



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

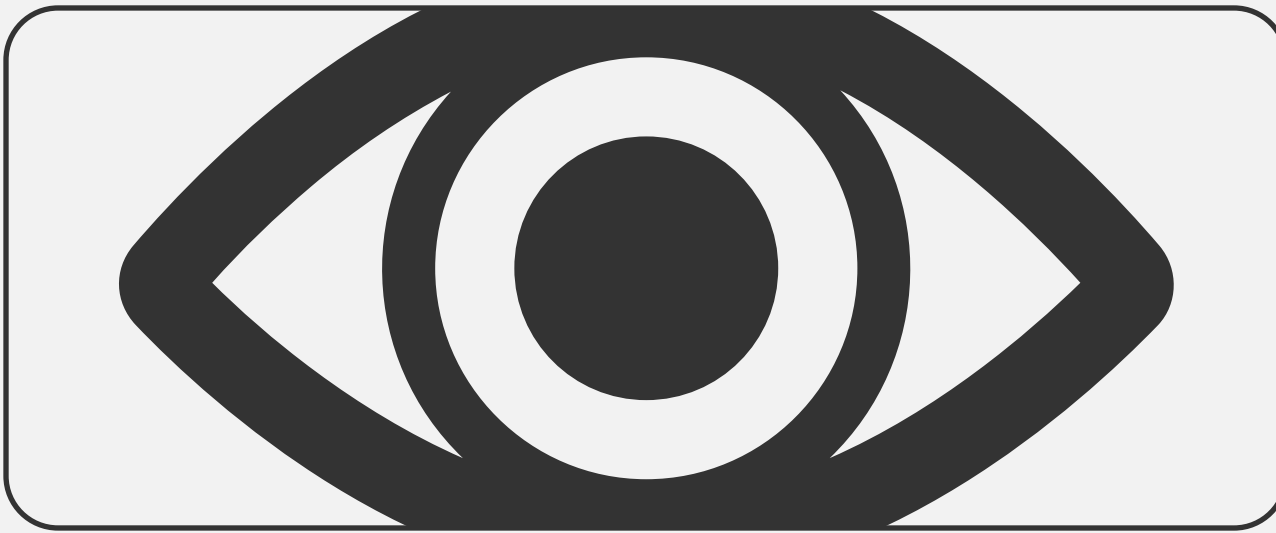
- Part 5: Pre-Trained Models

- Part 6: Advanced Architectures



Moving Forward

Fields of AI



Computer Vision

- Optometry



Natural Language Processing

- Linguistics



Reinforcement Learning

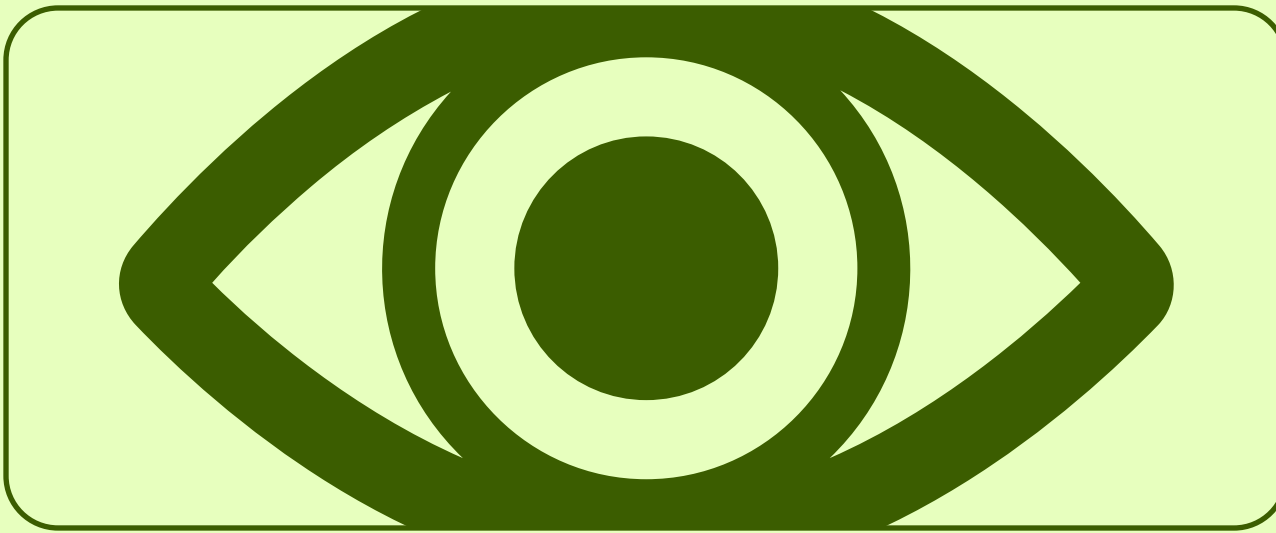
- Game Theory
- Psychology



Anomaly Detection

- Security
- Medicine

Fields of AI



Computer Vision

- Optometry



Natural Language Processing

- Linguistics



Reinforcement Learning

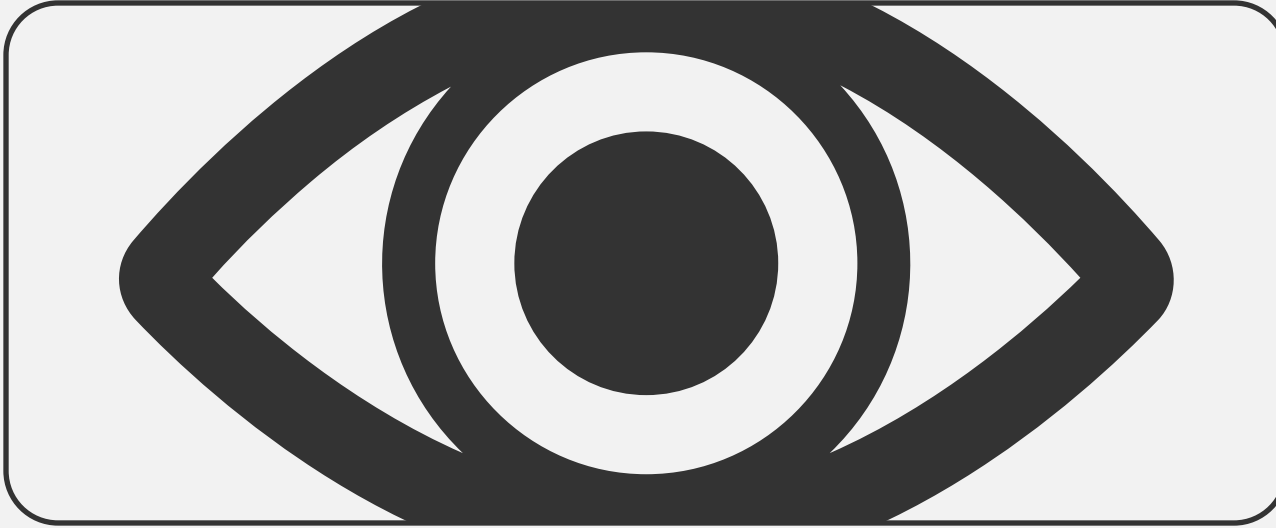
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Anomaly Detection

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Fields of AI



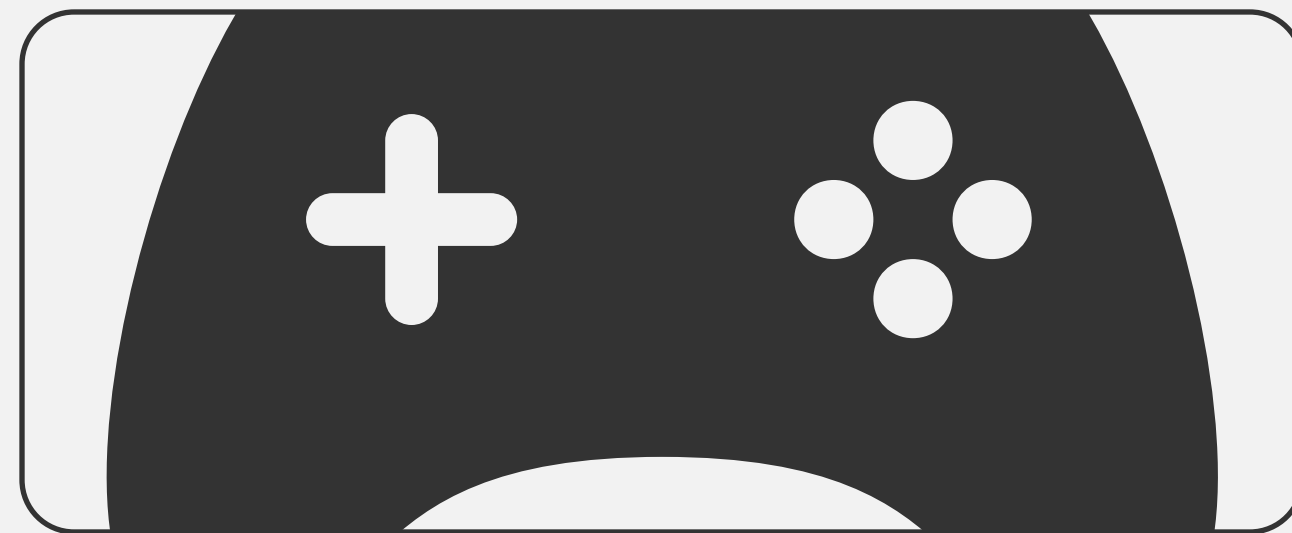
Computer Vision

- Optometry



Natural Language Processing

- Linguistics



Reinforcement Learning

- Game Theory
- Psychology



Anomaly Detection

- Security
- Medicine



Natural Language Processing

From Words to Numbers

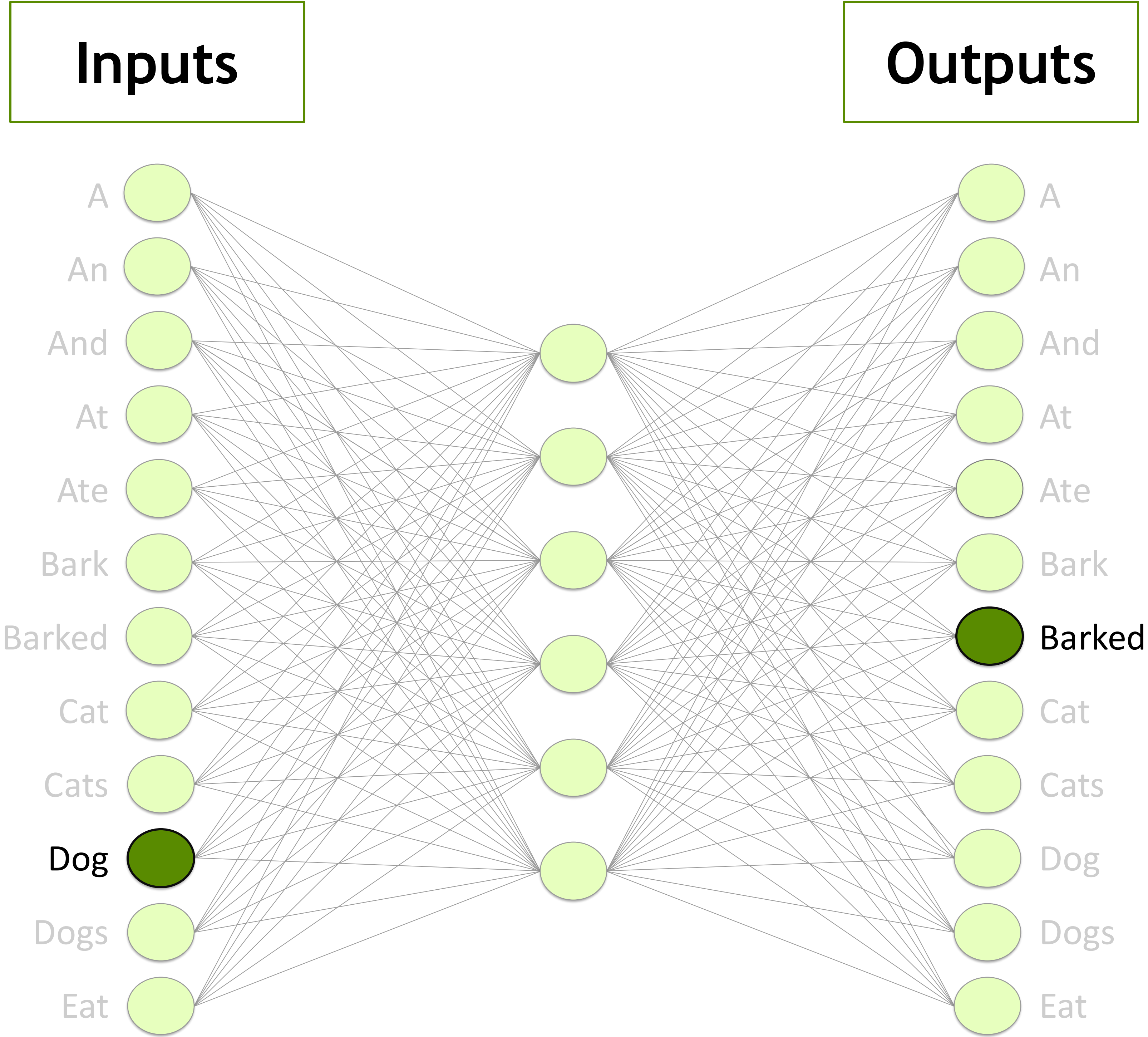
“A dog barked at a cat.”

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

DICTIONARY

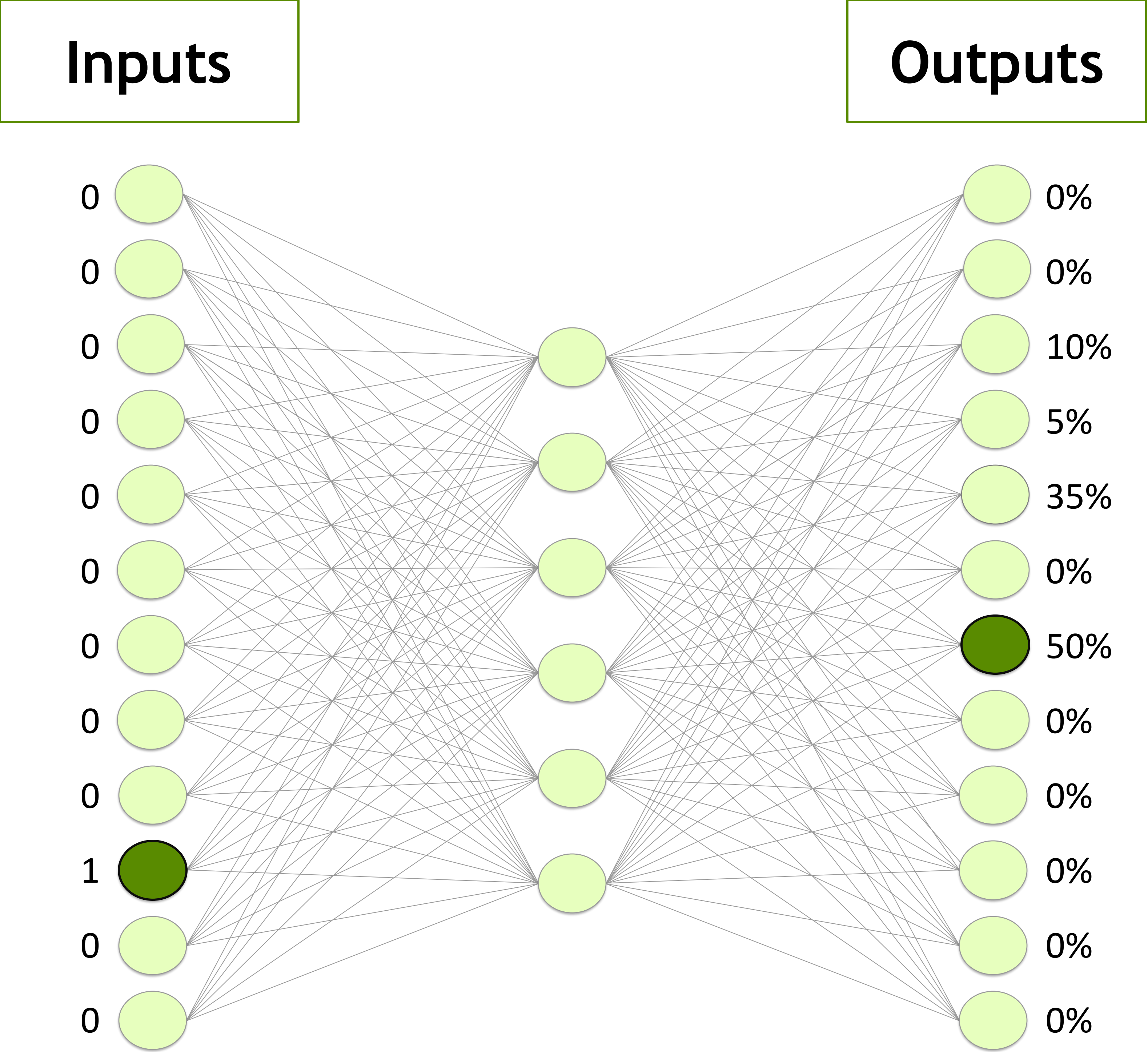
- | | |
|---------|-----------|
| 1. A | 7. BARKED |
| 2. AN | 8. CAT |
| 3. AND | 9. CATS |
| 4. AT | 10. DOG |
| 5. ATE | 11. DOGS |
| 6. BARK | 12. EAT |

From Words to Numbers



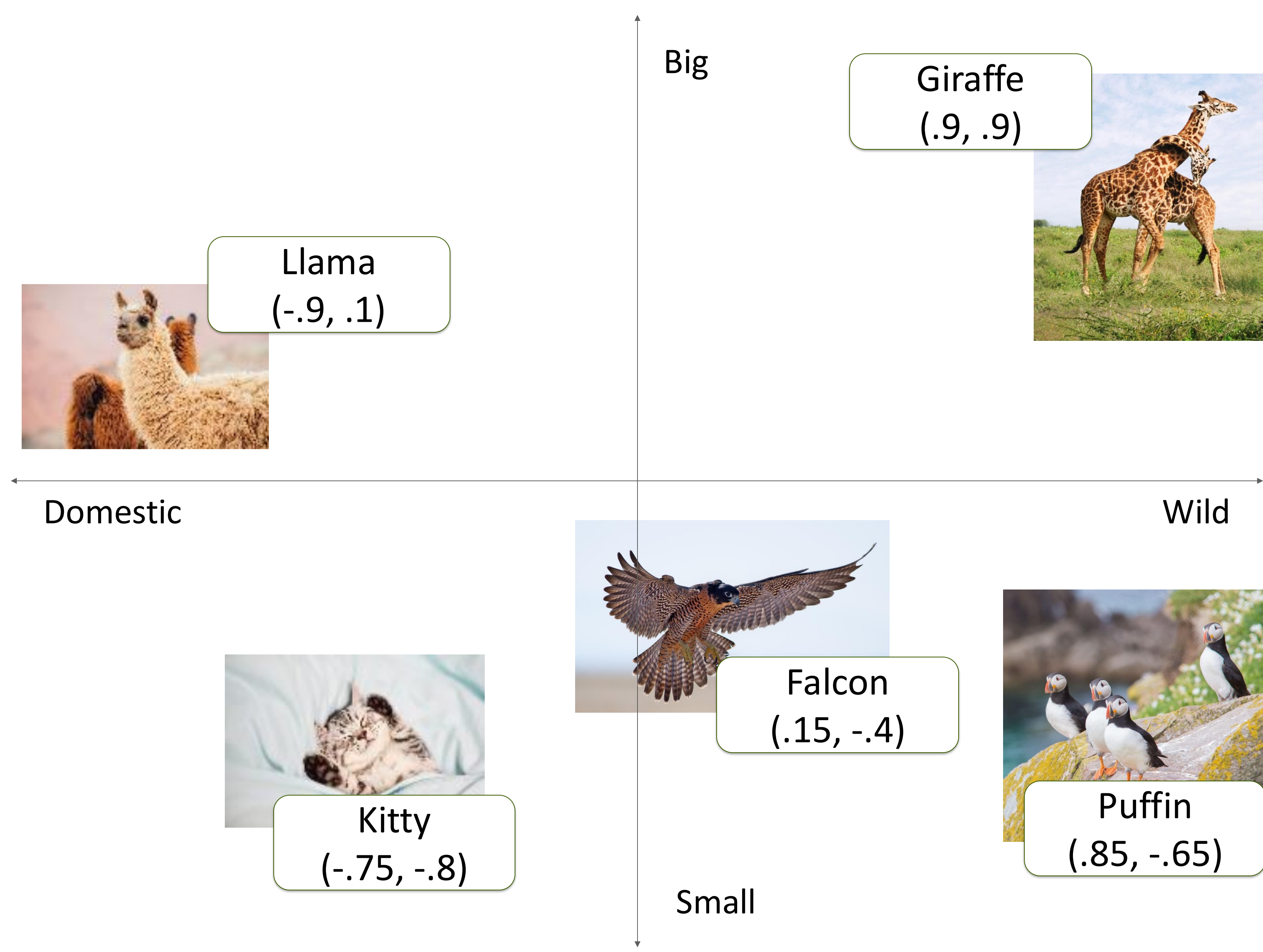
DICTIONARY	
1. A	7. BARKED
2. AN	8. CAT
3. AND	9. CATS
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5. ATE	11. DOGS
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From Words to Numbers



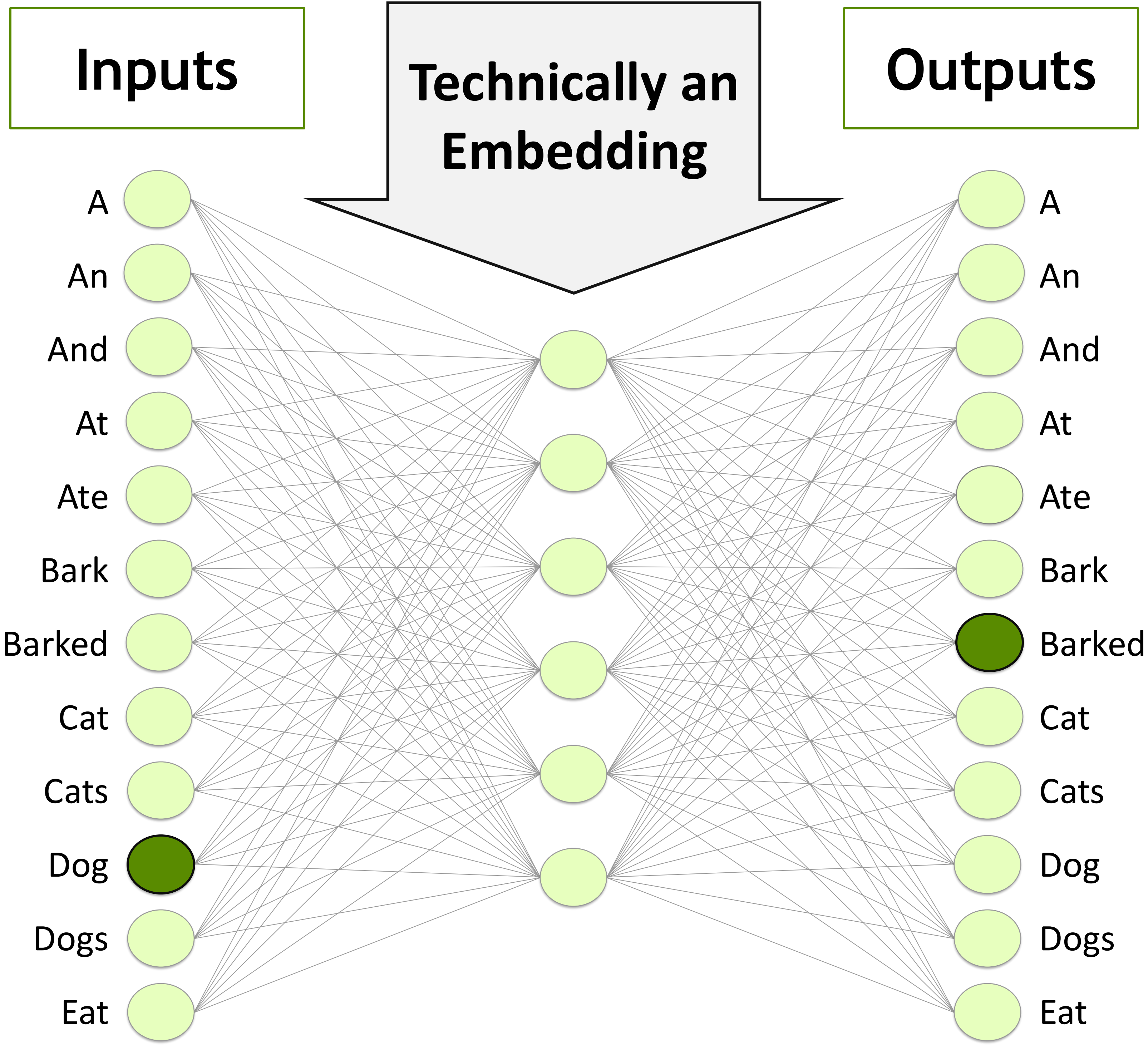
DICTIONARY	
1. A	7. BARKED
2. AN	8. CAT
3. AND	9. CATS
4. AT	10. DOG
5. ATE	11. DOGS
6. BARK	12. EAT

From Words to Numbers



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



BIGGER DICTIONARY

1.	A	33.	BARKED	65.	EATEN
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5.	ATE	37.	DOGS	69.	AT
6.	BARK	38.	EAT	70.	ATE
7.	BARKED	39.	EATEN	71.	BARK
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12.	EAT	44.	ATE	76.	DOGS
13.	EATEN	45.	BARK	77.	EAT
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29.	AND	61.	CATS		
30.	AT	62.	DOG		
31.	ATE	63.	DOGS		
32.	BARK	64.	EAT		



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

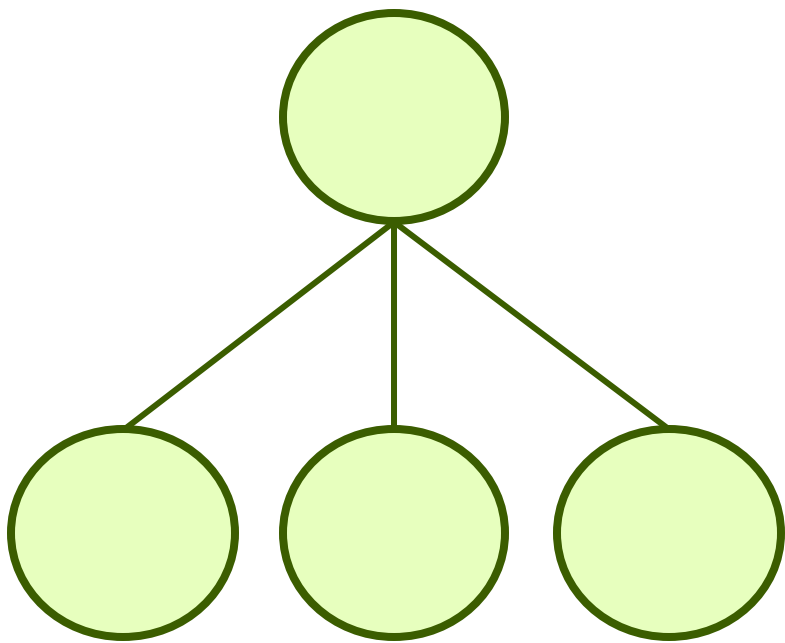
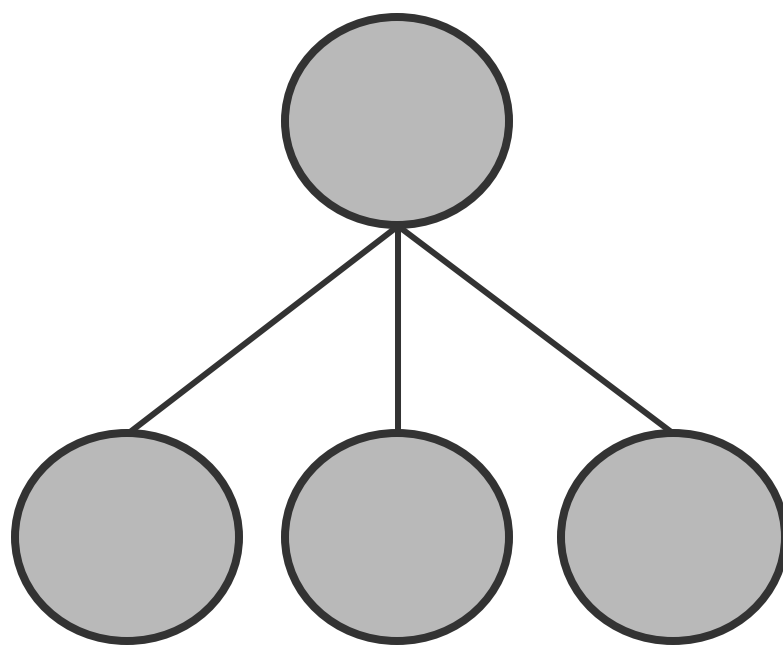
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In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.

~ Major-General Stanley

Attention



I
am
the
very
model

5 x 3

Q

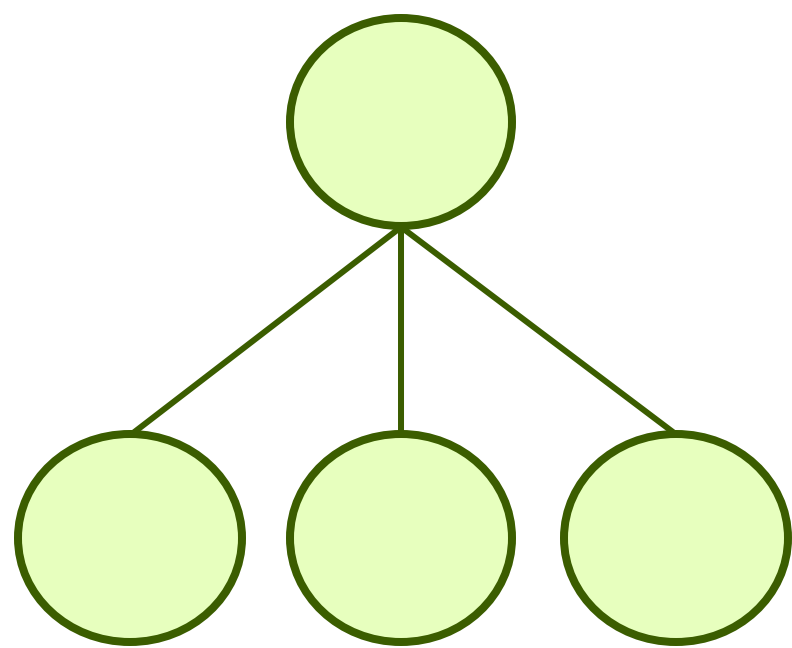
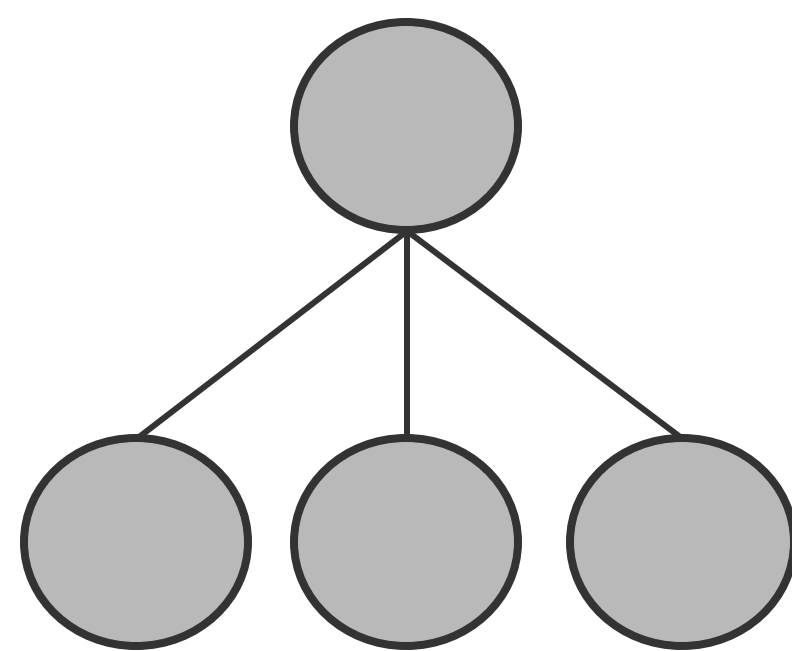
Query

5 x 3

K

Key

Attention



I						
am						
the						
very						
model						

5 x 3

5 x 3

Q

K

Query

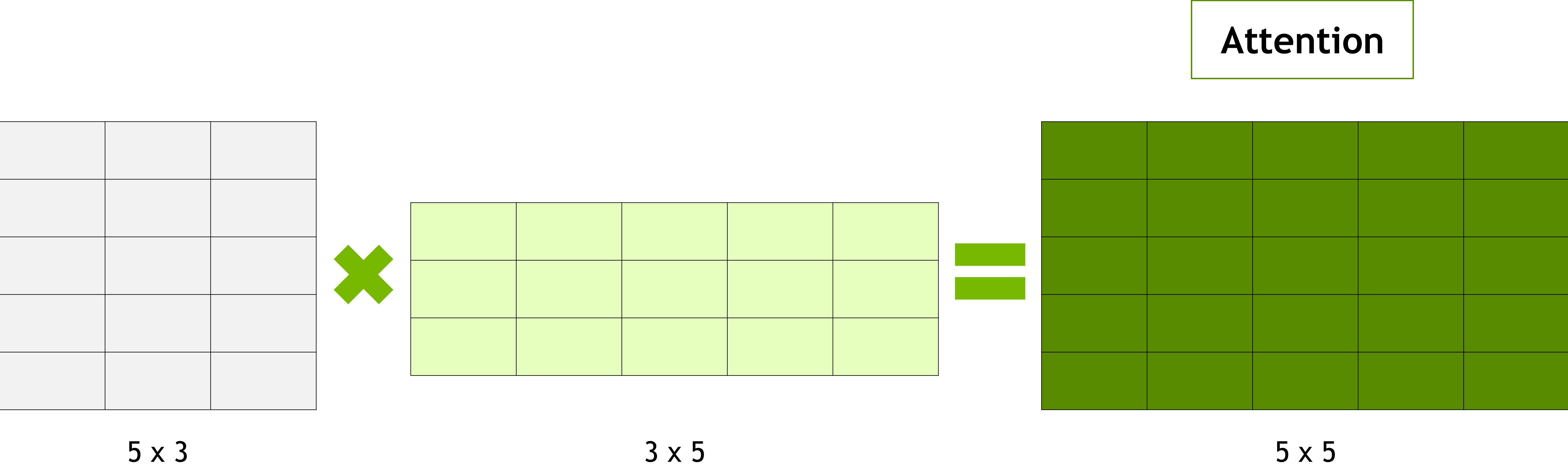
Key

Attention

5 x 3

3 x 5

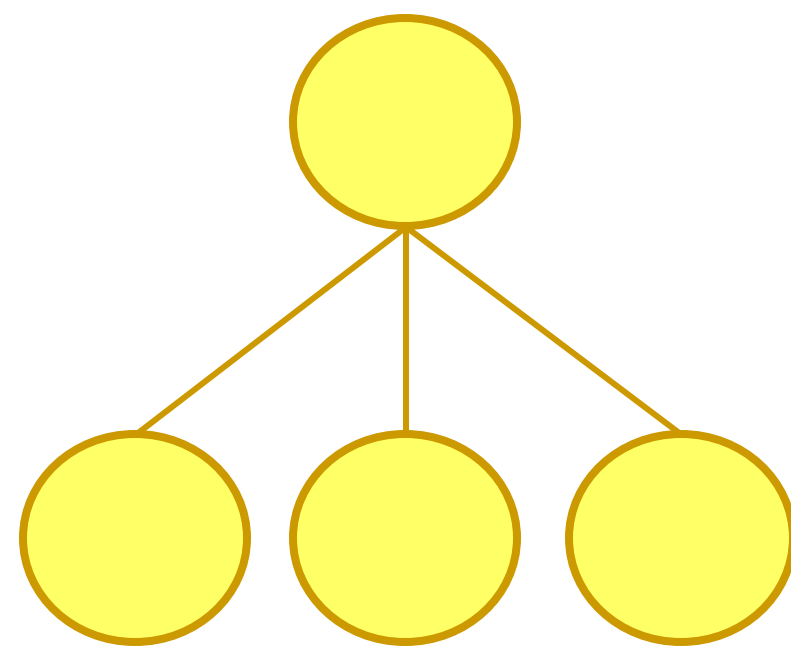
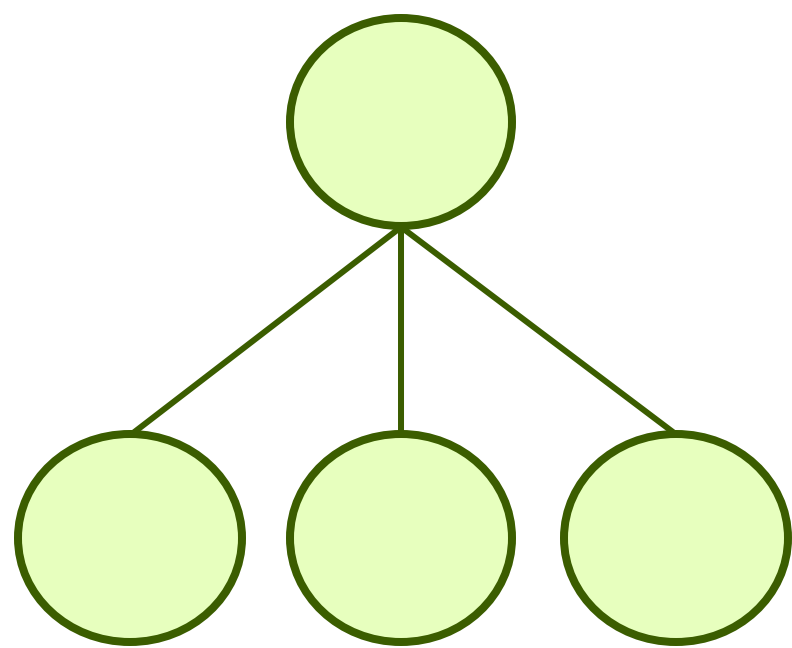
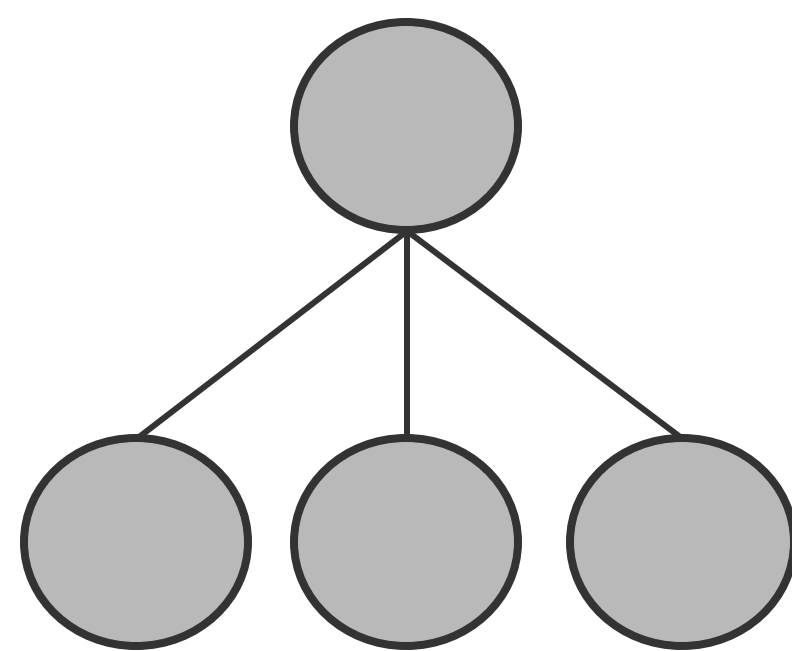
Attention



Attention

		Understand	Equations	Both	Simple	and	Quadraical
I							
Understand							
Equations							
Both							
Simple							
And							
Quadratical							

Attention



I									
am									
the									
very									
model									

5 x 3

5 x 3

5 x 3

Q

K

V

Query

Key

Value

Attention

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

I												
am												
the												
very												
model												

5 x 3

5 x 3

5 x 3

5 x 3

Q

K

V

Z

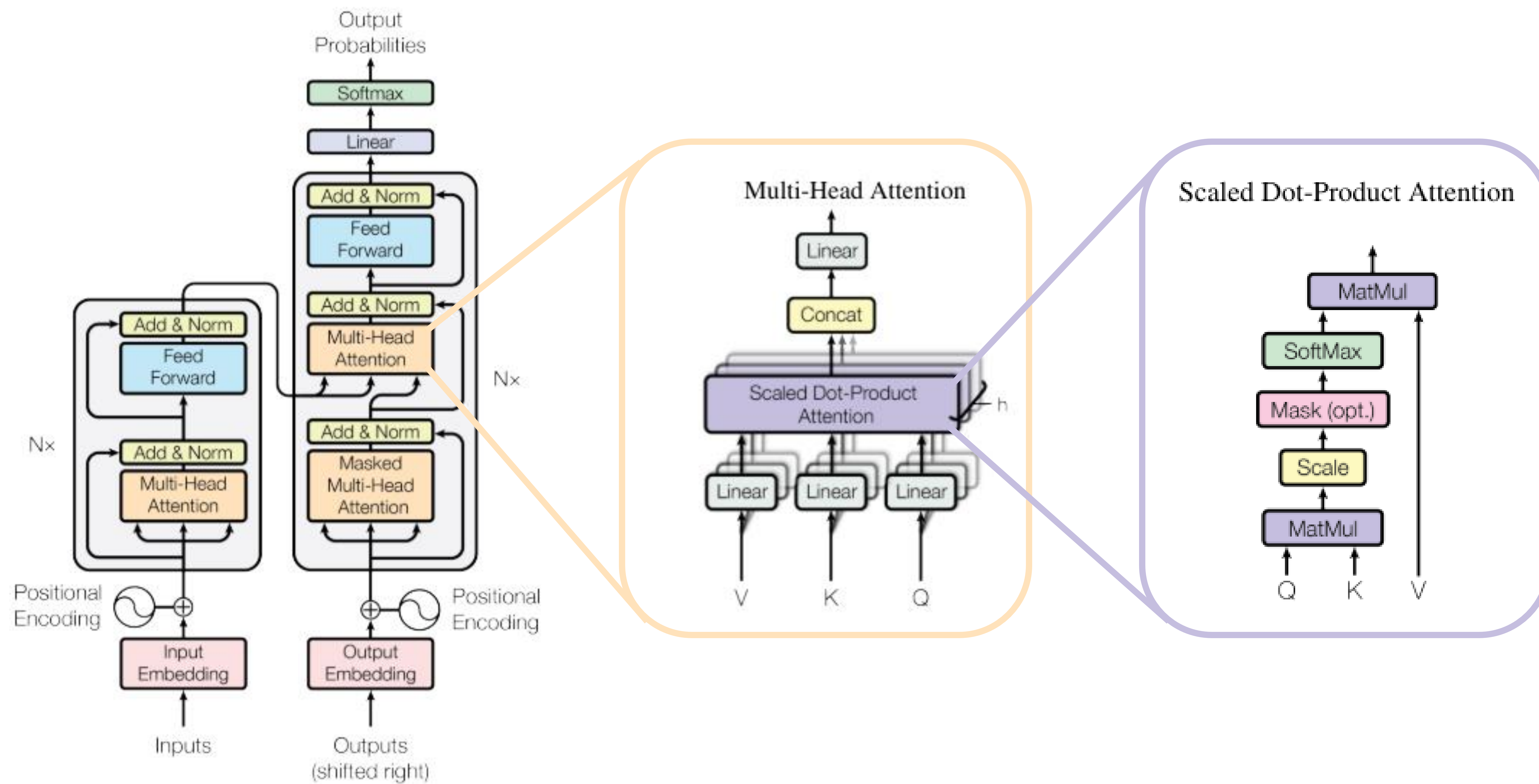
Query

Key

Value

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

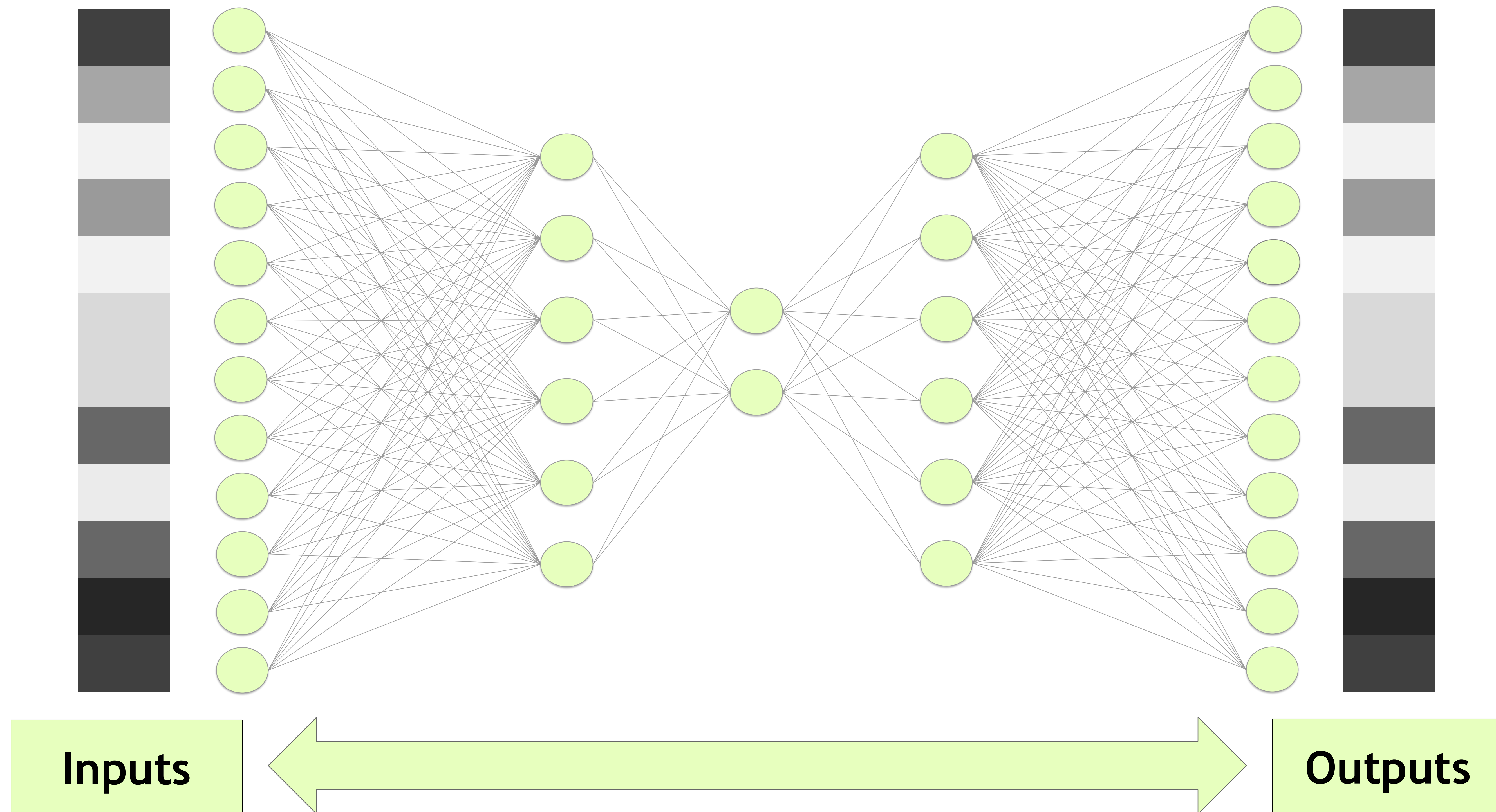
We introduce a new language representation model called **BERT**, which stands for **B**idirectional **E**ncoder **R**epresentations from

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

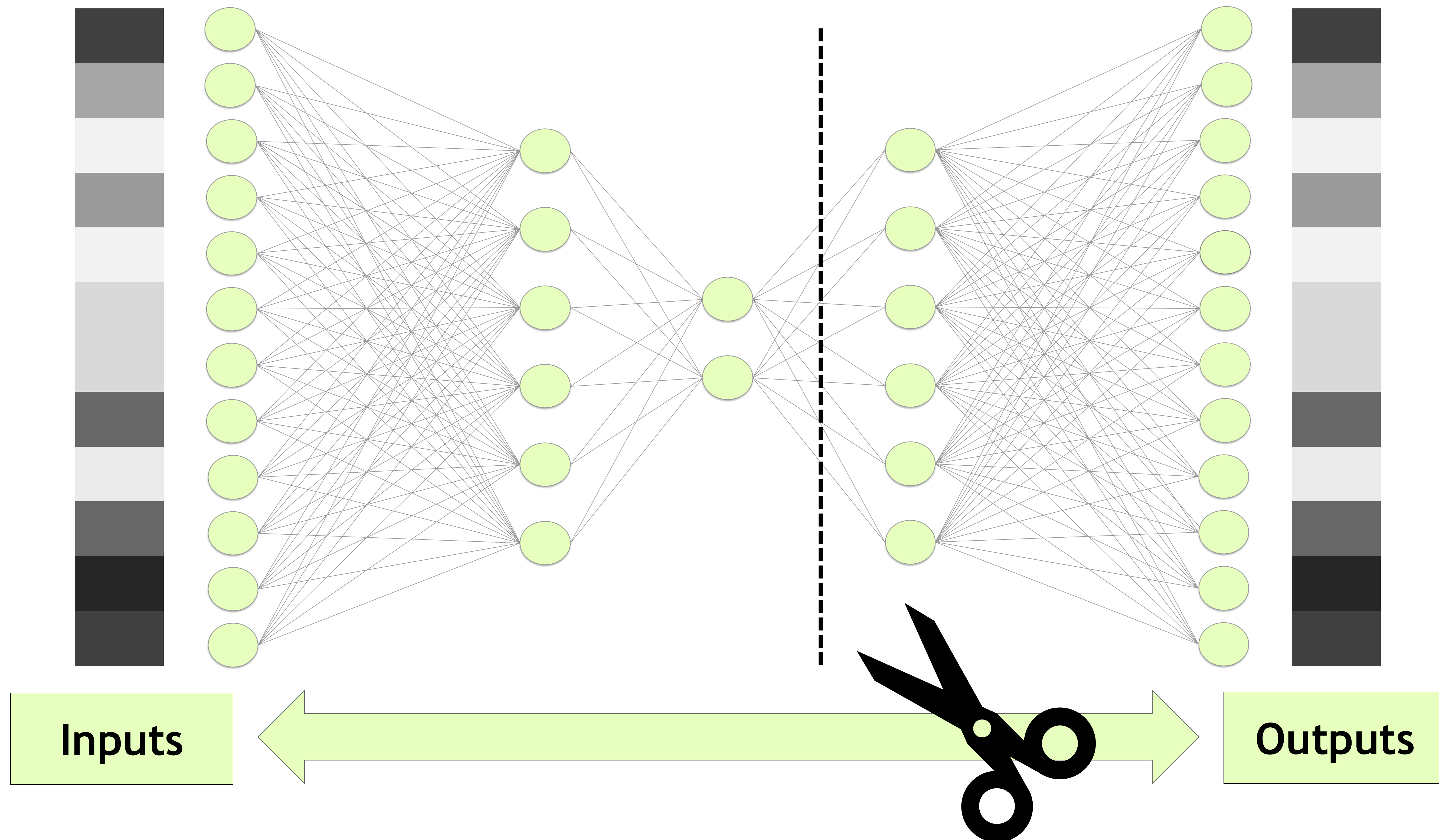


Other Architectures

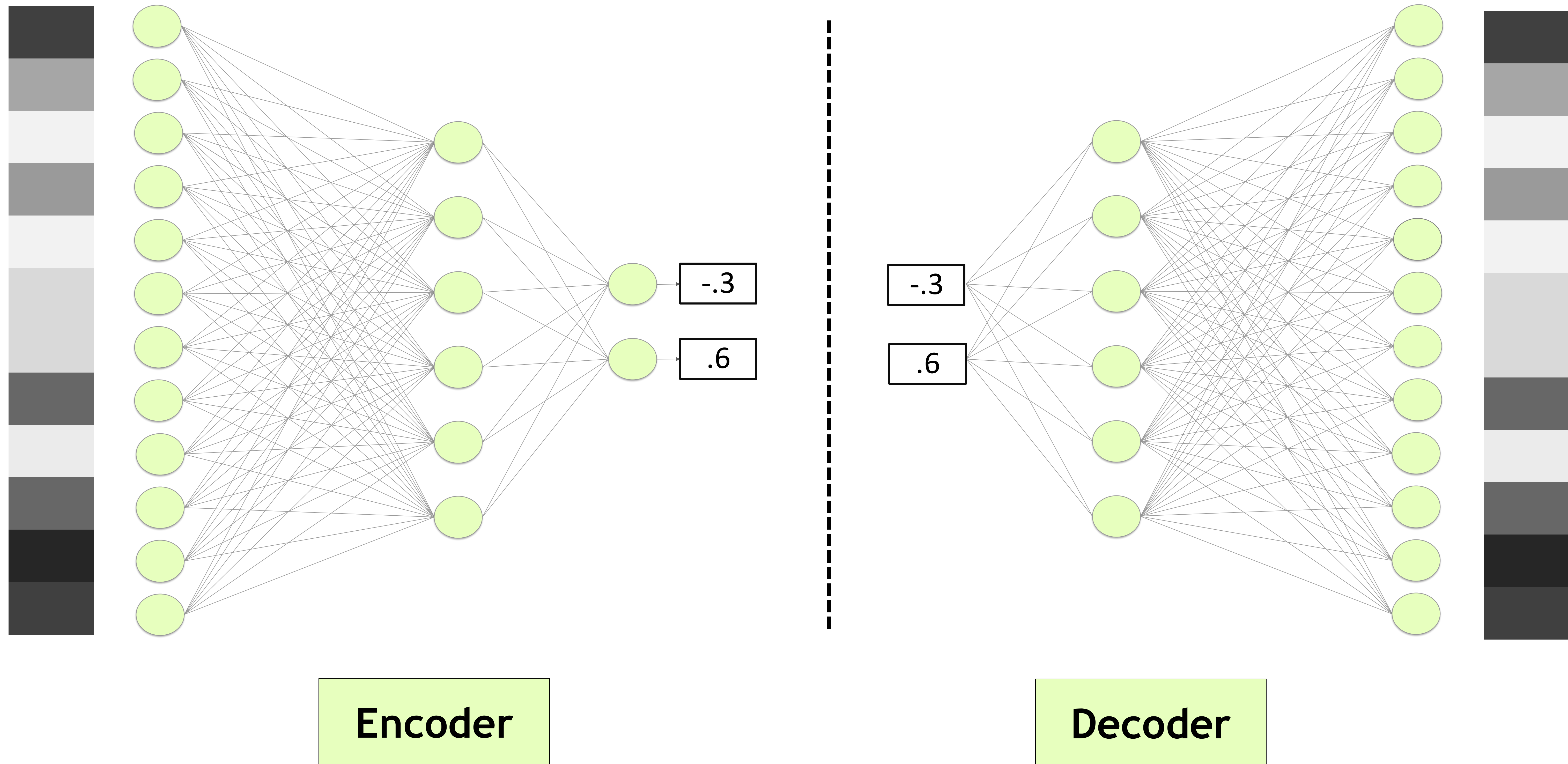
Autoencoders



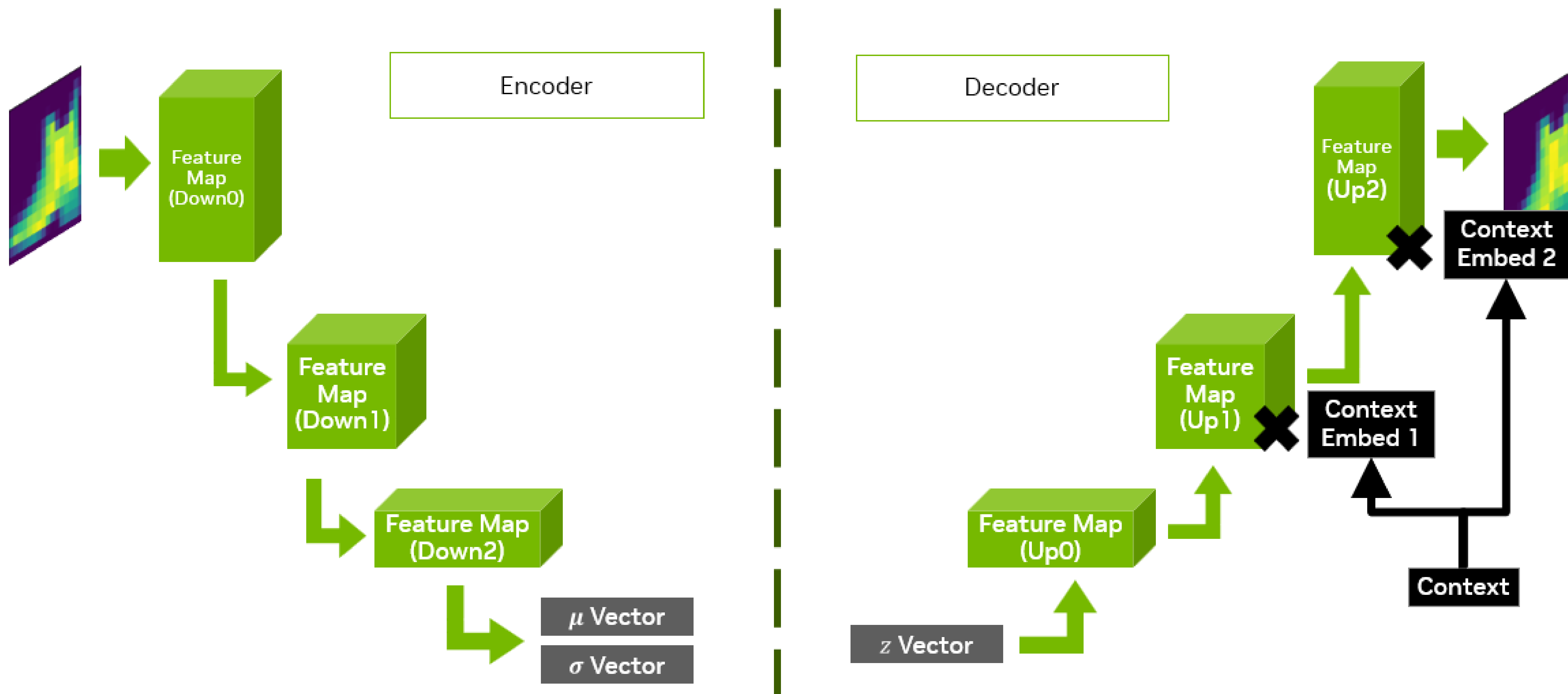
Autoencoders



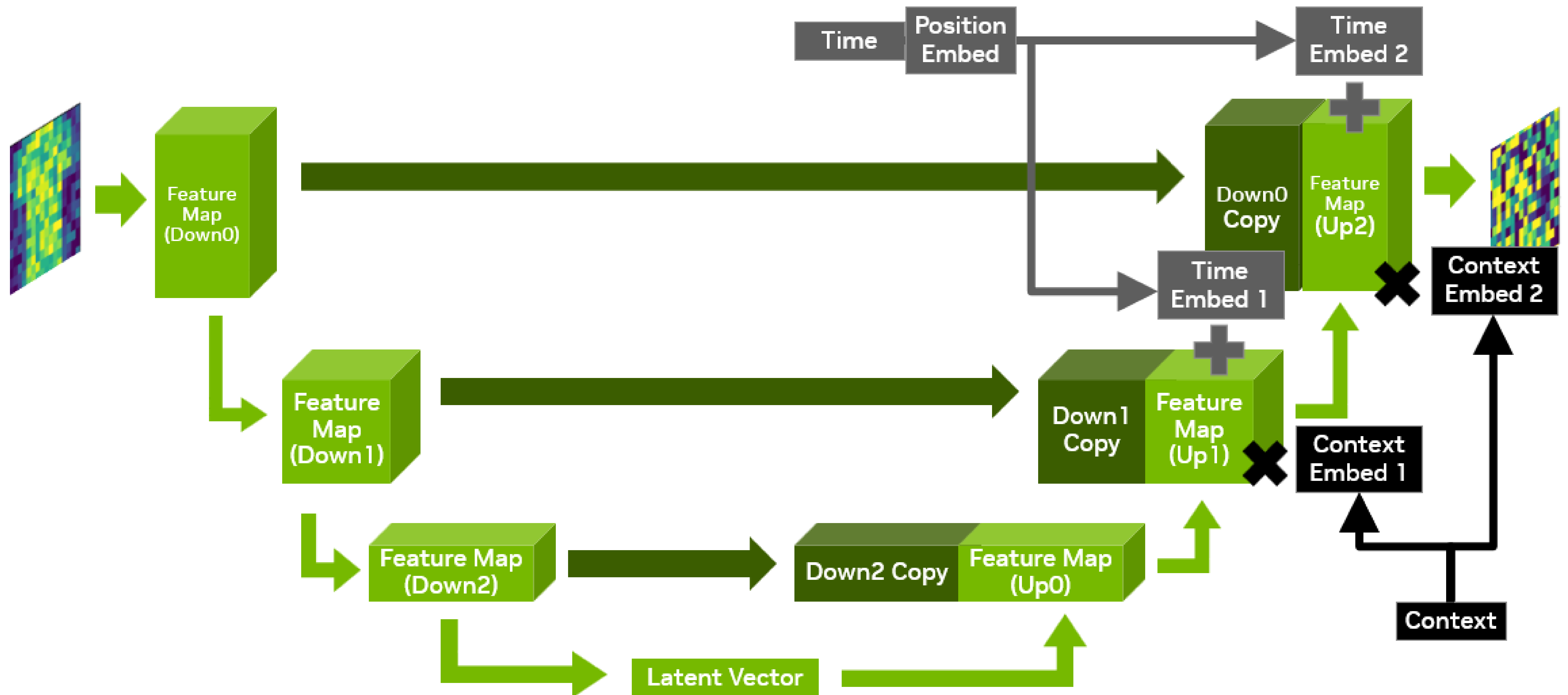
Autoencoders



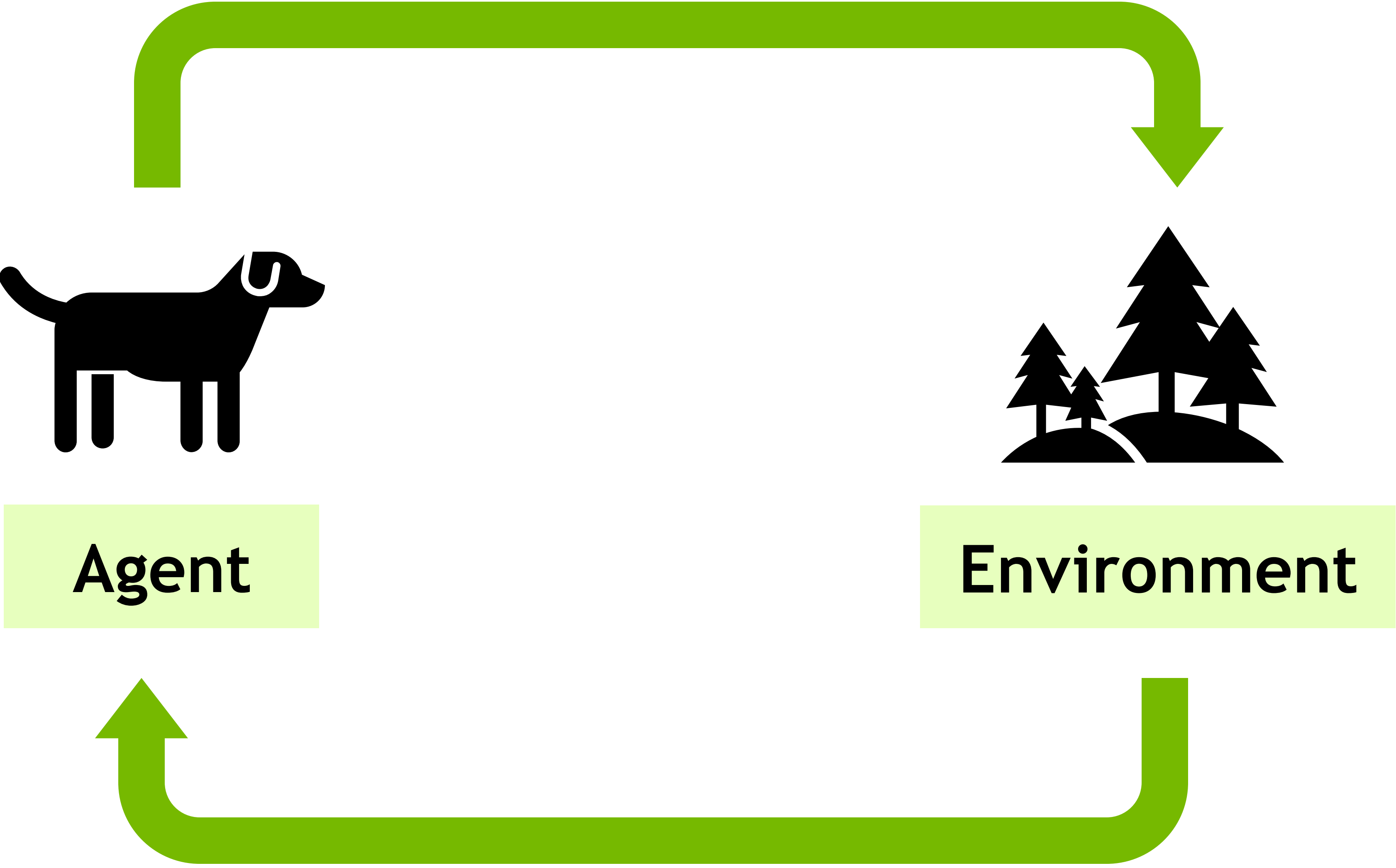
Variational Autoencoder



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

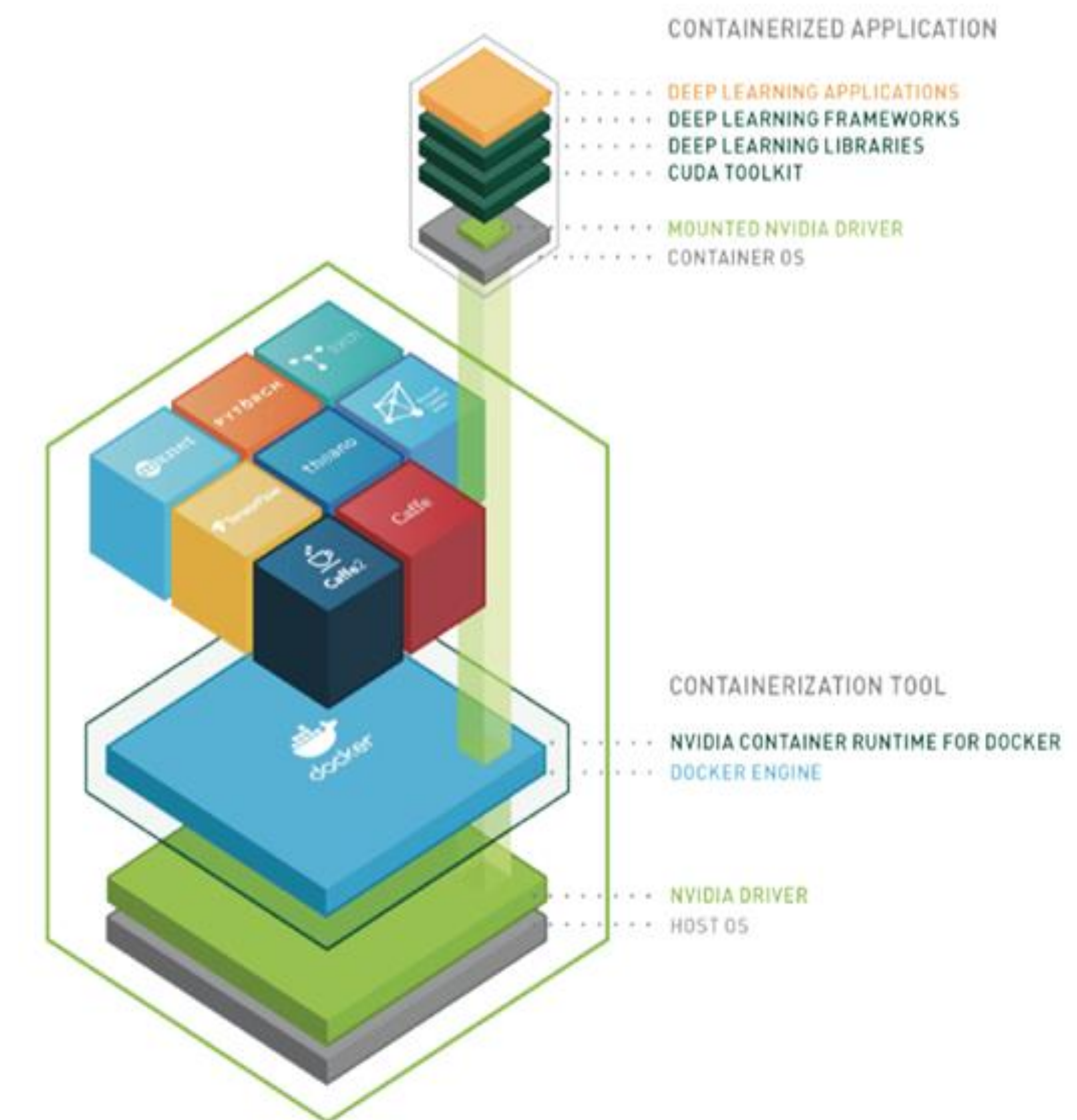
- Supports multi-GPU & multi-node systems

Designed for Enterprise & HPC

- Supports Docker, Singularity & other runtimes

Run Anywhere

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

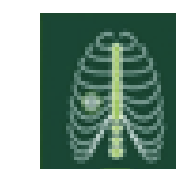


CONVERSATIONAL AI



Riva

HEALTHCARE



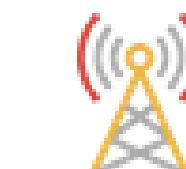
CLARA

SMART CITIES



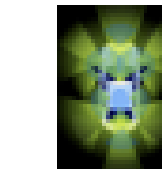
DEEPSTREAM &
SMART PARKING

TELECOM



AERIAL

AUTONOMOUS DRIVING



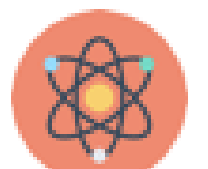
DRIVE

ROBOTICS



ISAAC

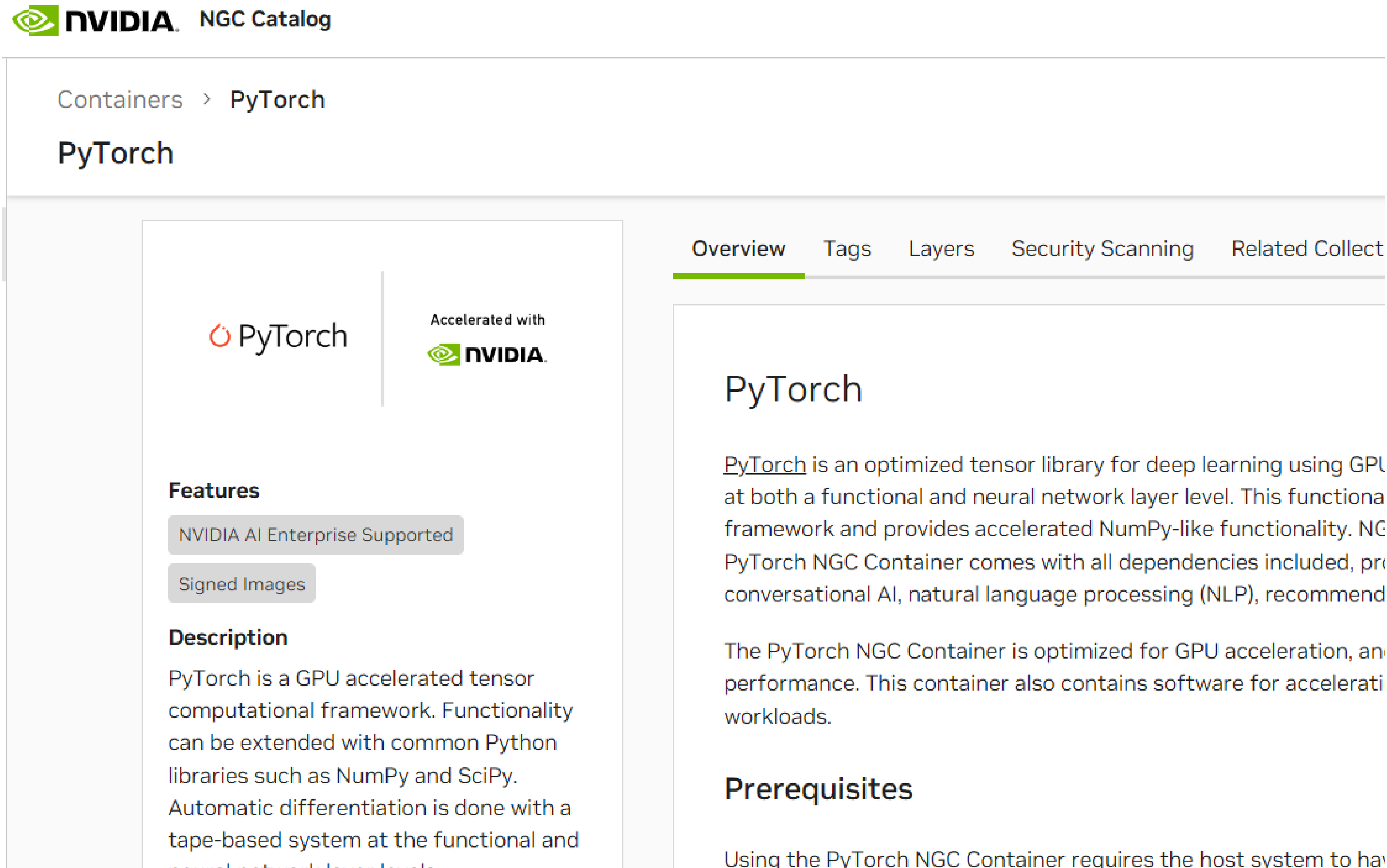
HPC



HPC SDK

[Learn more about NGC Containers](#)

Next Steps for This Class



The screenshot shows the NVIDIA NGC Catalog interface for the PyTorch container. The top navigation bar includes the NVIDIA logo and 'NGC Catalog'. Below it, a breadcrumb trail shows 'Containers > PyTorch'. The main content area is titled 'PyTorch' and features a sidebar with the PyTorch logo, 'Accelerated with NVIDIA' logo, and a 'Features' section listing 'NVIDIA AI Enterprise Supported' and 'Signed Images'. The main content area has tabs for 'Overview', 'Tags', 'Layers', 'Security Scanning', and 'Related Collections'. The 'Overview' tab is active, displaying a description of PyTorch as an optimized tensor library for deep learning using GPU, and a section for 'Prerequisites' stating that the host system must have certain requirements.

NVIDIA NGC Catalog

Containers > PyTorch

PyTorch

Overview Tags Layers Security Scanning Related Collections

PyTorch

Accelerated with NVIDIA

Features

- NVIDIA AI Enterprise Supported
- Signed Images

Description

PyTorch is a GPU accelerated tensor computational framework. Functionality can be extended with common Python libraries such as NumPy and SciPy. Automatic differentiation is done with a tape-based system at the functional and computational level.

Prerequisites

Using the PyTorch NGC Container requires the host system to have:

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





Let's get Started!

