# Working with Images

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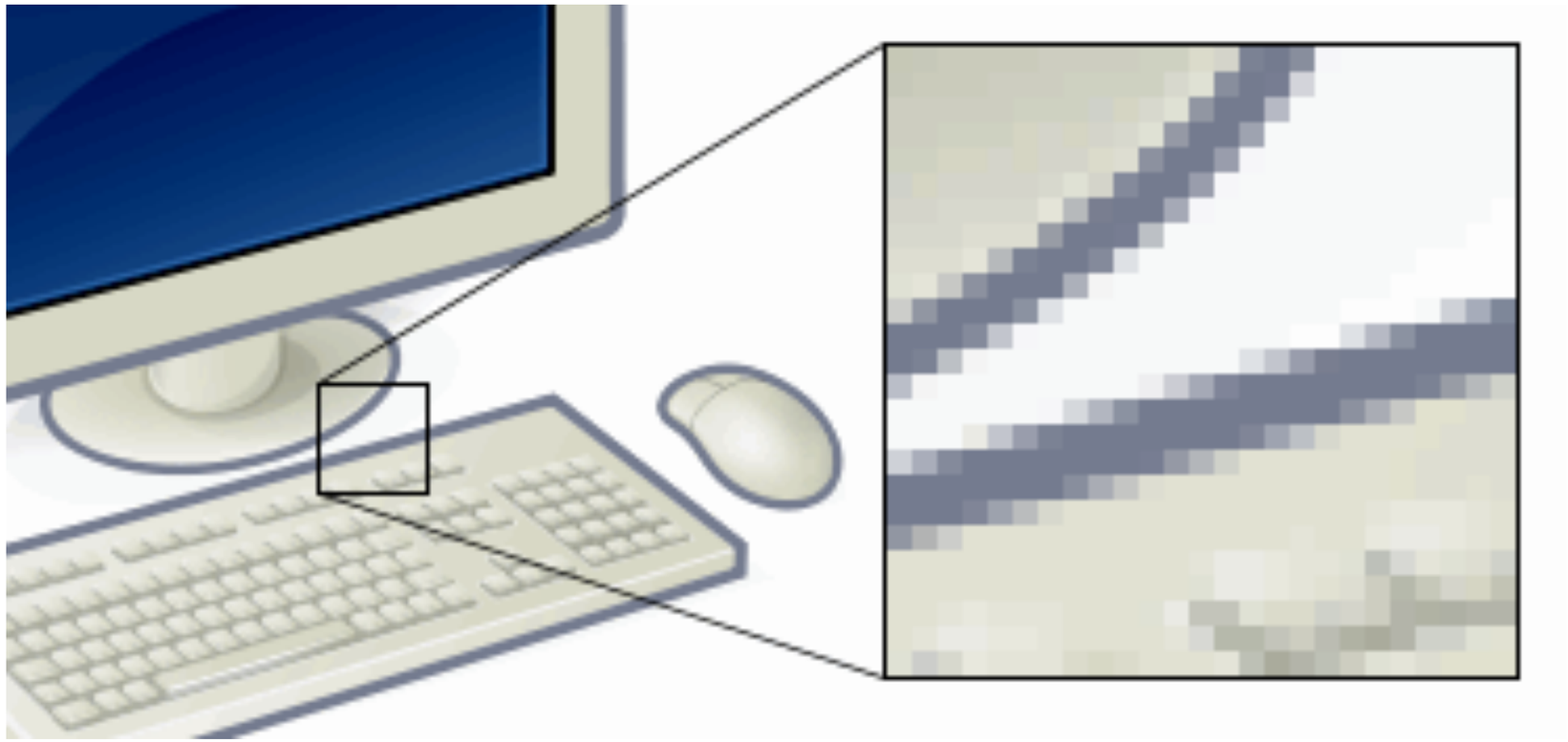
# Overview

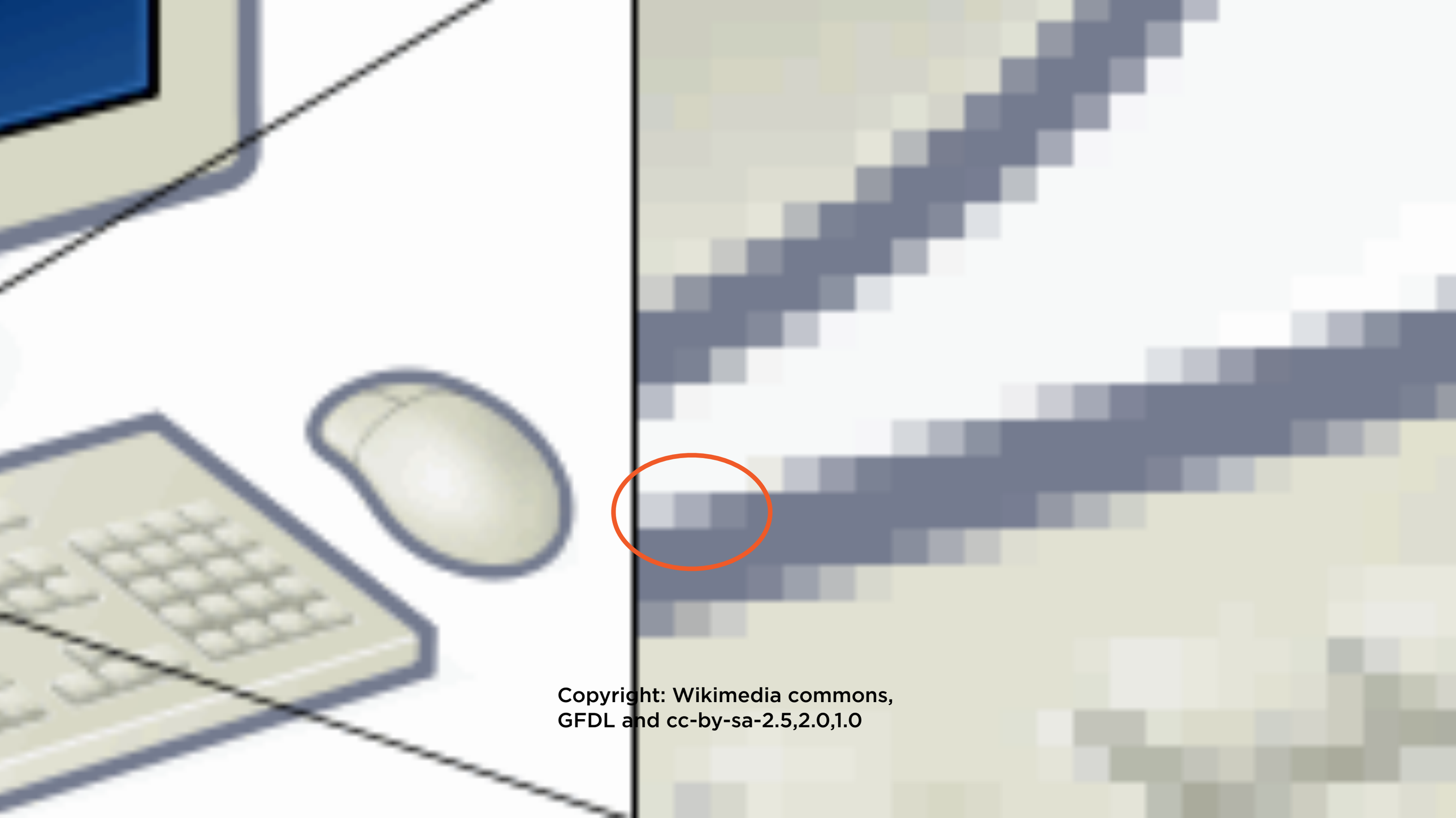
Representing color and grayscale images as Tensors

Implementing image operations such as transpose, resize, cropping

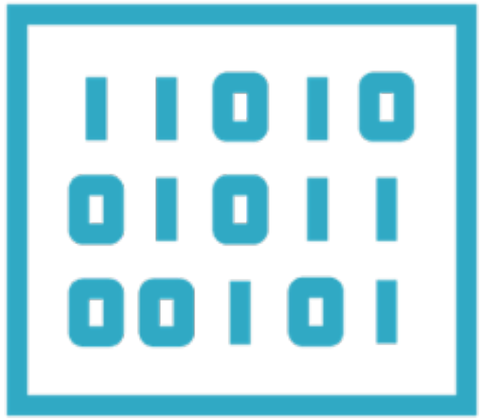
# Image Recognition

# Pixels in Images





# Image Recognition



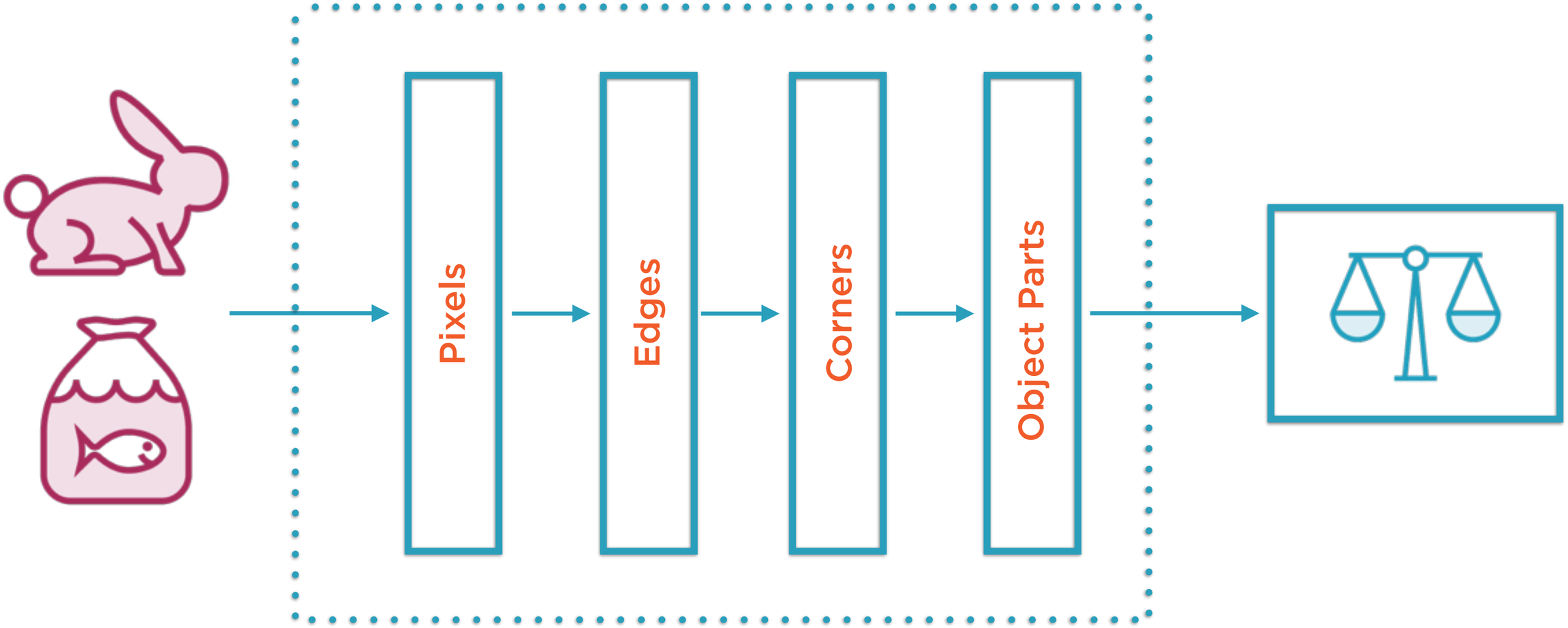
Images represented as pixels

Identify edges, colors, shapes

A photo of a horse

Neural networks, specifically convolutional neural networks (CNNs) work well for hard image recognition tasks

# Image Recognition Using Neural Networks

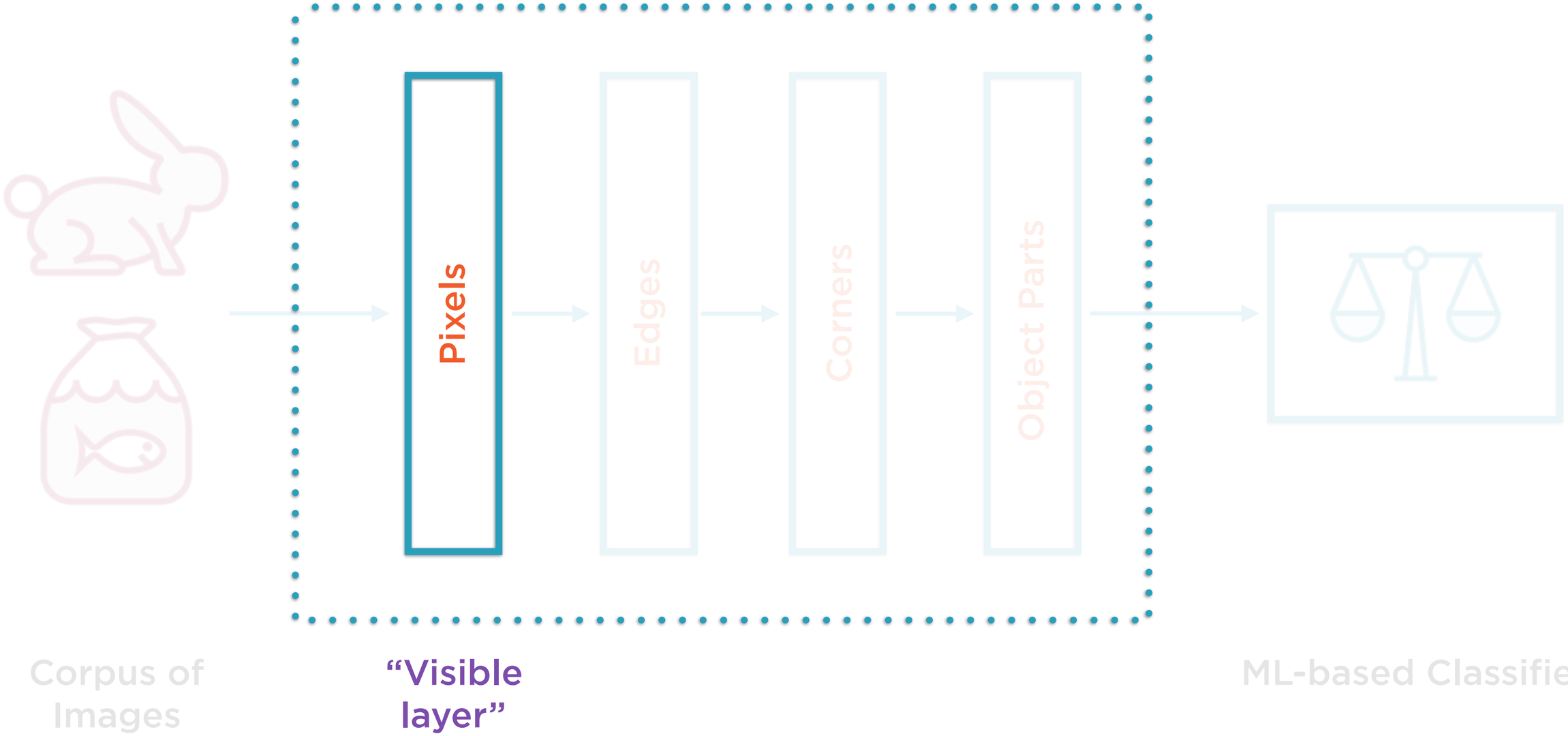



Corpus of Images

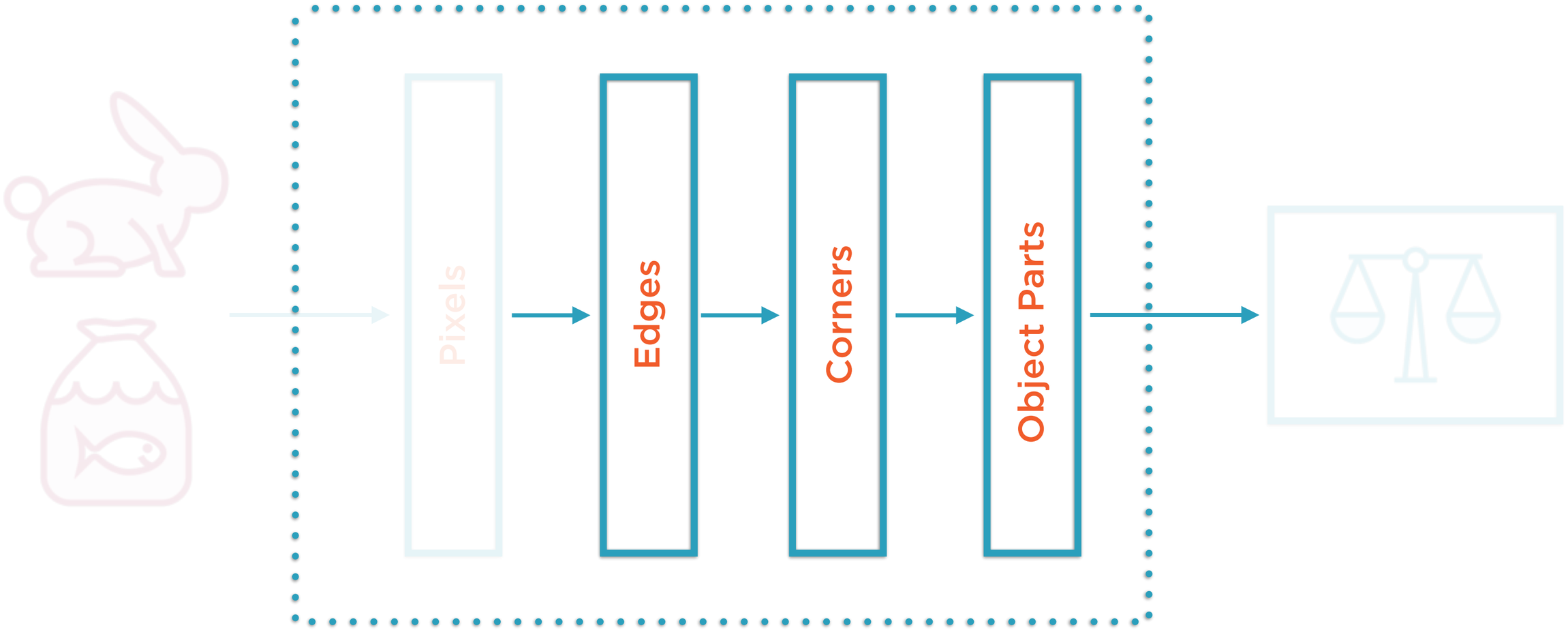
Feature Selection & Classification Algorithm

ML-based Classifier

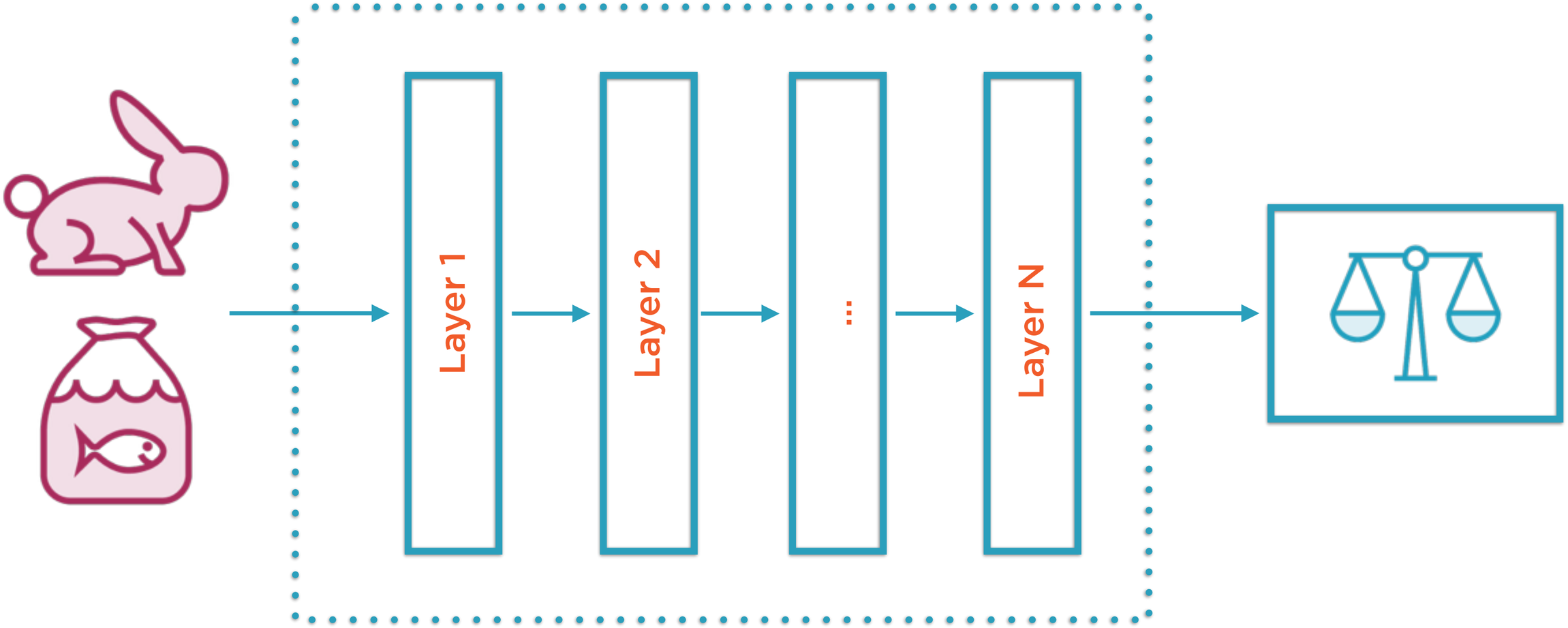
# Image Recognition Using Neural Networks



# Image Recognition Using Neural Networks



# Neural Networks Introduced

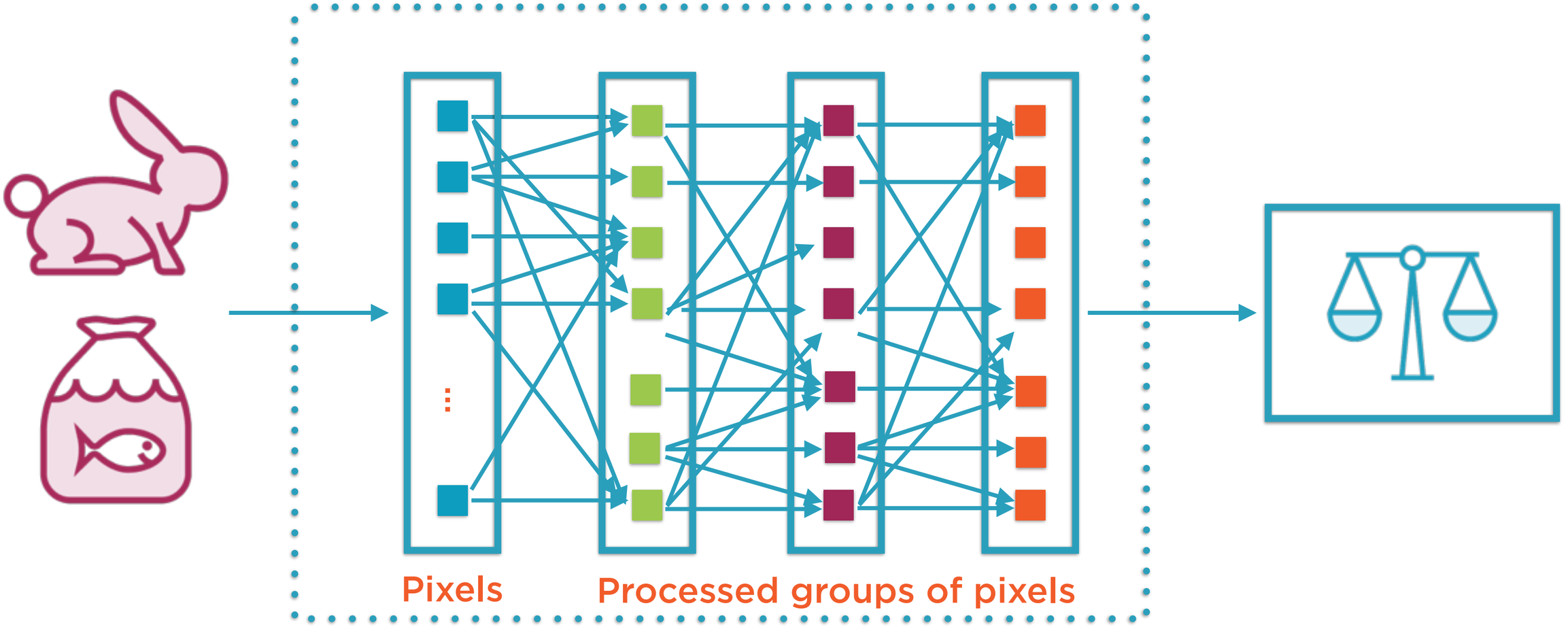



Corpus of Images

Layers in a neural network

ML-based Classifier

# Neural Networks Introduced




Corpus of Images

Each layer consists of individual interconnected neurons

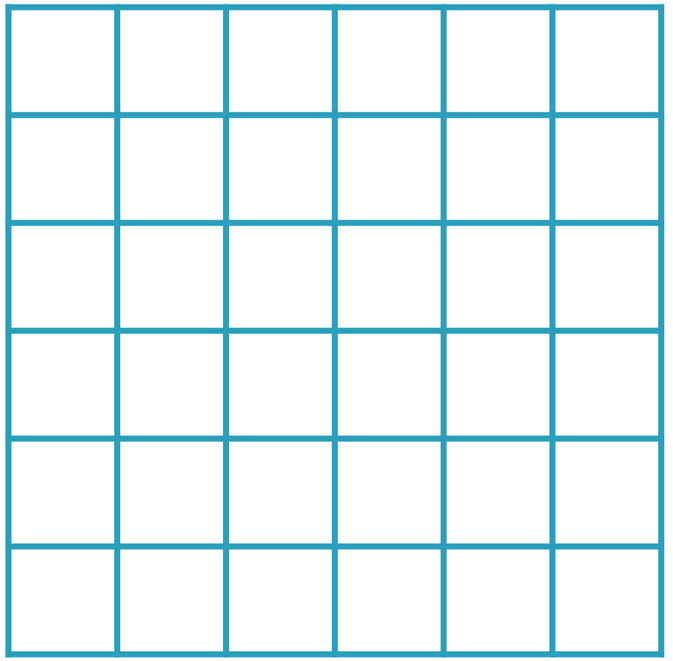
ML-based Classifier

TensorFlow is optimized at building neural network solutions for image recognition

# Representing Images as 3-D Tensors

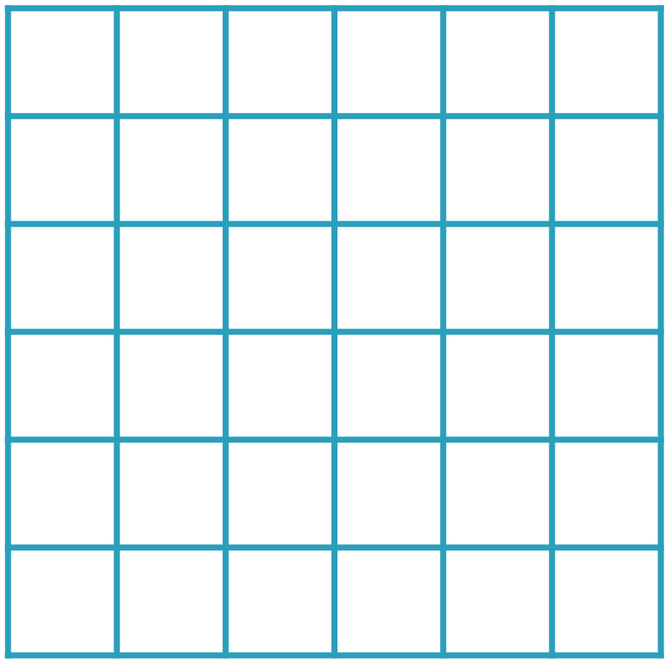
# Images as Tensors

# Images as Tensors



**Each pixel holds a value based on the type of image**

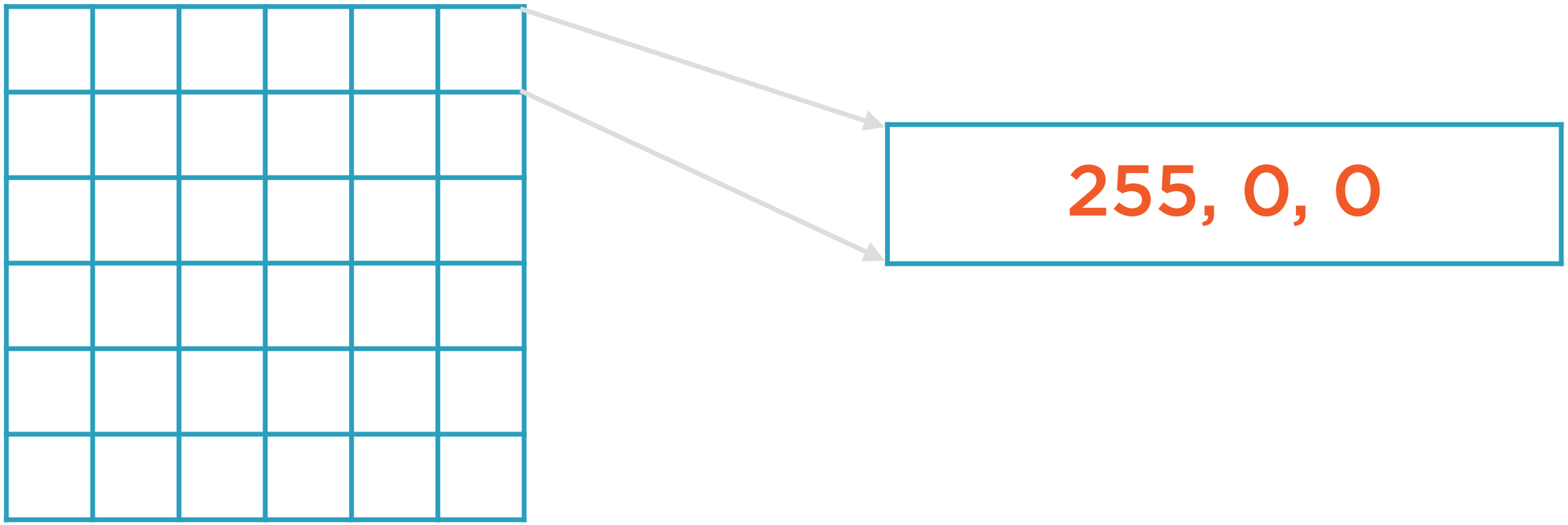
# RGB Images



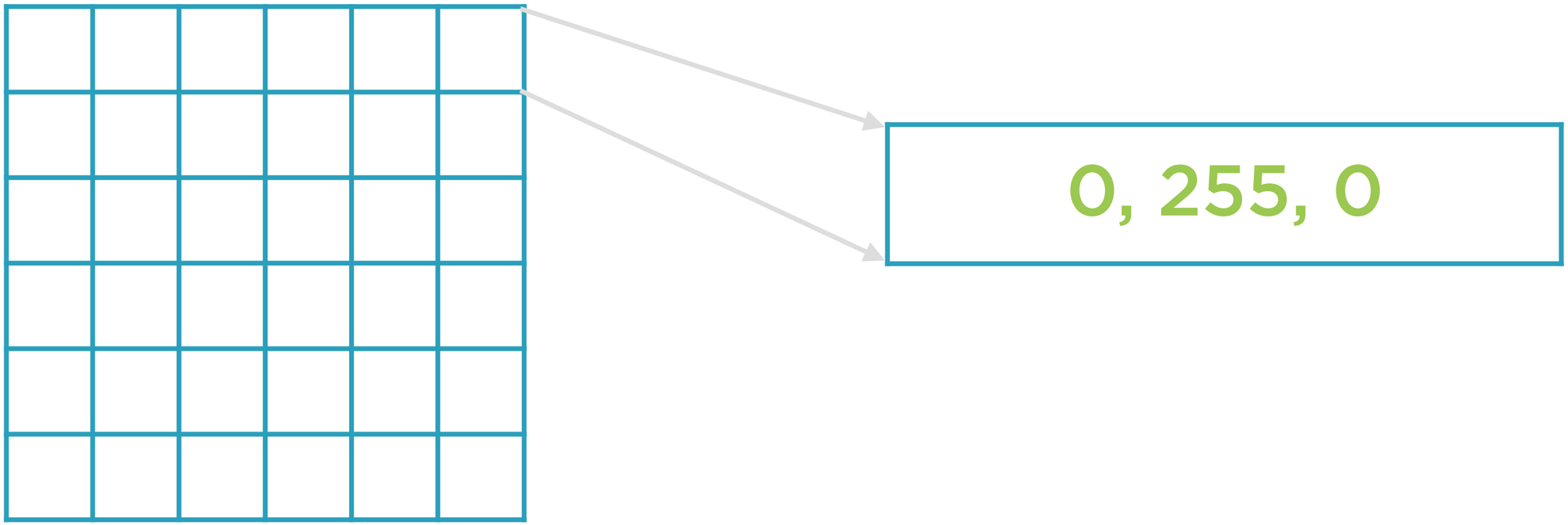
**RGB values are for color images**

**R, G, B: 0-255**

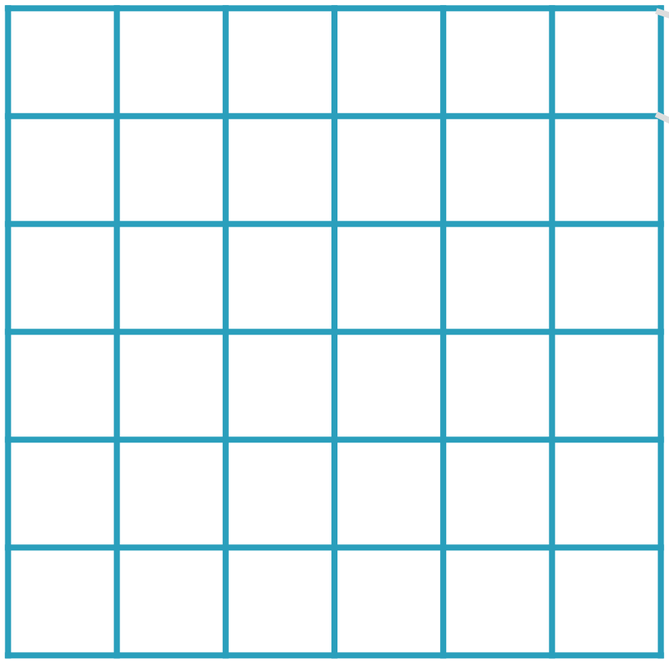
# RGB Images



# RGB Images



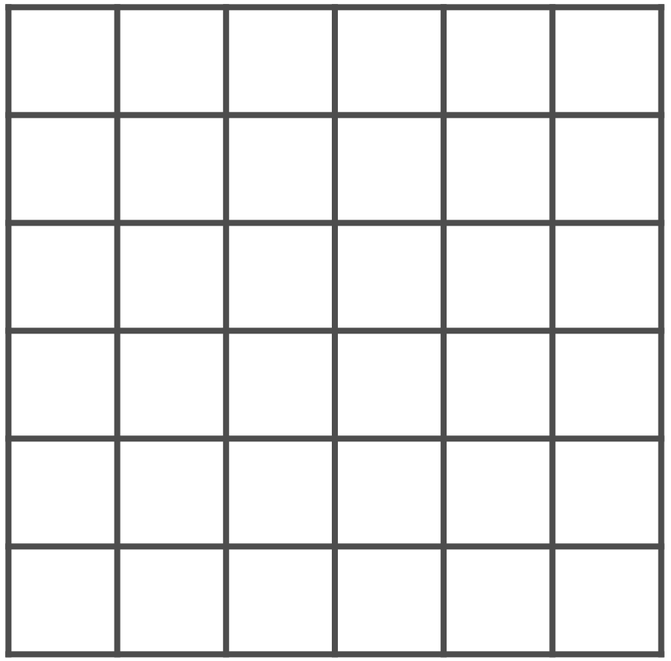
# RGB Images



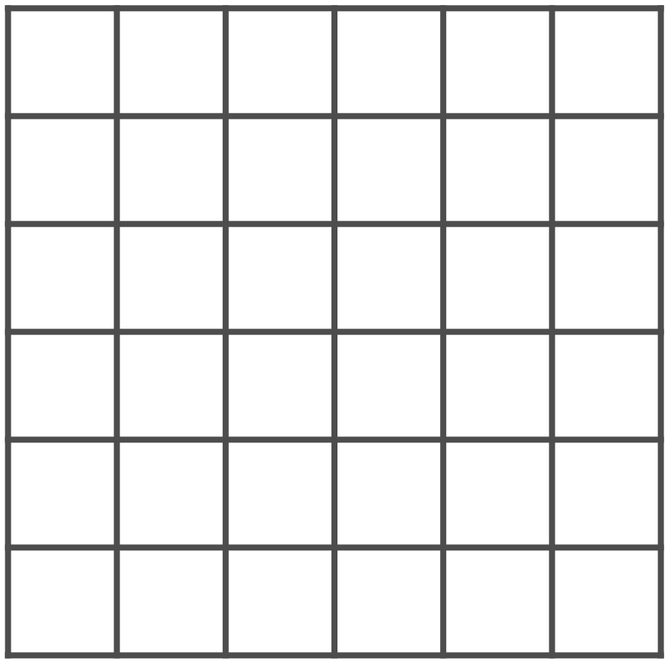
0, 0, 255

3 values to represent color, 3 channels

# Grayscale Images



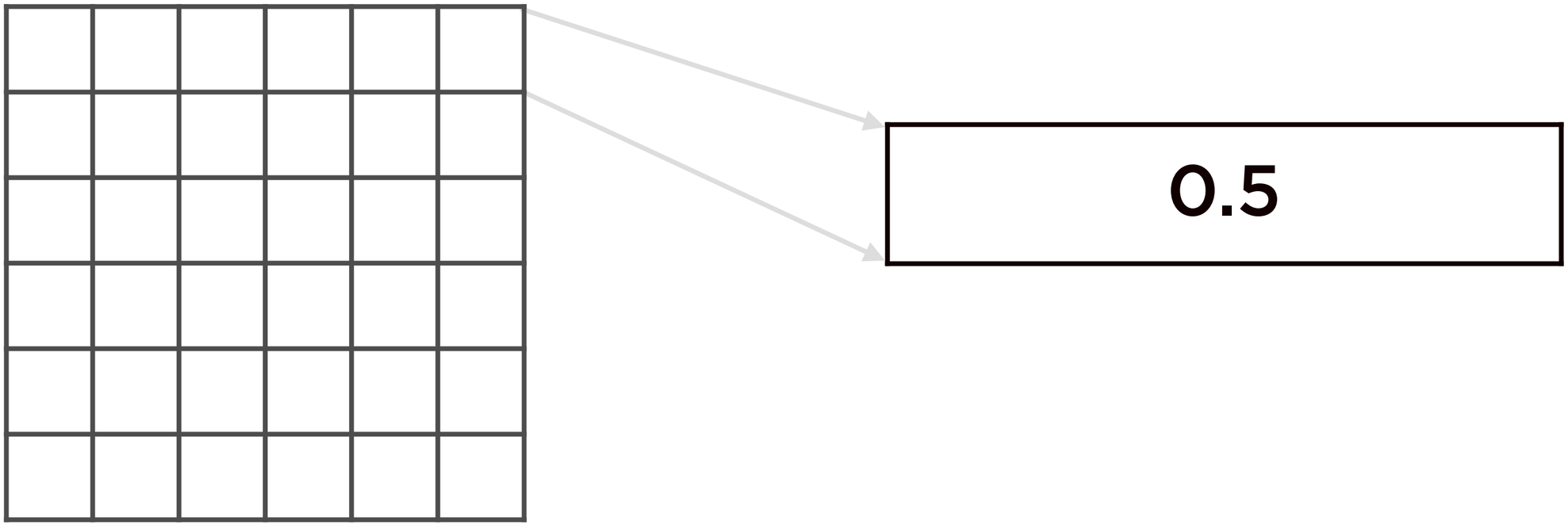
# Grayscale Images



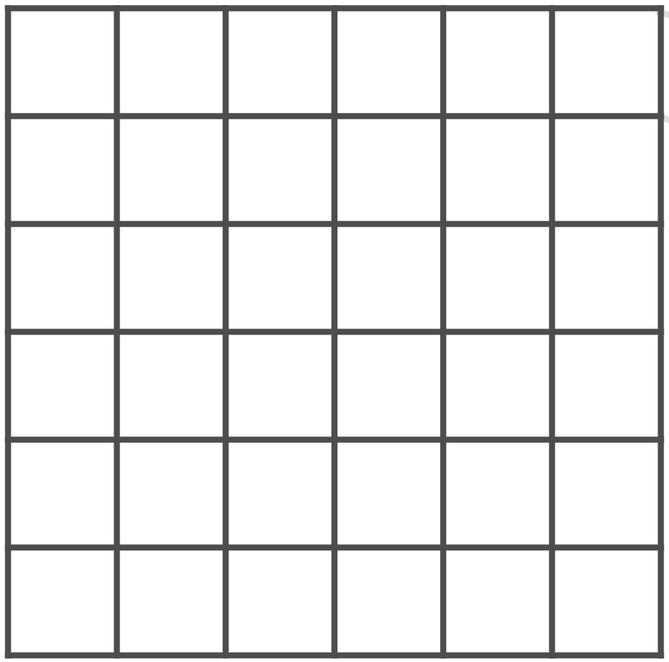
**Each pixel represents only intensity information**

**0.0 - 1.0**

# Grayscale Images



# Grayscale Images

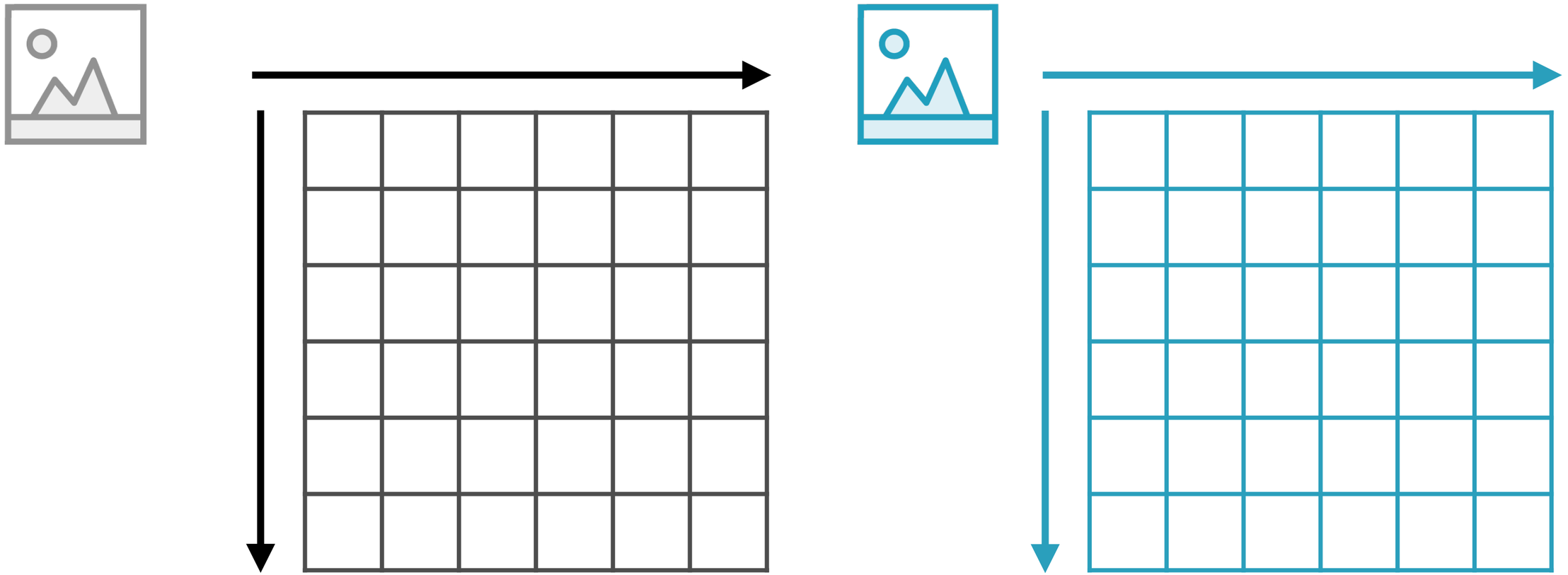



**1 value to represent intensity, 1 channel**

# Images as Tensors

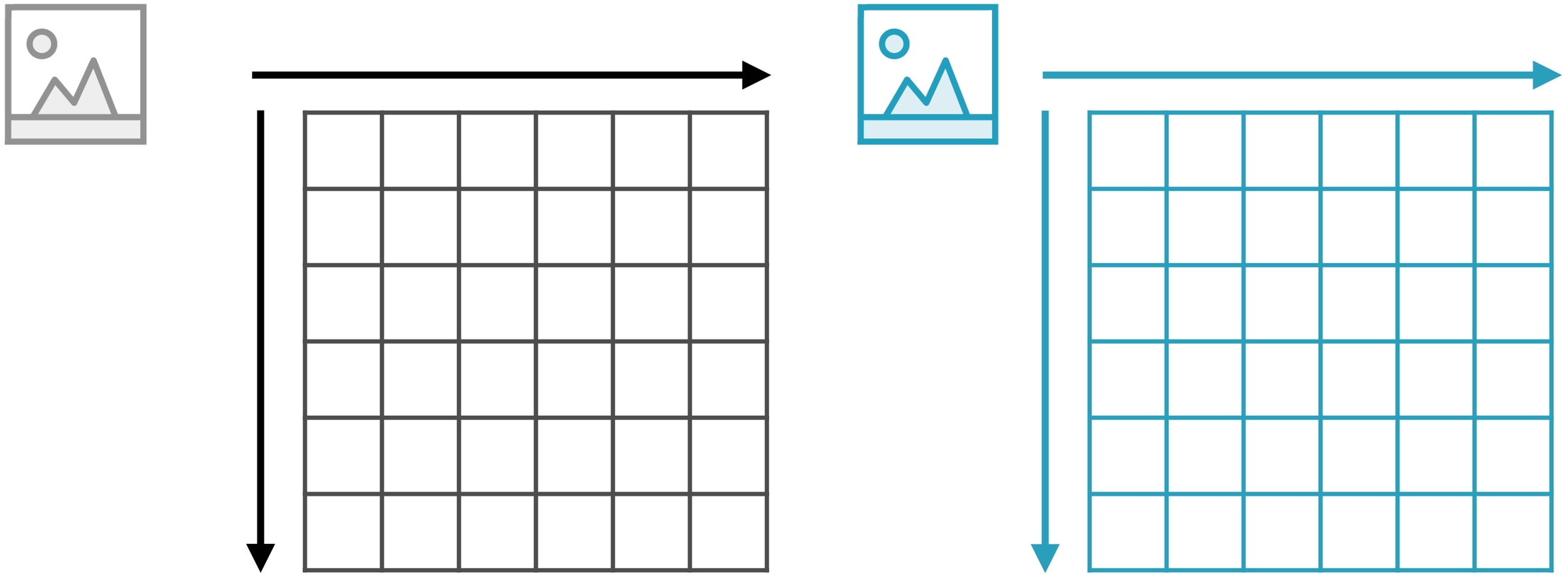
**Single channel and multi-channel images**

# Images as Tensors



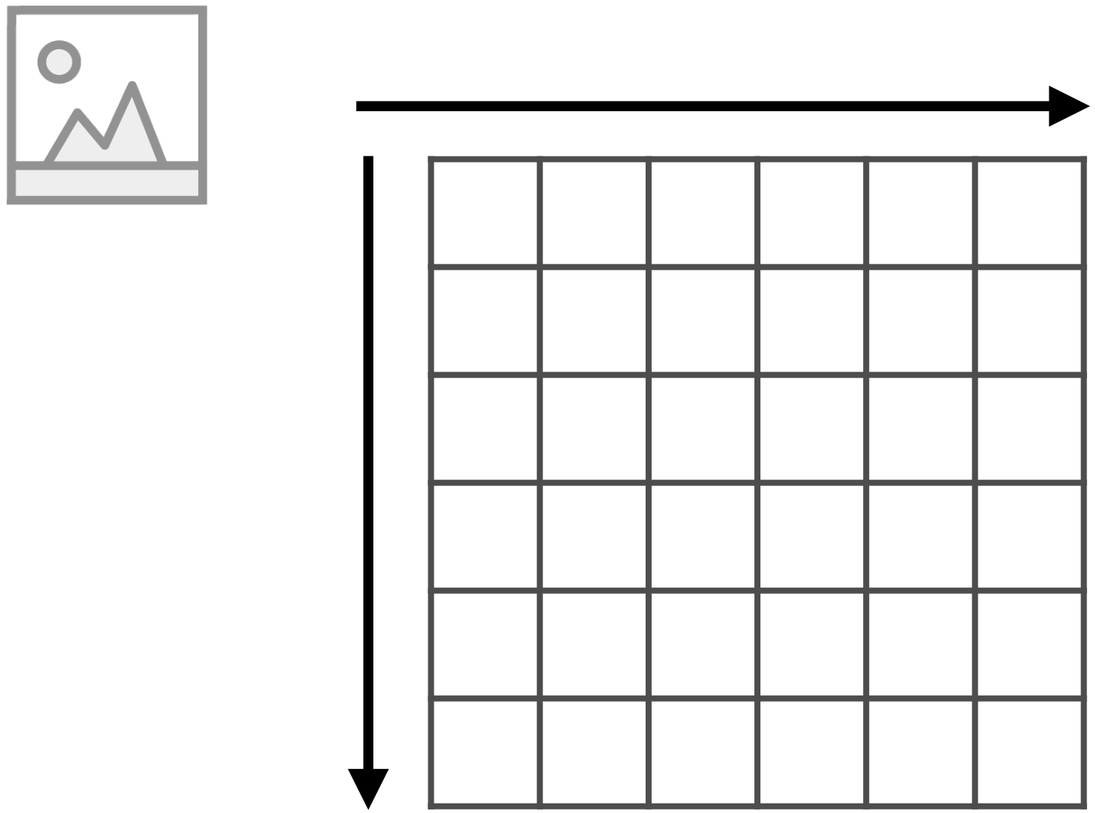
**Images can be represented by a 3-D matrix**

# Images as Tensors

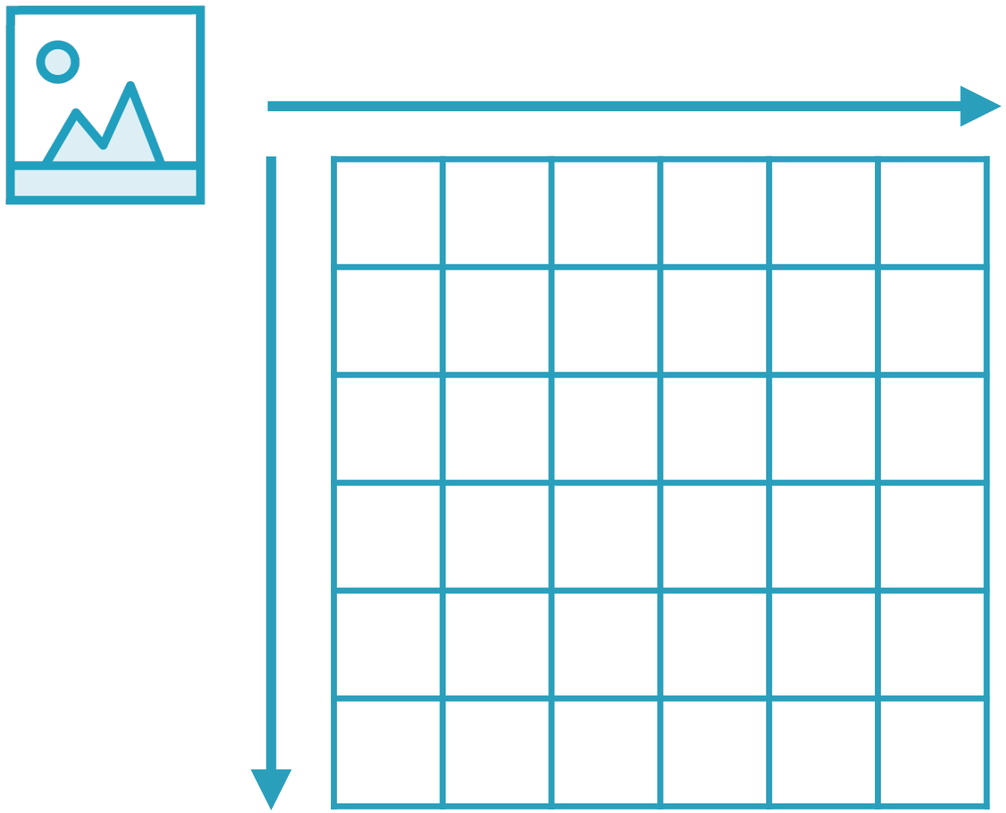


The number of channels specifies the number of elements in the 3rd dimension

# Images as Tensors



(6, 6, 1)



(6, 6, 3)

# Demo

**Read in an image using matplotlib and then transpose it using TensorFlow**

# Demo

Read in a list of images in TensorFlow using a queue and coordinators

Resize images to be of the same dimensions

Show image summaries in TensorBoard

# List of Images as 4-D Tensors

# List of Images

**TensorFlow usually deals with a list of images in one 4-D Tensor**

# List of Images

**The images should all be the same size**

List of Images

(10, 6, 6, 3)

The number of channels

List of Images

(10, 6, 6, 3)

**The height and width of each image in the list**

List of Images

(10, 6, 6, 3)

The number of images

# Demo

Perform flip, crop and other transformations on images

Pack a list of images into one Tensor

Display a list of images on TensorBoard

# Summary

Understood image representation of color and grayscale images as Tensors

Learnt image transformations such as resize, flip and crop

Worked with multiple images in TensorFlow