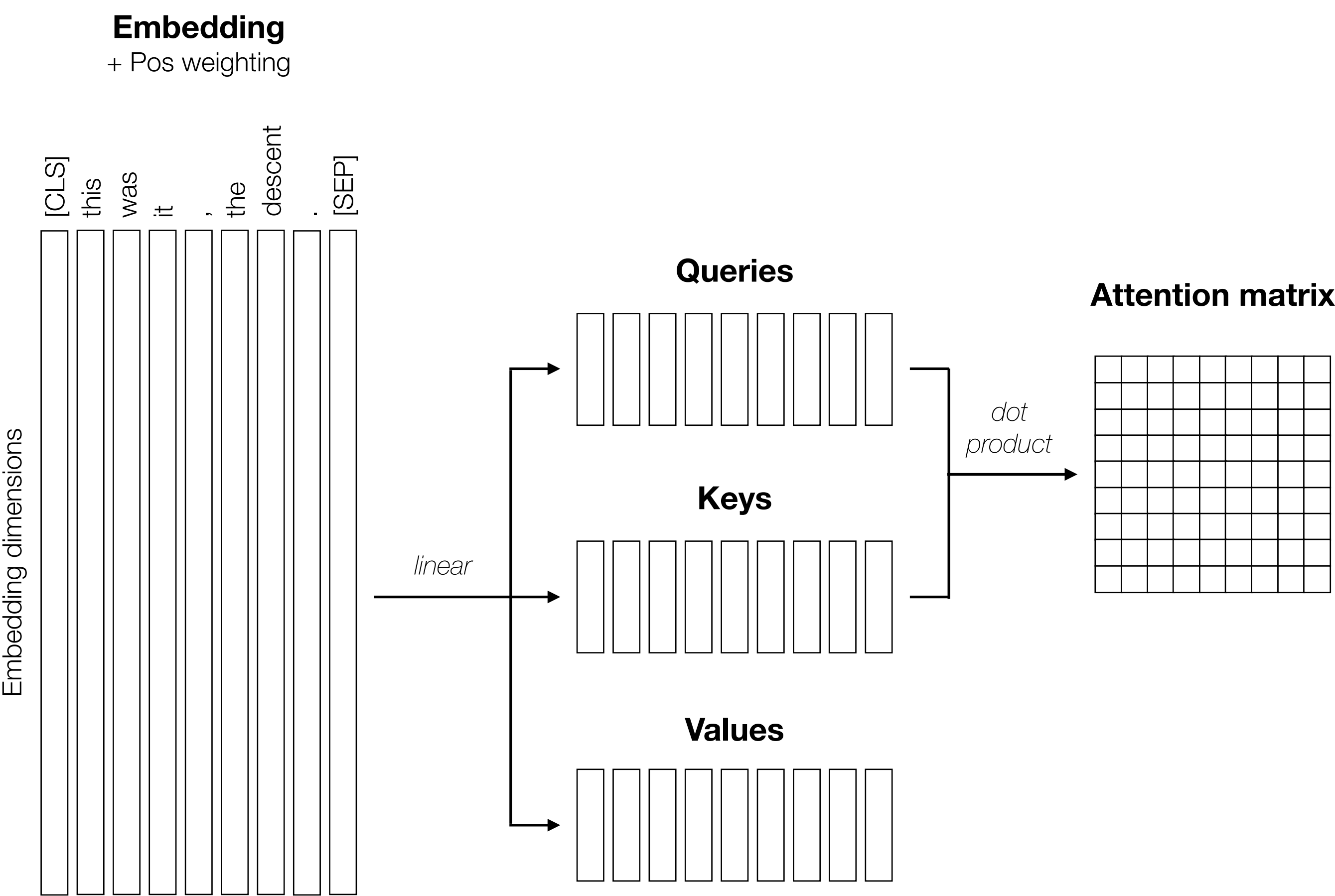
Transformer

Attention



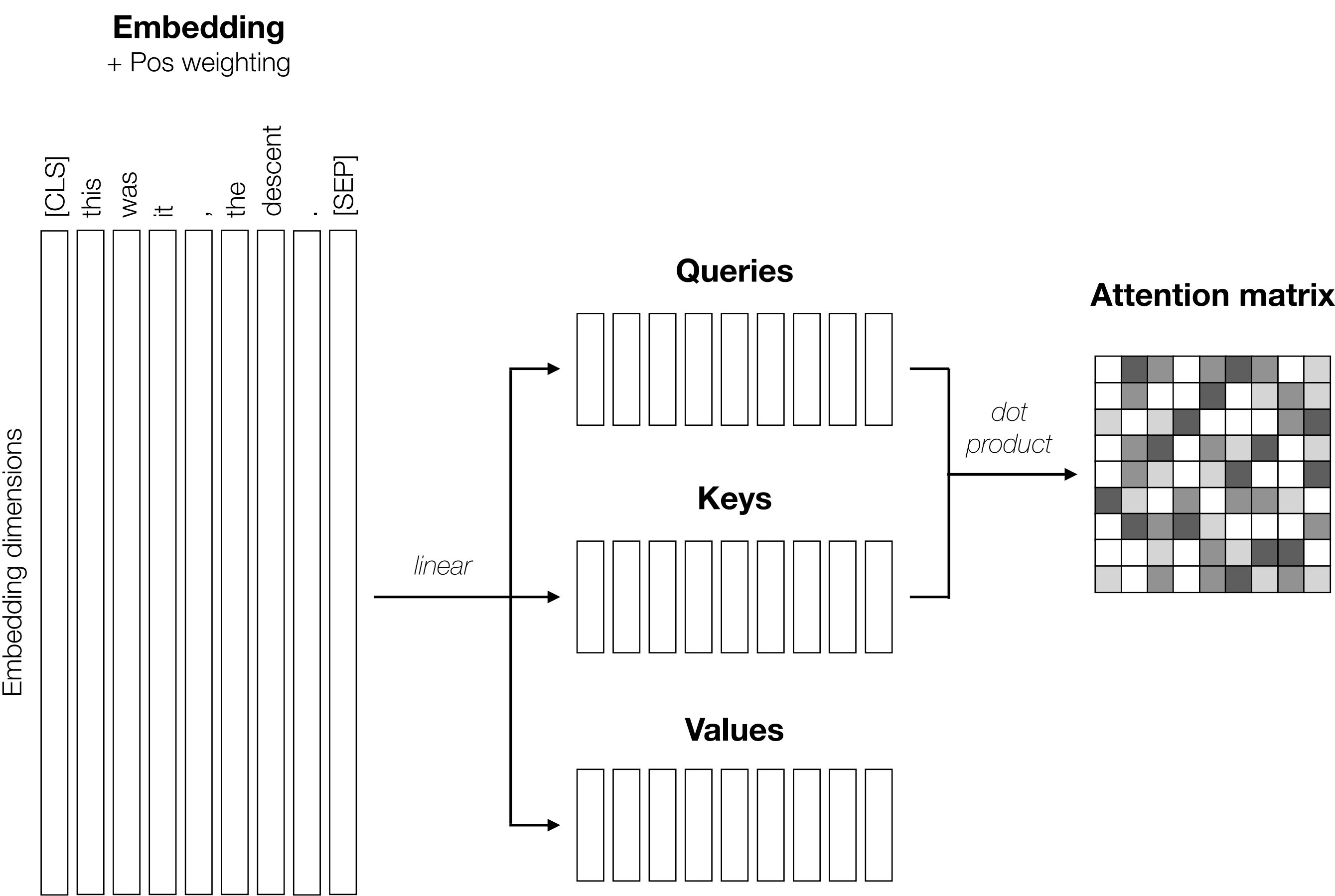
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Attention



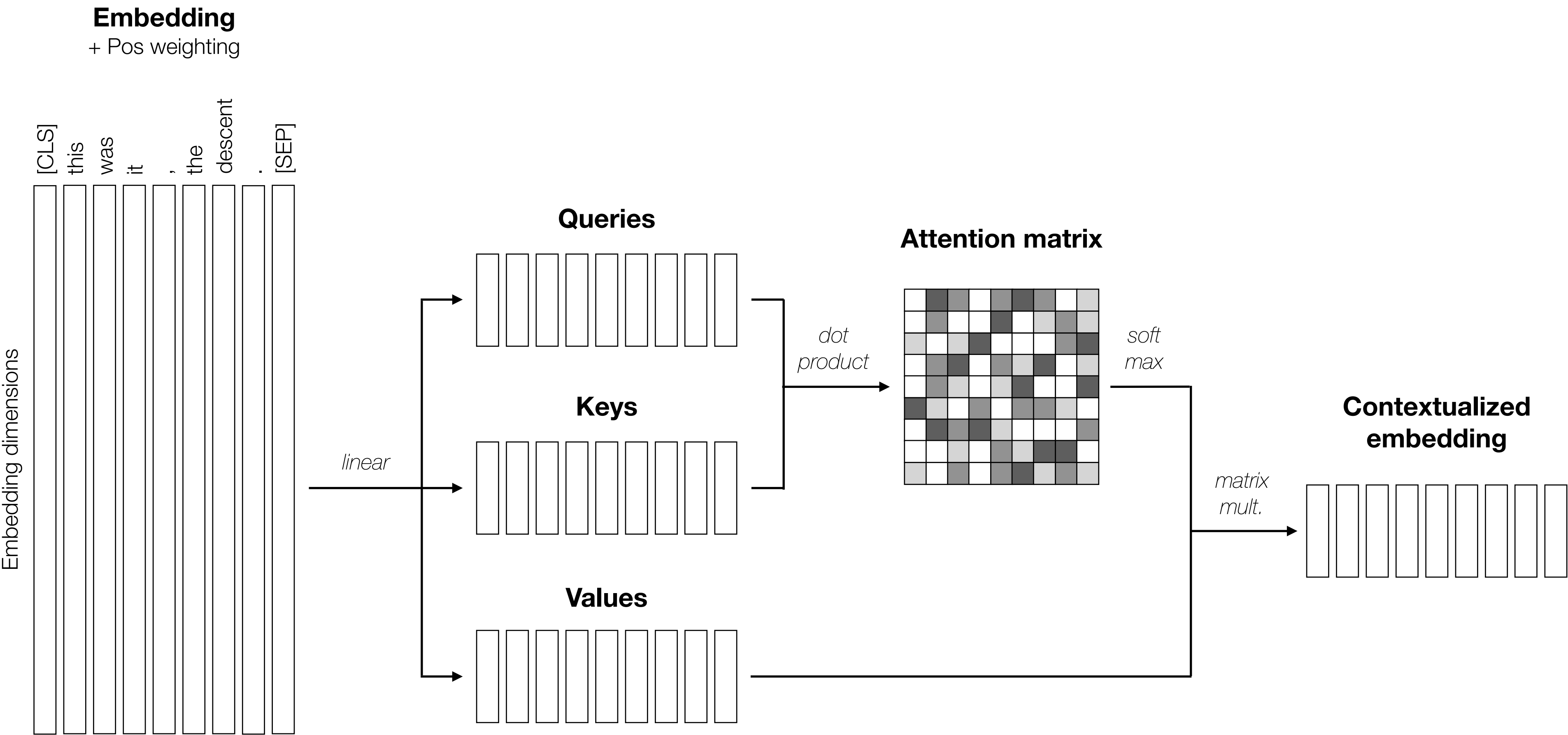
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Attention



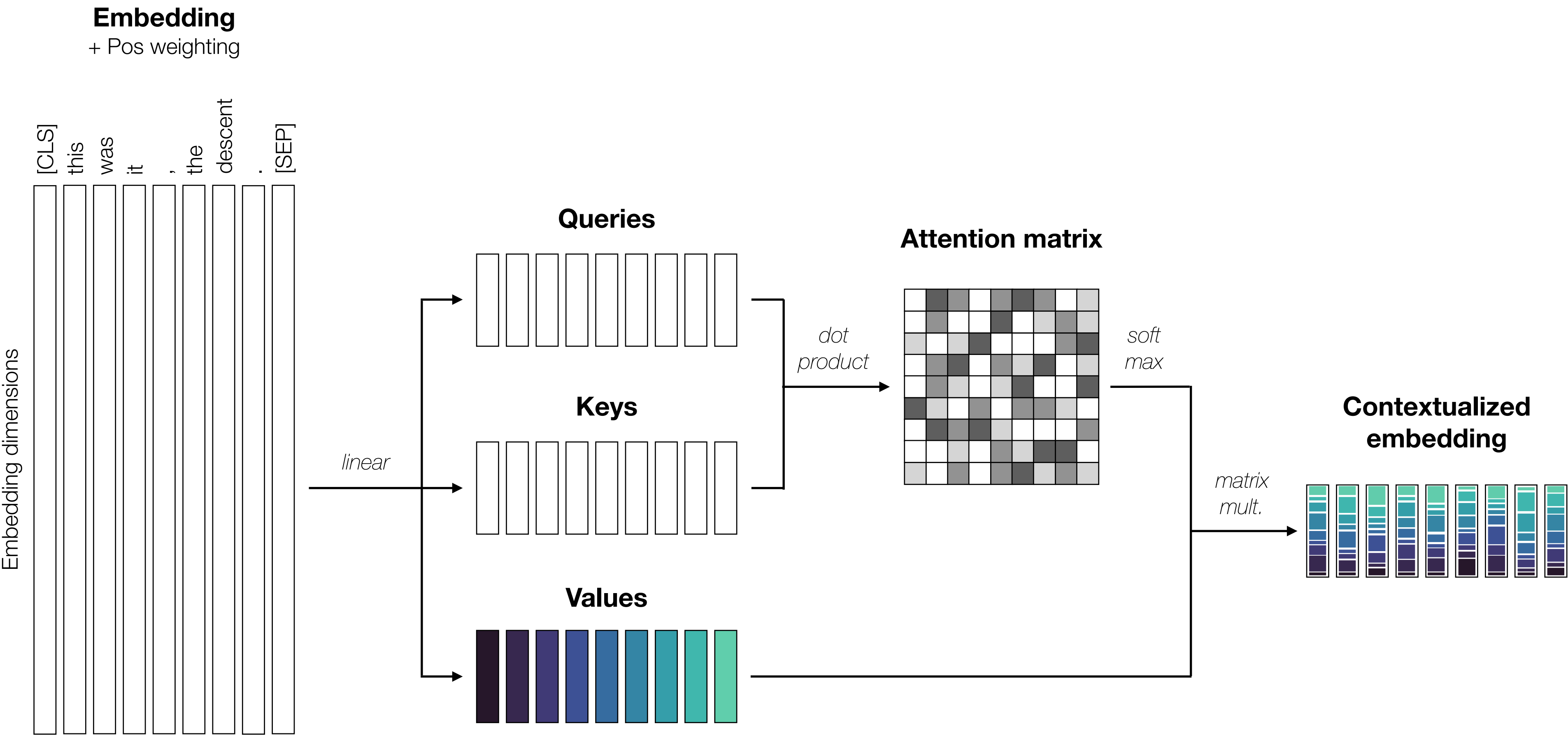
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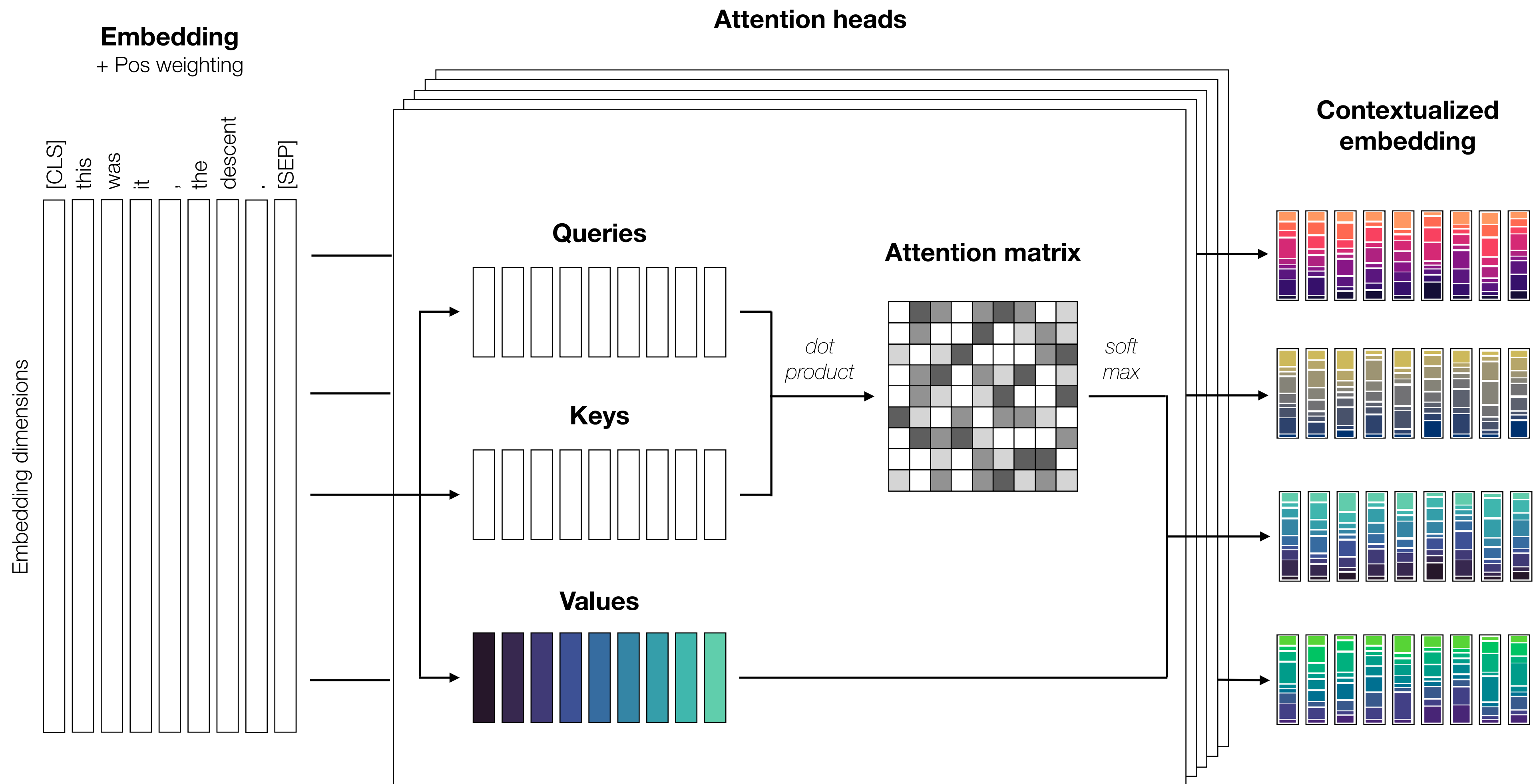
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Attention



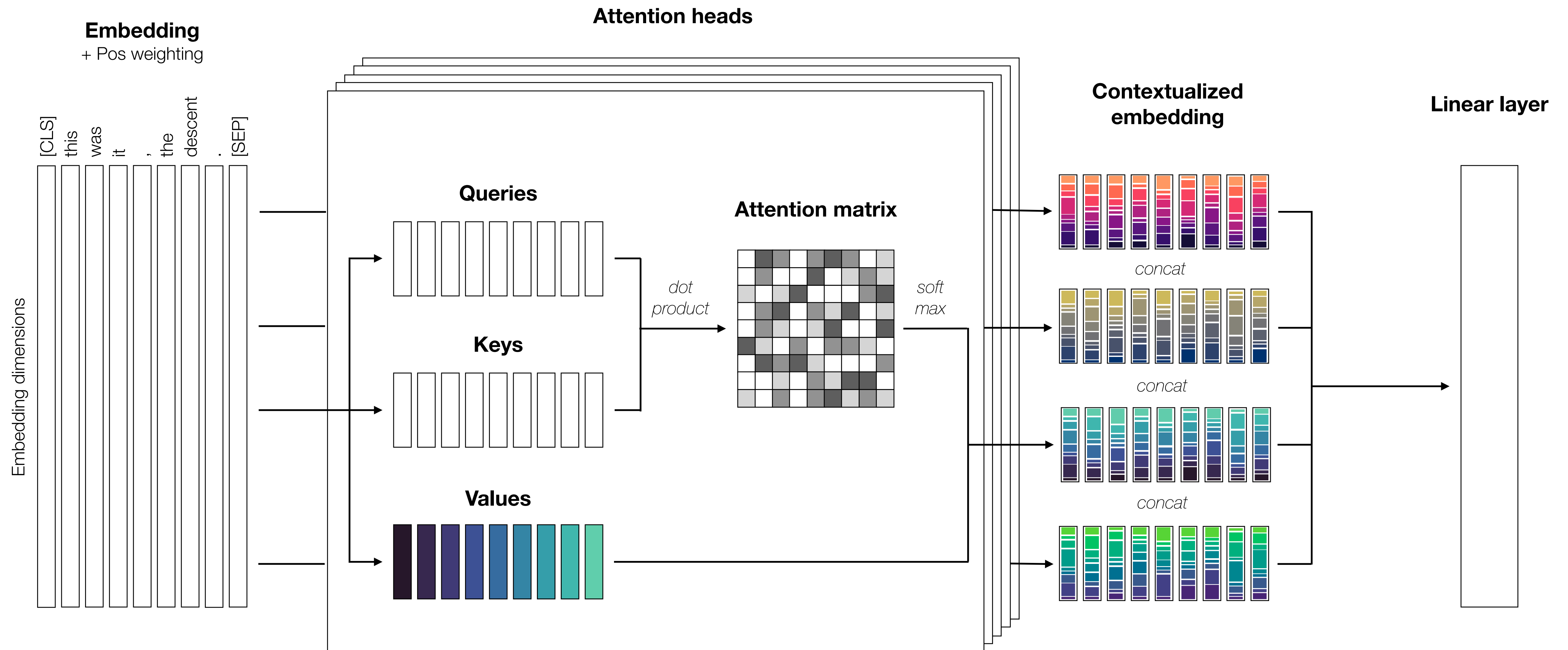
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Attention



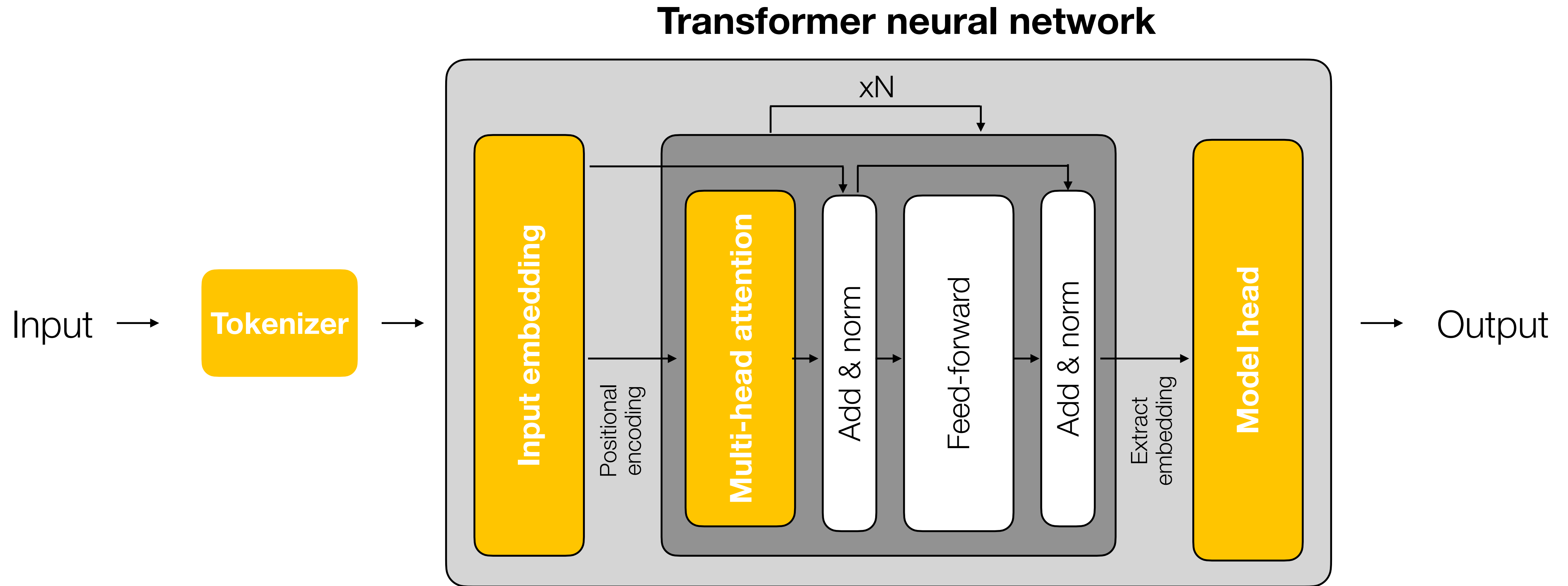
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Attention



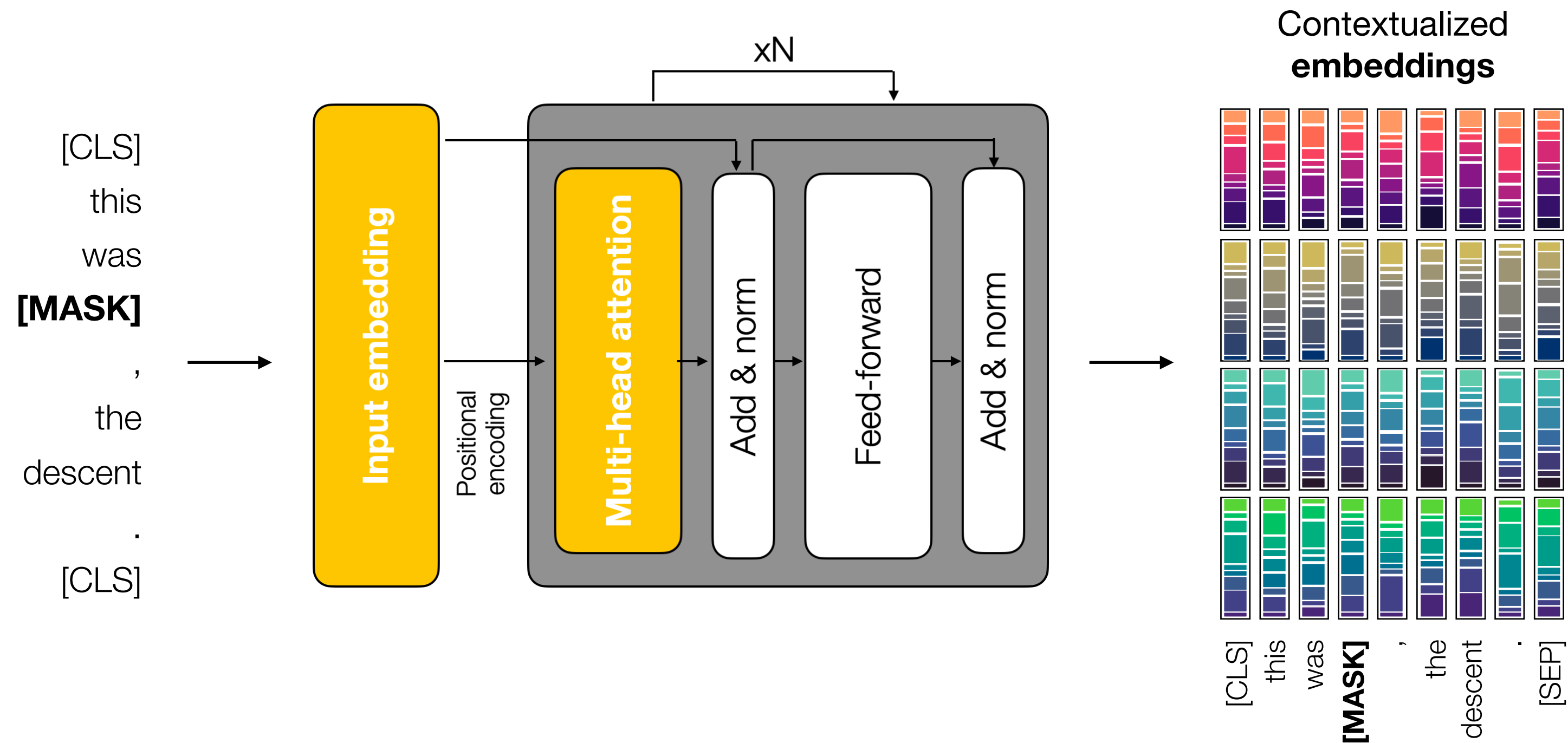
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Architecture



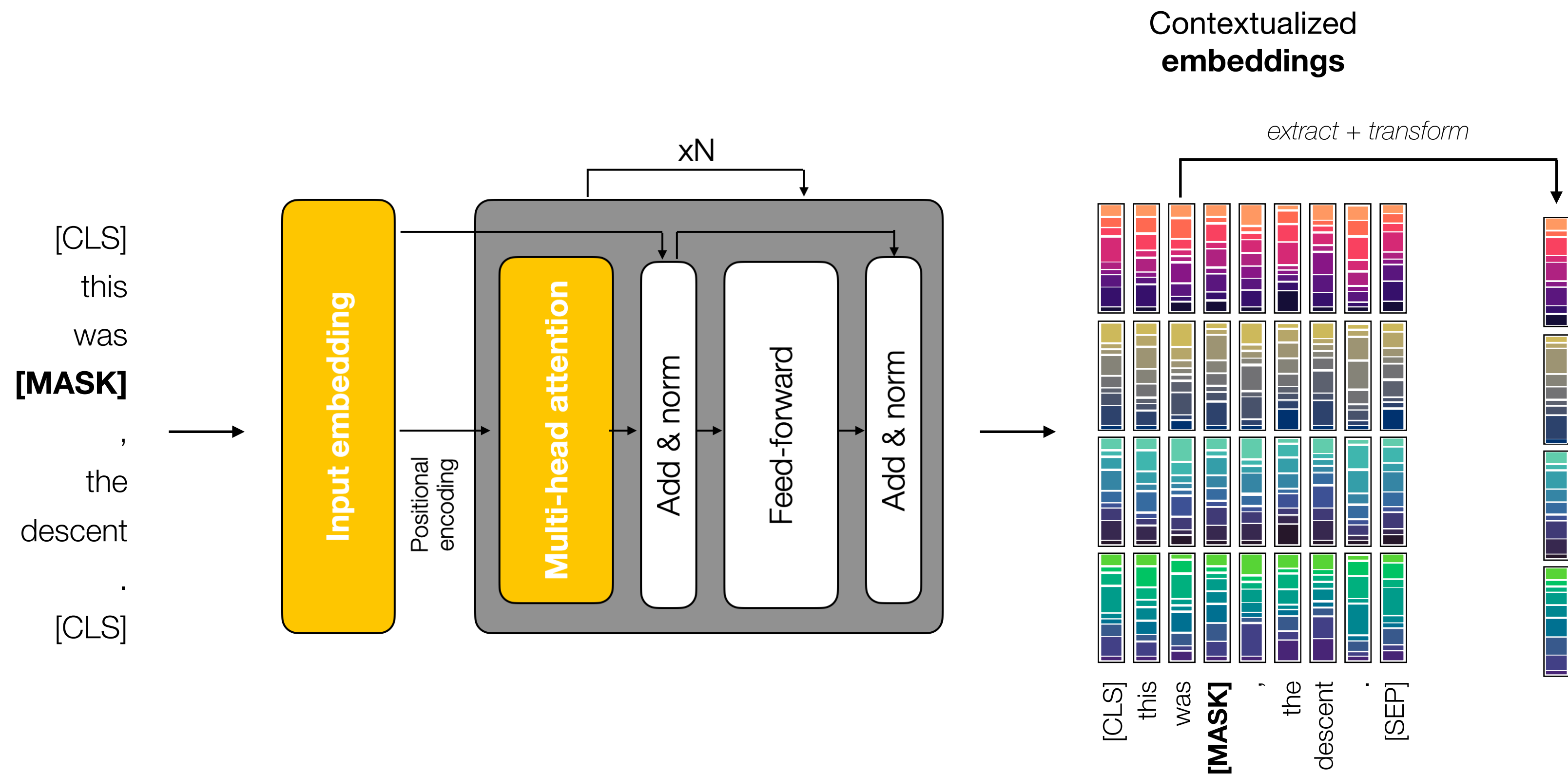
Transformer

Model head for **masked language modeling**



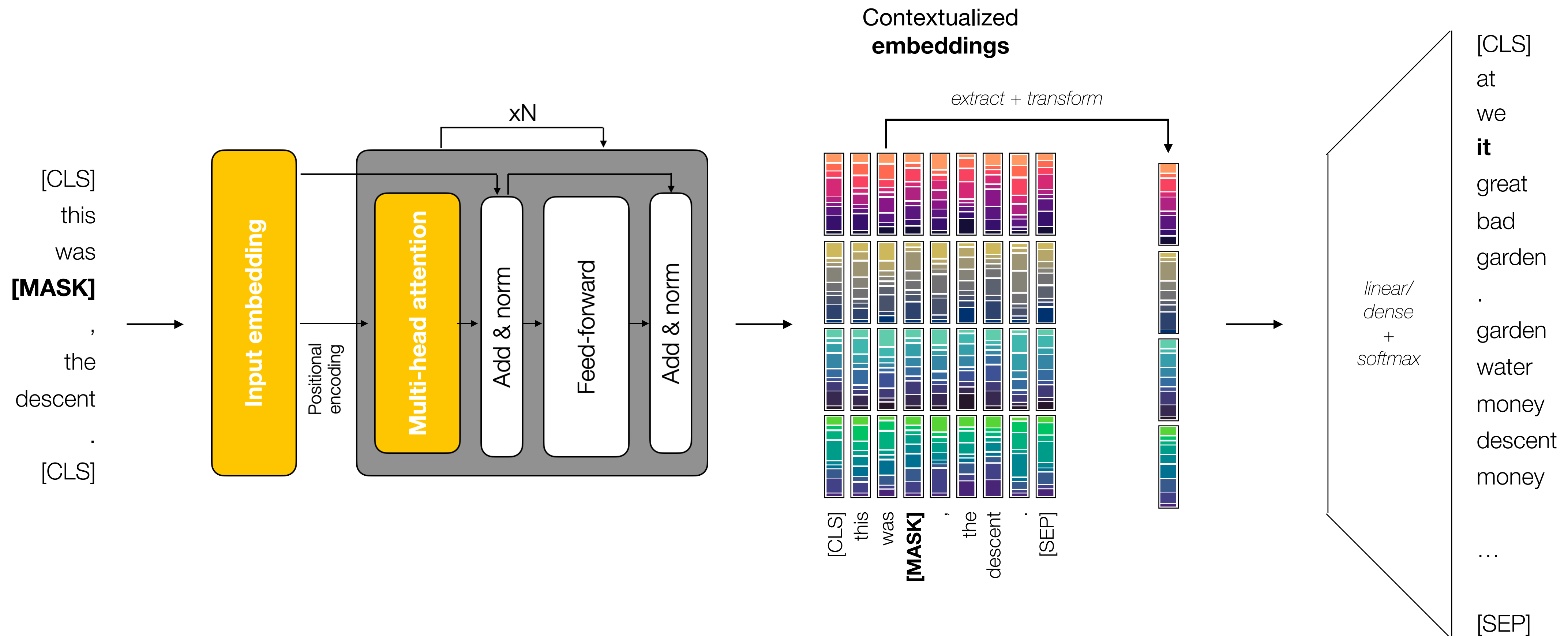
Transformer

Model head for **masked language modeling**



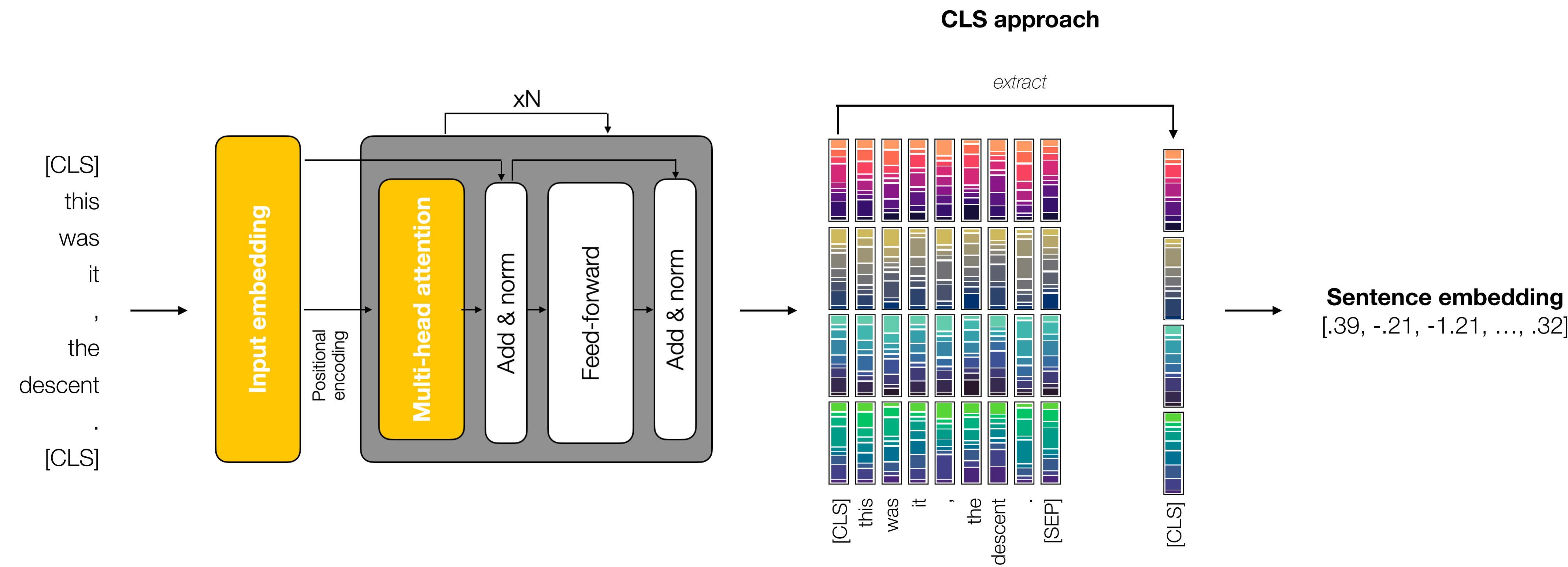
Transformer

Model head for masked language modeling



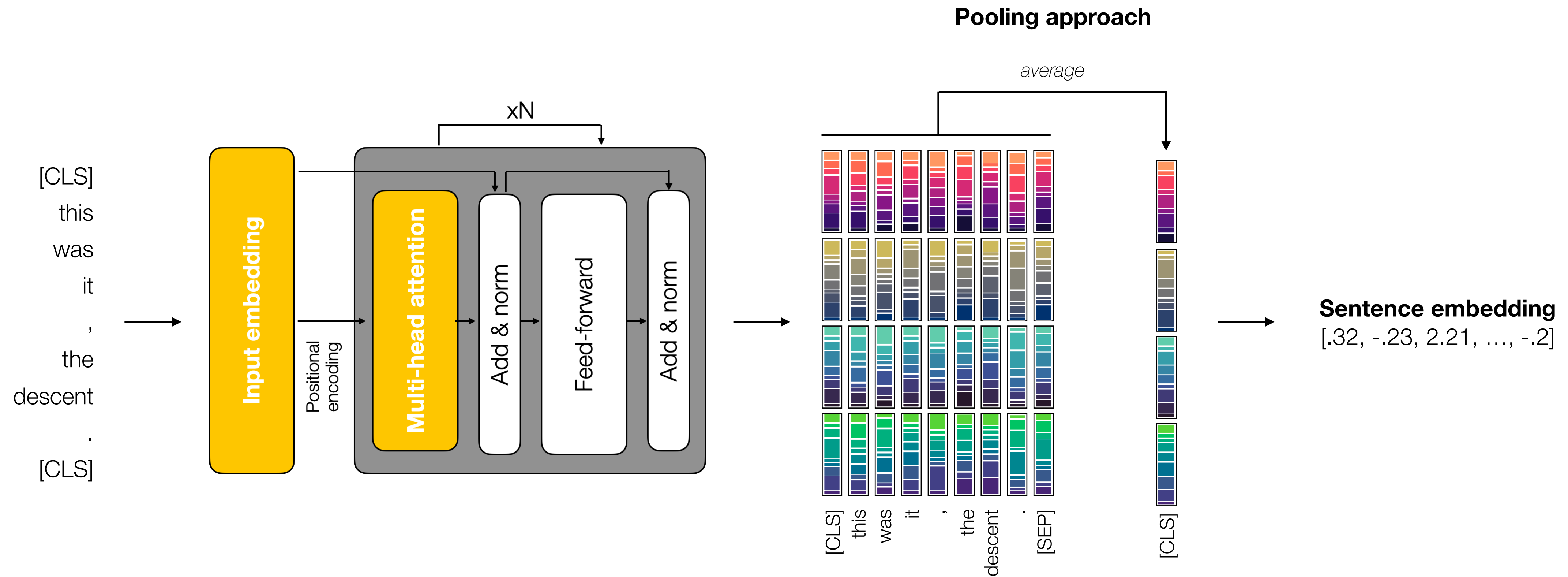
Feature extraction

to generate sentence embeddings



Feature extraction

to generate sentence embeddings



Exercise

Using **feature extraction** to analyze personality survey items

factor	construct	item
Openness	Emotionality	Enjoy examining myself and my life.
Neuroticism	Immoderation	Do things I later regret.
Openness	Liberalism	Tend to vote for liberal political candidates.
Conscientiousness	Orderliness	Like to tidy up.
Conscientiousness	Achievement-Striving	Plunge into tasks with all my heart.
Neuroticism	Anger	Seldom get mad.
Conscientiousness	Achievement-Striving	Demand quality.
Agreeableness	Trust	Believe that others have good intentions.
Neuroticism	Self-consciousness	Only feel comfortable with friends.
Agreeableness	Morality	Would never cheat on my taxes.
Openness	Aesthetic Appreciation/Artistic Interests	Do not enjoy going to art museums.
Neuroticism	Anxiety	Worry about things.
Conscientiousness	Achievement-Striving	Do just enough work to get by.
Neuroticism	Immoderation	Love to eat.
Agreeableness	Altruism	Have a good word for everyone.
Agreeableness	Modesty/Humility	Dislike talking about myself.
Conscientiousness	Self-Discipline	Am always prepared.
Conscientiousness	Dutifulness	Tell the truth.