



# Fundamentals of Deep Learning

Part 6: Advanced Architectures



# Agenda

- Part 1: An Introduction to Deep Learning

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- Part 2: How a Neural Network Trains

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- Part 3: Convolutional Neural Networks

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- Part 4: Data Augmentation and Deployment

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- Part 5: Pre-Trained Models
- Part 6: Advanced Architectures

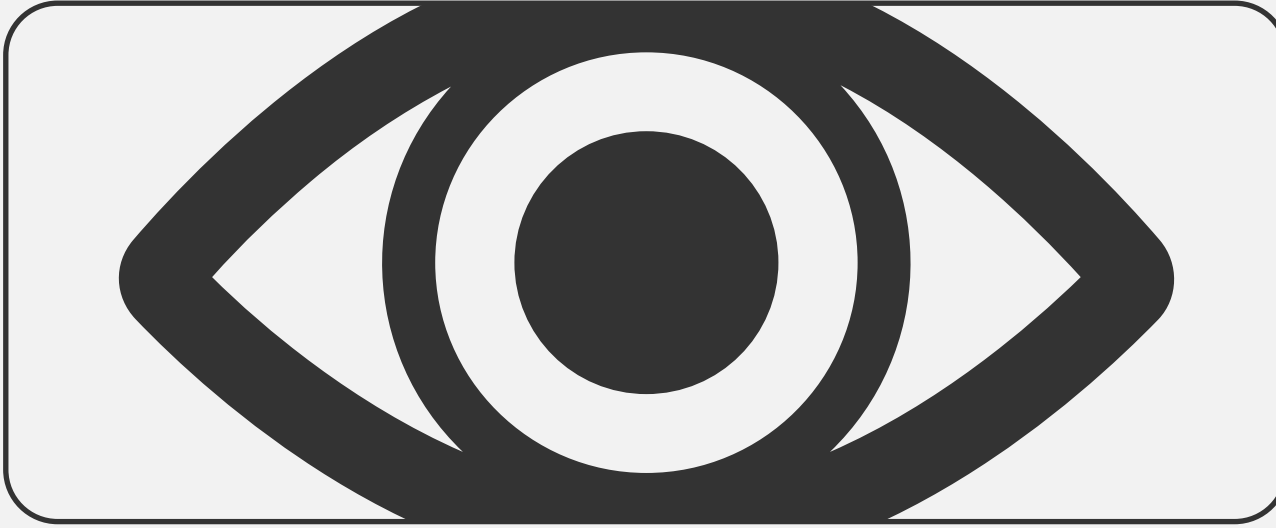




**Moving Forward**

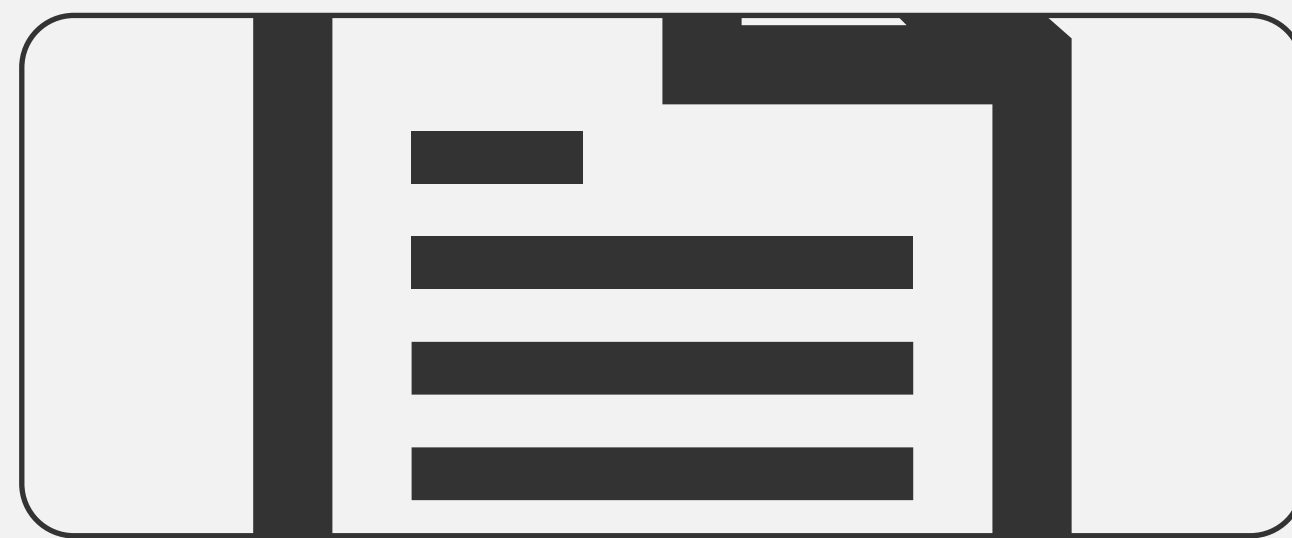


# Fields of AI



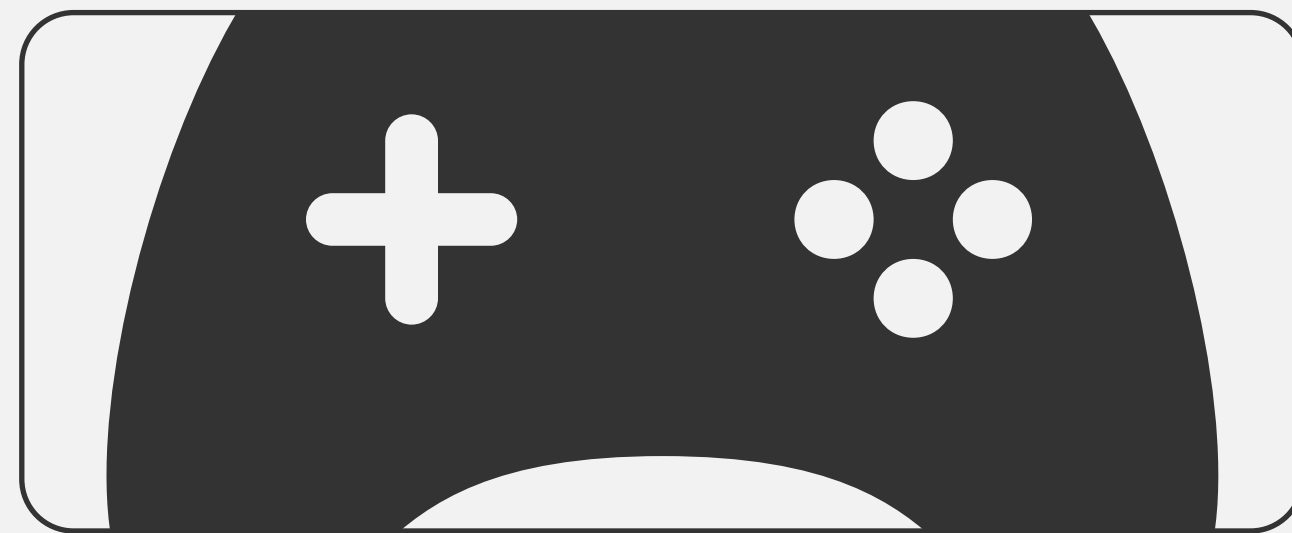
## Computer Vision

- Optometry



## Natural Language Processing

- Linguistics



## Reinforcement Learning

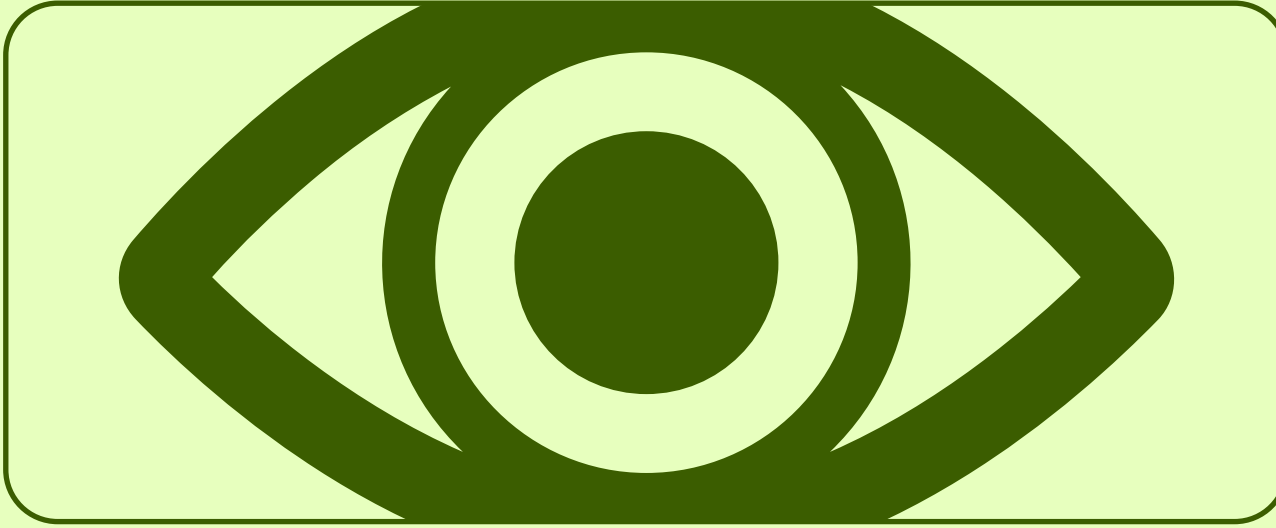
- Game Theory
- Psychology



## Anomaly Detection

- Security
- Medicine

# Fields of AI



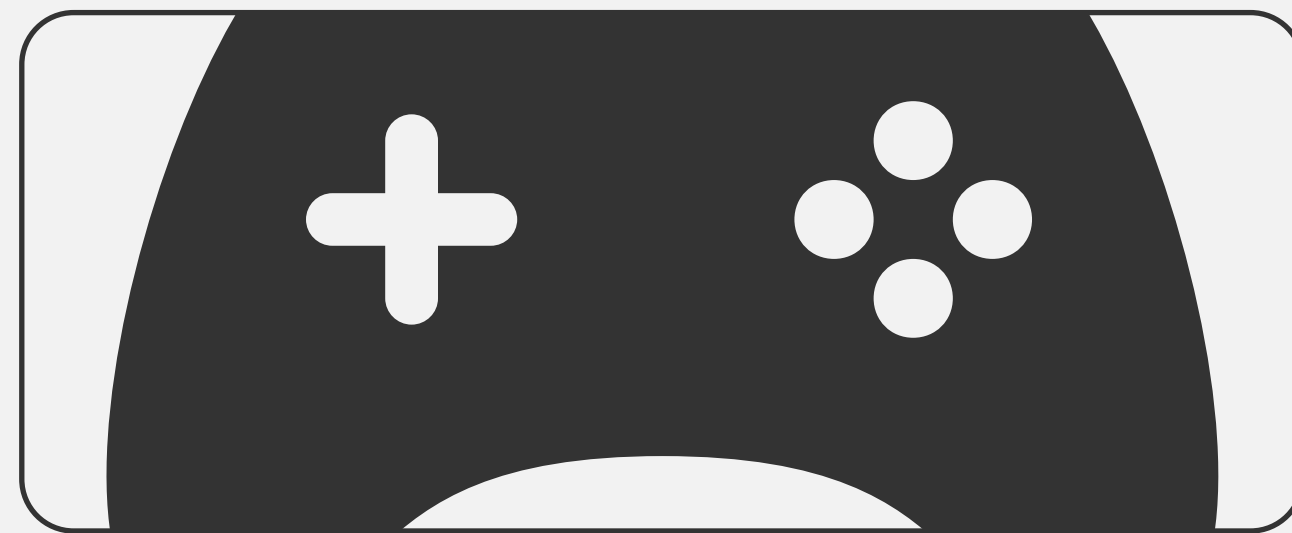
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## Reinforcement Learning

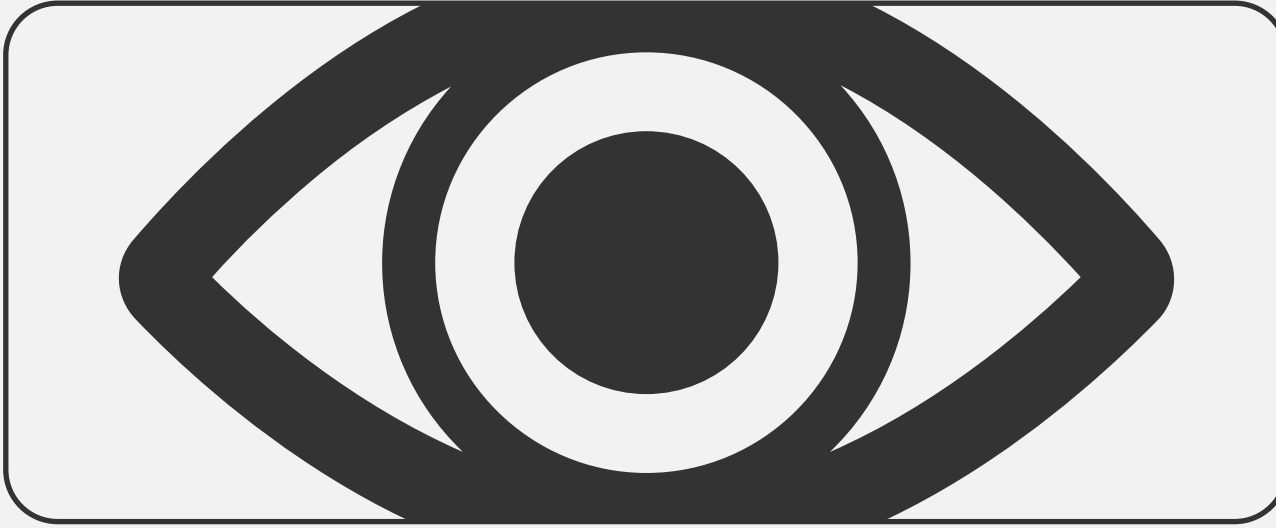
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## Anomaly Detection

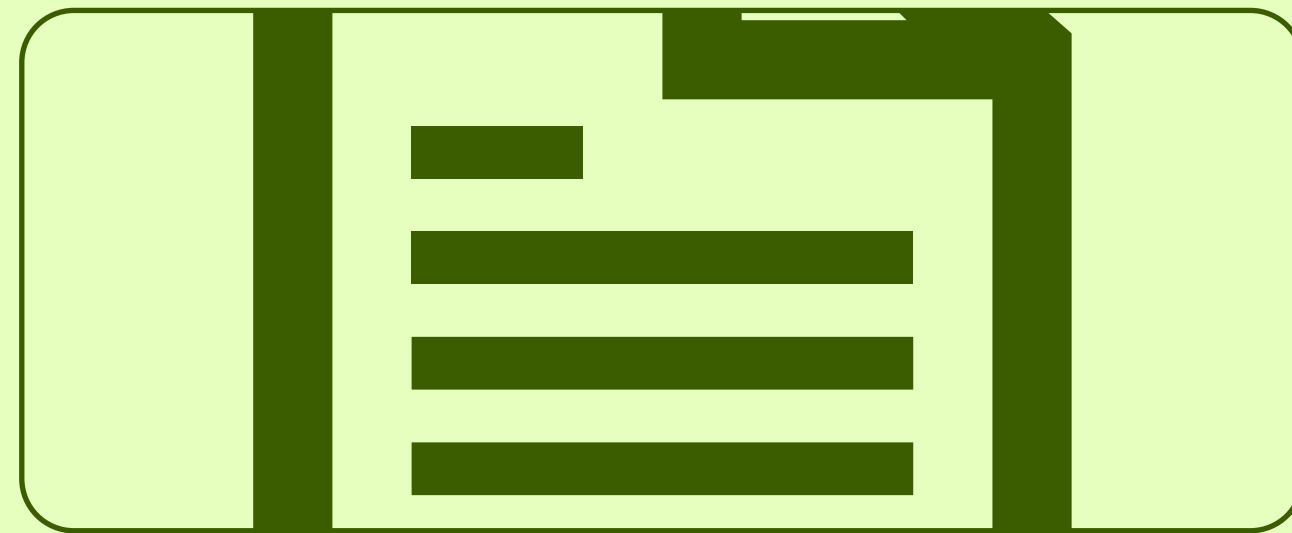
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# Fields of AI



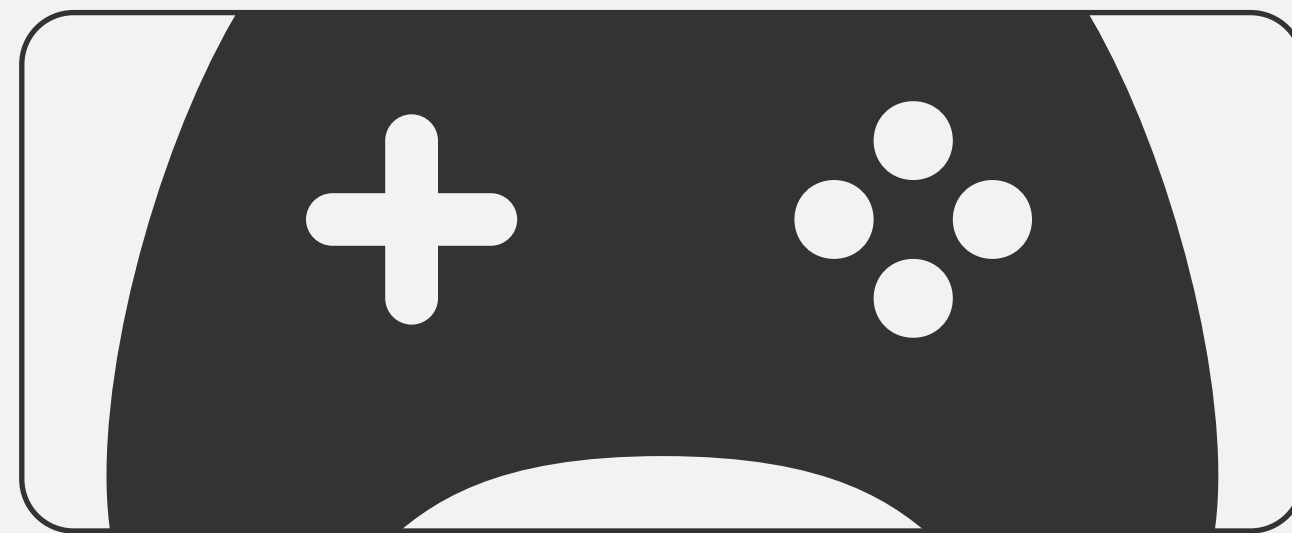
## Computer Vision

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## Reinforcement Learning

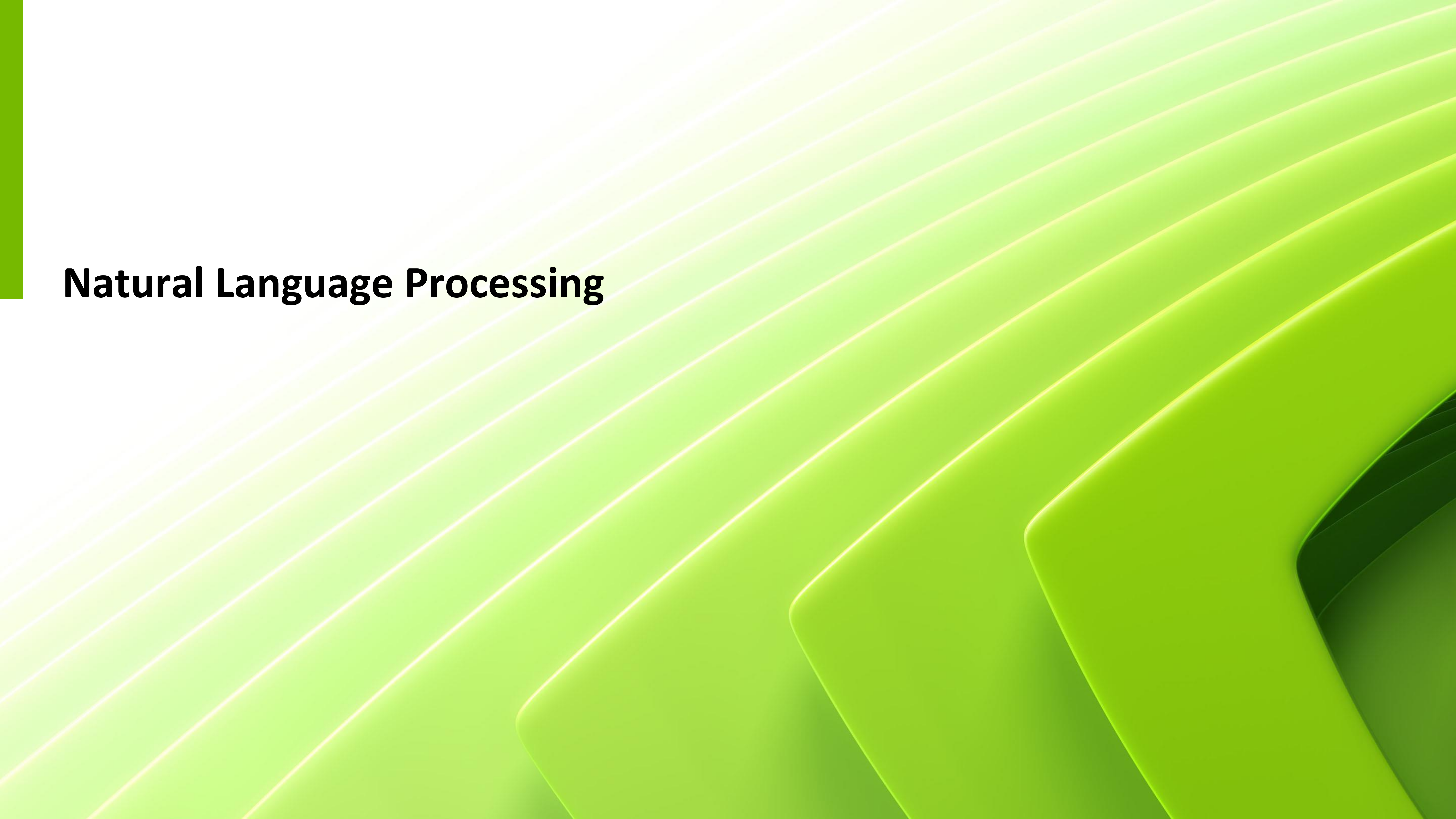
- Game Theory
- Psychology



## Anomaly Detection

- Security
- Medicine





# **Natural Language Processing**



## From Words to Numbers

“A dog barked at a cat.”

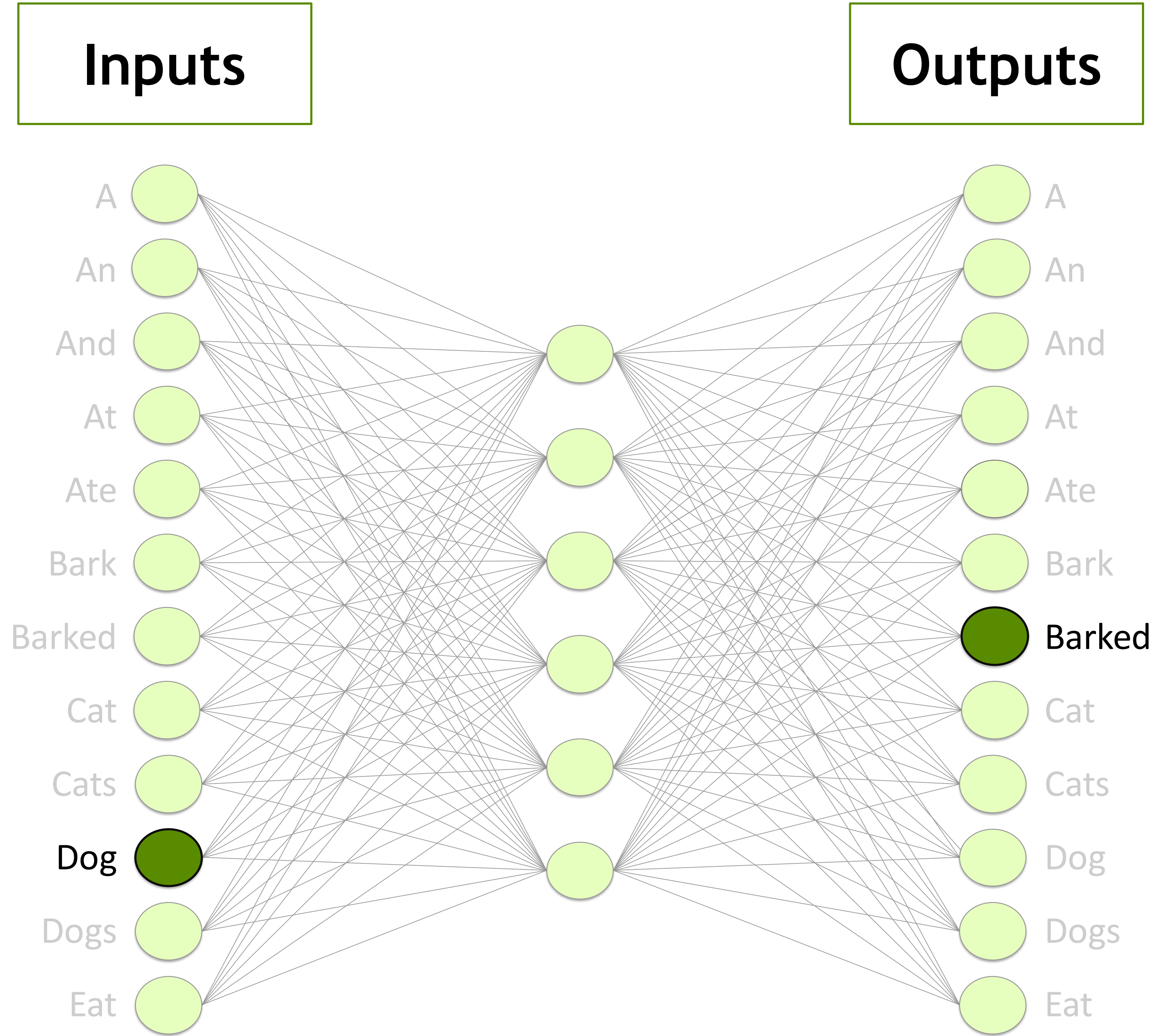
[1, 10, 7, 4, 1, 8]

### 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   |



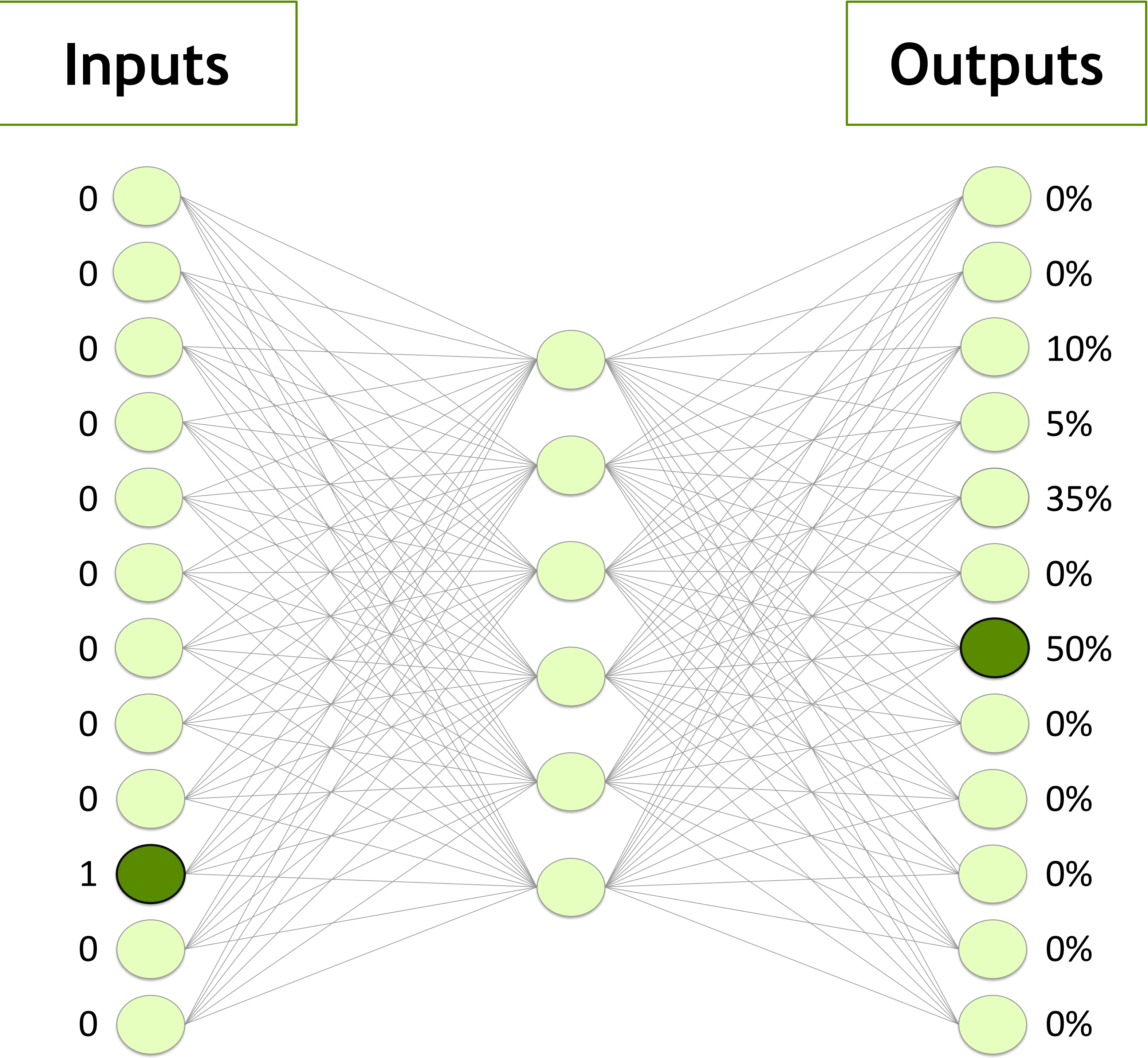
# From Words to Numbers



DICTIONARY	
1. A	7. BARKED
2. AN	8. CAT
3. AND	9. CATS
4. AT	10. DOG
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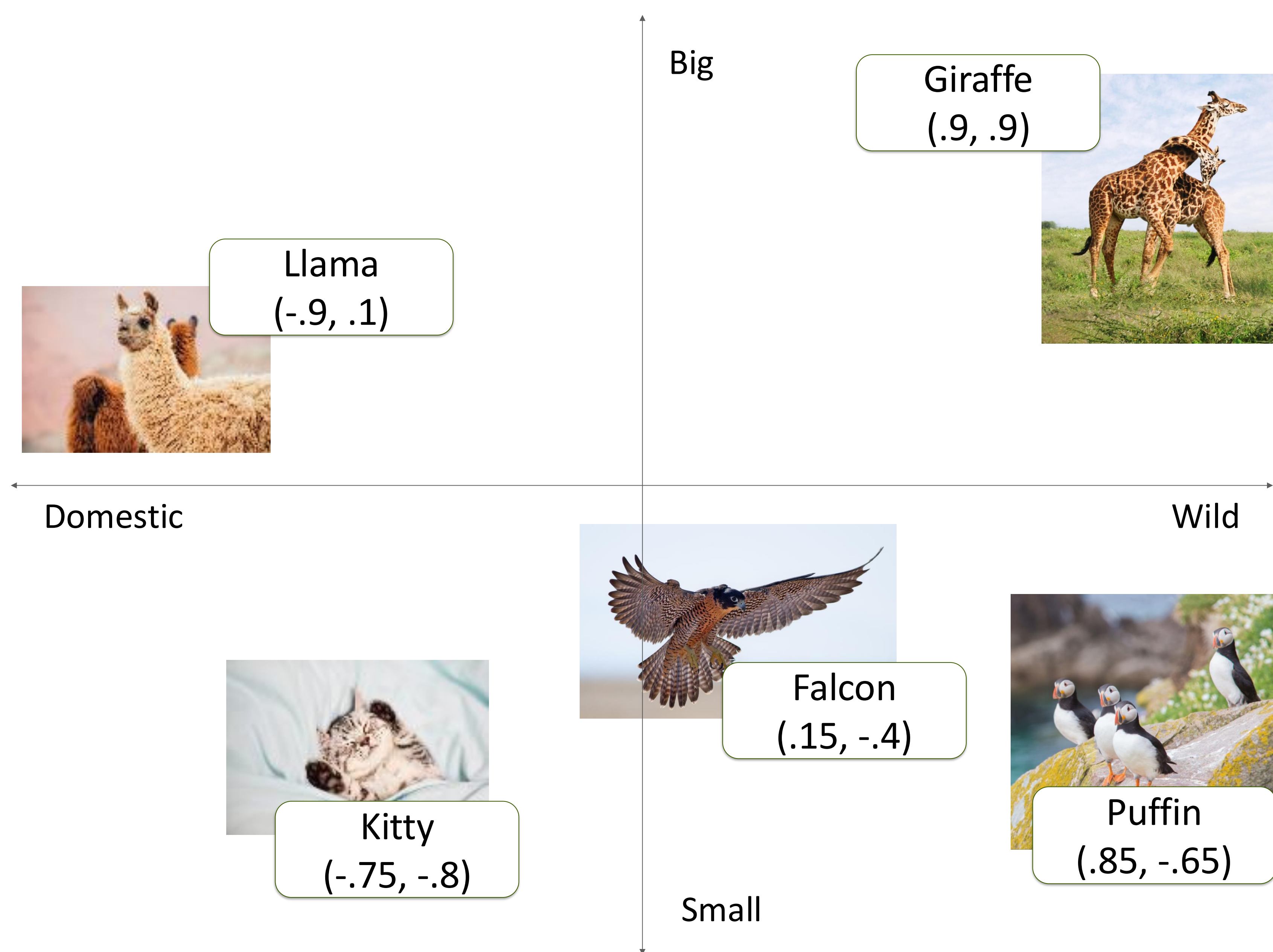
# From Words to Numbers



DICTIONARY	
1. A	7. BARKED
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4. AT	10. DOG
5. ATE	11. DOGS
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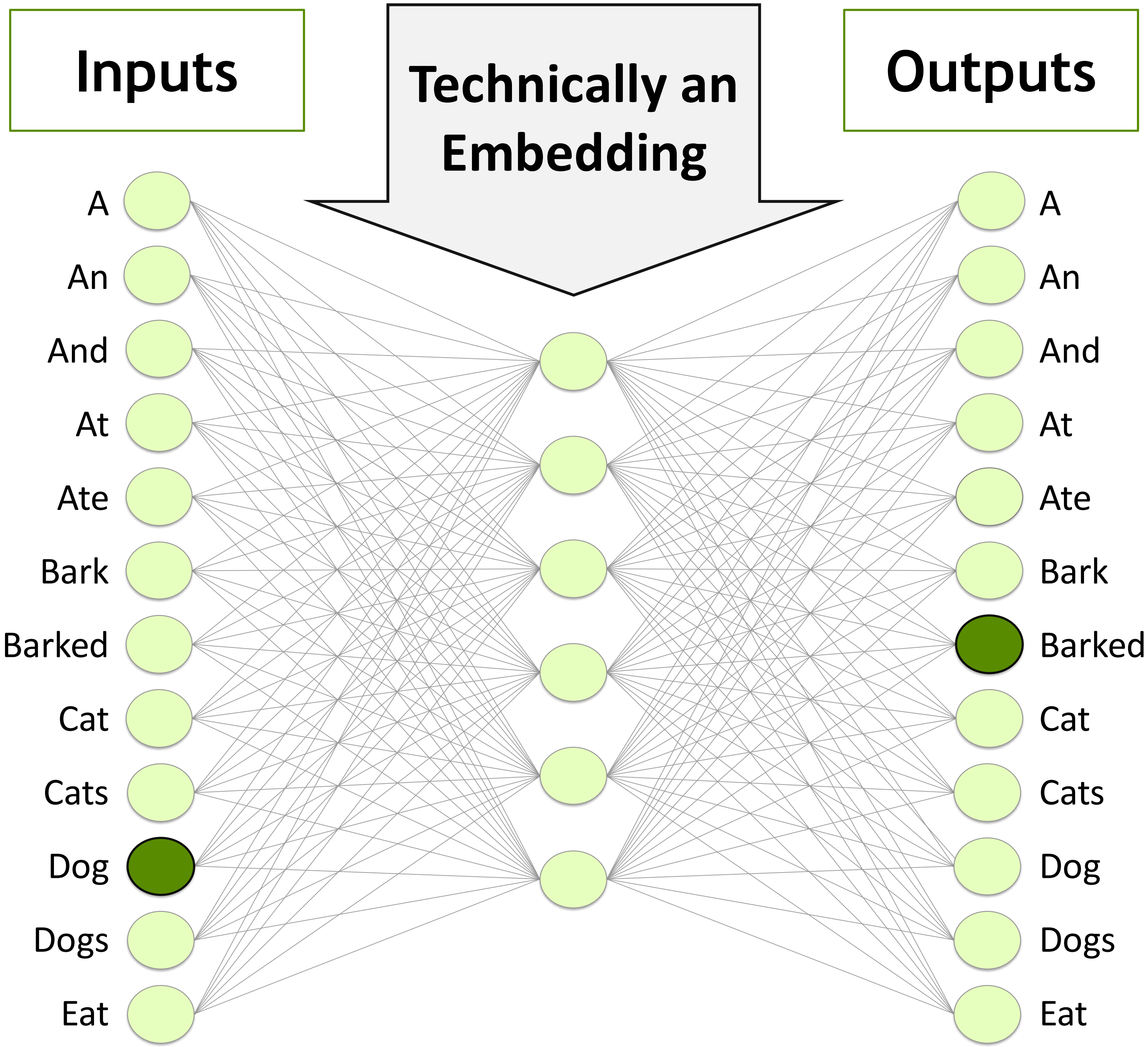
# From Words to Numbers



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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24.	DOGS	56.	AT		
25.	EAT	57.	ATE		
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27.	A	59.	BARKED		
28.	AN	60.	CAT		
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

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

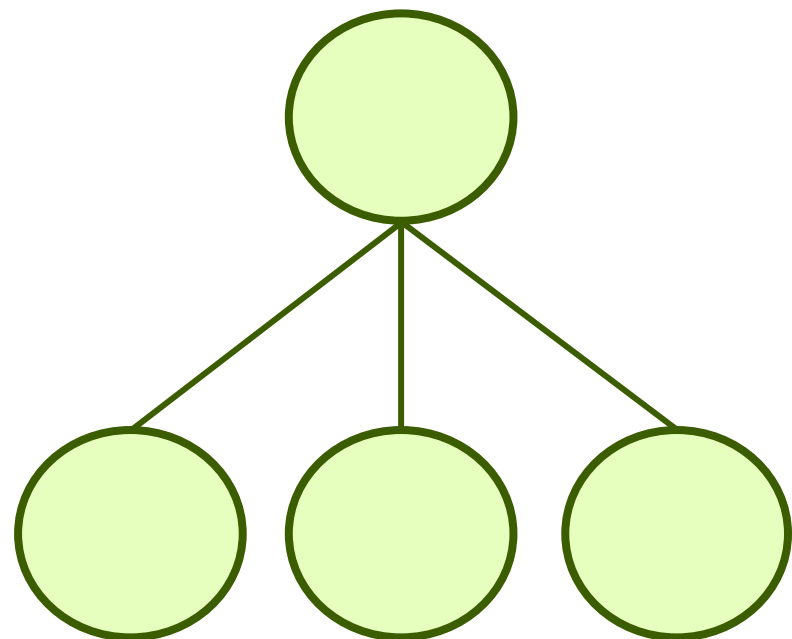
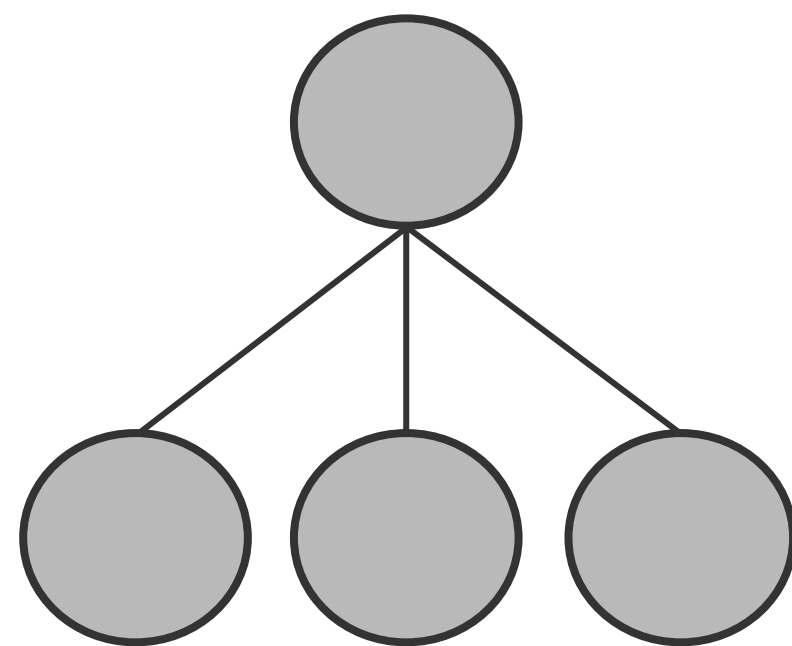
...

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 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



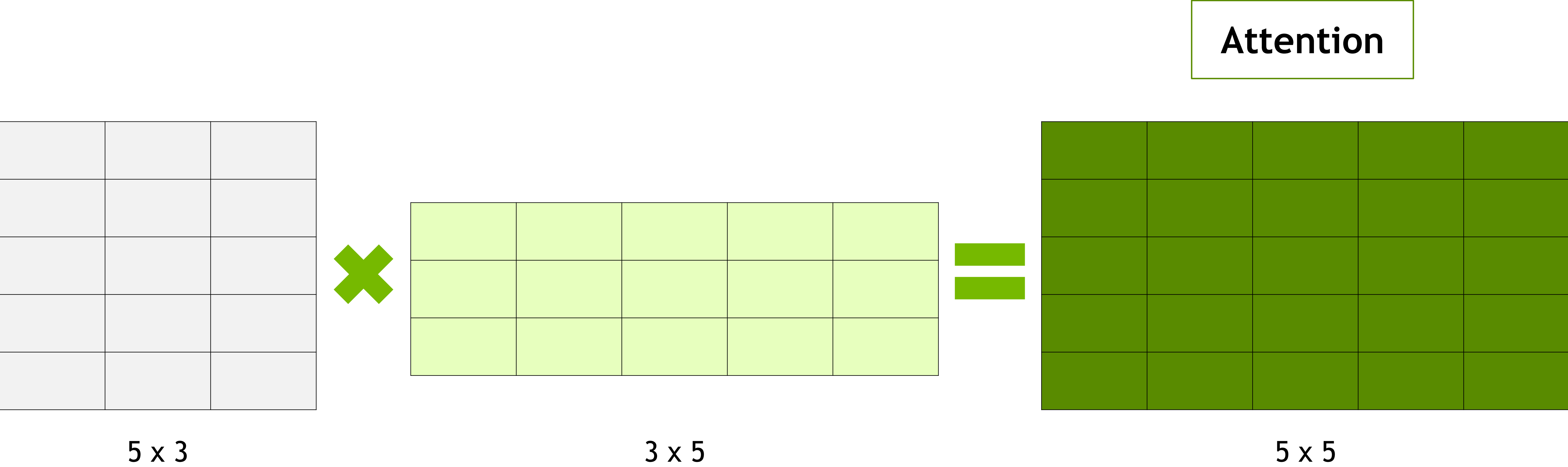
# Attention


5 x 3


3 x 5



# Attention



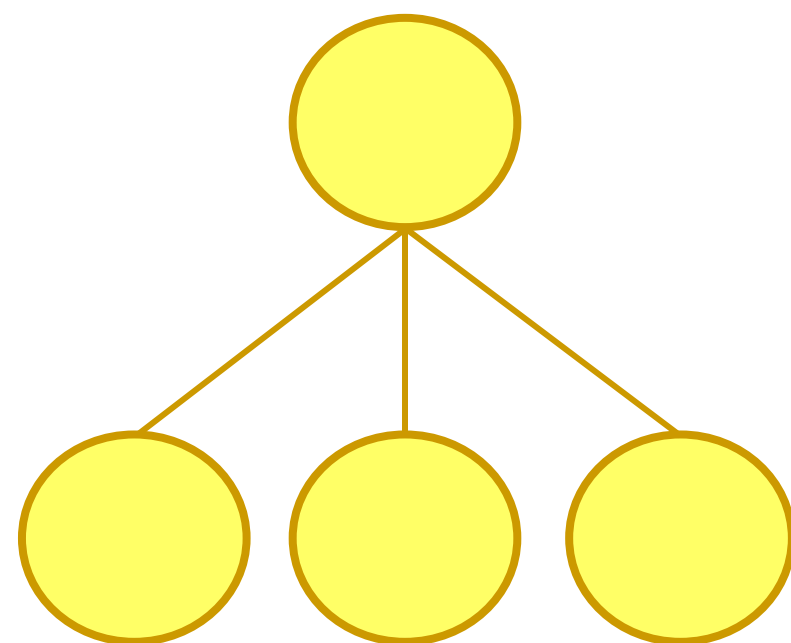
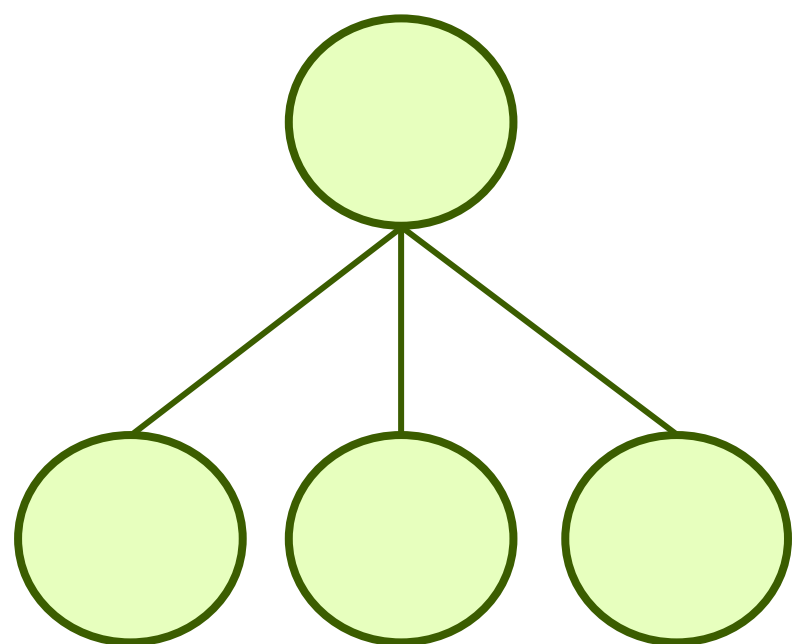
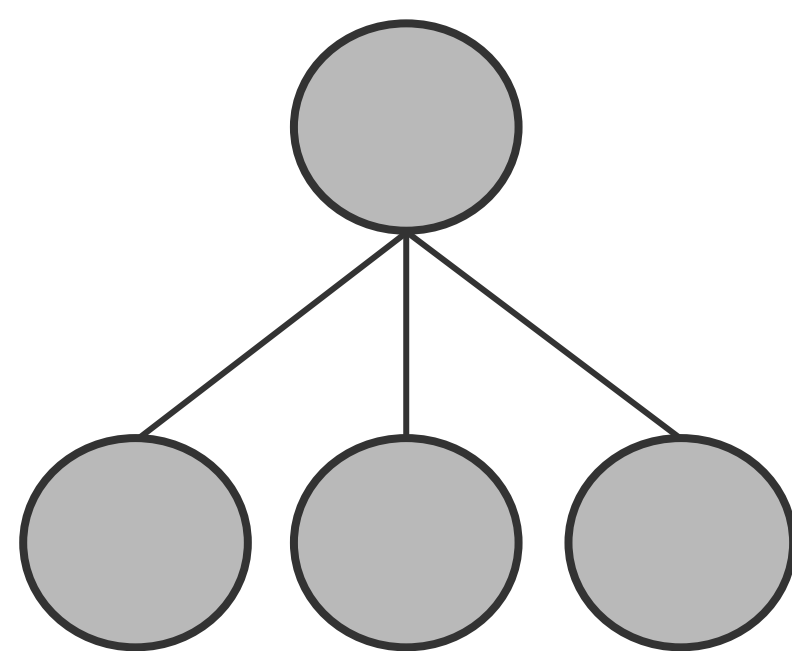


# Attention

		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

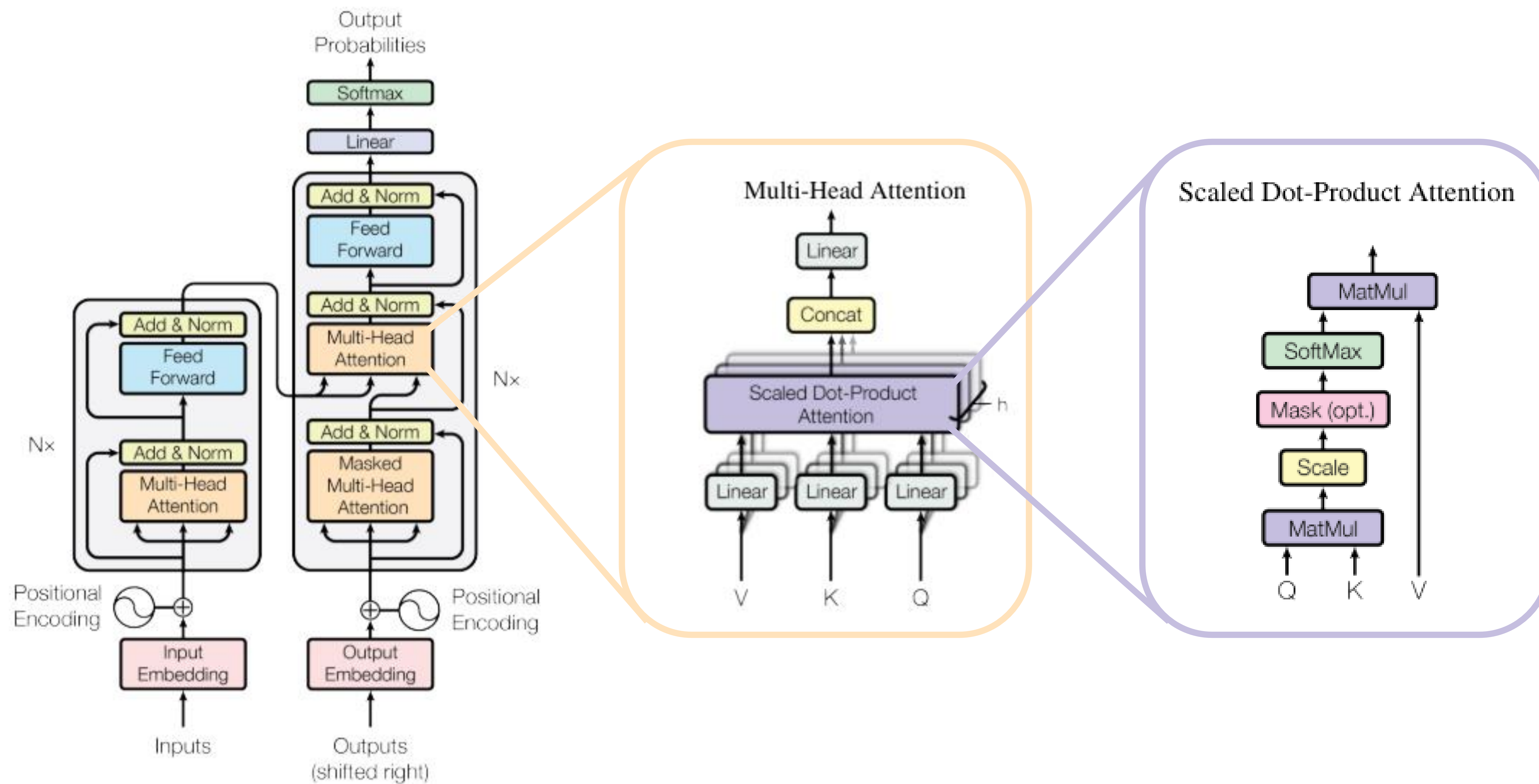
Query

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

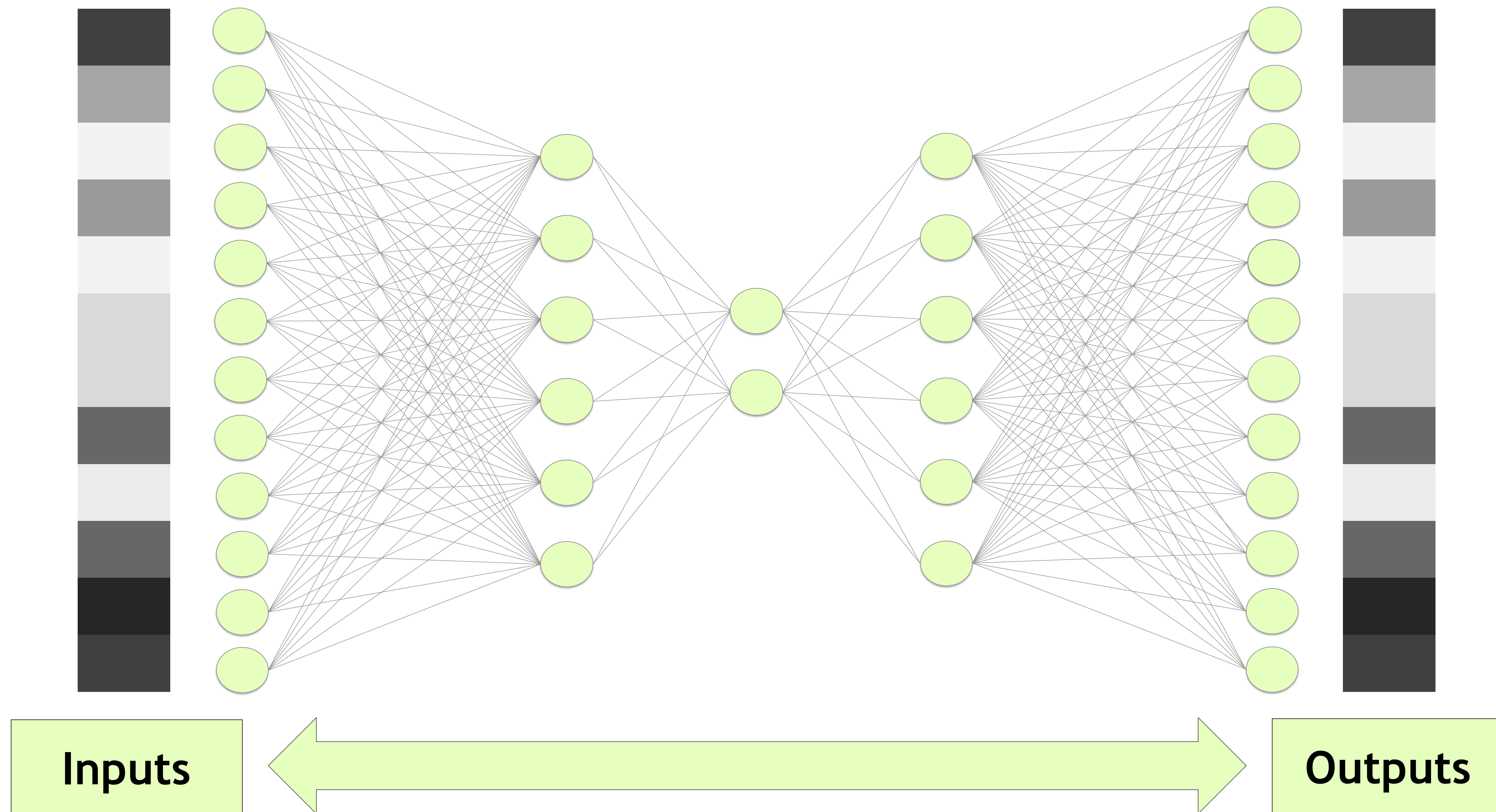




# **Other Architectures**

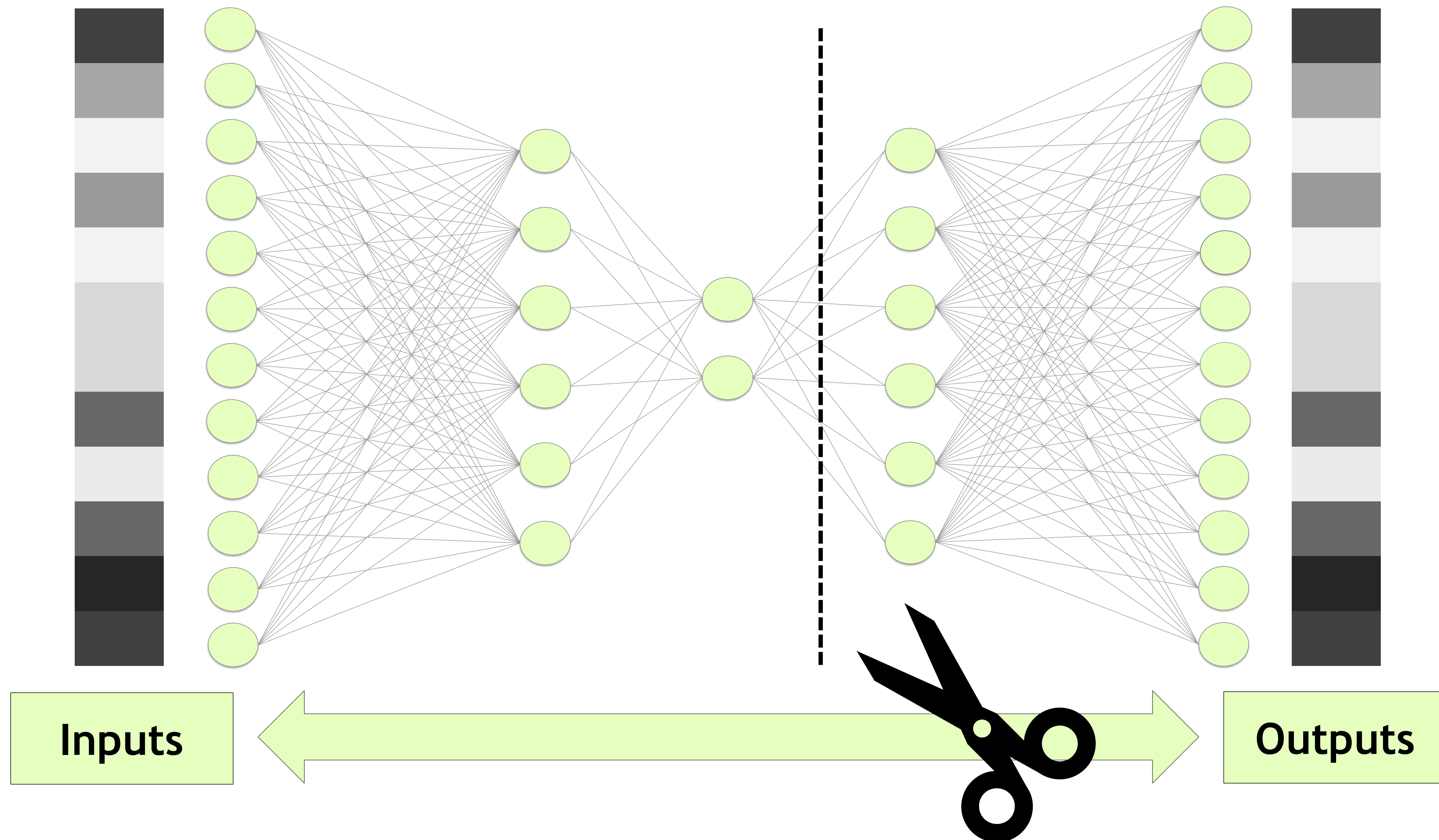


# Autoencoders



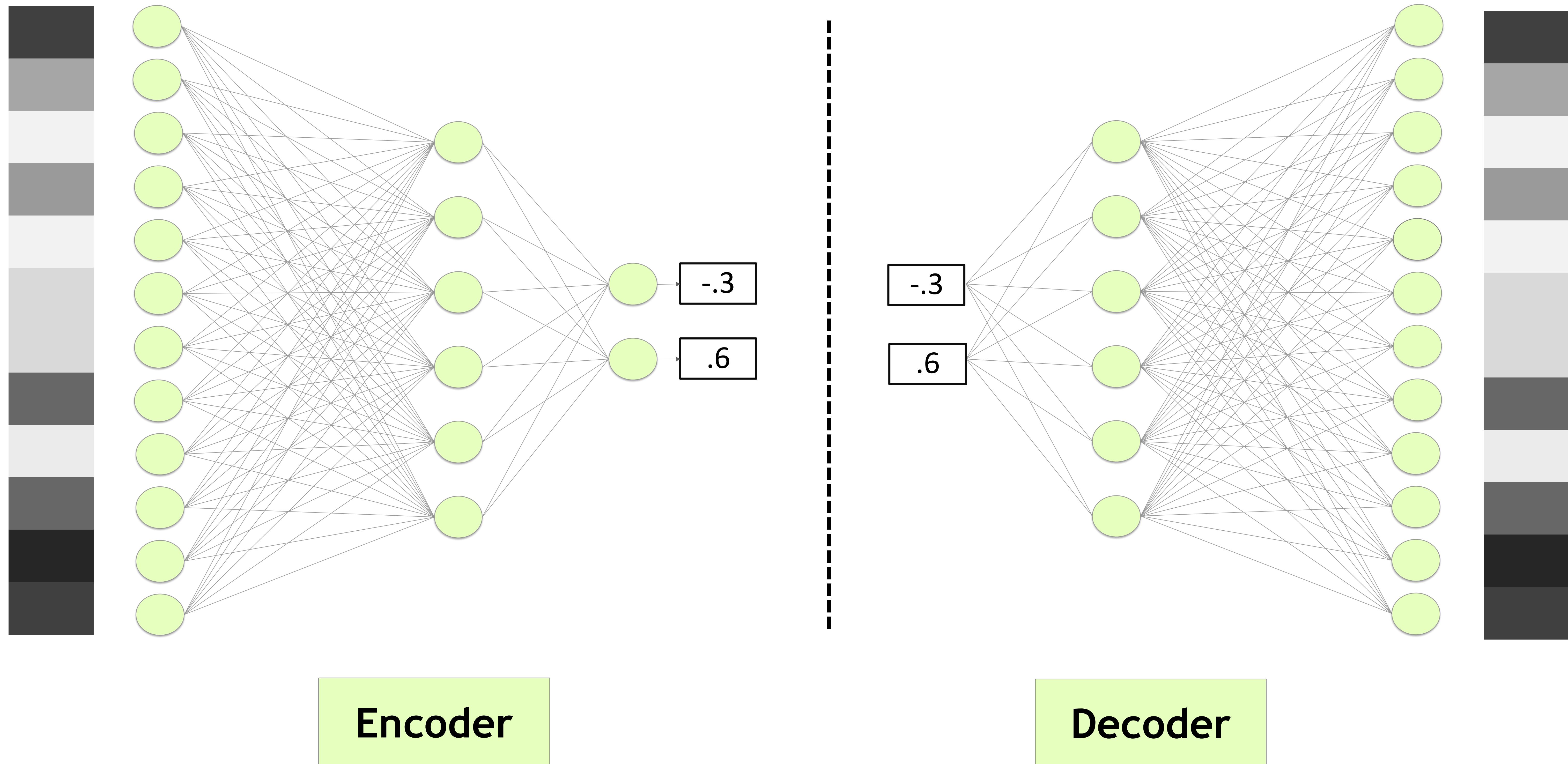


# Autoencoders

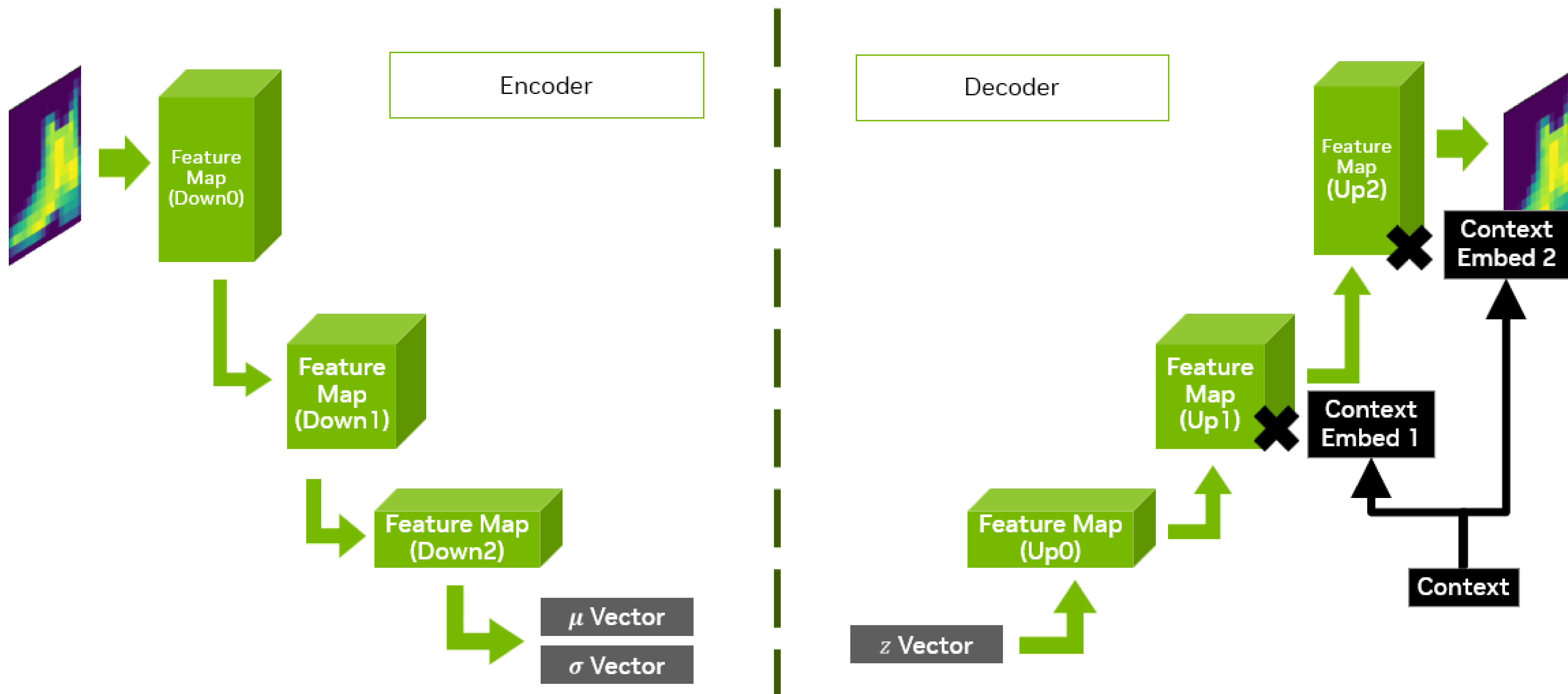




# Autoencoders

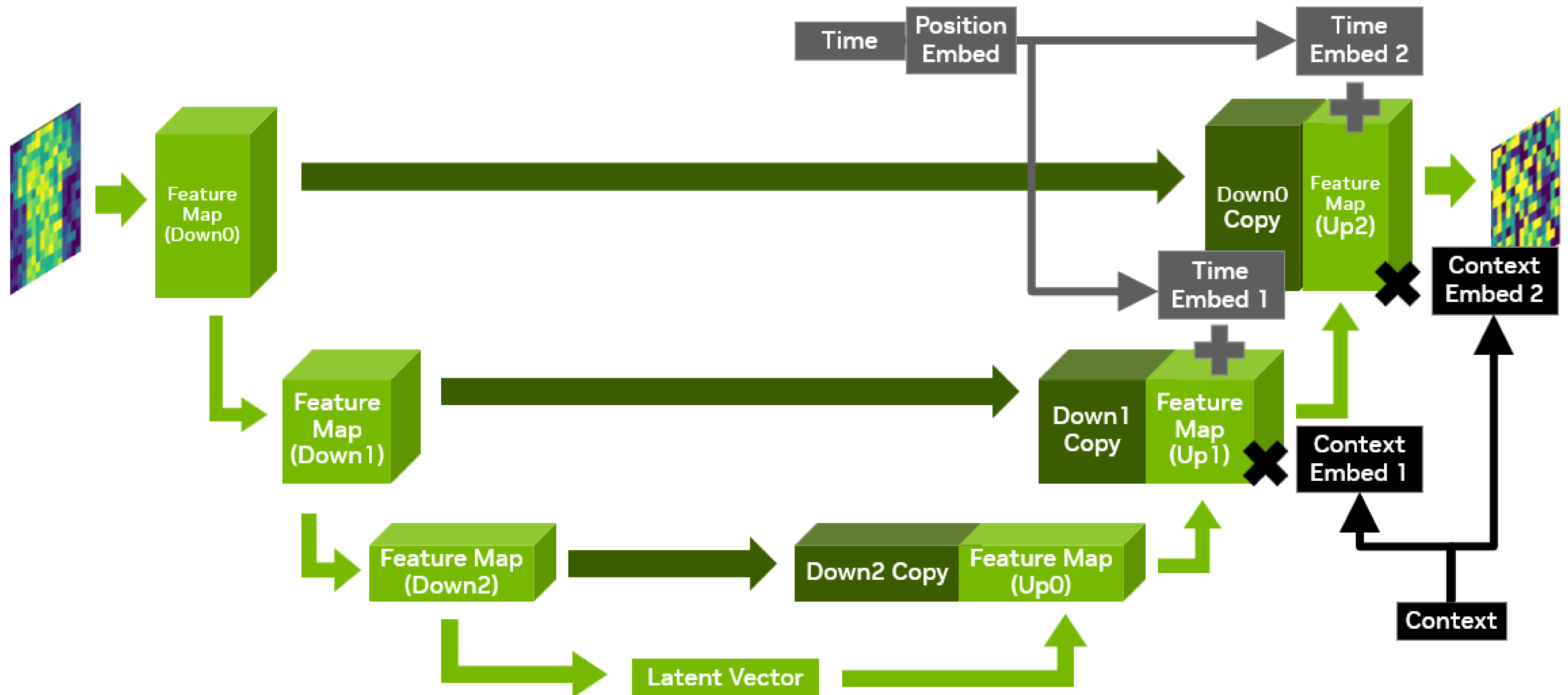


# Variational Autoencoder

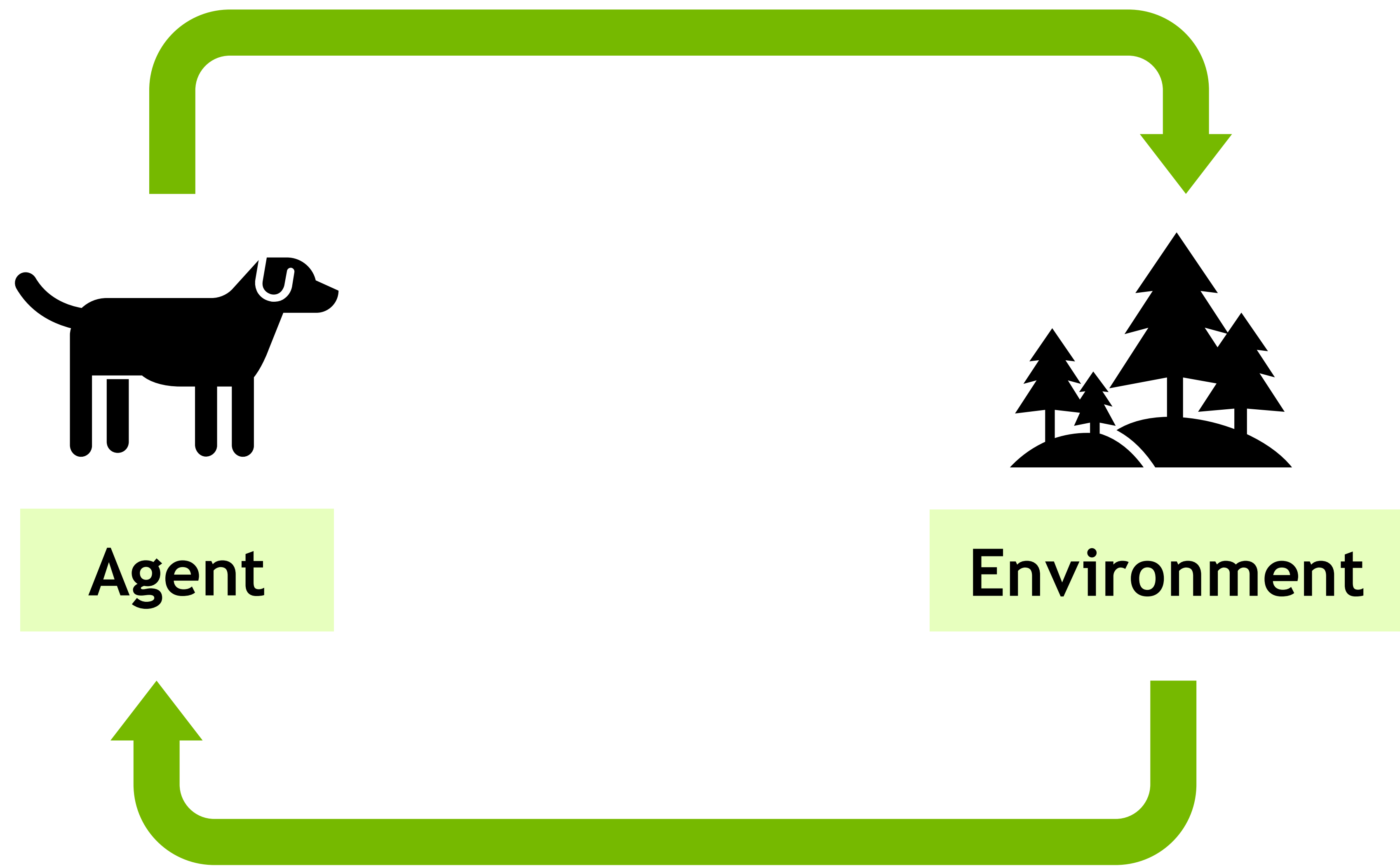




# Diffusion Models



# 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

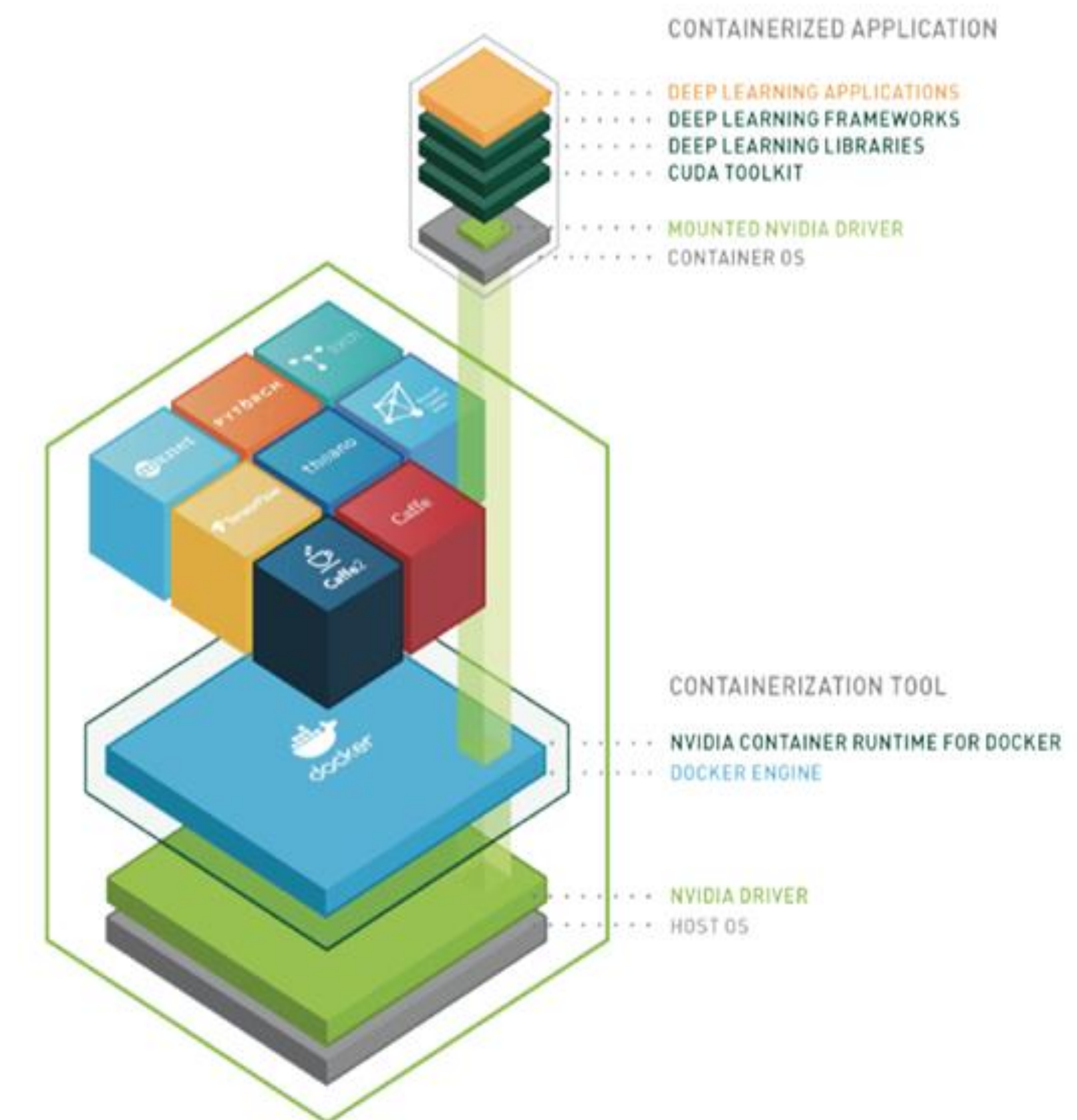
- Supports multi-GPU & multi-node systems

### Designed for Enterprise & HPC

- Supports Docker, Singularity & other runtimes

### Run Anywhere

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

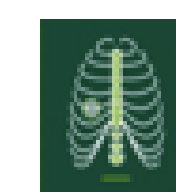


CONVERSATIONAL AI



Riva

HEALTHCARE



CLARA

SMART CITIES



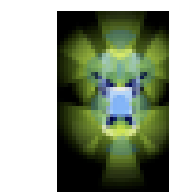
DEEPSTREAM &  
SMART PARKING

TELECOM



AERIAL

AUTONOMOUS DRIVING



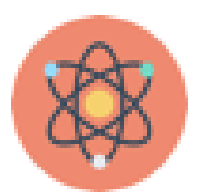
DRIVE

ROBOTICS



ISAAC

HPC

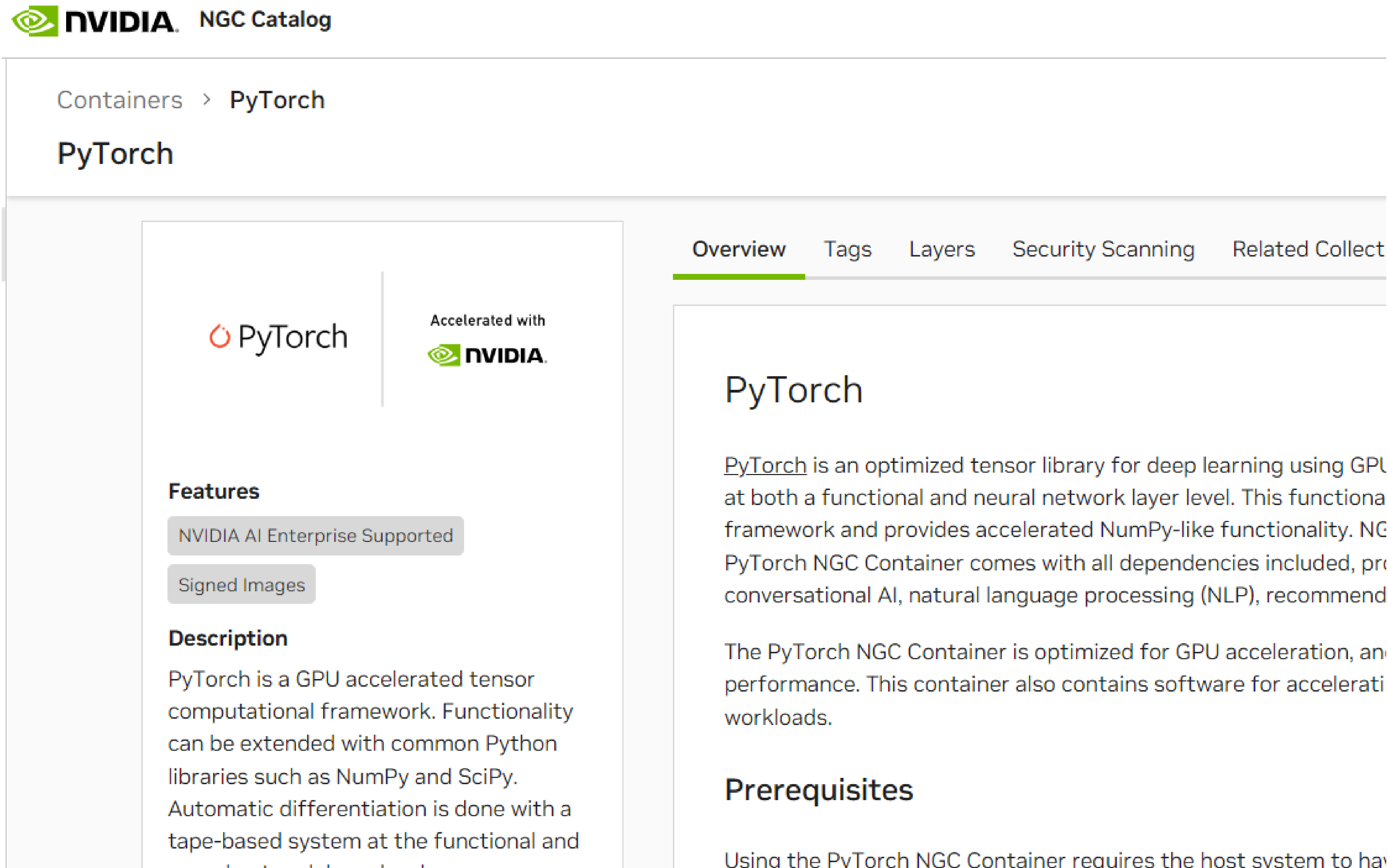


HPC SDK

[Learn more about NGC Containers](#)



# Next Steps for This Class



The screenshot shows the NVIDIA NGC Catalog interface. At the top, the NVIDIA logo and 'NGC Catalog' are visible. Below the navigation bar, the breadcrumb 'Containers > PyTorch' is shown. The main content area is titled 'PyTorch' and includes a sidebar with the PyTorch logo and 'Accelerated with NVIDIA' text. The sidebar also lists 'Features' (NVIDIA AI Enterprise Supported, Signed Images) and a 'Description' of PyTorch as a GPU accelerated tensor computational framework. The main content area has tabs for 'Overview', 'Tags', 'Layers', 'Security Scanning', and 'Related Collect'. 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 using the PyTorch NGC Container requires the host system to have certain capabilities.

NVIDIA NGC Catalog

Containers > PyTorch

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

**Overview** Tags Layers Security Scanning Related Collect

**PyTorch**

PyTorch is an optimized tensor library for deep learning using GPU at both a functional and neural network layer level. This functional framework and provides accelerated NumPy-like functionality. NGC PyTorch NGC Container comes with all dependencies included, pre-configured for conversational AI, natural language processing (NLP), recommendation systems, and more.

The PyTorch NGC Container is optimized for GPU acceleration, and performance. This container also contains software for accelerating workloads.

**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!**



