



Fundamentals of Deep Learning

Part 6: Advanced Architectures



Agenda

- Part 1: An Introduction to Deep Learning
- Part 2: How a Neural Network Trains
- Part 3: Convolutional Neural Networks
- Part 4: Data Augmentation and Deployment
- Part 5: Pre-Trained Models
- Part 6: Advanced Architectures



A close-up photograph of a green notebook with horizontal ruling lines. The notebook has a dark green cover visible along the right edge. The pages are white with light blue horizontal lines and vertical red margin lines. The text is positioned in the upper left corner of the first page.

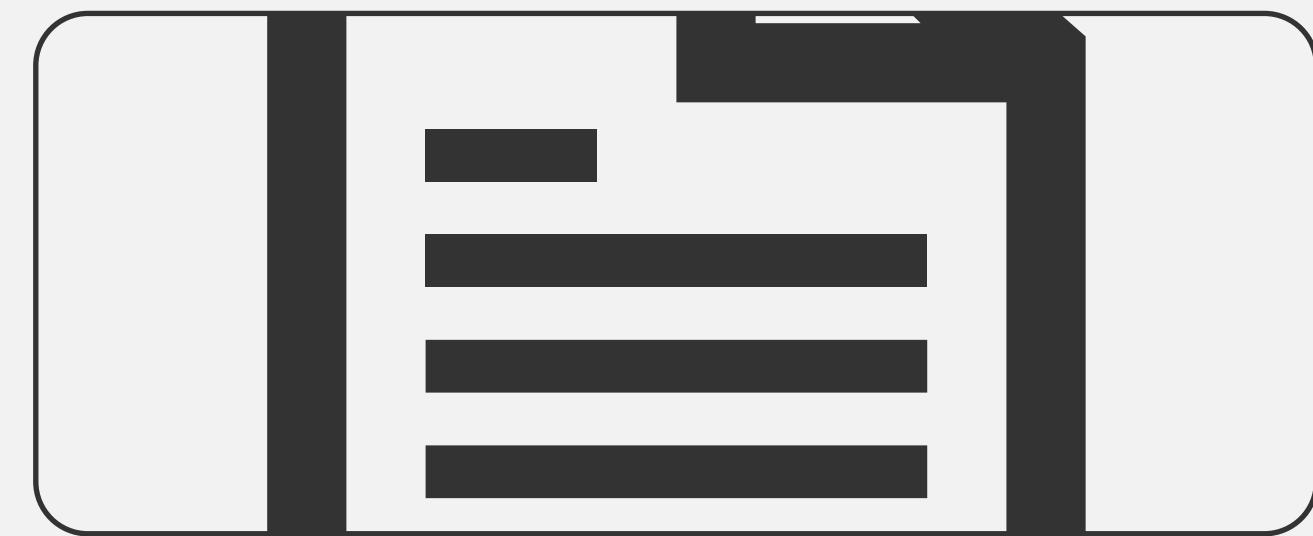
Moving Forward

Fields of AI



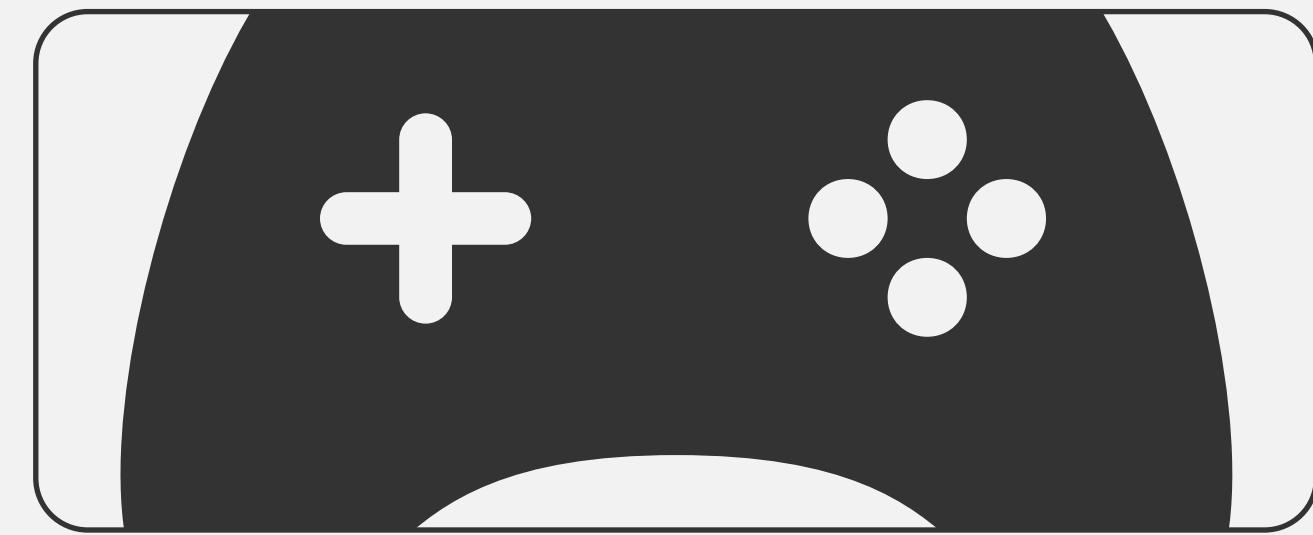
Computer Vision

- Optometry



Natural Language Processing

- Linguistics



Reinforcement Learning

- Game Theory
- Psychology



Anomaly Detection

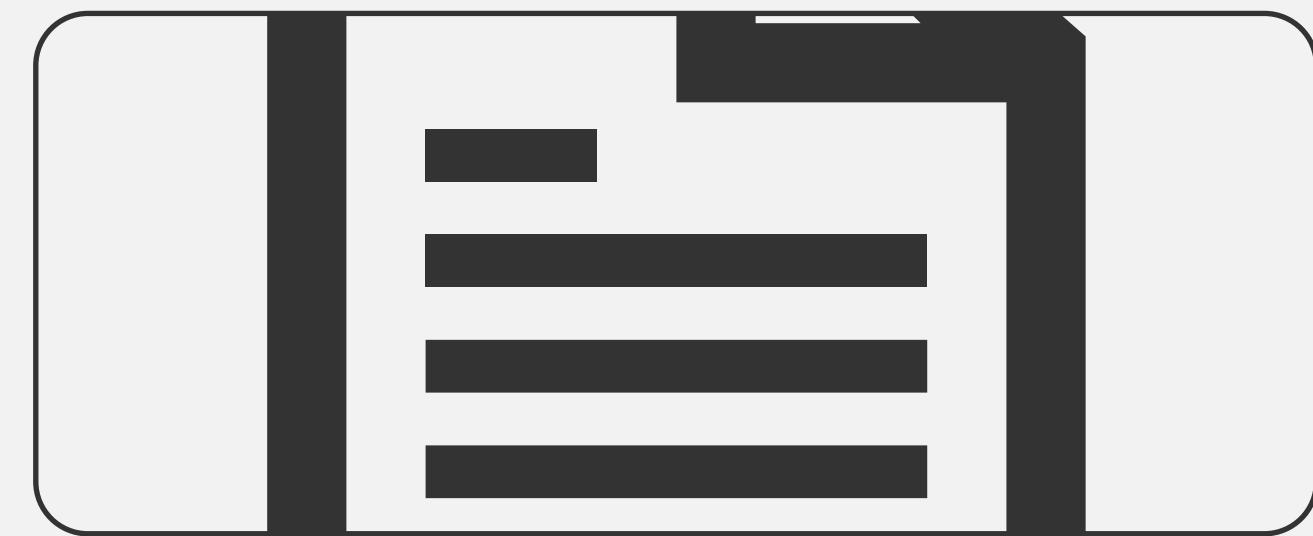
- Security
- Medicine

Fields of AI



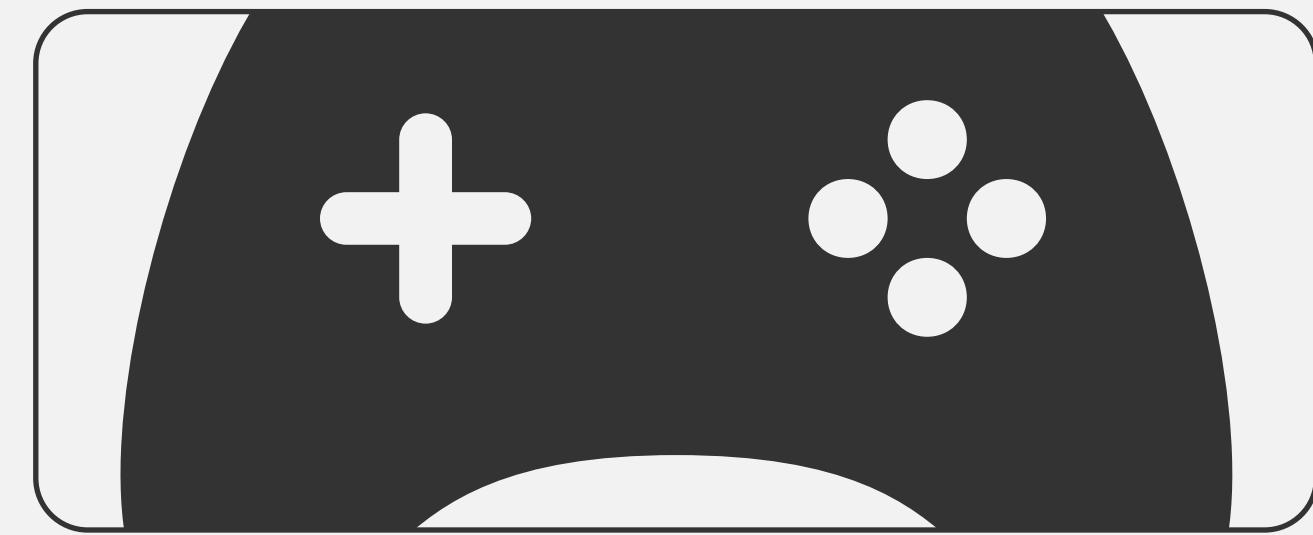
Computer Vision

- Optometry



Natural Language Processing

- Linguistics



Reinforcement Learning

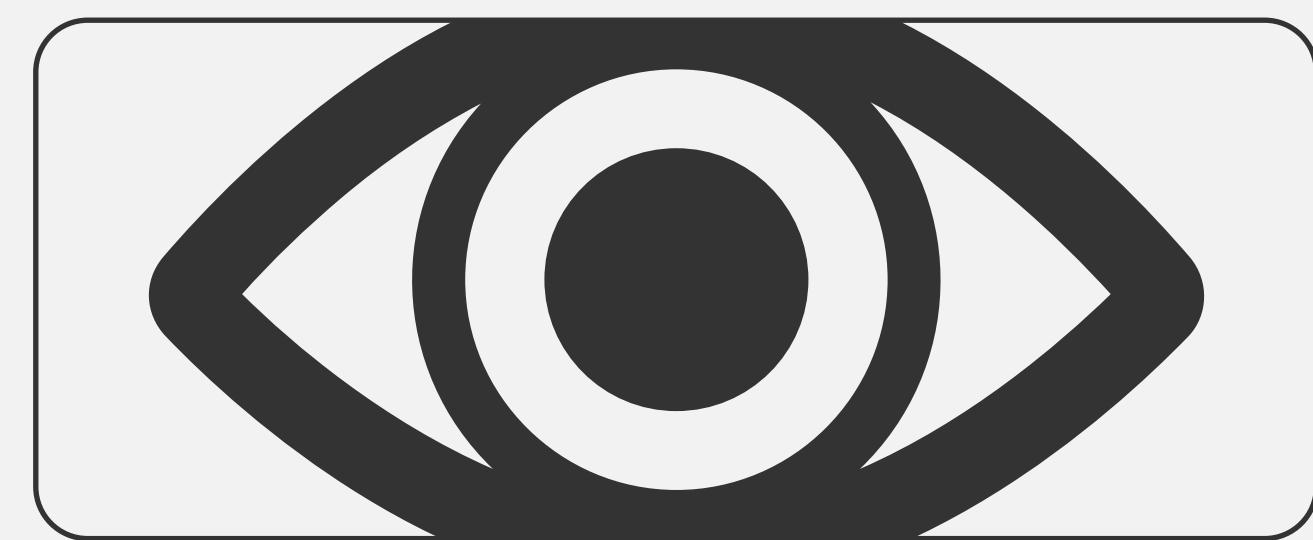
- Game Theory
- Psychology



Anomaly Detection

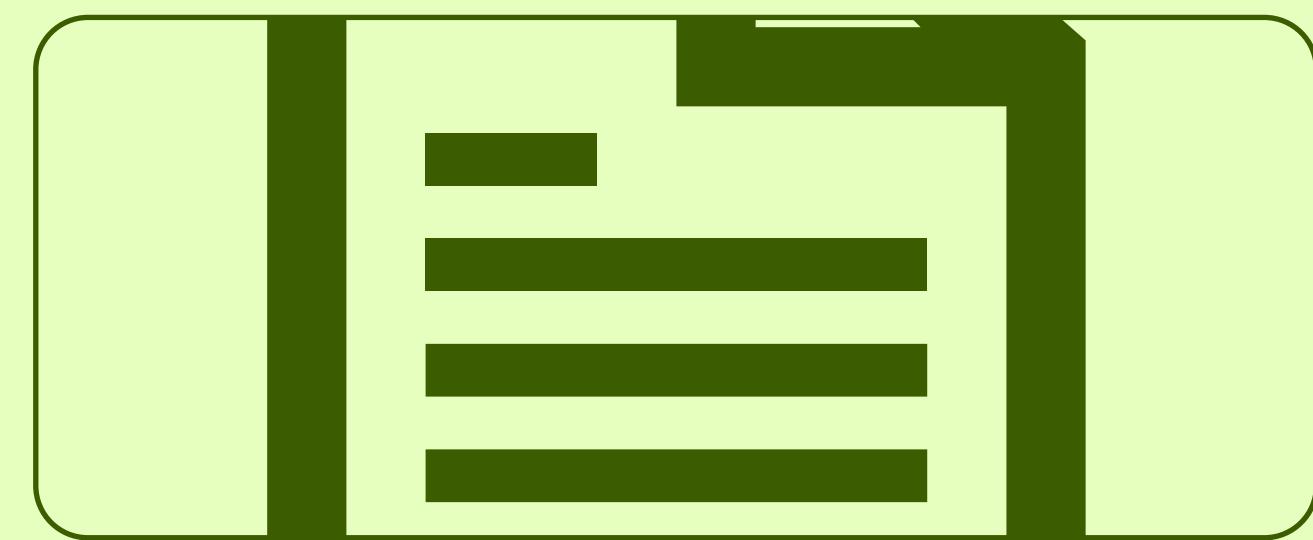
- Security
- Medicine

Fields of AI



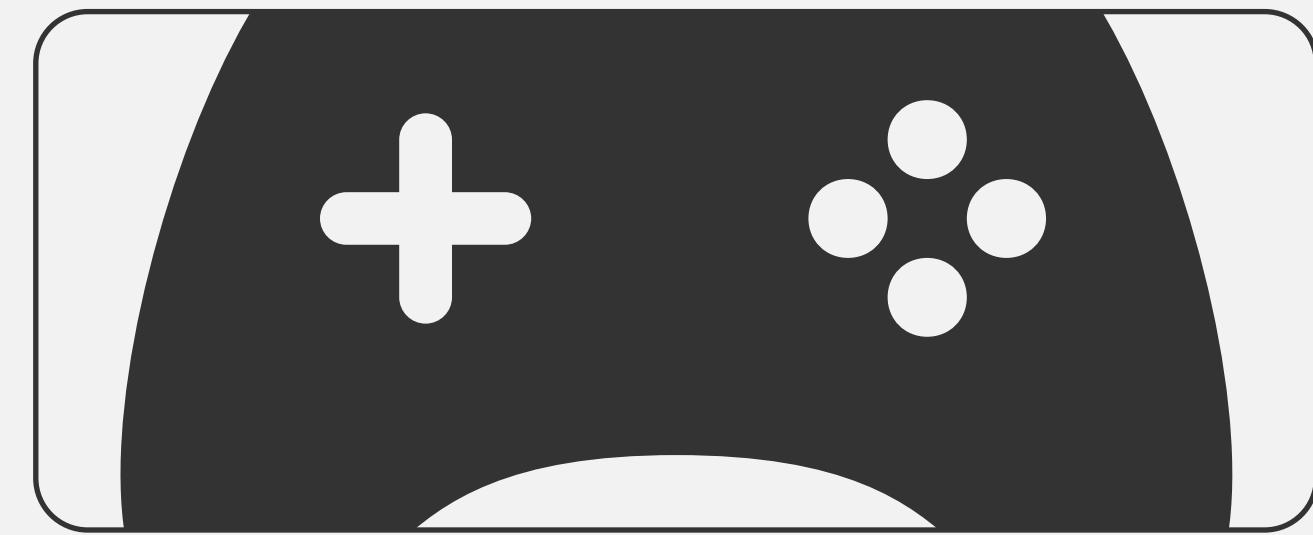
Computer Vision

- Optometry



Natural Language Processing

- Linguistics



Reinforcement Learning

- Game Theory
- Psychology



Anomaly Detection

- Security
- Medicine

Natural Language Processing

From Words to Numbers

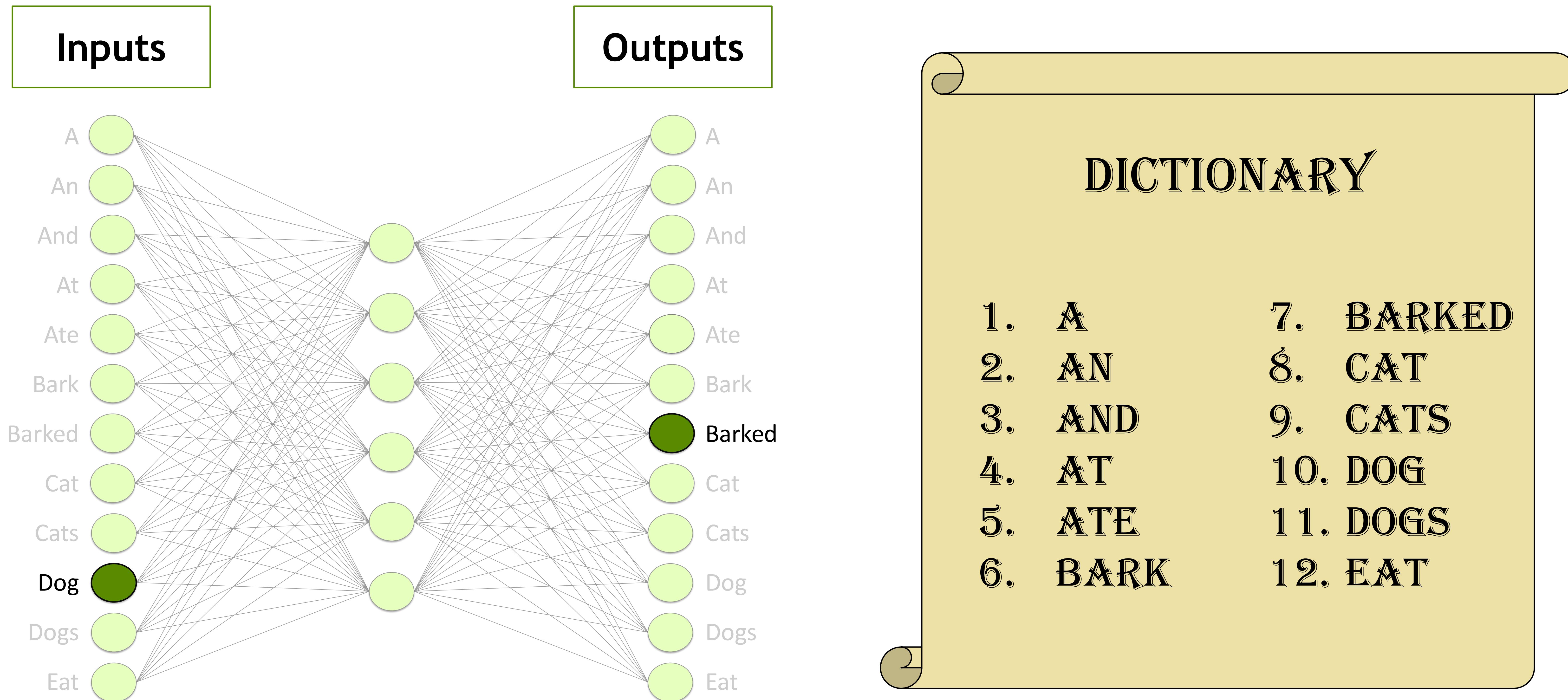
“A dog barked at a cat.”

[1, 10, 7, 4, 1, 8]

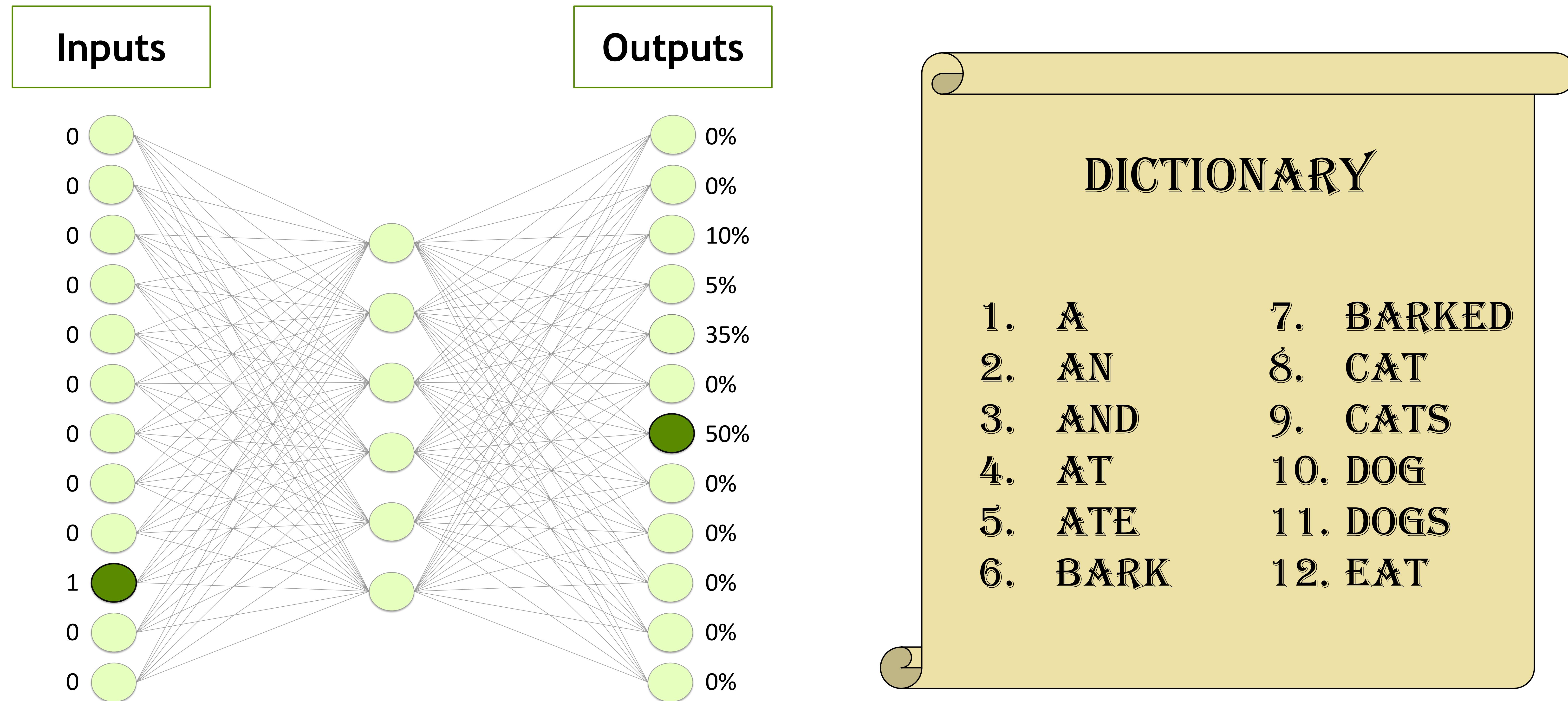
DICTIONARY

1. A	7. BARKED
2. AN	8. CAT
3. AND	9. CATS
4. AT	10. DOG
5. ATE	11. DOGS
6. BARK	12. EAT

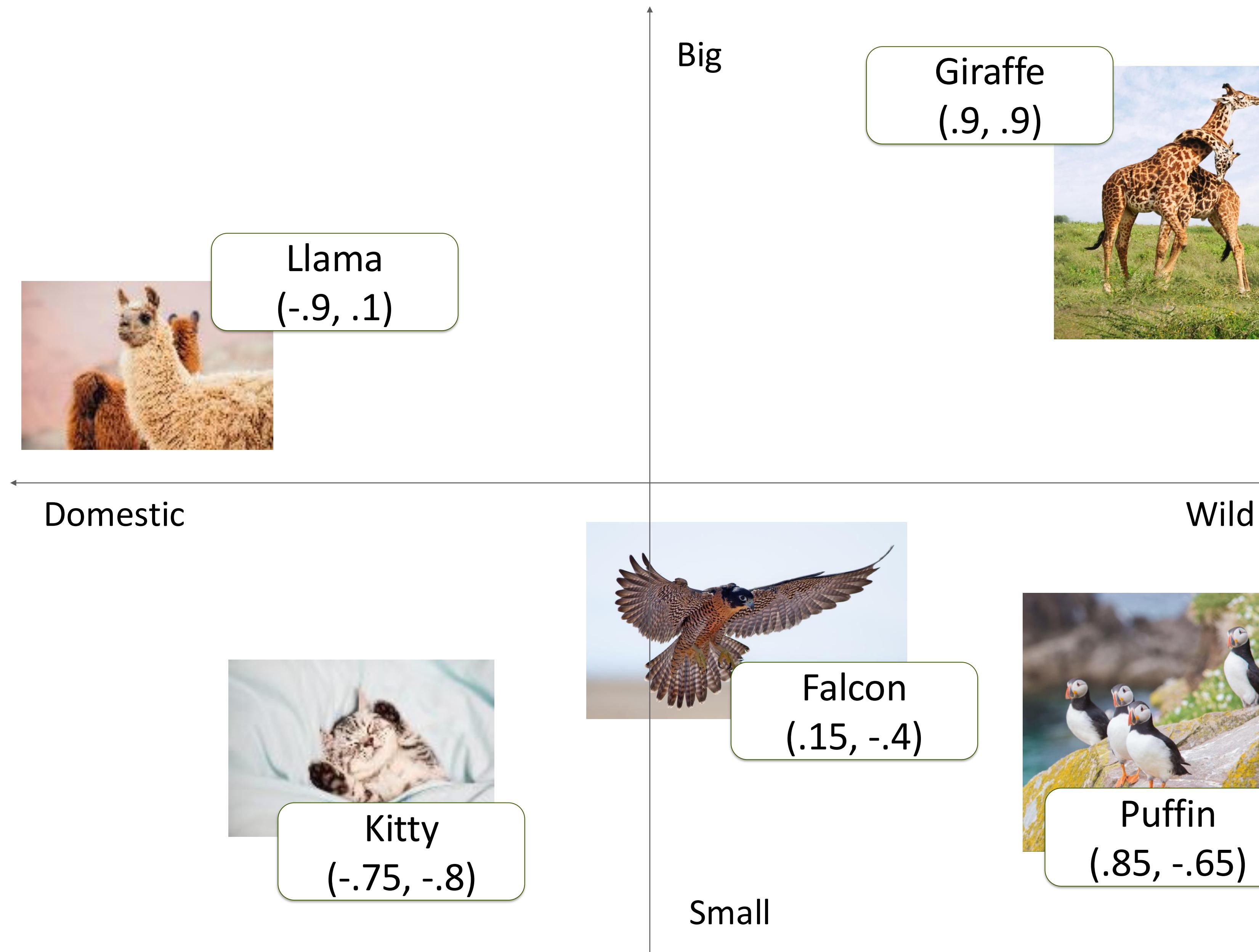
From Words to Numbers



From Words to Numbers



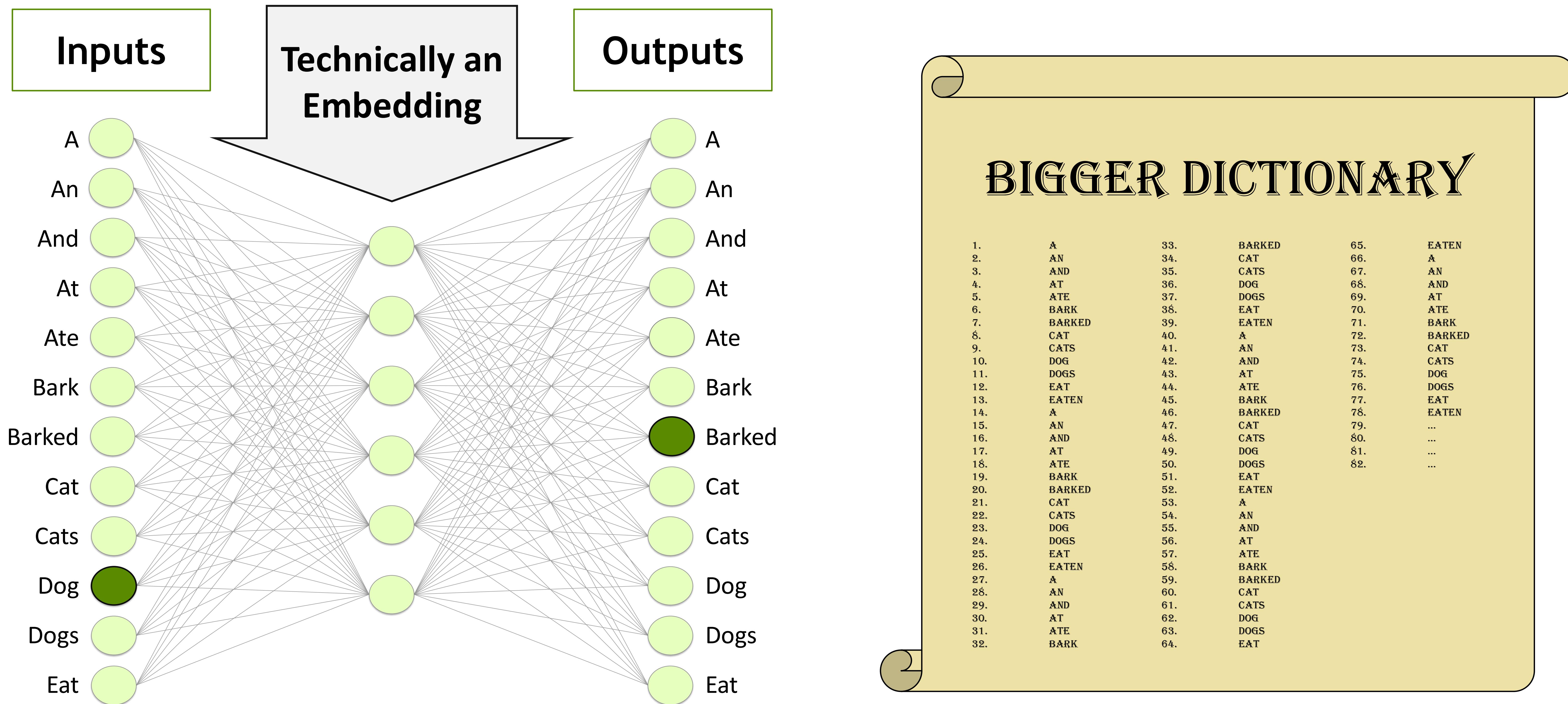
From Words to Numbers



BIGGER DICTIONARY

1.	A	33.	BARKED	65.	EATEN
2.	AN	34.	CAT	66.	A
3.	AND	35.	CATS	67.	AN
4.	AT	36.	DOG	68.	AND
5.	ATE	37.	DOGS	69.	AT
6.	BARK	38.	EAT	70.	ATE
7.	BARKED	39.	EATEN	71.	BARK
8.	CAT	40.	A	72.	BARKED
9.	CATS	41.	AN	73.	CAT
10.	DOG	42.	AND	74.	CATS
11.	DOGS	43.	AT	75.	DOG
12.	EAT	44.	ATE	76.	DOGS
13.	EATEN	45.	BARK	77.	EAT
14.	A	46.	BARKED	78.	EATEN
15.	AN	47.	CAT	79.	...
16.	AND	48.	CATS	80.	...
17.	AT	49.	DOG	81.	...
18.	ATE	50.	DOGS	82.	...
19.	BARK	51.	EAT		
20.	BARKED	52.	EATEN		
21.	CAT	53.	A		
22.	CATS	54.	AN		
23.	DOG	55.	AND		
24.	DOGS	56.	AT		
25.	EAT	57.	ATE		
26.	EATEN	58.	BARK		
27.	A	59.	BARKED		
28.	AN	60.	CAT		
29.	AND	61.	CATS		
30.	AT	62.	DOG		
31.	ATE	63.	DOGS		
32.	BARK	64.	EAT		

From Words to Numbers



Attention

Sentence Prediction

I am the very model of a modern Major-General,
I've information vegetable, animal, and mineral,

...

I'm very good at integral and differential calculus;
I know the scientific names of beings animalculous:
In short, in matters vegetable, animal, and mineral,
I am the very model of a m



~ Major-General Stanley

Sentence Prediction

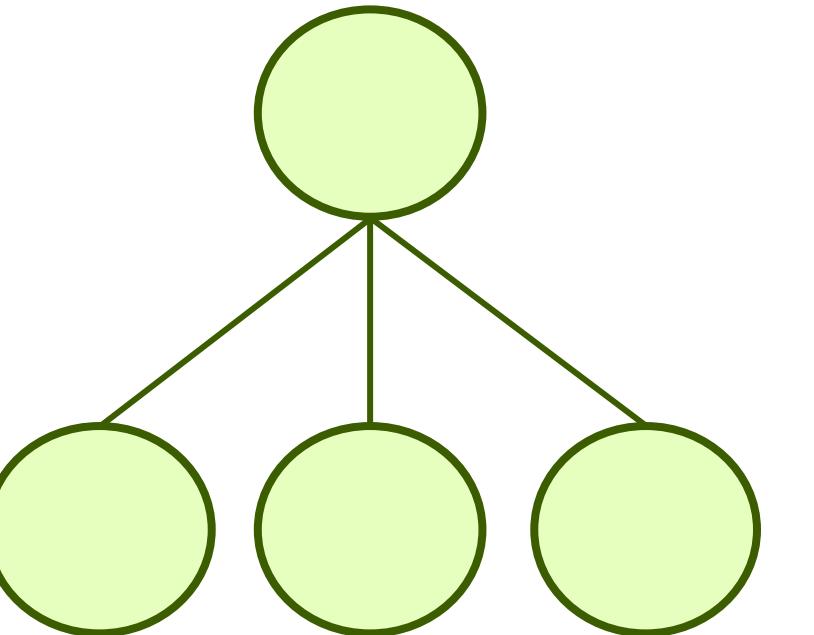
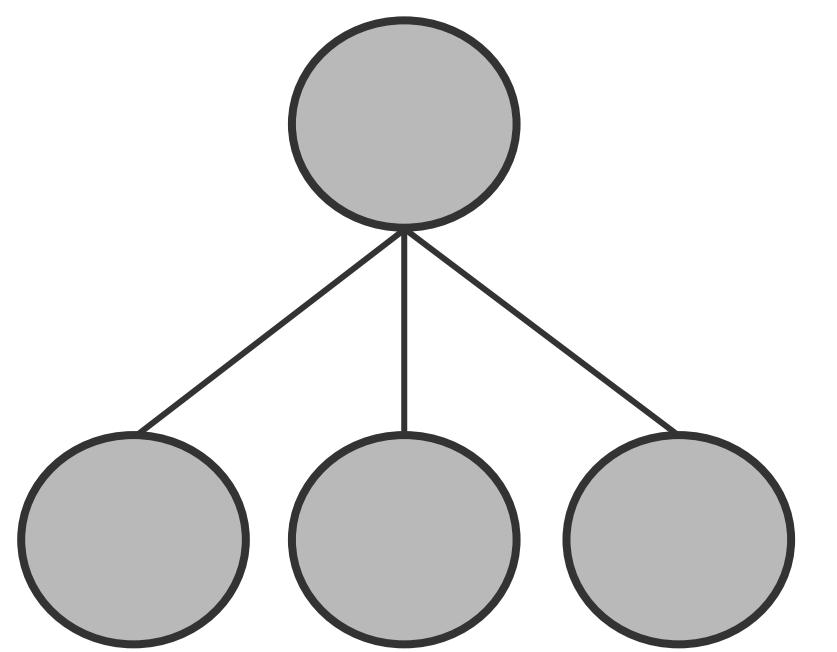
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I'm very good at integral and differential calculus;
I know the scientific names of beings animalculous:
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.

~ Major-General Stanley

Attention



I
am
the
very
model

5×3

Q

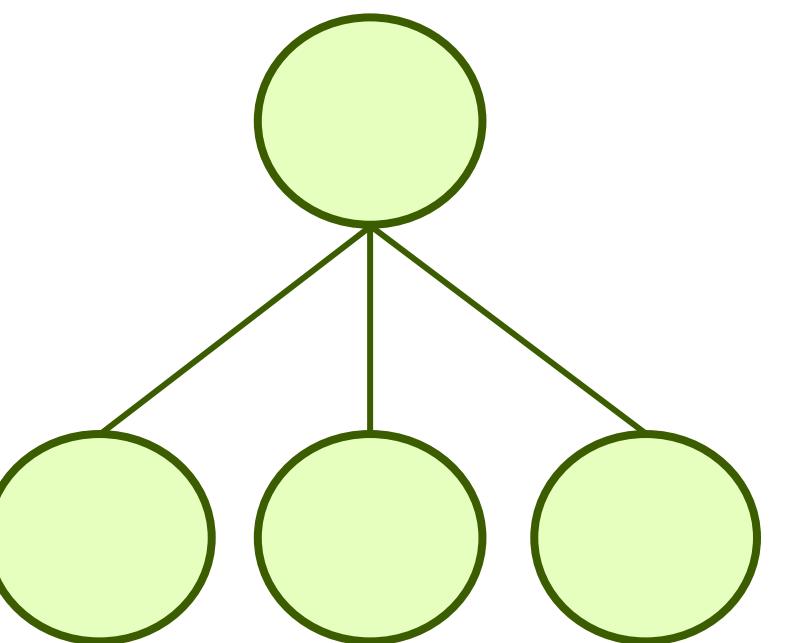
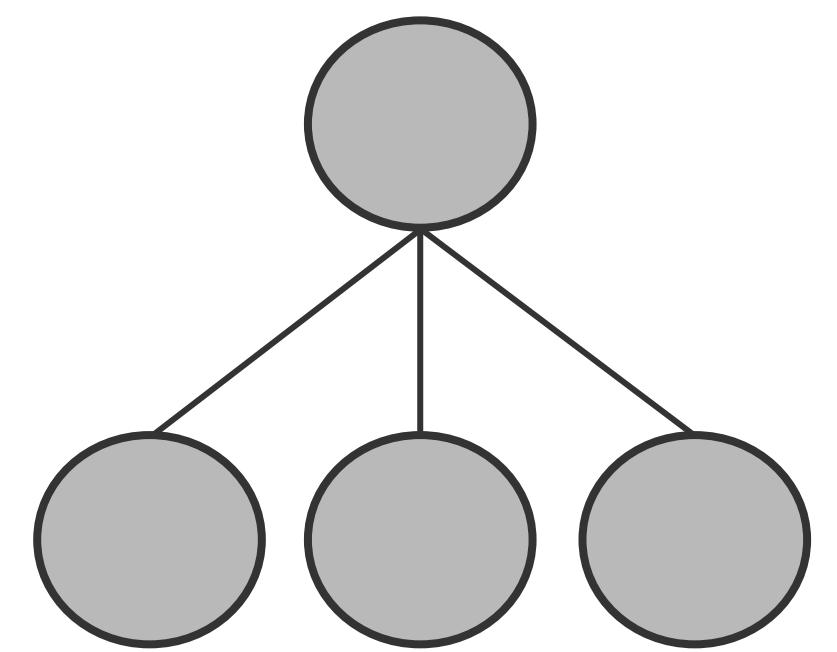
Query

5×3

K

Key

Attention



I						
am						
the						
very						
model						

5×3

Q

Query

5×3

K

Key

Attention

5×3

3×5

Attention



5×3

3×5



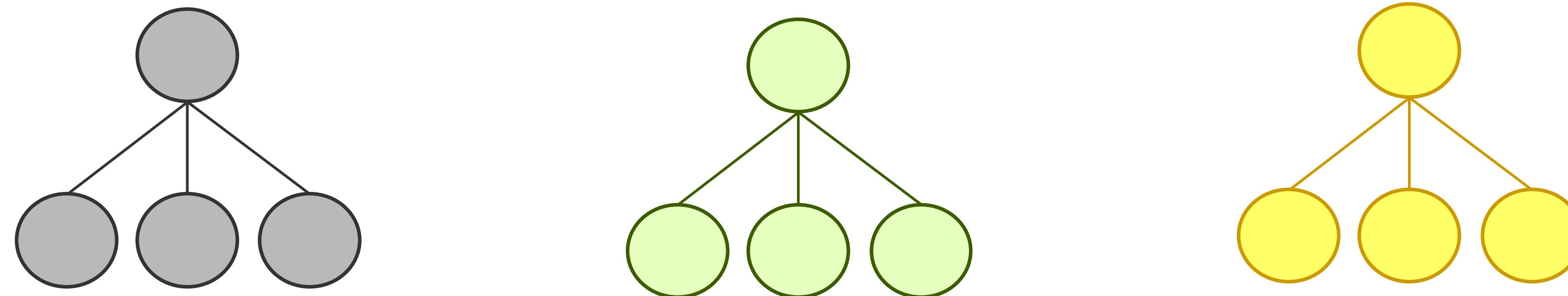
5×5

Attention

Attention

	-	Understand	Equations	Both	Simple	and	Quadratical
I	█	█					
Understand		█	█		█		
Equations			█				█
Both		█		█		█	
Simple			█		█		
And				█		█	
Quadratical			█				█

Attention



I									
am									
the									
very									
model									

5×3

Q

Query

5×3

K

Key

5×3

V

Value

Attention

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

I																			
am																			
the																			
very																			
model																			

5 x 3

Q

Query

5 x 3

K

Key

5 x 3

V

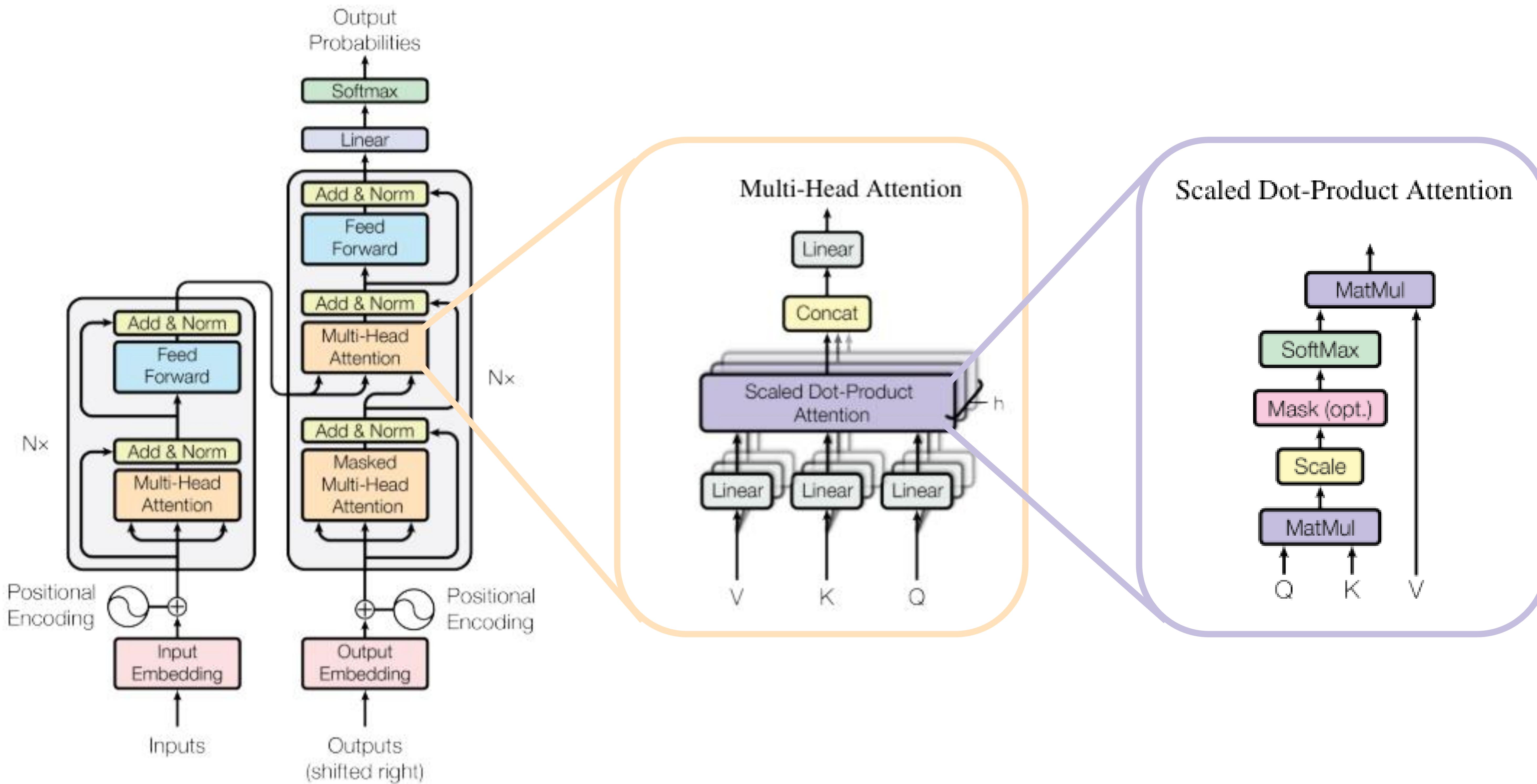
Value

5 x 3

Z

Attention Score

Transformers



BERT

BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding

Jacob Devlin Ming-Wei Chang Kenton Lee Kristina Toutanova

Google AI Language

{jacobdevlin, mingweichang, kentonl, kristout}@google.com

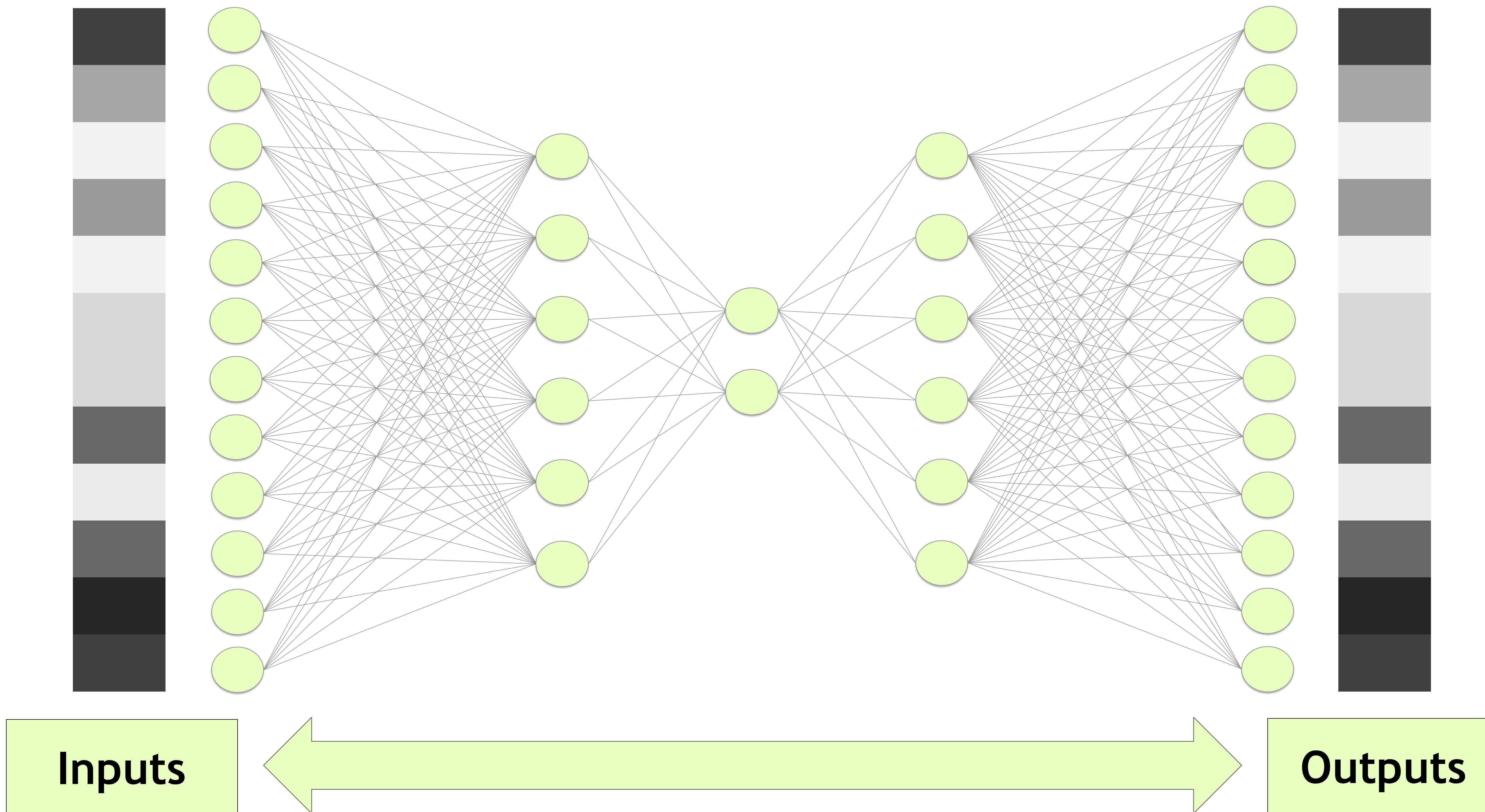
Abstract

We introduce a new language representation model called **BERT**, which stands for Bidirectional Encoder Representations from

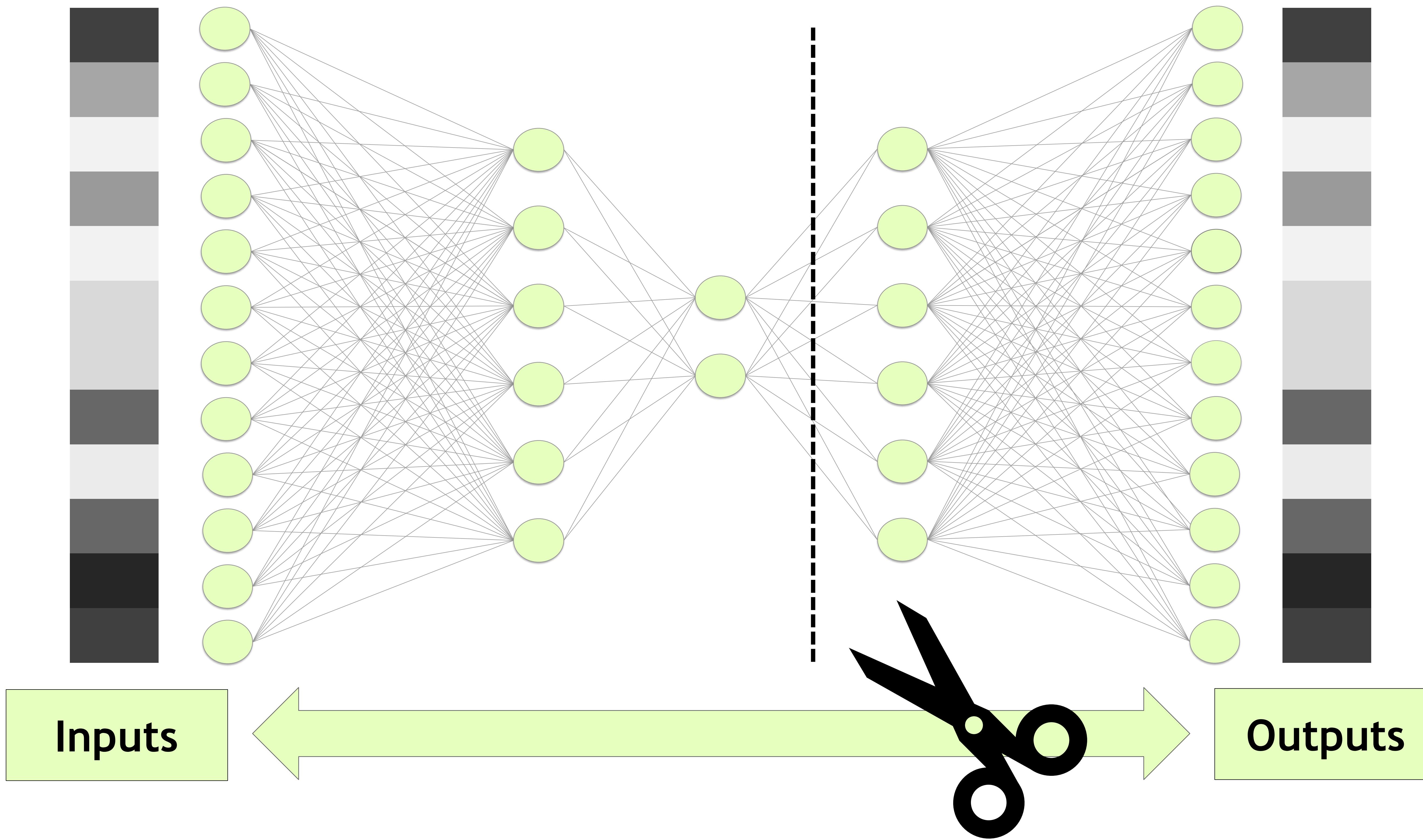
There are two existing strategies for applying pre-trained language representations to downstream tasks: *feature-based* and *fine-tuning*. The feature-based approach, such as ELMo (Peters

Other Architectures

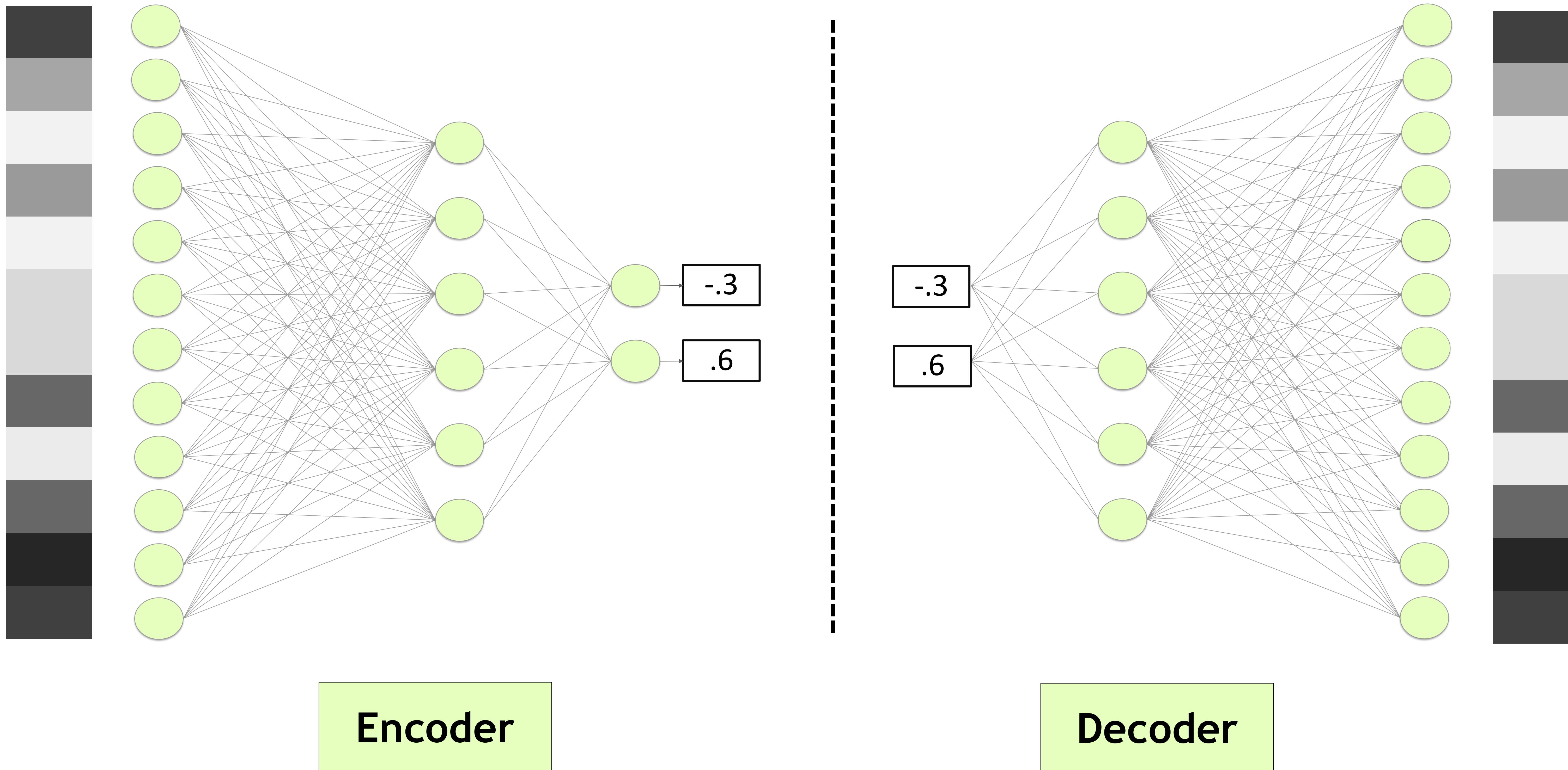
Autoencoders



Autoencoders



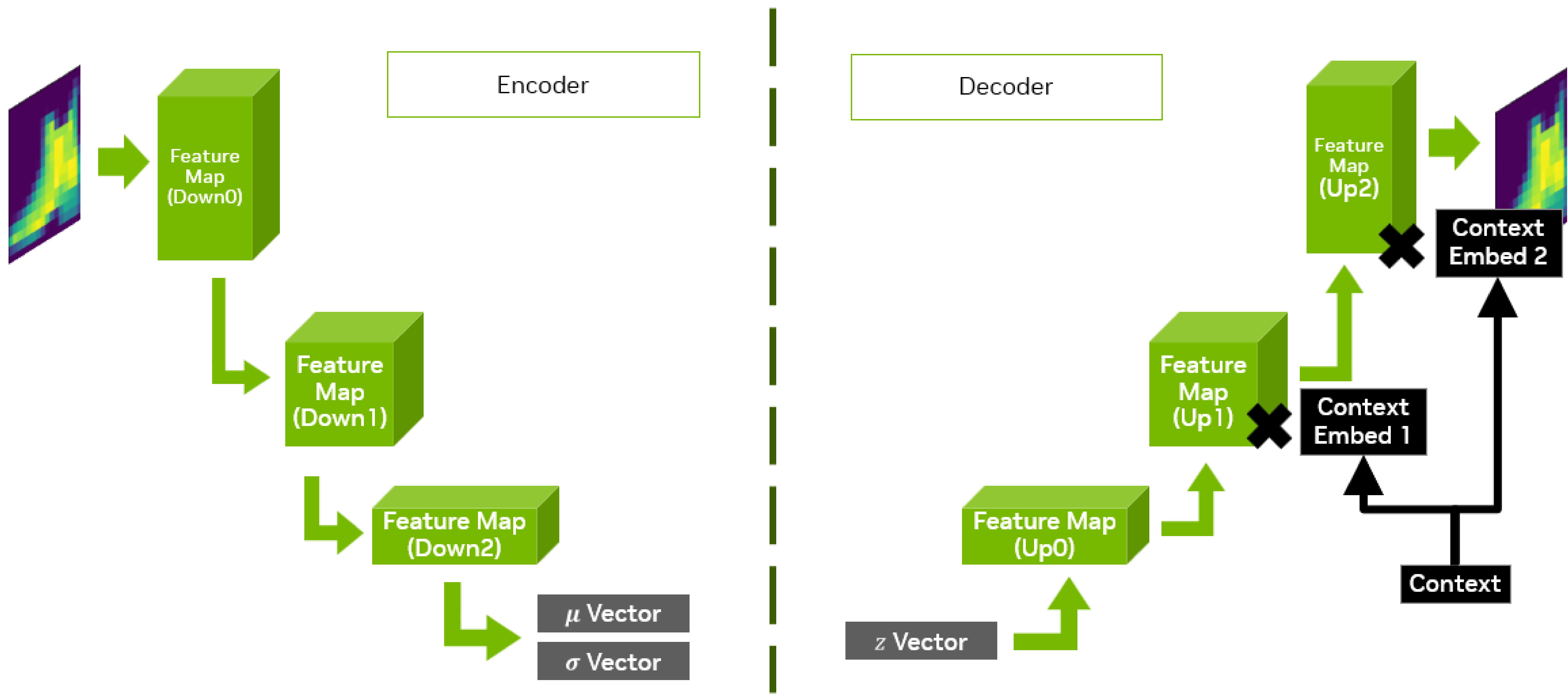
Autoencoders



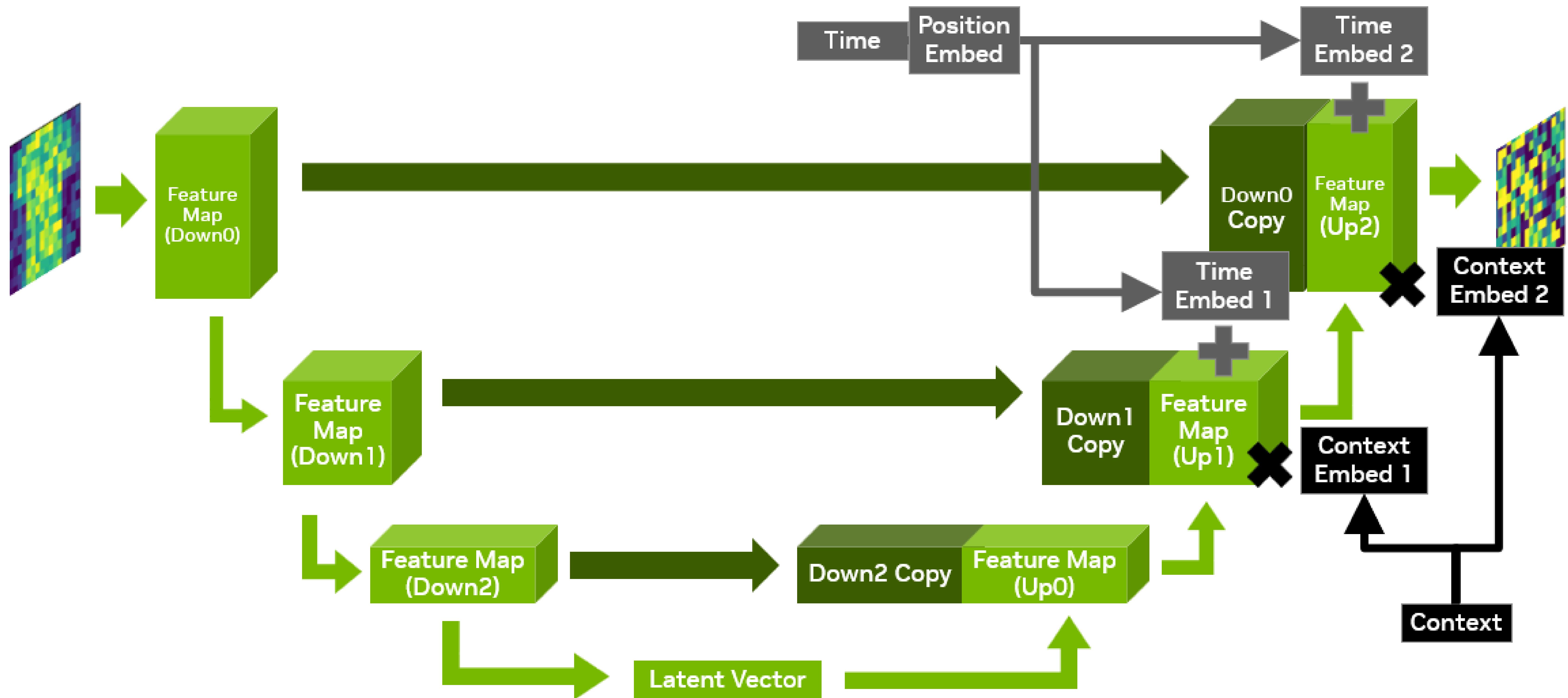
Encoder

Decoder

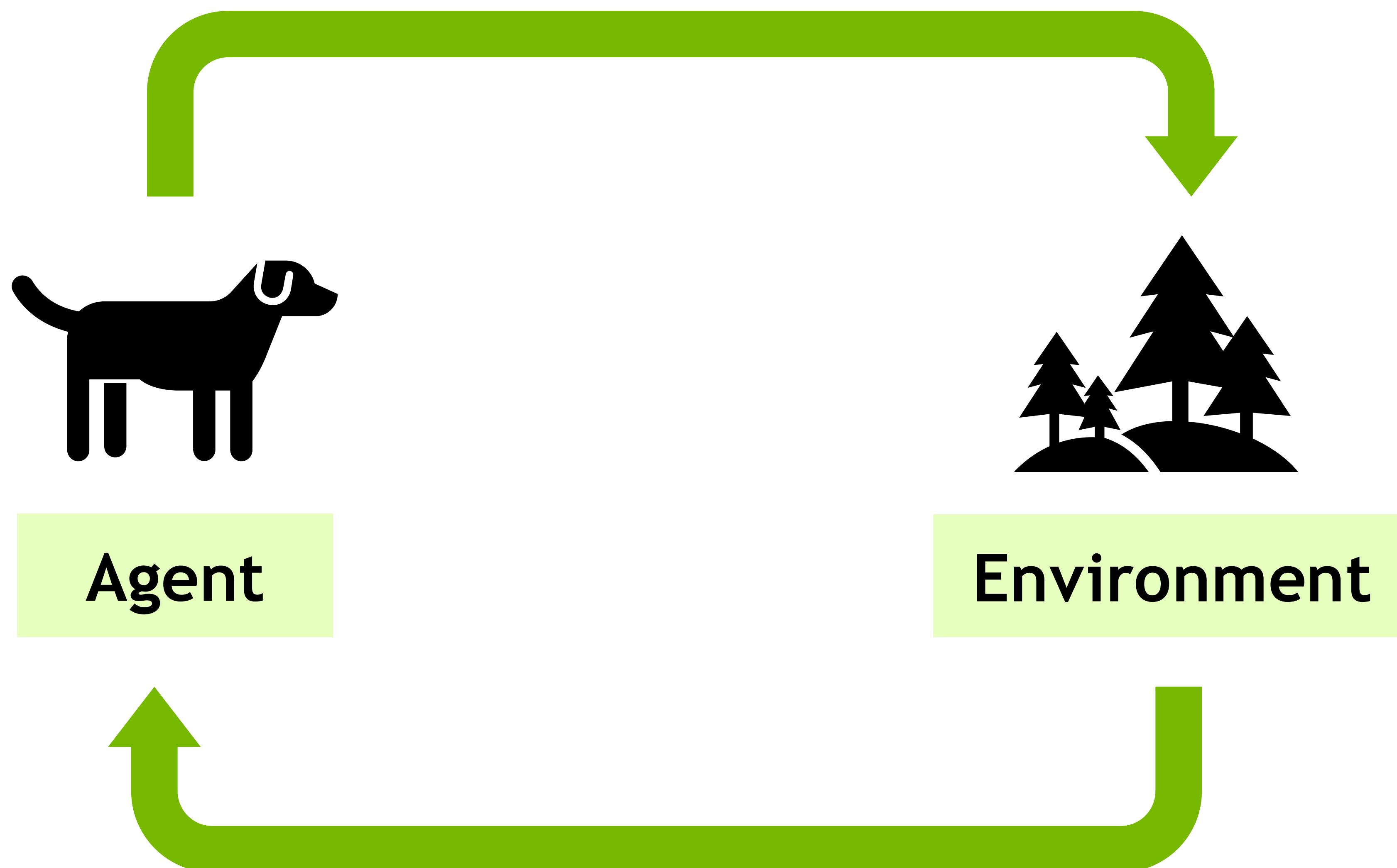
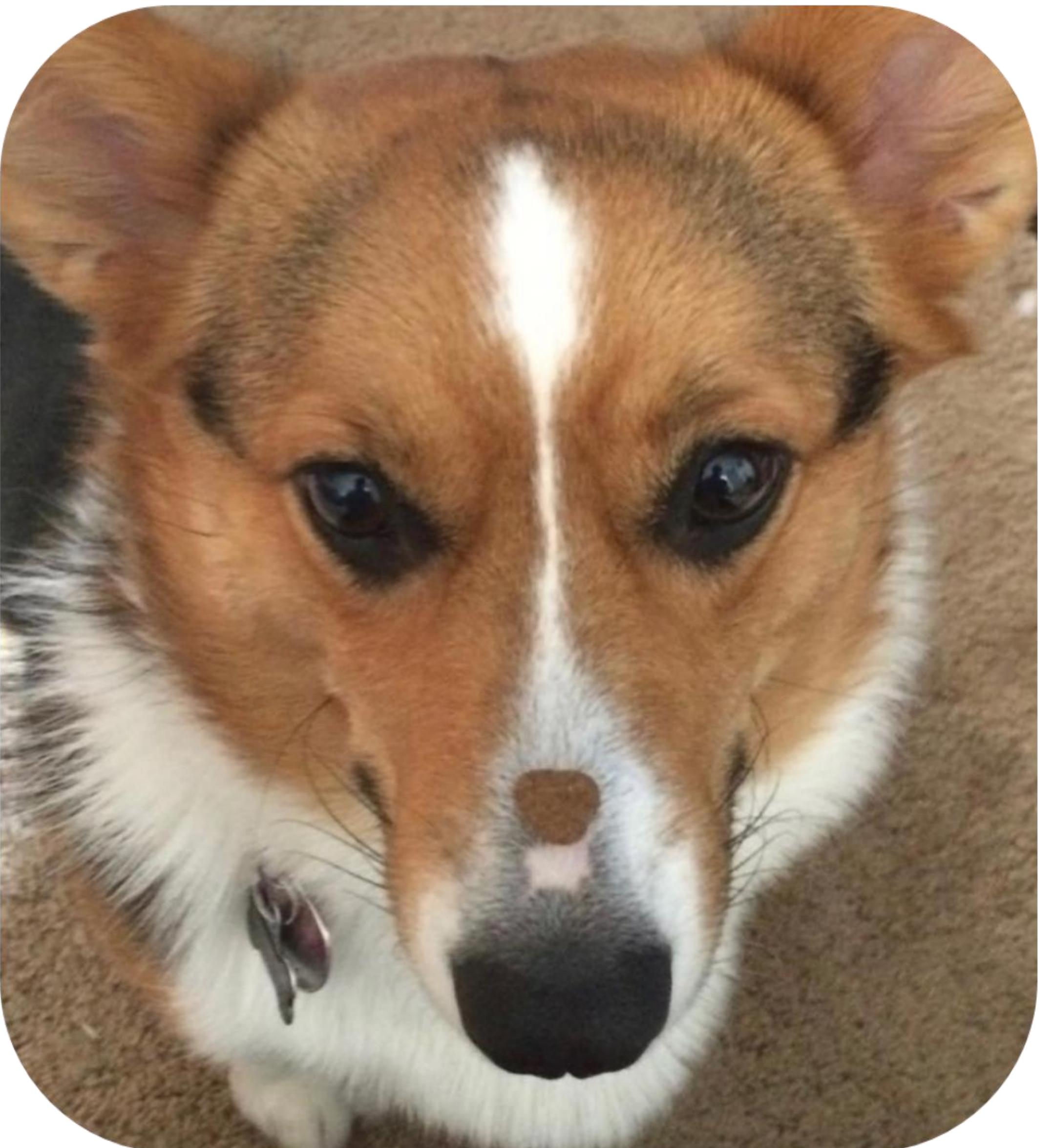
Variational Autoencoder



Diffusion Models



Reinforcement Learning



Next Steps

ENABLING PORTABILITY WITH NGC CONTAINERS

NGC Deep Learning Containers

Extensive

- Diverse range of workloads and industry specific use cases

Optimized

- DL containers updated monthly
- Packed with latest features and superior performance

Secure & Reliable

- Scanned for vulnerabilities and crypto
- Tested on workstations, servers, & cloud instances

Scalable

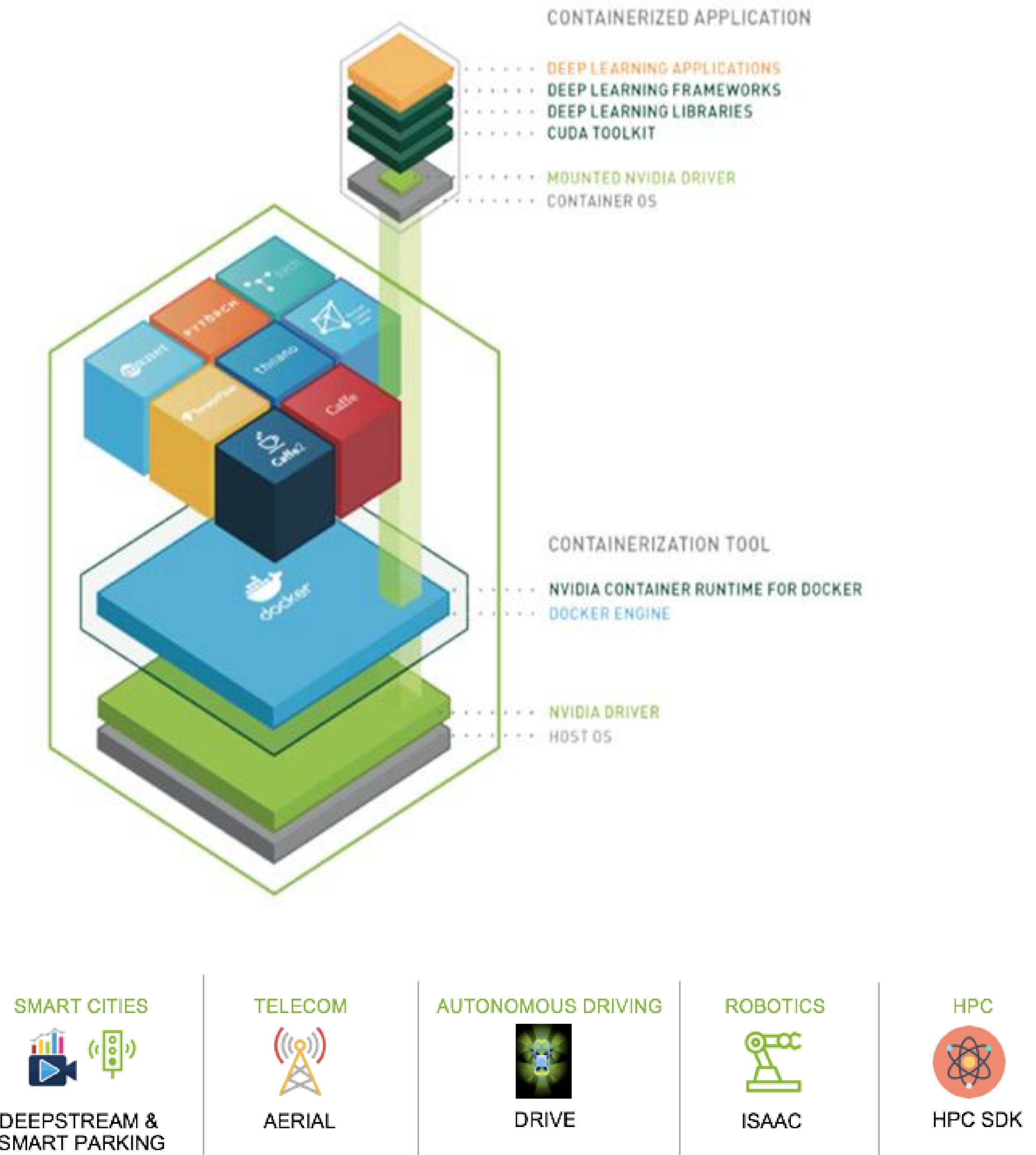
- Supports multi-GPU & multi-node systems

Designed for Enterprise & HPC

- Supports Docker, Singularity & other runtimes

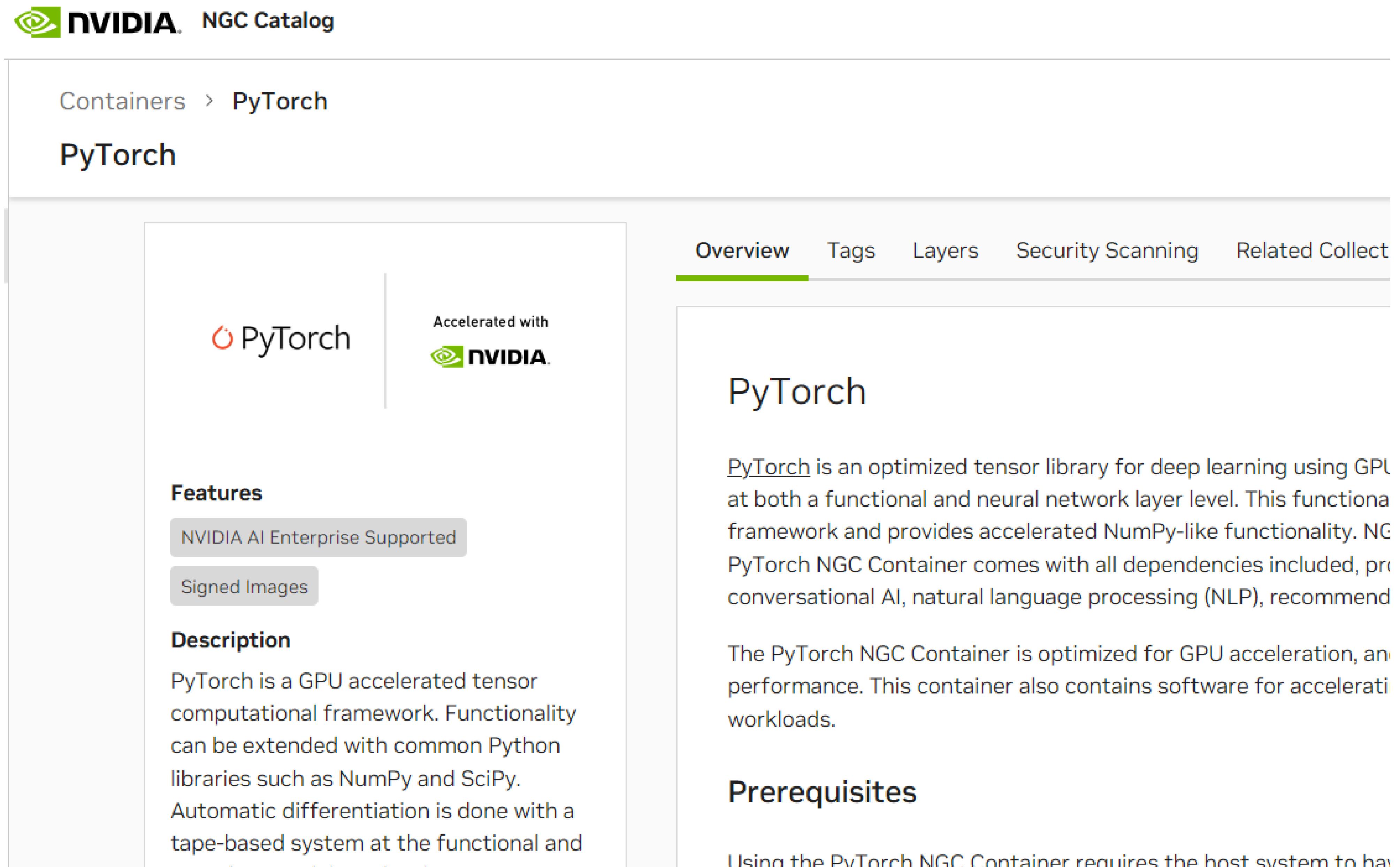
Run Anywhere

- Bare metal, VMs, Kubernetes
- x86, ARM, POWER
- Multi-cloud, on-prem, hybrid, edge



[Learn more about NGC Containers](#)

Next Steps for This Class



The screenshot shows the NVIDIA NGC Catalog interface. At the top, there's a navigation bar with the NVIDIA logo and the text "NGC Catalog". Below it, a breadcrumb navigation shows "Containers > PyTorch". The main title is "PyTorch". On the left, there's a sidebar with sections for "PyTorch" (highlighted with an orange circle), "Features" (listing "NVIDIA AI Enterprise Supported" and "Signed Images"), and "Description" (describing PyTorch as a GPU accelerated tensor computational framework). The right side has a "Overview" tab (which is selected, indicated by a green underline) and other tabs for "Tags", "Layers", "Security Scanning", and "Related Collect". The "Overview" section contains a large heading "PyTorch", a detailed description of what PyTorch is, and a "Prerequisites" section. The description mentions PyTorch is an optimized tensor library for deep learning using GPU at both a functional and neural network layer level. It provides accelerated NumPy-like functionality. The PyTorch NGC Container comes with all dependencies included, supporting conversational AI, natural language processing (NLP), recommendation systems, and more. The prerequisites section notes that using the PyTorch NGC Container requires the host system to have an NVIDIA GPU.

Step 1 Sign up for NGC

<https://docs.nvidia.com/dgx/ngc-registry-for-dgx-user-guide/index.html>

Step 2 Visit NGC Catalog

<https://catalog.ngc.nvidia.com/orgs/nvidia/containers/pytorch>

Step 3 Pull and Run Container

Visit <localhost:8888> to check out a JupyterLab environment

Closing Thoughts

Copying Rocket Science





A close-up, low-angle shot of a green notebook with horizontal ruling lines. The notebook is bound on the right side, and the pages are visible, showing the texture of the paper and the lines.

Let's get Started!

