

# Understanding the Drawbacks of Using Deep Neural Networks with Images

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# Overview

**Deep Neural Networks (DNNs) for image classification**

**Drawbacks of using DNNs for image classification**

**Implementing a fully-connected neural network for image classification**

# Deep Neural Networks for Image Classification

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# Deep Learning and Neural Networks

## Deep Learning

Algorithms that learn  
what features matter

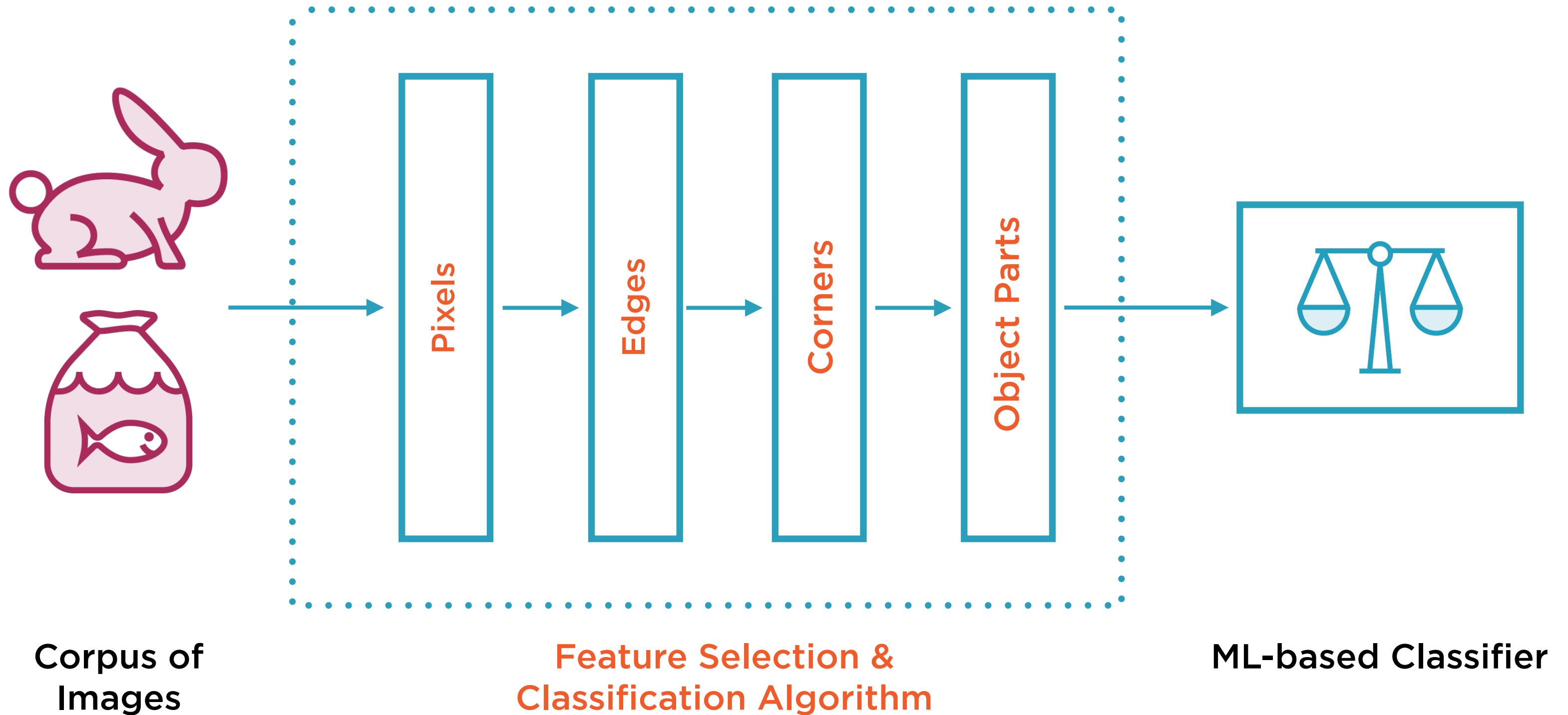
## Neural Networks

The most common class  
of deep learning  
algorithms

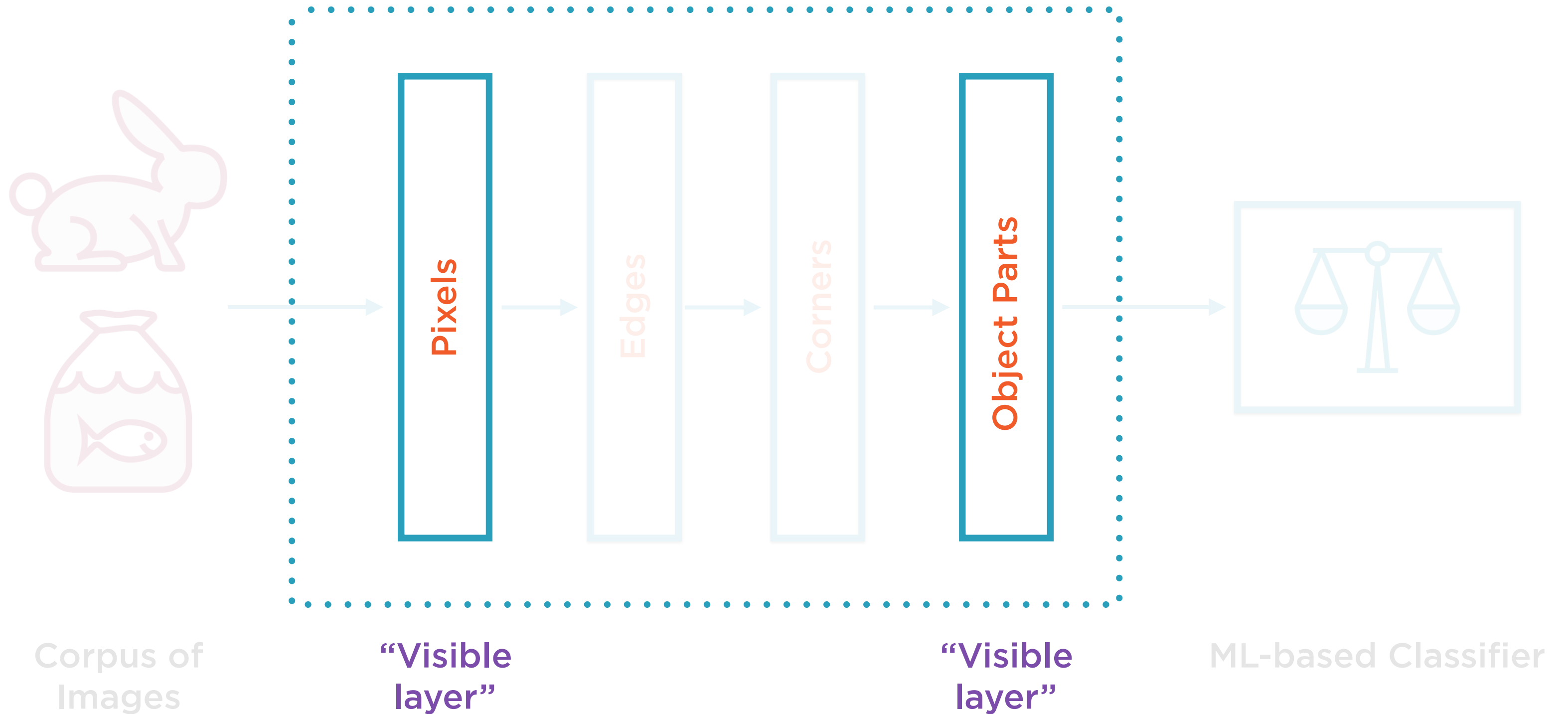
## Neurons

Simple building blocks  
that actually “learn”

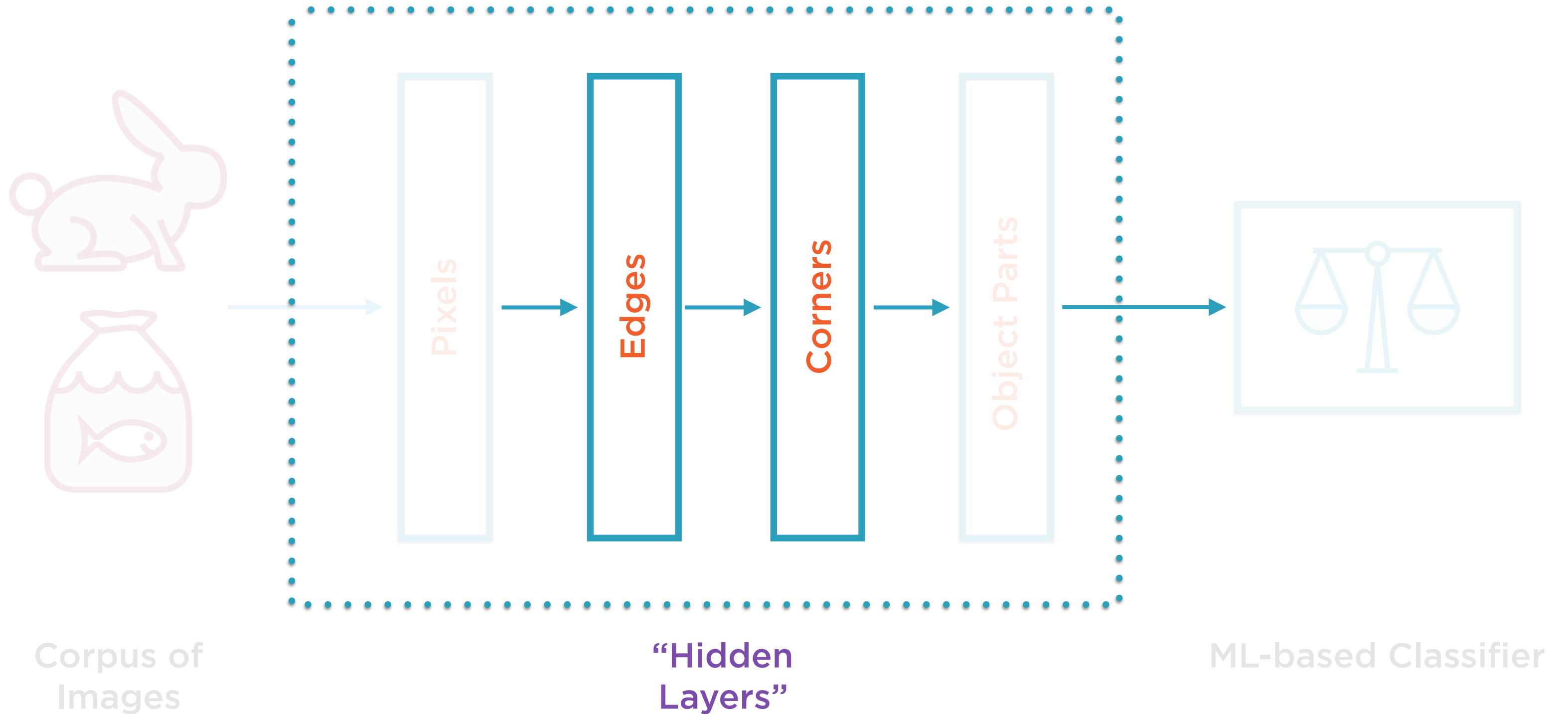
# “Deep Learning”-based Binary Classifier



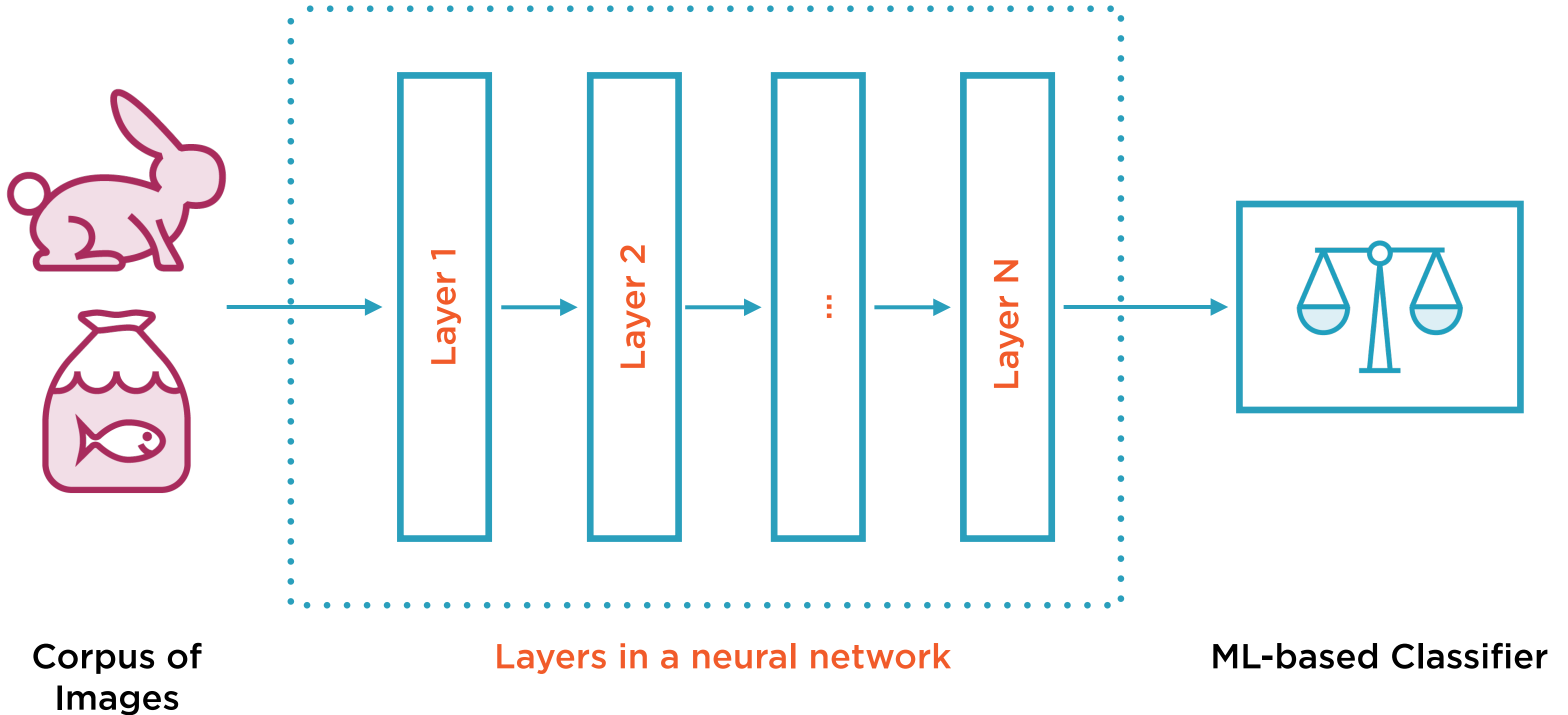
# “Deep Learning”-based Binary Classifier



# “Deep Learning”-based Binary Classifier

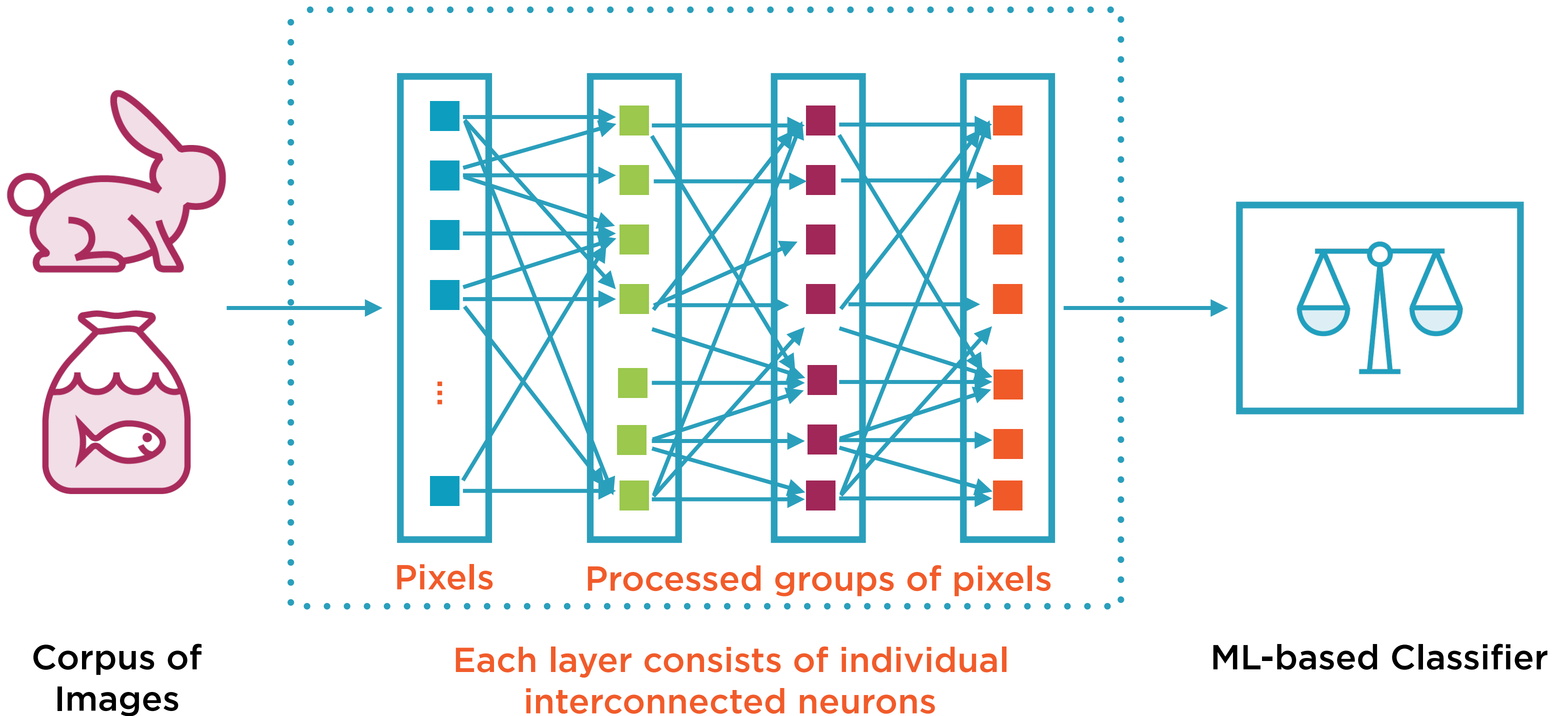


# Neural Networks

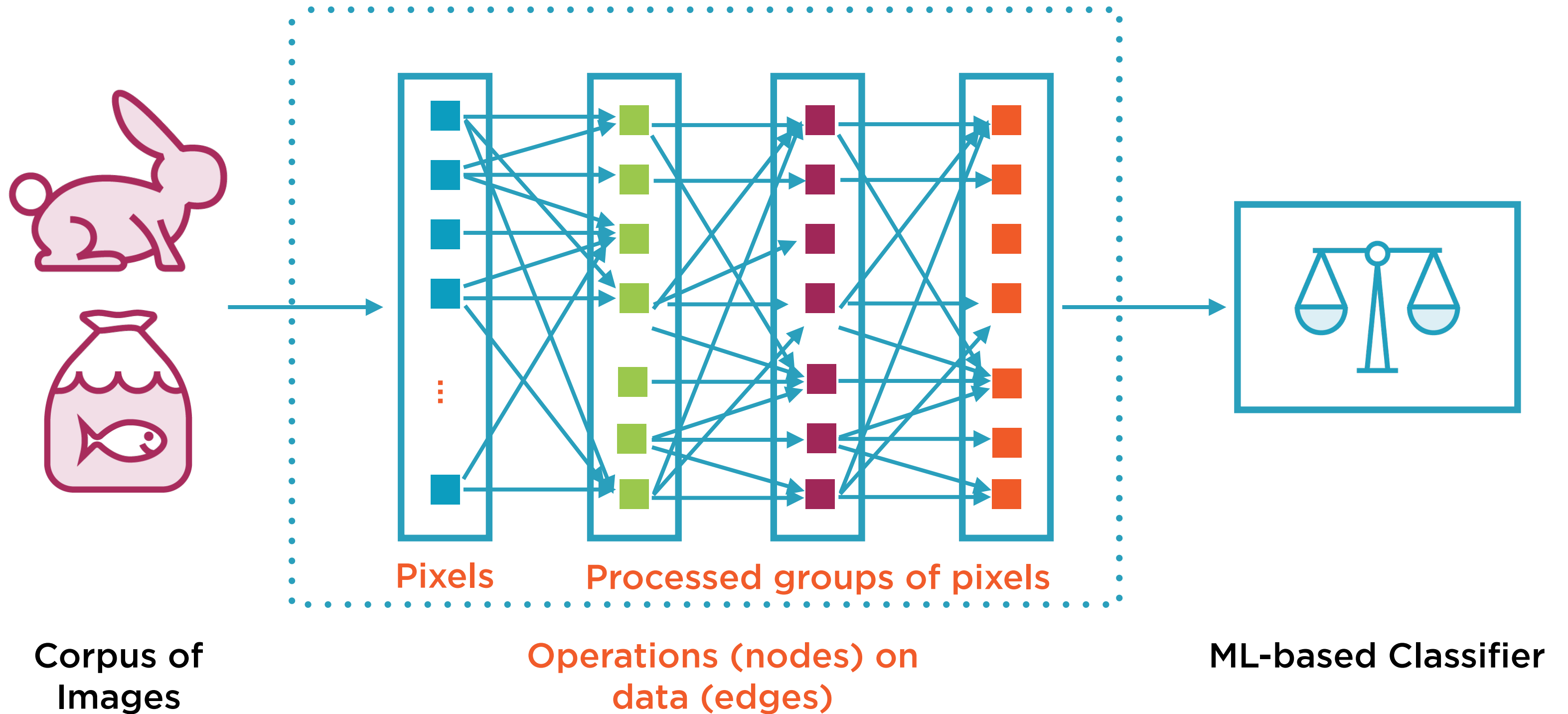




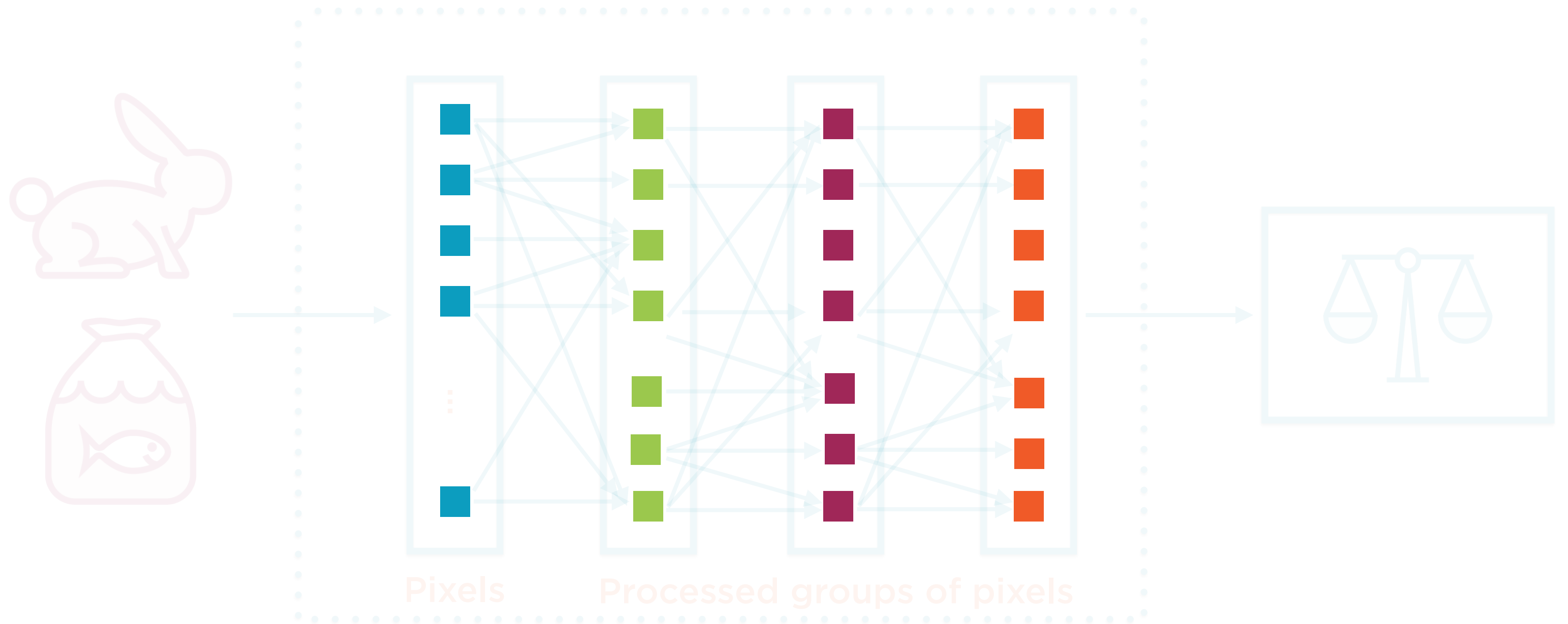
# Neural Networks



# The Computational Graph



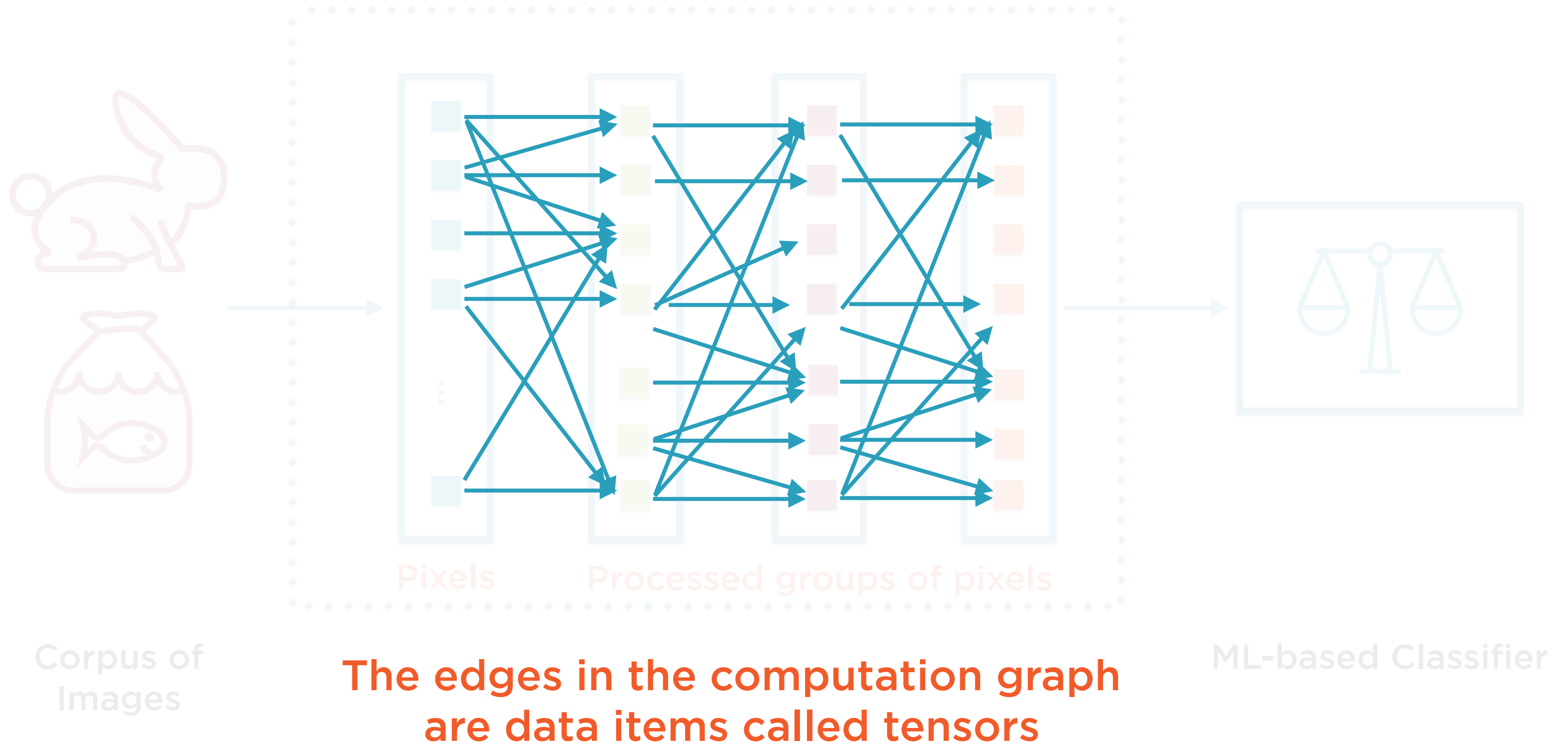
# The Computational Graph



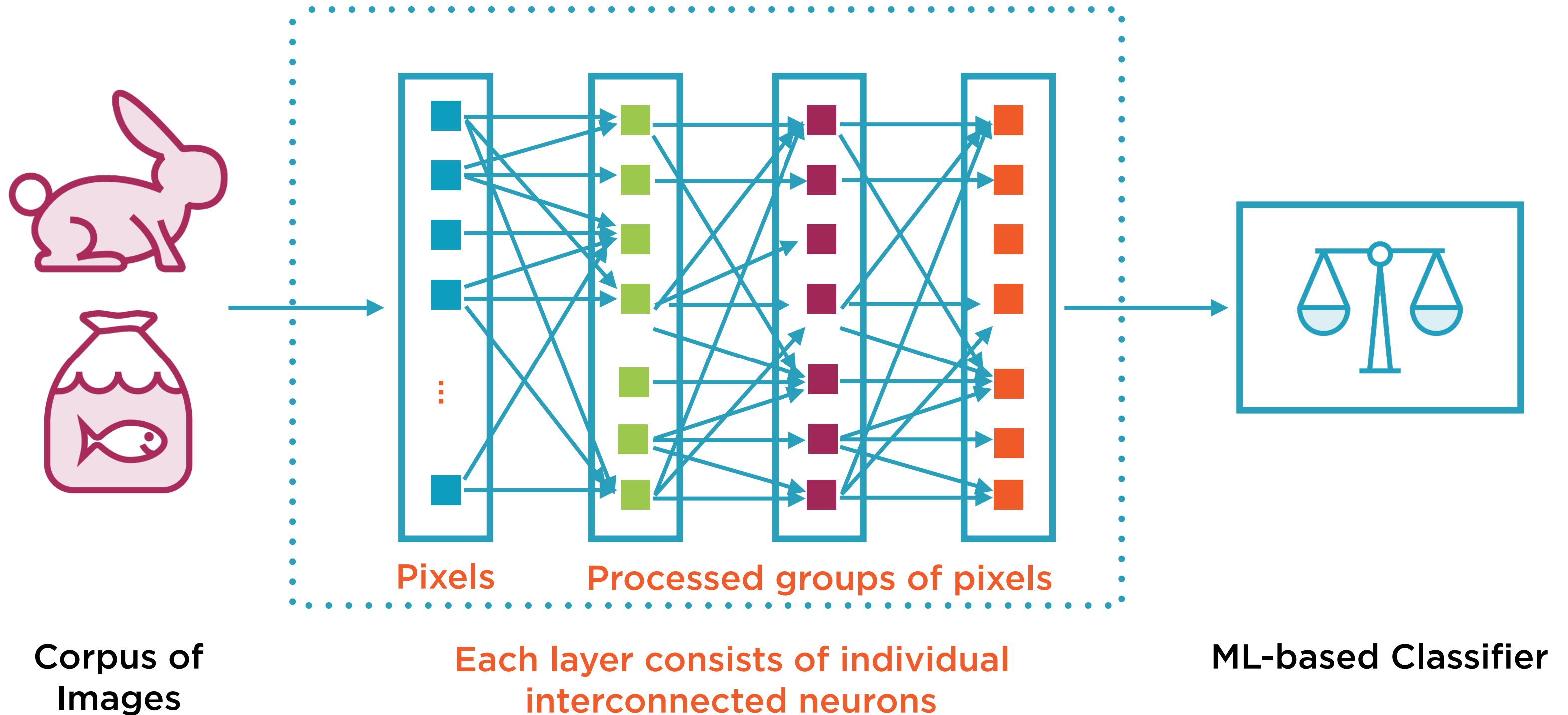
Corpus of  
Images

**The nodes in the computation graph are neurons (simple building blocks)** ML-based Classifier

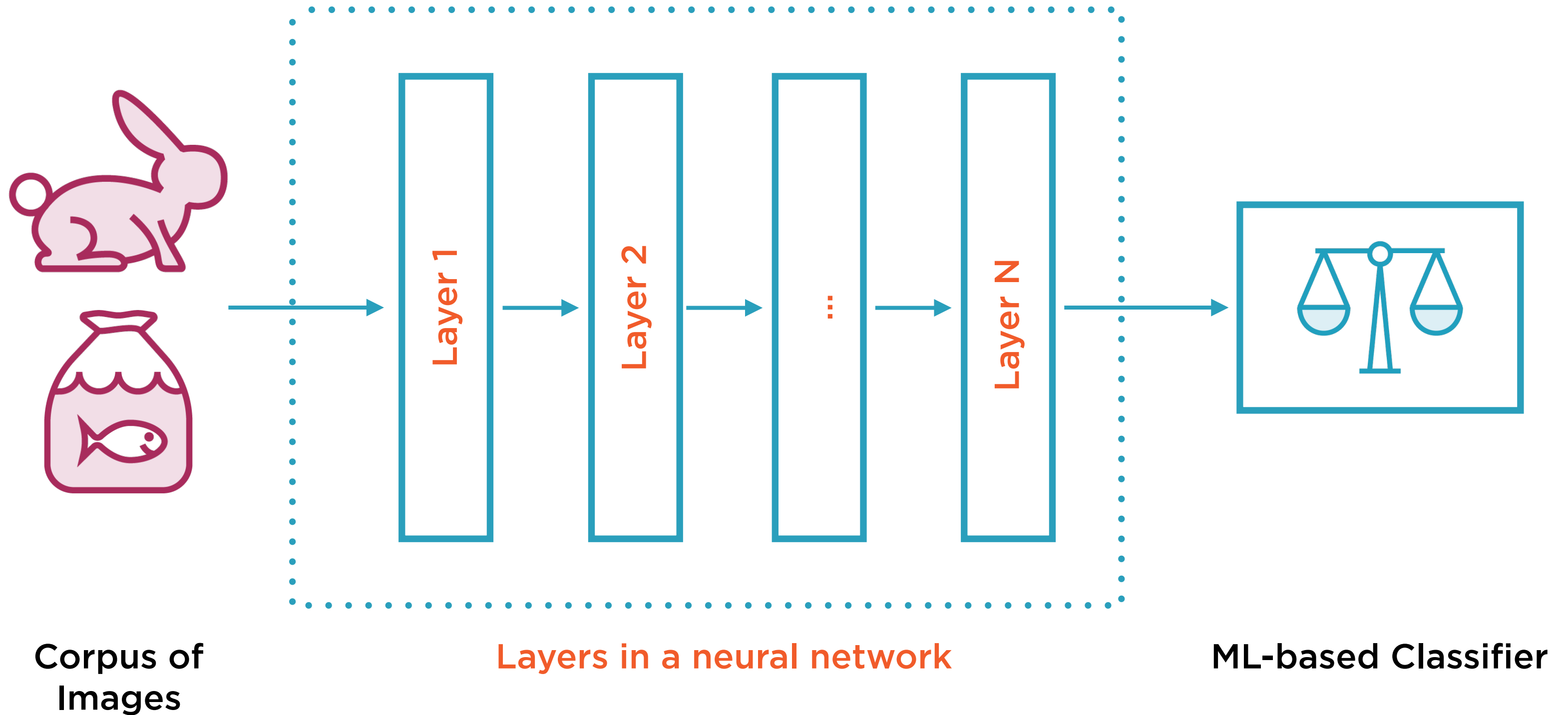
# The Computational Graph



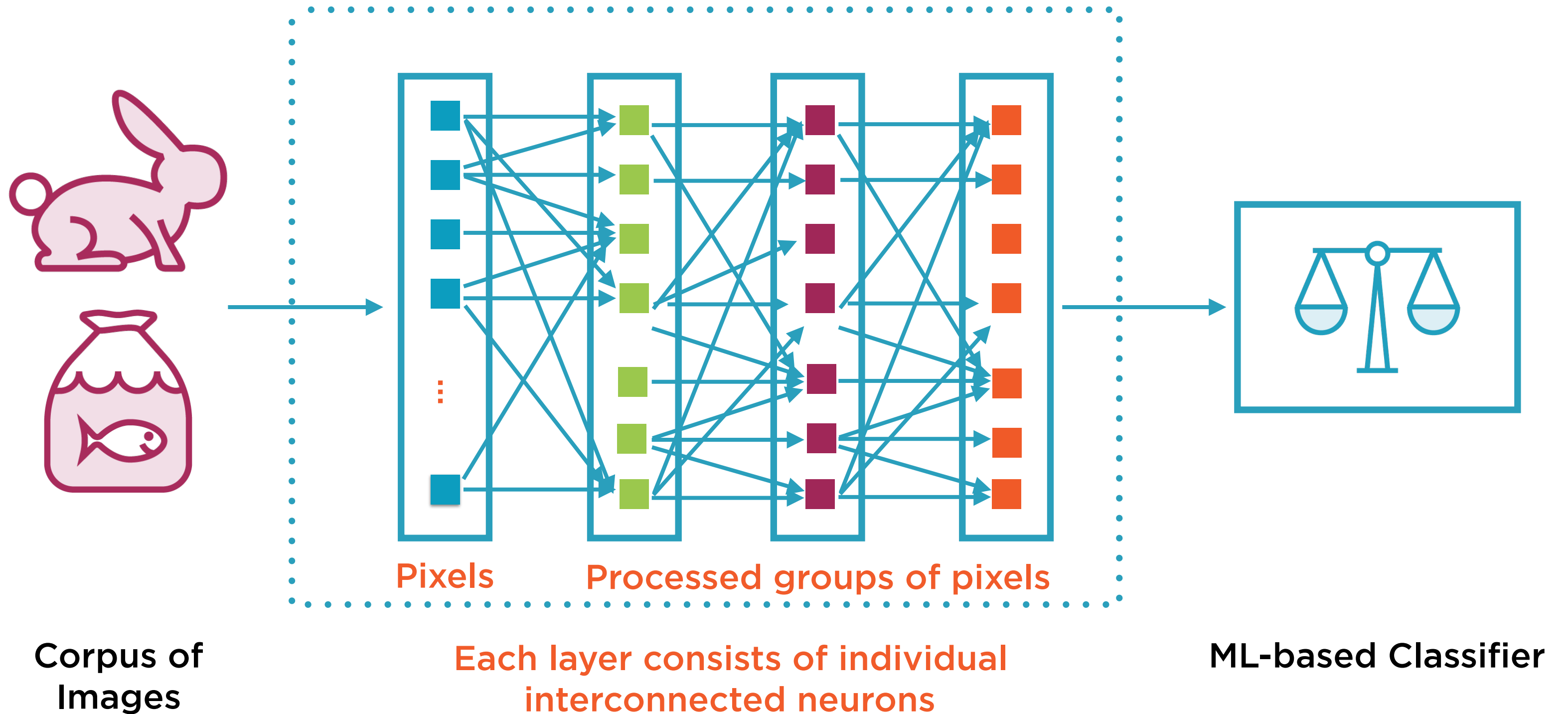
# Neural Networks



# Neural Networks for Image Classification



# Neural Networks for Image Classification



# Parameter Explosion



**Consider a 100 x 100 pixel image  
(10,000 pixels)**

**If first layer = 10,000 neurons**

**Interconnections ~  $O(10,000 * 10,000)$**

**100 million parameters to train neural  
network!**



# Parameter Explosion



**Dense, fully connected neural networks  
can't cope**

**Also do not provide feature extraction  
with location invariance**

**Convolutional neural networks to the  
rescue**

Deep neural networks do  
not consider the spatial  
aspects of images

# CNNs Introduced



**Eye perceives visual stimulus in 2D visual field**

**“Local receptive field”**

**Eye sends 2D image to visual cortex**

# CNNs Introduced



**Visual cortex adds depth perception**

**Individual neurons in cortex focus on small field**

# CNNs Introduced



**CNNs perform spectacularly well at many tasks**

**Particularly at image recognition**

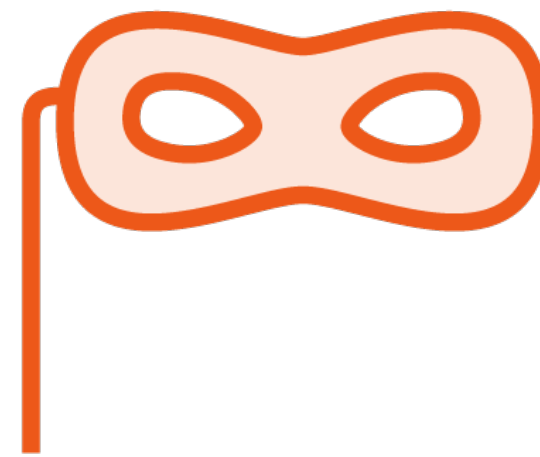
**Dramatically fewer parameters than DNN with similar performance**

# Inspirations for CNNs



## **Two Dimensions**

Data comes in expressed  
in 2D



## **Local Receptive Fields**

Neurons focus on narrow  
portions

# CNN Layers



**Convolution layers - zoom in on specific bits of input**

**Successive layers aggregate inputs into higher level features**

**Pixels >> Lines >> Edges >> Object**

# MNIST Dataset



## **Handwritten digits database**

**Large quantity of handwritten digits  
commonly used for training image  
processing systems**

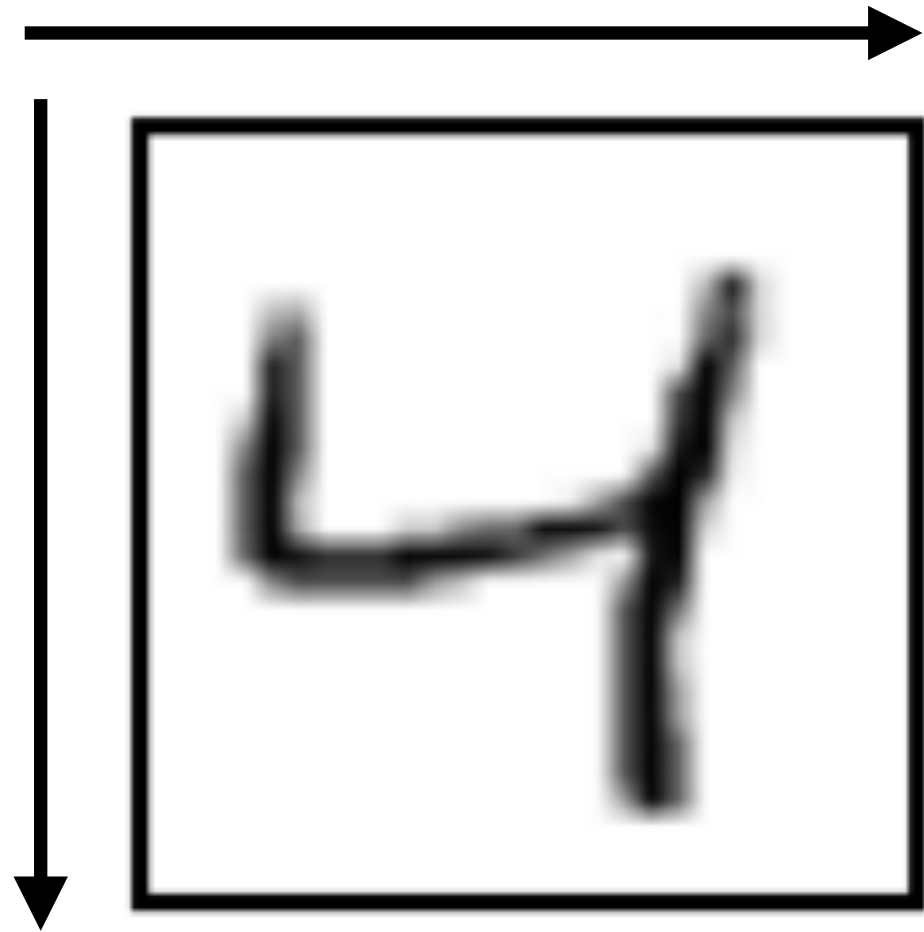


# MNIST Dataset



**Each digit is in grayscale**

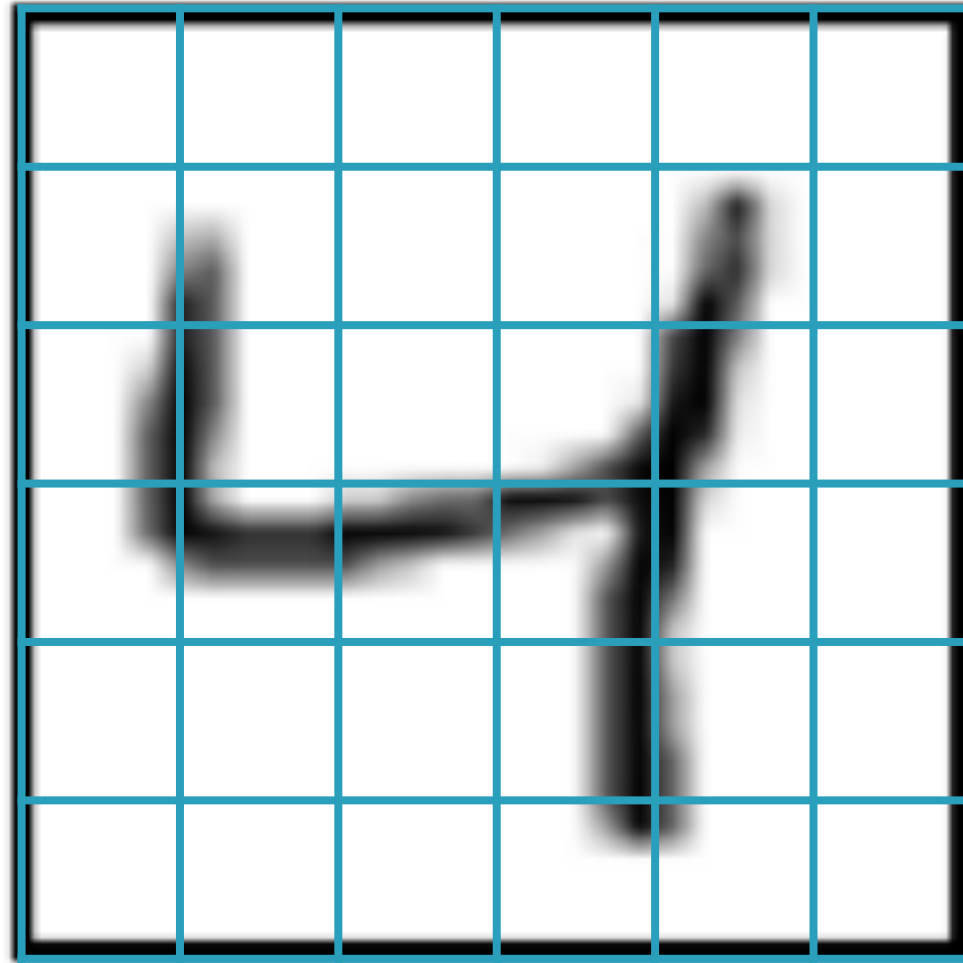
# MNIST Dataset



Every image is standardized  
to be of size **28x28**

**= 784 pixels**

# MNIST Dataset



Every pixel holds a **single** value for intensity

# MNIST Dataset



0	0	0	0	0	0
0.2	0.8	0	0.3	0.6	0
0.2	0.9	0	0.3	0.8	0
0.3	0.8	0.7	0.8	0.9	0
0	0	0	0.2	0.8	0
0	0	0	0.2	0.2	0

# MNIST Dataset



0	0	0	0	0	0
0.2	0.8	0	0.3	0.6	0
0.2	0.9	0	0.3	0.8	0
0.3	0.8	0.7	0.8	0.9	0
0	0	0	0.2	0.8	0
0	0	0	0.2	0.2	0

# MNIST Dataset



0	0	0	0	0	0
0.2	0.8	0	0.3	0.6	0
0.2	0.9	0	0.3	0.8	0
0.3	0.8	0.7	0.8	0.9	0
0	0	0	0.2	0.8	0
0	0	0	0.2	0.2	0

# MNIST Dataset



0	0	0	0	0	0
0.2	0.8	0	0.3	0.6	0
0.2	0.9	0	0.3	0.8	0
0.3	0.8	0.7	0.8	0.9	0
0	0	0	0.2	0.8	0
0	0	0	0.2	0.2	0

# MNIST Dataset



**Every image has an associated label**



# MNIST Dataset



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0



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# Demo

**Implement image classification using a deep, fully-connected neural network**

# Summary

**Deep Neural Networks (DNNs) for image classification**

**Drawbacks of using DNNs for image classification**

**Implementing a fully-connected neural network for image classification**